HATCHERY AND GENETIC MANAGEMENT PLAN

FOR

MAD RIVER HATCHERY

WINTER-RUN STEELHEAD

Prepared for:

National Marine Fisheries Service
Arcata, California

By:

California Department of Fish and Wildlife

Foreword

This document adheres to the guidelines recommended by National Marine Fisheries Service (NMFS, aka NOAA Fisheries) (2003a) in *Updated July 2000 4(d) Rule Implementation Binder for Threatened Salmon and Steelhead on the West Coast* for development of an HGMP. The HGMP format follows the template published on the NMFS West Coast Region's Sustainable Fisheries Division's web site www.nwr.noaa.gov/1hgmp/hgmptmpl.htm.

The terms and age class designations (by size) within this plan were defined by NMFS (2003a); they are presented in Appendix 1 and 2, respectively. The use of the words "wild" and "unmarked" are synonymous with the term "natural", which NMFS (2003a) defines as "a fish that spent its entire life in the wild and whose parents naturally spawned in gravels of tributary streams."

Photographs of the Mad River Hatchery facilities are presented in Appendix 3 for reference.

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On behalf of the steelhead in the Mad River, Thank you.

Philip K. Bairrington

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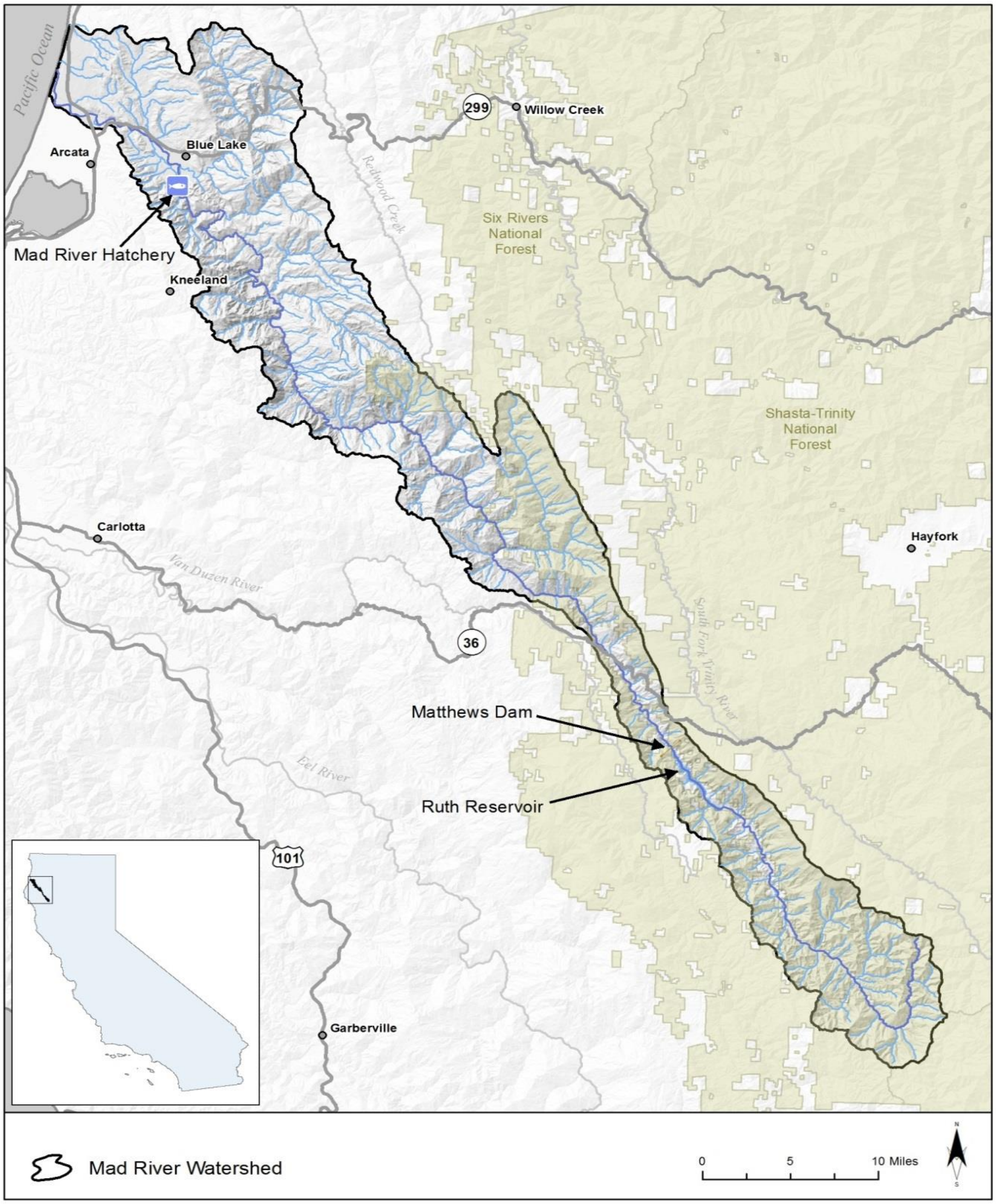

Figure 1. Geographic boundaries of the Mad River Watershed.

List of Frequently Used Acronyms and Abbreviations

AD-clip	Adipose fin-clip
BRT	Biological Review Team
CDFW	California Department of Fish and Wildlife
cfs	cubic feet per second
CPUE	Catch Per Unit Effort
DPS	Distinct Population Segment
ESA	Federal Endangered Species Act
ESU	Evolutionarily Significant Unit
FMEP	Fishery Management and Evaluation Plan
fpp	fish per pound
gpm	gallons per minute
HGMP	Hatchery and Genetic Management Plan
HOR	Hatchery Origin or Hatchery-origin Returner
mg/l	milligram/liter
MOA	Memorandum of Agreement
MRH	Mad River Hatchery
NOAA	National Oceanic & Atmospheric Administration
NMFS	National Marine Fisheries Service (aka "NOAA Fisheries)
NOR	Natural Origin or Natural-origin Returner
N_e	Effective Population Size
NPDES	National Pollutant Discharge Elimination System
pHOS	Proportion or Proportionate Hatchery Spawners
PNI	Proportionate Natural Influence
pNOB	Proportion or Proportionate Natural Broodstock
RWQCB	(North Coast) Regional Water Quality Control Board

SAR	Smolt-to-Adult return
SFRA	Sport Fish Restoration Act
SONCC	Southern Oregon/Northern California Coast
VSP	Viable Salmonid Population

Section 1.0 General Program Descriptions

1.1 Name of hatchery or program

Mad River Hatchery (MRH) winter-run steelhead program.

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

The species under propagation is Steelhead Trout (*Oncorhynchus mykiss)*. Steelhead Trout previously propagated by MRH that were HOR steelhead crossed with HOR steelhead were not ESA listed, and HOR steelhead crossed with NOR steelhead are also un-listed. Natural origin Steelhead Trout removed from the river and used for hatchery broodstock remain listed, however, their progeny under hatchery conditions are considered un-listed.

On August 7, 2000, the National Oceanic and Atmospheric Administration National Marine Fisheries Service (referred to in this document as NMFS and also known as "NOAA Fisheries") listed natural origin (NOR), Steelhead Trout(*Oncorhynchus mykiss)* in the Northern California (NC) Evolutionarily Significant Unit (ESU) as a federally Threatened species. At that time, NMFS considered most hatchery production as nonessential for the recovery of NC steelhead and excluded them from the listing due to their perceived divergence from natural stocks and exotic broodstock origins. In 2004, pursuant to "Alsea Valley Alliance versus Evans, 161 F. Supp.2d 1154 (D. Or. 2001)" United States District Court Ruling, NMFS revised its 1993 hatchery listing policy for coast-wide salmon and steelhead ESUs to clarify the contribution of artificially propagated salmonids for the viability of their respective populations since they could not be reproductively isolated from other conspecific population units, and they represent an important component in the evolutionary legacy of the species. The new "Policy on the Consideration of Hatchery-Origin Fish in Endangered Species Act Listing Determinations for Pacific Salmon and Steelhead" (NMFS 2005) included an impact assessment of hatchery origin (HOR) fish and directed NMFS to consider these fish when determining listing status relative to their contribution to conserving natural self-sustaining populations. Subsequently, NMFS designated some HOR steelhead (populations below natural and manmade impassable barriers in California coastal waters from Redwood Creek southward to, but not including, the Russian River) as part of the NC Steelhead Distinct Population Segment (DPS). The listing status of NC steelhead DPS was most recently reaffirmed as 'Threatened' under the Federal ESA on May 20, 2011 (FR 75:13082).

Since 2006, the NC steelhead DPS has included two (now discontinued) artificial propagation programs: Yager Creek Hatchery and North Fork Gualala River Hatchery (Gualala River Steelhead Project), but the DPS does not include NC steelhead propagated at Mad River Hatchery (MRH). Referring to the Alsea Valley Alliance versus Evans ruling, NMFS excluded the MRH propagation program because the MRH HOR fish were thought to be substantially reproductively isolated from other conspecific population units and that they do not represent an important component in the evolutionary legacy of the species. Because progeny of HOR crossed HOR NC steelhead propagated by MRH are not considered part of the DPS, they are also not federally listed. Since 2009, ESA listed steelhead (NOR) have been taken into the hatchery and used for hatchery broodstock and these fish are listed, howerver, their progeny are considered un-listed.

1.3 Responsible organization and individuals

California Department of Fish and Wildlife (CDFW) owns and operates MRH.

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

During the 2003/2004 fiscal year, CDFW announced it planned to close MRH due to a budget shortfall. In response to CDFW's proposal, steelhead anglers, concerned citizens, elected officials, business, and public representatives formed a non-profit organization called "Friends of the Mad River Fish Hatchery (Friends)" with Dave Varshock as President. Friends rallied community volunteers and solicited financial aid to support CDFW's effort to maintain yearling steelhead production at MRH. In November 2004, Friends and CDFW memorialized the accord with a Memorandum of Agreement (MOA), which was renewed in the 2006 calendar year. Friends disbanded on September 10, 2007 after CDFW secured funding for MRH. There are numerous organizations, such as the Humboldt Bay Municipal Water District, Humboldt County Resource Conservation

District, and stakeholder groups like the Redwood Community Action Agency, Mad River Alliance, and City of Blue Lake that support sound scientific fisheries management and fisheries monitoring of investments in Mad River. Additionally, several federal agencies (eg U. S. Forest Service, USF&WS, NMFS, BLM), tribal entities (eg Blue Lake Rancheria), and non-government entities (eg Green Diamond Resource Company) also support scientific fisheries management and monitoring in the Mad River.

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

MRH rears catchable-size Rainbow Trout for lakes and reservoirs in Humboldt and Del Norte counties and yearling steelhead to support a harvest fishery in Mad River. Though MRH had stocked excess steelhead production in Ruth Reservoir in years past, beginning in 2014 MRH no longer stocks excess steelhead in Ruth Reservoir. MRH's total annual current operating budget is approximately $624,000, funded by two sources. Fishing license sales provide approximately $310,000 in annual funding through the Hatchery and Inland Fishery Fund (HIFF) for the management, operation, maintenance, and capital improvements for rainbow trout production.

This funding is subject to annual approval by the Legislature in the annual budget process and may be adjusted accordingly. MRH also receives federal support through a Sport Fish Restoration Act (SFRA) grant. The current federal grant for 2010-2013 was approximately $314,000 and covered steelhead production costs. A Fish Hatchery Manager I, and three Fish and Wildlife Technician Range B staff operate MRH, along with temporary help. SFRA pays for 1.5 person-years and HIFF pays for 2.5 person-years. Volunteers and staff from CDFW's Anadromous Fisheries Resource Assessment and Monitoring Program contribute time for fisheries monitoring (brood stock genetic sampling), spawning, fish marking, and Quality Assurance and Quality Control (QA/QC) of MRH yearling smolts.

1.5 Location of hatchery and associated facilities

MRH is located on the southwest bank of Mad River at RM 13.3, which is approximately two miles south of Blue Lake, Humboldt County. The geographic coordinates of MRH are 40° 51' 19.11" N, 123° 59' 23.41" W (Figure 1). Hatchery facilities include a fish ladder, gathering tank (trap), four adult holding ponds, spawning and incubator building, incubator equipment building, electrical control building, primary and secondary pumps, sump and aeration systems, blower house, ten 600-foot raceways, office, shop, a freezer with an 80,000-pound capacity, garages, and four three-bedroom, two-bath residences for permanent employees. MRH offers free parking, public restrooms, fishing access (including handicap access) to the river and a serene meadow-like setting with picnic tables.

1.6 Type of program

The Hatchery Scientific Review Group (HSRG, 2005) and the California Hatchery Scientific Review Group (CHSRG, 2012) suggested that hatchery operators classify artificial propagation programs as either integrated or segregated (isolated) for assessing project risk and benefit. CDFW and NMFS have developed a spawning matrix, implemented since 2009, to incorporate natural origin (NOR) steelhead adults into the broodstock with hatchery origin (HOR) adult steelhead, with the eventual goal to use primarily NOR adults as broodstock, if possible. Improvement in the ratio of NOR/HOR fish used as broodstock will: 1) counter the potential for continued divergence of HOR and NOR stocks, and 2) avoid potential for domestication selection in the hatchery. The intergration rate is 50 – 100% NOR for breeding purposes, and production of yearling smolts may be reduced below the current 150,000 if not enough NOR steelhead are collected for breeding purposes. The lowest integration rate will be 50% NOR for breeding purposes. This HGMP proposes to maintain an Integrated Hatchery Program at MRH, with conservation potential.

1.7 Purpose of program

The original goal of the steelhead program at MRH (as an enhancement hatchery) was to support a harvest fishery for HOR steelhead. Although the HSRG (2005) did not review the MRH program specifically, under HSRG guidelines, this program would normally be designed as a segregated program. However, we propose to manage the MRH steelhead program as an integrated program, with conservation potential, because 1) gene flow from HOR to NOR stocks cannot be eliminated, though with increased monitoring it may be possible to further understand HOR to NOR gene flow, and 2) continued use of NOR fish as broodstock (i.e., integrated program management) will reverse genetic drift in the hatchery stock, which had been observed (Reneski 2011). Increasing the integration of NOR fish into MRH will also help increase the PNI (Proportionate Natural Influence), and help insure that natural selective forces (eg PNI > 0.50), rather than hatchery selective forces, dominate. This integrated approach can provide opportunity for hatchery-based recovery of genetically compatible fish, should the NOR population decline. Additional information in Section 3.0 will describe the interrelationship and interdependence of the program with fisheries management.

1.8 Justification for the program

Busby (1996) identified Robert W. Mathews Dam, built in 1962, at River Mile 84 (RM 84) as a permanent barrier in the Mad River. The reservoir above the earthen dam impounds runoff from 121 square miles, which is about 25% of the watershed surface area (NMFS 2005) and 36% of the basin steelhead production potential (Spence et al. 2008). The geology in the Mad River basin is conducive to surface flow erosion and episodic mass wasting, which, in combination with historic land use, contribute large amounts of sediments to the river. In 1992, pursuant to Section 303(d) of the Clean Water Act, the Environmental Protection Agency added Mad River to California's list of impaired waters. The North Coast Regional Water Quality Control Board (RWQCB) retained Mad River as an impaired river in the 2006 listing cycle, due to elevated sedimentation/siltation and included temperature as an additional impairment to water quality. Goode et al. (2005) reported that sedimentation of stream habitat was a significant factor in the historic decline in steelhead abundance.

From 1938 through 1963, the number of steelhead passing the fish ladder at Sweasey Dam at river mile 19.2 declined markedly. Annual winter-run adult steelhead counts in the1940s averaged 4,720 fish. The size of the natural spawning population decreased to an average of 2,894 steelhead in the 1950s and averaged 1,985 adults from 1960 through 1963. CDFW responded to the declining numbers of steelhead by constructing MRH in 1971 to enhance angler opportunity (McEwan and Jackson 1996).

Jackson (2007) reported that angling on the Mad River accounted, on average, for approximately 32% of all statewide steelhead trips taken, in part, because the steelhead catch rate was higher on the Mad River compared to other north coast streams (Table 1). Sparkman (2000, 2002a) reported that Mad River anglers fished 65,891 hours and caught 7,016 steelhead in the 1999/2000 and 2000/2001 seasons, on average, and that hatchery-produced steelhead comprised 86% and 79.1% of the catch, respectively. Sparkman (2002a) reported the CPUE for Mad River, Smith River and Trinity River was 0.21, 0.07 and 0.09 fish/hour, respectively, during the 2000/2001 season. Zuspan and Sparkman (2002) concluded that Mad River might be the best river in California for the average angler to catch steelhead. Jackson (2007) reported that the number of steelhead caught per trip in the Mad River for the period between 1993 and1998 was 0.8 and between 1999 and 2005 was 1.75, which was second only to the Klamath River in northern California.

Table 1. Annual average number of steelhead fishing trips and catch in NC DPS (2003-2005)

Stream Location	Number of Trips	Wild		Hatchery	
		Kept	Released	Kept	Released
Klamath to Mad River	190	2	219	13	23
Mad River	**1,244**	**9**	**248**	**650**	**1,320**
Mad to Eel River	23	0	5	9	31
Eel River	111	3	130	5	31
Van Duzen River	74	1	67	1	6
South Fork Eel River	250	4	265	2	30
Middle Fork Eel River	20	1	23	1	1
Eel to Mattole River	10	0	15	0	0
Mattole River	132	10	173	1	4
Mattole to Noyo River	65	0	42	1	1
Noyo River	12	0	9	0	0
Noyo to Navarro River	14	0	14	1	2
Navarro River	104	0	105	0	9
Navarro to Gualala River	164	2	195	1	9
Gualala River	316	2	231	4	13
Gualala to Russian River	17	0	2	3	2
Russian River	1,089	4	115	249	204

Source: Jackson (2007)

The steelhead fishery supported by MRH provides a significant economic benefit to the local and regional economies (Driscoll 2005). CDFW adipose fin-clips all HOR steelhead to facilitate sport harvest. MRH also enhances environmental education by providing eggs for the Classroom Aquarium Education Program, tours for local schools, wheelchair fishing access, wildlife viewing, and a serene setting for people to enjoy and picnic.

In 2001, CDFW estimated the natural winter-run steelhead population in the Mad River was 1,419 steelhead (95% CI 953 – 2,164), however this estimate may be biased low because the hatchery was the main recapture point. This estimate excluded all tributaries downstream of the hatchery, including North Fork Mad River (Zuspan 2002), although there were probably few adult steelhead in the tributaries below the hatchery (Sparkman, pers. comm.). Spence et al. (2008) estimated that a population of 11,200 steelhead represented a low risk of extinction for historically available habitat in the Mad River, and a current population of 7,000 steelhead distributed over a smaller habitat area currently available would represent a low risk of extinction. A high-risk extinction threshold for the historic population (the depensation point where adult steelhead cannot find mates due to critically low abundance) was estimated at 553, and the current population high-risk extinction threshold for Mad River is 352 winter-run steelhead. Although the 2001 estimate of 1,419 NOR winter steelhead is above the estimated depensation point of 352, it is well below the low-risk of extinction population abundance estimated to be 7,000 NOR adults for the Mad River in its current state. Given the current catch of steelhead and harvest of HOR steelhead, CDFW concludes that Mad River NOR steelhead cannot support a fishery because impaired stream habitat conditions limit NOR abundance. NOR steelhead, which have an adipose fin, are currently not legal to harvest. When caught incidentally while fishing for HOR steelhead, NOR steelhead must be relased immediately. Incidental mortality of NOR steelhead by anglers that target HOR fish is not considered high enough to warrant a determination of significant impact (Barnhart 1989). However, CDFW AFRAMP is in the process of developing the Fishery Management Evaluation Plan (FMEP) specifically addressing issues of incidental capture of listed salmonids (NOR Steelhead Trout, Chinook Salmon, and Coho Salmon) by anglers targeting HOR MRH Steelhead Trout.

The process of developing and updating the MRH HGMP has taken several years. As a result, some of the data used has become dated due to funding issues outside of the control of the hatchery or Department. However, there have been improvements with the Steelhead Restoration and Report Card (SRRC) and a few other areas of monitoring. Previously, some steelhead anglers did not report accurately or at all at the end of the year. Currently, the SRRC Sport Fishing regulation has been changed to: 1) require filling out initial fields in the card for the day before starting fishing; 2) adding new fishing location codes; and 3) requiring the card to be turned in at the end of the calendar year or face penalties. These changes in the SRRC should improve accuracy, and minimize bias. Efforts are underway to speed up the SRRC data processing to provide information on more of a “real” time basis.

Operating MRH as an integrated hatchery program promotes natural stock conservation and recovery of the Northern California DPS by maintaining and/or increasing NOR steelhead demographics above a level of depensation (CDFW/NMFS 2009). In addition, an intregrated program can reduce risk to natural populations due to stochastic events. Subsequent sections in this plan will describe how the population size will be monitored, but the predominate indicators for the hatchery will be the genetic analysis of adult steelhead returning to the hatchery, the determination of the relative abundance of NOR and HOR steelhead returns to the Mad River, and the calculation of the PNI index.

1.9 List of program "Performance Standards"

NMFS (2003a) recommends the use of the Artificial Production Review: Report and Recommendations of the Northwest Power Planning Council (NPPC 1999) to develop criteria for hatchery program benefit and risk assessments. The concepts for benefit and risk performance standards for the Steelhead Program at MRH originated from this publication (Table 2).

1.10 Benefits and risk performance standards associated with an augmentation hatchery

The list of benefit and risk performance indicators for the steelhead program at MRH were developed by NMFS and CDFW staff (Table 3).

Table 2. MRH program performance standards.

Performance Standard	Definition
Achieve Best Management Hatchery Practices	Culture practices developed by CDFW to increase life-stage specific survival rates, protect the genetic resources of the cultured and naturally produced population, produce a high quality rearing environment, and comply with 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 Mad River steelhead trout.
Achieve Harvest Objectives	Provide for sport harvest of MRH origin steelhead trout.

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

Indicator	**Benefits and Risks**
Broodstock Composition, Timing, Genetic Structure Similar to Natural Steelhead	**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 various adult age classes for spawning purposes (to maintain genetic continuity between generations). **Risk:** To the extent these indicators are not met, the hatchery population will become more divergent, have less genetic diversity, greater domestication, and less productivity compared to their natural counterparts. These factors can reduce the natural population productivity and

Indicator	Benefits and Risks
	diversity.
Mating Protocols (pNOR, % males) that minimize inbreeding, domestication, and conserve existing diversity of natural population	**Benefit:** Proper mating protocols ensure high fertilization rates (increased survival) and maximize genetic diversity of the broodstock. Incorporating natural fish (with 50% as a minimum, and 100% as the maximum) into the breeding program will correct/prevent genetic drift and/or domestication within the hatchery, which in turn will maintain a non-divergent hatchery population structure, maintain natural stock abundance and fitness, and increase the abundance of natural spawners for recovery of the NC Steelhead Trout DPS. **Risk:** Poor mating protocols may reduce genetic diversity and thereby reduce overall population productivity, and reproductive success in the natural environment, leading to reduced fitness.
High Adult Holding and Spawning Survival Rates, and Egg-to-juvenile-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, and may artificially select for genes/traits that are more conducive for survival in the hatchery rather than the natural environment.
Proportionate Natural Influence (PNI) of 0.5 or greater (Campton, 2009)	**Benefit:** Incorporating natural fish into the breeding program will increase genetic diversity, decrease inbreeding, and decrease domestication of the hatchery stock. Achieving the PNI goal (0.5 or greater) helps ensure that the natural, rather than the hatchery environment, is driving local adaptation. Fish

Indicator	Benefits and Risks
	better adapted to the natural environment are more productive and more resilient to environmental change. In 2014 a PNI of 0.5 was estimated by incorporating a pNOB of 50% in the spawning matrix and by using current escapement estimates and historic harvest data. **Risk:** A pNOB (a component of PNI) greater than 20% was not practical at the current hatchery production goal of 150,000 yearling steelhead in 2014. In 2014, with a pNOB of 50%, the hatchery was only able to produce 30,000 juvenile steelhead, instead of the allotment of 150,000, due to the difficulty in obtaining NOR adults. This raised the PNI to 0.5, but at an unacceptable cost to hatchery production. A PNI calculated using a pNOB of 20% for the 2014 year would result in a PNI of 0.29.This lower PNI would be 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. Low PNI's will lead to a hatchery stock with decreased genetic diversity, increased inbreeding, and increased domestication.
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 because natural populations located close to the hatchery may be more impacted than those farther 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

Indicator	Benefits and Risks
	hatchery reduces (depending upon total numbers taken) natural spawning escapement, which may reduce population productivity, spatial structure, and diversity.
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, harvest objectives, and hatchery needs. A release timing of hatchery produced smolts that occurs before the natural smolts migrate downstream minimizes interactions and impacts of hatchery smolts with the natural counterpart. **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. The release of hatchery smolts at the same time as when natural smolts migrate downstream promotes negative interactions (competition for food and space).
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 physiological changes needed to enter the marine environment; resulting in increased survival. **Risk:** Releasing fish that are not ready to migrate to the ocean results in these fish residing in the stream, which can result in increased competition with natural fish for food and space. This competition can reduce the natural population productivity. If the hatchery fish are larger in size than natural fish, they may predate on these wild juveniles, thereby

Indicator	Benefits and Risks
	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 and reduced fitness. 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 abundance levels indicate that the population is healthy and has a low risk of extinction. Low 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 an indication that environmental conditions may be insufficient to maintain the population over time (high extinction risk). Hatchery production, with all of its potential risks to natural populations, is needed to achieve conservation and harvest objections.
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

Indicator	Benefits and Risks
	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 in 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 cause a loss in productivity, diversity, and spatial structure.
Low pHOS	**Benefit:** : Limiting the proportion of hatchery origin fish on the spawning grounds (pHOS) reduces possible genetic impacts to the natural population and increases the PNI value. Harvest of ad-clipped HOR fish helps reduce pHOS. **Risk:** A high pHOS value indicates that HOR steelhead have a larger influence on the natural spawning population. The more dissimilar the two populations are, the larger the risk hatchery strays pose on the natural population. In a well integrated program, the proportion of natural 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, and that natural selective forces dominate instead of hatchery selective forces.
Low HOR straying	**Benefit:** Good homing fidelity of HOR fish to the hatchery is important for eliminating the genetic risks hatchery fish may pose to wild fish

Indicator	Benefits and Risks
	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. Low HOR straying also allows for modifying pHOS, if deemed necessary. **Risk:** High HOR straying rates may result in the population becoming more and more adapted to the hatchery environment rather than the natural environment. This makes the population less resilient or adaptable to environmental change and also 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 / enhancement hatchery should produce a fish with the reproductive success of a natural fish. This indicates that the two components to the population are virtually identical in their ability to reproduce 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.
Protect Harvest Rate	**Benefit:** Maintaining appropriate harvest rates ensures that the fishery does not jeopardize the natural population, and that pHOS can be reduced, if deemed necessary **Risk:** Harvest rates that reduce population abundance and escapement levels needed to

Indicator	Benefits and Risks
	maintain the population over time increases the risk of population extinction, and decreases diversity and spatial structure.
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, and for the maintenance of healthy ecosystems. **Risk:** Hatchery effluent that degrades water quality may decrease the survival and overall productivity of the natural population, and cause degradation to the stream and ecosystem.

1.11 Proposed steelhead annual broodstock collection level

The proposed winter-run steelhead broodstock is 125 female fish and 125 male fish, of which a goal of 50-100% of the broodstock is NOR steelhead, per the Integrated Hatchery Program goal. We intend on using NOR (or setting pNOB) at a 50 – 100% integration rate in the breeding program. The pNOB will be at least 50%, and our goal is to have a PNI > 0.5. The term, PNI statistic (Campton, 2009) Proportionate Natural Influence was developed as a tool to guide hatcheries, reduce domestication, and as a management goal of at least 0.5 for all HGMPs. A more detailed discussion appears in Appendix 10.

We intend on opening the hatchery ladder in mid December, if stream flows are adequate for passage into the ladder, and adults are present within the system. However, recent sonar counts and direct observation (snorkeling) in 2015/16 showed that few winter-run steelhead are entering Mad River before January.

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

CDFW proposes the annual release of no more than 150,000 adipose fin-clipped (AD-clip) yearlings directly into Mad River from the hatchery facility. Releases will be made during higher flows, typically associated with rain events. Production of smolts will be reduced if few NOR's are collected for breeding purposes (all spawnings will be at least 50% NOR).

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

There is a paucity of data for Mad River salmon and steelhead population abundance, following the removal of the Sweasey Dam (RM 19.2) in 1963 with one exception. In 2001, CDFW tagged NOR and HOR steelhead near Blue Lake, Humboldt County, and subsequently monitored MRH and two upstream weir sites to recover tags and generate a change-in-ratio estimate for each stock. CDFW Fishery Biologists marked 242 adult steelhead and recovered 26 marked fish and 1,914 (95% CI = 953 – 2,164) unmarked fish, which resulted in a population estimate of 17,164 (95% C.I. = 11,478 – 26,077) winter-run steelhead in the 2001/2002 season. Of these, HOR steelhead comprised 91.7% (15,745) and NOR fish made up the remaining 8.3% (1,419). More recently, Sparkman (pers. comm. 2016), using species apportionment methods with a DIDSON sonar in the lower Mad River, determined that in 2013/14 55.7% (N = 4,336) of returning adult steelhead were HOR's, and 44.3% were NOR's (N = 3,449).

The pHOS value associated with current data is further improved when HOR fish are harvested prior to spawning or incorporated into hatchery spawning operations. For the 2014 brood year, pHOS was estimated closer to 56%.

Zuspan (2001, 2002a, 2002b) reported 51.5%, 13.7% and 44.1% of the adult steelhead entering the hatchery returned to the facility a second time within the same spawning season, indicating a high fidelity to their natal site in the 1999/2000, 2000/2001 and 2001/2002 seasons, respectively. Notably, these percentages are a minimum because hole punched steehead could have been harvested before entering a second, third, or fouth time. Zuspan and Sparkman (2002) also reported a lower incidence of straying in relation to distance upstream of MRH. At the Cañon Creek Weir (RM 19), 18 of the 29 (62%) steelhead were HOR as compared to two HOR of the eight steelhead (25%) fish recovered at the weir near Big Bend (RM 44.6). Zuspan (2002b) also reported the percent age composition of steelhead returns to the hatchery for the 1999/2000, 2000/2001 and 2001/2002 seasons (Table 4).

Table 4. Age composition of steelhead returns by percentage to Mad River Hatchery for the 1999/2000, 2000/2001 and 2001/2002 seasons.

Season	Number of Hatchery Steelhead	Age 2	Age 3	Age 4
1999/2000	3,085	9.4%	87.7%	2.9%
2000/2001	1,396	12.3%	81.5%	6.2%
2001/2002	5,893	8.9%	88.5%	2.6%

These data facilitate estimates of smolt-to-adult return ratio (SAR) by comparing the number of yearlings released with their respective age 2+, age 3+ and age 4+ returns at the hatchery (Table 5). SARs (by percent) for steelhead returns to MRH for BY 1998, BY 1999 and BY 2000, were 1.2%, 0.6% and 1.52%, respectively. Assuming the 2000/2001 year class structure for hatchery returns in Table 4 was representative of the entire basin, the hatchery population (N = 15,745) consisted of 1,938 age 2+, 12,839 age 3+ and 968 age 4+ steelhead. The SARs for age 2+, 3+ and 4+ steelhead in 2000/2001 season was 0.05%, 0.43% and 0.04%, respectively.

Table 5. Mad River Hatchery winter-run steelhead smolt-to-adult return rate (percentage) for BY 1998, BY 1999, BY 2000, BY2001, BY2002, and BY2003.

Year	Number		Smolt to Adult Return					
	Yearlings Released	Hatchery Returns	Age 2		Age 3		Age 4	
			No.	SAR	No.	SAR	No.	SAR
1997/1998	248,077	1,807						
1998/1999	263,495	2,364	184	0.07				
1999/2000	368,082	3,085	290	0.11	706	1.09		
2000/2001		1,396	172	0.05	1,137	0.43	87	0.04
2001/2002		5,893			5,216	1.42	153	0.06
2002/2003		4,465					174	0.05

CDFW may, in the future, operate a smolt trap in the lower Mad River. Data collected from naturally produced Steelhead Trout in the wild would include smolt abundance estimates, and samples of genetic tissue from age-1 and age-2 smolts. The genetic samples could then be analyzed for assessing pHOS in the natural environment. Determining NOR smolt to adult survival is currently a lower priority than other monitoring projects, however, the current sonar (ARIS, DIDSON) project will tell us how many NOR and HOR adult Steelhead Trout return to Mad River, among other informative outcomes .

Production of smolts from MRH is at a very low level, and if we reduce the smolt output, then the fishery for hatchery adult steelhead trout will decline to un-feasible levels. If there is a much higher return rate of MRH smolt to adult given NOR integration rates, MRH staff could reduce the number of adults used for breeding purposes at the expense of effective population size of the hatchery spawner genetics. However, we could employ methods (ie reducing eggs/female, and increasing the number of females for spawning purposes) to increase the effective population size of MRH spawners.

1.13 Date program started and years in operation

Mad River Hatchery started in 1971 and has been in operation 45 years.

1.14 Expected duration of program

CDFW proposes to rear steelhead at MRH indefinitely or until such time that natural production is sufficient to support a fishery at current harvest levels, and NOR steelhead status is changed to ‘unwarranted for listing’ by NMFS/NOAA. After the initial authorization and formal approval of the HGMP, the HGMP will be re-assessed every five years.

1.15 Watershed targeted by program

Mad River basin (Figure 1)

1.16 Alternative actions considered for attaining program goals, and reasons why an alternative is not being proposed

Alternative program actions are as follows:

<u>Alternative 1. Segregated (Isolated) Hatchery Program</u>

Fishery managers utilize a Segregated Hatchery Program strategy to maintain a cultured population that is genetically distinct from NOR counterparts by exclusively using hatchery-origin adults in subsequent broodstock (Spence et al. 2008). Segregated Hatchery Programs seek to maintain a distinct population dynamic, such as run timing or size to allow a selective harvest of marked HOR fish. The success of a Segregated Hatchery Program depends, in part, on a large artificially produced spawning population (>500) that exhibits a low staying rate and occurrence in natural spawning areas. The Mad River steelhead population is predominately HOR, which is congruent temporally and spatially with natural spawning stocks. CDFW/NMFS held a joint agency technical team summit meeting on August 25, 2009 that included molecular scientists, fishery biologists and policy makers. The team concluded that sufficient isolation of the MRH stock was not possible, and that, due to the inevitability of mixing NOR and HOR stocks, MRH should be operated as an Integrated Hatchery Program to sustain and eventually augment the NOR steelhead population in Mad River.

<u>Alternative 2. Integrated/Conservation Steelhead Program (Proposed Alternative)</u>

Spence et al. (2008) reported that a population of 7,000 winter-run adult steelhead represented a low risk spatial structure/diversity threshold and 352 winter-run adult steelhead represented high-risk (depensation) threshold for Mad River. In 2001, CDFW estimated the NOR winter-run population in Mad River was 1,417 steelhead, which is about four times the depensation point. More recently, CDFW determine the run size of NOR’s in 2013/14 to equal 3,449 individuals (M. Sparkman, pers. comm. 2016). CDFW and NMFS molecular scientists and fishery biologists concurred that managing MRH as an Integrated Hatchery Program would provide a component of recovery for the NC DPS, achieved through developing an HGMP that contributes to maintaining NOR steelhead demographics above a depensatory level (CDFW/NMFS joint-agency summit meeting on August 25, 2009).

A secondary byproduct of an integrated hatchery program is increased protection of the Mad River steelhead genotype in the event of catastrophic local extinction. This would allow for MRH to also operate as a conservation hatchery. CDFW and

NMFS further rejected the concept of terminating MRH production and opted for a program that uses steelhead as broodstock because, while hatchery production may have some negative impacts on NOR fish, these are preferable to extinction (Flagg et al. 2000). In general, the factors that influence genetic risk of a hatchery program within an anadromous ecosystem are the rate of natural stock integration into the broodstock and the proportion of HOR spawners compared to NOR spawners. Spawning only NOR steelhead as broodstock is conceptually an ideal strategy for the MRH steelhead program, but there are currently not enough NOR fish entering the facility to meet this objective. However, several alternative collection methods are proposed within this HGMP (seining, weirs, hook/line). A hatchery program that spawns a large number of NOR steelhead into its broodstock can result in a cultured population that is similar in heritable composition to the natural stock so that the artificially propagated fish pose a lower genetic risk when they spawn in the wild. An Integrated Hatchery Program operates to foster adaptation to the natural, rather than the hatchery, environment, which results in a higher level of fitness for both naturally spawning HOR and NOR steelhead. Integrated Hatchery Programs are consistent with CDFW hatchery policy and the *Steelhead Restoration and Management Plan for California* (McEwan and Jackson 1996).

Alternative 3. Terminating MRH steelhead production

NMFS (2005) identified MRH as a risk factor for NC steelhead because CDFW historically out-planted non-indigenous broodstock from this facility to other streams within the DPS. Goode et al. (2005) reiterated the concern raised by Busby et al. (1996) for the genetic divergence between MRH and natural stocks in Mad River based on broodstock origins. Fish culture can cause genetic drift and domestication in a hatchery population as well as alter the natural population genetic structure when HOR spawn with NOR stocks. The termination of MRH production would clearly eliminate any adverse genetic interaction between NOR and HOR stocks (Araki et al. 2007, cited by NMFS 2008, Chilcote 2003). Consideration of socio-political issues in the analysis of resource decisions is not without precedent. The Joint Hatchery Review Committee (CDFW/NOAA 2001) acknowledged that regulatory agencies must consider societal and economic benefits when making risk threshold assessments and project evaluations. Both genetic and socio-political factors have significant weight in the decision making process. Regardless of socio-economic issues, ending the MRH steelhead program may neither change the limiting factor of critical habitat, nor improve natural stock diversity, productivity or abundance. Conversely, terminating MRH production may allow NOR population levels to fall toward the depensation point through natural stochastic variation and issues related to climate change, affecting the conservation and recovery efforts in the NC DPS. Ending HOR steelhead production also terminates a very popular fishery that is a boon to the local economy.

Alternative 4. Exclusive Use of Natural Stock as Broodstock

A conservation protocol that exclusively uses natural broodstock is an ideal strategy for MRH and it is part of the program's long-term goal in subsequent HGMPs with a phased conceptual design. However, it is currently unlikely that sufficient numbers of NOR steelhead will enter MRH, or be available for capture to meet the necessary number of broodstock during the initial operations of implementing this HGMP. CDFW may propose exclusive use of NOR fish in future HGMP revisions if sufficient numbers of NOR fish become available. Currently there appears to be enough NOR's present in the system (based on 2013/14 Sonar estimates (pers. comm. Michael Sparkman) though care and judgement are required when removing NOR broodstock from natural spawning habitat. Unfortunatly, CDFW currently lacks sufficient funding, time, and staffing to carry this out at the level necessary.

Exclusive use of NOR broodstock is currently not acceptable because of the lack of NOR broodstock available via ladder and hook and line collection methods. The effective population size of 125 females mated to 125 males confers acceptable genetic diversity within a useful range. This year (2016) MRH staff mated approximately 119 NOR broodstock, all that were available and mature, to HOR broodstock and a few NOR broodstock (NOR x NOR) when the week's quota for predicted full run scope had been reached. Mating NOR to NOR broodstock additionally carries a low probability of sibling crosses; therefore rapid genetic testing would be a precautionary step. Isolating an anesthetized NOR spawner in wait for its corresponding NOR mate can cause additional mortality when the fish is re-anesthetized for handling. That said, when a NOR spawner of one sex arrives in the same batch of anesthetized fish as another NOR spawner of the opposite sex, consideration for spawning them together is given. In this way, MRH staff exceeded the 50% goal for 1:1 NOR x HOR with a number of added NOR x NOR spawnings.

Associated with Alternative 4 is the definition of a Conservation Hatchery. In that case, there would be no more sport angling, 100% NOR x NOR mating, intensive genetic testing, development of a "natural" hatchery rearing environment, and distribution of juveniles to specific places in the river, or weir and hatchbox operations on tributaries, among other tasks. MRH will not cross HOR x HOR, and has not for the past three years, but even the progeny of NOR spawners raised in the hatchery are technically hatchery influenced, are not truly wild, and become by definition HOR stock. Therefore, ceasing raising HOR steelhead is the same as ceasing hatchery operations for anadromous steelhead. In 2013/14, CDFW staff estimated 4,336 HOR and 3,449 NOR, or a 56% HOR run and the trend may be moving upward. Therefore, a Conservation Hatchery is not merited now. That would be a last ditch effort if the trend were downward, approaching the dispensation point of 353 NOR spawners.

Unless triggered by future evaluation of genetic analysis, CDFW will not add weir and/or hatch-box operations due to their increased expense. As an Integrated Hatchery, we discuss bringing the elements of an Enhancement Hatchery and a Conservation Hatchery together. The dual purpose of providing a fishery to anglers and recovering the natural population, trending upwards, is our plan.

Best Alternative to Obtain Hatchery GoalsAn Integrated Hatchery/Harvest Program can conserve steelhead biodiversity and maintain the Mad River steelhead fishery. The proposed MRH program facilitates spatial continuity within the NC steelhead DPS because viable independent populations can positively influence nearby dependent communities. An Integrated Hatchery Program at MRH is compatible with conservation goals and recovery of natural viable salmonid population (Table 6).

Table 6. MRH Operation in Relation to natural independent population VSP Objectives

Objective	Abundance	Productivity	Spatial Distribution	Diversity
Conservation	Operate MRH as an Integrated Hatchery Program to produce 150,000 AD-clipped yearling steelhead	Integrate NOR steelhead into broodstock to allow the natural environment to drive genetic selection in Mad River	Minimize intra- and inter-basin hatchery influence while maintaining spatial continuity within the NC DPS	Avoid genetic drift in MRH population and maintain genetic diversity, fitness, and abundance in the natural population
Harvest	Selective fishery for AD-clip steelhead to reduce the number of hatchery strays and protect NOR adults from harvest.	Maintain zero bag-limit for NOR steelhead to promote unimpeded natural population growth. Maximize HOR steelhead harvest. CDFW could promote to the F&G Commission more liberal bag limits (4 HOR fish/day) to increase HOR harvest and reduce pHOS.	Continue to concentrate fisheries in the lower river reach to prevent risk to tributary stock(s) and maintain a summer-run refugia upstream of MRH.	Fishery for HOR stock is concentrated in the lower mainstem of the river which will minimize hooking mortality of NOR stocks above the hatchery

Section 2.0 Program Effects on ESA-listed Salmonid Populations

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

CDFW scientists obtain annual approval from NMFS for research projects applied for and included in the CDFW 4(d) Research Program via 4(d) rule Limit 7. This HGMP, via the NMFS ESA 4(d) rule Limit 5, is the permitting document for hatchery operations which includes monitoring and collection methods directly tied to implementation, and monitoring and evaluation of performance standard indicators of the HGMP.

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

Three listed salmonids exist in the target area: Northern California (NC) Steelhead Trout, *Oncorhynchus mykiss*, California Coastal (CC) Chinook Salmon, *Oncorhynchus tshawytscha* and Southern Oregon/Northern California Coast (SONCC) Coho Salmon, *Oncorhynchus kisutch*. All three species are listed as Threatened under the federal ESA (NOAA 2006). Both winter-run and summer-run NOR steelhead are considered part of the Northern California Steelhead DPS. MRH HOR winter-run steelhead were not included in the DPS and were not listed when NMFS last updated the status of the DPS (NMFS 2011). Green sturgeon *Acipenser medirostris* and Pacific eulachon *Thaleichthys pacificus* are listed as Threatened under the federal ESA (NOAA 2005b and 2010) and are known to occur in the Mad River.

The four VSP parameters (abundance, population spatial structure, population growth rate, and diversity) (McElhany et al. 2000) associated with these listed species within the Mad River is unknown based upon past monitoring efforts. However, CDFW's Anadromous Fisheries Resource Assessment and Monitoring Program is currently, as of November 2013, operating a DIDSON sonar fish counting unit, in combination with species identification methods (seining, snorkeling) to provide adult abundances for Chinook salmon, Coho Salmon, Steelhead Trout, and Green Sturgeon. These data are currently being analyzed and will be reported in the future. The diversity is addressed in sections below, and recent monitoring efforts are collecting tissues for genetic analysis, a component to the diversity parameter. With respect to the two additional parameters (population spatial structure and growth rate), this data is not available and CDFW currently lacks funding necessary to implement additional monitoring efforts.

Methods of Take

In the past, adult hatchery Steelhead Trout were not marked, thus the breeding program at MR couldn't distinguish between NOR and HOR adults. Unlike the early years of operation, all hatchery steelhead are currently marked with an adipose fin clip. QA/QC of fin clipping shows that 99+% of hatchery smolts have a discernable fin clip. Additionally, MRH staff critically examine each NOR for any fin erosion (eg dorsal, ventral, pelvic). If any fin erosion is present, then that fish is not considered a NOR. Other methods besides putting river water in the ladder (to attract natural steelhead) are being used, such as hook and line sampling to collect NOR for cross-breeding purposes.

The primary method of take is trapping fish via the MRH fish ladder and trap (Table 7). Fish that volitionally enter the hatchery fish ladder can reverse course. However, once they enter the trap at the top of the ladder, escape is unlikely, and fish will be captured and handled. All fish are sorted for species, gender, marks, and general age groups, and eventually returned to the river after processing, except any mortalities. Processing includes anesthetizing with CO_2, sorting by hand, marking with a caudal fin hole punch after which fish are moved via flume into a holding tank where they are allowed to recover. The hole punch is applied every time an adult fish returns to the capture facility, and allows for assessing fidelity (general) to MRH. Fish may remain in the holding/recovery tanks for as long as they need to recover (up to 24 hours) before being released back to the river. An exception to this procedure allows hatchery staff to hold one or two unripe NOR broodstock steelhead for the following week's hatchery spawning because of their rarity in the trap. If the theoretical weekly spawning matrix and the actual occurrence of NOR broodstock indicate the need (50% integration rate is the minimum) for NOR broodstock may not be met, then one or two NOR broodstock will be held in the trap or a circular tank in the spawning building for one week. The rest of the spawned broodstock, NOR and HOR, will be sampled for genetic tissue using a partial caudal fin clip, and after recovery and/or reconditioning released back into the river that night or the following morning. Since the adult steelhead's "mission" is to spawn, the hatchery can only help recondition them for release after trapping.

We propose a suite of methods for NOR collection to increase our ability at capturing sufficient numbers for breeding purposes. The exact method for NOR collection will depend on the success rate, which in turn is influenced by environmental conditions and the amount of time spent on sampling. In some water years, seining may be very effective, and in other years, adult weirs may be much more effective. The total number of NOR used for breeding purposes will not exceed 250 fish each year (100% NOR). The total NOR for breeding will be a minimum of 125 (at a 50% integration rate), with a goal of greater than 50% integration rate. If pHOS is 55% (as in 2013/14), then for example a 67% NOR integration rate would make PNI greater than 50% (our target). If insufficient NOR's are captured for breeding, then production at MRH will be reduced to ensure a 50% NOR integration rate into the breeding program.

A secondary method of take of NOR broodstock to supplement in the event of insufficient NOR broodstock coming up the ladder is seining. The goal is to collect 125 – 250 NOR's, however, this will likely be unmet if we soley rely upon NOR's entering MRH. Seining will be done at various locations within the watershed, paying particular attention to not "mine" NOR steelhead in areas of low abundance (tributaries). We will not take more than 10% of NOR adults in any given tributary. Seining is accomplished with a 200' seine with four to eight staff deployinging the net from the hatchery bank to the far bank and then retrieving it in a "U" shape to sort out any NOR steelhead broodstock. NOR steelhead broodstock would then be netted and carried by a hand net in the water over to the hatchery's side bank and then lifted up to the hatchery tanker truck for transport to the spawning trap. All other fish would be counted, speciated, and immediately released back into the stream (Tables 7a and 7b).

A third method of take of NOR broodstock will be capturing adults with hook and line sampling. This method offers the advantage of sampling in areas where seine nets and adult weirs cannot be used. Only well trained and experienced personnel from CDFW, volunteers, and NMFS will be allowed to capture NOR for MRH breeding purposes. Captured fish will be handled according to the “Dry Spawning Protocol” and their gametes will be transported to MRH either the day before or the day of hatchery spawning. Collection goals for NOR are 10 – 250, however, it is unlikely we will be able to capture high numbers of NOR.

A fourth method of take for NOR broodstock will include using temporary adult weirs in the mainstem of the Mad River and tributaries. Trapping would occur for 2 days before spawning at MRH, and the weirs would be out of the water for 5 out of 7 days. The weirs would be checked continuously 24hrs/day during operation, in hopes of collecting 125 – 250 NOR’s. The weirs use picket fences that have 1 inch spaces between the conduit of the fencing. The weir panels would be held in place with 6 ft fence posts, and tied to the fence posts with baling wire. The weirs would direct fish into a holding box (L = 12 ft, W = 4 ft, H = 5 ft). The livebox also has 1 inch spaces between the conduit pieces. The temporary weir intended for the mainstem would trap only those fish migrating close to the shore, and would not span the Mad River. The DIDSON camera in the Mad River has shown that under high, turbid flows, adult steelhead trout will migrate upstream along the margin of the stream in water as shallow as 2 – 4 ft (M Sparkman, pers. comm. 2014). The weir panels would not be long (20 ft from bank to livebox). The livebox would be positioned near the bank as well (@ 20 ft from edge of stream). Tributary weirs will span the channel during low to moderate flows, and would not be in place during high flows. We will not collect more than 10% of the NOR steelhead trout for breeding purposes at any weir. We will survey areas above the tributary weirs to count NOR steelhead trout, and will collect only as many NOR steelhead for breeding as needed. For the mainstem weir, the capture of NOR steelhead will be much less than 10% of the NOR population. The NOR population will be enumerated as they migrate past the ARIS sonar camera, which is located at RM 7.01. We will also survey areas downstream of the tributary weirs to ensure we are not preventing fish from upstream migration. If we find that we are, we will remove the weir(s) to let these fish pass. We intend on operating weirs from January 1 – March 15, when MRH needs to collect NOR as broodstock. Capture of Chinook salmon and coho salmon should be incidental past February. All Chinook salmon and Coho Salmon captured will be immediately released back into the stream, upstream of the weir sites. All captured fish will be observed for condition at capture and release, and if adult fish appear stressed or tired, we will cease trapping.

Table 7a. Estimated annual collection and mortality of Northern California Steelhead (HOR, NOR) Trout, California Coastal Chinook Salmon, and Southern Oregon/Northern California Coast Coho Salmon for implementation of MRH winter-run steelhead trout program. There is no anticipated collection of green sturgeon, Pacific eulachon, or longfin smelt.

	MRH Winter-Run Steelhead Trout Program Activity							
	Winter Capture						Artificial Spawning	
	MRH Facility		Seining		Hook/Line		MRH Facility	
Species	Expected Collection	Indirect Mortality	Expected Collection	Indirect Mortality	Expected Collection	Indirect Mortality	No. of Spawners**	Indirect Mortality
NC Steelhead Winter-Run (HOR)	6,500	195	500	2	60	1	125	8
NC Steelhead Winter-Run (NOR) at 50-100% pNOB	125-250	1	125-250	1	10-250	0	125-250	1
CC Chinook Salmon	5	0	150	0	40	0	0	0
SONCC Coho Salmon	3	0	10	0	3	0	0	0

* Seining will be conducted to collect NC steelhead (pNOB) if counts at MRH are insufficient.Total collection of NOR's for spawning will range from 125-250 (at a 50 – 100% integration rate). **Spawner numbers are included in expected collection for MRH Facility Winter Capture.

Note: Highest catch in a single year from 2003/2004 to present is one CC Chinook and one SONCC coho and in the past five years it has been zero for both species; therefore, to be safe we expect that less than five could be collected in the fish ladder trap as these salmon populations fluctuate and begin to recover during the lifetime of the current HGMP (see Table 9).

Table 7b. Estimated annual collection and mortality of Northern California steelhead (HOR, NOR) trout, California Coastal Chinook salmon, and Southern Oregon/Northern California Coast coho salmon for implementation of MRH winter-run steelhead trout program. There is no anticipated collection of green sturgeon, Pacific eulachon, or longfin smelt.

	MRH Winter-Run Steelhead Trout Program Activity	
	Winter Capture	
	Adult Weirs	
Species	Expected Collection	Indirect Mortality
NC Steelhead Winter-Run (HOR)	300	2
NC Steelhead Winter-Run (NOR) at 50-100% pNOB	125-250	2
CC Chinook Salmon	50	1
SONCC Coho Salmon	20	0

More information about broodstock identity and collection is provided in Section 6.0 and7.0. Once the spawning activity is accomplished for HOR and NOR steelhead broodstock, take can be divided further as the ensuing steelhead eggs are reared to the yearling release size and smolt maturity level (Table 8). MRH yearling releases will occur in March during high flow events, when possible. Releasing fish at this time and during higher flows facilitates downstream migration, and reduces residualization (Sparkman 2002b). Take for these steps is described in Sections 8.0, 9.0, and 10.0, as well as the take following their release.

Table 8. Estimated Collection and Mortality of Northern California Steelhead Trout (HOR, NOR) Smolts, California Coastal Chinook salmon, and Southern Oregon/Northern California Coast coho salmon for implementation of MRH winter-run steelhead trout program. There is no anticipated collection of green sturgeon, Pacific eulachon, or longfin smelt.

	Winter-Run Steelhead Program Activity (Smolts)				
	HOR X NOR Smolts for Adipose Clipping			HOR and NOR Smolts for Pathology	
Species	Expected Number to be Clipped	Indirect Mortality		Lethal Collection	Indirect Mortality
NC Steelhead Trout Winter-Run (HOR, NOR)	150,000	1,500		100	0
CC Chinook Salmon	0	0		0	0
SONCC Coho Salmon	0	0		0	0

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

Federally Threatened salmonids in Mad River are California Coastal (CC) Chinook salmon, Southern Oregon/Northern California Coast (SONCC) Coho salmon, and Northern California (NC) Steelhead. NC steelhead adults are the only targeted species for the MRH Program. Adult SONCC coho salmon and CC Chinook salmon are not a program species at MRH. Therefore, any harm to individuals of these species returning to the facility is incidental to the purpose of the program. CDFW will complete a FMEP to evaluate incidental capture of adult Chinook Salmon, Coho Salmon, and naturally produced NC Steelhead Trout by sport fisherman who are targeting HOR Steelhead Trout.

Area influenced by hatchery operations

CDFW Habitat Conservation program staff approved the Habitat Conservation Plan for Humboldt Bay Municipal Water District (HBMWD 2004). The HCP discussed areas influenced by the hatchery, summarizing the recovery requirements for ESA-listed species in the Mad River as follows: 1) space for population growth and normal behavior; 2) nutrients for physiological development; 3) shelter; 4) breeding sites and areas for rearing progeny; and 5) functional habitat within the historic geographical and ecological distribution of the species. The significance of take for each listed species was estimated by examining where hatchery operations interact and potentially adversely affect each life history phase of natural stocks. Collectively, the “area of influence” for project impacts includes trapping and handling of natural salmonids within the hatchery, as well as the genetic and ecological interactions that occur in the wild between NOR and HOR juvenile and adult steelhead, and juvenile Chinook and Coho Salmon.

NMFS (2008) reported that the entire Mad River watershed up to Matthews Dam is open to anadromous fish. However, upstream steelhead migration is largely limited between Bug Creek (RM 50) and Deer Creek (RM 53). It is generally believed that under low to normal water years, a series of natural boulder fall barriers limit anadromy to the Mad River mainstem and tributaries below Bug Creek and Gravelly Bar (RM 50-51)(CDFW Eureka office files). Anadromy in the North Fork Mad River terminates at a bedrock cascade, which is 3.8 miles upstream from its mouth. Adult HOR steelhead could be present throughout the area accessible to anadromy in the Mad River, although Zuspan and Sparkman (2002) reported their occurrence decreased with distance upstream from the hatchery.

Hatchery planted fish have the potential to swim upstream and compete with natural juvenile salmonids (Pearsons 2008). However, because MRH plants steelhead yearlings directly into the river during high flow events, the potential for juvenile mixed stock interaction is more likely to occur downstream of the hatchery. The area of influence for hatchery releases excludes Mad River tributaries because most smolts migrate directly and rapidly into the ocean (Flagg et al. 2000, Tipping 1997, Wagner et al.1963). The current sonar work supports this assertion because large schools of smolts are seen migrating downstream shortly after MRH releases steelhead smolts.

In the following generation, the progeny of naturally spawning HOR steelhead likely compete with the progeny of naturally spawning NOR steelhead. By minimizing pHOS and increasing pNOB, we can reduce the take associated with these juveniles. In addition, once the HOR steelhead's progeny hatch in the wild, they are exposed to every evolutionary selective pressure their counterparts in the wild are exposed to, and they become more like wild steelhead via selective forces. Therefore, determining take for this generation which have both NOR and HOR parents would be difficult, particularly when divergence is no longer an issue. The lack of reproductive success of HOR spawners that stray can be estimated with redd traps in comparison with NOR spawners (with redd traps) and attributed to the rate of recovery of NOR steelhead, however, we are unlikely to perform this method for various reasons (eg cost). This form of take can be described, evaluated, and reduced by removing as many straying HOR spawners as possible.

Assessment method for adverse genetic and ecological effects

NOR salmon and steelhead in Mad River may be subjected to numerous potential threats from interactions with hatchery strays (CDFW/NMFS 2001). NMFS (2008) concluded that the genetic make-up of MRH steelhead could detrimentally affect their conspecifics within and outside of the geographic range of the NC DPS. Campton (1995) categorized project risks as the genetic effect of artificial propagation on the hatchery population, specifically, the direct genetic effect of cultured fish on NOR populations due to interbreeding and the indirect genetic effects of HOR on NOR populations due to ecological interactions or management decisions that affect abundance. The HGMP approval process requires an assessment of adverse genetic and ecological effects to ESA-listed species from hatchery operations. Quantifying the impact on NOR salmonids from the theoretical, albeit potential, effects caused by hatchery operations presented a significant challenge to development of this HGMP. Based in part on concepts of potential hatchery effects (Flagg et al. 2000), NMFS and CDFW developed a method to examine the Take of listed species. The method categorizes the ecological exposure for individuals of each listed species by life stage for each facet of hatchery operations.

Categories of ecological exposure assessment:

Negligible	The potential for interaction between NOR salmonids and HOR steelhead is rare and/or insignificant.
Low	The potential for interaction between NOR salmonids and HOR steelhead is limited to relatively few individuals.
Moderate	The potential for interaction between NOR salmonids and HOR steelhead is short term, but the cumulative rate of exposure results in a greater risk for lowering the abundance and/or survival of many ESA-listed individuals.
High	The potential for interaction between NOR salmonids and HOR steelhead is common, seasonal or extensive. The cumulative rate of encounter results in a high likelihood of lowering the abundance and/or survival of a large number of ESA-listed individuals.

Adverse Effect to Adult Federal ESA-listed Species Associated with Hatchery Operations (Effects from broodstock collection of winter-run steelhead at the MRH ladder, or by seining nearby the ladder)

California Coastal Chinook salmon ESU

Adult Chinook Salmon enter Mad River estuary in early September and migrate upstream during low stream flows, and in response to rain-induced flows from October through January. Spawning occurs in late October - December, and may extend through January. Chinook Salmon spawn in pool tailouts or riffle crests and runs using gravels that overlap the size that are preferred by coho salmon and steelhead. Chinook Salmon generally spawn in low gradient (<5%) areas of larger tributaries or the main channel.

MRH traps steelhead during the latter part of the Chinook salmon run (mid-December through January). Chinook Salmon that enter the hatchery ladder as adults are subject to trapping, anesthesia, and sorting. Chinook Salmon caught at MRH are subject to a short delay in migration. However, it is unlikely that trapping contributes to decline of the spawning population because Chinook adults are returned to the river in good condition and the number of Chinook salmon entering MRH since 2004 is negligible (two individuals)(Table 9).

Table 9. Number of steelhead, Chinook and coho salmon adult returns to Mad River Hatchery for BY 1972 through BY 2014.

Season	Coho	CHIN	Steelhead	Season	Coho	CHIN	Steelhead
1971/1972	337	323	42	1993/1994	39	11	5,591
1972/1973	466	1,036	52	1994/1995	74	67	11,118
1973/1974	327	495	2,872	1995/1996	12	56	11,520
1974/1975	160	231	2,138	1996/1997	259	64	8,713
1975/1976	2,103	278	190	1997/1998	40	7	1,807
1976/1977	1,193	661	658	1998/1999	13	40	2,364
1977/1978	648	250	1,317	1999/2000	20	50	3,085
1978/1979	577	246	2,190	2000/2001	17	11	1,399 (11)
1979/1980	352	145	1,411	2001/2002	13	52	5,893 (238)
1980/1981	503	86	730	2002/2003	9	11	4,519 (54)
1981/1982	135	251	442	2003/2004	No trapping		
1982/1983	622	900	1,087	2004/2005	0	1	1,880 (15)
1983/1984	87	437	838	2005/2006	0	1	1,671 (19)
1984/1985	24	82	1,015	2006/2007	0	0	1,528 (12)
1985/1986	45	275	753	2007/2008	1	0	3,005 (1)
1986/1987	324	299	13,833	2008/2009	0	0	305 (2)
1987/1988	953	846	4,303	2009/2010	0	0	2,441 (5)
1988/1989	845	242	2,529	2010/2011	0	0	4,846 (70)
1989/1990	256	46	1,027	2011/2012	0	0	3,948 (133)
1990/1991	92	1	915	2012/2013	0	0	3,118 (21)

1991/1992	37	10	3,463	2012/2013	0	0	3,192 (22)
1992/1993	67	27	7,497	2013/2014	0	0	1,841 (19)

Note: 1) 1999 BY to present production is AD-marked; ( ) represent number of non-AD-marked steelhead; HOR steelhead counts include 2 yr. old steelhead trout (jacks or jills). 2) The annual reports starting in 1971 do not record the number of broodstock released spawned or unspawned. From the 2004/2005 season to 2013, the Chinook and coho that enetered the fish ladder and trap were all released unharmed back to the river. Beginning in 2014, the number released and any mortalities will be recorded and reported in the annual report.

Southern Oregon/Northern California Coast Coho salmon ESU

Coho Salmon enter Mad River as sexually mature adults in fall and spawn in November, December and possibly through January/early February (Zuspan and Sparkman 2002), although Weitkamp et al. (1995) reported that some SONCC coho salmon migrate as late as March. Hassler (1987) reported the period of peak migration for Coho Salmon occurs in December and January in response to the highest winter flows. Coho Salmon stock(s) utilize unique spawning periods and optimal water temperature to maximize the survival of progeny. Coho Salmon may spawn in third and fourth order streams, but most utilize fourth and fifth order waters (Bjornn and Resier, 1991) with a gradient of 3% or less (Nickelson et al. 1992). Coho Salmon spawning is concentrated in riffles at the downstream end of pools with suitable water depth and velocity (Weitkamp et al. 1995). Spawning gravel ranges in size that compares from a pea to an orange (Nickelson et al. 1992).

Coho Salmon are at risk of capture from mid-December through February when MRH is trapping steelhead spawners, CDFW crews are seining NOR steelhead for broodstock, or when CDFW/NMFS is using hook/line to capture NOR steelhead for breeding at MRH. Coho Salmon caught at MRH are subject to a short delay in migration. However, it is unlikely that trapping contributes to decline of the spawning population because coho adults are returned to the river in good condition and the number of coho salmon entering MRH since 2004 is negligible (one individual) (Table 9). Adult coho salmon captured while seining or by hook/line will be briefly reconditioned and immediately released back into the river.

Northern California steelhead DPS (ESU)

Mad River steelhead exhibit nearly a year-round run of adult fish. Winter-run make up the bulk of returners, with lesser numbers returning in the fall, and spring/summer months. Summer-run steelhead migrate in spring through summer, typically hold over in deep pools downstream of boulder roughs near Deer Creek, and spawn the following winter. Summer-run adults do not migrate during mid-December through March when MRH is trapping winter-run broodstock. MRH does not propagate summer-run steelhead, although in past years there was a small, summer-run program.

Winter-run steelhead migrate into the Mad River during winter months. Though there is often insufficient flow in the river to enable the ladder to operate before the end of the year, antecdotal information from fishermen has suggested that earlier returns to the Mad River are composed of a greater number of NOR steelhead.

The total number of NOR steelhead entering MRH varies each year (range 1-238), but annually averages 48 adults (Table 7). Since NMFS geneticist's reccomend that at least 50% of the broodstock or approximately 125 spawners be NOR steelhead, the collection of NOR broodstock via the fish ladder may not be be sufficient, even when adding river water to the ladder. For years when the NOR brood stock collection from the fish ladder is not sufficient on a week to week basis, alternate means of obtaining NOR broodstock can be employed with seining, hook/line, and adult weirs (see Methods of Take in Section 2.2). Take at MRH of NOR winter-run steelhead includes their capture and use as broodstock, as proposed in this HGMP. In recent years, the fish ladder has been operated part time to prevent excess steelhead from being trapped and to keep fish in good condition, reducing trapping mortality for all fish and increasing survival of excess, non-target, and HOR fish. Hatchery staff prefer to work with no more than 500 fish on designated spawning days, thus reducing stress on trapped and sorted fish. In recent years, over the spawning period for each year, an average of 3,600 fish were handled at MRH (with up to 50% returning multiple times in the same season). It is a given that fewer fish are trapped at the beginning and end of the trapping period. In 2013, there were a total of 41 adult HOR steelhead mortalities (zero NOR steelhead mortalities) in the spawning facility, or 0.9% mortality due to handling stress. It is unknown exactly how many died in the trap before spawning commenced each week, although toward the middle to the end of the spawning season steelhead frequently entered the ladder and trap covered in fungus to varying degrees. Periodically, river otters were able to break through the anti-predation fencing and killed several steelhead in the trap. The trap or holding pen for adult steelhead trout at MRH is constantly monitored when the fish ladder gate is open to reduce overcrowding and mortality of captured fish. The gate is usually opened to allow fish to enter just days before spawning, which reduces overcrowding, potential predation, and water quality issues. However, MRH may open the gate for the entire season if there is a need to reduce the number of HOR fish that are returned to the river, thus reducing pHOS and increasing PNI values.

If on-site trapping at the hatchery does not provide sufficient numbers of NOR broodstock, CDFW may opt to collect NOR steelhead using alternative capture methods (e.g.seining, Section 2.2).

Currently one or two unripe NOR steelhead may be held for up to one week in a circular tank inside the spawning facility or within the trap for the next spawning session. MRH may decide to spawn the held NOR fish as soon as they become ripe, which may happen before the next spawning session. In future years, with MRH spawning facilities upgraded and water (NPDES discharge) permits updated and renewed, CDFW may be able to capture and hold NOR steelhead temporarily in these upgraded facilities until the next spawning session the following week. This practice could help meet the hatchery integration goal. The risk of affecting run-timing (and maturation rates) for these fish and their progeny is considered low because the adults were not ripe when first entering the hatchery.

Adverse effect to juvenile federal ESA-listed species associated with release of 150,000 yearling HOR steelhead

The number, size (length), timing and location of released HOR steelhead smolts in relation to the number, size, timing, and location of naturally produced downstream migrating juvenile salmonids are potentially significant factors influencing the extent of competition and predation between ESA-listed salmon and yearling HOR steelhead. However, Sparkman (2002b) found that in 2001, even with the later releases (late March/April) of HOR steelhead smolts, downstream migration timing of NOR fry, juveniles, and smolts (Chinook, coho, steelhead) had little overlap with HOR steelhead releases and subsequent migration. Sparkman (2002b) found that MRH-released steelhead smolts quickly emigrated towards the ocean and showed little residualism. In that study, of the 225,000 ad-clipped MRH steelhead, 205 individuals were immediately captured in downstream traps after release and given a second identifying mark. Of these captured fish, five fish were recaptured a second time post-MRH release. Though the study continued for four additional months, no MRH smolts were captured beyond four weeks after MRH release.

Currently, MRH releases HOR steelhead smolts in mid-March during high, turbid stream flows and this, in combination with little migration overlap, further minimizes potential adverse impacts by HOR steelhead on NOR Chinook salmon, coho salmon, and steelhead. MRH has also reduced the number and size of NOR x HOR steelhead smolts released, reducing potential negative impacts upon naturally produced juveniles.

Predators on salmonids generally prey upon fish 33% or less of their length (Beauchamp 1990), although there is evidence that salmonids can prey on fish 50% of their body size. Kelly and Grant (2001) reported that the mean prey size for 100 to 200-millimeter (3.9 to 7.9 inch) salmonids was 13-15% of their total body length.

The relative abundance and observed size of MRH HOR releases and NOR salmon and steelhead were reported by Sparkman (2002b) (Table 10) for a downstream migrant trap study in spring 2001. Sparkman (2002b) also reported the average size of MRH HOR smolts in 2001 equaled 205 mm (FL, n = 958) while performing a fin clip quality assessment within MRH rearing raceways. The average size of HOR smolts released in recent years is expected to be less than previously reported due to changes in juvenile rearing (> fish/lb).

Table 10. Average fork length for DSM trapped juvenile salmonids in Mad River, 2001

Year Class	Number	Fork Length (mm)
		Average
Steelhead		
Hatchery	27	231.3
0+ Natural	1,224	41.4
1+ Natural	726	84.3
2+ Natural	900	167.4
Chinook salmon		
0+ Natural	3,014	52.1

1+ Natural	856	79.6
Coho salmon		
0+ Natural	344	45.8
1+ Natural	51	94.0

Source: Sparkman 2002b

Environmental conditions within the main river channel, from the point of release to the ocean, influence the occurrence and biological significance of predation and competition between hatchery yearlings and juvenile ESA-listed salmonids. Suspended sediments in large concentrations can disrupt normal feeding behavior and efficiency, reduce growth rates, and reduce dissolved oxygen content (NMFS 2008). For example, Gregory and Levings (1998) reported that predation of young-of-year juvenile salmonids by piscivorous fish was reduced in turbid water compared to clear water, and Redding et al. (1997) reported that yearling coho salmon and steelhead trout experienced reduced feeding rates under high concentrations of suspended solids. In some cases turbidity can disperse fish into less suitable habitat and increase competition and predation (NMFS 2008). In other cases the opposite was found to be true (Gregory 1993, Ginetz and Larkin 1997).

HBMWD (2004) reported that turbidity in the Mad River was 5 to 50 times greater than comparably-sized streams within the United States. Tetra Tech (2007) reported that Mad River remains muddy for long periods and routinely exceeds turbidity threshold levels. These conditions are typical for the Mad River at the time of HOR smolt release. Turbid conditions correlate to flow or stage height, which serves as a gross indicator of the water quality condition. Mad River flow is 2,810 cubic feet per second, on average[1] and turbid in March, when MRH releases its yearling production.

California Coastal Chinook salmon ESU

Age 0+ (Ocean-type: Fry, Juveniles, and Smolts) and 1+ (Stream-type)

Chinook Salmon within the Mad River exhibit four different juvenile life history strategies based upon age, size, and time of downstream migration. Ocean-type Chinook salmon are most common, and migrate downstream as young-of-year in a fry, juvenile, and smolt form. Stream-type Chinook salmon are less common, and migrate downstream at age-1 at a size much larger than ocean-type juveniles (Sparkman 2002b). Most if not all juvenile 1+ Chinook salmon are smolts when migrating downstream (M Sparkman, pers. comm. 2016).

The incubation period of Chinook Salmon in spawning redds ranges from three to five months, depending on water temperature and the redd environment. Fry emerge from gravel and reside in shallow, slow-moving waters (Sparkman 2004, Moyle 1976), and begin to feed on small terrestrial and aquatic invertebrates and aquatic crustaceans (NMFS 2005). Some emergent fry migrate downstream

[1] The average flow for March is based on data from USGS Mad River Station near Arcata, CA (Appendix 5).

immediately after emergence from redds and disperse into other freshwater areas or the estuary. At a length of 50-75 mm, juvenile Chinook salmon move into deeper swifter water, but continue to use cover to minimize the risk of predation and reduce energy expenditure (NMFS 2005). Healy (1991, cited by NMFS (2005)), reported Chinook salmon diet varies by season and geography, but they are opportunistic feeders in any situation. Kjelson et al. (1982) and Healey (1991) cited by NMFS (2005)), reported aquatic insect larvae, adult *Daphnia*, and *Neomysis* are important food items for juvenile Chinook salmon. The protracted spawning season for Chinook Salmon in Mad River extends the duration of the presence of fry, juveniles, and smolts from March through July. Sparkman (2002b), reporting on data collected in 2001, found that peak Chinook salmon population emigration (ocean-type) occurred in May (70% of total).

Although some Chinook Salmon fry are present in the main channel downstream of MRH at the time CDFW releases HOR steelhead smolts into the river (historically late March/April), the majority (95%) of young-of-year Chinook salmon migrated downstream well after the release and downstream migration of MRH HOR steelhead smolts in 2001 (Sparkman, 2002b). Given that MRH now releases HOR steelhead in mid-February to mid-March during high turbid stream flows, predation on Chinook salmon fry by MRH steelhead is considered low. MRH HOR steelhead are not considered a competitor for prey items with Chinook salmon fry to any degree above negligible because fry occupy shallow near shore areas for rearing, consume much smaller prey items than larger HOR steelhead, and HOR steelhead migrate the thirteen mile distance to the ocean in a short time period, within several days (Sparkman, pers. comm. 2014).

Similar to Chinook salmon fry, the migration timing of juvenile and smolt Chinook salmon have little overlap with MRH HOR steelhead releases and downstream migration. Thus, we consider competition by Chinook life history forms for freshwater habitat with MRH steelhead to be negligible to low.

Potential predation upon juvenile and smolt Chinook salmon by HOR steelhead is also considered low to moderate because HOR steelhead are rapidly migrating downstream, and the migration timing overlap is small. In addition, residualism of MRH steelhead in the Mad River is very low. Sparkman (2002b) found that MRH-released steelhead smolts quickly emigrated to the ocean. In that study, of the 225,000 ad-clipped MRH steelhead, 205 individuals were immediately captured in downstream traps after release and given a second identifying mark. Of these captured fish, five fish were recaptured a second time post-MRH release. Though the study continued for four additional months, no MRH smolts were captured beyond four weeks after MRH release.

Stream-type (age-1) Chinook salmon smolts are much larger than ocean-type migrants at time of downstream migration. Sparkman (pers. comm.2014), reported that Chinook salmon smolt migration in 2001 began on April 30th, and peaked on May 13th. Due to little to no migration timing overlap with HOR steelhead smolts, and the relatively large size of Chinook yearling migrants, there is a low risk of competition and predation from HOR steelhead with the stream-type Chinook Salmon smolts.

The tidal prism for the Mad River extends from the mouth upstream to Highway 101 Bridge. The estuarine habitat varies in length[1] and quality due to levee confinement, which eradicated tidal sloughs and backwater rearing habitat (HBMWD 2004). The extent of estuarine carrying capacity and the potential for mixed stock interaction is unknown, but the risk for NOR salmon interaction with HOR steelhead smolts in tidewater is assumed low.

Southern Oregon/Northern California Coast Coho salmon ESU

Fry

In most streams within the SONCC, incubation occurs between November and April and gestation may take 38-48 days depending on temperature (Shapovalov and Taft 1954). More recently, Sparkman (2004) found that coho salmon first emerged from natural redds from 74 to 91d (or 682 – 752 temperature units) since redd formation. Sparkman (2004) also reported that the period of emergence from natural redds can range from 3 to 57 d after first emergence. Egg survival is 15-27% in average conditions (Neave 1949), but can be 65-85% in optimal environments (Shapovalov and Taft 1954). Briggs (1953) and Koski (1966) reported average egg survival to range from 27.1 to 74.3%. The time between hatching and fry emergence from natural redds is dependent on physical conditions within the redd (temperature, gravel composition, gravel permeability, fine sediment concentrations, and dissolved oxygen content).

Coho salmon alevins emerge from the gravel after yolk sac absorption (Sparkman 2004) and occupy shallow gravel areas near stream edges. Due to differences in habitat use by fry (stream margin areas) and HOR steelhead (deeper water), there is a negligible impact from competition for habitat on coho fry by HOR steelhead.

Similar to ocean-type Chinook salmon, some post-emergent fry will migrate downstream immediately after redd emergence (Sparkman 2002b, 2004). Peak emergence may occur between March and May (Shapovalov and Taft 1954). Within the Redwood Creek basin, which is just north of the Mad River, peak emergence from coho salmon redds occurred in May (Sparkman 2004).

Coho salmon fry (38-45 mm) can migrate a considerable distance in search of rearing habitat (NMFS 2005). Sparkman (2002b) reported that relatively small numbers of coho salmon fry were captured from April 16 – May 12, 2001 in the Mad River, thus there was little temporal overlap in downstream migration with HOR steelhead.

The early diet of emergent fry includes chironomid larvae and pupae (Mundie 1969; cited by NMFS 2005). Juvenile coho salmon are opportunistic feeders that primarily eat terrestrial and aquatic insects, but not stationary items on the stream bottom (Mundie 1969 and Sandercock 1991 as cited by NMFS 2005). Competition of HOR steelhead smolts and young-of-year coho salmon for prey base is

[1] The Mad River estuary expanded along the coastal bluffs from 1975 through 1997, but receded in 1998.

considered negligible because HOR smolts feed upon much larger prey items and do not occupy shallow, near shore areas. Additionally, the rapid downstream migration and low residualism of HOR steelhead reduces competition for prey items and limits the potential for predation upon coho salmon fry.

Fingerling (parr) Coho Salmon move upstream and downstream as they grow to locate and defend rearing habitat (Hassler 1987). Shapovalov and Taft (1954) report that coho salmon move to deep, quiet pools in late summer, while steelhead prefer swifter currents. In spring, Coho Salmon are more abundant in backwaters of small, low gradient streams. Juvenile Coho Salmon prefer to over-winter in large mainstem pools, backwater areas and secondary pools with large wood logs or root wads or undercut banks. HBMWD (2004) reported the overall quality and availability of rearing habitat in the mainstem Mad River is poor or lacking entirely and that the tributaries provide the primary spawning and rearing area for coho salmon. Although Coho Salmon generally require complex microhabitat, Halligan (2003; as cited by NMFS (2005) reported that juveniles successfully found and inhabited isolated cold water seeps in pools with overhanging vegetative cover in the main river channel (RM 6.6 to RM 14) during the summer of 2002. Competition for habitat between coho parr and HOR steelhead is negligible because HOR steelhead are rapidly moving downstream to the ocean and little stream residualism occurs (Sparkman 2002b). Caltrans (2008) reported the presence of 600 sub-yearling coho salmon during June and July, but only 49 individuals in September, within a fixed 3,280-foot mainstem survey area at the Highway 101 Bridge. Sparkman (2002b) reported that Coho Salmon parr were captured in small numbers in the Mad River moving downstream from April 19 – July 4, 2001, indicating little migration timing overlap with HOR steelhead.

Smolt

Moyle (2002) reported that newly emerged juveniles could migrate into the estuary and rear in marine intertidal areas, but Weitkamp et al. (1995) reported that Coho Salmon generally rear in freshwater for 15 months before migrating to sea in March and June. In some instances where growth is slow, Coho Salmon may reside in freshwater for a second year before moving into the ocean (Bell and Duffy 2007). Nickelson et al. (1992) assumed Coho Salmon spent only a brief time in tidal zones before entering the ocean, although McMahon and Holtby (1992) and Myer and Horton (1982) reported that Coho Salmon smolts remain in the estuary for about two months. In some riverine systems, Coho Salmon rear in the estuary over summer and return upstream to overwinter (Miller and Sadro 2003.) CDFW studies in the tidal portion of Humboldt Bay tributaries found that juvenile Coho Salmon exhibited three life history types; 1) sub yearling Coho Salmon move to tidal freshwater habitat during the spring and early summer and rear there for up to eight months; 2) nearly one year old juvenile (pre-smolt) Coho Salmon move into tidal freshwater habitat after the first significant rains and increased stream flows in the late fall or early winter and rear there throughout the winter and into the spring, and; 3) Coho Salmon rearing in stream habitat for ~1.5 years smolt and move quickly through the estuary in the late spring (Wallace and Allen 2012, 2009, 2007; Wallace 2006).

In 2001, Sparkman (2002b) reported migration for age 1+ Coho Salmon in Mad River occurred between April 18 and May 17. Captures in April accounted for 89% of all captures for the season, thus little migration timing overlap between 1+ coho Salmon smolts and HOR steelhead occurred (Sparkman 2002b). Shapovalov and Taft (1954) reported that reduced survival occurs during this period of coho life history. Although interspecific interaction between coho salmon smolts and HOR yearlings is possible in freshwater and in the Mad River estuary, it is not considered biologically significant because: 1) HOR steelhead most likely do not prey upon Coho Salmon smolts to any degree above low to moderate due to the size of Mad River Coho Salmon (mean = 94.0 mm FL; Sparkman 2002b), and 2) HOR are released from MRH prior to March 15 during high turbidity flow events. Releasing HOR yearling steelhead from February 15 through March 15 precedes the peak Coho Salmon smolt emigration and minimizes the risk of predation by the larger HOR fish. Interaction between Coho Salmon smolts and HOR steelhead in the estuary is considered low to moderate, but no data exists to confirm.

Northern California Steelhead DPS

Steelhead life history strategy is influenced by the time of river entry, among other factors. Summer-run enter freshwater streams between April and October as immature adults (Busby et al. 1996) prior to spawning in January and February (Barnhart 1986). Winter-run steelhead enter streams between November and April with well-developed gonads (Busby et al. 1996) and initiate spawning soon after entering fresh water (Barnhart 1986). In addition to the normal one year or more ocean residency exhibited by both summer and winter steelhead, steelhead called “half-pounders” (Snyder 1925) return at a smaller size after 2 to 4 months in the ocean (Barnhart 1986). Mad River supports all three life histories.

Steelhead generally spawn in tributaries with 3-5% gradient, build redds in riffle or pool tail-outs with an average depth of 0.18 meter (0.59 ft.) and an average velocity of 2.44 meter/second. Fecundity is approximately 2,000 eggs per kilogram of body weight. After spawning, most steelhead die or return to saltwater. Steelhead eggs hatch in 60 to 90 days, depending upon water temperature (Leitritz 1959). Subsequently, yolk-sac fry and alevins gradually work their way to the surface, and emerge from redd gravels as emergent fry. Fry inhabit shallow stream edges, usually in riffle, pool, and glide areas, unlike HOR steelhead that use relatively deeper waters for migration.

Fingerling NOR steelhead move into run and deep pool habitat and eat increasingly larger food as they grow (Shapovalov and Taft 1954). The diet of juvenile NOR steelhead varies, but includes aquatic and terrestrial insects (Chapman and Bjorn 1969; cited by NMFS 2005) and fry as they grow larger (NMFS 2005). Since HOR steelhead quickly move downstream after release, there is a low probability that HOR steelhead compete for prey and habitat with NOR steelhead fry. Therefore, negligible predation upon NOR steelhead fry by HOR steelhead is indicated.

Productive steelhead habitat is characteristically comprised of complex pools associated with large wood and boulders. Juvenile steelhead hold territories close to flow shear zones where they can make a quick dash to capture drifting food items. Sparkman (2002b) observed age 0+ trout in Mad River on April 1, the day following placement of a downstream migrant trap. The same study indicated that age 0+ steelhead captures in April and May accounted for 28.8 %, and 55.5 % of the total steelhead catch, respectively. Similar to other juvenile species at age, Sparkman (2002b) found minor migration timing overlap of HOR steelhead with NOR steelhead fry.

Juvenile

Juvenile steelhead occupy a wide range of stream depths and velocities, but they prefer habitat that provides food, refuge from flow, and shelter from predators. Moyle (2002) reported that predators affect microhabitat selection by rainbow trout. Older fish establish and defend territories and feed on a variety of aquatic insects, as well as emerging fry (NMFS 2005). Sparkman (2002b) concluded that specific microhabitat partitioning by steelhead life stage indicates a low rate of competition in Mad River below the hatchery. Keeley and McPhail (1998) reported a similar intraspecific relationship between HOR and NOR. Hill et al. (2006) also reported HOR fish had no detectable effect on habitat use by NOR steelhead juveniles.

Smolt

Juvenile salmonids change physiologically into smolts and generally enter the ocean at a size of 15-20 centimeters (Meehan and Bjorn 1991). Busby et al. (1996) reported that NOR juveniles generally spend 2 years in fresh water before they enter the estuary and ocean and begin feeding on estuarine invertebrates, krill and eventually small fish. Smolt migration is physiologically controlled, but it can correspond to environmental factors such as periods of increased flows.

Sparkman (2002b) reported age 1+ and 2+ steelhead caught in downstream migrant traps in Mad River peaked in May and June, and April and May, respectively. He also reported that a minor temporal overlap existed between HOR yearling and NOR age 2+ steelhead, but indicated the two groups were separated by instream position and differences in migration behavior. He also indicated that HOR steelhead demonstrated a low rate of residualism. Barnhart (1986) reported that HOR steelhead yearlings inhabit the project area from the time of release until they smolt and migrate to the ocean in March and April. But Sparkman (2002b) concluded that yearling hatchery steelhead emigrate rapidly, which reduced the potential for interaction with NOR salmon and steelhead juveniles. The risk to smolts in freshwater is generally similar to the fingerling life stage, and considered low in most cases, and low to moderate and negligible to low in other cases. The level of competition between hatchery yearlings and wild steelhead smolts in the estuary is unknown.

In summary, we think that the MRH smolt release stradegy minimizes interactions, and should not be changed.

Summary of risk potential for ESA-listed juveniles

HOR steelhead pose a low risk potential for ESA-listed juvenile species because:

1) HOR steelhead have minor migration timing overlap with NOR juveniles;

2) HOR steelhead rapidly move downstream after release from MRH;

3) MRH now releases HOR steelhead during high, turbid flows from mid-February – mid March, which further decreases the likelihood of interactions with NOR fish;

4) The occurrence of residualism for MRH HOR steelhead is low;

5) The number of HOR steelhead produced and released into the Mad River is much less compared to previous years; but,

6). Competition from the progeny of naturally spawning HOR steelhead is unknown. A collateral consequence of this program is large numbers of HOR steelhead may spawn naturally and competition between the progeny of these hatchery natural spawners and natural-origin natural spawners must be taken into account. However, if they are genetically similar the consequence of competition may not be as important as genetically dissimilar groups. The MRH HGMP strives to cause convergence in the genetics of HOR and NOR to reduce negative interactions such as these.

The relative risk exposure and take of each ESA-listed salmonid based on expected presence of each life stage with hatchery operation and release of HOR yearling steelhead is summarized in Table 11.

Table 11. Ecological risk exposure for ESA-listed salmonids by life stage from the MRH steelhead program

Species/ Life Stage	Period of Influence	Hatchery/ Spawning Operations	Ecological Interaction				
			Competition for Prey base		Competition for Habitat		Predation
			Freshwater	Estuary	Freshwater	Estuary	Freshwater Habitat
CHINOOK							
Eggs	Oct - January				Negligible (P,S,L/H)		
Fry	March - mid May		Negligible (P,S,L/H)		Negligible (P,S,L/H)		Low (P,S,L/M)
Juveniles	March - June		Negligible- Low (P,S,L/H)		Negligible (P,S,L/H)		Low- Moderate (P,S,L/M)
Smolts	April - July		Negligible -Low (P,S,L/H)	Low (P,L/U)	Low (P,S,L/M)	Moderate (L/U)	Low (P,S,L/M)
Spawning	Sept - January	Negligible (S/H)			Low (P,L/M)		
COHO							
Eggs	Nov- April				Negligible – Low (L/L)		
Fry	April - May		Negligible (P,S,L/H)		Negligible (P,S,L/H)		Negligible- Low (P,S,L/M)
Juveniles	All year		Negligible-Low (P,S/M)		Low (P,S,L/M)		Low- Moderate (P,S,L/M)
Smolts	April - June		Low-Moderate (P,L/M)	Low (P,L/U)	Low- Moderate (P, S,L/M)	Moderate (L/U)	Low- Moderate (P,L,S/M)
Spawning	Nov- February	Negligible (S/H)			Low- Moderate (P,L/L)		
STEELHEAD							
Eggs	Decembe r - June				Negligible- Low (P,S/H)		
Fry	Late Feb. - June		Negligible(P,S,L/H)		Negligible (P,S,L/H)		Negligible- Low (P,S,L/H)
Juveniles	All Year		Low (P,S/M)		Low (P,S/H)		Low- Moderate (P,S/H)
Smolts	Late March - August		Low-Moderate (P,S/H)	Low (L/U)	Low (P,S/H)	Moderate (L/U)	Negligible- Low (P,S/H)
Spawning	August - April	$\leq$ 60 NOR adults			Low* (P,S/H)		
( ) indicates source of data supporting impact assessment i.e., Literature (L), Steelhead Monitoring study specific to Mad River (S), Professional opinion (P) and an indication of confidence of assessment, High (H), Moderate (M), Low (L), Unknown (U)							

* Hatchery straying is greater in waters closer to MRH; Life stage occurrence was derived from Humboldt Bay Municipal Water District HCP, Appendix B (HBMWD 2004)

Adverse effects of hatchery strays on adult ESA-listed species

Spence et al. (2008) determined that the number (and/or proportion) of HOR steelhead that spawn on natural spawning areas and their effective contribution to the reproductive output are critical risk factors for hatchery programs. In 2001, HOR steelhead made up approximately 88% (15,745) of the steelhead population (N = 17,164) in Mad River (Zuspan and Sparkman 2002) however, the HOR estimate was possibly biased high because most sampling took place near the hatchery. As part of the 1998 *Strategic Plan for Management of NC Steelhead*, CDFW constructed and monitored counting weirs on Cañon Creek (RM 17) during the 1999/2000 and 2000/2001 seasons. CDFW estimated that 63% (39/62) and 62% (18/29), respectively, of the steelhead trapped in Cañon Creek were HOR. In 1999/2000, CDFW also monitored a counting weir 27 miles upstream of the hatchery and determined that 25% (2/8) of all steelhead captured were HO (Zuspan and Sparkman 2002). More recently, Sparkman (pers. comm. 2016) estimated that in 2013/14, 56% of the returning winter-run steelhead (counted using sonar) in the lower MR were HOR fish. Given that harvest of HOR occurs, this percentage would be lower as the HOR fish are subjected to harvest as they move upstream.

HOR adult spawners are common in Mad River, particularly in areas nearby MRH, and their abundance presents a higher likelihood for spawning habitat competition, redd superimposition, and interbreeding with NOR steelhead. The 2001 steelhead population structure estimated by Zuspan and Sparkman (2002) was the result of MRH releasing 250,000 yearlings. An action in this HGMP continues the reduction of the steelhead production goal, implemented in 2009, to 150,000 yearlings, or 60% of historic production levels to reduce straying and HOR/NOR adult interaction.

Genetic Hazards

Garza et al. (2004) reports that geographic distance explains 20% of genetic variation among steelhead samples taken from 41 basins throughout California. This indicates geographically neighboring populations are more similar than geographically distant ones; therefore, when natural in-river stocks are not available, it is preferable to develop hatchery programs with nearby stocks to avoid outbreeding depression. However, even hatcheries started with endemic broodstock have an inherent risk of altering the genetic composition of cultured fish (relative to their NOR counterparts) as well as reducing fitness and productivity of the natural stock if the HOR stock stray over a wide geographic range (CDFW/NMFS 2001, Lynch 2001, Campton 2009). Decreasing natural selection or stream factors that govern fitness may result when hatcheries propagate fish that are not subjected to the rigors of the natural environment. Hatchery fish are subjected to a different selective environment than those living in the natural environment. Hatchery fish straying can negatively affect natural populations when the two groups interbreed. Spence et al. (2008) reported risk from change of genetic composition and altered phenotypic characteristics (e.g., size of mature adults, smolt age, size and emigration timing, fecundity, egg size) of the integrated population over time. The ISAB (2002) reported that empirical evidence demonstrates a potential for adverse effects from HOR steelhead spawning in the wild, but offered no estimate of the level at which interbreeding is no longer risk-free.

From 1971 through 1973, MRH used South Fork Eel River steelhead broodstock to initiate the steelhead program, and in 1972 began incorporating Mad River natural stocks (Table 16). Genetic information indicates that the import of Eel River steelhead broodstock altered the population structure in the Mad River (Appendix 4); i.e., the markers for the original broodstock are evident in NOR steelhead (Goode et al. 2005, Spence et al. 2008). MRH also planted 36,960 at 2,240/lb. steelhead fry from imported eggs from Russian River (Dry Creek) within the same DPS in 1984 and 19,958 yearlings at a size of 3.4 fpp in 1985. However, it is unlikely that the small number of fry and yearlings planted were sufficient to have a lasting effect on the steelhead population structure in Mad River. Spence et al. (2008) reported that highly divergent populations are less successful at maintaining population fitness as compared to closely related populations. Spence et al. (2008) also concluded that fish of intermediate divergence are potentially the most damaging because they are more likely to be successful at reproduction and introgression in the recipient basin.

Integration between genetically similar NOR and HOR steelhead can maintain gene flow between stocks and reduce domestication of the hatchery population. MRH can achieve its primary goal to continue to provide a harvest fishery and minimize adverse genetic effects by spawning NOR steelhead into the HOR broodstock. Because of the difficulty in measuring gene flow, fisheries managers generally use a 10-20% rate of integration to prevent divergence, counter domestication selection, and promote relative fitness of hatchery production (HSRG 2004). However, we intend on using a NOR integration rate (or pNOB) of 50 – 100%. ISAB (2003) recommended that conservation hatcheries cross NOR fish with hatchery or captive fish when the natural population is small (Spence et al. 2008).

Fishery managers use straying rates to estimate potential for HOR gene flow into natural stocks. The ISAB (2002) recommended that the decision to allow hatchery spawners to interbreed in the wild should consider conservation goals, genetic characteristics of the natural population and the ability of habitat to support additional reproduction. Brannon (2004) reported that the measure of risk from introgression is dependent on the genetic difference between cultured and natural populations. Spence et al. (2008) reported that the assessment of genetic risk for an Integrated Hatchery Programs requires the following information:

- Estimated number (and proportion) of NOR fish that the hatchery incorporates into the broodstock (pNOB)

- Quantified change of genetic composition of the integrated population over time

- Quantified phenotypic characteristics (size of mature adults, smolt age, size, emigration timing, fecundity, and egg size) of the integrated population over time.

  Based on information needs identified above, this HGMP will:

  - Integrate a goal of greater than 50% NOR fish into the hatchery, with a minimum of 50% and a maximum of 100% intergration. For example, if ony 100 NOR's are collected for breeding, then only 100 spawns will occur (NOR x HOR); continue to use a spawning matrix that provides guidance for spawning HOR and NOR steelhead in proportion to run-timing (which began with the 2008/2009 brood year);
  - Genetically sample all broodstock used for spawning (which began with the 2008/2009 brood year);
  - Analyze broodstock genetic samples, starting in 2013, from backlog samples taken from all broodstock since 2008/09 to quantify the change of genetic composition of the integrated population over time (annual funding secured);
  - Genetically analyze current broodstock samples in near-real-time that avoids crossing closely related individuals or culturing their eggs (starting with the 2013/2014 season with secured funding) if warranted;
  - Analyze broodstock genetic samples at least annually (if funding allows) to determine changes of genetic composition of the integrated population over time; and,
  - Monitor HOR and NOR steelhead return rates using the California Steelhead Fishing Report-Restoration Card (Steelhead Report Card) to evaluate angler catch and effort information, HOR and NOR steelhead ratio, and ascertain the rate of straying for within basin and out of basin stocks. Additional monitoring projects, depending on funding, would estimate where and when HOR and NOR steelhead spawn in the Mad River basin using spawning ground surveys.
  - Monitor HOR and NOR steelhead return rates with the ARIS sonar unit located in the lower Mad River (RM 7) and associated methodology for species composition and run-timing. This method provides the most robust information regarding NOR and HOR returns to the Mad River.

Demographic Risk

An Integrated Hatchery Program can provide a benefit to the conservation of a natural population, but to do so it must maintain a hatchery population that is genetically representative of the NOR stock and comparable in reproductive success (Hess 2012). Analysis of program success requires an estimate of the spawning population size or spawner density, the number and proportion of NOR adults captured for broodstock, and the growth rate (i.e., natural productivity) of both NOR and HOR steelhead.

Lastly, it is also important to assure that the hatchery fishery program does not adversely affect NOR steelhead stocks and cause depensation (Spence et al. 2008).

Ecological Risk

Abundant and widely distributed hatchery straying increases the potential for interaction with NOR salmonids. CDFW/NMFS (2001) reported hatchery-produced adults can compete for redd sites, superimpose on existing redds, reduce diversity, and lower productivity of NOR stocks. Ecological interactions have genetic consequence because they can alter the natural selection process (Waples 1991). In general, steelhead spawning coincides with the latter part of the Chinook and Coho Salmon run timing. Coho salmon and steelhead spawn in similarly sized gravel, but coho salmon generally occupy lower gradient and slower moving streams compared to steelhead (Burnett 2005, Devries and Reiser 2007). A large hatchery population increases the potential for cultured fish to interact and adversely affect naturally spawning Chinook and Coho Salmon.

Most summer-run steelhead hold in deep pools below Deer Creek (RM 53), and some individuals are observed in the lower river each year. The number of summer-run steelhead in the river from the hatchery to tidewater averaged 22 fish and ranged from 2 to 59 for the period of 1996 through 2003 (NMFS (2005). These fish could be the descendants of Washougal River broodstock reared at MRH beginning in 1971 and 1978, or fingerlings planted from the Trinity River Hatchery in 1972 and 1973, or endemic Mad River stock.

It is unknown if a spatial distinction exists between summer-run and winter-run steelhead spawning in Mad River.

There is data indicating run timing entry differences for Mad River winter-run and summer-run steelhead based upon sonar counts in the lower Mad River. By comparison, races in the Rogue River spawn December-March and March-June, respectively. Everest (1973) as cited by Busby (1996) reported that although overlap occurs, peak spawning activity for the two run-types is generally separated by about 60 days. Neave (1949; cited by Busby (1996)) reported that winter-run and summer-run steelhead in the Cowichan River, Vancouver Island, British Columbia were temporally segregated. It is likely that spatial separation exists between spawning summer-run and hatchery-produced fish because the abundance of HO steelhead decreases with distance upstream from MRH. Conversely, the abundance of hatchery strays increases the ecological risk with NOR winter-run steelhead especially in streams close to MRH such as Cañon Creek, which is 4.4 miles upstream from MRH.

Behavior

Sparkman (2002c) implanted four NOR and HOR adult steelhead each with digitally encoded radio tags to investigate migration patterns and habitat use in winter of the 2000/2001 season and monitored the fish over a period of 11 to 87 days. The data indicated that habitat use or migration patterns did not significantly differ. The following year, Sparkman (2003) radio tagged nine NOR and HOR adult steelhead each and monitored them over a period of 12 to 92 days and reported that NOR steelhead traveled approximately 0.8 miles more than their HOR counterparts, although the difference was not significant. He concluded that the tagged adult steelhead, HOR and NOR, exhibited completely random migration patterns on a daily basis, and tendencies for spawning in non-natal tributaries.

Management Hazards

Release

Hatchery-produced and natural salmon and steelhead compete when resources are limited (CDFW/NMFS 2001). Juvenile HOR steelhead released at a size smaller than six inches total length have a greater tendency to remain in fresh water compared to their larger counterparts (Tipping, 1997, Wagner et al. 1963). Releasing larger (<10/pound. > 6 inches) smolts at MRH encourages rapid emigration and entry into the ocean, which reduces mixed stock predation and competition. However, releasing too large of a fish can also result in residualization of some precocious males (Garrison pers. comm. 2002). Sparkman (2002) found that MRH-released steelhead smolts quickly emigrated to the ocean. In that study, of the 225,000 ad-clipped MRH steelhead, 205 individuals were immediately captured in downstream traps after release and given a second identifying mark. Of these captured fish, five fish were recaptured a second time post-MRH release. Though the study continued for four additional months, no MRH smolts were captured beyond four weeks after MRH release.

Marking

This HGMP requires a specified level of accuracy (98-99%) for adipose fin removal of hatchery yearlings prior to release. Inadequately marked HOR production can bias estimates of NOR (unmarked) steelhead and conceal declining abundance and productivity of NOR stocks. In addition, marking HOR steelhead is essential to maintaining a properly managed Integrated Hatchery Program. The most recent QA/QC for marked steelhead at the hatchery found that only two fish out of a sample of 2,083 from a population of about 160,000 released in 2013 (0.1%) did not have a proper mark. QA/QC of marked steelhead trout occurs annually prior to release.

Fisheries

Angling regulations prohibit fishing in critical adult summer steelhead holding waters in the reach from Cowan Creek to Deer Creek, and in the months of April and May to protect emigrating smolts. A low-flow fishing closure is in effect to protect all listed adult anadromous salmonids on the Mad River from September 1 through January 31st, and takes effect when the Mad River flow at the Highway 299 Bridge gauging station is below 200 cubic feet per second. This low flow closure can be extended beyond January 1st if necessary. Sparkman (2002) estimated anglers caught 202 Chinook and zero coho salmon in 2001/2002. Similarly, anglers released all NOR steelhead with exception of two adults during the same period (Sparkman 2002). For the one year studied, outreach through education and enforcement of fishing regulations resulted in adequate compliance by anglers on the Mad River, in most cases. The low flow closure and public outreach does help reduce angling impacts upon wild Chinook Salmon, however, complete protection isn't possible. The FMEP will address such issues in detail.

Summary of risk potential for ESA-listed adults

A summary of potential adult interactions between ESA-listed salmonids and HOR steelhead (Table 12) shows that hatchery straying is greater in waters closer to MRH (low overall in basin, moderate near the hatchery). Otherwise, straying has a low-moderate to negligible effect. In summary, mating interactions of hatchery and naturally produced steelhead trout nearby the hatchery is potentially greater than areas further from the hatchery because naturally produced steelhead trout tend to spawn in areas that are not near the hatchery; most naturally produced steelhead trout will migrate past the hatchery to spawn where the incidence of hatchery strays is far less. In addition, the reduction in MRH smolt releases and subsequent reduction in HOR adult returns since the last study (Sparkman 2002), should result in a reduction in pHOS. Recent tissue collections from adult steelhead trout (HOR, NOR) associated with current monitoring in the Mad River, will allow for estimating probability of HORxHOR, HORxNOR, and NORxNOR matings. Furthermore, CDFW may operate a rotary screw trap to capture naturally produced smolts to collect genetic samples for analysis. Such results would provide direct evidence (or lack thereof) of gene flow from HOR to NOR steelhead trout.

Table 12. Potential for adult interaction and competition between ESA-listed salmonids and hatchery strays

ESA-listed Species	Run Timing	Mating Interaction	Spawning Gravel Competition	Redd Superimposition	
				Main River	Tributaries
Chinook	Sept-February	N/A	Negligible	Negligible	Neg. Low
Coho	Oct-February	N/A	Low.	Negligible	Low
Steelhead					
Winter-run	August –April	Low-Mod	Low	Low	Low-Mod
Summer-run	May-October	Negligible	Negligible	Negligible	Neg.- Low

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

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

Busby et al. (1996) and Weitkamp et al. (1995) list factors that influenced the decline of NC steelhead, Chinook and coho salmon populations, respectively along the Pacific coast. Additional status reports for listed species and environmental conditions on the Mad River are available in *Biological Opinions for Aquatic Habitat Conservation Plan and HCPs for Green Diamond Company Commercial Timber*

Operations (NMFS 2007), Humboldt Bay Municipal Water District Operations (NMFS 2005) and Caltrans Highway 101 Bridge improvements (NMFS 2008).

Spence et al. (2008) developed a strategy to assess viability of salmon and steelhead in the North-central California Coast Recovery Domain and concluded that NC steelhead, CC Chinook salmon and SONCC coho salmon are all at an elevated risk of extinction, moderate to high, moderate to high, and moderate risk of extinction, respectively. A synopsis for each species' viability follows:

Steelhead

Although steelhead are widely dispersed throughout the NC DPS (NMFS 2004b, Jackson 2007), NMFS (2003b) attributed a high risk and moderately high risk for the DPS to become endangered within the foreseeable future due to the lack of quantifiable abundance and productivity data, respectively. Spence et al. (2008) also reported a paucity of abundance data for NOR winter-run steelhead. In addition to the lack of abundance information, Busby (1996) considered the lack of understanding regarding genetic heritage of winter-run steelhead at MRH as potentially problematic for the DPS. The best genetic information at that time closely associated allozyme data for NOR and HOR steelhead in Mad River stocks and these stocks collectively with Eel River stocks. Spence et al. (2008) concluded Mad River steelhead are genetically similar to Eel River steelhead due to the transfer of broodstock from the Eel River basin, but stated that no easy way exists to evaluate historic hatchery practices. NMFS' molecular Scientist, John Carlos Garza, and CDFW's Genetic Coordinator, Michael Lacy, were consulted regarding population structure (pers. comm.) They concluded steelhead in South Fork Eel River and Mad River are genetically similar but distinct, based on samples taken for the study in 2001.

> A shift was found in the vicinity of Humboldt Bay, in between the two largest rivers in California's coastal mountains (the Eel and Klamath rivers), but may have been somewhat obscured by the effects of hatchery broodstock transfers. Freshwater Creek, a tributary of Humboldt Bay and the first basin sampled north of the Eel River, had high genetic similarity to populations further to the north, including the Klamath River and the other northernmost basins in California. However, the next basin to the north of Freshwater Creek, the Mad River,clustered with the Eel River, but it is also the site of a steelhead hatchery with a stock that was established using Eel River fish (Bjorkstedt et al. 2005). It is thus likely that this affinity is due to this broodstock transfer, and it is possible that, historically, a genetic shift occurred between the Eel River and Humboldt Bay (Garza 2014).

Boydstun (1977) believed that Mad River and Eel River stocks were already genetically similar before hatchery hybridization occurred due to ongoing natural straying. In addition, it seems unlikely that the native Mad River stock would be genetically eliminated or drastically altered by MRH using less than 1,050 adults (for breeding purposes) over a three year period over 40 years ago.

Steelhead straying is a natural behavior and an adaption that protects against warming trends, changing climates, and localized catastrophes. Several theories about the migration and origin of the species have been postulated (Nielsen 1999, Pearse 2011). Allendorf (1996) discussed the concept that steelhead originated in the Pacific Northwest and expanded southward, which is widely held by researchers today. Current studies by Carlos Garza (pers. comm.) on Central California stocks have estimated that approximately 5% of steelhead from the Nimbus population came (strayed) from the Feather River. He also explained that the species has expanded and contracted in cycles numerous times, genetically diverging and converging over thousands of years.

Spence et al. (2008) concluded that Matthews Dam, at RM 84, hinders the spatial distribution of Mad River steelhead because it restricts access to 36% of historic anadromous stream habitat. However, natural conditions in the middle section of the Mad River had intermittent flow during the summer and early fall between approximately RM 84 and the confluence with Pilot Creek at approximately RM 58 (Mad River Watershed Assessment 2010), and this section may not have provided consistent steelhead rearing habitat (and adult access) during that time period.

Spence et al. (2008) reported there was insufficient information to assess steelhead viability for any of the 41 functionally independent populations of winter-run steelhead in the NC DPS. They estimated the high-risk (depensation) threshold for the Mad River independent steelhead population under existing habitat conditions as 352 adults.

Winter-run escapement estimates by Zuspan and Sparkman (2002) of 1,419 NOR steelhead in Mad River for the 2000/2001 season contrast with the much higher estimate of 11,200 steelhead that represents a population at a low risk of extinction (Spence et al. 2008). In 2013/14, Sparkman (pers. comm. 2016) estimates that the total winter-run equaled 7,785 adults. Zuspan and Sparkman (2002) also reported a much smaller summer-run steelhead population with an estimated average abundance of 250 fish from 1994 through 2002, and showed a 23% rate of decline between those years. These data indicate Mad River summer-run steelhead could reach the critical threshold for depensation. MRH, operating as an Integrated Hatchery Program, could provide source recovery fish in the event of a catastrophic episode that reduces NOR steelhead to below the depensation threshold, but they currently do not plan on any summer-run conservation program.

Coho Salmon

The most productive Coho Salmon streams in the Mad River drainage are low gradient and associated with broad valley reaches below Wilson Creek at RM 40 (CDFW 2002). Lindsay Creek (and select tributaries), approximately three miles below the hatchery, supports the largest population of Coho Salmon in the Mad River basin. Smaller numbers of Coho Salmon occupy, or have occupied, North Fork Mad River, Grassy, Squaw, Mather, Warren, Hall, Noisy, Legit, Kelly, Powers, Sullivan Gulch, Camp Bauer, Dry, Maple, Cañon, Black, Boulder, and Blue Slide Creeks (Garwood 2012). More recently, over 15 adult Coho Salmon were observed in Hall Creek in 2014 (Sparkman, pers. comm. 2014).

Coho Salmon counts in Cañon Creek ranged from zero to 56 from 1963 through 2004 (Pacific Fisheries Management Council (2005). These counts are unreliable due to non-systematic survey methods, sampling periods that exclude high, turbid flows, and surveys did not normally extend through the duration of the coho spawning season. Brown et al. (1991) identified twenty-two historic and/or current coho salmon streams within the Mad River Watershed. CDFW (Garwood 2012) conducted a second independent review using all available historic, as well as current source data, and verified coho salmon historic and current presence in 19 streams originally identified by Brown and Moyle, and three new streams that were not included in Brown and Moyle. Four streams listed by Brown and Moyle could not be substantiated as historic or current coho salmon streams. CDFG field surveys conducted during 2001, 2002, and 2003 determined Coho Salmon presence in 6 of the 14 streams that were able to be surveyed. Population productivity, abundance and trend information are unavailable, but the Mad River coho functionally independent population is considered non-viable by NMFS because adult escapement is thought to be less than the depensation threshold for the species. However, emphircal data supporting this assertion is lacking.

Chinook Salmon

Based on commercial salmon shipping reports in the Arcata *Union*, Ridenhour (1961), as cited by HBMWD (2004), reported that the Mad River produced a historical population of 10,000 Chinook salmon, if not more. The population declined to approximately 5,175 fall-run Chinook salmon by 1958. Additional information on trends are not comparable due to the removal of Sweasey Dam in 1963. Although Chinook Salmon were counted at MRH, these annual counts are poor indicators of population trends due to various diversion mechanisms used to gather broodstock.

Spring-run Chinook salmon are extinct in Mad River (Spence 2008).

CDFW and/or Green Diamond Company biologists conduct annual spawning survey counts on Cañon Creek as an index for population abundances and trends over time. Goode et al. (2005) concluded that adult spawner estimates in Cañon Creek capture gross signals from basin counts and support the hypothesis of a recent positive trend in abundance. Since 1963, the spawning population estimate ranged from zero to 514 adult California Coastal ESU (CC) Chinook salmon (PFMC 2005). Due to the high variability in these counts, short- and long-term trends do not differ significantly from zero, although the trend is positive (Goode et al. 2005). These data do not allow development of population-level estimates of abundance or productivity (Spence et al. 2008). Spence et al. (2008) estimated an independent population abundance for existing available habitat within the entire Mad River of 94 and 3,000 CC Chinook salmon, corresponding to high-risk of extinction (depensation) and low-risk of extinction (viable) thresholds. Spence et al. (2008) also reported that insufficient information existed to assess CC Chinook salmon viability. Spence et al. (2008) and NMFS (2008) do not consider any population within the CC Chinook ESU as viable. However, sonar work in the lower Mad River also enumerates adult CC Chinook returns, and abundance information will become available in the near future. Based upon preliminary counts, the abundance will most likely be greater than 3,000 adults.

The most recent 12 year progeny-to-parent ratios, survival data by life stage, or other measures of productivity for the listed population. Indicate the source of these data

Although data are lacking to completely answer this section, Tables 3 and 4, discussed in section 1.12, offer some data on age composition of returns and smolt to adult return rates. Limited data show at least 80% of the returning steelhead were three year olds. Zuspan and Sparkman (2002) reported a single run size estimate of 1,419 NOR and 15,745 HOR steelhead in Mad River for the 2000/2001 season, however, NOR estimates may be biased low and HOR estimates may be biased high because most sampling (mark/recapture) took place near the hatchery. CDFW also operated a counting weir on Cañon Creek (4.4 miles upstream of the hatchery) during the 1999/2000 and 2000/2001 seasons and estimated that 63% (39/62) and 62% (18/29), respectively, of the steelhead trapped were HOR. In 1999/2000, 25% (2/8) of all steelhead captured in the main stem approximately 27 miles upstream of the hatchery, were HOR (Zuspan and Sparkman 2002). More recently, specie identification methods for DIDSON/ARIS sonar fish counts in the Mad River in 2013/2014 determined HOR comprised 56% of the steelhead population, and NOR comprised 44% of the winter-run steelhead population (Sparkman, pers. com. 2016).

Downstream migrant (screw trap) derived population abundances (Table 13) are available for 2001 and 2002 (Sparkman 2002b, 2003). Estimates of the juvenile population in 2001 and 2002 were 11,455 ± 45% and 14,284 ± 13.0% for yearlings and 63,918 ± 55% and 41,375± 39.6% for age 2+ steelhead. The number of age 2+ steelhead smolts was less in 2002 than 2001, , but the yearlings in 2002 were approximately 1.2 times more abundant than their counterparts in 2001.

Table 13. Number and age of juvenile steelhead caught by DSM (RM 12.5) in the 2001and 2002 seasons

Duration of Study	Number	Age	Population Estimate	
Year			**2001**	**2002**
March 30-July 14	749	1+	11,455 ± 45%[1]	14,284 ± 13.0%
March 20-July 19	1,249	2+	63,918± 55%[1]	41,375 ± 39.6%

[1]Carlson Estimate (Carlson et al. 1988)

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

A 12 year data set for this section is not available. Zuspan and Sparkman (2002) estimated 63% (39/62) and 62% (18/29) of the weir-trapped steelhead in Cañon Creek, which is approximately 4 miles upstream of the hatchery, were HOR during the 1999/2000 and 2000/2001 seasons, respectively. For the same period, 25% (2/8) of all steelhead captured at Big Bend Weir, which is approximately 27 miles upstream of the hatchery, were AD-clipped (Zuspan and Sparkman 2002). This indicates that pHOS declines in relation to upstream distance from MRH. In 2014, preliminary study results (DIDSON with species composition surveys) indicate that total Mad River pHOS may be reduced from historic levels, and was estimated at approximately 0.56. The 56% value would naturally decrease as harvest of HOR adult steelhead trout by anglers occurs. This overall reduction is likely in part due to a permanent reduction in the hatchery allotment from historic levels, and also from the biases associated with methods used in the early 2000's. CDFW, given adequate funding, is committed to continue DIDSON or ARIS Sonar/species composition studies to improve pHOS/pNOS estimates.

2.2.3 Hatchery activities, including associated monitoring, 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

Traditionally, MRH trapped continuously (7d/wk) and spawned Chinook and/or Coho Salmon as well as steelhead each week. In the 2007/2008 season, MRH trapped continuously, but spawned steelhead every two weeks. The two-week confinement of adult steelhead caused a greater incidence of mortality, in part due to the large number of fish entering the ladder and accumulating in the trap that year. In the 2008/2009 season, MRH trapped, sorted, and spawned again at weekly intervals. Prior to the 2008/2009 season, MRH retrofitted the bottom of the fish ladder with a gated screen to regulate the total number of fish trapped and keep HOR steelhead in the river longer to provide a greater opportunity for angler harvest. Mad River Hatchery annual reports document the number of ESA-listed salmon and steelhead that enter the fish ladder each year (Table 7). During the last nine seasons (through 2012/2013), only one salmon or less, entered the hatchery on an annual basis. The number of NOR steelhead entering MRH each year over the last nine seasons was 15, 19, 12, 1, 2, 5, 70, 133, and 21 adults. A small volume of surface flow (~1% of the total flow down the ladder) of Mad River water (pumped to a garden hose at the top of the ladder) was added to the fish ladder beginning in the 2010/2011 season and continues to the present. That surface flow is thought to have improved the attraction of NOR steelhead to MRH.

Alternative Broodstock Procurement Methods

The unpredictable number of NOR steelhead entering the ladder at MRH poses the greatest risk for failure of the hatchery to meet HGMP goals for HOR/NOR integration. To meet the targets for increasing levels of integration over the lifespan of this project, CDFW may need to employ alternative measures to collect natural broodstock, e.g.seining in the main stem, adult weirs, etc. (See Table 7.)

Monitoring

Monitoring activities proposed by this plan will adhere to annual take limits authorized by NMFS to conduct scientific research and monitoring for Chinook, Coho Salmon, and Steelhead Trout pursuant to the ESA 4(d) Rule. The DIDSON/ARIS escapement study has a separate 4(d) take authorization that is renewed on an annual basis. For specific monitoring evaluation see Table 22.

Fisheries

HRSG (2004) reported that hatchery programs could affect NOR stocks. Goode et al. (2005) concluded that since the original NMFS steelhead status review (Busby et al.1996), changes in fishing regulations to require the immediate release of unmarked steelhead probably reduced the extinction risk in the NC steelhead DPS. Anglers must comply with those regulations, but catch and release fisheries incur incidental hooking mortality. CDFW estimated HOR and NOR steelhead population levels and the number of fish caught by Mad River anglers in the 2000/2001 season. Based on hooking mortality values of 2.9 percent as reported by Hooten (1987, 1991), anglers incidentally killed an estimated 41 NOR steelhead out of 1,409 NOR caught and released in the 2000/2001 season. For the same period, Sparkman (2002) reported anglers caught and released 202 Chinook and zero coho salmon in Mad River. As mentioned earlier in text, CDFW will develop an FMEP for the Mad River.

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

Mad River Hatchery's annual reports document the number of ESA-listed salmon and steelhead that enter the fish ladder each year (Table 7).

From NMFS web site: http://www.nmfs.noaa.gov/pr/glossary.htm

"**Take:** Defined ***under the MMPA*** as "harass, hunt, capture, kill or collect, or attempt to harass, hunt, capture, kill or collect." Defined ***under the ESA*** as "to harass, harm*, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct."

* Definition of harm (from 64 FR 60727, no. 215 November 8, 1999) includes "Releasing non-indigenous or artificially propagated species into a listed species' habitat or where they may access the habitat of listed species".

Therefore, records for “take” of NC steelhead and other listed species in MRH, other than the number entering the fish ladder and trap, were not kept, so no data exist. The pages in Section 14.0 “Estimated Listed Salmonid Take Levels by Hatchery Activity” are based on Tables 6 and 7 for the past twenty years. Zero salmon entered the MRH trap most of the years between 2004 and the present, and the three that entered the trap since 2004 were returned to the river unharmed (Bairrington pers. comm.).

The 1999 BY HOR steelhead were the first to be marked with an adipose fin clip to distinguish HOR from NOR at MRH. The number of NOR steelhead that returned to MRH since the 2000/2001 season to the present was always less than 250 fish and the number exceeded 100 fish only two years.

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

In the event that procurement methods cause the unintentional mortality of > 25 NOR steelhead in any season, CDFW will notify NMFS within 48 hours describing the circumstances of the mortality and methods to abate additional mortality. Addtionally, records of capture of NOR adults for breeding purposes will be closely monitored over a given season so as not to exceed the maximum allotment of 250 individuals.

Section 3.0 Relationship of Program to Other Management Objectives

3.1 Alignment of the hatchery program with any ESU-wide hatchery plan or other regionally accepted policies, and explanation of proposed deviation from the plan or policies

This HGMP conforms to the 1998 *Strategic Plan for Management of Northern California Steelhead* and provisions of the Joint Hatchery Review Committee (CDFW/NOAA 2001), which codified a collaborative effort between state and federal co-managing resource agencies to conserve steelhead. This HGMP also compliments the Steelhead Restoration and Management Plan for California (McEwan and Jackson 1996).

We are currently reviewing the CSHRG 2012 report (which was written for other hatcheries) for areas that MRH can incorporate recommendations for improved operations. We return HOR adults (spawned or unspawned) back to the river after they are trapped from the fish ladder and processed in the spawning facility each week for two reasons: 1) we don’t want to lose the low frequency iteroparity (repeat spawning) gene in steelhead; and 2) the hatchery’s first mission is to enhance the fishery giving the anglers an opportunity for harvest. To achieve appropriate PNI target we may cease to recycle or release HOR steelhead that returned to the hatchery. The PNI target should also increase when HOR steelhead are removed from the river via the fishery by correcting pHOS gathered from sonar counts. In other words, if we subtract the HOR’s that are removed from the river, then pHOS will decrease, and if pHOS decreases, then PNI will increase. Associated with reducing interactions of HOR with NOR in the natural environment, is the possibility of stripping the HOR females of eggs and the HOR males of milt and then release them back to the river. However, at this time funds are not available, and the likelihood of removing all milt from males is very low, if not impossible. Holding males until after the spawning period is also not feasible at MRH facilities for a variety of reasons (costs, high mortality, public perception, etc.). This monitoring data would enable a review of this aspect of the process of hatchery spawning when the HGMP is evaluated in its review cycle.

3.2 Existing cooperative agreements, memoranda of understanding, memoranda of agreement, or other management plans or court orders under which program operates

MOA between State of California and National Marine Fisheries Service

California Steelhead Restoration and Management Plan

California Strategic Plan for Steelhead Trout

Department of Fish and Wildlife Operations Manual

3.3 Relationship to harvest objectives

The fishing season on the Mad River extends from the last Saturday in May through March 31, but many anadromous waters, including the Mad River, close during periods of low flow to protect migrating adult salmon and steelhead. In the Mad River this low flow closure extends from September 1 through January 31, and in some cases (drought) may be extended into later months. Fishing regulations prohibit angling during April and most of May to protect smolts during their migration to the ocean. Anglers must use artificial lures from the last Saturday in May through September, and barbless hooks are required all year. Mad River anglers may only keep HOR steelhead that are identified by a missing adipose fin and a healed scar in the location of the missing fin. Current angling regulations allow a harvest of two HOR steelhead per day and four HOR steelhead in possession. NMFS has encouraged CDFW to consider a regulation against the return of landed HOR steelhead to the stream, or alternatively, increased angler education that encourages anglers to retain HOR steelhead and not release them back into the stream to potentially spawn naturally. CDFW proposed new angling regulations in 2009 to liberalize bag and possession limits to encourage anglers to harvest HOR steelhead. Although the bag limit may be raised to 4 HOR’s per day to reduce pHOS and increase the PNI index, it is unlikely that CDFW will mandate retention of all HOR fish caught by anglers. Anglers must immediately release all NOR salmonids.

The presence of HOR fish in Mad River induces a higher level of angler effort, increasing the incidental catch of NOR steelhead. Steelhead Report Card data (annual average) for the years for 2003-2005 indicate that the total number of HOR steelhead kept or released per year was almost 2,200 fish. The average annual reported number of NOR steelhead released in the Mad River was 257, with 3.5%

of the total number caught being reported as kept. Incidental mortality by anglers that target HOR fish was not considered high enough to warrant a determination of significant impact (Barnhart 1989). However, NMFS (2005) reported that recreational fisheries could affect natural stock viability under some circumstances, such as drought, when habitat is impaired or refugia are decreased. During drought conditions, CDFW may increase the low flow closure season beyond January 31st. Angling regulations are reviewed annually to assure maximum protection to NOR stocks is achieved, while allowing reasonable use of Mad River fisheries.

Concurrently with this HGMP development, the Department of Fish and Wildlife is developing a Fisheries Management Evaluation Plan (FMEP) for Winter-run Steelhead in the Northern California Distinct Population Segment. The FMEP is a completely different regulatory document compared to the HGMP which is essentially a permiting document for the hatchery. There are areas of overlap, but the purpose of the FMEP is to evaluate the effectiveness of management that is designed to reduce negative impacts to listed fish recovery from angling for other species or non-listed fish. CDFW is committed to completing a draft of this document for NMFS review a year after the approval of the HGMP. This FMEP will address potential impacts from MRH and the angling public upon listed fishes with the MR basin. This should include all threatened and endangered species, including an examination of Mad River estuarine species.

In the FMEP there will be a discussion of the Sport Fishing Regulations and proposed regulation changes aimed at protecting listed fish. The following includes examples of the discussion points:

1. We have discussed increasing the daily bag limit on hatchery steelhead, however a limiting/constraining factor is incidental bycatch of listed fish and a very small percentage of latent mortality associated with catching them. Additionally, an increased bag limit may evetually lead to illegal commercial harvest activites when anglers possess more fish than they will eat.

2. Results from genetic monitoring may cause a trigger for changes such as an increased bag limit proposal for regulation changes. Current direction from CDFW Fisheries Branch Chief is against “boutique” regulations unique to a specific river, and for overall regulation simplification. Additionally, if we increase the hatchery bag limit, then more natural fish would be captured and released. Furthermore, it is against CDFW law to ‘waste fish’ and if an angler didn’t want to eat the captured fish and was forced to keep it, then that angler would break the law regarding wasting fish.

3. By 2017, all 3 year old Mad River Hatchery winter-run steelhead will be NOR x HOR and thereafter many may be NOR x NOR; therefore, according to our previously agreed upon NOR broodstock introgression rates of 50% to 100% the idea of negative impacts from straying hatchery fish should be minimized.

4. The Mad River is a very popular fishing destination for anglers who want to catch and harvest steelhead, so any regulation that forces the angler to keep

their first two hatchery fish and then stop fishing will be unpopular. That may result in fewer steelhead anglers to harvest those hatchery steelhead.

5. Very few anglers want to keep or eat a spawned-out hatchery steelhead; therefore the California Sport Fishing Regulations would also have to be modified to refine terminology for consumption of steelhead versus wasting fish.

3.3.1 Fisheries Benefiting from the Program, and Indicate Harvest Levels and Rates for Program-Origin Fish for the Last Twelve Years

CDFW conducted extensive creel surveys in Mad River during the 1999/2000, 2000/2001 and 2001/2002 seasons, including angler effort, catch per unit effort (catch per hour), total catch, number of NOR steelhead caught and the number of HOR fish harvested (Table 14).

Table 14. Creel survey results for the 1999/2000, 2000/2001 and 2001/2002 seasons in Mad River

Season	Angler Effort (hours)	Catch/Unit of Effort	Catch		Number of Hatchery Steelhead Harvested
			Total	Natural Steelhead[1]	
1999/2000	62,830	0.116	7,288	1,020	2,260
2000/2001	68,944	0.097	6,743	1,409	2,275
2001/2002	88,009	0.205	18,015	1,982	5,486

[1] Caught and released

Creel data for these three seasons indicate steelhead catch per hour (C/H) is relatively high (0.10 – 0.21 C/H). In comparison, during the 1974/1975 season, prior to hatchery production, anglers fished a total of 59,923 hours and caught 1,323 steelhead (0.02 C/H). Sparkman (2002a) reported catch rates for the 2000/2001 season in Mad, Smith and Trinity rivers were 0.21, 0.07 and 0.09 C/H, respectively. The availability of HOR fish contribute to a superior catch rate, which is the primary reason anglers statewide frequent Mad River.

The best months to fish for HOR steelhead are January and February, but environmental conditions have a significant influence on fishing opportunity and catch rate. For example, Boydstun (1974) reported that the Mad River is not fishable when turbidity is 30 Jackson Turbidity Units or more because salmonids are sight feeders and do not feed during high (turbid) flow events. During times of high flow and elevated suspended sediment and organic matter, which muddies Mad River to visibilities of less than 0.5 feet, most anglers stop fishing until water clarity improves.

CDFW initiated a voluntary Steelhead Fishing Report and Restoration Card (Steelhead Report Card) in 1993, but in 2002 state law mandated that anglers return the Steelhead Report Card to CDFW. The Steelhead Report Card provides potentially valuable information, allowing evaluation and management of steelhead resources in individual streams in California. Card data revealed that for the period of 1993 through 1998, Mad River steelhead anglers made up 8.3% of all statewide use. Mad River anglers made 1,244 annual fishing trips and caught 257 NOR and 6,970 HOR steelhead, on average. Steelhead Report Card data also indicates that steelhead catch in Mad River is considerably higher than other north coast streams.

Recent report card data for the period 1999-2005 indicates a lower average total catch of HOR and NOR steelhead in the Mad River as compared with previous CDFW creel surveys and past report card data. However, the Mad River ranks near the top of California's successful steelhead fisheries (Table 1).

There have been improvements to the Steelhead Report Card. Previously, some steelhead anglers did not report accurately or at all at the end of the year. Currently, the Report Card Sport Fishing regulation has been changed to: 1) require filling out initial fields in the card for the day before starting fishing; 2) adding new fishing location codes; and 3) requiring the card to be turned in at the end of the calendar year or face penalties. These changes should improve accuracy, and minimize bias. Efforts are underway to speed up the Report Card data processing to provide information on more of a "real" time basis.

3.4 Relationship to habitat protection and recovery strategies

NMFS developed theoretical historic population structures for listed species in the North-Central Coast Recovery Domain (Spence et al. 2008). The Mad River included a functionally independent summer-run and winter-run steelhead population in both the Northern Coastal and North Mountain Interior diversity strata. There are no data to support the viability of steelhead in Mad River by stock, race, or strata. However, due to the initial import of Eel River broodstock for the steelhead program the first three years of the project (43+ years ago) and planting of hatchery-produced fry in the headwaters, the strata in Mad River are improbable distinct reproductive units. Further investigation is warranted.

NMFS molecular scientists and CDFW biologists concur that the hatchery should operate as an Integrated Hatchery Program for the purpose of managing genetic drift within the hatchery population. In addition, an integrated/conservation population maintains the independent steelhead population above the critical (depensation) threshold level.

CDFW administers the Fisheries Restoration Grant Program (FRGP) which supports habitat improvement projects that benefit NOR salmon and steelhead populations in the Mad River basin. FRGP activities include culvert replacement to improve fish passage to open additional stream miles to anadromy, riparian planting to control water temperature and increase natural food items, construction of instream structures for microhabitat improvement, and road stabilization to reduce sediment delivery to the Mad River.

NMFS-approved Habitat Conservation Plans for Humboldt Bay Municipal Water District's water management and Green Diamond Timber Company's industrial operations will likely improve habitat conditions for NOR salmonids in Mad River.

The operation of MRH as an Integrated Hatchery Program compliments the Steelhead Restoration and Management Plan (SRMP) for California (McEwan and

Jackson 1996). The SRMP establishes objectives for restoration of naturally produced stocks using the following management strategies:

1) restore degraded habitat;

2) restore anadromy to historic habitat areas;

3) review angling regulations to assure proper management and harvest rates of NOR and HOR adult and juvenile steelhead;

4) maintain and improve hatchery runs; and

5) develop research to address gaps in steelhead life history, behavior and habitat requirements.

3.5 Ecological interactions

Organisms that could negatively impact the program

Pinnipeds feed at river mouths and probably account for the single greatest mortality of adult steelhead. Sparkman (2000, 2002a) reported bite marks on 8% and 32% of all steelhead observed by creel clerks during the 1999/2000 and 2001/2002 seasons, respectively. However, more recently (2014 – 2016), the prevalence of bite marks on adults held in MRH's fish trap appear much higher (M. Sparkman, pers. comm. 2016). In 2008/2009, river otters were observed chasing steelhead within the fish ladder and fish trap at night. Both HOR and NOR juvenile steelhead are prey for cormorants, mergansers, kingfishers, herons, river otters, garter snakes, as well as many other animals.

Organisms that Could Be Negatively Impacted by the Program

There is no anticipated negative impact by the program on species like green sturgeon, Pacific eulachon, or longfin smelt.

The MRH steelhead program could affect natural salmonids in the following ways:

- Intra- and interspecific competition for food and rearing habitat
- Intra- and interspecific predation
- Disease transfer between HOR and NOR stock(s)
- Influencing outmigration behavior of natural populations
- Outbreeding depression and loss of diversity of NOR steelhead
- Angler harvest (direct illegal take and hooking mortality)

Organisms That Could Positively Impact Program

HOR fish provide food for birds of prey, such as osprey, bald eagle, kingfisher and cormorant, and mammals. Zuspan and Sparkman (2002) reported that seals inflicted wounds on 44.4% and 52.6% of HOR and NOR steelhead that were caught in seine nets, respectively. However it is uncertain if HOR fish provide a buffer to predation on NOR steelhead. Human beings are positively impacted by MRH operations, and with their support of MRH operations, positively impact the MRH program.

Section 4.0 Water Source

4.1 Quantitative and narrative description of the water source, water quality profile, and natural limitations to production attributable to the water source

MRH obtains water from a series of eighteen 12-inch (30.5 cm) diameter wells, which are located in the floodplain. The wells range from 38-75 feet (11.6 - 22.9 meters) in depth and each has a flow capacity between 300 and 800 gallons per minute (gpm) or 0.7 - 1.8 cubic foot per second (cfs). Well water is pumped directly into a main sump and then to an aeration tower by a series of three pumps, each with a 4,488 gpm (ten cfs) capacity. Water flows by gravity from the aeration tower through the rearing ponds. The hatchery can divert a portion of the flow at the midpoint of each pond series to a secondary aeration tower, settling basin or directly into the river. A dedicated pipe in the main sump supplies water to a secondary sump adjacent to the hatchery building. One of four available pumps supply water to the hatchery building from the secondary sump via a 55-gallon drum with filter rings. MRH can recycle 84% of the rearing pond water by rerouting up to 17,000 gpm (38 cfs) of raceway effluent through a biological filtration system consisting of eight ponds filled with crushed rock and oyster shells. Ultraviolet light sterilizes the recycled water at the headworks of each raceway. The surplus raceway flow discharges into a settling basin and percolates through the gravel back into the floodplain.

The Regional Water Quality Control Boards (RWQCB) are established to protect the quality of California's surface and groundwater pursuant to the Porter-Cologne Water Quality Control (Clean Water Act) in 1969 and are overseen by the State Water Resources Control Board. This act allows the RWQCBs to establish waste discharge standards and regulate compliance using National Pollutant Discharge Elimination System (NPDES) permits for discharges of waste to the waters of the state. MRH discharge complies with National Pollutant Discharge Elimination System Permit (NPDES) standards to protect the beneficial uses of the Mad River (Table 15).

Table 15. Standard for Mad River Hatchery effluent discharge

Parameter	Unit	Monthly Average	Maximum
Suspended Solids	mg/l	8	15
Suspended Solids	lb/day	138	259
Settleable Solids	ml/L	0.1	0.2
Hydrogen Ion	pH	$6.5 \leq 8.5$	
Flow	mgd	7.5	--------

The NPDES Permit # CA0006670 mandates continuous flow monitoring at all discharge locations, daily temperature measurements, weekly testing of flow in the fish ladder and spawning house effluent during floor cleaning operations for pH, turbidity, settle-able matter, suspended solids and residue in solution. Other conditions require that hatchery discharge cannot alter the temperature or turbidityof the Mad River. In addition, no more than 10% of critical life stage chronic toxicity bioassay determinations, in any calendar year, can produce statistically significant deleterious effects to test organisms from undiluted effluent exposure.

Points of Discharge:

Fish Ladder (discharge 001) -

Well water conveyed through the raceways supplies flow to the holding ponds and then down the fish ladder into the river. NPDES standards require water flow from the holding ponds to be $\leq$ 1.1 mdg (1.7 cfs) during the period of December 1 through April 1. A small amount of river water is added to the well water to promote NOR adults to enter the hatcher ladder.

Spawning House (discharge 002) -

MRH discharges approximately 0.8 cfs of effluent directly into the Mad River from the spawning house during the period of December 1 through May 15. The discharge consists of water used to temporarily hold broodstock in small tanks, incubate eggs and rinse the floor after spawning. The floor rinse water contains minute amounts of carbon dioxide (CO_2) that fish culturists use to anesthetize steelhead prior to spawning. The amount of CO_2 discharge is so minuscule that dilution in the effluent reduces the concentration to non-detectable levels.

Rearing ponds and settling basin (discharge 003) -

At maximum production, MRH discharges $\leq$ 5.9 mgd (9.12 cfs) from the raceway ponds into a settling basin, which consists of a pair of evaporation/percolation ponds. The percolation ponds filter metabolic waste, feed, algae, silt and detritus from the wastewater as it percolates through the gravel into the river. During the period of May 15 through September 30, wastewater discharge from the hatchery must remain below 1% of the Mad River flow as measured at the USGS Gage No. 111-4810.00 at Highway 299.

Fish release water (discharge 004)-

During fish releases, yearling steelhead swim from MRH raceways into the river. MRH may discharge up to 1.5 mgd of water from the raceways to convey fish directly to the Mad River. This is a single annual event held between March 1st and April 15th.

4.2 Risk aversion measures that will be applied to minimize the likelihood for the take of listed natural fish because of hatchery water withdrawal, screening, or effluent discharge

MRH drafts well water for production purposes, but has the capacity to pump surface water from Mad River as a means to attract broodstock, if sufficient NOR steelhead do not volitionally enter the hatchery to meet program objectives. As per NMFS fish screening criteria, there are no risks to listed species from surface water diversion due to: 1) the small size of the sump-pump (1/2 horsepower), 2) dual intake screening that prevents intake of fry, 3) pumping flow equivalent to a one inch diameter garden hose, and 4) pumping when salmonid fry are not susceptible to impingement or entrainment prior to their emergence from redds. Fry are not susceptible to impingement during July – February in any given year, depending upon time of adult spawing, stream temperatures, and time of downstream migration for fry, among other variables. Similarly, there are no ecological risks from effluent discharge from the hatchery due to rigid standards outlined in the NPDES Permit.

Section 5.0 Facilities

5.1 Broodstock collection facilities (or methods)

MRH uses a small amount of river surface flow to attract adult steelhead into a 17-step modified pool-and-weir configured fish ladder. The ladder leads fish into a trap adjacent to the spawning house. Hatchery personnel gather fish into the spawning house bay with a hydraulically controlled fish screen equipped with a protruding lip that travels along the trap floor. The moving screen crowds and lifts fish up to the access door of the spawning house.

Obtaining the full scope of the run is desirable. However, early in the season, in December, MRH staff would have difficulty holding more than a few green broodstock within the MRH facility, and the river in dry years (drought) doesn’t reach the ladder In dry years, CDFW could try other means of obtaining NOR broodstock (eg beach seining, hook/line). MRH staff also have specific start and stop dates for water use and discharge which must be adhered to. CDFW is looking into the feasibility of opening the ladder during a more ‘wet’ water year in mid-December, however, based upon sonar results in 2013/14, the run timing of NOR and HOR is nearly identical, and few NOR or HOR were present in December.

If sufficient numbers of NOR steelhead cannot be captured in the hatchery ladder, DFW will develop off-site collection locations and methods for this express purpose. DFW proposes three methods to obtain adequate numbers of NOR for breeding at MRH: seining, adult weirs, and hook/line sampling. Although each method has benefits and limitations, we believe we can collect adequate numbers of NOR for breeding purposes (at a 50% integration rate and 125 NOR captures). For the methods to be successful, we intend on using these methods at any location within the Mad River basin where anadromy occurs. Seining is accomplished with a 200’ seine with four to eight staff deployinging the net from the hatchery bank to the far bank and then retrieving it in a “U” shape to sort out any NOR steelhead broodstock. NOR steelhead broodstock, if captured near MRH, would then be netted and carried by a hand net in the water over to the hatchery’s side bank and then lifted up to the hatchery tanker truck (100-500 gallons) for transport to the spawning trap. All other fish would be counted, speciated, and immediately released (SeeTable 7a and 7b for a break-down of expected collection numbers by species and origin). For NOR collection off site of MRH, fish will be placed in adult holding tubes that are designed to safely hold adult fish. CDFW will then call MRH personnel, who would use the hatchery tanker truck to deliver NOR fish to MRH. MRH personnel will also be notified of sampling locations prior to fish collection to facilitate logistics of transporting NOR adults. In the event the NOR population falls below the critical depensation threshold , then CDFW will consult with NOAA and propose a shift of hatchery operations to a Conservation Program.

Another method of collection for NOR broodstock will include using temporary adult weirs in the mainstem of the Mad River and tributaries. Trapping would occur for 2 days before spawning at MRH, and the weirs would be out of the water for 5 out of 7 days. The weirs would be checked continuously 24hrs/day during operation. The weirs use picket fences that have 1 inch spaces between the conduit of the fencing. The weir panels would be held in place with 6 ft fence posts, and tied to the fence posts with baling wire. The weirs would direct fish into a holding box (L = 12 ft, W = 4 ft, H = 5 ft). The livebox also has 1 inch spaces between the conduit pieces. The temporary weir intended for the mainstem would trap only those fish migrating close to the shore, and would not span the Mad River. The DIDSON camera in the Mad River has shown that under high, turbid flows, adult steelhead trout will migrate upstream along the margin of the stream in water as shallow as 2 – 4 ft (Sparkman, pers. comm. 2014). The weir panels would not be long (20 ft from bank to livebox). The livebox would be positioned near the bank as well (@ 20 ft from edge of stream). Tributary weirs will span the channel during low to moderate flows, and would not be in place during high flows. We will not collect more than 10% of the NOR steelhead trout for breeding purposes at any weir. We will survey areas above the tributary weirs to count NOR steelhead trout, and will collect only as many NOR steelhead for breeding as needed. For the mainstem weir, the capture of NOR steelhead will be much less than 10% of the NOR population. The NOR population will be enumerated as they migrate past the ARIS sonar camera, which is located at RM 7.01. We will also survey areas downstream of the tributary weirs to ensure we are not preventing fish from upstream migration. If we find that we are, we will remove the weir to let these fish pass. We intend on operating weirs from January 1 – March 15, when MRH needs to collect NOR as broodstock. Capture of Chinook salmon and Coho Salmon should be incidental past February. All Chinook salmon and Coho Salmon captured will be immediately released back into the stream, upstream of the weir sites. All captured fish will be observed for condition at capture and release, and if adult fish appear stressed or tired, we will cease trapping.

5.2 Fish transportation equipment

Currently there are none (See Section 6.6). However, if off-site collection of NOR fish is deemed necessary, DFW, in consultation with NOAA Fisheries, will develop a fish transportation and equipment plan, to be appended to this HGMP.

5.3 Broodstock holding and spawning facilities

Steelhead enter the spawning house through a hydraulically controlled door and fall into an elevator basket, which sits in an vat of water treated with CO_2 .to anesthetize the fish. MRH personnel administer CO_2 at an initial rate of 30 liters/minute for 20 minutes and then 15 liters/minute to pacify steelhead before processing. Fish culturists monitor and adjust the application levels and buffering agent (sodium bicarbonate) as necessary to adjust pH in the holding water. After steelhead become passive, hatchery workers sort fish by species, sex, ripeness and identifying marks (hole punches etc). Fish culturists spawn selected ripe steelhead immediately. Hatchery personnel place anesthetized Chinook Salmon, Coho Salmon, unripe and spawned steelhead into a freshwater recovery-holding pond for recovery before returning fish to the river. The spawning operation generally requires a minimum of four people.

In the past (pre-2003) hatchery personnel placed immature steelhead and unused adults into one of eight 6' x 75' concrete holding ponds. Holding ponds are equipped with a mechanical fish screen that can cycle fish back into the primary fish trap without handling. Because water pumps for this part of the hatchery are inadequate to provide proper flow for numerous adult steelhead, MRH will not hold large numbers of unripe steelhead. However, small numbers (one or two) of unripe NOR steelhead captured for broodstock may be held for one week to meet hatchery integration goals the following week. The current NPDES Permit will be revised in 2014 to allow for additional discharge flows that will facilitate adult fish holding capability in the 75' holding ponds. MRH is currently seeking to modify current flows near the spawning facility so that they can hold adult fish long enough for a genetic analyis to be conducted prior to spawning, if necessary.

Integrated with the spawning matrix, MRH operations could include rapid genetic analysis each spawning season to guide genetically-based spawning; however, current practice of mating NOR x HOR steelhead precludes the reason for spawner genetics testing since they would not be closely related (not brothers and sisters). The spawning matrix shows the theoretical goal of how many HOR and NOR steelhead should be spawned each week of the twelve week spawning season. The matrix distributes the total of 250 broodstock in a “bell-shaped” curve according to run-timing. Since a goal of greater than 50% or 126 of the steelhead broodstock will be NOR (our goal, with a minimum of 50% integration and a maximum of 100% integration), they are also theoretically distributed in an evenly stratified way along the “bell-shaped” curve according to run-timing. As mentioned above, until the water supply is improved and the discharge permit revised, HOR broodstock steelhead will not be held in the eight 75' long concrete holding ponds connected to the spawning building. NOR broodstock will not be held in these holding ponds as well, but one or two extra unripe NOR steelhead per week, if available, beyond that week's spawning needs can be held successfully in either the trap's primary holding tank or a four foot diameter circular holding tank inside the spawning facility for the next week's spawning. When hatchery facility improvements are made, each of the 75' concrete ponds, which have a separate water gate, will be capable of holding approximately 750 adult salmonids.

For the 2014/15, 2015/16, and 2016/17 spawning seasons, brood stock will be spawned following existing practices, using existing facilities, with the existing spawning matrix. The rapid genetic analysis , if employed, will simply tell MRH techinians which broodstock to use to complete the goals of the spawning matrix with matings of individuals that are not closely related to each other, thus greatly reducing in-breeding potential. However, as previously mentioned, spawning NOR x HOR greatly reduces the potential for sibling crosses.

Real-time genetics monitoring for mate pairing is not necessary at this time as a pairing mechanism. The spawning matrix using NOR x HOR precludes or avoids sibling crossing. There is a low probability of sibling crossing with NOR x NOR, given that in 2013/14 CDFW estimated a return of 3,449 winter-run NOR's to the Mad River. In summary, genetic monitoring will strive for 1) a one-time comprehensive assessment, now, with Dr. Kinziger's steelhead grant, 2) a proposal to address the genetic composition convergence of NOR and HOR in 2019, and 3) a five year cycle of review over time. CDFW will implement a small MRH HGMP Coordination Team to meet annually in November or December before the spawning season begins to review and evaluate practices (nuts and bolts) of the program. Finalized evaluations are available to the public.

The ultimate goal for this program is to develop a genetically informed spawning program at MRH. In the near term, spawning NOR x HOR negates the immediate need for genetic testing of potential mates because they would not be closely related. Additionally, incorporating more NOR's for breeding increases PNI, so that domestication is reduced. The results of the genetic analysis of the backlog of spawner genetic tissues may indicate the need for testing potential spawners, especially when more NOR x NOR matings begin to occur. In contrast to holding one or two unripe NOR broodstock for the following week's spawning, as discussed above, all HOR and NOR broodstock selected for spawning on a given week will have a genetic tissue sample taken from their caudal fin and sent to the NOAA Science Lab in Santa Cruz (or the CDFW Genetics Lab currently being developed) for rapid genetic analysis. There are two methods for handling spawners for rapid genetic analyisis that are being considered: 1) **Real-Time** genetic analysis in which potential spawners will require holding as individually identifiable fish for 2-4 days to allow time for the genetic analysis results to be returned to MRH staff to assess optimal matings; and, 2) **Near-Real-Time** genetic analyisis in which the spawners are selected, eggs fertilized, spawners are released, their adult tissue is sent out for genetic analysis, and eggs are kept or culled according to the results of the genetic analysis. Culliing will only happen during the egg stage.

The Real-Time method requires short term holding for spawning within the same week, not for the next week. The facilities and procedures necessary to achieve this approach would include minor improvements to MRH equipment within their existing budget. Broodstock will be identified with an external tag and placed back in the trap partioned from in-coming spawners for the following week so that they may be uniquely identified for implementation of the spawning matrix once the genetic results are back.

The currently preferred alternate method, should this type of testing be needed, is the Near-Real-Time method because of concerns for spawner health while being held a few days and recaptured for spawning after the rapid genetic analysis results are returned in the Real-Time method. Testing these different methods will be ongoing, and within the confines of the hatchery's budget and discharge permits.

Until the larger holding facilities are improved, the water supply is improved, and the discharge permit revised, steelhead broodstock will not be held in the eight 6' x 75' concrete holding ponds that are connected to the spawning building.

5.4 Incubation facilities

The spawning house at MRH is equipped with forty-eight Heath stacks (metal racks that hold sixteen egg incubation trays each). The maximum steelhead egg capacity for each tray is 3,000 eggs. Hatchery workers adjust an overhead 3-inch pipe to provide flow to the top tray of each stack, which is left empty to buffer the force of falling water. Hatchery personnel increase the flow from three to eight gpm (0.007 to 0.02 cfs) to seven to ten gpm (0.016 to 0.022 cfs) when ova reach the eyed egg stage. Each tray is pulled about three times per week to remove air bubbles, which can suffocate eggs.

The hatchery building contains four pairs of 50-gallon troughs, two 500-gallon troughs and three 300-gallon circular tanks. Fish culturists place emergent sac fry into troughs for short periods to start them on feed. Circular tanks and troughs in the hatchery building are equipped with automatic feeders that can be used to rear select lots of fish. The facility's plumbing configuration allows water to recirculate through the incubator/trough system in case of emergency (refer to Section 5.1). The hatchery building uses up to 449 gpm (1 cfs) of water at full production capacity.

Hatchery personnel traditionally inventory egg production by averaging three random counts from each egg lot, using a 2-ounce measuring cup, and multiplying the mean count by the total number ounces that they place into each incubator tray. Traditionally, hatchery workers place 30 ounces of steelhead eggs in each incubator tray and put older progeny into the bottom trays to keep the egg-hatching enzyme from inducing a premature hatch. The protocol in this plan is to individually label the egg inventory from each family group and incubate each family separately. These measures provide a means to track the contribution of each family to total production, and facilitate proper egg culling, if necessary.

5.5 Rearing facilities

Rearing facilities consist of five paired concrete raceways ten feet wide and 600 feet long. Fish screens or dam boards separate each raceway into a series of six 100-foot long ponds. In addition, hatchery workers can further subdivide the first

200 feet of each raceway into 25-foot ponds and the remaining 400 feet into 50-foot pond to isolate small lots of fish.

An adjustable valve regulates an average flow of approximately 1,250 gpm (2.8 cfs) into each raceway series through three rectangular openings in the head flume. Four stacked 2” x 6” boards below each pond maintain raceway water depth at 24 inches. Hatchery personnel can manipulate the raceway effluent to recycle, discharge to the fish trap/ladder or directly into settling ponds.

5.6 Acclimation/Release facilities

MRH releases HOR steelhead as yearlings from the raceways, through the tailrace, directly into the river. This occurs between March 15th and April 15th each year, preferably when river flows are at a higher level. Releases are intended to be concurrent with a recent storm event.

5.7 Fish pathogen history at MRH

CDFW fish pathologists and veterinarians have examined MRH production fish numerous times over years of operation. Diseases in MRH production fish have been attributed to external and systemic bacterial infections caused by *Flavobacterium psychrophilum* (coldwater disease bacteria), *Flavobacterium columnare* (columnaris), *Flavobacterium branchiophilum* (bacterial gill disease), and motile Aeromonas/Pseudomonas sp. bacteria. A variety of external parasites have also been identified at MRH, including *Gyrodactylus sp*., *Ambiphrya sp*., *Ichthyobodo necator* (costia), *Tetrahymena sp*., and *Ichthyophthirius multifilis* (Ich). Extrasporogonic stages of the myxozoan parasite, *Tetracapsuloides bryosalmonae*, the causative agent of proliferative kidney disease (PKD), has been observed in MRH production fish and is assumed endemic to the Mad River watershed.

Treatment of water entering the hatchery with ultraviolet light has greatly decreased pathogen/disease problems at MRH. All of the identified pathogens are routinely observed throughout the Pacific Northwest.

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

MRH is located above the 100-year floodplain. However, hatchery operations have an inherent risk of mortality due to disrupted water supply, water quality, disease outbreak, fish handling or release MRH’s water supply is equipped with a low water alarm, which alerts staff when power is disrupted. Hatchery managers train their staff to respond to specified emergencies in order to avert fish loss. A hatchery employee is on duty or on-call at all times to respond quickly to any emergency at the facility.

Hatchery operations include daily assessment of fish health. Fish hatchery managers and technicians are trained to observe changes in fish behavior/health that may be attributed to disease problems and report them to CDFW fish pathologists and veterinarians for follow-up. When warranted, diagnosis of disease problems is performed, and legal therapies are recommended. Department fish pathologists and veterinarians also conduct annual certifications for pathogens of concern, and perform pre-release inspections of fish for Disease Certification as well as pre-release Health Condition Profiles to ensure production fish are healthy prior to release. See http://dfgintranet/opm/opsmanual/ for CDFW's disease procedures.

The New Zealand mud snail (NZMS) is an invasive aquatic species found in some waters of the north coast. CDFW has not found NZMS at MRH, but as a precaution, CDFW instituted an education program to inform anglers about cleaning waders and fishing equipment when moving between streams. In addition, MRH routes anglers from the parking area around the production ponds to minimize risk of NZMS infestation at the facility. Mad River Hatchery has installed CDFW-approved implements for the effective monitoring of aquatic invasive species at the hatchery and performs visual surface surveys for these unwanted and introduced organisms.

Section 6.0 Broodstock Origin and Indentity

The origin and identity of broodstock used in the program, its ESA-listing status, annual collection goals, and relationship to NOR fish of the same species or population

6.1 Source

Table 16 lists the initial broodstock sources used to develop the winter-run steelhead program at MRH. CDFW trapped NOR steelhead in the fish ladder at Benbow Dam, South Fork Eel River (same DPS as the natural Mad River stock) and exported them to MRH from BY 1971 through BY 1973 (Will 1973a, 1973b, 1973c, 1975). From 1972 through 2013, CDFW procured broodstock from steelhead volitionally entering the MRH fish ladder (Will 1976, 1978a, 1978b, 1979; Ducey 1980, 1982a, 1982b, 1982c; Barngrover 1983, 1986, 1987a, 1987b, 1988, 1990a, 1990b, 1991; Gallagher 1992, 1994a, 1994b, 1994c, 1995; Cartwright 1996, 1997, 1998, 1999, 2000, 2001, 2002; Ayers 2003, 2005, 2006, 2007, 2008, 2009; Radford 2010, 2011, 2012; Overton 2013). Fish returning to MRH have been used exclusively as broodstock since 1974.

Table 16. Origin of Mad River Hatchery winter-run steelhead broodstock

Brood Year	South Fork Eel River				Mad River			
	Male	Female	Eggs	1+	Male	Female	Eggs	1+
1971	157	144	793,274	635,235	0	0	0	0
1972	209	243	1,399,017	92,207	29	13	49,508	17,940
1973	172	223	1,418,144	135,250	42	10	57,602	20,400
1974	none				2,872	792	4,125,652	165,499

MRH also planted 2,240 fingerlings, at a size of 2,240 fish/lb, and 19,958 yearlings at a size of 3.4 fish/lb into Mad River in 1984 and 1985, respectively, from steelhead eggs imported from Dry Creek, Russian River (Barngrover 1986, 1987). NMFS (2008) cited Goode et al. (2005) for sources of MRH steelhead broodstock, which included import of eggs from San Lorenzo River in 1972. The DPS for Russian River and San Lorenzo River stocks is different than the DPS for Mad River. Goode et al. (2005) speculated that MRH planted San Lorenzo River stock into Mad River, but annual reports do not support this supposition.

MRH also tried to develop a summer-run steelhead program from non-indigenous Washougal River stock (Skamania Hatchery, Washington State) in 1971, 1973 and 1980, as well as Eel River stock transferred from Trinity River Hatchery in 1972 and 1973 (Will, 1973b, 1973c, 1982). CDFW terminated production of summer-run steelhead in 1996 because the program failed to sustain spring and summer-run angling opportunities due to a low catch rate from low returns. The history of the MRH summer-run steelhead program is presented in Appendix 7.

6.2 Supporting information

6.2.1 History

From 1994/1995 through 2002/2003, MRH personnel annually spawned, on average, 129 female steelhead broodstock. This number of females produced a larger number of HOR yearlings than was thought appropriate for the ratio of HOR to NOR in the Mad River. Therefore, in the 2004/2005 through 2012/2013 seasons, MRH personnel annually spawned, on average, 77 female steelhead broodstock (Table 17). This change substantially reduced the number of HOR yearlings produced. Recent years of spawning at MRH have seen a steady increase in the number of spawners used to reflect an increased effective spawning population and an increase in diversity while maintaining the same release goal.

6.2.2 Annual size

This HGMP proposes a broodstock size of 250 steelhead (125 ♀ and 125 ♂). The release goal is 150,000 yearlings (+/-10%) and will follow a 5 year average, not to exceed 150,000 yearlings per year. This remains the annual allotment number for Mad River. Collecting eggs from the increased number of paired adults will increase the hatchery effective population size, but will also require egg culling to prevent excess yearling production. As previously mentioned, the current practice of spawning HOR X NOR precludes the need to perform rapid genetic testing since the two spawners are not closely related (not from same family). Spawning NOR x NOR would suggest the need for rapid genetic testing to prevent sibling matings; however, the number of NOR x NOR spawnings is small, and sonar counts of NOR in 2013/14 (N = 3,449) suggest that the two NOR's for breeding would most likely not be related. MRH staff try to make sure they have represented the theoretical spawning matrix targets for that week before they spawn two NORs together. It is unusual for both genders of NOR steelhead to appear in the same anesthetized batch. Holding a NOR steelhead for a subsequent batch with the opposite gender is hard on the first NOR steelhead because it would be coming out of anesthetization. However, there are cases when we can spawn NOR x NOR.

There are two methods of spawning with rapid genetic testing; 1) **Near Real-time**- spawn first, get results of genetic analysis of parents back, if closely related then cull (disposed by freezing) fertilized eggs, if not closely related keep fertilized eggs; and 2) **Real-time**- identify individual candidate spawners, get results back from potential parent's genetic analysis, spawn only those individuals which are not closely related, and no eggs are culled for this purpose. Uniform culling of all matings' eggs will occur due to the larger effective population size. Culling, due to large effective population size, will be performed such that an equal representation of all remaining spawning pairings will be attained and spawning distribution over time will be preserved.

6.2.3 Past and proposed level of natural fish in broodstock

MRH did not keep historic records for the rate of integration, but the Hatchery Managers presume that the number of natural (and hatchery) steelhead spawned prior to BY 2004 was in relative proportion to their return to the hatchery. The Regional Hatchery Supervisor for northern California reported that the annual rate of integration may have been as high as 5% (6 fish) prior to the 2004/2005 season and comprised of mostly male fish. Data for NOR (unmarked) and HOR (AD-clip) steelhead returns to MRH (Table 17) from BY 2001 through BY 2013 and from BY 2009 to the present, show the relative number of NOR adults (unmarked) incorporated into the spawning matrix to achieve the recent past 20% integration level. The 20% integration of NOR broodstock goal in the spawning matrix was achieved in the past three brood years, 2011, 2012, and 2013. Prior to these years from 2008 through 2010 CDFW did not make the integration goal. Prior to 2008 it is unclear what level of attainment of the 20% integration goal took place because the goal didn't exist then, there were prohibitions from using NOR in some years, and prior to 1999 HOR steelhead were not marked to be recognized as a hatchery product. In 2014 and the immediate future, we propose using a goal of greater than 50% NOR in the breeding program, with a minimum of 50% and a maximum of 100%.

Table 17. Number and mark of steelhead returns to Mad River Hatchery from BY 2001 through BY 2014

Brood Year	Total Return	AD-clip	Unmarked
2001	1,412	1,404	8
2002	6,269	6,031	238
2003	4,473	4,419	54
2004	no trapping		
2005	1,895	1,880	15
2006	1,690	1,671	19
2007	1,540	1,528	12
2008	3,005	3,004	1
2009	450	448	2
2010	2,446	2,441	5
2011	4,916	4,846	70

2012	4,081	3,948	133
2013	3,139	3,118	21
2014	1,841	1822	19

6.2.4 Genetic or ecological differences.

Reisenbicher et al. (1992) examined 10 polymorphic loci in 37 NOR and HOR steelhead populations from the Pacific Northwest, which includes 24 populations in Oregon and one each from Trinity River (summer-run) and MRH (winter-run), and concluded that MRH steelhead were genetically distinct from other HOR and NOR steelhead populations in California and Oregon. Busby et al. (1996) reported that MRH steelhead were diverged from the natural population based on allozyme data and, in part, by the initial importation and propagation of non-indigenous broodstock. Busby et al. (1996) as cited by Goode et al. (2005) reported that steelhead allozyme data clustered Freshwater Creek, a tributary with Humboldt Bay, with stocks north of Mad River and grouped Mad River with Eel River stocks. Reneski (2011) demonstrated genetic divergence of the contemporary HOR stock in comparison to contemporary NOR, historical NOR, and historical HOR stocks. The likely cause was genetic drift due to exclusive use of HOR fish as broodstock and small effective population size of hatchery stock. However, MRH personnel were not allowed to use NOR broodstock starting the 2006/2007 season when NMFS revised the hatchery policy and excluded MRH HOR steelhead from the ESA listing of the NC Steelhead DPS. Domestication can occur rapidly in only a few years when only HOR steelhead are spawned with HOR steelhead in the hatchery. NC DPS Steelhead were first ESA listed as Threatened in 2000, but the practice of purposely excluding NOR broodstock from the MRH spawning matrix started in 2006 and lasted through the 2008 spawning seasons. Concurrently, CDFW and NMFS molecular scientists agreed that NOR should be spawned with HOR fish at a minimum level of 20% to reduce the potential for continued stock divergence from 2009-2012 spawning seasons. CDFW adhered to using at least 20% NOR broodstock for spawning. This practice initiated genetic convergence from 2009 to the 2013 spawning season. More recently, CDFW is proposing to increase the percentage from 20% to 67% NOR, and will not spawn adults below the 50% NOR level.

CDFW and NMFS molecular scientists concur that there was minimal difference between NOR and HOR steelhead in the Mad River prior to listing NC Steelhead and that MRH should minimize genetic drift within the hatchery population by incorporating NOR steelhead into the broodstock.

6.2.5 Reasons for choosing

Steelhead (NOR and HOR) naturally returning to the Mad River Hatchery are the most appropriate natural stock for this program.

An Integrated/Conservation Hatchery Program maintains similar genetic, biological and phenotypic characteristics between the NOR and HOR steelhead populations by allowing gene flow in both the hatchery and natural spawning areas. In addition, crossing NOR, unmarked, with HOR, AD-clipped, steelhead lowers the potential for mating between relatives, reduces domestication of MRH steelhead, and prevents the loss of genetic variation in a finite hatchery population.

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 because of broodstock selection practices

This HGMP proposes incorporation of 50 – 100% (minimum, 125 adults at 50%) of NOR steelhead into the annual broodstock in order to counter NOR-HOR divergence, and to reduce inbreeding, genetic drift, and domestication (see Section 7.9). Given a NOR run size of around 1,000+ adults, we propose taking 12.5% of the run for breeding purposes. Additionally, Sparkman (pers. comm. 2014) will be determining adult NOR and HOR steelhead escapement to the Mad River using DIDSON sonar technology. CDFW and NOAA Geneticists concur that 50+% integration is adequate to quickly stave off genetic divergence, and increase the PNI index; therefore it is our goal and our target. To achieve an intergration rate of 50 – 100% NOR's, we would use from 125 – 250 adult NOR's. We have currently attained the goal of 50% in recent, past years. The DIDSON technology will provide a better estimate of NOR and HOR steelhead in the Mad River and it is predicted to be a higher number than what was previously estimated over ten years ago. We will not adjust the production numbers downward if the goal is not met with NOR broodstock returning to the hatchery via the fish ladder because we will opt to obtain additional NOR broodstock remaining to fill in the matrix via seining and other methods. However, we will only spawn adults using the goal of greater than 50% NOR ratio and 50% as the minimum. There has been discussion of what level of integration is the maximum. Obviously 100% NOR, or all 250 spawners could be a theoretical maximum, but that level is not likely for this HGMP for practical reasons, unless methods for obtaining NOR off site become more practical. Only steelhead naturally returning to the Mad River will be used as broodstock, as has been the case since 1973, and no other source of broodstock should ever be used.

Spence et al. (2008) reported that a population of 11,200 and 352 winter-run steelhead presented a low risk (spatial structure/diversity) threshold and high-risk (depensation) threshold, respectively for Mad River. The current goal in this HGMP is to incorporate more than 125 (50%) NOR broodstock annually, and 50% (125 NOR adults) as a minimum, with the remaining 125 fish being HOR steelhead (see Section 7.9). In the future, a revised HGMP may direct the use of up to 100% NOR steelhead. In that case, the removal of as many as 250 NOR steelhead for spawning in the hatchery would be approximately 17.6% of the wild spawning NOR steelhead population, based on the 2000/2001 run size estimate (1,419 NOR steelhead) reported by Zuspan and Sparkman (2002). However, partially spawned adult male NOR steelhead released from the hatchery can continue their migration and spawn in the wild. Therefore, the estimated net effect of the hatchery program to the NOR spawning population using entirely NOR broodstock would be approximately 8.8%. However, the more recent estimate of NOR adundance in 2014 equalled 3,449, and the use of 125 NOR's for breeding would equate to 3.6% of the NOR population, and the use of 250 NOR's would equate to 7.2%. The operation of MRH as an integrated/conservation hatchery program, with a goal of increasing the number of NOR broodstock per generation, promotes recovery of the Northern California DPS by maintaining NOR steelhead demographics above a level of depensation

(CDFW/MNFS 2009). The collection of NOR as broodstock (up to 125-250 adults) will be compared to the DIDSON/ARIS escapement estimate of NOR and HOR fish, and NOR for breeding will be reduced if NOR abundances are low. If NOR abundances are low, then hatchery production of yearling smolts will be less (to meet the 50% NOR integration rate).

CDFW and NMFS (2009) rejected the concept for ending steelhead production at MRH and opted for an Integrated Hatchery Program that maximizes the number of NOR broodstock in its program (50 – 100% intergration rate).

Section 7.0 Broodstock Collection

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

Adult winter-run steelhead.

7.2 Collection or method of sampling design

MRH personnel trap returning adult steelhead for broodstock from as early as mid-December through March. The broodstock spawning matrix proposes inclusion of up to 250 (targets 125 ♀ and 125 ♂) NOR and HOR returning steelhead in relative proportion to their natural run timing.

MRH personnel collect NOR steelhead as broodstock from adults volitionally entering the fish ladder. Over the years the HGMP has been developed, the total number of spawners and NOR broodstock has increased. In 2013 the total number of female spawners in the theoretical spawning matrix was 110. At a 1:1 ratio of females mated to males the effective population size of spawners was 220. We hope to obtain 67% as NOR broodstock. For this HGMP, CDFW and NOAA Geneticists reccommended increasing the total number of spawners annually to 250, or 125 females, because of the genetic importance of having a larger effective spawner population size. As a result, the number of NOR used for spawning also increased to maintain the 67% integration level. With the proposed increased numbers of NOR broodstock to be incorporated in the hatchery's spawning matrix, the number of NOR steelhead entering MRH may be insufficient. In the summer of 2009, hatchery staff changed the flow dynamics of the fish ladder to improve attraction of NOR steelhead into MRH by adding small amounts of river water to the ladder. These methods were moderately successful. As discussed in Methods of Take, Section 2.2, if needed, CDFW will collect NOR adults with seining and other activities (adult weirs, hook/line) in the mainstem and tributaries throughout the Mad River basin to make up for any deficiencies from the volitional fish ladder collection for that week.

The seining operation will use between four and eight staff to deploy a 200' seine from the bank on the hatchery side of the river. Upon retrieving the net, staff will identify the targeted NOR broodstock and immediate release any other species. Species, counts, and any injuries or mortalities will be recorded for reporting. Targeted NOR steelead broodstock will be inspected, hand netted, and handed to staff by an idling tanker truck installed with a 100-500 gallon, aerated, tank if seining occurs near the hatchery. The NOR broodstock will be monitored by trained staff, and transported to the spawning building's trap holding tank upon completion of the seining activity. This operation should last about an hour, however the transportation to the spawning facility only takes a couple of minutes. Thes NOR broodstock would be spawned the same week they were collected.

For off site sampling (seining, adult weirs, hook/line), NOR fish will be held in fish tubes, and MRH personnel will transport captured NOR to the hatchery using a tanker truck. Off site areas include mainstem and tributaries. NOR fish will not be 'mined' from any tributary, and a 10% maximum take from a given tributary should prevent mining. Adult weirs will be temporarily operated, and in the mainstem will be located in the margin of the stream during high flow events. Temporary adult weirs may be used in various tributaries on a temporary basis to collect NOR broodstock. When not in use, weirs will be removed to provide natural, upstream access to adults. Weirs will be operated 24 hrs/d for 2 days prior to MRH spawning, using standard techniques, by CDFW personnel (see page 22). Hook/line sampling offers advantages to seining and adult weirs in that areas can be sampled where seines and adult weirs will not work. Only qualified personnel (CDFW, NMFS) will collect NOR fish using safe, angling techniques (barbless hooks), and captured fish will also be placed in tubes for eventual delivery to MRH by the tanker truck, or samples of milt from males will be collected on site, and taken to MRH.

The proposed target (female half of the spawning matrix) (Table 18a) is based on only females because of the calculation of egg harvest. In practice, this theoretical spawning matrix is complicated by several factors including the following:

1. The typical spawning session utilizes small batches of fish that are anesthetized for a short time and cannot be held in the anesthetized state for long (~five minutes);

2. Hatchery staff are limited to the gender, age, and origin of fish that come in with a particular anesthetized batch;

3. Female fish account for half of the spawning matrix in a 1:1 ratio, or 125 of the spawners for developing this matrix, but the reality is that a NOR female's split egg lot accounts for an isolated pairing with two HOR males. The NOR to HOR ratio for spawing will be at least 1:1, 50% NOR will be used. Achieving a higher percentage integration of NOR broodstock in the actual spawning matrix will be a combination of NOR females and NOR males and the number of females, shown in the matrix in Tables 18b, may be substantially reduced and still have the higher goal met (67% integration goal is used as an example). All crosses will be NOR x HOR, or NOR x NOR;

4. If post hoc determination of the usefulness of pairings, based on rapid genetic analysis is used, then analysis may indicate the need for culling fertilized eggs. To compensate for that, more eggs may need to be taken; and

5. The spawning matrix shows a theoretically balanced bell-shaped curve of frequency of returning spawners over the weeks of the spawning season or run-

timing. In practice, the frequency of returning spawners is also influenced by rainfall events.

Table 18a. Proposed female half of the spawning matrix and egg harvest for MRH representing 50% Integration Rate [1]

Week	Matings			Green Egg Take[2]		No. Fertilized Eggs[3]	
	Total	H x H	H x N[4]	H x H	H x N	H x H	H x N
1	4	-------	4	-------	18400	-------	16192
2	6	-------	6	-------	27600	-------	24288
3	10	-------	10	-------	46000	-------	40480
4	12	-------	12	-------	55200	-------	48576
5	15	-------	15	-------	64400	-------	56672
6	16	-------	16	-------	73600	-------	64768
7	16	-------	16	-------	73600	-------	64768
8	14	-------	14	-------	64400	-------	56672
9	12	-------	12	-------	55200	-------	48576
10	10	-------	10	-------	46000	-------	40480
11	6	-------	6	-------	27600	-------	24288
12	4	-------	4	-------	18400	-------	16192
Total	125	-------	125	-------	575000	-------	506000

Table 18b. An example of a higher Integration Rate of the NOR female half of the spawning matrix and egg harvest for MRH representing a 67% Integration Rate

Week	Matings			Green Egg Take[2]		No. Fertilized Eggs[3]	
	Total	N x N	H x N	N x N	H x N	N x N	H x N
1	4	1	3	4600	13800	4048	12144
2	6	1	5	4600	23000	4048	20240
3	10	2	8	9200	36800	8096	32384
4	12	2	10	9200	46000	8096	40480
5	15	3	12	13800	55200	12144	48576
6	16	3	13	13800	59800	12144	52624
7	16	3	13	13800	59800	12144	52624
8	14	2	12	9200	55200	8096	48576
9	12	2	10	9200	46000	8096	40480
10	10	2	8	9200	36800	8096	32384
11	6	1	5	4600	23000	4048	20240
12	4	1	3	4600	13800	4048	12144
Total	125	23	102	105800	469200	93104	412896

1 These tables depict a theoretical target, not a precise operational protocol

2 Assumes average fecundity of 4,600 eggs/female

3 Assumes an average 88% fertility rate

4 Assumes equal sex ratio of unmarked steelhead entering Mad River hatchery, but NOR females egg production may be split into two sub-lots which are fertilized by two different males,

7.3 Broodstock Identity

All broodstock will be HOR and NOR steelhead naturally returning to the Mad River. HOR adults are identified by the absence of the adipose fin (AD-clip). All

(100%) HOR steelhead produced at MRH receive an AD-clip. The 2013-16 QA/QC of marked juvenile HOR steelhead has demonstrated that 99.9% of those sampled had a distinguishing hatchery mark. Additionally, MRH technitians look at several other phenotypic indicators (such as the condition of dorsal, pectoral, and pelvic fins) to be sure they have correctly identified HOR or NOR spawners before spawning. Some of the HOR adults have missing or partially missing fins besides the adipose fin, due to being raised in concrete ponds.

7.4 Proposed number to be collected

With a standard annual broodstock target of 250 steelhead and protocol for 50% - 100% integration rate of NOR fish, the minimum target number of NOR steelhead is 125 (and 125 HOR), and the maximum would be 100% NOR (n = 250) and 0% HOR (n = 0). Table 18a shows the theoretical number of female fish required each week of the spawning season as though the NOR females were the only source of NOR broodstock; and therefore, 125 equals a 50% rate, always NOR x HOR. Table 18b shows an example of achieving greater than the 50% intregation rate, with 102 NOR x HOR pairings and 23 NOR x NOR pairings which equals an approximate 67% integration rate.

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

See Sections 8.1 through 8.4.

The program goal is to consistently spawn at most 125 adult HOR and at least 125 NOR steelhead annually to produce 150,000 (+/-10%) yearlings for release to the Mad River. The proposed broodstock collection and mating protocols will target incorporation of 67% NOR fish and only breed NOR's x HOR's and NOR's x NOR's to counter the effects of genetic drift, inbreeding, and domestication of the hatchery stock. This is an integrated program designed to retain and preserve the genetic integrity of both NOR and HOR stocks, and to allow for natural selective forces to dominate, compared to hatchery selective forces. An explicit goal of the program is to correct and reverse the observed divergence of contemporary HOR and NOR stocks (see Reneski 2011) by incorporation of NOR fish as broodstock.

Under this program, mating protocols will conform as closely as possible to the spawning matrix shown in Table 16. The minimum number of NOR broodstock (at 50% level) required to implement this program for the first four years is 125 (63 males:62 females, or any combination of NOR males and females that add up to 125). This is an incorporation rate goal of 67% NOR into the broodstock annually. Thereafter, we intend on incorporating a NOR percentage of 50 to 67 on a running average into the spawning matrix, which equates to 125-167 NOR fish.

7.4.2 Broodstock collection levels for the last twelve years

The number of female steelhead spawned, green eggs harvested and subsequent yearling production for the1994/1995 through 2012/2013 seasons at MRH are presented in Table 19. MRH did not collect data on the number of males used during this period. From BY 2009 on, NOR females have been allowed to be part of the broodstock. When improvements to the fish ladder were made to attract more

NOR broodstock into the trap, all NOR broodstock have been incorporated into the spawning matrix up to 20% of the total number of spawners for any given year. In 2010/2011, 2011/2012, and 2012/2013 spawning seasons the 20% integration rate had been achieved. In the past, we used more adults than necessary to produce 150k smolts to increase the effective population size. In 2014, we used a 50% NOR integration rate, but at reduced production.

Table 19. Number of female steelhead spawned, green eggs harvested and yearling production from BY 1995 through BY 2014

Brood Year	Number of Females Spawned	Number of Green Eggs Harvested	Yearlings Released
1995	83	381,065	226,010
1996	109	570,124	184,451
1997	153	761,722	248,077
1998	94	485,825	263,495
1999	170	842,832	368,082
2000	138	619,560	225,549
2001	140	560,455	261,417
2002	140	665,425	241,167
2003	133	630,246	213,500
2004	No Production		
2005	78	351,120	196,989
2006	49	251,400	143,739
2007	60	306,565	152,471
2008	67	367,863	254,604
2009	42	258,861	149,032
2010	51	310,276	150,994
2011	126	604,388	164,752
2012	108	504,329	163,631
2013	113	587,021	151,391
2014	21	100,876*****	

*****2014 Spawning was reduced from 12 weeks to 5 weeks and due to constraints associated with spawning only NOR females there were other difficulties, such as over-ripe eggs which reduced the number of green eggs harvested.

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

Hatchery employees release adult steelhead, in excess of broodstock needs, back to the river from the recovery-holding pond (primary release method) or the return pipe in the floor of the hatchery building (secondary release method). Fish are given a hole punch in the caudal fin prior to release into the river to document general site fidelity when they return to MRH. This fidelity data will represent a minimum because an unknown number of hole punched HOR steelhead will be harvested by anglers before they could return a second, third, or fourth time. Additionally, there are HOR steelhead that will be harvested before entering the hatchery a first time. These data will be reported on an annual basis. We will return HOR adults (spawned or unspawned) back to the river after they are trapped from the fish ladder and processed in the spawning facility each week for three reasons: 1) we don't want to lose the low frequency iteroparity (repeat spawning) gene in steelhead; 2) we now spawn every natural origin adult with a hatchery origin adult or another natural origin adult, 100% of the time, and 3) increase anlger opportunity to harvest a hatchery steelhead trout. Removing the gametes of all HOR adult steelhead that enter the hatchery before releasing them back to the river for angler opportunities is something CDFW could possibly do in response to results from genetic analyses, if divergence isn't turning to convergence. A lack of convergence could trigger many new activities following the appropriate genetic analyses. Stripping eggs from all HOR hatchery returners would be time consuming and expensive, but CDFW will look into the logistics/feasibility of stripping eggs. Stripping males of milt is more difficult because not all milt can be stripped, and holding males at MRH until the spawning run is over is not feasible due to excessive mortality, lack of holding area(s), lack of water available for storage, and cost(s) associated with pumping extra water.

The determination of PNI monitoring data will enable a review of the above mentioned activities when the HGMP is evaluated in review cycles.

7.6 Fish transportation and holding methods

Primary broodstock collection at the hatchery does not require transportation. However, if alternate broodstock collection methods are required to obtain sufficient NOR fish, they will be transported by hatchery tanker trucks parked next to the river seining operations, or other collection techniques.

MRH does not hold steelhead broodstock in holding ponds more than twenty-four hours for recovery. However, in the situation where alternative procurement is necessary to yield NOR steelhead for broodstock, MRH may hold some NOR individuals in the hatchery trap channel until the next spawning session or until the fish are ripe, although this is not a preferable method.

Additional holding methods will be developed to enable enhanced genetic stock management using spawner candidate lists to reduce inbreeding potential, if deemed necessary

7.7 Fish health maintenance and sanitation procedures

MRH personnel sanitize spawning equipment, especially invasive equipment such as needles (for air spawning) after daily use. Scissors, used for collecting genetic samples, are simply wiped clean with a terry cloth towel after each collection, as per protocol(s). Fish culturists treat fertilized eggs with a commercial iodine solution (iodophor) at 100 ppm and perform daily health maintenance checks of egg lots. All hatchery personnel follow a strict standard for health and sanitation protocol to avoid the spread of disease. MRH uses equipment dedicated to one segment of the operation. For example, equipment in the hatchery building is not used anywhere else in the facility.

7.8 Disposition of carcasses

CDFW will dispose most carcasses from inadvertent mortality during the trapping and spawning process by collecting the mortalities and disposing them into the Mad River nearby the hatchery. This may increase the Marine Derived Nutrient (MDN) inputs to the energy system of the watershed, which is an integral component for the production of macroinvertebrate populations and the aquatic food web. If there is public outcry from observed carcasses, we may dispose of the carassess in other locations within the stream. A few carcasses are used for educational purposes in the classroom. Other rivers (Trinity) have pathologist denial for disposing carcasses in the river due to transmission of disease, however, at MRH this is not the case.

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

Artificial propagation programs have the potential to breed closely related individuals and amplify the divergence between HOR and NOR populations. CDFW proposes to collect and spawn a combination of HOR and NOR steelhead as broodstock (a 1:1 ratio) at MRH using a spawning matrix (Table 18) designed to reduce the potential for hatchery stock divergence, inbreeding, and domestication. The program is designed to correct and reverse the observed divergence of contemporary HOR and NOR stocks (see Reneski 2011) by incorporating NOR fish as broodstock into MRH.

The adverse effect to the NOR population from removal of NOR spawners for hatchery broodstock can be assessed using the 2000/2001 run size estimate (1,419) reported by Zuspan and Sparkman (2002), and a more recent (preliminary) estimate for 2014 (M. Sparkman pers. comm. 2016; N = 3,449 NOR adults). Fifty NOR spawners (maximum amount of natural spawners in the current hatchery's spawning matrix) is approximately 3.5% of the 2000/2001 run size estimate. However, male donors continue their spawning migration and contribute to the natural spawning population, which reduce the estimated loss of effective natural breeders from the hatchery program by half (1.8%). Recent monitoring efforts using DIDSON technology and species apportionment methods will provide data necessary for determining the percentage of NOR fish used for breeding compared to the abundance of NOR fish within the basin. If the NOR population equals 1,000 adults, then the MRH integration rate of 50% would equal 125 adults, or 12.5% of the population. If NOR's equal 3,449 (more recent estimate), then 125 and 250 NOR for breeding would represent 3.6% and 7.2%, respectively. With a goal of achieving the average of 67%, NOR integration rate would require 167 NOR adults, which is 4.8% of the most current NOR abudance estimate. We are confident that the DIDSON technology applied from 2013 to the present will show that if we collect 167 NOR adults, then "mining" from the natural spawning grounds will not constitute more than 10% of the natural population. If natural abundances are low, then CDFW will consult with NMFS, and possibly reduce the number of NOR fish used for breeding purposes at MRH. Nevertheless, a 1:1 NOR to HOR will be implemented for spawning purposes.

Section 8.0 Mating

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

8.1 Selection method

The optimal spawning protocol for MRH includes a broodstock size ($H_b = 250$) with an objective of incorporating all HORxNOR and NORxNOR matings. The spawning protocol uses an equal number of male and female spawners when the number of breedings is $\geq$250 (HSRG 2005). However when the number of breeding is < 250, we will split female egg lots into two sub-lots and spawn one male with each female's sub-lot, and a different male with the other sub-lot (HSRG 2005). The purpose of splitting a females eggs into sub-lots and using different males for each sub-lot is to increase the effective population size of spawners. Since we will not know if we will spawn 250 fish over the spawning season, will may perform sub-lots in one week and not the other(s) if we are below the targeted spawning matrix for a given week. For example, if a given week requires 14 spawnings, and we only have enough NOR's for 7, then splitting will occur for that week. The mating protocol includes a systematic selection (the spawning matrix) of a representational proportion of the hatchery population, based on the time of hatchery entry and sexual maturity. CDFW proposes to manage an Integrated Hatchery Steelhead Program at MRH with the following interim targets:

1. Spawn NOR steelhead into the hatchery broodstock using the following guidelines (listed in priority);

    a. Spawn NOR (unmarked) with HOR (AD-clip) steelhead (50% intergration) as a minimum.

    b. Never spawn HOR x HOR (0% NOR intergration rate).

    c. Cross NOR x NOR when possible (100% intergration rate).

2. Use some Age 2+ male steelhead as broodstock (~1% as a relative proportion of the returning spawners in the hatchery trap) when they are found in the hatchery spawning population; and

3. Spawn males and females of different sizes/age classes, as feasible with technicians' qualitative judgment, to reduce inbreeding potential. This is less of a concern when crossing NOR x HOR, since there is a very low chance they could related.

In addition, MRH will use the following spawning protocol guidelines when developing the spawning matrix:

Annually spawn 250 steelhead in representative proportion of their natural run timing;

1. When splitting female production into two sub-lots, use a different male for each sub-lot. For example, a NOR female's sub-lots could be fertized by two different HOR males. Conversely, a HOR female's sub-lots would be fertilized by two different NOR males.

2. Maintain a tissue archive for MRH broodstock for genetic analysis.

8.2 Males

The Joint Hatchery Review Committee did not recommend the use of age 2+ steelhead (jacks) for broodstock in proportion to their occurrence, because the expected result would be a bias in the reproductive success of maturing fish relative to those in naturally spawning populations (CDFW/NMFS 2001). Initially, NMFS (2008) suggested the exclusion of age 2+ steelhead spawners because they are opportunistic and marginally successful spawners, as compared to older, larger, and more competitive adults. Finally, CDFW/NMFS scientists concluded that MRH personnel should use some age 2+ steelhead (~1-2%) but the precise relative proportion to the NOR spawning steelhead returning to the hatchery was unknown (CDFW/NMFS 2009). Hatchery spawner return data have been collected since then and the proportion of NOR jacks to the mature males is currently being analyzed. This NOR genetic input from jacks would be beneficial and has the potential to compliment the NOR population's genetic characteristics.

8.3 Fertilization

MRH personnel spawn female steelhead into a fine-meshed strainer (two strainers for paired sub-lots of one female) by applying air pressure to the peritoneal cavity to extrude eggs through the vent. The tools for this procedure include a compressor that delivers approximately one to two pounds/inch^2 of compressed air, surgical tubing and an eighteen-gauge needle. After egg extraction, the Fish Culturist removes the needle, gently strips air from the body cavity, places the fish in a recovery tank and sets the strainer(s) with ova on a table set aside from the spawning area to avoid spilling. The Fish Culturist then spawns a male (when splitting is not required) into one 10-inch diameter and 4-inch deep egg pans that contain a biological buffering solution consisting of glycerine, salt, and water. The egg pan with milt is taken to the spawning table where the eggs are added and gently stirred by hand[1]. After several minutes, the Fish Culturist then pours the eggs into a bucket of water treated with iodophor to harden the eggs for at least thirty minutes. Hatchery personnel inventory eggs and transport them to incubation trays[2]. The Fish Culturist guards the fertilized eggs against exposure to ultraviolet light during the spawning process.

This HGMP adopts the recommendation of the Joint Hatchery Review Committee (CDFW/NMFS 2001) to split eggs from each female into two lots when the

[1] An individual male is used for each strainer (sub-lot).

[2] Sub-lots are treated and incubated separately.

broodstock size is < 250 fish. The group also suggested that hatcheries individually fertilize each sub-lot with a different male to maximize the effective population size.

8.4 Cryopreserved gametes

No gamete preservation program exists at MRH.

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

MRH's mating protocol for developing the spawning matrix includes a systematic selection of a representational proportion of all returning steelhead, based on the time of entry into the fish trap and sexual maturity, in order to maintain the natural run timing pattern. Sonar data (DIDSON/ARIS) can provide data on NOR and HOR run timing, and test for similarities or differences. In addition, the mating protocol in combination with a consistent broodstock size (H_b =250) is designed to minimize inbreeding and domestication potential and to maintain a consistently high effective population size for the hatchery stock.

SECTION 9.0 INCUBATION AND REARING

MRH management goals and data for achieving the success of meeting the desired hatchery goals.

9.1 Incubation

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

MRH production records indicate a relatively consistent release of steelhead smolts each year, regardless of the total number of green eggs taken. However, MRH also planted surplus fingerlings (78,000 to 834,480) prior to 1998/1999 season. Therefore, mortality rates for the early life stages are not available prior to this time.

The steelhead survival rate for each phase of production from BY 1999 through BY 2013 (Table 20, no data for 2004) from green egg to smolt was 56% and 46 %, respectively, in the 2005/2006 and 2006/2007 seasons compared to 50%, 69%, 58%, 49%, 27% and 32% for the six years of production since then. The decrease in overall survival is attributed to several factors, some natural and some anthropogenic:

1. Some mortality is due to natural causes (~12%). Variable egg viability has been shown by Sparkman (2004) to occur from year to year in nature.

2. At the hatchery:

    - of those that died from natural causes as eggs in trays, more are dying since the discontinuation of chemical treatment (such as the use of malachite green and formalin) to kill egg fungus as per CDFW policy around 2002;

- of those that survived without chemical treatments and developed into the juvenile stage, more are surviving due to reduced rearing density.

As a result, these cumulative reasons cause the green egg to smolt ratio to be lower than expected in recent years.

Historically, the bulk of the remaining mortality is due to culling juveniles to keep from exceeding larger production quotas, beginning prior to 2000. Previous hatchery management hedged against unforeseen losses by taking more eggs than necessary.

Today, with reduced production (in consideration of the effects of HOR steelhead on NOR steelhead) culling is also associated with a larger number of parents to increase the gene pool diversity. Spawning more females produces more eggs, but maintaining the production quota of yearlings the same as when there were fewer spawned females, in prior years, requires culling. Family sizes are also equalized which results in the same proportionate culling of NORxHOR sub-lots.

In recognition of the existing facilities and water discharge permits that do not allow for holding large numbers of adult spawners past the weekly spawning session until the results of the rapid genetic analysis are received, this HGMP allows for further culling of eggs, if necessary. Because results from possible rapid genetic analysis are unknown at the time of egg take, so are culling levels . Theoretically, NORxHOR pairings are preferred because of a lack of related-ness and they would rarely be culled, if at all. Near-Real-Time rapid genetic analysis will not be performed this spawning season due to the preferred practice of spawning HOR x NOR. Subsequent years of genetic analysis may indicate the need to do Near-Real-Time or Real-Time genetic analysis of spawners. These two methods are dependent on facility upgrades. The Real-Time rapid genetic analysis is being evaluated this year, but it is currently not the preferred method of handling spawners at Mad River Hatchery because of concerns for spawner health discussed in Section 5.3. Additionally, it will not be necessary when spawning NOR x HOR adults.

Table 20. Estimated Survival rate of at each life stage from BY 1999 through BY 2014

Brood Year	Green Egg	Number/Survival: Eyed Egg		Eyed Eggs kept after culling	Fry (in hatchery building)		Yearling* from hatchery building to raceway)			Eyed Egg To Smolt
	Number	Number	Survival	Number	Number	Survival	River Release Number	Other Release Number	Survival	Survival
99	554,831	476,496	0.86	N/D**	467,000	0.98	368,082	N/D	0.79	0.77
00	842,832	606,285	0.72	N/D	565,000	0.93	225,549	N/D	0.40	0.37
01	619,560	528,485	0.85	N/D	341,997	0.65	261,417	N/D	0.76	0.49
02	560,455	341,997	0.61	N/D	339,754	0.99	241,117	N/D	0.71	0.71
03	665,425	451,512	0.68	N/D	418,000	0.93	352,965	N/D	0.84	0.78
04				No production						
05	351,120	312,155	0.89	N/D	N/D	N/D	254,168	N/D	N/D	0.81
06	312,155	251,400	0.81	N/D	N/D	N/D	143,798	N/D	N/D	0.57
07	306,565	221,714	0.72	N/D	N/D	ND	152,346	N/D	N/D	0.69
08	367,873	302,306	0.82	N/D	N/D	N/D	254,604	N/D	N/D	0.84
09	258,861	200,796	0.78	N/D	N/D	N/D	149,032	16,747	N/D	0.83
10	310,276	238,518	0.77	N/D	N/D	N/D	150,994	24,830	N/D	0.74
11	604,388	445,030	0.74	334,079	306,238	0.92	164,752	124,722	0.64	0.87
12	512,576	422,340	0.82	276066	275,521	1.00	163,631	82,890	0.89	0.89
13	691,016	424,368	0.61	229,050	198,966	0.86	151,391	45,577	0.98	0.86
14	100,876	60,301	0.60	53,193						

*Yearlings were released to the river, but not all green eggs taken were for river production; some (~400-1500/year) were allocated for school programs (CAEP) and released into the river separately at different times. These school program eggs were always from HORxHOR pairings, although that has changed since 2014. Additionally, in years past, steelhead were allocated for Ruth Reservoir. This HGMP directs that Mad River steelhead not be stocked in Ruth Reservoir to remove the possibility of steelhead escaping the reservoir.** N/D means No Data.

9.1.2 Reason for and disposition of surplus egg take.

Because it is difficult to predict the amount of egg loss due to natural mortality, mechanical failure, flow disruption, or disease, hatcheries traditionally harvest surplus eggs to guarantee compliance with production goals. To end that habit, this plan proposes a green egg harvest from a fixed broodstock size, which requires MRH to sustain an advanced level of fertility and above average egg to smolt survival in order to meet its production goal. An additional 10% buffer against these losses should protect the production goal. In the event that surplus fingerlings render a potential release in excess of 150,000 (+/-10%) yearlings, MRH will adjust its egg take, in subsequent years, to prevent surplus production.

9.1.3 Loading densities applied during incubation.

The hatchery building contains forty-eight, 69-inch (175.3 cm) vertical Heath incubator stacks. Each stack holds sixteen, 23-3/4" (60.3 cm) wide x 25" (63.5 cm) trays, with each providing an approximate 30-ounce egg capacity. In BY 2012 and BY 2013, respectively, the number of eggs per ounce ranged from 162-181 and 164-185. Steelhead eggs per ounce has provided a stable measure of egg numbers over the years (Overton, pers. comm.) and one tray holds 4,860 to 5,550 eggs.

9.1.4 Incubation conditions.

The hatch period for steelhead eggs varies by temperature units and hatching can vary as much as six days between egg lots derived from fish with similar run timing. Leitritz (1959) reported that steelhead eggs take thirty days at 10 ^{o}C (50F) to hatch. Seasonal water temperature in the Mad River Hatchery spawning facility ranges from 4.4 ^{o}C (40 ^{o}F) to 11.7 ^{o}C (53 ^{o}F).

9.1.5 Ponding.

Hatchery personnel transfer newly emerged fry from incubator trays to rearing troughs, where they remain until yolk sac absorption is complete. Fish and Wildlife Technicians transfer fingerling steelhead into raceway ponds at an approximate size of 1,000 fpp. During the transfer of fingerlings, Fish and Wildlife Technicians make a standard 10% numerical inventory using weight count recorded in fish/pound, which they convert to total pounds of fish.

9.1.6 Fish health maintenance and monitoring.

The top tray of each incubator stack remains empty to filter silt and organics as well as buffer the impact of water cascading from the overhead pipe. During incubation, hatchery personnel pick eggs with a pipette on a weekly basis (or anytime excessive fungus becomes evident) to reduce sub-optimal rearing conditions and prevent the spread of fungus (See Section 8.7). Fish Culturists configure incubator stacks to isolate individual trays to control disease, as needed. A final egg count per family group will be recorded before hatching.

Steelhead fry are manually moved to rearing troughs after the lot has fully hatched. When steelhead begin to “swim-up” and move freely about the trough, Fish and Wildlife Technicians increase water depth and begin feeding processed food. Hatchery Personnel also routinely clean the rearing troughs to remove dead fish, unused feed, and feces.

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

Although unrealized, the potential exists for random mortality of incubating eggs and emergent fry in the hatchery building due to pump failure or an emergency power outage. MRH is equipped with low water alarms that notify the staff to engage one of the four diesel-powered generators to provide water to the hatchery building.

This HGMP supports egg incubation by sub-lot for documentation of parental contribution to the ponding stage. This protocol also allows hatchery workers to cull eggs from each mated pair and equalize their individual contribution, as appropriate, to the overall hatchery population. Segregated incubation of each family group is expected to increase green egg to fry survival.

9.2 Rearing

9.2.1 Survival rate data by hatchery life stage (eyed egg to fingerling; fingerling to smolt; green egg to smolt) for the most recent fourteen years or for years dependable data are available

From BY 1999 through BY 2003, the survival from eyed egg to fingerling, fingerling to yearling, and green egg to yearling steelhead averaged 89.6%, 63.4%, and 42% respectively. Raceway survival varied, due in part to bird predation, which has since been reduced with overhead wires. In BYs 2005 and 2006, the survival rate from green egg to yearling steelhead averaged 51%, compared to an average of 48% for the last six years of production. The apparent decline and low survival from green egg to smolts released into the river is also due in part to the practice of allocating some (~18% or more) of the total steelhead production (beyond the targeted 150,000 +/- 10% for river production) to Ruth Reservoir and < 1% to school classroom aquarium/aquatic education fish-rearing programs. Both of these allocations are not accounted for in the green egg to smolt calculation in Table 18, and therefore survival is underestimated. MRH actually increased fingerling steelhead survival by rearing fish in the raceways at a lower density. This HGMP directs ceasing the steelhead allocation to Ruth Reservoir, but maintaining the classroom aquarium/aquatic education program fish which are planted in the Mad River below the dam.

9.2.2 Density and loading criteria (goals and actual levels

MRH was originally designed to produce 700,000 yearling steelhead annually (Boydstun 1977), in addition to Chinook and Coho Salmon. Therefore, the original loading density of the ten rearing raceways must have been at least 70,000 fish per raceway.

MRH currently produces about 150,000 yearlings which is 40% fewer yearlings compared to historic (1999) rearing levels (~370,000); therefore, production goals do not dictate rearing-pond density. MRH is in a unique position to incrementally reduce rearing densities and compare any additional overhead cost with the benefit of producing fish that may have a higher SAR since at least one parent will be a NOR.

9.2.3 Fish rearing conditions

The rearing environment at MRH consists of cement raceways supplied with well water. The most variable component of the rearing environment is temperature. Water temperature at MRH ranges from an average low of 9.4 ^{o}C (49 ^{o}F) in winter to approximately 15.6 ^{o}C (60 ^{o}F), an average high, during summer months. These conditions are not expected to change.

9.2.4 Monthly fish growth information including length, weight, and condition factor data collected during rearing

Growth rate of winter-run steelhead at Mad River Hatchery (Table 21) is depicted below for BY 2006.

Table 21. Steelhead growth rate (weight count) for BY 2006

Date	Weight Count (fpp)	Date	Weight Count (fpp)
April	1,532	October	15.3
May	520	November	11.2
June	160	December	8.7
July	90	January	6.0
August	39	February	4.2
September	25	March	4.0

9.2.5 Monthly fish growth rate and energy reserve data

Leitritz (1980) published a weight-count method to standardize growth rate estimates of HOR fish. This method consists of placing a known number of juvenile steelhead into a pre-weighed bucket of water and subtracting the tare weight of the bucket and water to determine fish mass (fish/lb). Each recorded weight count is an average of three to four measurements. Overton (pers. comm.), the new Hatchery Manager at MRH, has observed little variation in monthly growth rate for steelhead at MRH.

No information about energy reserve data exists.

9.2.6 Food type used, daily application schedule, feeding rate range and estimates of total food conversion efficiency during rearing

Hatchery workers feed swim-up fry Bio-Oregon semi-moist BioVita Crum #0, #1, #2, 1.2 mm, and 1.5 mm. After five months, the fingerling steelhead are fed a dry, floating pellet approximately six to eight times a day by hand. This brand of fish food contains herring, cotton-seed, wheat kelp, tuna viscera, crab meal, and vitamin supplements. In general, Fish Culturists calculate the amount of feed based on the percentage of average total body weight for each lot of fish, following the manufacturer’s recommended rate of application. An approximate rate of feed application is twice the cumulative body weight of fish within the pond, but rearing conditions (water temperature) may alter the rate of food application.

From 1991 through 2000, the food conversion rate at MRH ranged from 1.01 to 1.34 and averaged 1.22 when hatchery personnel used a cart with a blower to broadcast feed equally along the length of the raceway. MRH will develop a food conversion rate as part of the program monitoring requirements.

To maintain fish health, Fish and Wildlife Technicians inventory and rotate feed to maintain quality, and discard tainted feed. They also carefully regulate feed applications to maximize growth and minimize waste. Fish growth maintenance and sanitation procedures include weekly pond cleaning to remove accumulated solids and fish feces, thereby maintaining a healthy rearing environment.

9.2.7 Fish health monitoring, disease treatment, and sanitation procedures

Department fish pathologists and veterinarians routinely respond to requests for assistance when disease issues are suspected in production fish. Diagnoses are made, and legal therapies recommended when appropriate. Fish losses are attributable to common, widespread fish pathogens. A yearly disease certification is performed at MRH to monitor for pathogens of concern. Health inspections are performed to ensure production fish are healthy prior to release.

Hatchery Managers routinely adjust stocking density to prevent overcrowding, regulate growth rate and maintain an optimal rearing environment. Carcasses from fish mortalities are frozen and disposed through a commercial disposal service.

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

MRH Fish and Wildlife Technicians do not analyze smolts for gill ATPase activity, thyroxin, nor plasma sodium levels before release. Zydlewski et al. (2003) reported that physiological smolt characteristics are indirect measures of gill Na+, K+-ATPase activity, and seawater tolerance. MRH uses physical or morphological characteristics (parr, pre-smolt, smolt) as indices of smolt development.

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

The absence of environmental and biological influences in a hatchery can result in a hatchery population that differs from the natural stock(s) (Zydlewski et al. 2003). HSRG (2005) and Schreck et al. (1985) report that hatchery conditions can resemble natural conditions and improve survival of salmonids after they are released to the wild. However, studies conclude that increased survival does not offset a reduced production level using fabricated rearing environments (Fuss and Byrne 2002). The selection factor(s) and level(s) of exposure necessary to mimic natural selection in a hatchery environment are unknown. It is unclear what parameters Hatchery Managers should measure to evaluate the success of an artificial environment or process of “fabricated” natural selection. Kostow et al. (1998) proposed a rearing protocol that incorporates equal opportunity for survival of all individuals to avoid selection of fish that do well solely in a hatchery setting.

Natural Rearing Enhancement includes, but is not limited to, camouflage netting or shade screens, raceway structure, including fir trees and pea-sized gravel pavers. Zydlewski et al. (2003) reported that the overall effects of semi-natural rearing conditions are not available at the production hatchery level. Semi-natural rearing techniques are unproven and costly. A few hatcheries in the Pacific Northwest practice Natural Rearing Enhancement Systems at some level, but generally only on a limited or experimental basis. To date, stream survival and enhanced cryptic coloration qualified as the measurement of program success. Fisheries scientists have not analyzed the effects of artificial simulation of natural rearing conditions on development of smolts (Zydlewski et al. 2003).

MRH uses standard fish husbandry practices and monoculture techniques and does not propose to include semi-natural rearing techniques such as those described by Flagg and Nash (1999).

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

MRH staff operate a state-of-the-art steelhead program. An experienced Hatchery Manager I supervises three Fish and Wildlife Technician Range B staff, oversees daily operations and assures that staff members are trained in standard fish husbandry methods. MRH is equipped with alarm systems, backup generators, and re-circulating water systems that provide a safe rearing environment and prevent the risk of catastrophic fish losses. Additionally, obtaining a PNI value ≥ 0.50 is a type of risk aversion method.

Section 10.0 Release

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

10.1 Proposed fish release levels

Traditionally, Fish and Wildlife Technicians released steelhead volitionally for a period of three to five days, and then manually crowded yearlings out of the raceways if present. MRH is capable of pumping up to 1.5 mgd to convey steelhead into the river, provided that funds are available to operate pumps for an extended emigration period are within the hatchery's budget. This HGMP recommends volitional release of yearlings up to ten days, if feasible. If volitional release is not feasible, then MRH will conduct a phased release over a 7-10 day period, which corresponds to a period of increased flow. MRH will manually crowd yearlings into the river if necessary.

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

MRH releases yearling steelhead from the hatchery directly into the river.

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

A summary of historic steelhead releases for MRH for 1992-2013 is provided in Table 22.

10.4 Actual dates of release and description of release protocols

Steelhead are released between March 15 – April 15th, depending on favorable river flow.

10.5 Fish transportation procedures, if applicable

Not applicable under current operations.

10.6 Acclimation Procedures

No acclimation is done at MRH because the system is based upon flow through river water.

10.7 Marks applied, and proportions of the total hatchery population marked

MRH marks all (100% as a target, 99+% realized) yearling steelhead with an adipose fin clip (AD-clip) prior to release

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

The plans for the disposition of steelhead yearlings exceeding the production goal of 150,000 ± 10% are to release the excess in non-anadromous local water.

Table 22. Number and size of steelhead releases from BY 1991 through BY 2014

Year of Release	Fry	Mean Size (fpp)	Release Date	Fingerling	Mean Size (fpp)	Release Date	Yearling	Mean Size (fpp)	First Day of Volitional Release or Release Date
1992	830,000	2,000	3/5-4/29				79,576	5.8	3/20
							187,058	5.1-5.4	3/24-4/1
							52,200	4.5	4/20
							91,000	2.0-4.0	4/21-26
							15,120	18.0	12/8
1993	318,600	1,770	4/29	10,500	35	10/5	99,275	5.5	3/29
				37,100	53-55	10/5 & 6	134,010	6.0	4/13
				36,250	29	10/7	81,200	5.0-5.5	4/19
				60,000	40-44	10/8 & 9	87,505	5.5	4/26
1994	460,000	2,000	3/24-4/26				129,000	8.0	1/4
	80,000	800	4/25				99,900	4.5	3/7
	104,000	360	6/10				99,960	4.9	4/19 & 20
1995	32,000	2,000	3/14				37,450	3.5	2/28
	20,000	2,000	3/28				81,200	4.2-4.3	3/1
	26,000	2,000	4/16				82,500	5.0	3/2
1996	174,000	2,000	3/1-4/28				170,210	6.1-6.2	3/1-15
							55,580	3.6	3/15
	262,000	2,000	2/1-4/28	11,240	40	9/8	43,784	5.2	3/10

Year of Release	Fry	Mean Size (fpp)	Release Date	Fingerling	Mean Size (fpp)	Release Date	Yearling	Mean Size (fpp)	First Day of Volitional Release or Release Date
1997				12,330	30	9/8	43,785	6.3	3/24
				11,900	68	9/8	96,882	6.7	4/7
1998							77,438	6.2	3/16
							170,639	6.9-7.0	3/24 & 4/2
							34,373	3.7	2/22
1999							111,618	5.2	3/19
							117,504	5.4	3/23
2000							102,202	4.8	3/29
							120,000	5.0	4/7
							145,880	5.6	4/14
2001							62,493	3.7	3/28
							63,360	4.5	4/4
							99,696	4.8	4/10
2002							79,420	5.5	3/18/02
							77,787	5.4	4/2/02
							104,210	6.8	4/16/02
2003							77,622	5.1	3/18/03
							77,662	5.8	3/27/03
							85,883	5.1	4/8/03
2004							85,000	5.0	3/15/04
							64,500	4.3	3/22/04
							64,000	5.0	3/29/04
2005	No Release								
2006							254,168	2-2.5	3/07/06
2007							143, 898	4.0	03/05/07
2008							152,471	4.2	03/01/08
2009							254,604	5.2	03/04/09
2010							149,032	4.2	03/03/10
2011							150,994	4.7	03/22/11
2012							164,752	5.5	03/16/12
2013							163,631	8.5	03/20/13
2014							151,391	6.6	03/19/14

10.9 Fish health certification procedures applied to pre-release

Department fish pathologists and veterinarians perform a pre-release inspection of production fish to ensure healthy fish are released into Mad River. Also, a yearly disease certification for MRH is performed to check for pathogens of special concern. Diagnostic procedures for pathogen detection follow American Fisheries Society professional standards as described in "*Bluebook: Suggested Procedures for the Detection and Identification of Certain Finfish and Shellfish Pathogens*", 2012 edition, John C. Thoesen, Editor.

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

CDFW constructed MRH above the 100-year flood plain to avoid flooding of the facility. MRH maintains a backup generator to provide power to the primary pumps in the event of power failure. In the unlikely event that both primary and emergency systems fail and steelhead survival is tenuous, hatchery workers can release a portion, or all raceway production, into the tailrace for egress into the river. Section 10.1.7 discusses backup power for the spawning house.

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

MRH CDFW lowered steelhead production by 40% in 2006. This HGMP supports the decrease and release of yearlings at a size of $\geq$ 10/lb., which is the optimal size for juvenile steelhead survival (Taylor, undated). MRH will release yearling steelhead into Mad River when flows are high and turbid, prior to April 15, to promote rapid emigration to the ocean. Collectively, the reduced number of yearling steelhead does not completely abate their potential for occurrence of adverse interaction (competition and predation) with ESA-listed juvenile salmon and steelhead. However, the release time(s) proposed occur before most fry from natural redds emerge or migrate downstream, and the natural smolt migration is usually weeks after the hatchery smolt release (Sparkman 2002). Additionally, CDFW data (smolt trapping, ARIS sonar) show that MRH yearling steelhead are quickly migrating downstream, with low residualism (M. Sparkman, pers. comm. 2016). We also suspect fewer hatchery adults will return or stray because of the reduced level of production. However, the effect on listed species, although diminished, may not be fully mitigated, and will be a possible concern if warranted. These risks factors are included in the monitoring components of the performance standards. The assessment of hatchery performance standards allows managers to implement adaptive management where the program may not fully comply with genetic and ecological risk aversion or an undisclosed threat potential by a key component of the hatchery operation (seeTable 23).

NMFS and CDFW will conduct project reviews of hatchery operations on a six-year cycle to evaluate current operations and monitoring information.

Section 11.0 Monitoring and Evaluation of Performance Indicators

11.1 Proposed plans and methods to collect data necessary to respond to each "Performance Indicator" identified for the program

HGMP approval requires project compliance assurance (reporting) for the goals and objectives of the project performance standards[1]. In addition, any unknown effect of a potential risk factor that is a consequence of hatchery operations must be assessed for significant impact on the genetics, ecology or demographics of ESA-listed species (Table 23).

[1] Performance indicators and reporting standards and indicators were previously presented in Table 2 and 3.

Table 23. MRH Steelhead Trout Hatchery Operations Indicators, Metrics, and M&E Methods.

Performance Indicator	Performance Metric	Monitoring and Evaluation Method
Broodstock composition, timing, age structure	<u>Similar to natural fish</u> QA/QC of adipose fin clipping hatchery smolts to equal <u>></u>99%; assessment of quality of additional fins (caudal, pelvic, dorsal, pectoral)	Maintain broodstock spawning records too ensure that 50% at minimum and 100% the maximum is met. We will examine each breeding fish for full (natural fish) or missing adipose fin (hatchery origin), and examine genetics of all breeders. We will collect fish randomly throughout the entire portion of the run to ensure timing is similar to natural fish. ARIS sonar data can also show run timing of NOR and HOR adults, using species apportionment methods. Age structure will be monitored by collecting scales from each mating, or by randomly choosing HOR spawners with NOR spawners. Perform QA/QC of hatchery smolt fin clipping for each brood year to ensure correct identification of adult HOR and NOR spawners in the future. NOR fish used for breeding, those not used, and those that may die will be documented each year. Above information will be reported in annual reports.
Safely collect NOR steelhead for breeding at MRH using temporary adult weirs in tributaries and mainstem areas of Mad River, hook/line sampling, and/or seining techniques.	Obtain adequate numbers of NOR steelhead to meet hatchery goals	Temporary weirs will be used, if necessary, to collect NOR for MRH broodstock on tributaries and mainstem areas from Jan 1 – March 15 in a given year. Weirs will operate for 24hrs/d for 2 days prior to MRH spawning, and will be continuously monitored during deployment. The weirs will operate under moderate flows, and removed from the stream during high flow events, and when not in use to collect NOR steelhead trout. We will take only 10% of NOR fish that are available on any given day, and survey areas in tributaries to ensure we do not exceed this goal. The DIDSON/ARIS sonar camera on Mad R will provide NOR

Performance Indicator	Performance Metric	Monitoring and Evaluation Method
		escapement data to assess mainstem weir collections. Tributary weirs will span the entire channel, and mainstem weirs will only trap the edge of the river. We will survey areas below the weir(s) to ensure that we are not blocking migration, and run timing. If we find that we are, the weirs will be removed. Only fish in good condtion will be used for spawning at MRH, and all other fish will be immediately released upstream of the weir(s). Captured NOR fish for broodstock will be immediately netted from the livebox, and placed into a CDFW water truck, designed to hold and transport adult fish. Capture of adult Chinook salmon and Coho Salmon should be low, and incidental in February and March; they will be assessed for condition, and immediately released upstream of the weir(s). Above information will be reported in annual report.
Morphometrics between NOR and HOR steelhead trout	Similar morphometrics of HOR compared to NOR	We will develop a baseline data set on various morphometrics (TL, fin quality) for HOR and NOR adults, with the goal of HOR adults being morphometrically equal to NOR counterparts. Morhometric data for all NOR and HOR used for broodstock will be recorded, with the goal of HOR spawners being similar to NOR spawners.To ensure fin quality of HOR juveniles, rearing densities have been reduced compared to past years, and may be additionally reduced if needed.
Mating Protocols (pNOB % males) that minimize inbreeding, domestication, and conserve existing diversity of natural population	50% as a minimum, and 100% as a maximum.	Maintain broodstock spawning records of NOR x HOR and NOR x NOR crosses. Culture staff will quantify pNOB for each brood year; genetic techniques may be used to report if divergence between hatchery and natural origin fish is decreasing compared to previous years. Two males will be spawned with each

Performance Indicator	Performance Metric	Monitoring and Evaluation Method
		female to increase effective population size of hatchery population when breeding are less than 250 adults. Inbreeding will be not be a problem when crossing NOR x HOR, and can also be determined if we use genetic techniques. If present, inbreed offspring will be removed from the population. Above information will be reported in annual report.
Adult Holding and Spawning Survival Rate	≥ 90%	Culture staff will enumerate-data to be reported in annual operating reports.
Culled Egg-to-Fry Survival Rate	≥ 80%	Culture staff will enumerate-data to be reported in annual operating reports.
Culled Egg-to-Smolt Survival Rate	> 70%	Hatchery culture staff will enumerate loss for each brood year. Data to be reported in annual operating reports.
Smoltification Level	Similar to natural fish	A sub-sample of hatchery smolts will be categorized into parr, pre-smolt (transitional smolt) and smolt indices prior to release using visual observation. Correlations between visual data (silveryness of fish) and levels of ATPase activity (index of smoltification) have been repored in the literature (Negus 2003, Haner et al. 1995). Data will be reported in annual operating reports.
Release Size	3-8 fpp	Size at release information will be collected prior to release. Data will be reported in annual operating reports.
Release Time (Hatchery Smolts)	March – April (before natural fry emerge from redds and natural smolts move downstream)	Hatchery smolts will be released during March/April during higher flow events to facilitate rapid downstream migration, and to decrease potential interactions with naturally produced smolts. The best release date would be in March. Data will be reported in annual report.

Performance Indicator	Performance Metric	Monitoring and Evaluation Method
Number and Severity of Disease Outbreaks. Prevent introduction, spread or amplification of fish pathogens.	CDFW Disease Policy	Pathology staff will conduct health inspections of cultured fish. Pathologists will implement corrective actions as needed. The number, type, and severity of any disease outbreaks will be included in annual report.
Natural Adult Abundance in relation to natural spawners used at hatchery	Natural abundance above 500 fish (high risk depensation point is 352 fish)	CDFW believes the annual run size of adult naturally produced steelhead trout in the Mad River is within the range of 1,000 – 4,000 returning adults in any given year. Current monitoring efforts using DIDSON technology and species apportionment methods will quantify NOR and HOR abundances. MRH intends to use a goal of 167 natural adults (NOR, at 67% integration, with 50% or 125 NOR as a miminum, and 100% or 250 NOR as a maximum) in the spawning broodstock. Thus, the use of natural broodstock should not adversely affect the natural abundance (assumed at least 1,000) in the Mad River. We expect to achieve a PNI index of 0.5 – 0.67, which would serve as a surrogate of gene flow. A PNI of > 50% is believed to allow for natural selective forces, rather than hatchery, to dominate.. CDFW may also capture natural steelhead smolts in the Mad River to quantify gene flow from HOR to natural populations. Data will be included in annual report.
Similar Adult Run-Timing (HOR and NOR)	Match run timing for HOR and NOR	Spawning will occur proportionately over the entire run which likely mirrors run timing of natural counterparts. CDFW may determine run timing of the steelhead trout population using DIDSON/ARIS sonar technology and seining efforts. Data will be included in annual report.
Low HOS straying	Less than the percentage of NOR in breeding program (currently NOR minimum target is 50% and the goal is set at greater than 50%)	Use CDFW Steelhead Report/Restoration Card Program to estimate harvest of hatchery steelhead trout in the Mad River. Use report card to assess natural and hatchery

Performance Indicator	Performance Metric	Monitoring and Evaluation Method
		steelhead trout catch upstream and downstream of MRH. Determine fidelity of adult hatchery steelhead trout that returned to MRH after initial capture at MRH by punching a hole into the fish’s caudal fin each time the adult fish returns to the hatchery. We may also perform adult surveys in select tributaries to count the number of hatchery and natural steelhead trout observed. We may also radio tag adult HOR fish below MRH, and at MRH prior to their release back into the stream. Data will be included in annual report.
Hatchery effluent discharges monitoring	Various, based on regulations	MRH operates under the NPDES general permit which conducts effluent monitoring and reporting, and operates within the limitations established in its permit. Information will be included in annual report.

Most of the identified adverse ecological interactions resulting from MRH operations are abated by 1) a reduction in total production (150,000 yearlings +/-10%), 2) early release of yearlings prior to the emergence of most NOR salmonids, 3) release timing of HOR yearlings that emigrate prior to most Chinook, coho, and natural steelhead smolts, and 4) synchronization of yearling release with high-flow events.

Conversely, it may take many generations of steelhead to develop an Integrated Hatchery Program that can sustain a HOR steelhead population compatible (non-divergent) with the NOR population structure. Furthermore, it can take another 10-15 years of post-supplementation monitoring to evaluate program efficacy.

CDFW hopes to monitor the genetics of NOR and HOR winter-run steelhead broodstock in future years to ensure NOR integration (into spawning program) is working to reduce the perceived genetic differences between NOR and MR HOR steelhead. The genetic management of broodstock monitors progress in the return of the HOR product to a previous genetic similarity to NOR stock. The backlog of genetic tissue from broodstock since 2009, when NOR were integrated into the spawning matrix, will also be genetically analyzed through a contract being developed with the NOAA Science Center to provide an analysis on the genetic status of HOR and NOR stock convergence.

A proposal under past consideration for a future revision of the HGMP recommended that the progeny from NORxNOR and NORxHOR be tagged with coded wire tags (CWTs), and only these fish out of the total production will be tagged. A CWT program required isolated rearing space to keep these fish segregated from the general population until large enough to be implanted.and integrated with the general hatchery population. Upon return as adults, they would be used for the spawning matrix in preference to HORxHOR. Since we do not ever plan on crossing HOR x HOR, we do not need to CWT fish for identifying future breedings. Rather, since we are only crossing NOR x HOR, and NOR x NOR, and also determining PNI the best we can, our methods should increase the fitness and genetic similariites of MRH HOR' with NOR's in the Mad River. Given the current knowledge, obtaining a PNI > 50% (our goal) allows for natural selective forces to dominate, rather than hatchery selective forces.

With respect to the depensation point of NOR steelhead in the Mad River, the most current estimate (2013/14) of NOR Steelhead Trout returns to Mad River is 3,449 and for HOR the return is 4,336; therefore, we are well above the depensation point. CDFW is committed to NOR x HOR by policy and NOR x NOR as a goal; therefore production may be decreased if not enough NOR's are collected for broodstock. Since no HOR x HOR will be mated, CWTs marks would not be necessary.

The annual genotyping of broodstock will provide a robust evaluation of the success of the HGMP goal to do no genetic harm to the NOR winter-run steelhead. (Appendix 8, SFRA 2013 narrative (proposal).

This HGMP proposes the use of adaptive management (i.e. an experimental process) that monitors the ecological community response to changes in hatchery operations, and allows adjustment of future actions to attain the goals for genetic performance. This process for adaptive management will require long-term monitoring, reporting, evaluation, and timely systematic review by NMFS and CDFW. Adaptive management allows co-managing agencies the means to modify hatchery operations when:

1. monitoring results indicate that elements of the program do not comply with the proposed mitigation measures to minimize risk aversion;
2. performance standards are not achieved/met; or
3. new information determines an undisclosed risk that entails jeopardy.

This Plan proposes a tri-annual report for MRH operations by CDFW and a hatchery program evaluation/review on a six-year cycle (two steelhead generations). NMFS will take the lead for scheduling routine review of hatchery operations and adaptive management/coordination meetings.

11.2 Funding, staffing, and other support logistics that are available or committed to allow implementation of the monitoring program

CFDFG/NMFS had sufficient funding to staff and implement the hatchery operations as outlined in the previous interim HGMP. However each change and improvement will often require a measurable increase in funding in order to implement rearing and infrastructure needs to accommodate future goals. The hatchery is over 43 years old and will require an estimated $1.5 million to retrofit for general maintenance, with additional costs associated with developing holding ponds next to the spawning facility to become spawner-friendly. These holding ponds, given improvements in flow, can contain spawners whose genetic make-up will be known prior to spawning, similar to CDFW's Iron Gate Hatchery, if necessary. MRH has implemented many of the changes identified within the previous interim HGMP including a 40% reduction in total production numbers and implementation of conservation spawning protocols. In addition, the monitoring requirements identified in the HGMP have also been implemented with new seasonal staff and funding through the 2013 Sport Fish Restoration Act agreements. Volunteers and staff from CDFW's Anadromous Fisheries Resource Assessment and Monitoring Program contribute time for fisheries monitoring, spawning, fish marking, and Quality Assurance and Quality Control (QA/QC.) of marked HOR smolts.

11.3 Risk aversion measures that will be applied to minimize the likelihood of adverse genetic and ecological effects to listed fish resulting from monitoring and evaluation activities

Scientific research, sampling techniques, and protocols given in this HGMP are subject to authorization and take provisions administered by NMFS. Monitoring activities proposed within this HGMP will be appended to DFG's existing 4(d) Rule provisions to minimize the likelihood for significant adverse effects to listed fish. CDFW personnel have extensive experience operating seine nets, sonar cameras, adult weirs, and hook/line sampling, as well as for handling, sampling, and holding captured adult fish.

A one year, 2016/17 Steelhead Report and Restoration Card grant, submitted from HSUauthored by Dr. Kinziger, may include Isolation by Distance Genetic Analysis within the whole Mad River basin and tributaries to monitor HOR steelhead imapcts on NOR steelhead over multiple years. Following this study, the newly hired CDFW Fisheries Geneticist, Jeff Rodzen, PhD, and his team, will periodically analyse genetic tissue samples as needed, both from hatchery spawning and from genetic tissue taken at stratified distances from the hatchery.

The following table (24) lists the areas where our monitoring should have risk aversion measures to prevent or minimize adverse effects on listed fish:

Table 24. Risk aversion measures associated with various monitoring and evaluations in the MRH HGMP.

Monitoring/Evaluation Activities Associated with:		Risk Aversion
Broodstock collection (HOR, NOR) at MRH Facility (adult capture, holding); Seining, adult weir, and hook/line operations within Mad River, Mating Protocols		MRH Capture: Fish volitionally enter the ladder and holding pen where they are then trapped. Small amounts of river water are added to the ladder as an attractant for NOR adults. The ladder and pen are only operated for enough consecutive days to capture sufficient fish for breeding to prevent over-crowding of adults. The ladder and pen may be operated longer if CDFW needs to reduce pHOR on spawning grounds. The pen is checked for possible overcrowding each day, and measures are in place to keep predators out of the pen. Fish are carefully processed (counted, spawned) and placed into cement raceways for recovery and later released back into the river directly, usually at night. Semi-unripe fish held for spawning the following week are kept in circular tanks, or placed back into the holding pen. Any mortalities associated with capture and holding are recorded daily. Data is reported in annual report. NOR broodstock collection at off-site locations: Seining, adult weirs, hook/line. Standard seining, adult weir, and hook/line sampling techniques will be used for adult NOR capture by experienced CDFW personnel and/or volunteers. Teams of 2-8 people will assist with collection activities, to safely capture adult fish. Captured fish will be placed in holding tubes, and CDFW water trucks will deliver captured fish to MRH Facility. Fish are then placed into holding pen and monitored daily. Alternately, for NOR males, sperm may be collected in the field and broght to MRH for spawning purposes. Few if any mortalities are expected, data will be recorded and reported in annual report. Mating Protocols: only well trained CDFW MRH staff are allowed to inspect adult fish

Monitoring/Evaluation Activities Associated with:		Risk Aversion
		captured at MRH as HOR or NOR, and perform selective spawning activities. Genetic tissue samples are taken from each spawner, with detailed information recorded on the genetic sample envelope that allow for documenting specific mating pairs and split egg lots. Spawned fish are immediately placed into well aerated circular tanks, and after recovery placed into the cement raceway for further recovery and later release. Any mortality is recorded, and reported in annual report. QA/QC: Smolts are captured from various locations within the rearing raceways with dip nets and anesthetized with CO2 for the examination of the adipose fin clip on a percentage basis. Fin erosion and the degree of smoltification will be conducted by CDFW Environmental Scientist and aides. After examination and data recording, fish are placed back into the rearing raceways. Multiple sampling events occur to prevent anesthetizing too many smolts at once. Any mortality is recorded, and reported to hatchery staff. Data is reported in annual report.
Egg-to-Fry Survival Rate; Egg-to-Smolt Survival Rate; Smoltification Level; Release Size		MRH staff will determine survival rates using standard hatchery practices. Mortaties associated with spawning and rearing will be documented, as well as mortaties associated with determining survival (handling, counting, etc). Data will be recorded and provided in annual report. Smoltification Levels: only trained CDFW personnel will conduct assessment of smoltification level prior to smolt release from MRH. Fish will be netted from rearing pens, anesthetized with CO2, and visually observed for parr, pre-smolt, and smolt conditions. Any mortalities will be recorded on data sheet.

Monitoring/Evaluation Activities Associated with:		Risk Aversion
		Data will be recorded and provided in annual report. The size of smolts released from MRH will be determined by CDFW personnel using standardized techniques. Any mortalities will be documented. Information will be included in annual report. Size of juveniles is also determined by CDFW prior to smolting, and will be included in annual report.
Number and Severity of Disease Outbreaks. Prevent introduction, spread or amplification of fish pathogens.		Pathology staff will conduct health inspections of cultured fish using standard techniques. Pathologists will implement corrective actions as needed. The number, type, and severity of any disease outbreaks will be included in annual report.
Natural Adult Abundance in relation to natural spawners used at hatchery		A study independent of the MRH HGMP will use DIDSON/ARIS sonar technology and species apportionment methods to count returning adult fish to the Mad River (M Sparkman, pers. Comm, CDFW). Information collected during this study will be included in the HGMP. DIDSONs use sonar to count fish and do not negatively affect fish (physically or behaviorly). We anticipate using at least 125 NOR steelhead (50% integration rate) at MRH, which in a low natural abundance year (1,000 adults) would equal 12.5% of the population. At an NOR abundance of 3,449 (most current estimate), a minimum goal of 125 NOR for breeding and a maximum goal of 250 NOR for breeding (maximum 100% integration rate), would equal 3.6 and 7.2% of total NOR abundance, respectively. If we were to have a pNOB of 0.67 (67% NOR integration rate) we would require 167 NOR broodstock, which equates to 4.8% of 3,449 NOR adults in the basin. For brood stock collections, we will not mine tributaries for NOR fish (i.e. will take <10% of adults).
Low HOR straying		CDFW MRH personnel will use a hole punch to make a hole in the caudal fin of every adult

Monitoring/Evaluation Activities Associated with:		Risk Aversion
		that returns to MRH. Each time the adult returns a new hole punch is given, thus providing some data on MRH site fidelity. This procedure is considered harmless, and part of the adult collection process. There is a future possibility of radio tagging HOR adults to more critically address stray rates. Any mortalities associated with this site fidelity study and/or radio tagging will be recorded and reported annually.
Hatchery effluent discharges monitoring		Standard techniques will be followed, and are not expected to cause any adverse impacts. Any negative impacts will be addressed, and reported in annual report.

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Section 13.0 Certification Language and Signature of Responsible Party

"I hereby certify that the foregoing information 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: _____________________________

Signature of Applicant: ____________________________

Certified by: ________________________ Date: ____________________

Philip K. Bairrington, Senior Environmental Scientist, Supervisor of the Anadromous Fisheries Resource Assessment and Monitoring Program

California Department of Fish and Wildlife
Region 1 – Northern

Section 14.0. Estimated Listed Salmonid Take Levels by Hatchery Activity

Listed species affected: Steelhead Trout **ESU/Population:** NC Steelhead Trout DPS **Activity:** Steelhead Program				
Location of hatchery activity: Mad River Hatchery **Dates of activity:** Year-round **Hatchery program operator:** California Fish and Wildlife				
	Annual Take of Listed Fish By Life stage (*Number of Fish*)			
	Egg/eyed egg	**Fry/Smolt**	**Adult**	
Observe or harass a)				
HORxHOR at MRH Facility				
HORxNOR at MRH Facility	550,000/328,000	230,912/184,720		
Smoltification Determination (visual)		Smolt 1,000		
QA/QC of Fin Clipping		1,500 – 2,200		
QA of additional fins (dorsal, pelvic, pectoral, caudal)		1,000		
Collect for transport b) NOR (at 50-100% integration rate)			125-250	
Capture, handle, and release c)				
HOR at MRH Facility			6,500	
NOR at MRH Facility*			125-250	
HOR (Seining)			500	
NOR (Seining)*			125-250	
HOR Adult Weirs			300	
NOR Adult Weirs*			125-250	
HOR Hook/Line			10-250	
NOR Hook/Line*			125-250	
Tag/mark/tissue sample, and release d)				
HOR at MRH Facility (hole punch)			6,500	
NOR at MRH Facililty (hole punch)			125-250	
Smolt Fin Clipping		150,000		
HOR BroodStock Tissue Sample			0-125	

NOR Broodstock Tissue Sample			125-250	
Broodstock e)				
HOR			0-125	
NOR			125-250	
Intentional lethal take f)			0	
Cull HOR x NOR Eggs (decrease if exceed egg take; increase effective population size)	222,200			
Cull HOR x NOR Fry (to increase NORxHOR fry if predict to exceed smolt production levels)		Fry 0		
Unintentional lethal take g)				
HOR x HOR egg to eyed egg	0			
HOR x NOR egg to eyed egg (88% survival)	39,360			
HOR x HOR eyed egg to fry; fry to smolt				
HOR x NOR eyed egg to fry; fry to smolt (20% mortality)		57,728/46,182		
HOR Spawners			18	
NOR Spawners			1	
MRH HOR Captures			195	
MRH NOR Captures			1	
Seining HOR Captures			2	
Seining NOR Captures			0	
Adult Weirs HOR			2	
Adult Weirs NOR			2	
Hook/line HOR			1	
Hook/line NOR			0	
Adipose Fin Clipping		1,500		
QA/QC of smolts for fin clipping		5		
Checking smolts for smoltification		5		
Other Take (specify) h) Pathology		Smolts 100		

**** The primary method for collecting NOR broodstock would be at MRH, however, if insufficient numbers (NOR) return, additional off-site collection(s) will occur.***

***Instructions*:**

1. *An entry for a fish to be taken should be in the take category that describes the greatest impact.*
2. *Each take to be entered in the table should be in one take category only (there should not be more than one entry for the same sampling event).*
3. *If an individual fish is to be taken more than once on separate occasions, each take must be entered in the take table*
   a. *Contact with listed fish through stream survey, carcass and mark and recovery projects or migration delay at weirs.*
   b. *Take associated with weir or trapping operations where listed fish are transported for release.*
   c. *Take coverage due to tagging and or bio-sampling of fish collected through trapping operations prior to upstream or downstream release, or through carcass recovery programs.*
   d. *Take associated with monitoring and evaluation (electrofishing, DSM trap) activities.*
   e. *Take of listed fish removed from the wild and collected as broodstock.*
   f. *Intentional take of listed fish associated with broodstock collection.*
   g. *Unintentional mortalities associated with research activities.*
   h. *Other mortality associated with this program*

Listed species affected: Steelhead Trout **ESU/Population:** CC Chinook Salmon **Activity:** Steelhead Program				
Location of hatchery activity: Mad River Hatchery **Dates of activity:** Year-round **Hatchery program operator:** California Fish and Wildlife				
	Annual Take of Listed Fish By Life stage (*Number of Fish*)			
	Egg/eyed egg	**Fry/Smolt**	**Adult**	
Observe or harass a)				
Collect for transport b)			0	
Capture, handle, and release c)				
Adult Chinook at MRH Facility			5	
Adult Seining			150	
Adult Weirs			50	
Hook/line			40	
Tag/mark/tissue sample, and release d) For genetic samples			40	
Broodstock e)			0	
Intentional lethal take f)			0	
Unintentional lethal take g)				
Adult Chinook at MRH Facility			0	
Adult Chinook Seining			0	
Adult Weirs			1	
Hook/line			0	
Other Take (specify) h) Pathology				

***Instructions*:**
1. *An entry for a fish to be taken should be in the take category that describes the greatest impact.*
2. *Each take to be entered in the table should be in one take category only (there should not be more than one entry for the same sampling event).*
3. *If an individual fish is to be taken more than once on separate occasions, each take must be entered in the take table*
   a. *Contact with listed fish through stream survey, carcass and mark and recovery projects or migration delay at weirs.*

b. Take associated with weir or trapping operations where listed fish are transported for release.
c. Take coverage due to tagging and or bio-sampling of fish collected through trapping operations prior to upstream or downstream release, or through carcass recovery programs.
d. Take associated with monitoring and evaluation (electrofishing, DSM trap) activities.
e. Take of listed fish removed from the wild and collected as broodstock.
f. Intentional take of listed fish associated with broodstock collection.
g. Unintentional mortalities associated with research activities.
h. Other mortality associated with this program

Listed species affected: Steelhead Trout ESU/Population: SONCC Coho Salmon Activity: Steelhead Program				
Location of hatchery activity: Mad River Hatchery **Dates of activity:** Year-round **Hatchery program operator:** California Fish and Wildlife				
	Annual Take of Listed Fish By Life stage (*Number of Fish*)			
	Egg/eyed egg	**Fry/Smolt**	**Adult**	
Observe or harass a)				
Adult Coho at MRH Facility	NA	NA	3	
Collect for transport b)	NA	NA	NA	
Capture, handle, and release c)				
Adult Coho at MRH Facility			3	
Adult Seining			10	
Adult Weirs			20	
Hook/line			3	
Tag/mark/tissue sample, and release d)				
Broodstock e)	NA	NA	NA	
Intentional lethal take f)	NA	NA	NA	
Unintentional lethal take g)				
Adult Coho at MRH Facility			0	
Adult Seining			0	
Adult Weirs			0	
Hook/Line			0	
Other Take (specify) h) Pathology	NA	NA	NA	

Instructions:
1. *An entry for a fish to be taken should be in the take category that describes the greatest impact.*
2. *Each take to be entered in the table should be in one take category only (there should not be more than one entry for the same sampling event).*
3. *If an individual fish is to be taken more than once on separate occasions, each take must be entered in the take table*

a. Contact with listed fish through stream survey, carcass and mark and recovery projects or migration delay at weirs.
b. Take associated with weir or trapping operations where listed fish are transported for release.
c. Take coverage due to tagging and or bio-sampling of fish collected through trapping operations prior to upstream or downstream release, or through carcass recovery programs.
d. Take associated with monitoring and evaluation (electrofishing, DSM trap) activities.
e. Take of listed fish removed from the wild and collected as broodstock.
f. Intentional take of listed fish associated with broodstock collection.
g. Unintentional mortalities associated with research activities.
h. Other mortality associated with this program

Appendix 1. Definition of (NMFS) terms referenced in the HGMP template.

Augmentation - The use of artificial production to increase harvestable numbers of fish in areas where the natural freshwater production capacity is limited, but the capacity of other salmonid habitat areas will support increased production. Also referred to as “fishery enhancement”.

Critical population threshold - An abundance level for an independent Pacific salmonid population below which: depensatory processes are likely to reduce it below replacement; short-term effects of inbreeding depression or loss of rare alleles cannot be avoided; and productivity variation due to demographic stochasticity becomes a substantial source of risk.

Direct take - The intentional take of a listed species. Direct takes may be authorized under the ESA for the purpose of propagation to enhance the species or research.

Evolutionarily Significant Unit (ESU) - NMFS definition of a distinct population segment (the smallest biological unit that will be considered a species under the Endangered Species Act). A population will be/is considered to be an ESU if 1) it is substantially reproductively isolated from other conspecific population units, and 2) it represents an important component in the evolutionary legacy of the species.

Harvest project - Projects designed for the production of fish that are <u>primarily</u> intended to be caught in fisheries.

Hatchery fish - A fish that has spent some part of its life-cycle in an artificial environment and whose parents were spawned in an artificial environment.

Hatchery population - A population that depends on spawning, incubation, hatching or rearing in a hatchery or other artificial propagation facility.

Hazard - Hazards are undesirable events that a hatchery program is attempting to avoid.

Incidental take - The unintentional take of a listed species as a result of the conduct of an otherwise lawful activity.

Integrated harvest program - Project in which artificially propagated fish produced <u>primarily</u> for harvest are intended to spawn in the wild and are fully reproductively integrated with a particular natural population.

Integrated recovery program - An artificial propagation project <u>primarily</u> designed to aid in the recovery, conservation or reintroduction of particular natural population(s), and fish produced are intended to spawn in the wild or be genetically integrated with the targeted natural population(s). Sometimes referred to as “supplementation”.

Isolated harvest program - Project in which artificially propagated fish produced <u>primarily</u> for harvest are not intended to spawn in the wild or be genetically integrated with any specific natural population.

Isolated recovery program - An artificial propagation project primarily designed to aid in the recovery, conservation or reintroduction of particular natural population(s), but the fish produced are not intended to spawn in the wild or be genetically integrated with any specific natural population.

Mitigation - The use of artificial propagation to produce fish to replace or compensate for loss of fish or fish production capacity resulting from the permanent blockage or alteration of habitat by human activities.

Natural fish - A fish that has spent essentially all of its life-cycle in the wild and whose parents spawned in the wild. Synonymous with *natural origin recruit (NOR).*

Natural origin recruit (NOR) - See *natural fish*.

Natural population - A population that is sustained by natural spawning and rearing in the natural habitat.

Population - A group of historically interbreeding salmonids of the same species of hatchery, natural, or unknown parentage that have developed a unique gene pool that breed in approximately the same place and time, and whose progeny tend to return and breed in approximately the same place and time. They often, but not always, can be separated from another population by genotypic or demographic characteristics. This term is synonymous with stock.

Preservation (Conservation) - The use of artificial propagation to conserve genetic resources of a fish population at extremely low population abundance, and potential for extinction, using methods such as captive propagation and cryopreservation.

Research - The study of critical uncertainties regarding the application and effectiveness of artificial propagation for augmentation, mitigation, conservation, and restoration purposes, and identification of how to effectively use artificial propagation to address those purposes.

Restoration - The use of artificial propagation to hasten rebuilding or reintroduction of a fish population to harvestable levels in areas where there is low, or no natural production, but potential for increase or reintroduction exists because sufficient habitat for sustainable natural production exists or is being restored.

Stock - (see “Population”).

Take - To harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct.

Viable population threshold - An abundance level above which an independent Pacific salmonid population has a negligible risk of extinction due to threats from demographic variation (random or directional), local environmental variation, and genetic diversity changes (random or directional) over a 100-year time frame.

Appendix 2. NMFS Age class designations by fish size and species for salmonids released from hatchery facilities.

	SIZE CRITERIA	
SPECIES/AGE CLASS	**Number of fish/pound**	**Grams/fish**
Chinook Yearling	≤20	≥23
Chinook (Zero) Fingerling	>20 to 150	3 to <23
Chinook Fry	>150 to 900	0.5 to <3
Chinook Unfed Fry	>900	<0.5
Coho Yearling 1/	<20	≥23
Coho Fingerling	>20 to 200	2.3 to <23
Coho Fry	>200 to 900	0.5 to <2.3
Coho Unfed Fry	>900	<0.5
Chum Fed Fry	≤1000	≥0.45
Chum Unfed Fry	>1000	<0.45
Sockeye Yearling	≤20	>23
Sockeye Fingerling	>20 to 800	0.6 to <23
Sockeye Fall Releases	<150	>2.9
Sockeye Fry	> 800 to 1500	0.3 to <0.6
Sockeye Unfed Fry	>1500	<0.3
Pink Fed Fry	≤1000	≥0.45
Pink Unfed Fry	>1000	<0.45
Steelhead Smolt	≤10	≥45
Steelhead Yearling	≤20	>=23
Steelhead Fingerling	>20 to 150	3 to <23
Steelhead Fry	>150	<3
Cutthroat Trout Yearling	≤20	≥23
Cutthroat Trout Fingerling	>20 to 150	3 to <23
Cutthroat Trout Fry	>150	<3
Trout Legals	≤10	≥45
Trout Fry	>10	<45

1/ Coho yearlings defined as meeting size criteria and 1 year old at release, and released prior to June 1st

Appendix 3. Photographs of Mad River Hatchery Facilities

Photograph 1	Fish ladder
Photograph 2	Fish trap and holding ponds
Photograph 3	Hydraulic fish crowder
Photograph 4	Hydraulic door to spawning house, anesthetic tank and fish basket
Photograph 5	Hatchery building , sump and pump house
Photograph 6	Fish sorting table
Photograph 7	Flume to holding ponds
Photograph 8	Holding ponds
Photograph 9	Post spawning recovery tank, release chute and pre-spawning holding tanks
Photograph 10	Pneumatic spawning needle
Photograph 11	Incubator stacks
Photograph 12	Rearing round tanks and troughs
Photograph 13	Raceway UV light treatment shed
Photograph 14	Raceway pond screen
Photograph 15	Mid-raceway tailrace
Photograph 16	Raceway tailrace
Photograph 17	Settling pond head works
Photograph 18	Settling pond
Photograph 19	Primary pumps and sump
Photograph 20	Secondary recirculation sump, pump house and aeration tower
Photograph 21	Oyster bed filtration system in operation


Figure 1. Fish ladder


Figure 2. Fish trap and holding ponds


Figure 3. Hydraulic fish crowder


Figure 4. Hydraulic door to spawning house, anesthetic tank and fish basket


Figure 5. Hatchery building (left) sump and pump house (right)

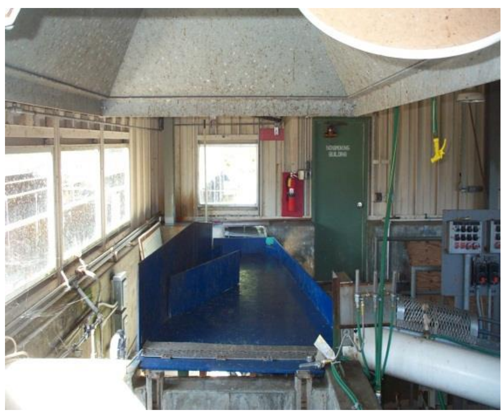


Figure 6. Fish sorting table

Figure 7. Flume to holding ponds

Figure 8. Holding Ponds

Figure 9. Post spawning recovery tank (back ground) release chute (left foreground) and pre-spawning holding tanks (right)

Figure 10. Pneumatic spawning needle

Figure 11. Incubator stacks

Figure 12. Rearing round tanks and troughs

Figure 13. Raceway UV light treatment shed

Figure 14. Raceway pond screen

Figure 15. Mid-raceway tailrace

Figure 16. Raceway tailrace

Figure 17. Settling pond head works

Figure 18. Settling pond

Figure 19. Primary pumps and sump

Figure 20. Secondary recirculation sump (right), pump house (center) and aeration tower (left)

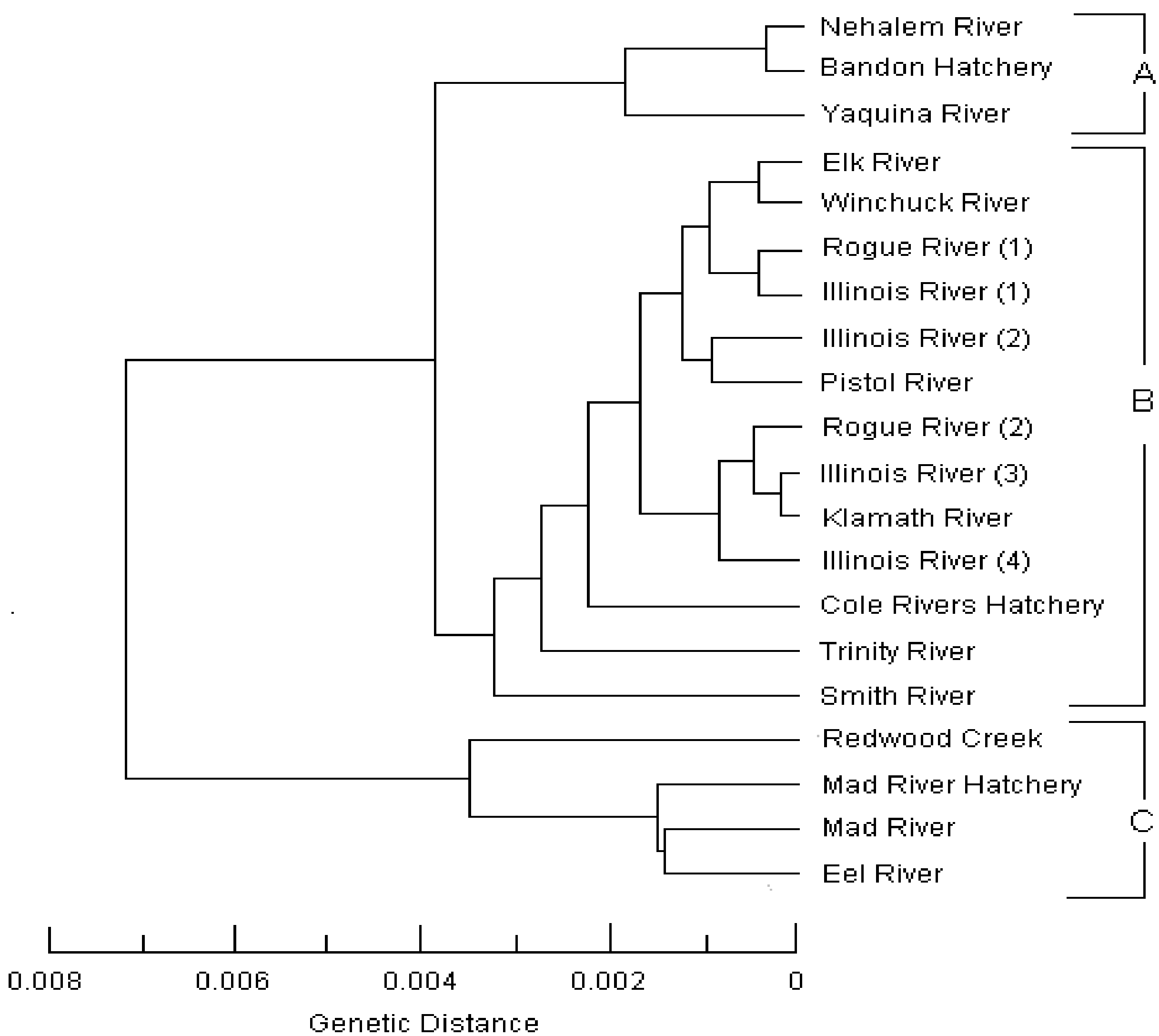
Figure 21. Oyster bed filtration system in operation

Figure 22. Oyster bed filtration system

Figure 23. Walkway to fishing access

Figure 24. Fishing access

Appendix 4. Dendrogram depicting genetic relationships among 20 coastal steelhead populations [Source: *NWFSC Tech Memo-19: Status Review for Klamath Mountains Province Steelhead]*



Appendix 5. Mad River Average Monthly Flow Discharge during spring release

Year	Jan	Feb	Mar	Apr	May	Jun
1963	679.3	3,078	2,416	6,253	1,453	251.8
1964	5,507	1,907	1,686	699.9	426.5	305.5
1964	6,177	1,401	438.5	2,129	382.2	172.6
1965	5,227	2,139	3,418	1,252	284.3	112.5
1966	3,244	1,269	2,201	2,225	1,519	194.4
1967	2,458	3,771	1,783	401.8	121.7	41.8
1968	7,143	4,284	1,990	1,488	599.2	124.2
1969	8,847	2,166	1,465	553.7	385.1	66
1970	5,092	1,028	5,265	2,389	602.5	204.1
1971	4,023	3,336	5,099	1,596	332.5	108.5
1972	3,880	2,769	2,405	1,042	212.2	66.8
1973	5,282	2,831	4,515	3,280	260.1	31.2
1974	2,104	5,756	7,150	2,135	1,032	123.9
1975	1,170	2,421	1,894	1,562	235.5	57.7
1976	135.4	138.3	863.7	180.4	219	31.5
1977	5,866	4,257	2,493	2,307	537.4	77.2
1978	1,047	2,155	2,282	1,359	1,300	86.7
1979	4,351	3,499	3,693	1,427	481.6	114
1980	1,612	2,505	2,388	882.9	369.5	112.3
1981	3,101	4,519	2,844	5,610	686.2	102.6
1982	3,964	6,818	6,336	3,410	1,407	260.3
1983	1,511	3,185	2,509	1,953	1,293	394.9
1984	505.1	1,871	1,124	1,060	181.2	89.1
1985	2,335	9,796	3,744	509	711	97.1
1986	1,887	2,306	3,174	427.3	140.8	38.7
1987	2,973	671.1	194	165.4	373.5	758
1988	3,216	1,559	5,411	1,820	365.4	131.1
1989	1,738	2,483	2,207	341.1	1,267	1,025
1990	481.1	551.7	2,383	1,396	740.3	130.5
1991	361.2	1,526	1,046	1,137	169.8	69.6
1992	4,458	2,934	3,601	2,988	1,408	1,721
1993	1,252	2,478	1,119	689.3	575.3	125.4
1994	8,811	2,413	6,000	3,681	1,654	390.9
1995	5,998	4,414	3,436	2,196	1,048	244.7
1996	7,109	1,886	1,278	1,155	528.9	167.9
1997	7,707	7,369	4,089	1,904	1,002	499
1998	2,519	5,899	3,698	1,998	752	175.4
1999	3,649	4,547	2,299	823.5	744.1	209.1
2000	502.4	1,135	1,083	551.9	219.3	79.6
2001	3,264	2,976	1,622	545.5	268.4	91.1
2002	3,814	1,896	2,597	3,829	2,119	238.9
2003	3,405	5,437	1,637	863.8	274.8	93.5
2004						
2005	6,819	4,225	4,759	4,057	903.5	202.9
2006	1,711	3,556	2,969	1,240	449.2	116.4
2007	3,660	3,659	1,850	803	411.6	135.8
2008	3,570	3,130	2,810	1,740	677	219

Appendix 6. Annual MRH HGMP reporting requirements

1) Hatchery Name
    a) production period for report - mm/dd/yr through mm/dd/yr.
    b) hatchery production goals and objectives
    c) miscellaneous data/information

2) Hatchery Trapping Operations
    A. Hatchery Trapping
        a) date, location
        b) the number of Chinook and coho salmon trapped and released
        c) the number of mortalities, by species, sex, mark and cause of take
        d) the number and disposal method for incidental mortalities
    B. Alternative procurement methods
        a) the number of Chinook and coho salmon trapped and released
        b) the number of mortalities, by species, sex, mark and cause of take
        c) the number and disposal method for incidental mortalities

3) Production Summary
    a) the number of steelhead spawned
    b) the number of steelhead eggs taken
    c) the number and sex of natural spawners used for broodstock
    d) the number of grilse spawned for broodstock

4) Hatchery Operations
    A. Spawning
        a) the number of broodstock
        b) description of spawning protocol i.e 1:1, split egg-lots
        c) fecundity
        d) fertility
        e) green to eyed-egg survival
        f) report the number of tissue samples taken and their disposition
    B. Incubation
        a) survival by family lot from fertilized egg to fingerling
        b) rate of integrated production (wild x hatchery prior to ponding)
    C. Rearing
        a) pond survival rates from fingerling to smolt
        b) feed rate, growth rate
        c) rearing density
        d) phenotype quality control
        e) alternative or natural rearing conditions
    D. Disease
        a) disease outbreaks,
            - number of fish affected
            - mortality
        b) treatment

c) prophylactic treatments

E. Marking

a) the number of steelhead
b) report the percent marked/unmarked steelhead

F. Release

a) date(s) of release
b) type of release (volitional, forced)
c) river flow during release

G. Facilities Management

a) water temperature
b) type of release (volitional, forced)
c) river flow during release
d) predator losses
e) NPDES report(s)

H. Public Relations Facilities Management

a) water temperature
b) list visitors, tours, educational opportunities

I Scientific Studies

a) experimental rearing methods
b) river and hatchery steelhead studies

5) Restoration

a) a)summary of all-in-river habitat

6) Steelhead Report Card Results for Mad Restoration

a) estimated number of natural and steelhead caught
b) estimated number of natural and steelhead released
c) comparison of angler catch (1+2) pre and post production goal change
d) estimate trend in hatchery/natural ratio
e) estimate trend in MRH strays to adjacent basin within NC DPS
f) evaluate changes in angling regulations for trend in (1-5)

Appendix 7. Historic Summer-run Steelhead Propagation at MRH

In 1971, California Department of Fish and Wildlife (CDFW) began artificial propagation of summer-run steelhead at Mad River Hatchery using eggs from Washougal River, Washington. Washington State fish hatcheries experienced broodstock shortages in the subsequent years, so CDFW transferred 100,000 summer-run fingerlings from Trinity River Hatchery to Mad River Hatchery in 1972 and again in 1973. From 1974 through 1977, Mad River Hatchery trapped summer-run broodstock at the hatchery. Summer-run steelhead production at Mad River Hatchery was augmented in 1978 with 152,640 yearlings (Washougal River strain), which were transferred from Silverado Fish Station in Yountville.

Knutson (1975) reported that the summer-run steelhead program resulted in a spring fishery (May and June) as planned, but some fish returned in early fall. In 1976, 170 and 52 summer-run adults returned to the hatchery in May and in fall, respectively. Adult summer-run returns to the hatchery decreased in time. The low return was partially the result of fractional marking (AD-clip) or the absence of marking in some years. The summer-run steelhead hatchery program was terminated in 1996.

Total releases for the period of 1972 through 1996 are as follows.

YEAR	PLANTED	SIZE	YEAR	PLANTED	SIZE
1972	67,030[1]	64.8-67.7/LB	1987	20,075	5.5/LB
1972	10,400[1]	87.2/LB	1987	37,260	6.9/LB
1976	17,897[1]	11.0/LB	1987	24, 790	6.7/LB
1976	59,893	32.2-32.4/LB	1987	21,760	3.4/LB
1978	35,034	13.4/LB	1989	79,205	7.3 /LB
1979	56,335	6.5/LB	1990	147,395	8.2/LB
1979	96,000[1]	10.0/LB	1990	2,205	3/LB
1979	14,200[1]	7.1/LB	1991	79,002	6.3/LB
1980	21,000	8.0/LB	1992	74,500	5.0/LB
1980	128,500[1]	10.0/LB	1992	40,380	12.0/LB
1981	52,355	10-11.4 LB	1993	96,000	6.0/LB
1981	33,750[1]	12.5/LB	1994	75,000	100/LB
1982	60,000	15.0/LB	1994	96,990	5.3/LB
1983	30,015	6.0/LB	1995	51,600	4.3/LB
1983	28,060	4.0/LB	1996	54,900	6.1/LB
1986	102,384	4.8/LB	1996	72,600	4.40/LB
1987	21,655	6.1/LB			

The United States Corps of Engineers (1973) reported the Mad River summer-run steelhead population was 500 fish. The source of this estimate is unknown. The United States Forest Service and CDFW made summer-run counts in Mad River within the Six River National Forest, as well as a few limited reaches in the river below the hatchery. These surveys were partial counts and varied in length. Complete river counts were not made until 1994. The summer-run fish count for 1989 through 2004 is as follows.

Year	2004	2003	2002	2001	2000	1999	1998	1997	1996	1995	1994	1993
Number	209	480[1]	501[1]	362	89[1]	152	344	239	444	564	434	48[2]
Year	1992	1991	1990	1989	1988	1987	1986	1985	1984	1983	1982	
Number	34[2]	59[2]	33[2]	20[2]	93	18	10	52	109	31	167	

[1] survey 50-69% of holding area [2] survey 50-69% of holding area 31

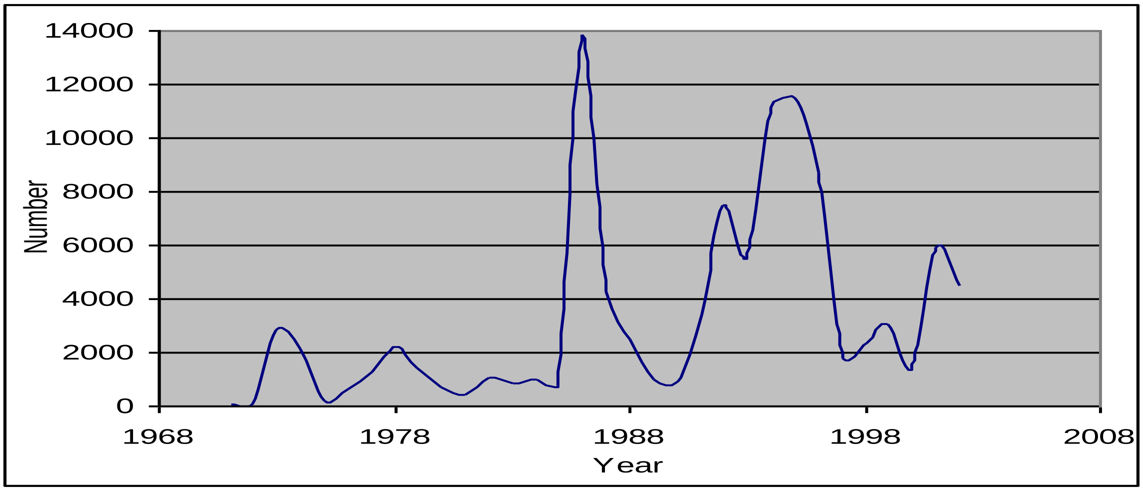


Figure 5. Steelhead returns to Mad River Hatchery

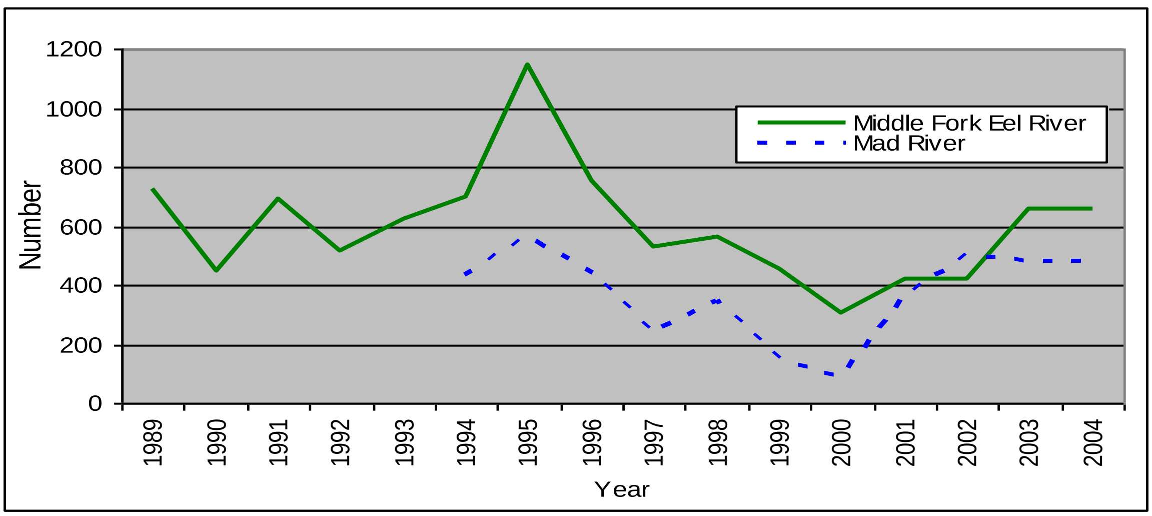


Figure 6. Summer-run steelhead count for Mad River and Middle Fork Eel River

Appendix 8. Sport Fish Restoration Act 2013 Narrative (Proposal)

ANADROMOUS FISH RESOURCE ASSESSMENT (Project Number ___)

Mad River Hatchery Adult Steelhead Trout Broodstock Genetic Analysis

INTRODUCTION

The Mad River watershed encompasses approximately 497 square miles, and empties into the Pacific Ocean, just north of Humboldt Bay in Humboldt County (Appendix 1). The composition of land ownership within the watershed is approximately 61% private and 39% public. There are approximately 169 miles of anadromous streams within the Mad River watershed. Land uses in the watershed consist predominantly of industrial and non-industrial timber management. Other land uses include ranching and agriculture, gravel mining, urban and rural residential development, road infrastructure, water storage, and power and gas line operations.

Mad River in Humboldt County, California is an important stream which supports annual runs of steelhead trout, Chinook salmon, coho salmon, and cutthroat trout. Recreational angling for steelhead trout on the Mad River is very popular, economically important, and is largely supported by the production of winter run steelhead trout by CDFW Mad River Hatchery (MRH). MRH produces winter run steelhead trout for enhancing the steelhead trout sport fishery, and to allow anglers the opportunity to harvest adult hatchery steelhead trout. Hatchery steelhead trout are identified by an adipose fin clip applied as juveniles at MRH. Genetic analysis of adult salmon and steelhead trout in other streams have shown that some hatchery stocks can consist of a limited number of families with many siblings and other close relatives amongst the returning fish (JC Garza, pers. comm. 2013). Mating of close relatives results in inbreeding and consequent inbreeding depression, which decreases survival and reproductive success, threatening the continuing existence of the Northern California Steelhead Trout ESU (Dr. JC Garza, pers. comm. 2013). Genetic broodstock management practices have been developed to avoid hatchery mating of close relatives and consequent inbreeding depression, which decreases survival and reproductive success. Straying of such hatchery fish could also threaten the natural spawning steelhead with which they interact (Dr. JC Garza, pers. comm. 2013).

Beginning in 2009/10, California Department of Fish and Wildlife's (CDFW) Anadromous Fisheries Resource Assessment and Monitoring Program (AFRAMP) and MRH personnel, in accordance with the Mad River Hatchery and Genetic Management Plan (HGMP) (version 1.96), began incorporating naturally produced winter run steelhead trout into the hatchery winter run steelhead trout breeding program at MRH. These changes were made in response to concerns of domestication and potential inbreeding (of siblings) of hatchery fish, and the genetic divergence of hatchery steelhead trout from naturally produced steelhead trout within the Mad River (Reneski, 2011). Several studies have shown that domestication, inbreeding, and lack of genetic diversity can lead to decreases in survival, however, these changes can be minimized or eliminated by incorporating naturally produced adults into the artificial breeding program(s) (Hess et al. 2012).

NEED

This project is needed:

4. To analyze genetic tissue samples collected from natural and hatchery origin steelhead trout used in artificial propagation at MRH beginning in 2009/10 to the present.

5. To analyze genetic tissues of spawners in ‘real time’ to eliminate the breeding of siblings.

6. To collect naturally produced adult steelhead trout from within the Mad River, if needed, for selective breeding purposes at MRH.

The information from the genetic analyses would identify if incorporating naturally produced steelhead trout into the spawning matrix decreased the genetic divergence of hatchery steelhead trout (from natural steelhead trout), and if our spawning practices were inadvertently breeding siblings with each other. The analysis of genetic tissues in real time (during a given spawning year) would prevent the inadvertent breeding of siblings during a given spawning season.

This information would allow for us to critically analyze our breeding program, and greatly increase our ability to produce a hatchery steelhead trout that is more like the natural counterpart. The overall goal of this project is to decrease hatchery domestication, inbreeding, and the observed genetic divergence of the hatchery steelhead trout with natural steelhead trout.

This proposed project has support from CDFW and the National Marine Fisheries Service (Santa Cruz, CA), and is considered to be an important component to the MR HGMP.

OBJECTIVES

The primary objective to this study is to perform genetic analysis (from tissues collected from hatchery and naturally produced adult steelhead trout) in our revised breeding program to ensure that we are reducing potential inbreeding and domestication of hatchery fish, and to decrease the apparent genetic divergence of hatchery fish with natural fish.

(1) Within the grant period, we will collect and send our MRH steelhead trout genetic samples collected from YR 2009 to the present to the National Marine Fisheries Service for analysis. We will incorporate findings on the degree of inbreeding of steelhead trout spawned at MRH, and the amount of divergence of hatchery steelhead trout with naturally produced steelhead trout into our breeding program and HGMP.

(2) We will use real time genetic data for each spawning event to select appropriate breeders and reduce inbreeding of siblings.

(3) During the period of this agreement, we may also use seine nets to collect natural Mad River steelhead trout for breeding purposes at MRH to meet HGMP.

For YR 2013/14, we are asking for $59,603 to analyze samples and report findings collected from 2009/10 to the present, to perform real time genetic analysis for spawning in 2013/14, and to collect adult steelhead trout (natural) for the 2013/14 spawning season (Appendix 2). Staffing for this project includes: CDFW Senior Environmental Scientist (Philip Bairrington, paid by CDFW), CDFW Environmental Scientist (Michael Sparkman, paid by CDFW), CDFW Fish/Wildlife Technician (paid by CDFW), CDFW Scientific Aid (paid for by this grant), and Dr. John Carlos Garza (geneticist, NOAA, Santa Cruz, CA; services paid for by this grant).

The specifiable endpoint to this grant would be December 31, 2014; however, we intend on performing 'real time' genetic analysis for selective breeding each spawning year. The cost per additional year for real time data would equal $24,000, plus associated overhead costs. The $24,000 would allow for up to 300 fish to be genetically analyzed.

EXPECTED RESULTS & BENEFITS

This project will support the operations of the Mad River Hatchery (MRH) facility in Blue Lake, CA by CDFW, by providing genetic data and analysis on steelhead raised and spawned at this facility, as well as technical expertise regarding their effects on US Endangered Species Act-listed steelhead in the Mad River basin. The expected results include gaining detailed genetic information concerning the revised breeding program at MRH, which is designed to increase the fitness of hatchery steelhead trout, and to decrease the genetic divergence of hatchery steelhead trout from naturally produced steelhead trout. The benefits of accomplishing the project objectives will be: 1) compliance with CDFW MRH HGMP, 2) increased fitness of hatchery steelhead trout (less domestication and inbreeding), and decreased genetic divergence from natural steelhead trout.

APPROACH

CDFW personnel will continue to collect genetic samples from all steelhead trout spawned in a given year, and organize those samples with reference to specific breeding protocols. Dr. John Carlos Garza (NOAA, Santa Cruz, CA) and his staff will perform all genetic analyses (both past and current samples) necessary to meet project objectives, and Dr. Garza is expected to co-author the findings with CDFW. Genetic data from 95 single nucleotide polymorphism (SNP) molecular assays and a gender identification assay will be collected, coefficients of relatedness estimated and then used to construct a breeding matrix which specifies optimal, acceptable and unacceptable mating partners for every reproductively mature fish that is trapped as potential broodstock at the MRH. The genotypic analysis and construction of the breeding matrix will be done on a weekly basis during the spawning season with results available in time for end-of-the-week spawning for fish sampled at the beginning of the week (Dr. JC Garza, pers. comm. 2013).

Schedule of Activities

Time Period		Duties
July1, 2013 – December 31, 2014		Send genetic samples to Carlos Garza (NOOA) for analysis and findings; continue to collect genetic samples from the selective breeding program at MRH; send samples to NOAA for immediate analysis (breeders in the 2013/14 season); seine for adult natural steelhead trout for breeding purposes at MRH; and report findings in scientific format

Job 1: To perform genetic analyses of MRH broodstock, continue to collect genetic samples, and collect natural adult steelhead trout for spawning purposes at MRH.

Dr. John Carlos Garza, carlos.garza@noaa.gov (NOAA, Santa Cruz, CA) is the leading geneticist in California with extensive experience with performing analyses relevant to this project. He oversees the genetics lab at NOAA, Santa Cruz and has agreed to perform the genetic analyses for both past and future genetic samples.

Michael Sparkman (Environmental Scientist, CDFW) will oversee the collection of tissue samples from selected breeders, and associated tasks involved with storing the samples. Philip Bairrington (Senior Environmental Scientist, CDFW) will assist Michael in the tissue collection process, and perform necessary tasks to fulfill project objectives. Paula Whitten (CDFW Fish and Wildlife Technician) will assist in the breeding program at MRH, and will also assist with seining operations. A scientific aid will assist in hatchery operations (tissue collection, sorting adult steelhead for spawning, etc.), and seining in the field.

Philip Bairrington Philip.Bairrington@wildlife.ca.gov (Senior Environmental Scientist) has over 28 years of experience, and is currently working on the MR HGMP. Phillip has been involved in a variety of anadromous salmonid studies, including juvenile (smolt, oversummer parr) and adult studies on Mad River steelhead trout, Chinook salmon, and coho salmon, Freshwater Creek adult and juvenile studies, Humboldt Bay adult and juvenile studies, Redwood Creek adult and juvenile studies, Smith River adult and juvenile studies, Noyo River and Pudding Creek adult and juvenile studies, Trinity River and New River adult and juvenile studies, and Scott and Shasta Rivers adult and juvenile studies.

Michael Sparkman Michael.Sparkman@wildlife.ca.gov (Environmental Scientist for the project) works for the California Department of Fish and Wildlife (Northern Region) and has 13 years experience as a CDFW fisheries biologist. He has a BS in Fisheries (Humboldt State University) and a MS in Natural Resources with emphasis in Fisheries (Humboldt State University). Michael has been responsible for collecting and archiving genetic tissue samples from the breeding program at MRH starting in 2009/10. Michael Sparkman can be reached at: 50 Ericson Court, Arcata, Ca. 95521; (707) 825-4856, (707) 496-5692.

PROJECT LOCATION

MRH is located on the left bank of Mad River at RM 13.3, which is approximately two miles south of Blue Lake, Humboldt County. The geographic coordinates of MRH are 40° 51’ 19.11” N, 123° 59’ 23.41” W. Seining for naturally produced steelhead trout will occur in various locations within the Mad River watershed.

ENVIRONMENTAL COMPLIANCE

The following Federal ESA species are found within the Mad River:

Chinook salmon (*Oncorhynchus tshawytscha):* ESU is California Coastal Chinook Salmon Evolutionarily Significant Unit, status is threatened.

Coho salmon (*Oncorhynchus kisutch):* ESU is Southern Oregon/Northern California Coasts, status is threatened.

Steelhead Trout (*Oncorhynchus mykiss) DPS* is Northern California Steelhead, status is threatened.

The collection of genetic tissue does not harm steelhead trout used for spawning purposes, and seining for adult steelhead trout (naturals) will occur when Chinook salmon and coho salmon are in very low numbers, if present at all. This project is expected to have no negative impact on adult salmon and steelhead trout.

- **Biological Assessment (BA)** – NMFS is a cooperator with this project, and is supportive of this study.

- **Biological Opinions (BO)** –See NMFS for any information.

- **Exemptions under ESA Section 4(d)** –We are not exempt from section 4(d) rule, and will comply with this program each year. MRH (or CDFW AFRAMP) will submit a 'new application' to the 4(d) rule program in September, 2013, which will allow for the take of Northern California steelhead trout.

- **Current or active State of California required permits** – MRH and Phillip Bairrington (CDFW) have a current state collecting permit. CDFW is the lead CEQA agency.

Our project contributes to the conservation of a listed species by producing a hatchery steelhead trout that is less domesticated and genetically more alike to naturally produced steelhead trout. In addition, this project and breeding program will decrease the divergence of hatchery steelhead from naturally produced steelhead. Thus, MRH would continue to enhance the steelhead trout fishery in the Mad River with hatchery fish that are more like the natural steelhead trout. If the breeding program is successful, MRH could then become a conservation hatchery which would greatly increase the long term viability of steelhead trout within the Mad River, while still providing angling and harvest opportunities for hatchery raised, steelhead trout.

- **National Environmental Policy Act (NEPA)** – N/A

- **Endangered Species Act (ESA)** –We will have a current NMFS 4(d) rule take permit for NC steelhead trout for MRH on-site collection and field collection of natural steelhead trout beginning in YR 2013. NMFS/NOAA recognizes the importance of this project.

- **National Historic Preservation Act (NHPA)** –N/A
- **Other Permits** –N/A

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CDFW. Draft version 1.96. Hatchery and Genetic Management Plan for Mad River Hatchery winter run steelhead. California Department of Fish and Wildlife.

Reneski. MR. 2011. Temporal genetic analysis of steelhead (*Oncorhynchus mykiss*) reveals hatchery –induced drift in captivity. Master's Thesis, Humboldt State University, Arcata, CA. 44 pps.

Hess, MA, CD Rabe, JL Vogel, JJ Stephenson, DD Neslon, and SR Narum. 2012**.** Supportive breeding boosts natural population abundance with minimal negative impacts on fitness of a wild population of Chinook salmon. Molecular Ecology, Blackwell Publishing, Ltd., pages 1 – 15.

Appendix 1: Mad River Location Map

Appendix 2: Budget for Job 1 (July 01, 2013 – December 31, 2014), Mad River Hatchery Adult Steelhead Trout Broodstock Genetic Analysis, MRH, Humboldt County, CA.

GRANT NUMBER & NAME							
Mad River Hatchery Adult Steelhead Trout Broodstock Genetic Analysis							
	2163	**TBD**					
Budget Contact Person:							FY 13/14
PERSONAL SERVICES	**POSITION**	**CNO**	**INCUMBANT**	**PY**	***SALARY***		**AMOUNT**
Total Permanent Staff Salaries						**$**	**-**
Temporary Help						$	4,386
Staff Benefits 37.33%						$	1,637
TOTAL PERSONAL SERVICES						**$**	**6,023**
OPERATING EXPENSES							
General Expenses						$	4,280
Telephone; Postage; Printing						$	-
Travel; Training						$	300
Resident/Facilities/Structures Maintenance						$	-
Utilities (Water, Etc)						$	-
C&PS-External (402) Contract with NOAA						$	49,000
Contracts						$	-
Equipment/Tractor Maintenance & Repair						$	-
Vehicle Maintenance & Repair						$	-
Gas/Diesel Fuel						$	-
Special Items of Expense						$	-

TOTAL OPERATING EXPENSES				**$ 53,580**
TOTAL OE&E/PERSONAL SERVICES				**$ 59,603**
-				
TOTAL FEDERAL FOR PROJECT	-	-	-	**$ 59,603**
Federal Share (75%)				$ 59,603
State Share (25%) DFW Staff Match (Bairrington, Sparkman, Whitten)				$19,868
TOTAL PROJECT COST	-	-	-	**$ 79,471**

Appendix 3: Landowner Agreement

CDFW Mad River Hatchery is in full agreement with this project.

Appendix 9. First Annual Report, MRH Water Flow Blue Print

ANNUAL REPORT
MAD RIVER SALMON AND STEELHEAD HATCHERY
FIRST YEAR OF OPERATION 1970-71[1]

by

Robert D. Will
Region 1, Inland Fisheries

ABSTRACT

This is the first annual report of the Mad River Salmon and Steelhead Hatchery. It reviews events leading to establishment of the hatchery and describes the initial period of operation from January 20, 1971 through June 30, 1971.

The hatchery was constructed to maintain and enhance runs of king salmon (Oncorhynchus tshawytscha), silver salmon (O. kisutch) and steelhead (Salmo gairdnerii gairdnerii) on California's north coast. It has a recirculating water system; this system is described. Figures include a map showing the hatchery's location, and a schematic drawing of the water system. Tables present daily water temperatures, weather data and numbers of salmon and steelhead received, reared and planted during the operating period.

1/ Anadromous Fisheries Branch Administrative Report No. 73-12
April 1973

INTRODUCTION

This is the first annual report of the Mad River Salmon and Steelhead Hatchery. It reviews events leading to establishment of the hatchery and describes the initial period of operation from January 20, 1971 through June 30, 1971.

Mad River Hatchery was constructed to maintain and enhance the native runs of king and silver salmon and steelhead trout in California's north coast streams. The hatchery was designed to produce one million yearling silver salmon and/or steelhead and five million king salmon fingerlings annually. Funds for its construction came from the Wildlife Conservation Board and the Anadromous Fish Conservation Act (Project: California AFSC-1).

The hatchery is located on Mad River approximately 3.2 km (2 miles) south of Blue Lake, Humboldt County, and approximately 16.1 km (10 miles) by river from the Pacific Ocean (Figure 1). It lies on the left bank of the river at a point where the Mad's narrow upstream canyon first widens to form the Blue Lake Valley. A paved county road connects the hatchery with the town of Blue Lake and provides easy year-around access to the installation. All buildings and ponds at the hatchery are situated on land located above the maximum water level reached during the record 1964 flood.

PRODUCTION SUMMARY

The first fish received at the hatchery, approximately 100,000 yearling silver salmon from Darrah Springs Hatchery, were placed in the ponds January 20, 1971.

Production for the 1970-71 season is summarized as follows:

Species	Adults received or trapped	Females spawned	Eggs taken or received	Fish received	Fingerlings planted	Yearlings planted	On hand June 30, 1971
King salmon							
1970 BY	0	0	0	680,112a/	423,120	0	244,000
Silver salmon							
1969 BY	0	0	0	100,005b/	0	99,550	0
1970 BY	0	0	1,000,000c/	352,800a/	0	0	491,000
Winter-run steelhead							
1971 BY	301d/	144	793,274e/	0	0	0	581,000
Summer-run steelhead							
1971 BY	0	0	108,200	0	0	0	91,000

a/ From Mt. Shasta Hatchery.
b/ From Darrah Springs Hatchery.
c/ From Trinity River Hatchery.
d/ From Benbow Dam.
e/ Includes 92,200 green eggs shipped to Mt. Shasta Hatchery.

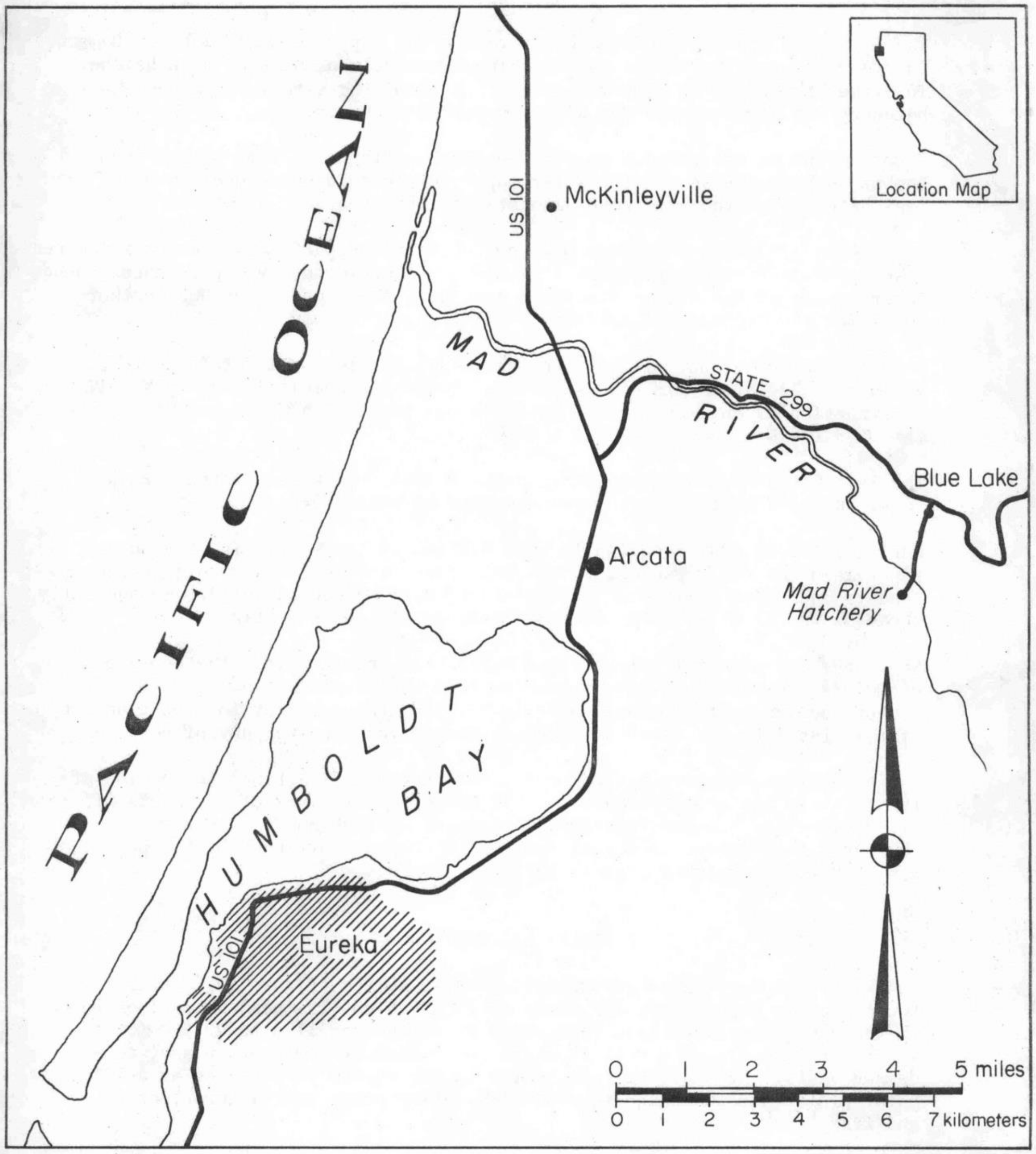

Figure 1. Area map.

HISTORY

The 1963 California State Senate instructed the Department of Fish and Game to study the feasibility of establishing a new salmon and steelhead hatchery in either Mendocino or Humboldt County. A promising site for the new hatchery was found on the Mad River in Humboldt County.

Negotiations were begun during 1965 to purchase the site from the Simpson Lumber Company. Planning for water supply exploration and development of a test hatchery at the site were also started that year.

Subsequent preliminary surveys made by California Department of Water Resources' (DWR) geologists indicated that it would be possible to develop an underground water supply at the site. A seismic survey of the property by DWR further confirmed the geologists' estimate.

In 1966 the Department of Fish and Game drilled a test well at the site which yielded 2,271 liters/min (600 gal/min). Following completion of this well, construction of an experimental hatchery was begun with funds supplied by the Wildlife Conservation Board.

The test hatchery was completed in January 1967. It was operated for one year. Results of this test were described by Will (1968).

During 1967 20 additional wells were drilled at the site. In 1968, under supervision of a DWR geologist, the well field was tested for total capacity. Results indicated a minimum total yield of 0.28 m^3/sec (10 cfs). Subsequently, three of the 21 wells were abandoned because of low production.

While the experimental hatchery and wells were being tested, the Department of General Services, Office of Architecture and Construction was designing the production installation. On July 22, 1969 the contract for construction of this facility was awarded to the C. Norman Peterson Company of Berkeley.

The production hatchery was completed in January 1971. Final inspection of the facility was made February 4, 1971 by representatives of the State Office of Architecture and Construction, Department of Fish and Game and the construction company. A formal dedication program, attended by 650 people, was held at the hatchery May 1, 1971 (Figure 2).

HATCHERY DESCRIPTION

Mad River Hatchery has a recirculating water system (Figure 3). Water for the system is supplied from a field of 18 30.5-cm (12-inch) wells located in the Mad River floodplain that range in depth from 11.6 to 22.9 m (38 to 75 ft) (Figure 4). The well input is controlled by computer on a system-demand basis. Most of the time, water in the system is replaced at a 10% rate. This rate increases to about 15% during pond- and filter-cleaning and fish treatment operations.

G. Ray Arnett, Director
Robert O'Brien, Manager, Region 1
Robert D. Will, Superintendent
Mad River Fish Hatchery

WILDLIFE CONSERVATION BOARD
Sherman Chickering, Chairman
Ray J. Nesbit, Executive Officer

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THE MAD RIVER FISH HATCHERY
DEDICATED MAY 1, 1971

The Department of Fish and Game's new Mad River Salmon-Steelhead Hatchery marks a new first for California. Unlike other salmon-steelhead hatcheries in the state that have been built near dams to mitigate the losses of fish due to dam construction, this is the first one to be constructed just to enhance a native fish population.

The production of this hatchery, estimated at one million silver salmon and steelhead and five million king salmon fingerlings annually, will be used to re-establish and to augment those salmon-steelhead runs in our coastal streams from Santa Cruz to the Oregon border. The major impact of this project will be felt in 3 to 4 years when the fish spawned and raised here reach the creels of the sportsmen and the catch of the commercial fishermen off the North Coast. It was largely due to the impact on ocean fishing that the Bureau of Sport Fisheries and Wildlife approved matching federal Anadromous Fish Act monies to assist in the project.

The state's participation in the project came through the Wildlife Conservation Board, which approved construction funds from its share of the 1964 Recreation Bond Act. The Department of Fish and Game researched the North Coast area for the best possible site and operated a test hatchery here to prove this spot to be feasible. Following WCB's purchase of the 44.6 acres of land arranged and expedited through the cooperation of the Simpson Timber Company in 1967, plans were prepared by the State Office of Architecture and Construction and a contract was let to the C. Norman Peterson Company of Berkeley. Total cost of the project was $2,760,000.

The completion of this hatchery coincides with the completion of the WCB's 10-year coastal stream clearance program which cleared logging debris and other blockage along miles of streams which had previously hindered anadromous fish migrations and isolated historic spawning areas. This stream restoration together with the new fish production of the hatchery will assure for many years to come the continued reputation of the state's North Coast as one of the nation's outstanding salmon and steelhead fishing areas.

The construction of fish hatcheries is a small but important function of the WCB. Now in its 24th year, the board has undertaken some 264 projects state-wide, both for habitat preservation and improvement and for public access to hunting and fishing. The fishing access at the Mouth of Mad River as a cooperative project with the County of Humboldt and the fish rearing ponds at the Arcata sewage treatment facility in cooperation with the city and Humboldt State College, are recent examples of the varied activities of the board.

THE MAD RIVER FISH HATCHERY

DEDICATION

Blue Lake, Humboldt County, California

Saturday, May 1, 1971

10:30 a.m.

DONALD F. PETERSON
Chairman, Humboldt County Board of Supervisors
Master of Ceremonies

MARSHALL T. ROUSSEAU
Mayor, City of Blue Lake

RECOGNITION OF DIGNITARIES
Chairman Peterson

SAM S. MITCHELL
Member, Humboldt County Board of Supervisors, 1962-1970

RAY J. NESBIT
Executive Officer, Wildlife Conservation Board

FRED HUMMELL
A. I. A., California State Architect

FORACE HOLLAND
Economic Development Administration, U. S. Department of Commerce

ROBERT O'BRIEN
Manager, Region I, California Department of Fish and Game

TRAVIS ROBERTS
Deputy Regional Director, U. S. Bureau of Sport Fisheries and Wildlife

SHERMAN CHICKERING
President, California State Fish and Game Commission
Chairman, California Wildlife Conservation Board

THE HONORABLE DONALD H. CLAUSEN
United States Congressman

THE REV. DOYLE E. FARNSWORTH
Blessing

GUIDED TOUR OF MAD RIVER FISH HATCHERY
ROBERT D. WILL, SUPERINTENDENT

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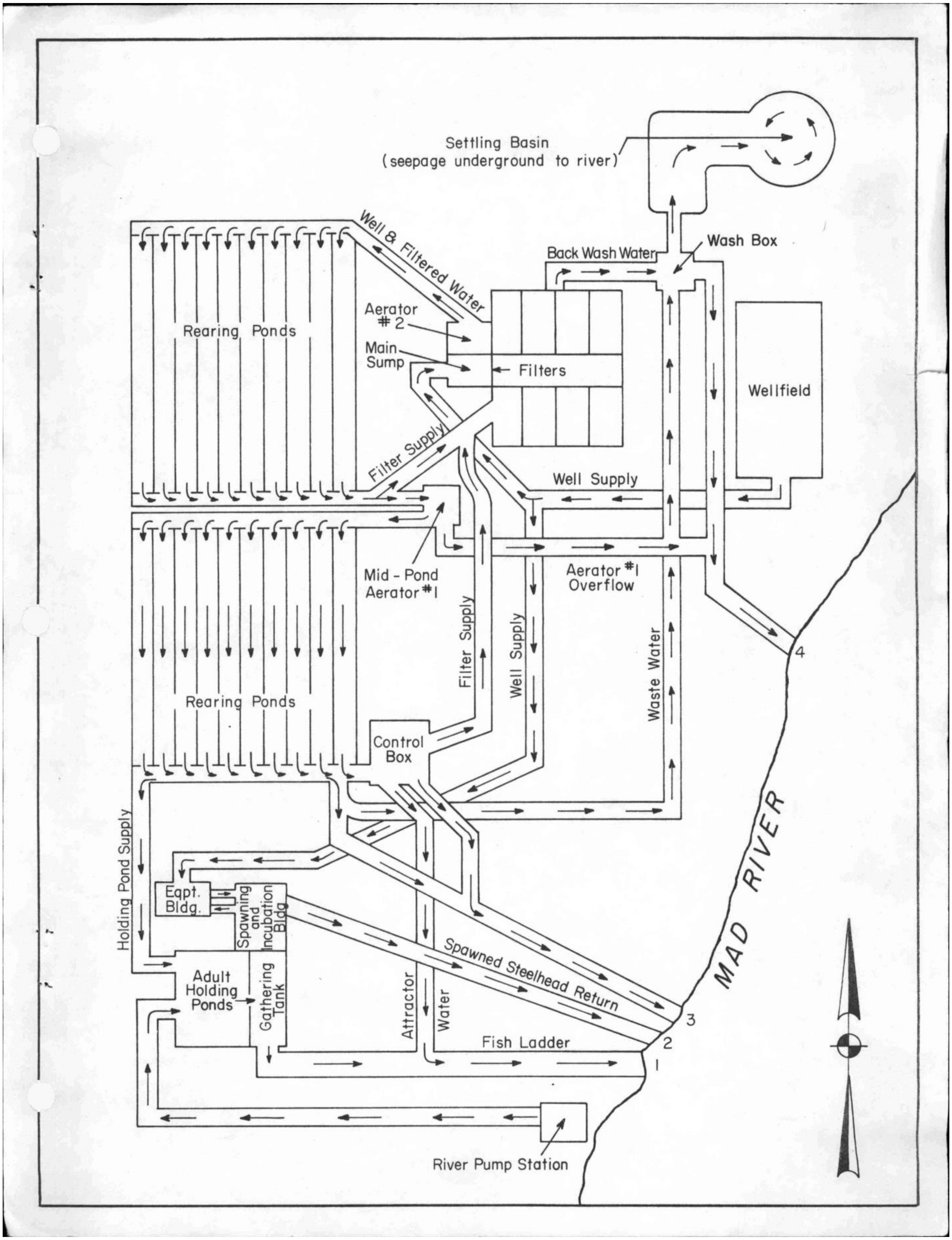
Figure 2. Mad River Hatchery Dedication program.

Figure 3. Schematic drawing of hatchery water system.



Settling Basin
(seepage underground to river)
Wash Box
Back Wash Water
Well & Filtered Water
Rearing Ponds
Aerator
2
Main
Sump
Filters
Wellfield
Filter Supply
Well Supply
Mid - Pond
Aerator #1
Aerator #1
Overflow
Filter Supply
Well Supply
Waste Water
Rearing Ponds
Control
Box
Holding Pond Supply
Eqpt.
Bldg.
Spawning
and
Incubation
Bldg.
Spawned Steelhead Return
Adult
Holding
Ponds
Gathering
Tank
Attractor
Water
Fish Ladder
1
2
3
4
MAD RIVER
River Pump Station

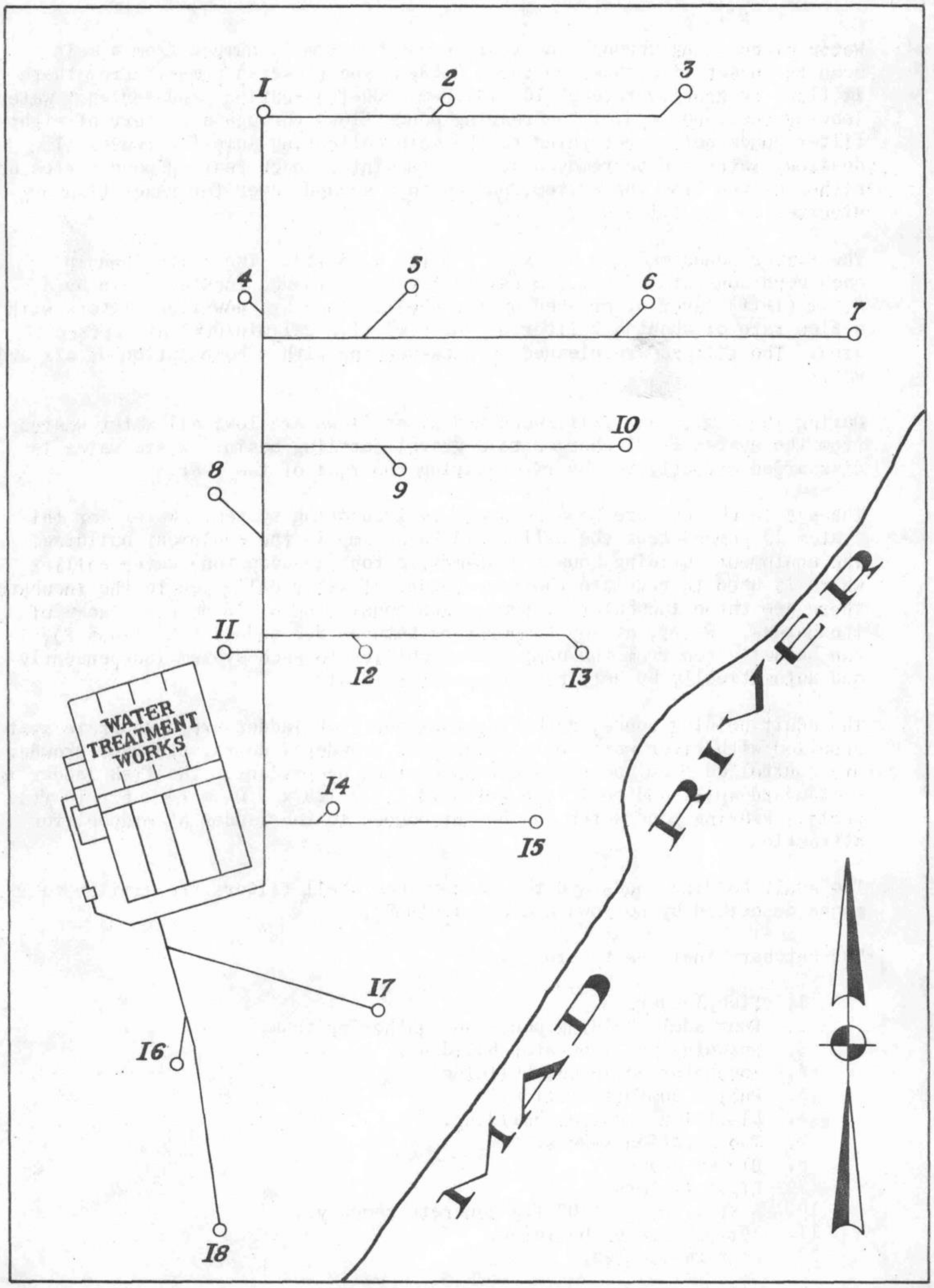


Figure 4. Well field plan.

Water circulating through the rearing pond system is pumped from a main sump to an aeration tower by three 0.28-m^3/sec (10-cfs) pumps. From there it flows by gravity through 10 182.9-m (600-ft) rearing pond series. Water leaving the lower end of the rearing ponds flows through a battery of eight filter ponds before returning to the main collecting sump for reuse. If desired, water can be removed at the midpoint of each rearing pond series and either wasted from the system, pumped to a second tower for reaeration or diverted to the filters.

The filter ponds measure 6.1 x 22.9 m (20 x 75 ft). The filter bed in each pond consists of a 1.2-m (4-ft) layer of crushed rock overlain by a 0.3-m (1-ft) layer of crushed oyster shell. They are downflow filters with a flow rate of about 5.7 liter/min/0.09 m^2 (1.5 gal/min/ft^2) of surface area. The filters are cleaned by back-washing with a combination of air and water.

During the summer and fall, when Mad River flows are low, all water wasted from the system is discharged to a gravel settling basin. Waste water is discharged directly to the river during the rest of the year.

The egg incubators are on a separate recirculating system. Water for this system is pumped from the well field to a sump in the equipment building. The equipment building houses a 45-metric ton (50-avdp ton) water chiller which is used to regulate the temperature of water delivered to the incubators. There are three incubator systems, each consisting of 16 double stacks of incubators. Water, at any temperature between 8.3 and 12.8 C (47-55 F), can be delivered from the sump and/or chiller to each system independently and automatically by setting a temperature dial.

The adult holding ponds, gathering tank and fish ladder are a separate system supplied with river water only. The pond crowders, doors, and tank crowder are controlled from one place during sorting operations. The fish ladder is a standard spill and pool type, with 22 1.2 x 1.8 x 3.0- m (4 x 6 x 10 ft) pools. Rearing pond water can be introduced to the ladder at midpool for attraction.

The adult holding ponds and the rock-oyster shell filters are similar to those described by Burrows and Combs (1968).

The hatchery includes the following:

1. Fish ladder.
2. Four adult holding ponds and gathering tank.
3. Spawning and incubator building.
4. Incubator equipment building.
5. Public comfort station.
6. Electrical control building.
7. Two aeration towers.
8. Blower house.
9. Eight filters.
10. Sixty, 30.5-m (100-ft) concrete raceways.
11. Administration building.
12. Four residences.

HATCHERY OPERATION

During the start-up period, numerous mechanical and operational problems were encountered. Most of these were relatively minor and easily corrected. Once use of the hatchery's recirculating water system began, it became quickly evident that this system differed greatly from that of a gravity-flow hatchery. Changes in pressure and flow occurred in the system when valves were opened or closed. This necessitated repeated checking of the flow pattern. Several times the water flow was found to be too high or too low because of improper valve openings.

A major problem showed up during steelhead spawning operations. Large amounts of silt suspended in water pumped from the river through the adult holding units settled out in the ponds and made the holding pond crowders inoperable most of the time. As much as 0.3 m (1 ft) of silt accumulated in the holding ponds during a four-day period. These buildups necessitated hand cleaning the ponds before the fish could be sorted.

Another problem encountered was inadequate aeration in the incubator system. This is suspected to have been the cause for a high occurrence of white-spot among steelhead eggs held in the incubators. This problem was temporarily corrected by repiping one pump and recirculating the sump water to increase its oxygen content.

Besides the incidence of white-spot reported above, the only other significant disease problem was a heavy fungus outbreak on the yearling silver salmon. This was primarily due to holding them past migration time. The fungus was controlled by treatment with malachite green. The steelhead fingerlings had a minor outbreak of gill bacteria, which was controlled with copper sulfate. All eggs shipped into the hatchery were treated with a Wescodyne bath.

During the period covered by this report, 10,850 people, in addition to the 650 that attended the dedication ceremony, visited the hatchery.

KING SALMON PROGRAM

The hatchery was not completed in time to take 1970 brood year king salmon eggs. Anticipating this, the Department obtained one million eggs from Minter Creek Salmon Hatchery in the State of Washington. The hatchery received 680,112 of these Minter Creek fish averaging 0.66 g (685/lb) from Mt. Shasta Hatchery during the first week of March.

Planting 1970 Brood Year King Salmon

Date	Area released	Average size (g)	Number
5/21/71	Mad River	5.5	423,120

The remaining 244,000 fish are being held for yearling plants this fall.

SILVER SALMON PROGRAM

As with the king salmon program, the hatchery was not in operation in time to take 1970 brood year silver salmon eggs. Eggs and fingerlings from two brood years were received from three hatcheries (see following table).

Silver Salmon Eggs and Fish Received

Date	Hatchery	Source	BY	Average size (g)	Number
1/20/71	Darrah Springs	Noyo R.	69	21.6	50,001
1/28/71	Darrah Springs	Noyo R.	69	25.2	50,004
1/28/71	Trinity River	Trinity R.	70	eggs	591,000
2/ 1/71	Trinity River	Trinity R.	70	eggs	409,000
3/15/71	Mt. Shasta	Noyo R.	70	0.6	234,400
3/18/71	Mt. Shasta	Noyo R.	70	0.6	118,400

Planting Silver Salmon

A total of 99,550 1969 brood year silver salmon were released in May and June. Most were released at the hatchery, the rest were released in the Smith River between Idyllwild and Jedediah Smith State Park (see following table).

Date	Source	Area released	BY	Average size (g)	Number
5/21/71	Noyo R.	Mad R. - hatchery	69	36.3	88,750
6/ 8/71	Noyo R.	Smith R.	69	75.6	10,800

All 1970 brood year silver salmon were held to be released as yearlings.

WINTER-RUN STEELHEAD PROGRAM

Adult steelhead were trapped in the south ladder at Benbow Dam on the South Fork Eel River. These fish were transported by helicopter from the ladder to tank trucks across the river. A total of 301 adults were transported to the hatchery during January and February. We took 793,274 eggs from 144 females for an average of 5,509/female. Because of a possible aeration problem in the incubation system 92,200 eggs were shipped to Mt. Shasta Hatchery for a test. All fish are being held at the hatchery for release as yearlings.

SUMMER-RUN STEELHEAD PROGRAM

On March 28, 108,200 eyed eggs were received from the Skamania Hatchery in the State of Washington. These fish will be released as yearlings in Mad River.

LITERATURE CITED

Burrows, Roger E., and Bobby D. Combs. 1968. Controlled environments for salmon propagation. Prog. Fish-Cult., 30(3): 123-136.

Will, Robert D. 1968. Mad River Test Fish Hatchery results. Calif. Dep. Fish and Game, Inland Fish. Admin. Rep. 68-6. 22 p.

Appendix Table 1
Mad River Salmon and Steelhead Hatchery
Weather and Water Data Report
January 21 to June 30, 1971

January	Air Maximum (C*)	Air Minimum (C*)	Water Maximum (C*)	Water Minimum (C*)	Weather
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					
11					
12					
13					
14					
15					
16					
17					
18					
19					
20					
21	10.0	1.7	13.3	12.2	clear
22	11.9	0.0	13.3	12.2	clear
23	12.2	2.2	13.9	12.2	clear
24	10.6	5.6	14.4	12.2	clear
25	12.2	2.2	14.4	12.2	clear
26	10.0	2.2	14.4	12.2	clear
27	13.9	2.2	13.9	12.2	clear
28	12.2	2.2	12.2	11.1	fog
29	13.3	3.3	14.4	13.3	fog
30	15.6	3.3	13.9	12.2	clear
31	12.8	3.3	14.4	13.3	clear

February	Air Maximum (C*)	Air Minimum (C*)	Water Maximum (C*)	Water Minimum (C*)	Weather
1	11.1	6.1	14.4	13.3	cloudy
2	13.3	5.6	14.4	12.2	clear
3	11.7	0.0	13.9	11.7	clear
4	11.1	4.4	13.3	11.1	cloudy
5	12.8	8.9	15.0	12.2	rain
6	12.8	8.9	15.0	12.2	overcast
7	14.4	10.0	15.0	13.3	sunny
8	12.8	6.7	13.9	11.7	clear
9	15.6	3.3	12.2	10.0	clear
10	18.9	8.9	14.4	11.1	clear
11	22.8	8.3	16.1	10.0	clear
12	22.2	8.9	16.1	11.1	clear
13	14.4	6.1	14.4	12.2	clear
14	12.2	7.8	14.4	11.1	overcast
15	13.3	7.8	14.4	11.1	clear
16	11.1	4.4	13.3	11.1	cloudy
17	12.8	4.4	13.3	11.1	cloudy
18	13.9	3.3	13.3	11.1	rain
19	12.2	3.3	13.9	8.9	clear
20	15.0	-1.1	13.3	8.3	clear
21	10.0	1.1	12.8	8.3	overcast
22	12.2	5.6	13.9	9.4	showers
23	17.2	2.8	13.9	9.4	sunny
24	11.1	3.3	14.4	8.3	showers
25	13.3	0.6	13.3	7.8	rain
26	11.1	-0.6	14.4	8.9	clear
27	8.9	2.2	14.4	8.9	rain
28	6.7	1.1	13.3	10.0	rain

* Temperatures measured to nearest whole degree F, and later converted to C.

Appendix Table 1 (Continued)

March	Temperatures (C*)				Weather
	Air		Water		
	Maximum	Minimum	Maximum	Minimum	
1	12.2	-1.1	15.0	10.0	clear
2	11.1	-1.1	14.4	10.0	rain
3	11.1	6.7	15.	10.6	showers
4	8.0	6.7	14.4	10.0	cloudy
5	13.3	1.1	15.6	10.0	clear
6	15.0	1.7	13.9	11.1	sunny
7	11.7	5.0	14.4	11.7	rain
8	11.7	1.7	-	-	cloudy
9	13.3	5.6	-	-	cloudy
10	11.1	6.1	-	-	rain
11	13.3	8.9	12.2	11.1	rain
12	12.2	5.6	11.1	10.0	rain
13	12.2	3.9	11.1	11.1	rain
14	12.8	6.7	10.0	9.4	cloudy
15	16.7	7.2	12.2	9.4	sunny
16	12.8	6.7	11.1	10.0	showers
17	15.6	2.2	11.1	8.9	sunny
18	14.4	3.3	11.1	8.9	sunny
19	21.1	1.1	11.1	8.9	sunny
20	21.1	4.4	11.1	10.0	sunny
21	15.6	4.4	12.2	10.0	sun/cloudy
22	12.2	8.9	11.1	11.1	rain
23	15.6	11.1	12.2	11.1	rain
24	13.9	10.0	12.2	11.1	overcast
25	12.2	7.8	11.1	11.1	cloudy
26	13.3	6.7	11.1	11.1	rain
27	15.6	3.3	12.2	10.0	clear
28	20.0	5.6	14.4	12.2	clear
29	18.9	5.6	16.7	11.1	sunny
30	15.6	8.9	15.6	11.1	sunny
31	16.7		16.7	13.3	sunny

April	Temperatures (C*)				Weather
	Air		Water		
	Maximum	Minimum	Maximum	Minimum	
1	15.6	3.3	16.1	10.0	sunny
2	18.9	4.4	16.1	10.0	sunny
3	15.6	6.7	16.1	6.7	sunny
4	18.9	6.7	18.9	5.6	sunny
5	12.2	6.1	20.0	10.6	cloudy
6	13.3	6.7	17.2	10.0	showers
7	14.4	4.4	16.7	10.0	cloudy
8	15.6	6.7	16.1	10.6	cloudy
9	15.6	7.8	16.1	10.6	rain
10	14.4	3.3	15.6	11.1	cloudy
11	17.8	5.6	17.2	10.6	cloudy
12	18.9	5.6	18.3	10.0	clear
13	16.7	7.8	13.3	12.2	rain
14	13.9	7.8	17.8	12.2	cloudy
15	16.7	6.7	18.9	11.1	clear
16	13.9	5.6	17.2	10.0	rain
17	7.8	4.4	15.6	10.0	rain
18	15.0	4.4	17.2	10.0	clear
19	14.4	0.0	17.8	10.0	cloudy/sun
20	12.2	4.4	17.8	10.0	rain
21	13.3	0.6	17.8	10.0	sunny
22	12.2	4.4	17.8	10.0	rain
23	14.4	4.4	17.8	10.0	sunny
24	17.2	1.1	17.8	10.0	sunny
25	18.9	3.3	17.8	10.0	sunny
26	17.2	8.9	17.8	11.1	overcast
27	15.0	9.4	17.2	11.1	overcast
28	13.9	7.8	16.7	11.1	overcast
29	17.8	5.6	18.9	11.1	sunny
30	18.3	4.4	18.9	11.1	clear

* Temperatures measured to nearest whole degree F, and later converted to C.

Appendix Table 1 (Continued)

May	Temperatures (C*) Air Maximum	Air Minimum	Water Maximum	Water Minimum	Weather
1	17.8	8.9	18.3	12.2	overcast
2	20.0	9.4	18.9	11.7	sun/rain
3	14.4	10.0	17.8	12.2	foggy
4	15.6	10.0	17.8	12.2	overcast
5	15.6	10.0	16.7	12.2	sunny
6	22.2	8.9	20.0	12.2	sunny
7	20.0	7.8	14.4	11.1	sunny
8	16.7	11.1	12.2	12.2	overcast
9	21.1	11.1	15.6	11.1	overcast/sun
10	18.3	7.2	14.4	11.7	clear
11	16.7	8.9	14.4	12.2	cloudy
12	13.3	8.3	13.9	11.7	rain
13	20.0	10.0	14.4	11.7	clear
14	20.0	4.4	15.0	11.7	clear
15	18.9	10.0	14.4	11.7	showers
16	16.7	6.7	13.9	11.7	showers
17	20.0	2.2	14.4	11.1	sunny
18	20.0	7.8	14.4	11.7	sunny
19	17.8	12.2	13.9	12.2	cloudy
20	16.7	5.6	13.3	13.3	cloudy
21	18.9	1.7	14.4	11.1	sunny
22	21.1	8.9	13.9	11.7	sunny
23	18.3	6.1	14.4	12.2	fog/sun
24	17.8	10.0	14.4	12.2	cloudy/sun
25	18.9	8.9	17.2	12.2	rain
26	20.6	7.8	16.7	12.2	sun/cloudy
27	18.9	11.1	16.7	13.3	sun/overcast
28	16.7	9.4	16.7	12.8	overcast
29	17.8	8.9	16.1	14.4	overcast
30	16.7	4.4	12.8	11.7	sun/overcast
31	15.0	5.0	12.8	11.7	cloudy

June	Temperatures (C*) Air Maximum	Air Minimum	Water Maximum	Water Minimum	Weather
1	16.7	8.9	12.8	11.7	cloudy
2	17.8	8.9	12.8	11.7	clear
3	18.3	10.0	12.8	11.7	clear
4	22.2	10.0	13.9	12.2	clear
5	22.2	13.9	13.3	11.7	cloudy
6	20.0	14.4	13.3	11.7	clear/cloudy
7	18.9	12.2	13.9	12.2	cloudy/sun
8	20.0	8.9	13.9	13.3	cloudy/sun
9	21.1	10.0	13.3	12.2	overcast
10	20.0	12.2	13.3	12.2	overcast
11	18.3	10.6	13.9	12.2	overcast
12	20.0	10.0	13.9	11.7	overcast
13	18.9	10.0	14.4	12.8	overcast
14	23.3	14.4	16.7	14.4	sunny
15	22.2	11.1	16.7	14.4	sunny
16	23.9	10.0	17.8	14.4	sunny
17	21.1	10.0	17.2	13.9	sunny
18	14.4	8.9	14.4	7.8	rain
19	21.1	14.4	14.4	13.9	overcast
20	23.3	13.3	17.8	13.3	sunny
21	25.6	13.3	16.7	14.4	sunny
22	25.0	13.3	16.7	14.4	cloudy/sun
23	17.2	12.2	16.7	14.4	clear
24	22.2	8.9	16.7	14.4	sun/overcast
25	16.7	13.3	15.0	12.8	rain
26	18.9	13.3	15.6	13.9	rain/overcast
27	20.0	10.0	15.6	14.4	sunny
28	21.1	8.9	17.2	14.4	sunny
29	23.3	6.7	16.7	13.3	sunny
30	22.2	11.1	16.7	14.4	cloudy

* Temperatures measured to nearest whole degree F, and later converted to C.

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Appendix 10. Implications of Take

Genetic and ecological interactions can occur between natural stocks and hatchery-produced fish (Hard et al. 1998, Lynch 1997, ISAB 2002, Pearsons 2002 and 2008, SRSRP 2004). Ecological interactions include, but are not limited to, disease transfer, altered behavior, predation, and competition between hatchery plants and naturally produced juvenile salmonids. Adult HOR steelhead can also compete for spawning gravel or superimpose redds of ESA-listed species. Similarly, adverse genetic interactions can occur when HOR and NOR steelhead interbreed, which may affect the fitness of natural fish and can result in the loss of genetic diversity, adult productivity, and decrease smolt survival (Chilcote 2003, Berejikian and Ford 2003, SRSRP 2004, Ford 2002). The following narrative addresses the risk potential for adverse impacts, as they theoretically apply to MRH operations. Reference to empirical studies of Mad River steelhead, status reviews, as well as literature from other areas is referenced to aid the assessment for genetic and ecological risk to natural stocks from this program.

Genetic Divergence

Essentially two primary sources of genetic divergence exist at MRH. The first source was the decision to use Eel River steelhead as the original broodstock in 1971 which lasted three years. Eel River steelhead were used exclusively during the first year, and Mad River steelhead as broodstock for winter-run steelhead propagation in years two and three.

Until the NC DPS of steelhead were listed in 2000, the hatchery production of steelhead were not identified by a mark, so it is unknown to what extent HORxHOR, HORxNOR, or NORxNOR matings took place. After listing, the MRH steelhead production was marked to enable both anglers and hatchery staff to identify a HOR fish for harvest or spawning. At that time, NOAA Fisheries Molecular Scientists indicated that Mad River NOR and HOR steelhead were very similar. From 2006 to 2008, in order to comply with current ESA interpretations, CDFW was directed by NOAA Fisheries to use only HORxHOR in the MRH spawning. The consequence of that decision over three years led to domestication of the MRH steelhead production and genetic divergence from NOR steelhead. Since 2009, the NOAA Fisheries interpretation of ESA was changed to allow the use of NOR Mad River steelhead at MRH for spawning and likely reversed the divergence.

Genetic and ecological interactions can occur between natural stocks and hatchery-produced fish, as cited above. Campton (1995) concluded that there are four possible outcomes for hatchery population structure resulting from artificial propagation. They are; 1) loss of genetic variation due to genetic drift from a small number of spawners (generally < 100), 2) introgression of exogenous genes via importation of fish, 3) artificial selection or selective breeding within the hatchery, and 4) selection toward domestication in lieu of natural selection in the hatchery environment.

Conversely, natural population structure reflects evolution through environmental adaptation. Genetic divergence between HOR and NOR steelhead originates from the different environmental influences affecting the survival of each stock, especially in Segregated Hatchery Programs (Busack and Currens 1995). Introgression of genetically divergent hatchery fish could affect diversity and fitness of natural populations because artificial propagation inadvertently selects for survival in hatchery settings (Allendorf and Ryman 1987 as cited by NOAA Fisheries 2008). The overall survival of “most” fish in a hatchery environment inadvertently allows maladaptive genotypes to persist within a cultured stock that nature would normally select against in the wild. The hatchery environment alters natural feeding behavior, competition, predator avoidance response, and inter- and intra-social interactions with other salmonids, which can affect fish phenotype and the natural selection process. Genetic change due to hatchery selection is more likely to accumulate in stocks cultured over multiple generations and consist exclusively of adults originating from hatchery-produced smolts. Fisheries managers can preserve the existing population structure and minimize the potential for genetic drift within the hatchery population by incorporating natural spawners and maintaining a genetically diverse broodstock. CDFW proposes to manage MRH as an Integrated Hatchery Steelhead Program that uses a suitably sized spawning population (N = 250) representative of the natural run timing. One of MRH’s spawning protocols uses one male for each sub-lot (two lots per female) derived from two different females. MRH will also incubate each lot separately to afford equalization (and documentation) of each family group contribution, if needed[1].

Although the percentages described below are currently not known for steelhead on the Mad River, the Hatchery Scientific Review Group (HSRG) (2004) proposed three parameters to assess the risk of hatchery programs on natural stock genetics, as follows:

- percentage of NOR adults relative to the total hatchery brood stock (pNOB)
- percentage of hatchery-origin spawners that spawn with the NOR (pHOS)
- proportion of natural influence (PNI) = pNOB/(pNOB + pHOS).

The proportion of HOR spawners (pHOS) and the proportion of natural influence (PNI) are measures of interbreeding between NOR and HOR fish. Diversity

[1] Culling options require the participation of NMFS SWFSC

within a population likely decreases with higher pHOS or lower PNI because the uniform hatchery environment is driving population diversity compared to the more diverse natural environment. The PNI statistic (Campton 2009) is an indicator for the relative fitness of the overall population (hatchery + wild). When PNI is 0.5, the natural and hatchery environment exert equal influence on the population. Thus, PNI must exceed 0.5 if the natural environment is to dominate selection. For populations of high biological significance, the HSRG (2009) has suggested that a PNI of 0.67 (between 0.5 and 1.0) is desirable to ensure the long-term fitness. In addition, the actual PNI will depend on many local variables and factors that need to be taken into consideration. Lastly, pHOS may be influenced by such factors as socioeconomics and angling opportunities, and some conservation programs may require supplementation or reintroduction. In these cases, pHOS could be between 5 and 100%. In the absence of data about these percentages for Mad River steelhead, this plan proposes to obtain surrogate knowledge from the genetic analysis of returning HOR and NOR broodstock. DIDSON unit counts, downstream in the Mad River basin, below the hatchery will produce a reliable count of all migrating steelhead. Estimating the return rate and harvest rate of 2+, 3+, 4+, and 5+ year old HOR steelhead will help, by subtraction, estimate the NOR steelhead component to the overall population. This will be the context used for PNI calculation, although interpretation may vary depending on what and where measurements are taken. In subsequent generations of the Mad River steelhead HGMP, additional biological monitoring may be implemented to refine these estimates.

The California HSRG (2012) made the following explicit recommendations for pHOS, pNOB and PNI:

> An “overall” pHOS should be calculated over the entire spawning population with which a hatchery is determined to be integrated.
>
> It would be imprudent to adopt a single numerical guideline for pHOS in all natural spawning areas integrated with hatcheries, because optimal pHOS will depend upon multiple factors. Among these factors are the amount of spawning by natural-origin fish in areas integrated with the hatchery, the value of pNOB, the importance of the integrated population to the larger stock, the fitness differences between hatchery- and natural-origin fish, and societal values, such as angling opportunity.
>
> Annual variation of pHOS can be considerable since it depends on the year-class strength of the contributing natural- and hatchery-origin cohorts. Controlling pHOS to specific values would require intensive management, even in years when pHOS thresholds would not be exceeded. Therefore, the California HSRG recommends that program-specific management plans be developed for the natural spawning areas and integrated with hatcheries that reflect these different factors, and with corresponding population-specific targets and thresholds. When

insufficient information or tools are available to designate such targets, average levels of pNOB and pHOS should be manipulated so that PNI at least exceeds 0.5 while further research can determine the importance of shifting PNI toward higher values.

Competition

Competition is the negative ecological interaction between organisms that require a common and limited resource necessary for survival. Competition is density dependent, often increasing the growth and survival of one population at the expense of the other. Density dependence is the basis by which most biologists conclude that interspecific competition occurs between salmonids (Flagg et al. 2000). Flagg et al. (2000) referenced several studies that suggest hatchery trout stocking may temporarily depress natural populations, but that the natural population quickly rebound to pre-stocking levels. Pearsons (2008) reported that the longer HOR fish occupy freshwater and estuarine environs, the greater the potential for competition between populations. Fresh (1997; cited by Flagg et al. 2000) suggested that competition is most likely to occur in the estuary or near shore environments where food resources are limited. McNeil (1991) concluded that there was no indication of competition in the marine environment. In Mad River, the significance of theoretical adverse interactions with NOR fish, in part, is proportional to the number of hatchery yearlings relative to natural stock abundance of steelhead, Chinook and coho salmon, and habitat carrying capacity at the time of release. For example, Pearsons (2008) theorized that emigrating HOR fish leave a shadow of reduced food abundance that affects subsequent natural emigrants, although O'Grady (1983) as cited by Flagg et al. (2000) reported hatchery trout ate less than their counterparts following release. Flagg et al. (2000) reviewed several studies that suggested competition between HOR and NOR stocks is reduced by the different habitat preference and dietary behavior of the two groups.

Pearsons (2008) reported that environmental conditions influence stock interactions and Hearn (1987) concluded that some environmental factors, such as floods (and turbidity) can neutralize the intensity or the occasion of competition altogether. HBMWD (2004) reported that there is a greater likelihood for competition between hatchery yearlings and natural stocks in Mad River due to the poor, habitat condition in the migration corridor below the hatchery release site. [Note Pearsons (2008) concluded that HOR fish may swim upstream, which expands the zone of influence for competition with native stock(s) above the hatchery].

Bergren and Filardo (1993) reported a positive relationship between river flow and the rate of emigration. WDFW (2003) reported that HOR steelhead typically migrate rapidly downstream, but Wagner et al. (1963) correlated larger fish with a faster seaward migration of smolts in Alsea River, Oregon. WDFW (2003) cited NOAA Fisheries (2002) and Flagg (2000) reported that where salmonids evolved sympatrically in the Pacific Northwest steelhead, Chinook and coho salmon evolved slight differences in habitat use and foraging behaviors. The practice of releasing hatchery yearlings reduces the potential for competition with natural stocks in the freshwater environment. MRH releases steelhead at a size $\geq$10 fish/lb. from mid-February to March 15 during high turbid flows to expedite yearling emigration into the ocean in an effort to minimize their interaction with natural stocks.

Predation

Flagg et al. (2000) reported that the effect of hatcheries on predator-prey relationships affecting ESA-listed salmonids could be separated into three categories; 1) predation by hatchery releases, 2) influence of HOR fish on predator populations, which may affect NOR fish, and 3) the effect of rearing and release protocols on the vulnerability of HOR fish to predation.

Moyle (2002) reported that yearling steelhead feed on insects and other aquatic invertebrates. Cannamela (1992) reported that older juvenile steelhead become increasingly piscivorous and Pearsons (2008) stated that predation by juveniles occurs primarily in freshwater[2], where hatchery stocks are concentrated and exposed to large numbers of prey. HSRG (2005) reported the behavior of hatchery yearlings reduce the number of NOR fish, but the significance of predation is dependent on the individual stock, as well as a number of stochastic factors including migration rate, stream condition, size and configuration, release location, and spatial overlap between stocks.

Fresh (2006), Lloyd (1987), Rowe et al. (2003) and Gregory and Levings (1998) report that turbid conditions reduce predation.

Although predation by HOR on NOR salmonids is a consequence of number and size of hatchery plants relative to the natural population(s), Mather (1998) concluded that predation is a composite of all ecological characteristics. Cannemela (1992) cited Perry and Bjornn (1991) who reported Chinook salmon fry are more vulnerable from emergence until moving to shallow water, but acknowledged a lower risk potential once fry reached shallow, edgewater habitat. Flagg et al. (2000) cited the USFWS (1992), Whitesell et al. (1993) and Johnson et al. (1994, 1995) who concluded that fry/fingerling predation by hatchery yearling steelhead was negligible because of inherently low predation or the absence of coexistence for the two species.

Flagg et al. (2000) concluded that hatchery-released steelhead consume between 0% and 22% of NOR salmonid juveniles in Columbia River tributaries. Flagg et al. (2000) also noted that two studies in northern California indicated a higher rate of fry/fingerling predation from yearlings compared to studies in the Columbia River, but neither study estimated prey abundance or error associated

[2] HSRG 2005 reported that there is little evidence for predation in estuarine and nearshore environments.

with the reported predation rates. Naman (2008) conducted a recent study for steelhead predation in a 3.2-mile section of Trinity River, immediately below Lewiston Dam, and reported that 437,697 HOR steelhead and 2,302 residualized hatchery trout consumed 61,214 [CI = 43,813 - 78,615] and 24,194 [CI = 21-066 - 27,323] salmonid fry from March 28 through April 26, 2007 and February 10 through March 2, 2007, respectively. Additionally, predation by HOR juveniles on NOR was significantly greater in areas of the Trinity River where salmon spawned.

Although predation occurs in Mad River, the above study results are not applicable to Mad River because TRH releases over 5x more yearlings than MRH, and in a concentrated spawning area below a dam. Sparkman (2002b) juvenile migrant studies indicate that there is little overlap between HOR and NOR downstream migrants and that steelhead residualism appeared to be negligible in Mad River.

Disease

MRH effluent is a potential source of pathogens for salmonids in the Mad River. Bacterial and viral pathogens can orally disperse between fish and disease transfer between HOR and NOR salmonids can result in natural stock mortality (HSRG 2005). NOR fish are more resistant to pathogens than their hatchery conspecifics (NOAA Fisheries 2005).

With rare exception, pathogens found in MRH are endemic to the basin. Brannon (2004), Saunders (1991) and Hastein and Linstad (1991) as cited by Flagg et al. (2000) concluded there was very little evidence to suggest that hatcheries routinely transmit disease to natural stocks. Campton (1995) reported a general absence of evidence to support the conveyance of parasites or disease from cultured fish to natural stocks, despite their occurrence within hatcheries. However, Pearsons (2008) reported that HOR fish could cause stress-induced susceptibility to pathogens in trout. In order to minimize the potential spread of pathogens from HOR to NOR fish, CDFW fish pathologists and veterinarians routinely investigate disease outbreaks at Department hatcheries and recommend legal therapies to treat pathogens and maintain fish health. CDFW pathologists and veterinarians conduct annual hatchery certifications for pathogens of concern and perform pre-release inspections on fish to ensure that fish are healthy at release.

Per department policy, CDFW pathologists conduct Health Condition Assessments on a subsample of fish to certify HOR yearlings are healthy and free of disease free before permitting release. CDFW hatchery policy forbids release of diseased fish, and Fish and Game Code section 6302 grants authorization to destroy captive populations of fish found infected, parasitized, or otherwise diseased.

Behavior

Campton (1995) reviewed scientific studies and concluded that the social interaction of hatchery-produced fish differed from their natural conspecifics. McMichael et al. (1999) concluded that the behavior of HOR fish in treatment and control streams threatened NOR steelhead. McMichael et al. (1999) also reported that where the two interacted, HOR fish displaced NOR steelhead in 79% of the observed contests. Brannon (2004) cited Reisenbichler and McIntyre (1977), who reported a differential growth and survival rate for HOR and NOR steelhead in altered environments. Conversely, Einum (1997) as cited by Brannon (2004) concluded that HOR fish perform comparable to their conspecifics.

Flagg et al. (2000) reported observations by scuba divers on hatchery plants to cause a “pied piper effect”, which refers to the movement downstream of NOR fish with large numbers of emigrating hatchery smolts, although there is no documentation of the impact of this phenomenon or the conditions under which it occurs (Pearsons 2008, Flagg et al. 2000).

Interbreeding

HOR fish rear in an artificial environment (consisting of high-density monoculture conditions) that is without any influence of natural selection. Bakke (1997), HSRG (2005), Reisenbichler et al. (2003), Taylor (1995) and Waples (1999) report that hatchery strays can dilute novel genotypes which are crucial for local adaptation. ISAB (2002) and SRSRP (2004) report that hatchery programs adversely affect the genetic makeup and the ecology of endemic stock(s) when large numbers of cultured fish spawn in the wild and reduce the endemic stock’s ability to adapt and survive habitat and environmental change. Reisenbichler and McIntyre (1977) report that interbreeding between HOR and NOR stocks can influence the natural population structure and its fitness in only a few generations.

Straying

Campton (1995) concluded that hatchery spawners in the wild diminish genetic variation and fitness between and within natural populations. Several factors affect the significance of mixed stock hybridization, but generally genetic and ecological concerns arise when distinct populations interbreed or a cultured stock exceeds 10% of the NOR population (Ford 2002). However, HSRG (2008) reported that the significance of pHOS is dependent on the proportion of natural spawners in the hatchery broodstock.

Subsequently, introgression can further reduce the productivity of progeny of parents from hybridized populations. Information on spawning success is inconsistent. Chilcote et al. (1986) reported that HOR fish produce on average 10-20% as many smolts compared to NOR fish. However, Brannon (2004) concluded that genetically similar (HOR and NOR) stocks can have comparable spawning success.

Jackson (2007) reported anglers are more successful in streams with steelhead rearing programs (Smith, Klamath, Trinity, Mad and Russian River). However, the Steelhead Report Card data indicates that anglers also catch low numbers of HO steelhead in wild streams. This HGMP proposes an interim 40% reduction in the historic production level to reduce within basin and inter-basin straying of MRH HO steelhead, which is crucial to developing a successful Integrated Hatchery Program. In addition, CDFW proposed regulation changes to increase the daily bag and possession limits for HRO steelhead to maximize angler harvest (FGC 2009).

Operating MRH as an Integrated Hatchery Program with conservation potential maintains the independent steelhead population within Mad River above a level of depensation, as well as maintains a hatchery population that genetically mimics the natural population structure (CDFW/MNFS 2009). A viable population in Mad River provides spatial continuity within the NC Steelhead DPS.

Appendix 11. Fish Health Policy

State of California – Natural Resources Agency
DEPARTMENT OF FISH AND WILDLIFE
Fisheries Branch, Fish Pathology Laboratory
2111 Nimbus Road, Rancho Cordova CA 95670

EDMUND G. BROWN JR., Governor
CHARLTON H. BONHAM, Director

California Department of Fish and Wildlife
Fish Health Policy for Anadromous Fish Hatcheries – General Outline

February 19, 2014

Policy Statement

It shall be the policy of the California Department of Fish and Wildlife to protect the anadromous salmonid resources of the State of California by restricting the importation, dissemination, and amplification of pathogens and diseases known to adversely affect fish.

Goals

1) Strive to produce healthy fish for release or transfer.
2) Ensure that all production fish are raised under a specific fish health management program.
3) Monitor and evaluate the health of wild and cultured fish populations.
4) Foster open and frequent communication among managers to jointly resolve fish health related issues.

Performance Standards

To protect anadromous fishery resources, health care standards must be followed to prevent the importation, dissemination, and amplification of pathogens and diseases known to adversely affect fish. These standards will include:

1) Hatchery monitoring visits by CDFW fish pathologists and/or veterinarians
2) Broodstock inspection programs for fish pathogens
3) Hatchery sanitation procedures
4) Hatchery biosecurity procedures
5) Hatchery HACCP plans for invasive species
6) Water quality parameters
7) General fish culture practices
8) Egg and fish transfer requirements
9) Communication among managers
10) Regulatory compliance
11) Research
12) Identification of future needs of the fish health program

Appendix 12. List of Diet Ingredients

Bio-Oregon®

BioClark's Starter

A Sustainable Starter Feed for Enhancement Applications

Bio-Oregon continues the Clark legacy with the introduction of a new highly palatable starter diet which combines traditional dietary values with an increasing requirement for sustainable fish feeds. Natural palatability enhancers, high quality prime fish meals and fish oils ensure an active feed response while an enhanced vitamin pack helps to get fish off to a healthy start. Bio-Oregon has carried out extensive research work on alternative raw materials and only the most tried and tested have been incorporated into BioClark's Starter. BioClark's Starter is ideal as a sustainable starter feed for all enhancement hatcheries and is formulated for salmonids including Pacific Salmon, Steelhead and Trout.

- Natural palatability enhancers ensure an active first feed response
- Highly digestible premium fish meals and fish oil promote increased feed intake and growth
- Select use of alternative raw materials provides improved raw material and price stability
- BioClark's Starter contains beta-glucans, nucleotides, organic selenium and a high level of vitamins to stimulate the immune system and ensure a healthy start
- Free flowing crumbles with optimal particle size distribution and sinking profile

Composition

Feed Size	Particle Size (mm)	Protein Min.	Oil Min.	Moisture Max.	Fiber Max.	Ash Max.	DE MJ/kg	Fish size Grams	Fish size #/lb
Mash	0.25-0.4	53%	18%	8.5%	1.5%	12%	18.8	<0.2	<3000
#0	0.3-0.6	53%	18%	8.5%	1.5%	12%	18.8	0.2-0.8	3000-570
#1	0.4-1.0	52%	20%	8.5%	1.5%	12%	19.2	0.8-1.5	570-300
#2	0.8-1.4	52%	20%	8.5%	1.5%	12%	19.2	>1.5	<300

Feeding Guidelines - Percent to feed: kg (lbs) feed per 100kg (lbs) fish per day

Fish Size		Feed	F	35.6	39.2	42.8	46.4	50.0	53.6	57.2	60.8
Weight (g)	Fish/lb	Size	C	2.0	4.0	6.0	8.0	10.0	12.0	14.0	16.0
<0.2	<3000	Mash		1.0	1.7	2.3	3.0	3.3	3.8	4.4	4.9
0.2-0.8	3000-570	#0		0.8	1.4	2.2	2.8	3.2	3.6	4.2	4.8
0.8-1.5	570-300	#1		0.7	1.3	2.0	2.6	2.9	3.3	3.9	4.7
>1.5	<300	#2		0.6	1.2	1.8	2.4	2.7	3.1	3.7	4.3

BioVita Fry

2.5 MM

Complete Feed for Salmonids

GUARANTEED ANALYSIS

Crude Protein (min)	50 %	Crude Fiber (max)	1.0 %
Crude Fat (min)	22 %	Phosphorus (min)	1.2 %

INGREDIENTS: Fish Meal, Fish Oil, Wheat Flour, Wheat Gluten, Brewer's Yeast, A Vitamin/Mineral Premix Containing: Vitamin A Acetate, Vitamin D3 Supplement, Ascorbyl Polyphosphate C, Vitamin E Supplement, Inositol, Zinc Sulphate, Nicotinic Acid, Calcium Pantothenate, Manganese Sulphate, Riboflavin, Pyridoxine Hydrochloride (B6), Thiamine Mononitrate, Menadione Sodium Bisulfite Complex (Vitamin K), Copper Sulfate, Folic Acid, Calcium Iodate, D-Biotin, Sodium Selenite and Vitamin B12 Supplement, Mono Ammonium Phosphate, Ascorbyl Polyphosphate C, Vitamin E Supplement, Vitamin B12 Supplement, Astaxanthin, and Ethoxyquin, a preservative.

Bio-Oregon

Manufactured for:
Bio-Oregon
1140 Industrial Way, Longview, WA 98632
800-962-2001 Phone 360-425-6785 Fax

Net Wt. 20 kg/ 44 lb.

THIS PACKAGE IS TO BE SOLD AS A COMPLETE UNIT ONLY
FEEDING DIRECTIONS: Feed as sole ration to salmon & trout

Product of Canada RG

BioPro

1.5 MM

Complete Feed for Salmonids

GUARANTEED ANALYSIS

Crude Protein (min)	50 %	Crude Fiber (max)	1.0 %
Crude Fat (min)	22 %	Phosphorus (min)	1.2 %

INGREDIENTS: Fish Meal, Fish Oil, Wheat Flour, Wheat Gluten, Mono Ammonium Phosphate, Brewer's Yeast, A Vitamin/Mineral Premix Containing: Vitamin A Acetate, Vitamin D3 Supplement, Ascorbyl Polyphosphate C, Vitamin E Supplement, Inositol, Zinc Sulphate, Nicotinic Acid, Calcium Pantothenate, Manganese Sulphate, Riboflavin, Pyridoxine Hydrochloride (B6), Thiamine Mononitrate, Menadione Sodium Bisulfite Complex (Vitamin K), Copper Sulfate, Folic Acid, Calcium Iodate, D-Biotin, Sodium Selenite, and Vitamin B12 Supplement, Magnesium Oxide, Ascorbyl Polyphosphate C, Vitamin E Supplement, Astaxanthin, Natural and Artificial Flavoring, and Ethoxyquin, a preservative.

Bio-Oregon

Manufactured for:
Bio-Oregon
1140 Industrial Way, Longview, WA 98632
800-962-2001 Phone 360-425-6785 Fax

Net Wt. 20 kg/ 44 lb.

THIS PACKAGE IS TO BE SOLD AS A COMPLETE UNIT ONLY
FEEDING DIRECTIONS: Feed as sole ration to salmon & trout

Product of Canada RG

## Appendix 13.	Public Comment Letters and Table of Repsonses

Blue Lake Rancheria
ENVIRONMENTAL PROGRAMS
P.O. Box 428 Blue Lake, CA | Office: (707) 668-5101 Fax: (707) 668-4272 | www.bluelakerancheria-nsn.gov/govLawEnviroPro.html

Wes Smith, NOAA Affiliate
Protected Resources Division
National Marine Fisheries Service, West Coast Region
Northern California Office
1655 Heindon Rd. Arcata, CA 95521

May 12, 2016

RE: Comments on Mad River Winter Steelhead Hatchery Plan

Dear Wes Smith,

We have reviewed NOAA's Draft Environmental Assessment (draft EA) "Impacts of NOAA's National Marine Fisheries Service Proposed 4(d) Determination under Limit 5 for the Mad River Winter-run Steelhead Hatchery Program," and have several comments to make on behalf of the Blue Lake Rancheria Tribe.

Initially, review of the draft EA was difficult not having reviewed the draft California Department of Fish and Wildlife (CDFW) Hatchery Genetics Management Plan (HGMP). CDFW did not respond to any requests for Government-to-Government consultations regarding the HGMP, or respond to requests to view the HGMP to inform our review of the draft EA. NOAA has taken the initiative to contact Blue Lake Rancheria (BLR), and staff members have made themselves available to discuss the draft EA. The HGMP did become available during the public comment period, so we are now able to review and comment on both the HGMP and NOAA's draft EA.

The HGMP for Mad River Hatchery contains several complicated assertions and protocols that, given the prior operation history, and historic budget shortfalls, seem unlikely to be successfully implemented. BLR would like to see the Mad River Hatchery (MRH) benefit anglers, native fish species, and the Mad River in positive and meaningful ways. To be effective at implementing hatchery operations efficiently and cost-effectively, while protecting the fishing resource and avoiding future lawsuits, we recommend the following steps be taken:

- Promulgate Alternative 4, exclusive use of natural stock as broodstock, as identified in the HGMP.
- Perform needed genetic analysis of NOR stocks to understand the makeup of the fish. A non-ad clip fish doesn't necessarily indicate a wild, native steelhead; HOR fish that stray and spawn in the river will produce non-ad clip offspring.

Blue Lake Rancheria
ENVIRONMENTAL PROGRAMS
P.O. Box 428 Blue Lake, CA | Office: (707) 668-5101 Fax: (707) 668-4272 | www.bluelakerancheria-nsn.gov/govLawEnviroPro.html

- Cease the rearing of HOR fish. To avoid HOR fish spawning in the river, strip the gametes from HOR fish that run up the fish ladder, and release HOR fish back to the river for angling opportunity.
- Change fishing regulations to force anglers to keep the first 2 hatchery fish (ad clip) landed each day and cease fishing afterwards.
- Discontinue "freeze and toss" of dead and dying steelhead captured at the hatchery facility. Vital marine-derived nutrients present in the corpses of these fish have been proven to benefit the habitat and food web of northwest rivers. Neighboring land managers on the Six Rivers National Forest are implementing "nutrient enhancement programs" where pressed "salmon cakes" are spread throughout the mountains and rivers to feed insects, plants, and animals throughout watersheds. Stop wasting precious resources by freezing, storing, transporting, and disposing of these vital nutrients in a landfill. Dead fish do not "diminish the outdoor experience," but rather, enhance the overall habitat health and provide a valuable educational opportunity.

BLR's Environmental Programs staff feels that managing hatchery operations using conservation hatchery methods is best for long-term sustainability and resilience of fisheries populations. These conservation methods should include weir and/or hatchbox operations on tributaries that enhance spawning capacity on the mainstem and tributaries of Mad River that have been impacted by excessive sediment, water diversions, and loss of habitat due to development. A conservation hatchery alternative would likely avoid any future lawsuits regarding "take" of listed species, provide direct benefits to wild fish, and sustain or enhance angling experience, including catch-and-keep fishing.

Adopting conservation hatchery techniques at MRH may bolster fish populations with robust genetics that is crucial in this age of adaptation to climate change, and ultimately lead to delisting of wild steelhead in Mad River. Implementing conservation hatchery methods would also support the current angling experience, and potentially enhance angling experience by providing a greater number of wild fish to catch.

In light of the most recent literature about the impact of hatchery operations on wild fish populations, BLR believes that the most realistic way to recover wild steelhead populations while maintaining a catch-and-keep fishery is by operating MRH as a conservation hatchery.

Respectfully,

Michelle Fuller
Environmental Programs Director
(707)668-5101 x1036
mfuller@bluelakerancheria-nsn.gov

Jacob Pounds
Environmental Programs Assistant
(707)668-5101x1038
jpounds@bluelakerancheria-nsn.gov

epic

Keeping Northwest California wild since 1977

Sent via electronic mail on date shown below

May 9, 2016

Wes Smith, NOAA Affiliate
Protected Resources Division
National Marine Fisheries Service, West Coast Region
Northern California Office
1655 Heindon Rd. Arcata, CA 95521

Dear Mr. Smith,

Please accept these comments on the draft "Hatchery and Genetic Management Plan For Mad River Hatchery Winter-Run Steelhead" on behalf of the Environmental Protection Information Center (EPIC).

EPIC supports the increase in use of native origin broodstock. We would also like to reflect on the vast change in management philosophy and practice over a short period of time—as late as 2013, there was only a 20% NOR broodstock integration target; today, the hatchery proposed a 67% target. EPIC fully supports the increased NOR broodstock requirement, which is at the heart of this Hatchery and Genetics Management Plan. EPIC appreciates the work by NOAA and the Department of Fish and Wildlife in moving towards this new standard.

To avoid redundancy, EPIC affirms and adopts the comments submitted by Mad River Alliance. Additionally, we wish to provide additional emphasis on the following points raised below.

Genetics Monitoring

EPIC supports "real time" genetics monitoring and mate pairing. EPIC understands there may be additional costs associated with improvement to the Mad River facility and we are committed to working with NOAA and the Department to find the necessary funds.

EPIC furthermore appreciates and encourages the active monitoring of fish genetics by brood year to ensure that the genetic divergence between HOR and NOR is decreasing and that information will be made publicly available. EPIC would appreciate copies of any future genetic annual reports.

Fisheries Management and Evaluation Plan

EPIC encourages the creation and adoption of a Fisheries Management and Evaluation Plan (FMEP). The FMEP will be useful in pending discussion on increased bag limits and other measures which can influence fisheries genetics.

Disposal of Carcasses

We disagree with the approach taken by the hatchery in the disposal of carcasses from inadvertent mortality. It is well known that nutrients supplied by decomposing fish carcasses are important to salmonid-bearing waters; the Mad River would likely benefit from these carcasses as well. As to the concerns raised, EPIC finds them spurious. First, the squeamishness of fishers is likely exaggerated, particularly since many enjoy the close communion with nature that fishing affords. Second, as to water quality concerns, the Humboldt Bay Municipal Water District draws potable water from well adjacent to the river and further treats with water to ensure its safety. Only bulk, non-potable water is drawn from surface flows. Additionally, fish decomposition is a natural process that will occur regardless of hatchery operation; normal conditions have not created deleterious results. EPIC urges the hatchery to release whatever carcasses are not diverted for educational or scientific reasons back into the Mad River.

Fish Ladder Operations

In Winter 2015, EPIC was approached by concerned anglers that the fish ladder was not turn on and that HOR were seen breeding far above the fish ladder. After concerns were raised, the ladder was soon turned on, but the lesson remains: when fish are returning to the river, the fish ladder should be in operation to encourage HOR hatchery return.

*   *   *

In closing, EPIC is content with many of the changes proposed by NOAA and the Department. EPIC thanks NOAA and the Department for their willingness to change.

Sincerely,

Thomas Wheeler

Thomas Wheeler

Wes Smith, NOAA Affiliate
Protected Resources Division
National Marine Fisheries Service, West Coast Region
Northern California Office
1655 Heindon Rd. Arcata, CA 95521

RE: Mad River Winter-run Steelhead Hatchery Program

Dear Wes Smith,

Mad River Alliance (MRA) is a community driven group organized to protect clean water and the ecological integrity of the Mad River watershed for the benefit of its human and natural communities. Our executive committee has reviewed the Mad River "Winter-run Steelhead Hatchery Genetics Management Plan," and we have several suggestions that we believe will support the best interests of all stakeholders.

1) We agree with the goal set forth in section 1.11 (page 14) of the Mad River HGMP: *"…proposed winter-run steelhead broodstock is 125 female fish and 125 male fish, of which a goal of 67% of the broodstock is NOR steelhead, per the Integrated Hatchery Program goal. We propose incorporating a goal of 67% NOR, with 50% as a running average into the MRH breeding program for four years starting with the 2014 spawning, and thereafter, propose 50-67% running average of NOR into the MRH breeding program."*

   However, we are aware that since 1971 HOR have been breeding in the river with NOR, as Reneski points out: *"From this starting point, the captive population diverged over 35 years while the wild population retained the historical condition but was also highly admixed (17-44%) with the newly formed hatchery population."*

   The confounding variable is the genetic identity of NOR, as Reneski points out: 17-44% of NOR are admixed with HOR. The proportion of natural influence (PNI) goal of 67% may be a challenge for Hatchery Managers to attain, given that for over 40 years admixing has occurred. When that fact is taken into consideration it is of concern to MRA that "*The primary method of take is trapping fish via the MRH fish ladder and trap."* (Section 2.2 page 20).

   The weakness in relying on the ladder and trap, as the primary method of NOR capture, is that managers may repeat the same pattern that led to population divergence. We recommend that
   Hatchery Managers expand other methods of take, such as hook & line, and other methods that may trap fish in tributaries further away from the Hatchery.

2) Mad River Alliance also encourages Hatchery Managers to follow the monitoring and evaluation performance indicators outlined in section 11.0 and described in table 23 regarding mating protocols, monitoring, and evaluation goals.

3) To further reduce the negative impact of HOR on NOR we suggest Hatchery Managers, in coordination with CDFW staff and NMFS, conduct a complete Isolation by Distance Genetic Analysis within the whole Mad River basin and tributaries to monitor HOR impacts on NOR fish.

4) We encourage earliest adoption of exclusive use of NOR broodstock as outlined in section 1.16 alternative 4, with the long term goal of improving NOR stocks to levels that well exceed the current dispensation point of 352, by an agreeable factor, as determined by NMFS and CDFW. In relation to this, we encourage MRH pursue the adoption of the coded wire tag proposal as outlined in section 11.0, *"A new proposal under consideration for a future revision of the HGMP recommends that the progeny from NORxNOR and NORxHOR will be tagged with coded wire tags (CWTs), and only these fish out of the total production will be tagged. … Upon return as adults, they would be used for the spawning matrix in preference to HORxHOR. If sufficient numbers returned, the entire spawning matrix could be populated with them and any other unmarked NOR broodstock. If insufficient numbers return, the additional NOR without the CWT would be used in the spawning matrix. HORxHOR would be used only as a last resort. The CWT marking program need only be implemented for five or six years in order to rapidly diminish genetic divergence and jump start convergence (Free, pers. comm.).* "

5) We recommend CDFW and NMFS coordinate, plan, and conduct a Fisheries Management and Evaluation Plan (FMEP), as required under the Endangered Species Act 4(d) Rules. Conducting a FMEP will reduce CDFW's legal risk and ensure proper monitoring of endangered and threatened species in the Mad River watershed. This should include all threatened and endangered species, including a full examination of Mad River estuarine species. (See attached species list on pages 3 & 4).

6) We encourage increased HOR bag limits as described in the HGMP: *"NMFS has encouraged CDFW to consider a regulation against the return of landed HOR steelhead to the stream, or alternatively, increased angler education that encourages anglers to retain HOR steelhead and not release them back into the stream to potentially spawn naturally. CDFW proposed new angling regulations in 2009 to liberalize bag and possession limits to encourage anglers to harvest HOR steelhead. Although the bag limit may be raised to 4 HOR's per day to reduce pHOS and increase the PNI index, it is unlikely that CDFW will mandate retention of all HOR fish caught by anglers."*

7) We encourage Hatchery Managers to open the Ladder earlier in the season to increase the opportunity to trap NOR broodstock and expand the temporal spawning window.

8) We encourage ongoing evaluation of the smolt to adult return ratios in an effort to reduce the impact returning HOR have on NOR. This will help to ensure a minimal proportion of HOR spawners in the wild.

9) We encourage Hatchery Managers to remove the gametes of all HOR that enter the hatchery before re-releasing them back to the river for angler opportunities.

10) We recommend any expired /dead HOR or NOR fish that have been spawned in the hatchery; once gametes have been removed, the fish carcasses should be returned to the river. This will serve to increase the Marine Derived Nutrient (MDN) inputs to the energy system of the watershed, which is an integral component for the production of macroinvertebrate populations and the aquatic food web.

Thank you for taking the time to read our comments and recommendations. We are grateful for the opportunity to provide public comments on the Mad River Hatchery Genetics Management Plan, and are confident that CDFW and NMFS will implement the best plan that encourages the recovery of all endangered and threatened fishes found in the Mad River watershed.

Sincerely,

Dave Feral
Executive Director
Mad River Alliance
707-382-6162

Native fish species found in the Mad River and Estuary as of June 2015

Common Name	Scientific Name	Status	Area Found
Coho Salmon	*Oncorhynchus kisutch*	Threatened Fed ESA	Mainstem & tributaries
Coastal Cutthroat	*O. clarki clarki*		Mainstem & tributaries
Chinook Salmon	*O. tshawytscha*	Threatened Fed ESA	Mainstem & tributaries
Chum Salmon	*O. keta*		Occasional stray
Sockeye Salmon	*O. nerka*		Occasional stray
Steelhead/Rainbow Trout	*O. mykiss*	Threatened Fed ESA	Mainstem & tributaries
Green Sturgeon	*Acipenser medirostris*	Species of concern	Estuary, mainstem & tributaries
Arrow Goby	*Clevlandia ios*		Estuary
Tidewater Goby	*Eucyclogobius newberryi*	Endangered Fed ESA	Estuary
Eulachon	*Thaleichthys pacificus*	Threatened Fed ESA	Estuary, mainstem & tributaries
Longfin Smelt	*Spirinchus thaleichthy*	Threatened CA ESA	Estuary
Night Smelt	*Spirinchus starski*		Estuary
Surf Smelt	*Hypomesus pretiosus*		Estuary
Pacific Lamprey	*Entosphenus tridentata*		Mainstem & tributaries
Buffalo Sculpin	*Enophrys bison*		Estuary, mainstem

			& tributaries
Coastrange Sculpin	*Cottus aleuticus*		Estuary, mainstem & tributaries
Prickly Sculpin	*Cottus asper*		Estuary, mainstem & tributaries
Sharpnose Sculpin	*11)* Clinocottus acuticeps		Estuary
Staghorn Sculpin	*Leptocottus armatus*		Estuary, mainstem & tributaries
Humboldt Sucker	*C. occidentalis humboldtianus*		Mainstem & tributaries
Sacramento Sucker	*Catostomas occidentalis*		Mainstem & tributaries
Three-spine Stickleback	*Gasterosteous aculeatus*		Mainstem & tributaries
English Sole	*Parophrys vetulus*		Estuary
Petrale Sole	*12) Eopsetta jordani*		Estuary
Speckled Sanddab	*Citharichthys stigmaeus*		Estuary
Starry flounder	*Platichthys stellatus*		Estuary
Penpoint Gunnel	*Apodichthys flavidus*		Estuary
Saddelback Gunnel	*Pholidae ornate*		Estuary
Pacific Herring	*Culpea pallasii*		Estuary
Jacksmelt	*Atherinopsis californiensis*		Estuary
Topsmelt	*Atherinops affinis*		Estuary
Black Rockfish	*Sebastes melanops*		Estuary
Cabezon	*Scorpaenichthys marmoratus*		Estuary
Copper Rockfish	*S. caurinus*		Estuary
Bay Pipefish	*Syngnathus loptorhyncus*),		Estuary
Shiner Surfperch	*Cymatogaster aggregata*		Estuary

List compiled by Dave Feral, Director, Mad River Alliance 6-11-15 & Dr. Tim Mulligan of Humboldt State University Fisheries Department, revised 6/28/2015 by Katharine Osborn (HSU Masters Student).

Table 1 CDFW's responses(s) to Public Comments associated with the Mad River HGMP.

Public Comment Entity	Public Comment	CDFW Response
Blue Lake Rancheria	Exclusive use of NOR as broodstock as identified in the HGMP	We are crossing NOR x HOR (50% integration rate), and when possible will cross NOR x NOR . The range of integration will be 50 – 100%. A 50% integration rate will produce an acceptable genetic diversity based upon consultation with NMFS geneticist. We cannot exclusively breed NOR x NOR at this time due to lower collection of NOR fish. We are also using the PNI index as a guide to the necessary percentage of NOR fish used in the breeding program (pNOB), and will increase more NOR into the breeding program if necessary. Pages 20, 73, 94.
Blue Lake Rancheria	Perform needed genetic analysis of NOR stocks to understand the makeup of the fish. A non-ad clip fish doesn't necessarily indicate a wild, native steelhead: HOR fish that stray and spawn in the river will produce non-ad clip offspring.	Humboldt State University geneticist and graduate student are in the process of conducting genetic analyses of MRH fish used for breeding with one goal being looking at divergence or convergence of NOR and HOR fish. We are aware that HOR fish that spawns in the wild will produce a non-ad clipped fish, which, in part, is why we will achieve at least a 50% NOR integration rate and a PNI value $\geq$ 0.50 to reduce domestication effects in the hatchery. We would also like to genotype the NOR fish within the basin in a spatially balanced manner. Page 99.
Blue Lake Rancheria	Cease rearing HOR fish. To avoid HOR fish spawning in the river, strip the gametes from HOR fish that run up the fish ladder, and release HOR fish back to the river for angling opportunity.	We no longer rear HOR x HOR fish at MRH, beginning in 2014. All juveniles are products from NOR x HOR and/or NOR x NOR. Juveniles from the breeding program are still considered HOR fish, since they are raised in a hatchery. We may strip all HOR females to reduce pHOS for the PNI equation, if merited (ie when PNI < 0.50). We can't strip all of the milt from HOR males (not feasible,

Public Comment Entity	Public Comment	CDFW Response
		due to their reproductive potential). Pages 76- 77.
Blue Lake Rancheria	Change fishing regulations to force anglers to keep the first 2 hatchery fish (ad clip) landed each day, and cease fishing afterwards.	We cannot force anglers to keep HOR adult steelhead that they catch. Many anglers do not want to eat the fish they catch, and prefer catch and release fishing. CDFW has also guided regulation development toward simplification and uniformity across the state, which is the opposite of “boutique” fishing regulations specific to one river. We can’t force anglers to waste fish they catch if they don’t want to eat them, which would then be a violation of CDFW code (CCRT14 Section 1.87). The incidental capture of NOR fish by anglers targeting HOR fish will be addressed in the Mad River Fishery Management and Evaluation Plan. Pages 55, 58.
Blue Lake Rancheria	Discontinue ‘freeze and toss’ of dead and dying steelhead captured at the hatchery facility. Vital marine-derived nutrients present in the corpses of these fish have been proven to benefit the habitat and food web of northwest rivers. Neighboring land managers on the Six Rivers National Forest are implementing ‘nutrient enhancement programs where pressed ‘salmon cakes’ are spread throughout the mountains and rivers to feed insects, plants, and animals throughout the watersheds. Stop wasting precious resources by freezing, storing, transporting, and disposing to these vital nutrients in a landfill. Dead fish do not ‘diminish the outdoor experience’, but rather, enhance the overall habitat health, and provide a valuable educational opportunity.	We intend on taking carcasses upstream of the hatchery to put back into the river. However, the number of carcasses is low (<50) and will probably not increase nutrients to the stream to any measurable degree. To some of the public, dead fish will diminish the angler experience, however, we will still dispose of carcasses to the stream. We are aware and agree with your statement about the benefits of the nutrients associated with carcasses. Page 77.
Blue Lake Rancheria	BLR’s Environmental Programs staff feels that managing hatchery operations using conservation	This HGMP specifies that MRH will be operated as an integrated, enhancement and conservation

Public Comment Entity	Public Comment	CDFW Response
	hatchery methods is best for long-term sustainability and resilience of fisheries populations. These conservation methods should include weir and/or hatch box operations on tributaries that enhance spawning capacity on the mainstem and tributaries of the Mad River that have been impacted by excessive sediment, water diversions, and loss of habitat due to development. A conservation hatchery alternative would likely avoid any future lawsuits regarding 'take' of listed species, provide direct benefits to wild fish, and sustain or enhance angling experience, including catch-and-keep fishing.	hatchery, specifically by using a 50%$^+$ integration rate of NOR's into the breeding program. The most current escapement for NOR fish (2013/14) is 3,449 adults, well above the depensation point of 352 NOR's. Since we are well above the depensation point, weirs and hatch boxes are not necessary to 'boost' natural production. This HGMP allows for the 'take' of listed NOR fish for breeding purposes, thus avoiding future lawsuit regarding the NOR take. CDFW believes the MR HGMP will benefit the natural populations during catastrophic, stochastic events (conservation potential), and enhance the angling experience without causing undue harm to natural populations. Pages 4, 20, 23-26, 100.
Blue Lake Rancheria	Adopting conservation hatchery techniques at MRH may bolster fish populations with robust genetics that is crucial in the age of adaptation to climate change, and ultimately lead to delisting of wild steelhead in Mad River. Implementing conservation hatchery methods would also support the current angling experience, and potentially enhance angling experience by providing a great number of wild fish to catch.	We agree that MRH, as an enhancement/conservation hatchery that utilizes at least a 50% NOR integration rate, will produce a hatchery fish with more 'robust' genetics compared to a HOR x HOR cross. The NOR x HOR and NOR x NOR crosses will produce juveniles under which the natural environment is the primary selective force (ie when PNI $\geq$ 0.50), compared to a hatchery selective force (ie when PNI < 0.50). However, both the federal and state listing process is at the ESU level, and not the population level for a given stream. Thus, MRH production will not be able to 'de-list' the wild steelhead trout population within the Mad River. We also agree that MRH HGMP will continue to support (enhance) the angling experience by providing a hatchery fish that is allowed to be kept. The progeny of all fish spawned at MRH are still

Public Comment Entity	Public Comment	CDFW Response
		considered a hatchery fish (HOR). Page1.
Blue Lake Rancheria	In light of the most recent literature about the impact of hatchery operations on wild fish populations, BLR believes that the most realistic way to recover wild steelhead populations while maintaining a catch-and-keep fishery is by operating MRH as a conservation hatchery.	We agree that past practices of hatchery operations have impacted natural populations in various streams and states. However, natural populations in the Mad River, based upon the most recent abundance estimate (N = 3,449), do not appear to need immediate recovery actions at this time. However, we also believe that the NOR abundance needs to be monitored, given adequate funding. We also agree with the merits of MRH as a conservation hatchery, however, the NOR population appears relatively robust, and thus, MRH is intended to be operated as an enhancement hatchery with conservation potential. Page 20.
EPIC	EPIC supports "real time" genetics monitoring and mate pairing. EPIC understands there may be additional costs associated with improvement to the Mad River facility and we are committed to working with NOAA and the Department to find the necessary funds.	We appreciate that EPIC may assist with finding funds to perform 'real time' genetic monitoring of the MRH breeding program. However, real-time genetics monitoring for mate pairing is not necessary at this time as a pairing mechanism. The spawning matrix using NOR x HOR precludes or avoids sibling crossings and reduces domestication. There is a low probability of sibling crossing with NOR x NOR because the most recent NOR abundance estimate is 3,449 individuals, thus there is a low likelihood that randomly selected NOR's for breeding would be siblings. In summary, genetic monitoring will strive for 1) a one-time comprehensive assessment, now, with Dr. Kinziger's steelhead grant, 2) a proposal to address the genetic composition convergence of NOR and HOR in 2019, and 3) a five year cycle of review over time. We will implement a small MRH HGMP

Public Comment Entity	Public Comment	CDFW Response
		Coordination Team to meet annually in September - December before the spawning season to review and evaluate practices of the program. Finalized evaluations will be available to the public. Page 99.
EPIC	EPIC furthermore appreciates and encourages the active monitoring of fish genetics by brood year to ensure that the genetic divergence between HOR and NOR is decreasing and that information will be made publicly available. EPIC would appreciate copies of any future genetic annual reports.	Humboldt State University geneticist and graduate student are in the process of conducting genetic analyses of MRH fish used for breeding, with one goal being quantifying the divergence or convergence of NOR and HOR fish. Finalized evaluations will be available to the public. Page 99.
EPIC	EPIC encourages the creation and adoption of a Fisheries Management and Evaluation Plan (FMEP). The FMEP will be useful in pending discussion on increased bag limits and other measures which can influence fisheries genetics.	We agree, and CDFW is committed to preparing a Mad River Winter-run SH FMEP or a comprehensive NC DPS SH FMEP one year in the future from the approved MRH HGMP. Staff have already been assigned to the task. We also recognize that harvest of HOR fish will increase the PNI index (by reducing pHOS), and allow for the natural environment to be the dominant selective force acting upon the steelhead population within the MR. There is a low likelihood of increasing the current bag limit of HOR fish in the MR because CDFW has guided regulation development toward simplification and uniformity across the state, which is the opposite of “boutique” fishing regulations specific to one river. There are other ways to reduce pHOS (the number of hatchery origin return spawners in the system), such as stripping all eggs from HOR steelhead that return to MRH. This may occur if the PNI index is less than 0.50. Pages 28 and 47.

Public Comment Entity	**Public Comment**	**CDFW Response**
EPIC	We disagree with the approach taken by the hatchery in the disposal of carcasses from inadvertent mortality. It is well known that nutrients supplied by decomposing fish carcasses are important to salmonid-bearing waters; the Mad River would likely benefit from these carcasses as well. As to the concerns raised, EPIC finds them spurious. First, the squeamishness of fishers is likely exaggerated, particularly since many enjoy the close communion with nature that fishing affords. Second, as to water quality concerns, the Humboldt Bay Municipal Water District draws potable water from well adjacent to the river and further treats with water to ensure its safety. Only bulk, non-potable water is drawn from surface flows. Additionally, fish decomposition is a natural process that will occur regardless of hatchery operation; normal conditions have not created deleterious results. EPIC urges the hatchery to release whatever carcasses are not diverted for educational or scientific reasons back into the Mad River.	We have made changes in the MR HGMP to allow for disposing carcasses back to the stream. We intend on taking carcasses upstream of the hatchery to put back into the river. Page 78.
EPIC	In Winter 2015, EPIC was approached by concerned anglers that the fish ladder was not turned on and that HOR were seen breeding far above the fish ladder. After concerns were raised, the ladder was soon turned on, but the lesson remains: when fish are returning to the river, the fish ladder should be in operation to encourage HOR hatchery return.	This issue has two parts- 1) the fiscal capacity of the CDFW to begin operating the hatchery in December; and 2) the biological response to ladder use. We agree that delaying the opening of the ladder after the first week of January has definite deleterious effects for undesirable HOR spawner straying. We are planning on opening the ladder during the middle of December to allow for HOR fish to enter the hatchery ladder and facility. Obtaining the full scope of the run is desirable and we

Public Comment Entity	Public Comment	CDFW Response
		plan on opening the ladder in December, however, the river in dry years doesn't reach the entrance to the ladder. In dry years we could try other means of obtaining NOR and HOR broodstock. We also have specific start and stop dates for water use and discharge which must be complied with. Page 15.
Mad River Alliance	The weakness in relying on the ladder and trap, as the primary method of NOR capture, is that managers may repeat the same pattern that led to population divergence. We recommend that Hatchery Managers expand other methods of take, such as hook & line, and other methods that may trap fish in tributaries further away from the Hatchery.	In the past, adult hatchery steelhead trout were not marked, thus the breeding program at MR couldn't distinguish between NOR and HOR adults. Unlike the early years of operation, all hatchery steelhead are currently marked with an adipose fin clip. QA/QC of fin clipping shows that 99^{+}% of hatchery smolts have a discernable fin clip. Additionally, MRH staff critically examine each NOR for any fin erosion (eg dorsal, ventral, pelvic). If any fin erosion is present, then that fish is not considered a NOR. Other methods besides putting river water in the ladder (to attract natural steelhead) are being used to obtain NOR for breeding, such as hook and line sampling. Additional methods to collect NOR's include beach seining, and weirs. Areas for collection will include the mainstem MR and various tributaries to MR. Page 93.
Mad River Alliance	Mad River Alliance also encourages Hatchery Managers to follow the monitoring and evaluation performance indicators outlined in section 11.0 and described in table 23 regarding mating protocols, monitoring, and evaluation goals	We agree, and propose to continue breeding NOR x HOR or NOR x NOR when possible. The integration rate for NOR (pNOB) into MRH breeding program will be at least 50%, and will range from 50-100%. The guiding index for evaluating the breeding program will be the PNI (proportionate natural influence) and genetic analyses. We are striving to have a PNI of $\geq$ 0.50, which reduces domestication and

Public Comment Entity	Public Comment	CDFW Response
		allows for the natural environment to be the dominant selective force acting upon the steelhead population within the MR. We are also striving for genetic convergence between HOR and NOR fish. Page 92.
Mad River Alliance	To further reduce the negative impact of HOR on NOR we suggest Hatchery Managers, in coordination with CDFW staff and NMFS, conduct a complete Isolation by Distance Genetic Analysis within the whole Mad River basin and tributaries to monitor HOR impacts on NOR fish.	To date, there is no scientific information showing that MRH has specifically negatively impacted natural populations. However, we do believe that impacts are probable. We agree that basin wide genetic information of NOR's would provide great insights into the genotype of MR NOR steelhead. We are currently working on the details to conduct this type of study and survey. To reduce the negative impacts of HOR on NOR in the wild, we intend to have a PNI $\geq$ 0.50, and to always breed a NOR x HOR, and in some cases NOR x NOR. Page 100.
Mad River Alliance	We encourage earliest adoption of exclusive use of NOR broodstock as outlined in section 1.16 alternative 4, with the long term goal of improving NOR stocks to levels that well exceed the current dispensation point of 352, by an agreeable factor, as determined by NMFS and CDFW. In relation to this, we encourage MRH pursue the adoption of the coded wire tag proposal as outlined in section 11.0, *"A new proposal under consideration for a future revision of the HGMP recommends that the progeny from NOR x NOR and NOR x HOR will be tagged with coded wire tags (CWTs), and only these fish out of the total production will be tagged. … Upon return as adults, they would be used for the spawning matrix in preference to HOR x HOR. If sufficient numbers returned, the entire spawning matrix could be populated*	We are crossing NOR x HOR (50% integration rate), and when possible will cross NOR x NOR (100% integration rate). The range of integration will be 50 – 100%. A 50% integration rate will produce an acceptable genetic diversity based upon consultations with NMFS geneticist. We cannot exclusively breed NOR x NOR at this time due to lower collection of NOR fish. We are also using the PNI index as a guide for the necessary percentage of NOR fish (pNOB) used in the breeding program, and will increase the number of NOR's into the breeding program (beyond 50%) if necessary. The most current estimate (2013/14) of NOR Steelhead Trout returns to MR is 3,449 and for HOR the return is 4,336; therefore, we are well above the depensation

Public Comment Entity	Public Comment	CDFW Response
	with them and any other unmarked NOR broodstock. If insufficient numbers return, the additional NOR without the CWT would be used in the spawning matrix. HOR x HOR would be used only as a last resort. The CWT marking program need only be implemented for five or six years in order to rapidly diminish genetic divergence and jump start convergence (Free, pers. comm.). "	point (352 individuals). Unless triggered by future evaluation of genetic analysis, CWTs are not currently needed. CDFW is committed to breeding NOR x HOR by policy and NOR x NOR when possible; therefore production may be decreased if not enough NOR's are collected for broodstock. Since no HOR x HOR will be mated, CWTs marks would not be necessary. Pages 73, 76-77, 98.
Mad River Alliance	We recommend CDFW and NMFS coordinate, plan, and conduct a Fisheries Management and Evaluation Plan (FMEP), as required under the Endangered Species Act 4(d) Rules. Conducting a FMEP will reduce CDFW's legal risk and ensure proper monitoring of endangered and threatened species in the Mad River watershed. This should include all threatened and endangered species, including a full examination of Mad River estuarine species. (See attached species list on pages 3 & 4)".	CDFW is committed to preparing a Mad River Winter-run SH FMEP or a comprehensive NC DPS SH FMEP one year in the future from the approved MRH HGMP. This FMEP will address potential impacts from MRH and the angling public upon all listed fishes within the MR basin, and will include estuary areas. Page 55.
Mad River Alliance	*We encourage increased HOR bag limits as described in the HGMP: "NMFS has encouraged CDFW to consider a regulation against the return of landed HOR steelhead to the stream, or alternatively, increased angler education that encourages anglers to retain HOR steelhead and not release them back into the stream to potentially spawn naturally. CDFW proposed new angling regulations in 2009 to liberalize bag and possession limits to encourage anglers to harvest HOR steelhead. Although the bag limit may be raised to 4 HOR's per day to reduce pHOS and increase the PNI index, it is unlikely that CDFW will*	Results from Genetic Monitoring and determination of the PNI may cause a trigger for changes such as an increased bag limit proposal for regulation changes. Current direction from CDFW is against 'boutique" regulations unique to a specific river, rather an overall regulation simplification is desired. Additionally, if we increase the hatchery bag limit, then more natural fish would be captured and released. Furthermore, it is against CDFW law to 'waste fish' and if an angler didn't want to eat the captured fish and was forced to keep it, then that angler would break the law regarding wasting fish (CCRT14

Public Comment Entity	Public Comment	CDFW Response
	mandate retention of all HOR fish caught by anglers."	Section 1.87). However, in order to reduce pHOS, CDFW may install a sign at MRH encouraging anglers to keep HOR fish they catch, within daily bag and possession limit(s). Another way we can reduce pHOS is to strip all HOR females that return to MRH, which may happen if PNI is < 0.50. Page 6.
Mad River Alliance	We encourage Hatchery Managers to open the Ladder earlier in the season to increase the opportunity to trap NOR broodstock and expand the temporal spawning window.	This issue has two parts- 1) the fiscal capacity of the CDFW to begin operating the hatchery in December; and 2) the biological response to ladder use. We agree that delaying the opening of the ladder after the first week of January has definite deleterious effects for undesirable HOR spawner straying. We are planning on opening the ladder during the middle of December to allow for HOR fish to enter the hatchery ladder and facility. Obtaining the full scope of the run is desirable and we plan on opening the ladder in December, however, the river in dry years doesn't reach the entrance to the ladder. In dry years we could try other means of obtaining NOR broodstock. We also have specific start and stop dates for water use and discharge which must be complied with. Page 15.
Mad River Alliance	We encourage ongoing evaluation of the smolt to adult return ratios in an effort to reduce the impact returning HOR have on NOR. This will help to ensure a minimal proportion of HOR spawners in the wild.	Obtaining smolts from the wild is desirable, especially for estimating reproductive success (using genetic techniques) of strayed HOR parents, and in general for genetic composition of the NOR smolts that have survived all freshwater sources of mortality; however, the expense of running a smolt trap (to get NOR smolt to adult survival) is a lower

Public Comment Entity	Public Comment	CDFW Response
		priority than other monitoring projects. The current sonar work will tell us how many NOR and HOR adult Steelhead Trout return to Mad River, and allow for determining PNI. Production of smolts from MRH is at a very low level, and if we reduce the smolt output, then the fishery for hatchery adult Steelhead Trout will decline to un-feasible levels. If we see a much higher return rate of MRH smolt to adult, we could reduce the number of adults used for breeding purposes. Additionally, with respect to reducing the impact of HOR on NOR stock, integrating 50%$^{+}$ NOR in the MRH breeding program should give genetic congruence between HOR and NOR, and also allow for a PNI value $\geq$ 0.50. A PNI value $\geq$ 0.50 means that the dominant selective force on the steelhead population is the natural environment, and not the hatchery environment. PNI values $\geq$ 0.50 also help reduce domestication of steelhead raised in the hatchery. Page 17.
Mad River Alliance	We encourage Hatchery Managers to remove the gametes of all HOR that enter the hatchery before re-releasing them back to the river for angler opportunities	This is something we could possibly do in response to results from genetic analyses, if divergence (of HOR) isn't turning to convergence (to NOR) and/or if the PNI value is < 0.50. Stripping eggs from all HOR hatchery returners would be time consuming and expensive, but we will look into the logistics/feasibility of such actions. Stripping males of milt is more difficult because not all milt can be stripped, and holding males at MRH until the spawning run is over is not feasible due to excessive mortality, lack of holding area(s), lack of water available for storage, and cost(s) associated with pumping extra water. As a side note,

Public Comment Entity	Public Comment	CDFW Response
		anglers in general do not want to capture spawned out fish (run-backs) for a variety of reasons: lack of a strong fight, fish will not taste as good since it is not fresh (ie has been in river long enough to have single eggs), and the possibility of the fish dying while being fought. Page 78.
Mad River Alliance	We recommend any expired /dead HOR or NOR fish that have been spawned in the hatchery; once gametes have been removed, the fish carcasses should be returned to the river. This will serve to increase the Marine Derived Nutrient (MDN) inputs to the energy system of the watershed, which is an integral component for the production of macroinvertebrate populations and the aquatic food web".	We agree that carcasses can influence the production of macroinvertebrates and help drive the aquatic food web. We intend on taking carcasses (collected at MRH) upstream of the hatchery to put back into the river. However, the number of carcasses is low (<50) and will probably not increase nutrients to the stream to any measurable degree. Page 78.
Mad River Alliance	Thank you for taking the time to read our comments and recommendations. We are grateful for the opportunity to provide public comments on the Mad River Hatchery Genetics Management Plan, and are confident that CDFW and NMFS will implement the best plan that encourages the recovery of all endangered and threatened fishes found in the Mad River watershed.	Thank you for taking the time to read the draft MRH HGMP, and for your comments. We appreciate your comments and concerns, and feel that collectively, we can make MRH a better hatchery that provides an important recreational steelhead trout fishery, without jeopardizing natural stocks and the MR ecosystem. However, although the MR HGMP will facilitate better practices, the recovery of "all threatened fishes in the MR watershed" depends upon not just MRH operations, but on the habitat within the Mad River basin. In other words, MRH operations are not the cause for the ESA listing of CC Chinook Salmon, SONCC Coho Salmon, and the NC DPS for Steelhead Trout within the Mad River. Listing determinations are made at a broader geographic scale. We have to remember that MR is

Public Comment Entity	Public Comment	CDFW Response
		‘sediment and temperature’ impaired due to a legacy of land management practices and associated cumulative impacts. Our goal for the MRH is to enhance/conserve the NC Steelhead Trout DPS within the Mad River basin, while continuing to provide an important, recreational fishery for adult Steelhead Trout. Pages 4-5.