HATCHERY AND GENETIC MANAGEMENT PLAN
FOR
MAD RIVER HATCHERY
WINTER-RUN STEELHEAD

VERSION 1.0
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Prepared for:

National Marine Fisheries Service
Arcata, California

By:

California Department of Fish and Game

March 2006
Foreword

The Mad River Hatchery Genetic and Management Plan follows the format recommended by the National Marine Fisheries Service (NMFS) in the Updated July 2000 4(d) Rule Implementation Binder for Threatened Salmon and Steelhead on the West Coast (NMFS 2003). The NMFS North West Region’s Sustainable Fisheries Division provides an electronic HGMP template at www.nwr.noaa.gov/1hgmp/hgmptmpl.htm. The format headings and queries of this template are presented verbatim in the Table of Contents as Section 1.0 through 12.0 and in bold type within the body of this plan.

The List of Performance Standards and Indicators by benefit and risk for an integrated hatchery program are taken from the Artificial Production Review: Report and Recommendations of the Northwest Power Planning Council as suggested by NMFS for HGMP development (Smith 2000). This document is included by reference and can be viewed electronically on the web at http://www.nwcouncil.org/library/1999/99-15.htm.

This HGMP also uses terms and age class designations by fish size as defined by NMFS (Smith 2000); they are presented in Attachment 1 and 2, respectively. The term “wild” in this document is used to infer fish with naturally spawned parents.

The California Department of Fish and Game terminated Chinook and coho salmon production at Mad River Hatchery based on the recommendation of the Joint Hatchery Review Committee (NOAA 2001). The committee recommended that the hatchery develop salmonid captive rearing programs, as the need arises. There is no consideration for this action at this time, but should the need arise and funding become available, CDFG will amend this plan to include a salmon stock recovery program.
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<td>adipose fin-clip</td>
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<tr>
<td>BOF</td>
<td>Board of Forestry</td>
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<tr>
<td>BRT</td>
<td>Biological Review Team</td>
</tr>
<tr>
<td>CDFG</td>
<td>California Department of Fish and Game</td>
</tr>
<tr>
<td>cfs</td>
<td>cubic feet per second</td>
</tr>
<tr>
<td>CPUE</td>
<td>catch per unit effort</td>
</tr>
<tr>
<td>ESA</td>
<td>Endangered Species Act</td>
</tr>
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<td>ESU</td>
<td>evolutionarily significant unit</td>
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<tr>
<td>fpp</td>
<td>fish per pound</td>
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<td>Friends</td>
<td>Friends of the Mad River Fish Hatchery</td>
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<td>GIS</td>
<td>Geographic Information System</td>
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<tr>
<td>gpm</td>
<td>gallons per minute</td>
</tr>
<tr>
<td>mgd</td>
<td>million gallons per day</td>
</tr>
<tr>
<td>mg/l</td>
<td>milligram/liter</td>
</tr>
<tr>
<td>MOA</td>
<td>Memorandum of Agreement</td>
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<tr>
<td>NOAA</td>
<td>National Oceanic Atmospheric Administration</td>
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<tr>
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<td>NPDES</td>
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<td>North Coast Regional Water Quality Control Board</td>
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<td>PFMC</td>
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<td>SAR</td>
<td>smolt-to-adult return</td>
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<td>viable salmonid population</td>
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Section 1.0 Introduction

Under the authority of the Federal Anadromous Fisheries Conservation Act, the Wildlife Conservation Board and the United States Fish and Wildlife Service (USFWS) funded $1.25 million each for the construction of Mad River Hatchery. Unlike most terminal mitigation hatcheries, the State of California built this unique enhancement facility 12.2 river miles (20 kilometers) upstream of the Pacific Ocean and 63.4 river miles (101 kilometers) downstream of the Robert L. Matthews Dam in Trinity County.

The California Department of Fish and Game (CDFG) proposed an initial production level of 5,000,000 Chinook salmon smolts and one million coho salmon and steelhead yearlings, in combination. The initial goal of the hatchery was to provide 51,000 angler days of fishing and 270,000 pounds of salmon to the ocean fishery by planting north coast waters from the Mad River to the Oregon Border.


Similarly, Mad River Hatchery developed a summer-run steelhead program using non-indigenous Washougal River stock from Washington State (Will 1973a, 1973b) in addition to Eel River stock transferred from the Trinity River Hatchery (Will 1973c). The CDFG continued artificial propagation of this run until 1996. Fishery Managers terminated production of summer-run steelhead because the program failed to produce additional angling opportunities.

In 2000, Mad River Hatchery terminated production of Chinook salmon (Oncorhynchus tshawytscha) and coho salmon (Oncorhynchus kisutch) because of their listing as a threatened species, pursuant to the Federal Endangered Species Act (ESA). The federal government also listed winter-run and summer-run steelhead trout (Oncorhynchus mykiss, as threatened, but excluded Mad River Hatchery stock. The hatchery continued production, as well as the integration of natural stock into its broodstock at a rate of 3% each year (Zuspan 2002). In 20045/2005 and 2005/2006 seasons, the hatchery used adipose fin-clipped steelhead exclusively for broodstock. This HGMP proposes to reinitiate the annual integration of wild steelhead into hatchery broodstock to preserve genotypes, minimize inbreeding and outbreeding.
In 2000, NFMS reported Mad River Hatchery steelhead to be, in all likelihood, substantially diverged from the natural population due, in part, by the initial propagation of non-indigenous broodstock (Busby et al. 1996). Despite a close association of allozyme data, the Biological Review Team (BRT) expressed uneasiness about the introgression of hatchery fish and their potential ecological interaction with wild steelhead. The CDFG concurs, in theory, with the BRT’s assessment that exotic stock imports and hatchery practices decreases productivity and increase the hatchery component of a steelhead run. However, CDFG does not consider that stock history is the most reliable data for estimating similarity between hatchery and natural stocks (CDFG 2004a). The CDFG proposes the broad use of genetics and stock history, as well as life history and phenotypes to assure a more reliable delineation of stock divergence.

Population divergence results from genetic, physical or behavioral isolation of stocks over time. The annual integration of wild fish into Mad River hatchery broodstock and conversely, the genetic exchange of hatchery fish in nature maintain, in all likelihood, genetically similar winter-run steelhead. The Federal Register (June 28, 2005) reported that the BRT is currently considering the Mad River Hatchery winter-run steelhead for inclusion into the Northern California ESU.

The Joint Hatchery Review Committee (CDFG/NOAA 2001) concluded that hatcheries, despite some potential for adverse action to ESA-listed species, provide a significant societal and economic benefit to regional economies. Hatchery evaluation should include these factors when considering risk threshold assessment. The Mad River Hatchery undoubtedly supports a significant winter-run steelhead fishery and an economic boon to the regional economy. The hatchery also provides eggs for classroom incubators, tours for local schools, fishing access and a serene environment for people to browse or picnic.

In fiscal 2003/2004, statewide budget shortfalls required serious cutbacks to hatchery programs and CDFG reluctantly proposed to close Mad River Hatchery. In response, citizens, steelhead anglers, teachers, business and public representatives organized a Humboldt County non-profit organization called Friends of the Mad River Hatchery Board (Friends) to raise funds and organize volunteers to keep the hatchery open. The CDFG agreed to supply permanent personnel to oversee daily hatchery operations, train and supervise volunteers, respond to emergencies and supply additional staff during peak spawning periods. Friends agreed to secure funding and assure that the production of steelhead yearlings could come to fruition prior to spawning each year. In November 2004, Friends and CDFG memorialized the pact with a Memorandum of Agreement (MOA). Friends and the CDFG began the cooperative steelhead hatchery program in winter 2004.

The Joint Hatchery Review Committee (CDFG/NOAA 2001) recognized that properly functioning ecosystems are the foundation for threatened and endangered species survival. Mitigating the effects of logging, agriculture, urbanization, and water withdrawals in waters that support anadromous salmonids requires continuing attention and effort.
The NMFS approved a Habitat Conservation Plan for Humboldt Bay Municipal Water District for water storage in Ruth Reservoir, power generation at Mathew’s Dam, water conveyance via Mad River and withdrawal near Essex Station, Arcata, California. Similarly, Green Diamond Timber Company is negotiating Habitat Conservation Plan requirements with NMFS for its industrial timber operations in a large portion of the Mad River watershed. These plans, in addition to stream and watershed restoration activities, although positive, are slow to provide quantifiable benefit to salmon or steelhead populations.

Section 9(a) (1) of the ESA prohibits the take of listed steelhead, Chinook and coho salmon. However, the 4(d) rule of the ESA provides for the development of Hatchery Genetic and Management Plans (HGMP) as a means for lawful take of listed species for artificial propagation on the condition that hatchery operation avoids jeopardy and monitoring and evaluation activity assures Section 10 compliance.

This HGMP follows the guidelines recommended by NMFS (Smith 2000) for a steelhead augmentation facility. It also compliments the Steelhead Restoration and Management Plan for California, which focuses on restoration of native and naturally produced stocks. California’s steelhead management strategy includes: 1) restore degraded habitat 2) restore anadromy to historic habitat areas 3) frequent review of angling regulations to assure proper management and harvest rates of 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 (McEwan 1996).

In 2000, NMFS funded Mad River steelhead studies, pursuant to their North Coast Steelhead Memorandum of Agreement (MOA) with CDFG. The results of these studies indicate that hatchery fish make up over 90% of the steelhead population in Mad River. The primary reason for this disproportionate number of hatchery fish is due to poor instream habitat conditions. However, the failure of fisheries management to adhere to hatchery production goals and the historic random plantings of fry and fingerling steelhead throughout the basin may also be contributing factors.

Monitoring is necessary to provide a greater understanding of salmonid aquatic ecology, population abundance, as well as a means to evaluate interaction between hatchery-produced and naturally spawning salmon and steelhead stocks in Mad River. This HGMP includes the 1999 through 2003 study results conducted by the Steelhead Research and Monitoring Program in an effort to address program benefits and risks.

Monitoring programs are generally unfunded throughout the Pacific North West. The Independent Scientific Advisory Board’s Scientific Review Team Guidelines (Brannon 1999) recommended that hatchery budgets should include performance monitoring programs, where additional funds are not available. Accruing monitoring funds is a significant challenge for a large public facility, needless to say, impossible for small public/private cooperative hatchery program. Most, if not all, of the monitoring associated with this plan will be made in conjunction with the Action Plan for Monitoring.
California’s Coastal Anadromous Salmonids (Boydstun et al. 2004). This plan is unfunded, but includes revenue options that include redirection of CDFG and NMFS staff and funding sources, using CDFG administered grant funds or finding new or augmented State or Federal funding sources.

As an interim measure, until funding for genetic assessment and monitoring becomes available, CDFG proposes to maintain a sustainable fishery and assist in the conservation and recovery of natural salmonid stocks as follows:

1) Spawn steelhead over a period of six weeks and in representative proportion of hatchery return.

2) Maintain steelhead production at \( \leq 150,000 \) yearlings.

3) Spawn unmarked steelhead with hatchery broodstock and produce progeny from these matings to represent \( \geq 10\% \) annual hatchery production using the following protocol;
   a) Spawn 3 hatchery ♀ with 6 unmarked ♂ (2 ♂ per female).
   b) Spawn 3 unmarked ♀ with 6 hatchery ♂ (2 ♂ per female).
   c) Spawn 44 hatchery ♀ with 88 hatchery ♂ males (2 ♂ per female).
   d) Incubate eggs of each spawning pair separately and cull eyed-eggs to equalize family group contribution.

4) Mark all hatchery production with an adipose fin-clip

5) Adjust harvest levels to reduce the hatchery stray rate into spawning tributaries to \( \leq 10\% \)
Section 2.0 General Program Descriptions

2.1 Name of Hatchery or Program

Mad River Hatchery Winter-run Steelhead Program.

2.2 Species and Population (or Stock) under Propagation, and ESA Status

In 1996, NMFS proclaimed that steelhead in the Northern California ESU were at risk of becoming endangered (Busby 1996). In 1998, NMFS published a final determination for the Northern California ESU that stated steelhead would remain a candidate because the available scientific information and proposed conservation measures indicated a lower risk of extinction than at the time of the 1996 status review (NOAA 1998). The NMFS also excluded hatchery stocks in this listing determination. In response to the anticipated federal action, the State of California codified a MOA with NMFS to implement steelhead conservation measures to mitigate the need for a listing determination.

Subsequent to the MOA, the California Board of Forestry (BOF) failed to implement conservation measures, specifically changes to the California Forest Practice Rules that NMFS considered critically important in its decision not to list. The NMFS considered the BOF’s failure to take action as a breach of the MOA and reassessed the state and federal conservation measures that were in place to protect the ESU. Based on their reconsideration, NMFS listed naturally spawned steelhead in the Northern California steelhead ESU as a threatened species on June 7, 2000 (NOAA 2000). The NMFS considered hatchery steelhead nonessential for the recovery of the species and again excluded them from the listing due to their professed divergence from natural stocks and exotic origins.

In accordance with the Alsea Valley Alliance v. Evans decision in 2001, NMFS began status reviews for 26 listed salmon and steelhead ESUs including listing determinations for hatchery stocks. In June 2004, NMFS proposed listing ten ESUs of West Coast *Oncorhynchus mykiss*, including both resident rainbow trout and steelhead, using the Pacific salmon evolutionarily significant policy. This policy considered the biological evolutionarily significant unit to be a “distinct population segment” (DPS) and a species under the ESA.

The NMFS received three independent scientific reports in spring, 2005 in addition to a response from USFWS. The USFWS informed NMFS about the legal bases for the proposed listing determinations of the ten *O. mykiss* ESUs. The USFWS disagreed with NMFS’ ESU designation and recommended that listing determinations for steelhead be consistent with distinct population segment policy, which is common to both agencies. In addition, USFWS presented new information concerning the relationship of anadromous and resident *O. mykiss* stocks and ESU viability. On June 28, 2005, NMFS published its review of sixteen salmon populations, but extended the comment period for the ten *O. mykiss* ESUs for six months to evaluate new information, discuss management policy with USFWS and finalize the listing determinations based on the new information. The NMFS is considering inclusion of Mad River Hatchery steelhead within the Northern California ESU. The status and 4(d) rule prohibition of ten steelhead ESUs, including Mad River hatchery steelhead with an intact adipose fin remains unchanged in the interim.
2.3) Responsible Organization and Individuals

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**On-Site Operations Lead**

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

Friends of Mad River Fish Hatchery (funding and volunteer labor).

2.4 Funding Source, Staffing Level, and Annual Hatchery Program Operational Costs

The Mad River Hatchery operates with a budget of approximately $300,000. Money for hatchery operations is derived from CDFG non-dedicated and Sport Fish Restoration funds and $20,000 cash and $90,000 of in kind labor from Friend of Mad River Fish Hatchery. The CDFG staff includes a Fish Hatchery Manager II and Fisheries Technician. Two CalWorks employees and volunteers from Friends of Mad River Hatchery provide a significant portion of the hatchery work force.
2.5 Location(s) of Hatchery and Associated Facilities

The hatchery is approximately two miles south of Blue Lake, Humboldt County, on the left bank of the river, where Mad River Canyon emerges into the Blue Lake Valley. The geographic coordinates are:

- 40° 51’ 19.11” N
- 123° 59’ 23.41” W

The hatchery facilities include a fish ladder, four adult holding ponds and gathering tank (trap), spawning and incubator building, incubator equipment building, public restrooms, electrical control building, primary and secondary pumps, sumps and aeration systems, blower house, eight filters, ten 100-foot raceways, office and four residences. The hatchery also offers a large visitor parking area, public restroom, a serene meadow-like setting with picnic tables and wheelchair access to a fishing area.

2.6 Type of Program

The Salmon Hatchery Evaluation and Inventory Effects Report (NOAA 2004a) classified Mad River Hatchery as an Integrated Harvest Program because wild steelhead are spawned as broodstock on an annual basis (note: except for BY 2005 and BY 2006).

2.7 Purpose (Goal) of Program

The primary purpose of this program is to provide steelhead for harvest, as well as maintain the social, recreational, educational and economic benefit of Mad River Hatchery.

2.8 Justification for the program.

During the 1938 through 1963 period, Sweasey Dam fish ladder counts provided a time series, which showed a declining trend for the winter-run steelhead population. The population averaged 3,167 and 4,720 winter steelhead in the 1930 and 1940s, respectively. Steelhead ladder counts plummeted to 2,894 in the 1950s and 1,985 for the 1960 through 1963 period. The BRT concluded that the Northern California Steelhead ESU is likely to become endangered within the foreseeable future because of the high risk and moderately high risk, respectively, for the categories of abundance and productivity (NOAA 2003a). The NMFS specifically referenced the declining Sweasey Dam ladder counts, habitat loss, sedimentation and water diversions as the reason for their listing.

The impaired waters of the Mad River are incapable of producing steelhead at a level of abundance that supports a viable fishery. Instream conditions are such that the North Coast Regional Water Quality Control Board, pursuant to U.S. Environmental Protection Agency Section 303 (d) of the Clean Water Act, listed Mad River as an impaired watershed due to warm spring and summer water temperature, high levels of turbidity and sediment. In 2002, The Steelhead and Research Monitoring Program reported that hatchery-marked steelhead comprised 79% to 89% of the catch for the 1999 through 2001 seasons (Sparkman 2002a).
The Steelhead Report Card results for angler catch in the Mad River for the same period indicated that 79.4% of all steelhead observed were adipose fin-clipped. Based on these corroborating reports, it is evident that natural production is inadequate to support a viable steelhead fishery in Mad River.

The Mad River Hatchery promotes recreation, tourism and education for the local community, which results in a significant economic benefit to the regional economy (Driscoll 2005).

2.9 List of Program “Performance Standards”

The NMFS recommends the use of performance standards that Northwest Power Planning Council (NPPC 1999) published for the purpose of hatchery program benefit and risk assessment. The list of performance standards for an augmentation program that provides fish exclusively for harvest are presented verbatim from this publication, with minor exception. This plan excludes some indicators due, in part, to funding, feasibility or need. The Department of Fish and Game may reinstate them, as necessary, dependent on funding and staffing availability.

The Northwest Power Planning Council also recommends the inclusion of conservation hatchery guidelines that the Independent Science Review Team developed for each performance standard (Brannon et al. 1999). This HGMP excludes these guidelines because Mad River Hatchery is not a conservation facility.

The CDFG terminated Mad River steelhead monitoring and research activity due to state and federal budgetary constraints in 2002. In addition, many of the tasks identified in the Steelhead Restoration Management Plan in California have yet to come to fruition and there is no timeline for their implementation. The CDFG and NMFS cooperatively developed the Action Plan for Monitoring Coastal Anadromous Salmonids (Boydstun 2005) to authorize and fund California’s coastal salmonid monitoring program. This program intends to document the status of salmon and steelhead populations, as well as their habitats to meet ESA and CESA stock assessment needs. These assessments will include estimates of abundance for natural spawning populations, the proportion of hatchery fish in naturally spawning areas and conversely, the number or proportion of wild fish contributing to hatchery production.

Many of the recommendations for Recovery Strategy for California Coho Salmon (CDFG 2004) include provisions that also benefit steelhead due to habitat improvements. This HGMP incorporates Recovery Strategy for California Coho Salmon activities by reference.

Performance Standards Addressing Benefits of the Program

B1. Provide a predictable and stable opportunity for steelhead harvest.

B2. Enhance local, regional and state economies.

B3. Fulfill legal/policy obligations.
B4. Provide fish to satisfy legally mandated harvest in a manner that eliminates impacts on weak hatchery and broodstock wild populations.

B5. Achieve within hatchery performance standards.

**Performance Standards Addressing Risks of the Program**

R1. Implement a harvest management plan to protect weak populations where mixed fisheries exist.

R2. Assure that the Hatchery Steelhead Program does not exceed the carrying capacity of fluvial and estuarine habitats.

R3. Assess detrimental genetic impacts among hatchery vs. wild steelhead where interaction exists.

R4. Assure there is a predictable egg supply to avoid leading to poor programming of hatchery production.

R5. Production cost of hatchery program outweighs the benefit.

R6. Cost effectiveness of hatchery production is ranked lower than other actions in the basin.

R7. Evaluate habitat use and potential detrimental ecological interactions.

R8. Avoid disease transfer between stocks.

R9. Evaluate impact on life history traits and hatchery steelhead, from harvest and spawning escapement.

2.10.1 List of Program “Performance Indicators,” by “Benefits” and “Risks”

**Performance Standard B1: Provide a predictable and stable opportunity for steelhead harvest.**

Performance Indicators:

B1A Assess the contribution of the hatchery program to the Mad River steelhead recreational fishery.

1. Data collection will assess comparisons of 1999 through 2001 angler creel surveys with past and future steelhead report and results. Compare the following parameters:

   • Catch/unit effort/year
   • Catch numbers/harvest/year
   • Established baseline and compare with 5-year survey or one generation
**Performance Standard B2**: Enhance local, state, regional, and national economies.

Performance Indicators:

B2A  Established increasing trend in the value of harvest by documenting:

1. Sport fisheries value (cannot value in dollar terms only)
2. Opportunity or angler days translated to dollars
3. Production cost of hatchery fish harvested

B2B  Develop an overall economic impact assessment to compute direct, indirect and induced effects from Mad River hatchery production.

**Performance Standard B3**: Fulfill legal/policy obligations.

Performance Indicators:

B3A  Assure that hatchery broodstock needs are met ± 10 percent, in 4 out of 5 years.

**Performance Standard B4**: Provide fish to satisfy legally mandated harvest in a manner that eliminates impacts on weak hatchery and broodstock wild populations.

Performance Indicators:

B4A  Develop a harvest management plan for hatchery steelhead.

B4B  Compute ratio of wild fish to total harvest.

1. Evaluate trend analysis of hatchery contributions to harvest
2. Define an upper maximum number of wild fish allowed in the harvest

B4C  Document total harvest of the fishery.

B4D  Determine that total harvest of wild fish populations of concern do not exceed upper maximum of absolute number of wild fish.

B4E  Establish and meet natural population escapement goal ± 10%, in 4 out of 5 years, where applicable.

**Performance Standard B5**: Achieve within hatchery performance standards.

Performance Indicators:

B5A  Assure that statewide hatchery performance standards are met.
2.10.2 Performance Indicators Addressing Risks

**Performance Standard R1:** Implement a harvest management plan to protect weak populations where mixed population fisheries exist.

The implementation of a harvest management plan requires specific knowledge regarding the abundance and productivity of spawning populations. Managers recognize a need to monitor steelhead populations in order to identify adverse impacts to “weak stocks” that might require specific protection within the framework of a harvest management plan.

Performance Indicators:

- **R1A** Maximum allowable impact to weak population not exceeded ± 10%, 4 out of 5 years.

- **R1B** Monitor life history characteristics of weak populations for changes in the baseline by comparing Year 1 and after one generation.

- **R1C** Maintain unique life history characteristics by comparing baseline at Year 1 and after one generation.

- **R1D** Maintain unique life history characteristics by comparing the baseline at Year 1 and after one generation, measuring the following characteristics.
  
  a. Age composition  
  b. Fecundity (number) and size  
  c. Body size (size, length, weight, age, maturity index)  
  d. Sex ratio  
  e. Juvenile migration timing  
  f. Adult run-timing  
  g. Distribution and straying  
  h. Time and location of spawning  
  i. Food habits

- **R1E** Document that natural population escapement goal for specific species and populations is not adversely affected by ≥10 percent in 4 out of 5 years.

**Performance Standard R2:** Assure that the program does not exceed the carrying capacity of fluvial and estuarine habitats.

Performance Indicators:

- **R2A** Develop an appropriate monitoring and evaluation plan to assure the Mad River Hatchery Steelhead Program does not exceed carrying capacity in freshwater habitat.
1. Conduct snorkel survey to quantify microhabitat partitioning

2. Evaluate emigration rate, growth, food habits, condition factor, and survival rate

3. Conduct control vs. treatment carrying capacity evaluation, estimating fish#/m² by year class and habitat type

   R2B Develop an appropriate monitoring and evaluation plan to assure the Mad River Hatchery Steelhead Program does not exceed carrying capacity in the Mad River Estuary.

**Performance Standard R3: Assess detrimental genetic impacts among hatchery vs. wild steelhead, where interaction exists.**

**Performance Indicators:**

   R3A Initially, it is assumed that hatchery stray rate is a surrogate for a thorough and more complex measurement of outbreeding depression.

   1. Evaluate the hatchery population stray rate. NMFS Fisheries suggests it is desirable that hatchery stray rates be ≤ 5 percent for non-indigenous populations and < 20% for indigenous populations

   R3B More specific measurements to be implemented on a selected basis.

   1. Experimental design for evaluating genetic analysis of Mad River stocks

   2. Measure introgression by comparing allele frequencies between hatchery and wild steelhead. Implement an appropriate experimental design to quantitatively measure outbreeding depression

   **Performance Standard R4: Assure there is a predictable steelhead egg supply to avoid leading to poor programming of hatchery production.**

   **Performance Indicators:**

   R4A Achieve egg take goal in 4 out of 5 years.

   R4B Implement CDFG disease protocol in any event involving egg transfer to the hatchery.

   **Performance Standard R5: Production cost of hatchery program outweighs benefit.**

   **Performance Indicators:**

   R5A Evaluate the trend in ratio of hatchery juvenile production cost per cost of juvenile production from habitat projects by subbasin by hatchery per adult production.
Standard = Hatchery production cost ≤1 ±10%, in 4 out of 5 years

**Performance Standard R6:** Cost effectiveness of hatchery production ranked lower than other actions in subregion or subbasin.

Performance Indicators:

R6A  Develop cost effective methods of producing benefits to the recreational fishery.

1. Cost per angler per day
   - Self-sustaining population compared to hatchery production
   - Habitat improvement compared to hatchery production

2. Cost per experience (economic model)

3. Cost per fish harvested in the recreational fishery

R6B  Achieve the highest numerical ration of returning adults recovery to healthy viable resident population levels per cost action (habitat improvement or hatchery).

R6C  Achieve the highest ratio of intrinsic social value (satisfaction survey) of returning adults or recovery of healthy viable population levels per cost action (habitat improvement or hatchery).

**Performance Standard R7:** Evaluate habitat use and potential detrimental ecological interactions.

Performance Indicators:

R7A  Selected tributaries by subbasin and hatchery by species conducted comparative evaluation of pre- and post stocking after one generation.

1. Evaluating emigration rate of hatchery steelhead smolts and naturally reproducing anadromous populations

2. Compute growth rate, condition factor, and survival of 1, above

3. Compute prey composition in diet of 1, above

4. Compare rearing densities (#m²) by habitat, before and after stocking

5. Evaluate direct intra- and inter-specific competitive interaction between hatchery steelhead smolts and wild fish. (Such evaluations could include comparisons of natural-origin steelhead condition factor, diet, rearing density, and microhabitat use before and after the release of hatchery-origin steelhead)
6. Conduct snorkel surveys to quantify microhabitat partitioning by species, life stage and hatchery compared to wild stock

7. Determine predation rate on hatchery steelhead by fish, and by birds and mammals, if believed to be significant

R7B Extrapolate monitoring results to other tributaries or sub basins, as appropriate.

R7C Develop monitoring and evaluation plan for the Mad River estuary by implementing an experimental design recommended by NMFS Fisheries.

1. Design yearling planting strategy to reduce interaction between hatchery and wild stocks in the estuary, as necessary

**Performance Standard R8: Avoid disease transfer between stocks.**

Performance Indicators:

R8A Establish comparative annual sampling of disease in hatchery and wild populations.

R8B Comply with CDFG fish health policies and procedures (CDFG 2000b) and fish health protocols recommended by NMFS (Hard et al. 1992).

R8C Apply disease standards to stocking activities.

R8D Evaluate incidence of drug-resistant pathogens by comparing baseline in Year 1 and one generation, where necessary.

**Performance Standard R9: Evaluate impact on life history traits and hatchery steelhead, from harvest and spawning escapement.**

Performance Standard R1 addresses these indicators.

### 2.11 Expected Size of Program

#### 2.11.1) Proposed steelhead annual broodstock collection level

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

Mad River Hatchery steelhead program proposes to release 150,000 adipose fin-clipped winter-run steelhead yearlings each year. Due to the inexact methods for determining production numbers by weight counts (Leitriz 1980), a maximum production proposed by this plan is 150,000 yearlings. The California Department of Fish and Game will plant surplus fry from hatchery x hatchery matings in excess of that needed to produce 150,000 in Freshwater Lagoon, non-anadromous catchable trout water.
2.12 Current program performance, including estimated smolt-to-adult survival rates, adult production levels, and escapement levels. Indicate the source of these data.

Table 1 presents the estimated number of steelhead returns to the hatchery by age class for the 2000 through 2003 BYs based on the 2002/2003 age composition reported by Zuspan (2003).

Table 1. Age structure of adult steelhead entering Mad River Hatchery, 1989/1999 through 2002/2003 seasons.

<table>
<thead>
<tr>
<th>Season</th>
<th>Steelhead Returns to Mad River Hatchery</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Age 2</td>
</tr>
<tr>
<td></td>
<td>%</td>
</tr>
<tr>
<td>1997/1998</td>
<td>-</td>
</tr>
<tr>
<td>1998/1999</td>
<td>9.4</td>
</tr>
<tr>
<td>1999/2000</td>
<td>81.5</td>
</tr>
<tr>
<td>2000/2001</td>
<td>88.5</td>
</tr>
<tr>
<td>2001/2002</td>
<td>-</td>
</tr>
<tr>
<td>2002/2003</td>
<td>6.5</td>
</tr>
</tbody>
</table>

Brood Year comparison of hatchery steelhead returns by each age class with the corresponding number of yearling plants provides a means to estimate smolt to adult return (SAR). The SAR for the 1998, 1999 and 2000 brood years are 1.13, 0.50 and 1.49, respectively (Table 2).


<table>
<thead>
<tr>
<th>Year</th>
<th>Number of Yearlings Released</th>
<th>SAR</th>
<th>Age 2</th>
<th>Age 3</th>
<th>Age 4</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No.</td>
<td>SAR</td>
<td>No.</td>
<td>SAR</td>
<td>No.</td>
<td>SAR</td>
</tr>
<tr>
<td>1997/1998</td>
<td>248,077</td>
<td>183</td>
<td>0.07</td>
<td>1,131</td>
<td>43</td>
<td>1.12</td>
</tr>
<tr>
<td>1998/1999</td>
<td>263,495</td>
<td>271</td>
<td>0.01</td>
<td>2,529</td>
<td>86</td>
<td>0.04</td>
</tr>
<tr>
<td>1999/2000</td>
<td>368,082</td>
<td>171</td>
<td>0.05</td>
<td>5,005</td>
<td>147</td>
<td>0.06</td>
</tr>
<tr>
<td>2000/2001</td>
<td>225,549</td>
<td>588</td>
<td>0.25</td>
<td>1,131</td>
<td>86</td>
<td>0.04</td>
</tr>
<tr>
<td>2001/2002</td>
<td>261,147</td>
<td>588</td>
<td>0.25</td>
<td>5,005</td>
<td>147</td>
<td>0.06</td>
</tr>
<tr>
<td>2002/2003</td>
<td>241,167</td>
<td>287</td>
<td>0.08</td>
<td>2,529</td>
<td>86</td>
<td>0.04</td>
</tr>
</tbody>
</table>
Zuspan et al. (2002) estimated that 15,745 (91.7%) of the 17,164 winter-run steelhead in Mad River were of hatchery origin in the 2000/2001 season. Assuming the age structure for marked fish returns at Mad River Hatchery in 2000/2001 represented the total population, the hatchery population was comprised of 1,936 age two, 12,832 three and 976 four year-old steelhead. Based on BY 1999, 2000, and 2001 plants, the SARs for age-two, three and four steelhead are 0.52, 4.9 and 0.39, respectively (Table 2). Zuspan et al. (2002) reported that 1,419 naturally spawned steelhead represented approximately 44% of the mean steelhead count (3,218) at Sweasey Dam over a 25-year period.

Busby et al. (1996) reported summer-run and winter-run steelhead are more genetically similar to each other than to the same run type in another basin. This indicates that summer-run steelhead did not descend from a common ancestral source and are therefore not a unique genetic unit. Thus, summer-run and winter-run steelhead are collectively one population within the Northern California ESU.

Table 3 illustrates the summer-run steelhead counts for the period of 1994 through 2004. The number of river miles surveyed for summer steelhead changed each year based on logistics and available personnel, which explains some of the population variability between years. The average run size for the period of record is 302 adult summer steelhead. There is an apparent resurgence in summer steelhead population abundance since the BY 2001.

<table>
<thead>
<tr>
<th>Year</th>
<th>Number of Adults</th>
<th>Number of ½ pounders</th>
<th>Year</th>
<th>Number of Adults</th>
<th>Number of ½ pounders</th>
</tr>
</thead>
<tbody>
<tr>
<td>1994</td>
<td>287</td>
<td>172</td>
<td>2000</td>
<td>80</td>
<td>54</td>
</tr>
<tr>
<td>1995</td>
<td>569</td>
<td>21</td>
<td>2001</td>
<td>171</td>
<td>10</td>
</tr>
<tr>
<td>1996</td>
<td>515</td>
<td>26</td>
<td>2002</td>
<td>197</td>
<td>92</td>
</tr>
<tr>
<td>1997</td>
<td>126</td>
<td>12</td>
<td>2003</td>
<td>480</td>
<td>5</td>
</tr>
<tr>
<td>1998</td>
<td>201</td>
<td>20</td>
<td>2004</td>
<td>617</td>
<td>8</td>
</tr>
<tr>
<td>1999</td>
<td>85</td>
<td>25</td>
<td></td>
<td></td>
<td>No data</td>
</tr>
</tbody>
</table>

2.14 Expected duration of program.

The CDFG proposes to operate Mad River Hatchery for a winter-run steelhead program indefinitely.

2.15 Watersheds targeted by program.

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

**Alternative 1. Terminate Mad River Hatchery Steelhead Program**

Termination of artificially propagated steelhead removes any possibility for introgression with natural stocks and avoids all potential for adverse ecological interaction by hatchery fish with naturally spawned steelhead Chinook or coho salmon. However, the difference between hatchery and natural winter-run steelhead genetic composition remains unresolved and in need of clarification to direct hatchery operations and fisheries management. In addition, restoration efforts have not improved instream habitat in Mad River to the extent that naturally spawned steelhead are at a level, which is capable of maintaining a viable fishery. Then consequence of terminating Mad River Hatchery steelhead production is abolishment of a harvest fishery and significant adverse economic impact on the local economy.

This HGMP proposes annual production of 150,000 steelhead yearlings at Mad River Hatchery. However, CDFG and NMFS shall review hatchery production goals as new scientific information becomes available or they identify significant adverse genetic and ecological impacts to natural salmonid stocks. In addition, co-managing agencies and stakeholder groups should regularly meet every six years to review hatchery goals and CDFG should review fishing regulations every three years. Zuspan et al. (2002) reported an 88.5% stray rate for hatchery steelhead. Daily bag limits should be regulated to maintain a straying rate in spawning tributaries of $< 10\%$ for hatchery steelhead.

**Alternative 2. Change from an Integrated Harvest to Integrated Recovery Program**


Lynch (2004) proposed a rationale for hatchery management in the absence of information. He stated that the number of spawning individuals (effective population size) for a total population of 1,000 should be at least several hundred fish. This option has a significant adverse impact on the 1,419 (estimated for BY 2001) natural spawning population within the Mad River (see Section 2.13). In addition, conversion of this Harvest Program to a Recovery Program using only natural stocks would result in take prohibitions of hatchery steelhead. This alternative is not consistent with the Fishery Management goals outlined in the Strategic Plan for Management of Northern California Steelhead (CDFG 1998).
Section 3.0 Program Effects on ESA-listed Salmonid Populations

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

The California Department of Fish and Game possesses the following authorizations for research and scientific studies in the Mad River Basin.

Section 10 (a)(1)(A) Permit Number 1067 (modification 3) - coho salmon

Interim 4(d) Rule Compliance Provision - Chinook salmon and steelhead

3.2 Provide descriptions, status, and projected take actions and levels for NMFS ESA-listed natural populations in the target area.

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

Three federally threatened salmonids present within the Mad River Hatchery project area are:

Chinook Salmon California Coast ESU

Coho Salmon Southern Oregon/Northern California ESU

Steelhead Northern California ESU

Chinook Salmon Northern California Coast ESU.

Adult Chinook salmon move into the Mad River estuary as early as September, but most migrate upstream with flow from October through January. Ocean residence can be from one to seven years, but most Chinook salmon return to their natal waters to spawn after two to four years in the ocean (Moyle 1976).

Chinook salmon spawn in coarse gravel, both in the main channel and tributaries. However, CDFG documented spawning in the main channel above tidewater under drought conditions (Preston 1993, 1994, 1995, 2000). Eggs develop in 60 days, depending on water temperature, and alevin remain in the gravel for several weeks and emerge from March through April (Moyle 1976).

Unlike the year-long residence life history of coho salmon and steelhead, Chinook salmon inhabit freshwater from two to four months and some fry move downstream soon after emerging from the gravel. Smolts emigrate primarily in May through June and have a better chance of survival from intra- and interspecific predation and competition due to their larger size. Steiner (1998) reported competition during between steelhead 1+ and chinook fry on the Eel River.
Reimers (1971) reported a significant smolt to adult survival from juveniles that remained in the estuary for extended periods. The additional rearing period resulted in additional growth and a subsequent entry into the ocean in better condition.

**Coho Salmon (Southern Oregon /Northern California ESU)**

Coho salmon enter the Mad River during November and spawn November, December and possibly through January (Zuspan et al. 2002). Weitkamp et al. (1995) reported that some coho salmon in the SONCC ESU migrate as late as March. The coho salmon life history is quite rigid, with a relatively fixed three-year life cycle. Most spawners return to spawn at age three after spending 18 months in the ocean, but some sexually mature males (grilse or jacks) return after six months in the ocean. Coho salmon age-four adults are less common in waters south of British Columbia.

Generally, coho salmon enter Mad River sexually mature and migrate into small tributaries to spawn. Water temperature dictates the duration of egg incubation, which varies from 35 to 50 days (48 days at 48 degrees Fahrenheit). Egg survival and fry emergence depends on many factors including gravel size, river flow, sediment, temperature and dissolved oxygen. Emergent fry move to shallow or slow water areas and disperse to deeper water, as they grow larger. Coho salmon also occupy riffles and shallow water niches before they move into pools as larger fish. Allee (1981) and Larkin (1956) documented adverse social interaction and competition between coho salmon and steelhead juveniles. Competition for preferred pool microhabitat occurs in streams where both species are present because coho salmon are more aggressive and territorial compared to juvenile steelhead (Allee 1981).

Water temperature and adequate food supply are key elements for growth and freshwater survival of juvenile coho salmon. Juvenile coho salmon require site-specific microhabitat, usually deep pools with large downed logs. Nickelson et al. (1992) reported that coho salmon alter their seasonal use of habitat, that is, they rear in main channel pools during summer and use backwater areas during high flow events. Coho salmon emigrate from April through June, and almost exclusively at age 1+.

Coho salmon status reviews identify the condition of freshwater habitat as a considerable deterrent to their recovery. Adverse factors affecting habitat are sediment, the absence of large wood elements or other suitable structure, and water quality. Poor water quality consists of either pollution or elevated water temperature in excess of growth and survival tolerances for coho salmon. Temperature in excess of 21 °C or 70 degrees Fahrenheit (°F) is considered detrimental to coho salmon and 17.7 °C (64 °F) is considered the maximum tolerance for natural fish in the wild (Welsh et al. 2000). Summer water temperatures often approach a detrimental level in the main channel of the Mad River in early through Mid October (HBMWD 1990-2000). Generally, production is limited to tributaries within the project area, but Trinity and Associates (2003) reported schools of 100-200 coho salmon in deep runs below the hatchery in summer 2002. This was the first observation of large numbers of coho salmon since the surveys began in 1996. Trinity and Associates (2003) reported that the occurrence of coho salmon in the main cannel was the theoretical result of density dependent downstream migration from fully seeded tributary streams.
Steelhead (Northern California ESU)

Steelhead in Mad River display three distinct life histories. Summer-run adult and half-pounder steelhead migrate in spring and summer, hold over in pools below a natural boulder roughs near Humbug Creek (RM 60) and spawn the following winter season. Half-pounder steelhead are immature fish that generally return to freshwater after two to four months in the ocean. Winter-run steelhead enter freshwater during high flow events in fall and winter. Generally, steelhead return to their natal waters and spawn from January through March. Straying is common throughout the basin. Resident juvenile rainbow trout occupy waters above natural barriers and Matthew’s Dam.

Busby et al. (1996) reported the risk factors for the Northern California ESU included freshwater habitat deterioration due to sedimentation and flooding related to land management practices. In 2002, the North Coast Regional Water Quality Control Board, pursuant to the Clean Water Act, listed the Mad River Basin as an impaired watershed for sedimentation and siltation. Fine sediment adversely affects egg survival (Bjornn 1969, Bjornn et al. 1974) and reduces pool volume.

Young-of-the-year steelhead occupy cool, shallow riffle habitat and larger 1+ fish occupy pools that provide adequate food and cover. The intensity of adverse interaction between natural salmonids and hatchery yearlings during freshwater residency is unknown, but could be significant based on the close relationship between survival from smolt to adult ratio and carrying capacity (Nickelson 1986).

Steelheads spawn in riffles within headwater tributaries. Spawning habitat preference for steelhead is 0.2 to four inch diameter gravel in water depth of six inches to two feet and velocity of two feet/second. Egg survival is dependent on gravel permeability, which is considered poor in the Mad River due to the high level of fine sediment.

Steelhead in the Northern California ESU reside in freshwater from one to four years before moving into the ocean, but most emigrate as 1+ and fewer as age 2+ (Shapovalov and Taft 1954). Sparkman (2003) reported that 11,455 and 14,284 age 1+ steelhead migrated to out of the Mad River in the 2001 and 2002 season, respectively. For the same period, Sparkman (2003) reported 41,375 and 63,918 age 2+ steelhead emigrated to the ocean. In 2001, the peak migration for age 1+ and 2+ steelhead occurred in June-July and April-May, respectively. Smolts emigrate between February and July depending on water temperature and flow.

Comparisons of annual juvenile screw trap catches for 2001 and 2002 illustrate a minor temporal overlap between hatchery yearling and naturally spawning 2+ steelhead, which indicates a rapid migration of hatchery yearlings following release (Sparkman 2002b, 2003). The studies also reported that hatchery fish did not behave like wild fish in stream positioning and downstream migration nor were there any indications of residualism.
3.2.2 Status of NMFS ESA-listed salmonid population(s) affected by the program.

Describe the status of the listed natural population(s) relative to “critical” and “viable” population thresholds.

Steelhead

The NMFS listed naturally spawned steelhead in the Northern California ESU as threatened because of perturbations to the nature environment on which they depend and low abundance. Busby (1996) reported that impacts to naturally spawned steelhead within the Mad River Basin include hatchery production, as well as the loss of habitat above Matthews Dam.

Naturally spawned steelhead abundance estimates are available for 1938 through 1963 from Sweasey dam ladder counts. The winter-run population averaged 3,167 and 4,720 steelhead in the 1930 and 1940s, respectively, declined to 2,894 in the 1950s and 1,985 for the 1960 through 1963 period. Zuspan (2002) reported a winter-run run size estimate of 1,419 naturally spawned steelhead, which was 8.3% of the 2000/2001 population and 44% of the 25-year average count at Sweasey Dam.

Since 1971, Mad River Hatchery recorded the numbers of returning adults each year; however, these counts are “relative estimates” because the attraction mechanism for the fish ladder changed over time from wooden weir to an electrical field and finally, a dysfunctional cement weir. In addition, Zuspan et al. (2002) reported that stock fidelity to Mad River Hatchery was 11.5% for BY 2001.

The NMFS (NOAA 2003a) BRT reported the steelhead status in the Northern California ESU included two major sources of uncertainty, the lack of run size data in the Northern California ESU and the lack understanding regarding the genetic heritage of winter-run steelhead at Mad River Hatchery. Generally, allozyme data closely associates natural and hatchery steelhead stocks in Mad River and they in turn, collectively with Eel River steelhead. The affects of hatchery steelhead on risk categories for a Viable Salmonid Population (VSP) in the Northern California Steelhead ESU are neutral or uncertain regarding abundance, productivity, spatial structure and diversity.

Coho Salmon

Coho salmon are generally limited to tributaries below Wilson Creek (RM 40). The Lindsay Creek watershed supports the largest population of coho, but they are present in low numbers in North Fork Mad River, Mill, Warren, Hall, legit, Powers, Maple and Canon creeks.

For the period of 1986 through 1991, Brown et al. (1991) reported coho presence in 8.6% of the twenty-three historic coho streams within the Mad River Watershed. The CDFG (2002) conducted a second review of all available data for the same period studied by Brown et el. (1991) and reported coho salmon present in 34.8% of the streams. In comparison, data confirmed presence in 60.1% of Mad River coho salmon streams for the recent period of 1996 through 2001. Although coho salmon are more widely distributed in recent years,
status reviews conclude that the naturally spawning coho salmon population abundance in
the SONCC are unable to adequately respond or recover from variation in stochastic
environmental and/or habitat conditions. Restoration efforts have restored some spawning
and rearing habitat in Mad River coho salmon tributaries, which may be the reason for
increased spatial distribution within the basin.

The Pacific Fisheries Management Council reports the historic coho salmon counts in
Canon Creek ranged from zero to 56 from 1963 through 2004 (PFMC 2005). However,
adult coho counts are difficult to make in small streams on the north coast because the
escapement numbers are low and water clarity is poor when coho salmon are present. This
was evident in 2000/2001, when surveyors saw only two coho spawners in Canon Creek,
but caught 20 fish at a weir near the stream mouth.

The Biological Review Team concluded that coho salmon in SONCC ESU demonstrated a
low, but increasing trend in population size. Despite the slight increase in abundance,
NMFS (NOAA 2004a) concluded that coho salmon in the SONCC ESU are likely to
become endangered within the foreseeable future. The SHEEIR (NOAA 2004b) reported
neutral or uncertain hatchery effects to VSP risk categories of productivity, spatial structure
and diversity. The Artificial Propagation Evaluation Workshop Report (NOAA 2004b)
credited the high level of coho salmon abundance within the California portion of the
SONCC ESU to state hatchery programs.

Chinook Salmon

Based on commercial salmon shipping reports in the Arcata Union, Ridenhour (1961), as
cited by Trinity and Associates (2003), reported that the Mad River produced a historical
population of 10,000 Chinook salmon, but declined to approximately 5,175 by 1958.
Chinook salmon population estimates for the Mad River are unavailable due, in part, to the
removal of Sweasey Dam. The CDFG biologists make infrequent Chinook salmon
escapement estimates for Canon Creek and North Fork Mad River as an index to population
abundance. Since 1963, the population estimates for Canon Creek ranged from zero to 514
adult Chinook salmon (PFMC 2005). The Chinook salmon returns to Mad River Hatchery
are not reflective of the population due to the inconsistency of diversion mechanisms and
techniques used to gather broodstock over the history of the project as discussed previously.

There are no data available to assess the interaction between hatchery production and
natural Chinook salmon stocks. The BRT found moderately high risks for all VSP risk
categories for the California Coast ESU due, in part, to the lack of quantifiable information
and the uncertainty of the data regarding the status of the Chinook salmon population.

Provide the most recent 12 year (e.g. 1988-present) progeny-to-parent ratios, survival
data by life stage, or other measures of productivity for the listed population. Indicate
the source of these data.

Zuspan et al. (2002) reported a run size estimate for Mad River of 1,419 wild and 15,745
hatchery steelhead in 2000/2001. Table 4 presents the number of juveniles caught by screw
trap and population estimates for Mad River in spring, 2001 and 2002. Sparkman (2002b,
2003) estimated the juvenile steelhead numbered $11,455 \pm 45\%$ and $14,284 \pm 13.0\%$ yearlings, respectively, in 2001 and 2002. For these same years, age 2+ steelhead numbered $63,918 \pm 55\%$ and $41,375 \pm 39.6\%$, respectively. The number of age 2+ in 2001 and 2002 was similar. However, the yearlings in 2002 were approximately 1.2 times more abundant numerically than their counterparts in 2001.

Table 4. Number of juvenile steelhead caught by screw trap and their respective population estimates for Mad River in 2001 and 2002.

<table>
<thead>
<tr>
<th>Duration of Study</th>
<th>Species</th>
<th>Number of Trapped Steelhead Trout</th>
<th>Population Estimate</th>
</tr>
</thead>
<tbody>
<tr>
<td>March 30-July 14</td>
<td>1+</td>
<td>749</td>
<td>11,455 \pm 45%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>14,284 \pm 13.0%</td>
</tr>
<tr>
<td>March 20-July 19</td>
<td>2+</td>
<td>1,249</td>
<td>63,918 \pm 55%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>41,375 \pm 39.6%</td>
</tr>
</tbody>
</table>

*Carlson Estimate (Carlson et al. 1988)

Provide the most recent 12 year (e.g. 1988-1999) annual spawning abundance estimates, or any other abundance information. Indicate the source of these data.

Zuspan et al. (2002) reported a run size estimate of 1,419 wild and 15,745 hatchery winter-run steelhead in the Mad River for the 2000/2001 season. Table 5 illustrates the number of winter-run steelhead returns to Mad River Hatchery for the period of 1971 through 2005. Summer-run steelhead returns from 1994 to 2004 were previously presented in Table 3.

Provide 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.

The CDFG operated a counting weir on Canon Creek during the 1999/2000 and 2000/2001 seasons and estimated that 63\% (39/62) and 62\% (18/29), respectively, of the steelhead trapped were hatchery origin. The survey also found that 27 and six artificially propagated steelhead in the 1999/2000 and 2000/2001 seasons, respectively, were previously caudal fin hole-punched, which means they had entered Mad River Hatchery earlier in the season. In 1999/2000, 25\% (2/8) of all steelhead captured at Big Bend Weir, which is approximately 27 miles upstream of the hatchery, were adipose fin-clipped (Zuspan et al. 2002).

3.2.3 Describe 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.

Historical Chinook and coho salmon returns to the hatchery averaged 375 and 252,
respectively. The average return of salmon to the hatchery from BY 1993 through BY 2005 is 45 coho salmon and 34 Chinook salmon. The absence of a functional diversion weir significantly reduced the number of salmon returns the hatchery; for example, one Chinook and zero coho salmon entered the hatchery in 2004/2005 season.

For the same period, returns to the hatchery ranged from 1,396 to 11,520 and averaged 5,443 steelhead. However, prior to approximately 1997/1998 steelhead were not marked as hatchery returns when workers released them back into the Mad River. Many fished returned to the hatchery trap multiple times, which inflated total hatchery return estimates.

The CDFG marked yearling steelhead production with an adipose fin-clip staring in 1999; therefore, hatchery workers could not separate wild from artificially propagated steelhead until 2001/2001. The average number of unmarked returns to the hatchery in BY 2001 through BY 2005 are 8, 238, 54, 0 (no trapping) and 15 steelhead.

Table 5. Number of steelhead, Chinook and coho salmon returns to Mad River Hatchery from BY 1972 through BY 2005.

<table>
<thead>
<tr>
<th>Season</th>
<th>Coho</th>
<th>Chinook</th>
<th>Steelhead</th>
<th>Season</th>
<th>Coho</th>
<th>Chinook</th>
<th>Steelhead</th>
</tr>
</thead>
<tbody>
<tr>
<td>1972/1973</td>
<td>466</td>
<td>1,036</td>
<td>52</td>
<td>1989/1990</td>
<td>256</td>
<td>46</td>
<td>1,027</td>
</tr>
<tr>
<td>1983/1984</td>
<td>87</td>
<td>437</td>
<td>838</td>
<td>2000/2001</td>
<td>17</td>
<td>11</td>
<td>1,396</td>
</tr>
<tr>
<td>1987/1988</td>
<td>953</td>
<td>846</td>
<td>4,303</td>
<td>2004/2005</td>
<td>0</td>
<td>1</td>
<td>1,865</td>
</tr>
</tbody>
</table>
3.2.4 Describe the activities that may lead to the take of listed salmonid populations in the target area, including how, where, and when the take may occur, the risk potential for their occurrence, and the likely effects of the take.

There is an inherent risk of mortality for adult steelhead during trapping and temporary confinement in hatchery holding ponds. Hatchery personnel sort trapped fish at regular intervals to reduce trapping and holding mortality to approximately ≤ 3%. The hatchery traps very few salmon because the fish ladder is not open during the salmon spawning season.

The spawning matrix in this HGMP includes nine (six male and three female) unmarked steelhead. The CDFG releases all steelhead after they recover from the fish anesthetic with few, if any, mortalities. Fertility rate from six lots of steelhead taken in 2004/2005 ranged from 81% to 93%. Survival from green egg to smolt release is ≥ 75%. The mortality rate by progeny of natural x hatchery matings life stage is approximately 9,956 eggs, fry and fingerlings, in combination.

This plan addresses the Mad River fishery because incidental take of wild steelhead occurs from anglers fishing for Ad-marked hatchery fish. State and Federal regulations prohibit the take of natural steelhead, Chinook and coho salmon in Mad River. Despite complete angler compliance with regulations requiring release of all wild salmon and steelhead, the potential for incidental hooking of wild stocks is inevitable. The estimated incidental angler take of naturally spawned steelhead each year is approximately ≤10 fish, based on the hooking mortality reported by Hooten (1991). The BRT (2005) reported that despite the closure of many fishing areas and implementation of catch and release requirements reduced extinction risk, but the risk reduction could not be measured due to the absence of natural abundance estimates. Zuspan (2002) reported an estimated naturally spawning population of approximately 2000 steelhead. A take of steelhead by hooking mortality is ≤ 0.5% of the total population. Clearly, anglers can not be considered a part of the extinction risk for Mad River winter-run steelhead.

Monitoring and evaluation activities include the capture, handling, marking and tissue sampling of listed adult and juvenile salmonids. Section 10 Permit 1067 (modification 3) permits the take of coho salmon. The NMFS granted CDFG an Interim 4(d) Rule Compliance Provision for steelhead and Chinook salmon. Monitoring activities proposed by this plan do not exceed the take limit for listed species authorized by NMFS for scientific research and monitoring by CDFG.

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

There is potential harm of naturally spawned steelhead, Chinook and coho salmon because of adverse interaction with hatchery production, specifically predation of wild fry by larger hatchery fish (Allee 1981, Larkin 1956). Researchers have not studied the interaction between natural salmonids and hatchery yearlings during freshwater residency in the Mad River. However, Sparkman (2002b, 2003) reported rapid emigration of hatchery steelhead after release and a low rate of residualism. These results suggest aversion of adverse ecological action by hatchery production.
Provide projected annual take levels for listed fish by life stage (juvenile and adult) quantified (to the extent feasible) by the type of take resulting from the hatchery program (e.g. capture, handling, tagging, injury, or lethal take).

An average of 79 wild winter-run steelhead entered Mad River Hatchery from BY 2001 through BY 2005. The total return of wild winter-run steelhead ranged from eight to 238 fish. Mad River Hatchery personnel will, in all likelihood, trap, sort and release <100 wild steelhead in any given year. Mad River Hatchery will spawn only nine unmarked steelhead each year for egg procurement. Hatchery personnel release spawned-out steelhead immediately after recovery from anesthesia with negligible mortality, if any.

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

In the event that take occurs or conditions are such that excess take is imminent outside the parameters of this plan, CDFG will notify NMFS within 48 hours describing the circumstances of the unauthorized mortality, including an evaluation plan with techniques and procedures to prevent further take or the need for amendment to hatchery operation outlined in this HGMP.
Section 4.0  Relationship of Program to Other Management Objectives

4.1  Describe Alignment of the Hatchery Program With Any ESU-Wide Hatchery Plan or Other Regionally Accepted Policies. Explain Any Proposed Deviations from the Plan or Policies.

The Mad River Steelhead Program conforms to the provisions of the CDFG/NOAA MOA. This agreement codifies a collaborative effort between co-managing resource agencies for conservation efforts for the Northern California ESU, including steelhead within the Mad River Hydrologic Unit. This agreement also compliments the conservation measures outlined in the California Strategic Plan for Steelhead Trout. This plan protects wild steelhead, provides harvest opportunity for hatchery fish, develops monitoring activities and proposes angling regulations based on the abundance of adipose fin-clipped steelhead.

4.2  List All Existing Cooperative Agreements, Memoranda of Understanding, Memoranda of Agreement, or Other Management Plans or Court Orders Under Which Program Operates.

Memorandum of Agreement between State of California and the National Marine Fisheries Service

Memorandum of Agreement between State of California and Friends of Mad River Fish Hatchery Board

California Steelhead Restoration and Management Plan

Recovery Strategy for California Coho Salmon

California Strategic Plan for Steelhead Trout

4.3  Relationship to Harvest Objectives

Mad River Hatchery provides a unique harvest opportunity within the Northern California ESU for non-listed hatchery steelhead. The primary purpose of the Mad River Hatchery Steelhead Program is to sustain a viable harvest fishery. This plan does not include harvest objective for any listed species of steelhead, Chinook or coho salmon in Mad River. Fishing regulations require the immediate release of any incidental bycatch of listed species.

4.3.1  Describe Fisheries Benefiting from The Program, and Indicate Harvest Levels and Rates for Program-Origin Fish for the Last Twelve Years (1988-99), if available.

The California Department of Fish and Game conducted three extensive Mad River creel surveys in 1973/1974, 1999/2000 and 2001/2002 seasons. The results of these creel surveys, including angler effort, estimated total catch, catch per unit effort (CPUE), total hatchery catch and harvest rate (where possible) are presented in Table 6.

<table>
<thead>
<tr>
<th>Season</th>
<th>Angler Effort (hours)</th>
<th>Estimated Total Catch</th>
<th>Catch/Unit of Effort</th>
<th>Hatchery Stock Total</th>
<th>Hatchery Stock Harvest</th>
</tr>
</thead>
<tbody>
<tr>
<td>1973/1974</td>
<td>30,990</td>
<td>6,719</td>
<td>0.217</td>
<td>no mark</td>
<td></td>
</tr>
<tr>
<td>1999/2000</td>
<td>62,837</td>
<td>7,288</td>
<td>0.116</td>
<td>6268</td>
<td>2,430</td>
</tr>
<tr>
<td>2001/2002</td>
<td>88,009</td>
<td>18,015</td>
<td>0.205</td>
<td>16,033</td>
<td>5,484</td>
</tr>
</tbody>
</table>

1 steelhead CPUE only

Sparkman (2002a) reported the steelhead CPUE in 2002 for Mad River was considerably higher than the Smith River (0.07) or Trinity River (0.9) in 2000/2001. The data also indicates that anglers release most steelhead, regardless of origin. Sparkman (2002a) also reported good compliance of take prohibitions for listed species. Anglers incidentally caught (and released) a total of 17 and zero coho salmon in Mad River, respectively, in the 1999 and 2001 fishing seasons. For the same period, anglers released 68% of all Chinook salmon (n = 597) prior to their listing and all after take was prohibited.

The California Department of Fish and Game initiated a Steelhead Report Card in 1993. However, the Steelhead Report Card data does not allow the development of statistical catch estimates. The Steelhead Report Card results are available for naturally spawned and hatchery fish for the years 1993-1995, 1997, 1998 and 1999, but only the 1999 results have comparable creel survey data. Table 7 presents these results. The angler report cards received by CDFG for Mad River indicate 103 anglers made 632 trips and released 97.4% of the 191 wild and 60% of hatchery steelhead in 1999. Creel clerks accounted for 498 steelhead on 82 of the 152 available fishing days during the 1999/2000 season, but anglers only reported a total catch of 710 steelhead. The Steelhead Report Card Project is making an effort to compare steelhead report card with creel survey results for future harvest estimates.

Table 7. Summary of angler report card results for the 1999/2000 season in Mad River.

<table>
<thead>
<tr>
<th>Method</th>
<th>Number of Anglers</th>
<th>Angler Effort (hours)</th>
<th>No. Trips</th>
<th>Steelhead (kept/released)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Report Card</td>
<td>103</td>
<td>n/a</td>
<td>632</td>
<td>191/186</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>519/312</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>710/498</td>
</tr>
<tr>
<td>Creel</td>
<td>4,137</td>
<td>88,009</td>
<td>n/a</td>
<td>2,954</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>15,564/2,430</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>18,015</td>
</tr>
</tbody>
</table>

* Age 4+ hatchery steelhead were unmarked
4.4 Relationship to Habitat Protection and Recovery Strategies.

The California Coho Salmon Recovery Plan (CDFG 2004), Steelhead Restoration Action Plan (1996) and Strategic Plan for Northern California Steelhead (1998) are currently being implemented, where funding is available.

4.5 Ecological Interactions

Organisms that Could Negatively Impact Program

Pinnipeds feed on adult salmonids at river mouths and may 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. Juvenile steelhead are prey for otters, cormorants, mergansers, kingfishers, herons, river otters, garter snakes, as well as many other animals.

Organisms that Could Be Negatively Impacted by Program

The Mad River Hatchery Steelhead Program has the potential to cause negative effects to wild juvenile steelhead, Chinook and coho salmon. The potential for negative impact may include:

- Intra- and inter-specific competition for food and rearing habitat
- Intra- and inter-specific predation
- Disease transfer between hatchery and natural stock(s)
- Influencing outmigration behavior of natural populations
- Artificial selection of natural steelhead stock(s)
- Loss of diversity
- Outbreeding depression of steelhead stocks(s)
- Angler harvest (direct take and hooking mortality)

Organisms That Could Positively Impact Program

The Mad River Hatchery Steelhead Program is an integrated harvest program, which provides a robust fishery and a unique opportunity for anglers to keep a steelhead within the Northern California ESU. The program benefits to natural steelhead are unknown, but hatchery production provides additional resources for birds of prey, such as osprey, bald eagle, kingfisher and cormorant, as well as river otters. Zuspan et al. (2002) reported that seals inflicted wounds on 44.4% and 52.6% of hatchery and wild steelhead, respectively. Although the injury rate is less for hatchery fish compared to wild stock, artificially produced fish provide a buffer against excessive predation of less abundant natural steelhead by offering an alternative food source.
Section 5.0 Water Source

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

The water source for the hatchery originates from a series of eighteen 12-inch (30.5 cm) wells located in the floodplain of the Mad River. The wells range in depth from 38-75 feet (11.6 - 22.9 meters) and each has an individual flow capacity between 300 and 800 gpm (0.7 - 1.8 cfs). Well water is pumped directly into a main sump and then to an aeration tower by three ten cfs (4,488 gpm) pumps. Water flows by gravity from the aeration tower through the rearing ponds. If necessary, the hatchery can direct water at the midpoint of each rearing pond series through a secondary aeration tower or discard some or all of the flow into a settling basin or directly into the river. A dedicated pipe in the main sump supplies water to secondary sump adjacent to the hatchery building. One of four available pumps supply water to the hatchery building from the secondary sump.

The hatchery’s water system reroutes up to 17,000 gpm (38 cfs) of flow through a biological filtration system consisting of eight ponds made of crushed rocks and oyster shells. Conceptually, the hatchery recycles 84% of the rearing pond tail water and releases 16% to the river. Ultraviolet light near the head works of each raceway eliminates pathogenic agents in recirculated water.

Raceway tail water discharges into a settling basin to assure that the hatchery effluent complies with the standards and conditions of NPDES permits. The North Coast Regional Water Quality Control Board established discharge standards for settling pond effluent to protect the beneficial uses of the Mad River. Table 8 details these standards.

Table 8. Standard for Mad River Hatchery effluent discharge.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Units</th>
<th>Monthly Average</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Suspended Solids</td>
<td>mg/l</td>
<td>8</td>
<td>15</td>
</tr>
<tr>
<td>Suspended Solids</td>
<td>lb/day</td>
<td>138</td>
<td>259</td>
</tr>
<tr>
<td>Settleable Solids</td>
<td>ml/L</td>
<td>0.1</td>
<td>0.2</td>
</tr>
<tr>
<td>Hydrogen Ion</td>
<td>pH</td>
<td>6.5 ≤ 8.5</td>
<td>--------</td>
</tr>
<tr>
<td>Flow</td>
<td>mgd</td>
<td>7.5</td>
<td>--------</td>
</tr>
</tbody>
</table>

The NPDES permit mandates that no more than ten percent of critical life stage chronic toxicity bioassay determinations in any calendar year shall produce statistically significant deleterious effects to any test organism from exposure to undiluted effluent.
Points of Discharge:

Fish Ladder (discharge 001) -

Water that flows from the holding ponds through the fish ladder and into the river can not exceed 1.1 mdg (1.7 cfs) during the period of December 1 through April 1. Most of this flow is well water conveyed through the hatchery raceways.

Spawning House (discharge 002) -

The hatchery releases up to 0.5 mgd (0.8 cfs) of water from the spawning house directly into the Mad River from December 1 through May 15. This discharge includes egg incubator overflow and floor rinse water used during spawning. The water contains small quantities of carbon dioxide used to anesthetize steelhead prior to spawning. The amount of CO2 is so minute that dilution in the effluent reduces the concentration to nondeductible levels.

Rearing ponds and settling basin (discharge 003) -

Raceways discharge up to 5.9 mgd (9.12 cfs) of water into a settling basin with two evaporation/percolation ponds. Wastewater from the rearing ponds contains fish metabolic waste, excess feed, algae, silt, and detritus. This material settles out and allows clean water to percolate through the gravel bed to the river. During the period of October 1 through May 14, the discharge from the hatchery can not exceed one percent of the Mad River Flow as measured at the USGS Gage No. 111-4810.00 at Highway 299. In addition, the hatchery releases up to 1.5 million gallons of water from the raceways to allow yearling steelhead to swim to the Mad River. This single annual event occurs between March 15 and April 15th.

Water quality standards prohibit effluent discharge from the hatchery with any detectable level of chemical used for the treatment of disease, other than sodium chloride.

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

The majority of water for the hatchery is drafted well water. Generally, if the hatchery pumps water from the river, it only occurs during the months when juvenile salmonids are not emigrating.

Humboldt Bay Municipal Water Region (HBMWD) controls Mad River flow from Matthew’s Dam to the Essex Diversion site. The State Resources Control Board requires HBMWD to maintain and monitor flow standards for aquatic resources, pursuant to an appropriated water right. In addition, Humboldt Bay Municipal Water Region currently operates under a NMFS-approved Habitat Conservation Plan for listed steelhead, Chinook and coho salmon. There are no risks to listed species from diversion or effluent discharge from the hatchery due to the rigid standards outlined in the NPDES Permit as previously discussed in Section 5.1.
SECTION 6.0 Facilities

6.1 Broodstock collection facilities (or methods).

Steelhead access Mad River hatchery by a 17-step modified pool and weir configured fish ladder. The ladder leads to a fish trap adjacent to the spawning house. Hatchery personnel move 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.

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

None. (See Section 6.6)

6.3 Broodstock holding and spawning facilities.

Steelhead enter the spawning house through a hydraulically controlled door and fall into a basket, which sits in an elevating anesthetic tank. Mad River Hatchery uses CO₂ at a rate of 30 liters/minute for 20 minutes and then 15 liters/minute to anesthetize steelhead. Hatchery workers monitor and adjust CO₂ levels as necessary, because this gas can lower the hydrogen ion concentration (pH) in water.

After the steelhead become passive, hatchery workers raise the fish basket to the level of the sorting table. The hatchery personnel remove the fish and sort them by species, sex ripeness and identifying marks. Hatchery workers release salmon back to the river through the drain hole in the spawning room floor and spawn ripe steelhead immediately. They place unripe AD-marked steelhead needed for future egg take into the flume leading to the respective male or female holding pond. Each of the eight 6’ x 75’ concrete holding ponds is equipped with a mechanical fish screen that can cycle fish back into the primary fish trap without handling. The spawning operation generally requires a crew of two permanent and four volunteer employees.

6.4 Incubation facilities.

The spawning house at Mad River Hatchery is equipped with forty-eight Heath (Heath Tecna Corporation ™) stacks with sixteen trays in each stack. The steelhead egg capacity for each tray is 3,000 eggs. Water from an overhead 3-inch pipe provides a flow of three to eight gpm (0.007 to 0.02 cfs) to the top tray of each stack, which is empty to buffer the force of falling water. Hatchery workers adjust the initial water flow to allow it to move from tray to tray without spilling over the top of the tray. They increase the flow to seven to ten gpm (0.016 to 0.022 cfs) when ovaries reach the eyed-egg stage and pull each tray plug 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 hold sac fry in tanks or troughs for short periods to start them on artificial feed. Hatchery workers move fry to the to production ponds when their yolk sacs have been completely absorbed. The circular tanks
in the hatchery building are equipped with automatic feeders and they, as well as the troughs can be used to rear select lots of fish.

Hatchery personnel use the volumetric method to inventory production by averaging three random counts from each lot or group of eggs using a 2-ounce measuring cup and then multiplying the mean by the number ounces that they place into each Heath Tray. Traditionally, hatchery workers placed thirty ounces of steelhead eggs in each incubator tray. They place the older progeny in the bottom trays to keep the egg-hatching enzyme from inducing a premature hatch.

The hatchery building uses 449 gpm (one cfs) of water during peak egg production. The facility’s plumbing configuration allows water to recirculate through the incubator/tract system in case of emergency.

6.5 Rearing facilities.

Rearing ponds consist of a series of five paired concrete raceways 10 feet wide and 600 feet long. Each raceway can be divided into a series of six 100-foot long ponds by screens or dam boards. In addition, the first 200 feet of each series can be subdivided into 25-foot ponds and the remaining 400 feet can be subdivided into 50-foot ponds to isolate small groups of fish.

Water enters into each raceway series through three rectangular openings in the head flume and flow is controlled by an adjustable valve. Four stacked 2” x 6” boards below each pond maintain raceway water depth at 24 inches. Flow is approximately 1,250 gallons/minute (2.8 cfs). Raceway effluent discharges through either a shallow or a deep flume, which empty into the fish trap and ladder or directly into the settling ponds, respectively.

6.6 Acclimation/release facilities.

Fish are volitionally released through the raceway and tailrace system into the river. The remaining yearlings are crowded into the tailrace after three to five days.

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

Mad River Hatchery endured many normal occurrences of piscine pathogens including egg fungus (*Saprolegnia sp*) and parasites (*Scyphidia sp.*, *Costia sp.*, *Gyrodactylous sp.*, *Epistylis sp.*), as well as isolated outbreaks of Bacterial Septicemia, Infectious Hematopoietic Necrosis (IHN) and Herpes Viris salmonis. Furunculosis caused some significant epidemics during the hatchery’s start-up years through the 1976/1977 season, but the disease was mitigated by the installation of an ultraviolet water treatment system. The worst disease epidemic occurred in 1983, when Proliferative Kidney Disease tested positive at Mad River Hatchery. This was the first recorded occurrence in California and CDFG destroyed all fish as a safeguard to protect California fish resources.
Mad River Hatchery has detected and treated other moderate pathogenic outbreaks throughout its history including Bacterial Columnaris (*Flavobacter columnare*), a ciliated protozoan called Ich (*Ichthyophthirius multifilis*) and various myxobacteria. Mad River Hatchery Annual Reports for the period 1971/1972 through 2001/2002 documented annual outbreaks of myxobacteria with varying degrees of severity. Mad River Hatchery annual reports indicate a slight occurrence in most years and above normal outbreaks from 1997/1998 through 1999/2000 seasons.

On March 28, 2005, a high level of mortality was observed in lots 1, 3 and 4. Gill scrapes and spleen and kidney samples confirmed the presence of a myxobacterium (*F. psychrophilum*), which causes coldwater disease. The California Department of Fish and Game Pathologist identified the pathogen and recommended treatment with Penicillin G.

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

Hatchery operations have an inherent element of risk of mortality due to disrupted water supply and water quality, disease, handling and transport. The hatchery managers train all staff member to respond to an unforeseen emergency and avert stochastic fish loss. A hatchery employee or volunteer are on duty or stationed in the housing on grounds at all times. The water supply for the fish ladder and trap originates from either the rearing pond tail water or water pumped directly from Mad River by one or more back-up pumps. The water system for incubators and tanks in the hatchery building are equipped with a low water alarm, which immediately notifies the hatchery staff in the case of a disrupted water supply.

Daily hatchery operations include daily removal of dead fish and an assessment of fish health, behavior and physical attributes. Although pathogens within hatchery fish are endemic to the Mad River watershed, fish culturist report an abnormal rate of mortality, behavior or physiological condition that indicates disease or parasitic to the CDFG Fish Pathology Lab. Fish Pathologist immediately test for pathogenic agents and prescribe treatment. Rapid assessment and treatment minimizes infection to other hatchery ponds.

As previously stated, Mad River Hatchery is located above the 100-year floodplain, so there is no chance of flooding at this facility.
SECTION 7.0 BROODSTOCK ORIGIN AND IDENTITY

Describe the origin and identity of broodstock used in the program, its ESA-listing status, annual collection goals, and relationship to wild fish of the same species/population.

7.1 Source.

Table 9 illustrates the source of broodstock for the Mad River Hatchery winter-run steelhead program. The CDFG transferred eggs to Mad River Hatchery from Benbow Dam from 1971 through 1973 and San Lorenzo River in 1973. Returns to the hatchery made up approximately 90% and 100% of the yearling releases for the 1972 through 1973 and 1974 brood years, respectively.

Table 9. Source of Mad River Hatchery winter-run steelhead broodstock

<table>
<thead>
<tr>
<th>Season</th>
<th>South Fork Eel River</th>
<th>Mad River</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Number of</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Fish</td>
<td>Females</td>
</tr>
<tr>
<td>1970/1971</td>
<td>301</td>
<td>144</td>
</tr>
<tr>
<td>1971/1972†</td>
<td>452</td>
<td>243</td>
</tr>
<tr>
<td>1972/1973</td>
<td>395</td>
<td>233</td>
</tr>
<tr>
<td>1973/1974</td>
<td>none</td>
<td></td>
</tr>
</tbody>
</table>


7.2 Supporting information.

7.2.1 History.

See Section 7.1.

7.2.2 Annual size.

The number of female spawners at the hatchery averaged 124 and ranged from 83 to 138 winter-run steelhead for the 1993 through 2005 BYs.

7.2.3 Past and proposed level of natural fish in broodstock.

Although exact data are unavailable, Zuspan (2002) reported that the average annual integration rate of wild stock into the hatchery broodstock was 3% (3 fish). The Regional Hatchery Supervisor for CDFG in Northern California reported that the annual rate of integration may have been as high as 5% (6 fish) prior to the 2004/2005 season (Overton Personal Communication). Most of the natural stock broodstock were male and spawning was conducted using the techniques practice described in Section 9.4 (Gutierrez Personal Communication).
7.2.4 Genetic or ecological differences.

Busby (1996) presented allozyme data associates naturally spawning stock from Mad River with Mad River Hatchery. Collectively, the allozyme data groups Mad River Basin and Eel River samples.

7.2.5 Reasons for choosing.

The CDFG selected Mad River for hatchery production because AD-marked steelhead are considered by NMFS to be genetically different from their naturally spawned counterpart, thus this stock is unlisted, which allows them to be artificially propagated for a harvest fishery.

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

Mad River Hatchery began marking winter-run steelhead production in BY 1997. Marking provides a ready means of hatchery program evaluation, as well as identification and enumeration of naturally spawned steelhead. The number of wild steelhead entering Mad River Hatchery in brood years 2001 through 2005 ranged from eight to 238 (Table 10).

<table>
<thead>
<tr>
<th>Year</th>
<th>Total Steelhead</th>
<th>Mark</th>
<th>Unmarked</th>
</tr>
</thead>
<tbody>
<tr>
<td>2001</td>
<td>1,396</td>
<td>1,388</td>
<td>8</td>
</tr>
<tr>
<td>2002</td>
<td>5,893</td>
<td>5,655</td>
<td>238</td>
</tr>
<tr>
<td>2003</td>
<td>4,465</td>
<td>4,411</td>
<td>54</td>
</tr>
<tr>
<td>2004</td>
<td>no trapping</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2005</td>
<td>1,865</td>
<td>1,850</td>
<td>15</td>
</tr>
</tbody>
</table>

Table 10. Number of marked and unmarked steelhead returns to Mad River Hatchery from BY 2001 through BY 2005.
SECTION 8.0 BROODSTOCK COLLECTION

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

The Mad River Hatchery winter-run steelhead program proposes a broodstock size of 150 adults comprised of nine unmarked and 141 AD-marked hatchery steelhead.

8.2 Collection or method or sampling design.

Mad River Hatchery will take eggs from 150 steelhead returns throughout a six week spawning period following the sample protocol outlined in Table 11, approximately 25% of the adult run occurs in January and February, thus 25% of the eggs taken for the year will be from steelhead trapped during those months. The proposed steelhead spawning protocol includes mating of fish exhibiting the same run timing to the hatchery.

Table 11. Broodstock selection based on run timing, estimated egg take and production number of hatchery/hatchery and hatchery/natural matings.

<table>
<thead>
<tr>
<th>Week</th>
<th>Run Timing</th>
<th>Matings</th>
<th>Egg Take¹</th>
<th>Production²</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Total</td>
<td>H x H</td>
<td>H x N</td>
</tr>
<tr>
<td>1</td>
<td>10%</td>
<td>5</td>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td>2</td>
<td>15%</td>
<td>8</td>
<td>7</td>
<td>1</td>
</tr>
<tr>
<td>3</td>
<td>25%</td>
<td>10</td>
<td>9</td>
<td>1</td>
</tr>
<tr>
<td>4</td>
<td>25%</td>
<td>10</td>
<td>9</td>
<td>1</td>
</tr>
<tr>
<td>5</td>
<td>15%</td>
<td>8</td>
<td>7</td>
<td>1</td>
</tr>
<tr>
<td>6</td>
<td>10%</td>
<td>5</td>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td>Total</td>
<td>100%</td>
<td>50</td>
<td>44</td>
<td>6</td>
</tr>
</tbody>
</table>

¹ assumes fecundity of 4600 egg/♀
² assumes 80% fertilization rate and survival rate from green egg to yearling

8.3 Identity.

Hatchery produced steelhead are marked with an adipose fin-clip to distinguish them from naturally produced trout.

8.4 Proposed number to be collected.

The Mad River Hatchery HGMP proposes a take of 230,000 eggs from nine unmarked and 141 AD-marked winter-run steelhead. The proposed number of three female and six male unmarked steelhead spawners may vary depending on the number of returns to the hatchery.
8.4.1 Program goal (assuming 1:1 sex ratio for adults).

See section Sections 8.1 through 8.4.

8.4.2 Broodstock collection levels for the last twelve years.

The number of female steelhead spawned, green eggs harvested and subsequent yearling production for the period of 1993/1994 through 2004/2005 seasons are presented in Table 12.

Table 12. Number of female steelhead spawned, green eggs harvested and yearling production for the 1994 through 2005 brood years.

<table>
<thead>
<tr>
<th>Season</th>
<th>Number of Females Spawned</th>
<th>Number of Green Eggs Harvested</th>
<th>Yearlings Released</th>
</tr>
</thead>
<tbody>
<tr>
<td>1994/1995</td>
<td>83</td>
<td>381,065</td>
<td>226,010</td>
</tr>
<tr>
<td>1995/1996</td>
<td>109</td>
<td>570,124</td>
<td>184,451</td>
</tr>
<tr>
<td>1998/1999</td>
<td>170</td>
<td>842,832</td>
<td>368,082</td>
</tr>
<tr>
<td>1999/2000</td>
<td>138</td>
<td>619,560</td>
<td>225,549</td>
</tr>
<tr>
<td>2000/2001</td>
<td>140</td>
<td>560,455</td>
<td>261,417</td>
</tr>
<tr>
<td>2002/2003</td>
<td>133</td>
<td>630,246</td>
<td>213,500</td>
</tr>
<tr>
<td>2003/2004</td>
<td>No Production</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2004/2005</td>
<td>78</td>
<td>351,120</td>
<td>255,428⁹</td>
</tr>
</tbody>
</table>

⁹Number AD-clipped 2/01/2006

8.6 Fish transportation and holding methods.

From the sorting table, hatchery workers separate unripe steelhead by sex and place them in the flume leading to the respective male or female holding pond. There are eight 6-foot x 75-foot concrete holding ponds, each with a mechanical fish screen that can cycle fish back into the primary fish trap without handling. The hatchery plants its yearling steelhead directly into Mad River; therefore, no trucking is necessary.

8.7 Describe fish health maintenance and sanitation procedures applied.

Mad River Hatchery uses a commercial iodine solution, as a disinfectant throughout the hatchery. Hatchery workers cautiously sanitize equipment between and among all incubational and rearing facilities, especially if disease or pathogens are evident. Spawning equipment, especially invasive equipment such as needles used for egg harvest
and tissue collection is treated before and after each fish. Hatchery personnel perform daily scheduled health maintenance and sanitation procedures.

Hatchery workers take additional precaution to avoid the spread of disease by using equipment in an infected incubation or rearing pond that is specific to that site. Hatchery workers remove dead fish from raceways ponds daily and report elevated or abnormal mortality levels to the CDFG’s Fish Pathology Lab in Rancho Cordova. The Pathology Lab tests for the presence of parasites infestation or bacteria and viral outbreaks. The Pathology Lab is also responsible for treatment recommendations.

Fertilized eggs are water hardened for two to three hours in iodine and transferred to incubation trays in the hatchery building. Hatchery personnel closely monitor eggs during incubation for siltation, fungus and natural mortality. At the eyed-egg stage, hatchery personnel pick dead eggs by hand resulting from natural causes and addling (gentle blow to the tray to disrupt weak egg membranes). Hatchery workers regulate feed closely to minimize waste and clean ponds weekly to remove unused feed and feces.

8.8 Disposition of carcasses.

The hatchery disposes of carcasses that result from inadvertent mortality during the trapping and spawning process to the landfill. Carcasses are not returned to the river because of the municipal water source located downstream of the hatchery.

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

The potential for inbreeding closely related individuals, as well as the potential for amplifying divergence between hatchery and natural populations exists in an artificial propagation program, especially when the natural population is small. Mad River Hatchery Program proposes to take approximately 230,000 eggs in the approximate proportion of adult arrivals by month including nine unmarked steelhead (See Section 8.2). The potential for adverse genetic or ecological effects to the natural population resulting from brood stock collection is negligible because male hatchery donors can continue their spawning migration and contribute to the wild offspring. The removal of three females from the natural spawning population equates to 0.21%, based on the 2000/2001 run size estimate of 1,419 (Zuspan et al. 2003b).
SECTION 9.0 MATING

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

9.1 Selection method.

Prior to 2004/2005 season, the hatchery annually included 3% unmarked steelhead into broodstock (Zuspan 2002). Only AD-marked winter-run steelhead were spawned at Mad River Hatchery in 2004/2005 and 2005/2006. This plan proposes a protocol that results in the release of steelhead progeny from unmarked/hatchery into Mad River Hatchery that represents approximately ≥ 10% of all yearling production. The proposed spawning protocol is as follows:

- Spawn three wild ♀ with six hatchery ♂ (1:2)
- Spawn 3 hatchery ♀ with six wild ♂ (1:2)
- Spawn 44 hatchery ♀ with 44 hatchery ♂ (1:2)

There is potential for a steelhead return to the hatchery consisting of a disproportionate or unequal sex ratio. In 2005 BY, a total of thirteen male and two female natural stock steelhead entered Mad River Hatchery. Under this scenario, unmarked males spawned with AD-marked hatchery females would replace the shortfall of naturally spawned female donors.

9.2 Males.

Mad River Hatchery does not propose to spawn age 2+ steelhead.

9.3 Fertilization.

The Joint Hatchery Review Committee (CDFG/NOAA 2001) recommended that hatchery mating protocol be developed to maximize effective population size in terms of genotypes. Hatcheries should spawn breeding populations >500 fish using one-on-one spawning. Hatcheries with smaller populations (200-500) should split eggs into multiple lots and individually fertilize each with a different male. This HGMP proposes spawning two unique males with each female steelhead.

Fish Culturists at Mad River Hatchery wet spawn two unique male steelhead in a round 10-inch and 4-inch deep egg pan containing a solution that is comprised of TRIS® by Ultapure™, glycerine, salt and water. They spawn one ripe female steelhead into the egg pan using approximately one to two pounds/inch² of compressed air, which flows through surgical tubing and an eighteen-gauge needle. A cork placed 0.5 to 0.75 inches
above the needlepoint keeps the fish culturist from inadvertently piercing internal organs while applying pressure to extrude the eggs through the vent. After egg extraction, the fish culturist removes the needle and gently strips air from the body cavity.

After spawning, hatchery workers placed the eggs into a bucket treated with an iodine solution. Fertilized eggs were allowed to water harden for fifteen to thirty minutes and then inventoried for size and volume. The hatchery technicians inventory eggs for volume and size and transported them to incubation trays. The technicians guard eggs against exposure to ultraviolet light during the entire spawning process.

9.4 **Cryopreserved gametes.**

There is no gamete preservation program at Mad River Hatchery.

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

In an effort to reduce the risk of loss of within population genetic diversity, the mating protocol within this plan includes a randomized selection of a representational proportion of spawners based on the time of hatchery entry. The hatchery workers will also spawn ten unmarked steelhead also based on run timing to minimize risk of inbreeding. However, the hatchery may use more unmarked steelhead for broodstock as new information clarifies the genetic uncertainty between hatchery and natural stocks.

The potential for inbreeding closely related individuals always exists in an artificial propagation program, especially when a total population size is small. Tissue samples from hatchery and natural stocks should be analyzed for mtDNA by polymerase chain reaction (PCR). The results of this analysis will set the foundation for the most appropriate spawning procedure for Mad River Hatchery as either an isolated or integrated harvest program. Changes in spawning protocol will be cooperatively developed by the NMFS’ Molecular Ecology Team Leader and CDFG’s Geneticist as a greater understanding of steelhead stock genetic composition is known.
Section 10.0 Incubation and Rearing

Specify any management goals (e.g., "egg to smolt survival") that the hatchery is currently operating under for the hatchery stock in the appropriate sections below. Provide data on the success of meeting the desired hatchery goals.

10.1 Incubation:

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

Production records for Mad River Hatchery indicate a relatively consistent annual release of steelhead yearlings despite an inconsistent number of eggs taken. Annual reports for the 1994 through 1997 BYs indicate a large number (78,000 to 834,480) of randomly planted steelhead fingerlings. Some eggs die during incubation because of poor fertilization or improper development. Table 13 presents the survival rate for green to eyed-egg, green egg to fingerling (1998 through 2003 BY), as well as green egg to smolt plant for the 1994 through 2003 BYs, which is discussed in Section 10.2.1.

Table 13. Survival rate for green egg to eyed-egg, green egg to fry and green egg to smolt for the 1994 through 2003 brood years.

<table>
<thead>
<tr>
<th>Brood Year</th>
<th>Total Number Taken (A)</th>
<th>Number of Eyed (B)</th>
<th>Survival Rate (%) (A to B)</th>
<th>Number of Fry Ponded (C)</th>
<th>Survival Rate (%) (A to C)</th>
<th>Number Released (D)</th>
<th>Survival Rate (%) (A to D)</th>
<th>Survival Rate (%) (C to D)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1994†</td>
<td>1,214,585</td>
<td>N/A</td>
<td>N/A</td>
<td>Data Unavailable</td>
<td>Data Unavailable</td>
<td>201,150</td>
<td>84.2</td>
<td>47.5</td>
</tr>
<tr>
<td>1995†</td>
<td>381,065</td>
<td>341,722</td>
<td>89.7</td>
<td>467,000</td>
<td>84.2</td>
<td>226,010</td>
<td>43.7</td>
<td>65.5</td>
</tr>
<tr>
<td>1996†</td>
<td>570,124</td>
<td>502,025</td>
<td>88.1</td>
<td>529,685</td>
<td>85.5</td>
<td>365,000</td>
<td>55.0</td>
<td>64.5</td>
</tr>
<tr>
<td>1997†</td>
<td>761,722</td>
<td>652,578</td>
<td>85.7</td>
<td>339,754</td>
<td>60.6</td>
<td>248,077</td>
<td>47.6</td>
<td>77.2</td>
</tr>
<tr>
<td>1998</td>
<td>554,831</td>
<td>476,496</td>
<td>85.9</td>
<td>418,000</td>
<td>62.8</td>
<td>241,167</td>
<td>36.3</td>
<td>57.7</td>
</tr>
<tr>
<td>1999</td>
<td>842,832</td>
<td>606,285</td>
<td>71.9</td>
<td>368,000</td>
<td>58.4</td>
<td>213,500</td>
<td>33.9</td>
<td>57.9</td>
</tr>
<tr>
<td>2000</td>
<td>619,560</td>
<td>528,485</td>
<td>85.3</td>
<td>508,000</td>
<td>67.0</td>
<td>368,000</td>
<td>47.6</td>
<td>65.5</td>
</tr>
<tr>
<td>2001</td>
<td>560,455</td>
<td>341,997</td>
<td>61.0</td>
<td>225,549</td>
<td>36.4</td>
<td>225,549</td>
<td>46.6</td>
<td>57.7</td>
</tr>
<tr>
<td>2002</td>
<td>665,425</td>
<td>451,512</td>
<td>67.9</td>
<td>241,167</td>
<td>36.3</td>
<td>241,167</td>
<td>57.7</td>
<td>77.2</td>
</tr>
<tr>
<td>2003</td>
<td>630,246</td>
<td>510,550</td>
<td>81</td>
<td>213,500</td>
<td>33.9</td>
<td>213,500</td>
<td>57.9</td>
<td>77.2</td>
</tr>
<tr>
<td>2004</td>
<td>No Production</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2005</td>
<td>351,120</td>
<td>312,155</td>
<td>88.9</td>
<td>279,021</td>
<td>79.5</td>
<td>255,428</td>
<td>72.5</td>
<td>91.5</td>
</tr>
<tr>
<td>Mean</td>
<td>351,120</td>
<td>312,155</td>
<td>88.9</td>
<td>279,021</td>
<td>79.5</td>
<td>255,428</td>
<td>72.5</td>
<td>91.5</td>
</tr>
</tbody>
</table>

† Fry plants between 1994 and 1997 BY do not allow estimate of survival rate.
10.1.2 Cause for, and disposition of surplus egg takes.

Because of the difficulty to foresee mechanical failures or disease outbreak, the hatchery spawning protocol requires the harvest of surplus eggs to guarantee production goals. This plan proposes that Mad River Hatchery staff harvest approximately 230,000 steelhead eggs to produce 150,000 yearlings. This plan does not propose culling surplus eggs. The CDFG proposes to plant progeny from H x H matings that are in excess of 150,000 yearlings, should they occur, into Freshwater Lagoon, which is a local catchable trout water without anadromy.

10.1.3 Loading densities applied during incubation.

The spawning house at Mad River Hatchery is equipped with forty-eight Heath (Heath Tecna Corp™) vertical incubation stacks with sixteen trays in each stack. The steelhead egg capacity for each tray is approximately 30 ounces of eggs. (In BY 2005 and 2006, egg size ranged from 162-181 and 164-185 eggs/ounce, respectively. This plan proposes separate incubation of eggs from N x H and H x H matings to maximize survival, provide a means to produce a $\geq 10\%$ rate of integration for unmarked steelhead within yearling production.

10.1.4 Incubation conditions.

Pumps supply water from the main sump directly to the hatchery building’s sump. Secondary pumps supply water to the hatchery building through a 55 gallon drum with filter rings and then into the vertical flow incubators. Seasonal water temperature ranges from 4.4 °C (40 °F) to 11.7 °C (53 °F). The hatchery workers check water quality parameters monthly.

10.1.5 Ponding.

Hatchery personnel transfer newly emerged fry from the incubator trays to the rearing troughs for rearing until the yolk sacs are fully absorbed on all fish. The hatchery workers move the fingerlings to raceways after they have adapted to processed feed. The hatchery workers make a standard 10% numerical inventory of fingerlings during this move using weight count recorded in fish/pound and converted to total production numbers.

10.1.6 Fish health maintenance and monitoring.

The top tray of each Heath stack is empty to buffer the impact of water cascading from the pipe above and filter silt and organics. Hatchery personnel regularly clean egg trays to remove sediment and organic materials. Hatchery workers are able to configure the stacks to isolate individual trays, in part, to control disease as needed. Hatchery personnel handpick dead eggs and fungus with a pipette weekly or anytime they are evident (see Section 8.7).
10.1.7 Indicate risk aversion measures that will be applied to minimize the likelihood for adverse genetic and ecological effects to listed fish during incubation.

The greatest potential for stochastic mortality to eggs and fry is disturbance in water flow to the hatchery building due to a power failure. Diesel-powered generators provide backup power in the event of an electrical power outage.

Fish culturist leave the top tray in each Heath stack empty to cushion the impact of falling water and filter sediment and organics, which reduces fungus growth. Hatchery personnel consistently agitate and pick eggs to reduce fungal invasion.

10.2 Rearing:

10.2.1 Provide survival rate data (average program performance) by hatchery life stage (fry to fingerling; fingerling to smolt) for the most recent twelve years (1988-99), or for years dependable data are available.

Survival from green to the eyed-egg and fingerling life history phases averaged 79.6% and 72.5%, respectively, for the 1994 through 2003 BYs. Survival to yearling from green egg and fingerling was 40.7% and 59.6, respectively. Survival variability in the rearing ponds was due, in part, to bird predation. The proposed reduced pond-rearing density (Section 10.22) may improve survival rates. In 2005 survival rate from green egg to yearling was approximately 76%.

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

Generally, rearing space and hatchery production numbers dictate rearing-pond density. However, rearing-pond density varies by rearing unit, water temperature, water quality, flow rate, rate of feed, disease and release date. In general, literature reports an inverse relationship between growth and salmonid stocking density and supports rearing at lower density to promote growth and smoltification, but lower density is not directly related to adult survival (Banks 1992; Banks et al. 2002; Ewing et al 1995; Schreck et al. 1985; Zydlewski et al 2003). Mad River Hatchery is in a unique position to provide conditions, which can increase growth, reduce disease-related mortality and generate smolt development by reducing fish density. Hatchery workers utilize addition raceway ponds to increase fingerling survival and time smolting to early March of each year.

10.2.3 Fish rearing conditions.

Water temperatures range from 9.4 °C (49 °F) in winter to approximately 15.6 °C (60 °F) and sometimes warmer during the summer months.
Zydlewski et al. (2003) reported that hatchery rearing conditions could be modified to produce cultured fish that are more similar to their wild counterparts. Many hatcheries in the Pacific North West practice Natural Rearing Enhancement Systems (Nature) at some level, but mostly at an experimental scale. Natural Rearing Enhancement includes, but is not limited to camouflage netting or shade screens, raceway structure, including fir trees and pea-sized gravel pavers. To date, in stream survival and enhanced cryptic coloration qualified as a measure of success. Zydlewski et al. (2003) reported that the overall effects of semi natural rearing conditions are not available at the production hatchery level. Similarly, fisheries scientists have not analyzed the effects of more natural rearing conditions on development of smolt plants (Zydlewski 2003; Hamelberg Personal Communication).

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

Table 13 depicts the growth rate for BY 2005 winter-run steelhead at Mad River Hatchery.

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

Lietritz (1980) standardized hatchery weight-count procedure to determine monthly growth rates. At Mad River Hatchery, workers make a weight-count measurement by placing a bucket of water on a scale and weighing it, introducing a known number of fish into the bucket, and recording the weight of the fish after subtracting the tare weight of the bucket and water. Three to four measurements are averaged to determine fish/lb. Table 14 presents the growth rate for BY 2005 steelhead.

<table>
<thead>
<tr>
<th>Date</th>
<th>Weight Count (fpp)</th>
<th>Date</th>
<th>Weight Count (fpp)</th>
</tr>
</thead>
<tbody>
<tr>
<td>April 19, 2005</td>
<td>300</td>
<td>June (mean)</td>
<td>82.9</td>
</tr>
<tr>
<td>May 2, 2005</td>
<td>260</td>
<td>August (mean)</td>
<td>35.0</td>
</tr>
<tr>
<td>May 16, 2005</td>
<td>195</td>
<td>October (mean)</td>
<td>6.6</td>
</tr>
<tr>
<td>May 31, 2005</td>
<td>129</td>
<td>November (mean)</td>
<td>4.8</td>
</tr>
<tr>
<td>June, 6, 2005</td>
<td>109</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 14. Steelhead growth rate (weight count) for BY 2005.
10.2.6 Indicate food type used, daily application schedule, feeding rate range (e.g. % B.W./day and lbs/gpm inflow), and estimates of total food conversion efficiency during rearing (average program performance).

Fish culturists calculate the amount of feed based on the percentage of total weight for each lot of fish, following the manufacturer’s recommended rate of application. Generally, hatchery workers fed fish six to eight times a day by hand. An approximate rate of fed application is twice the cumulative body weight of fish within the pond. The fish food contains herring, cotton-seed, wheat kelp, tuna viscera, crab meal and vitamin supplements.

The food conversion rate for hatchery production from 1991 through 2000 ranged from 1.01 to 1.34 and averaged 1.22. Prior to 2004/2005, hatchery workers fed fish using a motorized cart with a feed blower, but fish are now feed by hand. The current rate of food conversion rate for hand feeding at Mad River hatchery is unknown, but will be developed as part of the winter-run steelhead program monitoring requirements.

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

Routine sanitation procedures are standard in hatchery operations. Fish culturists inventory, rotate and discard feed to maintain fish health. Fish health maintenance and sanitation procedures also include weekly pond cleaning, which removes accumulated solids and fish feces in order to maintain a healthy rearing environment. Pond stocking density is continuously monitored and adjusted to prevent overcrowding. Hatchery personnel assess health conditions on a daily basis.

CDFG Pathology routinely tests fingerling steelhead for viral, bacterial and parasitic agents at Mad River Hatchery. This requires a sacrifice of up to 150 steelhead progeny from unlisted hatchery/hatchery matings. Testing of natural/hatchery hybrids will occur only as needed to address a specific disease outbreak.

If a severe disease outbreak occurs, the hatchery manager notifies CDFG pathology to assist in the identification of the pathogenic agent and a prescribed treatment. This may require a sample of up to 60 steelhead fingerlings.

Fish culturists implement prescribed treatment. Depending on the cause of a disease or parasitic outbreak, treatments may vary. Carcasses from juvenile fish mortalities are frozen and subsequently disposed of through the commercial disposal service.

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

Steelhead yearlings are not analyzed 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. Hatchery personnel will utilize physical “smolt” characteristics as indices smolt development.
10.2.9  Indicate the use of "natural" rearing methods as applied in the program.

Mad River Hatchery employs standard fish husbandry practices. The use of “semi natural rearing techniques” (NATURES) is not feasible because of fixed hatchery funding and staffing. In addition, Vidergar et al. (2003) reported that semi natural rearing practices do not improve smolt survival in comparison to standard hatchery practices. This plan proposes the use of cryptic raceway coloration or shade screening only on an experimental basis, and on the condition that a research funding source is available.

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

Mad River Hatchery Steelhead are generally reared to a size of ≥10/lb and a length that is larger than most natural stock 1+ and 2+ steelhead. Sparkman (2003) concluded after two years of study that the catch distribution data of hatchery releases shows minimal overlap with natural stocks during emigration, thereby minimizing the risk of adverse ecological interaction to listed fish.

Table 15. Comparison of minimum, maximum and average size of hatchery and naturally spawned juvenile steelhead emigrants in 2001 and 2002.

<table>
<thead>
<tr>
<th>Year</th>
<th>Natural Stock</th>
<th>Hatchery</th>
<th>Yearlings</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1+</td>
<td>2+</td>
<td>1+</td>
</tr>
<tr>
<td></td>
<td>Range¹</td>
<td>Mean¹</td>
<td>Range¹</td>
</tr>
<tr>
<td>2001</td>
<td>54-124</td>
<td>84.3</td>
<td>125-226</td>
</tr>
<tr>
<td>2002</td>
<td>50-119</td>
<td>73.9</td>
<td>120-242</td>
</tr>
</tbody>
</table>

¹ Measurements are in millimeters
SECTION 11.0 RELEASE
Describe Fish Release Levels and Release Practices Applied Through the Hatchery Program.

11.1 Proposed Fish Release Levels.

The Mad River Hatchery Steelhead Program proposes an annual release of 150,000 yearlings. The yearlings will be released during February through early April at a size of \( \geq 10 \) fpp to increase survival (Taylor, undated). Hatchery workers will open the raceway tailraces to allow volitional movement of smolts from the rearing ponds to the river at the appropriate time of release. The hatchery workers will force all remaining fish in the ponds into the river after three to five days.

11.2 Specific Location(s) of Proposed Release(s).

Stream, river, or watercourse: Mad River
Release point: Mad River Hatchery
Major watershed: Mad River

11.3 Actual Numbers and Sizes of Fish Released By Age Class Through the Program.

Production, as measured by fry, fingerling and smolt plants, has varied by number, size and release dates throughout the operation history of Mad River Hatchery (Table 15).

11.4 Actual Dates of Release and Description of Release Protocols.

See Section 10.3 and Table 16.

11.5 Fish Transportation Procedures, if Applicable.

Not applicable.

11.6 Acclimation Procedures

None

11.7 Marks Applied, and Proportions of the Total Hatchery Population Marked.

All hatchery steelhead production is marked with an adipose fin-clip

11.8 Disposition Plans For Fish Identified at the Time of Release as Surplus to Programmed or Approved Levels.

Not applicable
Table 16. Number of steelhead fry, fingerling and yearling plants for BY 1991 though BY 2003.

<table>
<thead>
<tr>
<th>Year of Release</th>
<th>Fry</th>
<th>Mean Size (fpp)</th>
<th>Release Date</th>
<th>Fingerling</th>
<th>Mean Size (fpp)</th>
<th>Release Date</th>
<th>Yearling</th>
<th>Mean Size (fpp)</th>
<th>Release Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>1992</td>
<td>830,000</td>
<td>2,000</td>
<td>3/5-4/29</td>
<td>10,500</td>
<td>35</td>
<td>10/5</td>
<td>79,576</td>
<td>5.8</td>
<td>3/20</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>187,058</td>
<td>5.1-5.4</td>
<td>3/24-4/1</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>52,200</td>
<td>4.5</td>
<td>4/20</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>91,000</td>
<td>2.0-4.0</td>
<td>4/21-26</td>
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<tr>
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<td></td>
<td></td>
<td></td>
<td>15,120</td>
<td>18.0</td>
<td>12/8</td>
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<tr>
<td>1993</td>
<td>318,600</td>
<td>1,770</td>
<td>4/29</td>
<td>37,100</td>
<td>53-55</td>
<td>10/5 &amp; 6</td>
<td>99,275</td>
<td>5.5</td>
<td>3/29</td>
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<td>134,010</td>
<td>6.0</td>
<td>4/13</td>
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<td></td>
<td>60,000</td>
<td>40-44</td>
<td>10/8 &amp; 9</td>
<td>81,200</td>
<td>5.0-5.5</td>
<td>4/19</td>
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<tr>
<td>1994</td>
<td>460,000</td>
<td>2,000</td>
<td>3/24-4/26</td>
<td>10,000</td>
<td>35</td>
<td>10/5</td>
<td>129,000</td>
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<td>4.5</td>
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<td>4/19 &amp; 20</td>
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<td>37,450</td>
<td>3.5</td>
<td>2/28</td>
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<td>20,000</td>
<td>2,000</td>
<td>3/28</td>
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<td>81,200</td>
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<td>3/1</td>
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<td>26,000</td>
<td>2,000</td>
<td>4/16</td>
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<td>5.0</td>
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<td>6.9-7.0</td>
<td>3/24 &amp; 4/2</td>
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<td>34,373</td>
<td>3.7</td>
<td>2/22</td>
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<td>1996</td>
<td>262,000</td>
<td>2,000</td>
<td>2/1 -4/28</td>
<td>11,240</td>
<td>40</td>
<td>9/8</td>
<td>77,438</td>
<td>6.2</td>
<td>3/16</td>
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<td>43,785</td>
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<td>3/24 &amp; 4/2</td>
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<td>111,618</td>
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<td>117,504</td>
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<td>3/23</td>
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<td>2000</td>
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<td>102,202</td>
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<td></td>
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<td>99,696</td>
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<td>4/10</td>
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<td>104,210</td>
<td>6.8</td>
<td>4/16/02</td>
</tr>
<tr>
<td>2003</td>
<td></td>
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<td></td>
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<td></td>
<td></td>
<td>77,622</td>
<td>5.1</td>
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<td>77,662</td>
<td>5.8</td>
<td>3/27/03</td>
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<td></td>
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<td>85,883</td>
<td>5.1</td>
<td>4/8/03</td>
</tr>
<tr>
<td>2004</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>85,000</td>
<td>5.0</td>
<td>3/15/04</td>
</tr>
<tr>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>64,500</td>
<td>4.3</td>
<td>3/22/04</td>
</tr>
<tr>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td>64,000</td>
<td>5.0</td>
<td>3/29/04</td>
</tr>
</tbody>
</table>
11.9 **Fish Health Certification Procedures Applied to Pre-release**

None Proposed

11.10 **Emergency Release Procedures in Response to Flooding or Water System Failure.**

Flooding is not a concern at Mad River Hatchery because the facility was built above the 100-year flood plain. The hatchery well pumps are backed up with one emergency generators in the case of power failure. In the event of both primary and secondary power failure, it is conceivable that a portion of the steelhead production would be released into the tailrace. However, it is more conceivable that a secondary power failure would result in significant loss in production.

11.11 **Indicate Risk Aversion Measures That Will be Applied to Minimize the Likelihood for Adverse Genetic and Ecological Effects to Listed Fish Resulting from Fish Releases.**

The Mad River Hatchery Steelhead Program proposes yearling (smolt) releases prior to March 15 each year at a size of ≥ 10/lb. to minimize competition between hatchery and naturally spawned steelhead, Chinook and coho salmon.
SECTION 12.0 MONITORING AND EVALUATION OF PERFORMANCE INDICATORS

12.1 Monitoring and evaluation of “Performance Indicators”.

12.2 Describe plans and methods proposed to collect data necessary to respond to each “Performance Indicator” identified for the program.

Table 17 links the performance indicators that were presented in Section 2.9 with the proposed monitoring activities. Some performance indicators do not have a monitoring activity associated with them. The category of “none proposed” denotes that monitoring activity would not address genetic or ecological concerns or, in all likelihood, the results of the monitoring activity would not alter the Mad River Hatchery Steelhead Harvest Program.

Table 18 describes the monitoring activity within the tasks of each objective. Every activity is associated with a priority, status, identification of responsible agency and potential funding source.

This plan acknowledges that the need for Mad River Hatchery evaluation is unquestionably the primary responsibility of California Department of Fish and Game, the hatchery owner and operator. However, resource management stewardship for Mad River steelhead is the joint responsibility of both CDFG and NMFS.

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

Funding and staffing for full implementation of the monitoring and evaluation program have not been identified. Significant coordination efforts will be required between state and federal agencies to facilitate monitoring activities.

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

Monitoring and evaluation activities are subject to the take provisions of the ESA. NMFS pursuant to the 4d Rule of the ESA requires the use of sampling protocols and techniques to minimize any risk to individually listed fish. The Section 10 permit requirements are applicable to individual agency or person(s) responsible for the monitoring components of this project.
Table 17. Association of performance indicators with monitoring activity and sampling status.

<table>
<thead>
<tr>
<th>Performance Indicator</th>
<th>Monitoring Activity</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>B1</strong> Provide a predictable and stable opportunity for harvest.</td>
<td></td>
</tr>
<tr>
<td>Assess contribution to the recreational fishery</td>
<td>3.21 + 3.22</td>
</tr>
<tr>
<td><strong>B2</strong> Enhance local, regional, and state economies.</td>
<td></td>
</tr>
<tr>
<td>Establish increasing trend in the value of harvest by translating opportunity or angler day to dollars</td>
<td>None Proposed</td>
</tr>
<tr>
<td>Develop an overall economic impact assessment to compute direct, indirect and induced effects from Mad River Hatchery production</td>
<td>None Proposed</td>
</tr>
<tr>
<td><strong>B3</strong> Fulfill legal/policy obligations.</td>
<td></td>
</tr>
<tr>
<td>Assure that hatchery broodstock needs are met within ± 10% in 4 out of 5 years</td>
<td>1.17 2.14 through 2.18 3.11 + 3.12</td>
</tr>
<tr>
<td><strong>B4</strong> Provide fish to satisfy legal mandated harvest in a manner that eliminates impacts on weak hatchery and broodstock wild populations.</td>
<td></td>
</tr>
<tr>
<td>Develop a harvest management plan for hatchery fish</td>
<td>5.11</td>
</tr>
<tr>
<td>Compute ratio of wild fish to total harvest</td>
<td>3.21 + 3.22</td>
</tr>
<tr>
<td>Compute total harvest</td>
<td>3.21 + 3.22</td>
</tr>
<tr>
<td>Determine that the total harvest of wild fish populations of concern do not exceed the upper maximum of absolute number of wild fish</td>
<td>California fishing regulations do not permit the harvest of wild trout.</td>
</tr>
<tr>
<td>Establish and meet the natural population escapement goal ± 10%, 1 out of 5 years, where applicable</td>
<td>Natural population escapement goals are not established in Mad River</td>
</tr>
<tr>
<td><strong>B5</strong> Achieve within-hatchery performance standards.</td>
<td></td>
</tr>
<tr>
<td>Assure hatchery performance standards are met</td>
<td>6.11 through 6.13</td>
</tr>
<tr>
<td>Hatchery operational procedures are achieved</td>
<td>2.11 through 2.18</td>
</tr>
<tr>
<td>R1</td>
<td><strong>Implement a harvest management plan to protect weak populations where mixed population fisheries exist</strong></td>
</tr>
<tr>
<td>----</td>
<td>--------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td></td>
<td>Maximum allowable impact to weak populations not exceeded 4 out of 5 years ± 10%</td>
</tr>
<tr>
<td></td>
<td>Natural stocks are not impacted by this program</td>
</tr>
<tr>
<td></td>
<td>Monitor life history characteristics of weak populations for change by comparing the baseline at Year 1 and after one generation or six years</td>
</tr>
<tr>
<td></td>
<td>1.14 + 1.15</td>
</tr>
<tr>
<td></td>
<td>Maintain unique life history characteristics by comparing baseline at Year 1 and after one generation</td>
</tr>
<tr>
<td></td>
<td>1.15</td>
</tr>
<tr>
<td></td>
<td>Document that natural population escapement goal not adversely affected in 4 out of 5 years ± 10% for specific species and populations</td>
</tr>
<tr>
<td></td>
<td>1.18 + 3.11 + 3.12</td>
</tr>
<tr>
<td>R2</td>
<td><strong>Assure that program does not exceed the carrying-capacity of fluvial and estuarine habitats.</strong></td>
</tr>
<tr>
<td></td>
<td>Develop an appropriate monitoring plan to assure program does not exceed the carrying capacity of freshwater habitats</td>
</tr>
<tr>
<td></td>
<td>3.11</td>
</tr>
<tr>
<td></td>
<td>Develop an appropriate monitoring plan to assure program does not exceed the carrying capacity of Mad River estuary</td>
</tr>
<tr>
<td></td>
<td>4.12 through 4.14</td>
</tr>
<tr>
<td>R3</td>
<td><strong>Assess detrimental genetic effects among hatchery vs. wild where interaction exists</strong></td>
</tr>
<tr>
<td></td>
<td>Assess genetic effects through stray rates as a surrogate for a thorough and more complex measurement of genetic effects</td>
</tr>
<tr>
<td></td>
<td>3.11</td>
</tr>
<tr>
<td></td>
<td>Determine genetic analysis of Mad River stocks. Make specific genetic comparisons including allele frequencies, between hatchery and wild steelhead as a measure of hatchery steelhead introgression, as needed</td>
</tr>
<tr>
<td></td>
<td>1.11 through 1.18</td>
</tr>
<tr>
<td>R4</td>
<td><strong>Assure there is a predictable egg supply to avoid poor programming of hatchery production</strong></td>
</tr>
<tr>
<td></td>
<td>Achieve egg take goal in 4 out of 5 years.</td>
</tr>
<tr>
<td></td>
<td>2.11 + 2.17 + 2.18</td>
</tr>
<tr>
<td></td>
<td>Implement CDFG disease protocols in any event involving egg transfer to the hatchery</td>
</tr>
<tr>
<td></td>
<td>CDFG Policy prohibits inter-basin stock transfers</td>
</tr>
<tr>
<td>R5</td>
<td><strong>Production cost outweighs fishery benefits</strong></td>
</tr>
<tr>
<td></td>
<td>Evaluate the trend in ratio of hatchery juvenile production cost per cost of juvenile production from habitat projects by subbasin per adult production</td>
</tr>
<tr>
<td></td>
<td>Hatchery production cost ≤ 1, in 4 out of 5 years</td>
</tr>
<tr>
<td></td>
<td>None Proposed</td>
</tr>
<tr>
<td></td>
<td>Achieve the highest numerical ratio of returning adults per cost of action (hatchery or habitat)</td>
</tr>
<tr>
<td></td>
<td>Achieve the highest numerical ratio of intrinsic social value of returning adults or recovery of healthy viable population levels per cost of hatchery or habitat</td>
</tr>
<tr>
<td>Action</td>
<td>Description</td>
</tr>
<tr>
<td>-----------------------------------------------------------------------</td>
<td>-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
</tbody>
</table>
| Cost effectiveness of hatchery ranked lower than other actions in the subregion or basin | - Develop cost effective methods of producing benefits to the recreational fishery
- Achieve the highest numerical ratio of returning adults per cost of action (hatchery or habitat)
- Achieve the highest numerical ratio of intrinsic social value of returning adults or recovery of healthy viable population levels per cost of hatchery or habitat | None Proposed |
| Evaluate habitat use and potential detrimental ecological interactions. | - Selected tributaries by subbasin and hatchery by species conducted comparative evaluation of pre-stocking population with post stocking population after one generation
- Extrapolate monitoring results to other tributaries or sub basins, as appropriate
- Develop a monitoring and evaluation plan for the Mad River estuary using experimental design recommended by NMFS Fisheries | 4.12 + 4.13 |
| Avoid disease transfer between stocks.                                | - Establish comparative annual sampling of disease in hatchery and wild populations
- Compliance with CDFG standards and NMFS Fisheries guidelines
- Apply disease standards to stocking activities
- Evaluate incidence of drug resistant pathogens by comparing baseline in Year 1 and after one generation, where necessary | 2.14 through 2.16 |
| Evaluate effect on life-history traits of wild and hatchery fish, from harvest and spawning escapement | - Track specific life history trends to evaluate change by comparing a baseline at year 1 with a 5-year survey, or after one generation | 1.15 |

Table 18 provides a description of each monitoring activity proposed by this plan in association with:

- priority, status, responsible agency or agencies for collection and reporting and potential funding source
<table>
<thead>
<tr>
<th><strong>Objective 1.0</strong></th>
<th><strong>Maintain Steelhead Genotypes</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Activity</strong></td>
<td><strong>Description</strong></td>
</tr>
<tr>
<td>Task 1.1</td>
<td>Collect tissue samples and conduct DNA analysis.</td>
</tr>
<tr>
<td>Activity 1.11</td>
<td>Inventory tissue archives and determine the need for additional sampling in Mad River</td>
</tr>
<tr>
<td>Activity 1.12</td>
<td>Collect tissue samples, as needed</td>
</tr>
<tr>
<td>Activity 1.13</td>
<td>Analyze tissue samples, as needed</td>
</tr>
<tr>
<td>Activity 1.14</td>
<td>Develop genotypic classification of hatchery and key or index natural stocks and compare genetic structure for change</td>
</tr>
<tr>
<td>Activity 1.15</td>
<td>Compare hatchery and key or index natural stocks for change in phenotypic and life history characteristics</td>
</tr>
<tr>
<td>Activity 1.16</td>
<td>Evaluate the relative fitness of hatchery-reared adults spawning in and key or index tributaries</td>
</tr>
<tr>
<td>Activity 1.17</td>
<td>Conduct six year review and adapt hatchery spawning protocol to preserve genotypes, minimize inbreeding and outbreeding depression</td>
</tr>
<tr>
<td>Activity 1.18</td>
<td>Ascertain whether hatchery steelhead increase, maintain or decrease natural steelhead stocks.</td>
</tr>
<tr>
<td>ACTIVITY</td>
<td>DESCRIPTION</td>
</tr>
<tr>
<td>------------</td>
<td>-----------------------------------------------------------------------------</td>
</tr>
<tr>
<td><strong>OBJECTIVE 2.0</strong></td>
<td><strong>DETERMINE IF THE HATCHERY PRODUCTS ARE MEETING PROGRAM GOALS AND PERFORMANCE EXPECTATIONS.</strong></td>
</tr>
<tr>
<td><strong>TASK 2.1</strong></td>
<td><strong>MONITOR IN-HATCHERY OPERATIONS ND MAINTAIN PERFORMANCE REQUIREMENTS</strong></td>
</tr>
<tr>
<td>Activity 2.11</td>
<td>Assess fertilization, egg-to-fry, fry-to-parr, parr-to-smolt survival rate. Maintain at ( \geq 75% )</td>
</tr>
<tr>
<td>Activity 2.12</td>
<td>Document numbers, size, time of yearling release</td>
</tr>
<tr>
<td>Activity 2.13</td>
<td>Volitional yearling release</td>
</tr>
<tr>
<td>Activity 2.14</td>
<td>Comply with CDFG hatchery standards for diseases prevention and hatchery maintenance.</td>
</tr>
<tr>
<td>Activity 2.15</td>
<td>Identify and assess factors that caused disease outbreak</td>
</tr>
<tr>
<td>Activity 2.16</td>
<td>Treat disease outbreak and increase sampling intensity, as needed</td>
</tr>
<tr>
<td>Activity 2.17</td>
<td>Steelhead yearling production levels adhere to program, goals and constraints</td>
</tr>
<tr>
<td>Activity 2.18</td>
<td>Mark hatchery steelhead with an adipose fin-clip for identification</td>
</tr>
<tr>
<td><strong>OBJECTIVE 3.0</strong></td>
<td><strong>STEELHEAD POPULATION ABUNDANCE</strong></td>
</tr>
<tr>
<td><strong>TASK 3.1</strong></td>
<td><strong>ESTIMATE HATCHERY AND NATURAL STEELHEAD RETURN</strong></td>
</tr>
<tr>
<td>Activity 3.11</td>
<td>Determine the number of hatchery returns to Mad River Hatchery and key or index tributaries</td>
</tr>
<tr>
<td>Activity 3.12</td>
<td>Quantify the abundance of naturally produced winter-run steelhead in Mad River every xth(^1) year.</td>
</tr>
</tbody>
</table>

\(^1\)To be determined
<table>
<thead>
<tr>
<th>ACTIVITY</th>
<th>DESCRIPTION</th>
<th>PRIORITY</th>
<th>STATUS</th>
<th>AGENCY</th>
<th>FUND SOURCE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Activity 3.13</td>
<td>Implement the elements of the Steelhead Restoration and Management Plan &amp; California Action Plan for Monitoring California’s Coastal Anadromous Salmonids</td>
<td>High</td>
<td>Needed</td>
<td>CDFG</td>
<td>TBA</td>
</tr>
<tr>
<td>TASK 3.2</td>
<td>Estimate Angler Harvest of hatchery steelhead and the incidental take of natural steelhead stocks</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Activity 3.21</td>
<td>Determine angler effort, total catch, CPUE, hatchery catch and harvest rate and incidental take of natural steelhead using Steelhead Report Card</td>
<td>High</td>
<td>Ongoing</td>
<td>CDFG</td>
<td>CDFG</td>
</tr>
<tr>
<td>Activity 3.22</td>
<td>Creel survey Mad River to estimate the number of angler-caught hatchery and wild steelhead</td>
<td>Moderate</td>
<td>Needed</td>
<td>CDFG</td>
<td>Unknown</td>
</tr>
</tbody>
</table>

**OBJECTIVE 4.0**

<table>
<thead>
<tr>
<th>TASK 4.1</th>
<th>DETERMINE AFFECT OF HATCHERY YEARLINGS TO FISH POPULATIONS IN MAD RIVER BELOW THE HATCHERY</th>
<th>Moderate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Activity 4.12</td>
<td>Compare juvenile density of natural spawned steelhead before and after hatchery yearling plant</td>
<td>Moderate</td>
</tr>
<tr>
<td>Activity 4.13</td>
<td>Monitor natural and hatchery yearling emigration time</td>
<td>Moderate</td>
</tr>
<tr>
<td>Activity 4.14</td>
<td>Evaluate natural and hatchery yearling estuary residence</td>
<td>Moderate</td>
</tr>
</tbody>
</table>

**OBJECTIVE 5.0 FISHERIES MANAGEMENT**

<table>
<thead>
<tr>
<th>TASK 5.1</th>
<th>MINIMIZE THE AFFECT OF HATCHERY OPERATIONS ON MAD RIVER FISH POPULATIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Activity 5.11</td>
<td>Revise fishing regulations for hatchery marked steelhead to reflect adult abundance and straying rate</td>
</tr>
<tr>
<td><strong>ACTIVITY</strong></td>
<td><strong>DESCRIPTION</strong></td>
</tr>
<tr>
<td>--------------</td>
<td>----------------</td>
</tr>
<tr>
<td><strong>OBJECTIVE 6.0.</strong></td>
<td><strong>RESOURCE MANAGER COORDINATION, COMMUNICATION AND MANAGEMENT</strong></td>
</tr>
<tr>
<td><strong>TASK 6.1</strong></td>
<td><strong>DATA MANAGEMENT AND REPORTS</strong></td>
</tr>
<tr>
<td>Activity 6.11</td>
<td>Develop annual hatchery production reports</td>
</tr>
<tr>
<td>Activity 6.12</td>
<td>Develop project monitoring reports</td>
</tr>
<tr>
<td>Activity 6.13</td>
<td>Facilitate coordination meeting for hatchery operation and production review every six years.</td>
</tr>
</tbody>
</table>
SECTION 13. CITATIONS


Bjornn, T.C. 1969. Embryo Survival and Emergence Studies: Spawning and Emergence of Chinook Salmon as Related to Temperature. Idaho Fish and Game Department. 23 pp.


Shapovalov, L., and A.C. Taft. 1954. The Life Histories of the Steelhead Rainbow Trout (*Salmo gairdneri gairdneri*) and Silver Salmon (*Oncorhynchus kisutch*) with Special Reference to Waddell Creek, California, and Recommendations Regarding Their Management. California Department of Fish and Game, Fish Bulletin No. 98. 375 pp.


Taylor, S. undated. California Department of Fish and Game Policies Affecting Public Salmon and Steelhead Restoration Programs. pages 62-72


Section 13.1 Personal Communication


"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, and Signature of Applicant:

Certified by_____________________________ Date:_____________
**Section 15.0. Estimated Listed Salmonid Take Levels by Hatchery Activity**

**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:** Northern California  
**Location of hatchery activity:** Mad River Hatchery  
**Dates of activity:** Year-round  
**Hatchery program operator:** CDFG

**Activity:** Steelhead Program

### Annual Take of Listed Fish By Life stage (Number of Fish)

<table>
<thead>
<tr>
<th>Life stage</th>
<th>Egg/Fry</th>
<th>Juvenile/Smolt</th>
<th>Adult</th>
<th>Carcass</th>
</tr>
</thead>
<tbody>
<tr>
<td>Observe or harass a)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Collect for transport b)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Capture, handle, and release c)</td>
<td>annual mean 79 (range 8 to 238)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Capture, handle, tag/mark/tissue sample, and release d)</td>
<td>same as c</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Removal (e.g., broodstock) e)</td>
<td>10</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intentional lethal take f) hooking mortality</td>
<td>10</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unintentional lethal take g)</td>
<td>≤5% of total number trapped</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Other Take (specify) h)** pathology (only unlisted steelhead will be sampled to the greatest extent possible)

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.
**ATTACHMENT 1**

**DEFINITION OF 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)** – NOAA Fisheries definition of a distinct population segment (the smallest biological unit that will be considered to be a species under the ESA). 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.

**F2** – Refers to the generations removed from the parental generation. F1 refers to the progeny of a given parental cross; F2 refers to the offspring of those progeny.

**Harvest project** – Projects designed for the production of fish that are primarily 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 primarily 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 primarily 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 primarily 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.