February 2017

4(d) Rule Limit 5
Evaluation and Recommended Determination

Title of HGMP: Hatchery and Genetic Management Plan for Mad River Hatchery Steelhead

HGMP Submitted by: California Department of Fish and Wildlife

ESU/DPSs: California Coastal Chinook Salmon ESU
Southern Oregon/Northern California Coho Salmon ESU
Northern California Steelhead DPS

4(d) Rule Limit: ESA 4(d) Rule Limit 5

NMFS Tracking Number: WCR-2016-5423

1 BACKGROUND

NOAA's National Marine Fisheries Service (NMFS) issued a final Endangered Species Act (ESA) 4(d) Rule adopting regulations necessary and advisable to conserve salmonid species listed as threatened under the ESA (65 FR 42422, July 10, 2000; 70 FR 37160, June 28, 2005). The 4(d) rule exempts the take of salmon and steelhead listed as threatened species under the ESA if the entity follows a Hatchery and Genetics Management Plan (HGMP) that meets the 4(d) rule criteria and is approved by NMFS (July 10, 2000, 65 FR 42422, amended June 28, 2005, 70 FR 37160).

The HGMP provides the framework through which California Department of Fish and Wildlife (CDFW) manages the Mad River Hatchery operations, and monitoring, and evaluation activities, while meeting requirements specified under the ESA. CDFW developed the plan, with technical assistance from NMFS, and has provided the HGMP for review and determination by NMFS as to whether the plan addresses the criteria of limit 5 of the 4(d) Rule, and whether limitation of application of ESA section 9 take prohibitions will therefore apply for hatchery and associated monitoring and evaluation actions operating consistent with the HGMP.

2 PROPOSED ACTION

NMFS describes a hatchery program as a group of fish that have a separate purpose and that may have independent spawning, rearing, marking, and release strategies (NMFS 1999). The operation and management of every hatchery program is unique in time, and specific to an identifiable stock and its native habitat (Flagg et al. 2004). In this case, the Proposed Action is NMFS' proposed approval of the CDFW's Mad River HGMP (CDFW 2016) that proposes to collect adult winter steelhead and release juvenile steelhead into the Mad River near Blue Lake, California.

In November 2014, the CDFW submitted a final HGMP pursuant to the 4(d) Rule for the Mad River Hatchery (MRH) winter-run steelhead program to NMFS's Northern California Office in Arcata, California. The CDFW requested final review and approval of the HGMP under the 4(d) Rule Limit 5. The 2014 HGMP was then modified in response to public comments and resubmitted to NMFS to facilitate this consultation (CDFW 2016). The Mad River HGMP (2016) outlines the winter-run NC steelhead supportive breeding and associated monitoring and evaluation actions that would occur in the lower Mad River watershed. The MRH is currently operating under a court settlement agreement and releases winter-run NC steelhead into the lower Mad River. The proposed HGMP actions include:

1. Broodstock would be collected at MRH and throughout the Mad River watershed using seining, angling, volitional entry into the fish ladder, and weir collection methods. All natural-origin steelhead in excess of broodstock needs will be immediately released, at the collection location. Broodstock would include both hatchery and natural fish. Natural broodstock would be incorporated into the spawning population in the same proportions as collected, such that 50-100 percent of the hatchery broodstock, with a target of 67%, would be of natural origin. Collections will be made throughout the run. Since the MRH may take up to 100 percent of their broodstock from the natural population, the number of natural fish collected for broodstock will follow the same rules for spawning at the hatchery, which means they will be collected based on a bell-shaped curve or normal distribution so that it is representative of the natural run, which means the collection will be apportioned based on the expected number of fish that comprise the run over time. Up to 250 adult steelhead or up to approximately 10% of the natural spawning population would be collected for broodstock. Collection methods may include volitional entry into the MRH fish ladder, seining, angling, or weir operations. Collection will primarily rely on volitional entry into the ladder; however, if the goal of using at least 50% natural-origin spawners cannot be met, then angling, seining, or weirs will be employed, in that order. Weirs would consist of temporary pipe weirs placed in tributary streams and anytime weirs are in operation they would be manned and non-target fish would be immediately placed upstream of the weir. Weirs would only operate to catch the target goal of broodstock and would not be used for enumeration or other purposes. Spawning would occur at the Mad River Hatchery. The hatchery would release adult fish, of both natural and hatchery origin, not used in the broodstock process back into the Mad River. Additionally, natural-origin fish used for spawning would be rehabilitated and released to encourage survival and repeat spawning. Any mortalities that occur in the hatchery ladder or spawning facility will be relocated into the Mad River above the hatchery to promote ecosystem function.
2. Egg incubation and juvenile fish would be reared at the MRH for approximately one year prior to being released.
3. The MRH would release up to 150,000 juvenile steelhead into the Mad River during March and April each year. Before they are released, all juvenile steelhead will have their adipose fin clipped off to mark them as hatchery fish. Clipping the adipose fin of 100 percent of the hatchery-origin juveniles prior to release would make these fish

distinguishable from naturally produced fish, and provide options for management of fisheries that can selectively target hatchery-produced fish.

4. Monitoring and evaluation activities would assess the performance of the program in meeting conservation, harvest augmentation, and risk minimization objectives for listed fish. Monitoring activities may include use of DIDSON or other sonar equipment to count fish; mark-recapture and run apportionment activities using seining, angling, and snorkeling; and collection of adult and juvenile steelhead using traps, seines, or other methods for genetic analysis and population monitoring. Species apportionment is necessary because the DIDSON does not discern fish by species so additional observations are necessary to determine what proportion of fish observed by the DIDSON belong to which species. Broodstock collection activities that require the use of a seine or angling will be scheduled to occur at the same time as species apportionment activities, if possible, to reduce the capture of coho salmon, Chinook salmon, and steelhead.
5. The hatchery would be operated as an integrated hatchery program. The Proposed Action would also be consistent with the *Steelhead Restoration and Management Plan for California* (McEwan and Jackson 1996). MRH spawning protocol would use one male for each sub-lot (two lots per female) derived from two different females. Mad River Hatchery would also incubate each lot separately to afford equalization (and documentation) of each family group contribution, if needed[1].
6. No construction would occur.

The number and species of fish expected to be collected or otherwise affected by broodstock collection and monitoring programs is found in Table 1 and Table 2.

[1] Culling options may require the participation of the NMFS Southwest Fisheries Science Center.

Table 1. The number and species of adult, natural-origin steelhead, coho salmon, and Chinook salmon that may be collected annually during broodstock collection and monitoring operations under the Mad River HGMP. Expected mortalities (morts) are in parentheses and are based on observed mortalities in this and other similar programs.

	Ladder (morts)	Angling (morts)	Seining (morts)	Weirs (morts)
Steelhead*	175-300 (1)	175-300 (1)	175-300 (1)	175-300 (1)
Coho salmon	3 (0)	3 (0)	10 (0)	3 (0)
Chinook salmon	5 (0)	40 (1)	300 (1)	5 (0)

* The number of NC steelhead collected by each method will vary depending on the effectiveness of using the preferred method. The preferred order for broodstock collection is the ladder, angling, seining, and weirs. As such, the collection of coho salmon and Chinook salmon will also vary depending on which method or combination of methods is used. In addition, monitoring activities that require the capture of adult salmon and steelhead will be scheduled to coincide with broodstock collection activities, if necessary and when possible, to reduce the number of salmonids captured and potentially injured or killed. No more than 125-250 adult steelhead may be taken for broodstock and, at this level, up to another 50 may be captured during ME&R activities

Table 2. The number and species of juvenile steelhead, Chinook salmon, and coho salmon annually collected as part of monitoring, evaluation and research that may be conducted as part of the HGMP implementation. Most fish would be captured, enumerated and released, but a certain proportion will be marked and used to develop capture statistics and population estimates. The maximum expected injuries/mortalities from all activities are in parentheses.

	Fry	Juvenile	Smolt
Steelhead	45000 (450)	65000 (650)	15000 150
Chinook salmon	42500 (425)	N/A	256000 (2560)
Coho salamon	3600 (36)	5000 (50)	6000 (60)

The action area for the Mad River HGMP includes all areas of the Mad River accessible to steelhead adults and juveniles that are produced at the Mad River Hatchery, which can be defined as all mainstem and tributaries of the Mad River below Ruth Dam that are accessible or may become accessible in the future as a result of natural or human events. NMFS acknowledges that steelhead from the Mad River Hatchery are also present in the Pacific Ocean and a very small number of fish may stray to streams outside of the Mad River watershed. However, NMFS believes that the effects of either straying or hatchery steelhead presence in the Pacific Ocean is

negligible due to the low number of fish that stray (*e.g.,* 0.3%-2.3%; Westley et al. 2013) and the relatively small number of fish that the steelhead from the Mad River represent in the Pacific Ocean.

3 EVALUATION

The following discussion evaluates whether the submitted plans address the criteria in section 223.203(b)(5) of the 4(d) Rule for salmon and steelhead.

3.1 Limit 5 Criteria and HGMP Evaluation

3.1.1 5(i)(A) The HGMP has clearly stated goals, performance objectives, and performance indicators that indicate the purpose of the program, its intended results, and measurements of its performance in meeting those results.

Goals, performance objectives (standards), and performance indicators for the Mad River Hatchery steelhead program are clearly described in sections 1.7, 1.9, and 1.10, respectively, of the HGMP (CDFW 2016).

The general goal of the program described in section 1.7 of the HGMP is to provide a viable recreational fishery for winter steelhead on the Mad River. The hatchery will be operated as an integrated program (HSRG 2004) with conservation potential to reduce divergence between the hatchery and natural population in the Mad River and provide for hatchery-base recovery if the natural-origin population precipitously declines.

NMFS (2003) recommends the use of the Artificial Production Review: Report and Recommendations of the Northwest Power Planning Council (NPPC 1999) to develop criteria for hatchery program benefit and risk assessments. The concepts for performance standards for the Steelhead Program at MRH originated from this publication (Table 3).

Table 3. Mad River Hatchery program performance standards

Performance standard	Definition
Achieve best management hatchery objectives	Culture practices developed by CDFW to increase life-stage specific survival rates, protect the genetic resources of the cultured and naturally-produced population, produce a high quality rearing environment, and comply with effluent discharge requirements
Produce high quality smolts	A high quality smolt is defined as having similar genetic, physical, behavioral traits and survival rates of naturally-produced smolts
Achieve production targets	Collect, culture, and release the number of adults, eggs, and juveniles required to achieve

	yearly production targets (150k smolt release)
Achieve conservation objectives	The conservation objective of the program is to protect the genetic resources of the natural Mad River winter steelhead population
Achieve harvest objectives	Provide for recreational harvest of Mad River hatchery-origin steelhead

Responsive monitoring and evaluation actions that would be implemented to collect information relevant to each indicator are also described in that section. Separate performance standards, indicators, and monitoring and evaluation actions are presented to track achievement of hatchery program performance relative to objectives, and monitor program effects on affected fish populations. HGMP implementation approaches would be generally designed to determine program consistency with proposed hatchery actions and intended results (e.g., juvenile fish release and adult return levels); measurement of the program's success or failure in attaining results; and effects of the program on natural-origin fish populations in the Mad River.

In general, species-specific standards and indicators included in each HGMP address the four viable salmonid population parameters for the native salmon populations that are the subjects of the plans. Performance standards and indicators addressing abundance would track achievement of broodstock collection goals by origin (hatchery or natural); maintenance of on-station juvenile fish release objectives; the status of *total* adult return levels and returns by origin; and natural smolt production. Performance standards and indicators addressing productivity would track hatchery smolt to adult survival rates and natural-origin population growth and recruitment. Population spatial structure standards and indicators would address hatchery and natural adult fish migration dispersal in the watershed. Program standards and indicators for diversity would track hatchery program success in maintaining hatchery populations that would retain the genetic traits of the native steelhead population, marking all hatchery-origin fish to allow for monitoring of program effects on diversity, and determining broodstock and spawner composition by origin.

For the proposed program, annual natural and hatchery-origin salmon and steelhead population abundances would be assessed by monitoring adult returns to the Mad River and to the hatchery. Abundance estimates derived through these methods would be evaluated to determine the status of the listed Chinook salmon steelhead, and coho salmon populations relative to recovery criteria. The estimated contribution of hatchery-origin steelhead to the hatcheries, recreational fishery, and to natural spawning areas would be monitored by marking all hatchery-origin fish prior to their release as juveniles to allow for their distinction from natural-origin fish upon return as adults. Estimates of fish-origin would be made based on mark observation and recovery, and age class composition through scale sampling. Using mark recovery information, the number of natural and hatchery-origin steelhead contributing to annual escapement would be estimated.

Assessments of natural-origin steelhead, Chinook salmon, and coho salmon productivity would be enabled by monitoring of natural-origin adult abundances and trends through hatchery escapement levels and adult monitoring in the Mad River. The productivity performance standards and indicators proposed for steelhead produced by the hatchery would be assessed

through review of broodstock collection, holding, and spawning results, and the performance of the hatchery program in producing healthy fish, meeting desired smolt to adult survival rates, and meeting the program goal of providing a robust fishery while minimizing the effects on natural-origin steelhead and salmon in the Mad River.

The degree to which the steelhead program meet performance standards and indicators for spatial structure would be determined through adult monitoring and, potentially, spawning ground surveys conducted upstream and downstream of the Mad River Hatchery.

Compliance with diversity-related performance standards and indicators would be indicated through completion of genetic analyses of steelhead escaping to natural spawning areas and the hatchery, and annual tracking of population morphometric, meristic, and life history characteristics. Monitoring of the number and proportion of hatchery-origin and natural-origin steelhead in natural spawning areas within the action area would be an additional diversity indicator.

3.1.2 5(i)(B) The HGMP utilizes the concepts of viable and critical salmonid population thresholds, consistent with the concepts contained in the technical document entitled "Viable Salmonid Populations."

HGMPs proposed for consideration under the 4(d) Rule must use the concepts of viable and critical thresholds as defined in the NMFS Viable Salmonid Population (VSP) document (McElhany et al. 2000). Application of these VSP concepts is needed to adequately assess and limit the take of listed salmonids for the protection of the species. Listed salmonids may be purposefully taken for broodstock purposes only if: the donor population is currently at or above the viable threshold and the collection will not impair its function; the donor population is not currently viable but the sole objective is to enhance the propagation or survival of the listed ESU; or the donor population is shown with a high degree of confidence to be above the critical threshold although not yet functioning at viable levels, and the collection will not appreciably slow attainment of viable status for that population.

The Mad River is part of the Central Coast diversity stratum for Southern Oregon/Northern California Coast (SONCC) coho salmon, and the North Coastal diversity stratum for California Coastal (CC) Chinook salmon and Northern California Coast (NC) winter steelhead (Spence et al. 2008, Williams et al. 2008). In addition, the Mad River is part of the Northern Coastal/North Mountain Interior diversity stratum for NC summer steelhead. For CC Chinook salmon and NC steelhead, the Mad River is identified as an area that should ultimately support a viable population (one at low risk of extinction) because these populations are expected to play a key role in recovery of the ESU or DPS. In order for an ESU or DPS to be viable and eligible for delisting, all diversity strata that make up that ESU or DPS must be viable (Spence et al. 2008, Williams et al. 2008). Coho salmon only have to achieve a moderate level of extinction risk. Given the current expected roles of each population in recovery, the Mad River must support a viable population in order for the Central Coastal and Northern Coastal diversity strata of Chinook

salmon and NC steelhead, respectively, to be viable. Table 4 provides a summary of the status of coho salmon, steelhead, and Chinook salmon in the action area (Mad River).

Table 4. Status of the three ESA-listed salmonid species' populations found within the action area—the Mad River—as outlined in each species recovery, or draft recovery plans.

	SONCC Coho Salmon	**CC Chinook Salmon Fall-Run**	**NC Steelhead (Winter-Run)**	**NC Steelhead (Summer-run)**
Population within the Action Area	Mad River	Mad River	Mad River	Mad River
Diversity Stratum	Central Coastal	North Coastal	North Coastal/North Mountain Interior	North Coastal/North Mountain Interior
Role within ESU/DPS	Functionally Independent	Functionally Independent	Functionally Independent	Functionally Independent
Extinction Risk	High	Low*	Low*	High*
Depensation Threshold	Likely below	Above*	Above*	Below*
Spawner Abundance Target	612 adults	3,000 adults	Lower Mad River=3,200 adults Upper Mad River=6,100 adults	Effective populations size N_e>=500
Most recent 5-Year Viability report	Williams et al., 2016	Williams et al., 2016	Williams et al., 2016	Williams et al., 2016

*The Multispecies Recovery Plan (NMFS 2016) did not assign extinction risk categories or address depensation levels, so professional judgement was used to assign these categories to be consistent with the SONCC Coho Salmon Recovery Plan.

Actual population estimates for coho salmon, summer-and winter- steelhead, and Chinook salmon are limited. CDFW has been operating sonar and apportioning results to species in the Lower Mad River since 2013. Preliminary estimates for 2013-2014 are 2,174 adult (does not include jacks) Chinook salmon and 7,785 winter steelhead of which 4,336 were of hatchery origin and 3,449 were naturally produced (Michael Sparkmann, CDFW, pers. comm., 2016). In addition, snorkel surveys for summer steelhead observed 282 summer steelhead in 2013 and 322 in 2014. Numbers for 2015 are not yet compiled; however, at least 1,900 Chinook salmon were counted in the lower Mad River during a one-time snorkel survey suggesting the numbers are likely similar to 2013-2014 (Michael Sparkmann, CDFW, pers. comm., 2016). Expansion of coho salmon

sonar and apportionment data has not been conducted due to the low number of coho salmon observed.

The viability goals would be used as reference points for identifying the status of the listed salmon and steelhead populations during implementation of the hatchery program. The goals would be used to gauge the program performance and effects in achieving population recovery goals and conservation or risk reduction objectives specified in the HGMP, and for determining the need for adjustment of the hatchery actions. General descriptions of how the Mad River hatchery program for winter steelhead would be implemented to not harm the viability status of listed Mad River CC Chinook salmon, NC steelhead, and SONCC coho salmon are provided below.

In each review of an HGMP, NMFS starts from this viewpoint and applies all relevant scientific information (including new studies), as well as other relevant factors specific to the watershed where the proposed hatchery operations take place, in order to complete its determination. Considering that the Mad River winter steelhead population is currently well above the depensation threshold and because the HGMP applies VSP criteria that are incorporated as recovery goals and into monitoring objectives, it is consistent with this 4(d) rule criterion that listed winter steelhead may be purposefully taken for use as broodstock.

3.1.3 5(i)(C) Taking into account health, abundances, and trends in the donor population, broodstock collection programs reflect appropriate priorities.

The proposed hatchery steelhead program account for the health, abundance, and trends in the listed Mad River Chinook salmon, coho salmon, and steelhead populations affected by broodstock collection actions, and reflect appropriate priorities, consistent with the conservation and harvest augmentation intent of the HGMP. Under this 4(d) Rule criterion, the prioritized purpose of a broodstock collection program using listed fish is to provide a fishery while reducing the effect of hatchery fish on natural Chinook salmon, steelhead, and coho salmon populations in the Mad River. Consistent with this prioritized purpose, the Mad River Hatchery steelhead program would be operated using conservation principles. The Mad River Hatchery steelhead program would be implemented using methods that would adequately safeguard listed fish in the Mad River that are affected incidentally by broodstock collection activities.

As described in the HGMP (CDFW 2016), the proposed hatchery steelhead program takes into account the health, abundance, and trends for the ESA-listed winter steelhead population population by incorporating natural-origin fish (50-100% PNI) as broodstock to maintain the genetic diversity of the native population and limiting removal levels of returning adult fish from the natural environment (no more than 10%) as the status of the natural population improves. Broodstock are collected from indigenous-origin adults returning to the Mad River. To allow for their differentiation from natural-origin steelhead, all hatchery-origin fish would receive an adipose fin clip, enabling detection and parsing of fish by origin during broodstock collection operations that would help meet genetic diversity preservation objectives.

Measures are applied to safeguard the health and abundance of listed Chinook salmon, coho salmon, and steelhead in the Mad River that may be affected incidentally by broodstock collection activities associated with the proposed steelhead hatchery program. Steelhead broodstock are primarily collected as volunteers to the Mad River Hatchery ladder during the adult return period for the species, and incidental effects on listed Chinook salmon and coho salmon are rare In-river activities proposed to collect steelhead broodstock (i.e., opportunistic seining during monitoring activities, hook and line capture, and operation of tributary weirs) would be confined to specific locations and periods to reduce the risk of negative impacts on spawning Chinook and coho salmon adults and their redds and would only be conducted if broodstock needs are not met with volitional ladder captures. Any listed Chinook salmon and coho salmon that are unintentionally captured during broodstock collection actions would be immediately released. The carcasses of steelhead, both hatchery and natural-origin that die during holding or spawning operations would be returned to the Mad River as a means to benefit rearing natural-origin listed fish through nutrient enhancement.

The above approaches support a finding that the proposed broodstock collection activities for the program reflect appropriate priorities for benefiting and safeguarding the donor natural-origin steelhead population for the Mad River Hatchery steelhead program, and the listed Chinook salmon and coho salmon populations that may be incidentally affected by broodstock collection activities associated with the proposed hatchery salmon program.

3.1.4 5(i)(D) The HGMP includes protocols to address fish health, broodstock collection, broodstock spawning, rearing and release of juveniles, deposition of hatchery adults, and catastrophic risk management.

The Mad River Hatchery HGMP includes protocols or “best management practices” (BMPs) for fish health, broodstock collection, broodstock spawning, rearing and release of juveniles, disposition of hatchery adults, and catastrophic risk management. These practices, when implemented, would be appropriate for their purpose of adequately limiting the risk of substantial direct and incidental adverse effects on listed fish in the Mad River watershed for the following reasons.

Fish Health

BMPs addressing fish health, including fish health maintenance and hatchery sanitation procedures applied during broodstock collection, mating, fish incubation, rearing, and release, are detailed in performance standard and indicator, adult management, and fish rearing and release sections of each of the Mad River Hatchery steelhead HGMP. Fish health monitoring and evaluation measures are also described in those HGMP sections.

The hatchery program would be operated in compliance with “California Department of Fish and Wildlife Fish Health Policy for Anadromous Fish Hatcheries” protocols (CDFW 2014). The policy would “protect the anadromous salmonid resources of the State of California by restricting the importation, dissemination, and amplification of pathogens and diseases known to adversely

affect fish." For all steelhead propagated through the Mad River Hatchery program, CDFW fish health pathologists and veterinarians would provide fish health management support and diagnostic fish health services (CDFW 2016).

Adult fish collected as broodstock for the program would be held at the hatcheries before they are spawned. Minimally invasive fish health maintenance procedures would be conducted during the pre-spawn holding period to reduce the risk of handling injuries that would lead to secondary infections (e.g., dermal fungal invasion). Behavior and external condition of the fish would be routinely observed, in addition to occasional non-lethal sampling to detect external parasites in conjunction with other handling. Any fresh pre-spawning mortalities of adult fish would be removed from holding ponds and examined. If necropsy is warranted, the carcass would be either examined immediately by fish health staff or frozen and examined during the next monitoring visit. At the time of annual spawning, non-lethal monitoring of adult fish and gametes would be conducted to for pathogens and parasites. Fish health would be monitored by hatchery staff throughout the juvenile fish rearing periods at the hatcheries. CDFW fish health professional staff would visit the hatchery fish rearing sites monthly, or as needed, to perform routine monitoring of juvenile fish, advise hatchery staff on disease findings, and recommend remedial or preventative disease treatments with administration of therapeutic and prophylactic treatments when appropriate. All fish scheduled for release from the hatcheries would be certified as disease-free prior to release through collection and diagnostic analysis of representative samples of pre-smolts. CDFW maintains a fish health database to identify trends in fish health and disease and implement fish health management plans based on findings.

BMPs for monitoring the health of fish the Mad River Hatchery specified in the fish health policy (CDFW 2014; CDFW 2016) help reduce the likelihood of disease transmission from hatchery steelhead to naturally produced fish. When implemented, these BMPs would help contain any fish disease outbreaks in the hatchery, minimizing the release of diseased fish from the hatchery, and reducing the risks of disease transfer and amplification to natural-origin fish (NMFS 2012). BMPs applied to minimize risks of adverse effects on listed Chinook salmon, coho salmon, and steelhead associated with fish disease pathogen transfer and amplification for the Mad River Hatchery HGMP are based on best available science, and are expected to be sufficiently protective of listed natural and hatchery fish populations.

Broodstock Collection

Sections 6 and 7 of the HGMPs describe BMPs for broodstock selection and collection, carrying forth salmon production goals and objectives for the hatchery program, and addressing adult fish capture, transport, holding, and handling practices.

The Mad River winter steelhead population returning as adults to the watershed is the brood source for the proposed hatchery program. Steelhead adults serving as broodstock would be collected mostly as volunteers that enter the Mad River Hatchery. However, broodstock collection of steelhead would also occur through seining, hook and line, and weirs if broodstock needs can't be met through volitional hatchery returns. Seining and hook and line collection

methods would typically be used in conjunction with monitoring activites, but may be conducted specifically to capture broodstock, if necessary. Weirs would only be used as a last resort to capture broodstock and would consist of placing a temporary pipe weir in a Mad River tributary stream and manning the weir constantly until broodstock needs are met. The number of natural-origin steelhead necessary for broodstock would be 125-250 individuals (in approximately equal proportion of males to females) or 50-100% PNI in order to meet the smolt release goal of 150,000.

Risk minimization protocols that would be applied to reduce the likelihood of harm to listed Mad River Chinook salmon, coho salmon, and steelhead include: random collection and selection for spawning of steelhead broodstock across the entire breadth of the total annual adult return period to reduce the risk of hatchery-induced selection effects; minimization of in-river broodstock collection activity to reduce the risk of negative impacts on actively spawning fish and redds; monitoring to ensure that adult broodstock collection operations do not substantially alter spatial and temporal distribution of naturally-produced salmonid populations; immediate release of any non-target listed and non-listed fish incidentally captured during broodstock collection activities; and maintenance of adult fish retained for use as broodstock in high quality, low temperature water if they are not ready to spawn to enhance their survival to maturation. Broodstock collected for spawning would be representative of the migration timing, sex ratio, age class, and morphological traits for the returning adult steelhead populations from which broodstock are taken.

Broodstock Spawning

BMPs for broodstock spawning are described in section 8 of the HGMP. Risk reduction measures would be applied to minimize the likelihood for adverse genetic or ecological effects on listed salmon and steelhead resulting from steelhead broodstock spawning. To help accomplish genetic diversity loss and demographic risk reduction objectives, the hatchery steelhead program would implement best available science spawning actions consistent with hatchery scientific review groups' recommendations (HSRG 2005 and CHSRG 2012) and broodstock spawning guidelines. Proposed mating procedures for listed steelhead are also consistent with NMFS guidelines for hatchery propagation under the ESA (Hard et al. 1992). Full details regarding proposed spawning practices, and evaluations of the effects of hatchery steelhead broodstock spawning on listed steelhead are presented in the HGMP (CDFW 2016).

Following the aforementioned guidelines, spawning protocols implemented through the Mad River Hatchery steelhead program would ensure that all broodstock are spawned across the entire adult fish maturation period (CDFW 2016). Steelhead adults to be spawned would be chosen at random. Out-of-basin stray steelhead would not be knowingly spawned or incorporated into the gene pool. Mating practices applied would help ensure that egg-takes would be representative of the entire steelhead run in the Mad River in terms of migration timing, sex ratio, age composition, and morphology.

Both hatchery and natural-origin fish would be used as broodstock with a minimum composition of 50% natural-origin fish. If warranted, up to 100% natural-origin fish may be used as broodstock. Hatchery fish will only be spawned with a natural-origin fish, but natural-origin fish may be spawned with each other. To minimize the risk of directed, artificial selection of traits that could negatively affect the diversity and fitness of the steelhead population, factorial crosses would be implemented when possible during spawning to maximize the representation of each individual adult into the entire brood. Factorial 2x2 crosses would be the preferred mating method: eggs spawned from two females would be separated into two containers per female, and milt expressed from two males would be separated into two containers per male. The eggs and milt from the separate containers would then be mixed in all possible pairwise combinations.

Rearing and Release of Juveniles

BMPs for salmon rearing and release through the program are described in sections 9 and 10 of the HGMP. Rearing and release practices proposed for implementation would help ensure release of healthy seawater-ready smolts that emigrate downstream rapidly after release, leading to high juvenile fish survival rates to adult return. Potential effects of ecological interactions between newly released hatchery-origin salmon and natural-origin salmon and steelhead in the action area are described in the Section 2.0 of the HGMP (CDFW 2016).

In general, the progeny of all fish spawned through the programs would be incubated and reared using water sources, water quantities, facilities, and fish cultural practices proven to be effective in promoting high egg-to-smolt survival rates, ensuring fish health, and meeting annual juvenile fish release goals. In particular, fish rearing densities and feeding amounts and methods would be consistent with fish growth and health maintenance protocols generally applied in successful California and Pacific Northwest anadromous fish rearing operations. Reducing the risk of adverse ecological effects on natural-origin salmon and steelhead after the juvenile hatchery steelhead are released is also an important objective. Post-release interactions of concern include competition between hatchery-origin steelhead and natural-origin salmon and steelhead for food and space, and hatchery fish predation on natural-origin fish. To reduce competition and predation risks, all juvenile fish releases would be made at fish sizes, life stages, and at times that would reduce or avoid substantial spatial and temporal interactions with natural-origin salmon and steelhead. Full details regarding the rearing and release practices that would be applied are provided in the HGMP.

All eggs collected from females for the Mad River Hatchery steelhead program would be incubated to the eyed egg life stage and through hatching at the Mad River Hatchery. Fertilized eggs from each female spawned would be held in individual vertical incubator trays. Upon emergence, fry would be ponded and reared to a size of <10 fish/pound prior to release. The adipose fin will be clipped on each hatchery fish prior to release. All steelhead would be fed a high-quality commercial diet at amounts and frequencies that would meet fish growth rate objectives and maintain fish health. Fish mortality levels and fish health would be monitored daily by hatchery staff. All rearing facilities would be continuously attended by trained hatchery personnel to ensure that the steelhead under propagation are safeguarded. The Mad River

Hatchery steelhead HGMP includes data indicating that egg-to-smolt survival rates for fish reared in the program have been high (Section 9, Table 20), and reflective of a well-operated program that adequately safeguards listed fish while under propagation.

Proposed steelhead release sizes, timings and location would minimize the magnitude and duration of any interactions with listed natural-origin Chinook salmon, coho salmon, and steelhead that would lead to adverse effects from competition or predation. Steelhead smolts would be released as seawater-ready, migrating smolts to ensure rapid emigration downstream through watershed areas where interactions with rearing listed fish may occur. Fish size, behavior, population uniformity, and morphology would be monitored at the hatchery to assess readiness of the fish for release as smolts. Up to 150,000 steelhead smolts would be released each year between March 15th and April 15th coinciding with a high flow event. Fish will be released volitionally over a 7-10 day period and then manually crowded from the raceways, as necessary.

In summary, BMPs included in the HGMP for juvenile steelhead rearing and release would reduce the risk of adverse ecological interaction effects (competition and predation) on listed natural-origin fish populations in the Mad River watershed, while promoting high juvenile fish to adult return survival rates consistent with meeting proposed program harvest augmentation objectives.

Disposition of Hatchery Adults

Allsteelhead adults that are either spawned or that enter the hatchery facility, but not used for spawning, will be marked with a fin punch and released back to the Mad River to provide additional angling opportunities or to promote iteroparity. Future efforts to rehabilitate kelts to enhance iteroparity may be undertaken, which may require extended holding at the hatchery. Any mortalities that occur in the hatchery will be placed in the Mad River above or below the hatchery to provide marine-derived nutrients to the ecosystem. Marine-derived nutrients provided by decaying hatchery adult carcasses would benefit natural productivity in the watershed, improving growth and survival conditions for rearing and emigrating natural-origin salmon and steelhead.

Catastrophic Risk Management

The Mad River Hatchery HGMP includes catastrophic risk management protocols designed to reduce the risk of injury and mortality of listed salmon and steelhead associated with hatchery operation. Inclusion of these protocols in the proposed plan for steelhead addresses the need to operate the program for the species in a manner that adequately safeguards listed fish while under propagation.

The Mad River Hatchery HGMP describes available back-up water supply systems and risk aversion measures that would be applied at the hatchery to minimize the likelihood for listed steelhead mortalities resulting from equipment failure, water loss from power failure, vandalism, and flooding. At the Mad River Hatchery, a generator would supply back-up power in the event of power loss. The Mad River Hatchery is attended full time by qualified fish culture staff, and

water supply systems at the hatcheries have low-flow alarms with 24-hr/day monitoring to indicate, and allow rapid responses to, water supply failures, vandalism, or other events threatening fish survival. The Mad River Hatchery HGMP describes emergency fish release procedures that would be applied to respond to water system failures that cannot be remedied in an expeditious manner. Emergency fish release measures includes allowing fish to prematurely migrate from the ponds into the river. During a flood or drought, events that would threaten rearing fish and water supplies, fish would be released early directly into the Mad River to prevent mortalities due to injury.

In summary, catastrophic risk management protocols included in the Mad River Hatchery HGMP (CDFW 2016) are proposed to safeguard steelhead while fish are maintained in the hatchery. As described above, facility operational and management measures for the programs are specifically designed to minimize the potential for water supply loss through power loss and/or flooding, pump failure, and vandalism that would lead to the loss of listed fish while under propagation.

3.1.5 5(i)(E) The HGMP evaluates, minimizes, and accounts for the propagation programs' genetic and ecological effects on natural populations, including disease transfer, competition, predation, and genetic introgression caused by straying of hatchery fish.

The Mad River Hatchery steelhead HGMP provides an evaluation of potential genetic and ecological effects on listed Mad River salmonids in section 2.0 of the plan. The HGMP includes risk minimization measures (in HGMP Sections 6-10) that would reduce the risks of adverse disease transfer, competition, predation, and genetic introgression effects. The HGMP accounts for potential effects on listed fish in section 2.0 and in appended take tables.

In general, the HGMP would apply risk adverse hatchery salmon management approaches that allow for the adaptive management actions based on the performance of the program in harvest augmentation objectives and limitation of adverse effects on listed fish to acceptable levels.

Genetic Effects

The Mad River Hatchery winter steelhead program (CDFW 2016) may pose genetic risks to the natural Mad River winter steelhead population. Potential genetic risks to Mad River winter steelhead that may be associated with the Mad River winter steelhead HGMP implementation are loss of within-population diversity, outbreeding effects, and hatchery-induced selection ("domestication") (NMFS 2012).

Loss of Within-Population Diversity

Loss of within-population genetic diversity (variability) is defined as the reduction in quantity, variety, and combinations of alleles in a population (Busack and Currens 1995). Quantity is defined as the proportion of an allele in the population and variety is the number of different kinds of alleles in the population. Genetic diversity within a population can change from random

genetic drift and from inbreeding. Random genetic drift occurs because the progeny of one generation represents a sample of the quantity and variety of alleles in the parent population. Since the next generation is not an exact copy of the parent generation, rare alleles can be lost, especially in small populations where a rare allele is less likely to be represented in the next generation (Busack and Currens 1995). Inbreeding is the interbreeding of related individuals. Inbreeding per se does not lead directly to changes in the quantity and variety of alleles but can increase both individual and population homozygosity. This homozygosity can change the frequency of phenotypes in the population, which are then acted upon by the environment. If the environment is selective towards specific phenotypes, then the frequency of alleles in the population can change (Busack and Currens 1995). Increased homozygosity can lead to a reduction in fitness called inbreeding depression.

To reduce the threat of within-population diversity loss, the Mad River Hatchery steelhead program has implemented, or would implement, the following measures (CDFW 2016):

- At least 50% of the broodstock will be natural-origin and no hatchery x hatchery matings will occur.

- Measures would be applied to help ensure that broodstock collected for the program are representative of the total run-at-large each year.

- Broodstock would be collected randomly throughout the entire adult steelhead return period to the watershed.

- The program would endeavor to ensure that run timing, age, and sex ratio of the steelhead population collected as broodstock each year are reflective of the total adult return for each year with regards to run timing, age class, and sex ratio.

- Run timing, return location, age class, and sex ratio data would be collected annually from the total returns and from fish collected as broodstock to monitor whether hatchery broodstock are reflective of the run-at-large.

- Factorial mating strategies will be applied to help ensure that all fish collected have an equal opportunity to contribute to the production of progeny as a measure to retain the genetic diversity of the steelhead population collected and spawned.

- Genetics of the hatchery- and natural-origin steelhead will be monitored over time to monitor divergence.

Outbreeding Depression

As reviewed in NMFS (2012), outbreeding depression is a loss in fitness after interbreeding with another population. Outbreeding depression can be a simple loss of adaptation caused by changes

in allele frequency or by the introduction of new alleles. It can also result in the disruption of co-adapted gene complexes.

The proposed Mad River Hatchery steelhead program would be sustained only through the collection of broodstock from the adult steelhead population returning to the Mad River (CDFW 2016). The program is designed to preserve remaining diversity of a unique population of the species in the Mad River watershed, and would not increase the risk of outbreeding depression to the population by using an out-of-basin-origin steelhead stock for propagation. There are no data indicating that Mad River steelhead stray into the other watersheds in Northern California where other steelhead populations are present, and where those populations would be affected by Mad River hatchery-origin steelhead spawning. However, measures would still be implemented through the Mad River Hatchery program to reduce the risk of outbreeding depression and straying resulting from production of returning adult hatchery-origin steelhead:

- The proposed program would continue to propagate and release only fish from the local Mad River population.

- To reduce the risk of straying, juvenile fish reared through the program would be adequately acclimated to Mad River to encourage a high return fidelity to the Mad River Hatchery when the fish return as adults.

Hatchery-Induced Selection ("Domestication")

Hatchery-induced selection (commonly called "domestication") pertains to fitness loss and phenotypic change caused by differences between the hatchery and natural environments (includes intentional selection and relaxation of selection), and sampling "errors" during fish culture (includes advertent or inadvertent selection of traits for fish under propagation). Hatchery-induced selection may lead to changes in quantity, variety, and the combination of alleles between a hatchery population and its source population that are the result of selection in the hatchery environment (Busack and Currens 1995). This hazard is also defined as the selection for traits that favor survival in a hatchery environment and that reduce survival in natural environments (NMFS 2012). The concern is that hatchery-induced selection effects will decrease the performance of hatchery fish and their descendants when exposed to natural selection conditions in the wild. Busack and Currens (1995) identified three types of hatchery-induced selection: intentional or artificial selection, representing purposeful attempts to change the population to meet management needs, such as time of adult return or spawning time; biased sampling during some stage of culture leading to hatchery-induced selection caused by errors during any stage of hatchery operation; and, unintentional or relaxed selection that may cause genetic changes to occur because salmon in hatcheries usually have (by design) much higher survival rates during the incubation and juvenile rearing periods than they would have in the wild.

First-generation hatchery-origin fish make up a high proportion of the total adult return to the Mad River each year. Recent data from the Mad River Hatchery steelhead HGMP (CDFW 2016) indicate that, in 2014, the proportion of hatchery-origin fish of the total naturally spawning

steelhead population was approximately 60%. This is less than historically since production numbers have been reduced over the years. This number does not account for hatchery fish that are removed in the recreational fishery and fish that enter the hatchery. In addition, the hatchery is in the lower 1/3rd of the watershed, which affects distribution of hatchery steelhead as hatchery fish make-up a smaller percentage of fish that occur in the Mad River and its tributaries as distance increases upstream from the hatchery. Therefore, the actual proportion of hatchery steelhead that co-mingle on spawning grounds with natural-origin fish may be substantially less than 60%. However, the actual proportion is unknown so there is an unknown risk of hatchery-induced selection that could be associated with implementation of the Mad River Hatchery steelhead HGMP.

The following genetic risk management measures are proposed in the HGMP to reduce the risk of intentional or unintentional hatchery-induced selection and biased sampling effects on Mad River winter steelhead population diversity (CDFW 2016):

- Broodstock used to sustain the program each year would be Mad River steelhead collected from the run-at-large adult return to the Mad River.
- Broodstock would be collected randomly across the breadth of the adult return timing, and representative of the age class distribution and sex ratio for the species, from the combined number of fish collected at the Mad River Hatchery and from the mainstem river and tributaries through seining, hook and line capture, and weirs, if necessary.
- Natural-origin fish will be incorporated as broodstock at rates of 50-100% and no hatchery x hatchery crosses will be made.
- In-river broodstock collection activities would be implemented in a manner that would protect naturally spawning steelhead and their redds.
- The survival and diversity of the population collected and maintained for spawning would be enhanced by holding the fish in high-quality well water.
- Mating protocols would be applied to reduce the risk of directed or unintentional selection of traits that could negatively affect the diversity of the population. These protocols would include:

    - Maximize representation of individual adult fish in the propagated population through use of all steelhead collected randomly from broodstock retained for spawning.
    - Factorial 2x2 crosses would be the preferred method used for mating, but if necessary, other combinations can be utilized to maximize genotypic diversity. In 2x2 crosses eggs from two females would be split into two separate containers per female, milt from two males would be split into two separate containers per male, and eggs and milt would be mixed in all possible pairwise combinations.

Ecological Effects

As called for under this criterion, the ecological effects resulting from implementation of the HGMP are also evaluated, minimized (through application of operational practices), and

accounted for by steps described in the HGMP (section 2.0 in CDFW 2016). Ecological effects of concern include fish disease pathogen transfer, resource competition, and predation effects on listed Chinook salmon, coho salmon, and steelhead that may result from implementation of the HGMP.

Disease

The HGMP addresses general threats from disease transfer in section 2.0 of each plan. Fish disease transfer and amplification risk reduction measures are more specifically addressed for broodstock selection and collection actions in sections 6.0 and 7.0; incubation and rearing actions in section 9; and for fish release actions in section 10.0. Within these sections, the plan describes fish disease pathogen issues of concern and actions that would be implemented to minimize risks of disease transfer and amplification. As noted in the plan, all hatchery actions would be implemented in accordance with the "California Department of Fish and Wildlife Fish Health Policy for Anadromous Fish Hatcheries" (CDFW 2014). Protocols described in the policy and applied through the programs would help reduce risks of fish disease to propagated and natural fish populations through regular fish health monitoring and reporting, and application of best management practice measures to reduce fish health risks. The health of salmon under propagation would be monitored and managed consistent with fish health policy practices. Under the fish health plan, professional fish pathologists and veterinarians from the CDFW Fish Health Section would visit the hatchery rearing locations monthly, or as needed, to perform routine monitoring of adult and juvenile fish, advise hatchery staff on disease findings, and recommend disease treatments when appropriate. All fish monitored for fish health assessment purposes would be sampled consistent with policy, and procedures referenced in the policy, to minimize the proportion of the total rearing population exposed to handling and non-lethal and lethal sampling. In addition, all CDFW hatchery personnel are trained in standard fish propagation and fish health maintenance methods to help ensure that fish under propagation are adequately protected from catastrophic loss due to poor hatchery practices, adverse water quality conditions, or fish health issues associated with poor water quality or inadequate water quantity.

High egg-to-smolt survival rates for fish propagated in the hatchery indicate that protocols for monitoring and addressing the health of fish in hatcheries have been successful in containing disease outbreaks, minimizing the release of fish carrying disease pathogens, and reducing the risk of transfer to wild fish populations. For these reasons, fish disease pathogen transmittal and amplification risks that would be associated with HGMP implementation appear to be adequately addressed and minimized.

Competition

Release of hatchery-origin species into a listed species' habitat, or where they may access the habitat of listed species, may harm listed species and therefore constitutes a "take" under the ESA (NMFS 1999). Among the mechanisms of potential harm is competition (Tartara and Berejikian 2012). Competition occurs when the demand for a resource by two or more organisms exceeds the available supply. If the resource in question (e.g., food or space) is present in such abundance

that it is not limiting, then competition is not occurring, even if both species are using the same resource. Adverse impacts of competition may result from direct interactions, whereby a hatchery-origin fish interferes with the accessibility to limited resources by naturally produced fish, or through indirect means, as when utilization of a limited resource by hatchery fish reduces the amount available for naturally produced fish (SIWG 1984). Specific hazards associated with adverse competitive impacts of hatchery salmonids on listed naturally produced salmonids may include food resource competition, competition for juvenile rearing sites, and, to a lesser extent, competition for spawning sites (NMFS 2012). For these competition risks between fish origins or fish species to occur, substantial levels of spatial and temporal overlap and limited resources shared by the fish must exist (Tartara and Berejikian 2012).

To reduce the risk of spatial overlap between juvenile hatchery-origin and listed natural-origin fish that might lead to competition effects, the primary juvenile hatchery-origin fish release location for the program would be in the lower Mad River. The release of fish in the lower watershed would reduce the intensity and duration or interactions with natural-origin fish relative to releasing hatchery fish in upper portions of the watershed where natural-origin fish would primarily rear. Fish released from these locations would emigrate seaward through downstream areas where rearing or migrating natural-origin fish may also be present.

In addition to spatial overlap, the degree to which listed natural-origin fish and hatchery-origin juvenile salmon and steelhead will interact, potentially leading to competition effects, also depends on the opportunity for temporal overlap between the two groups (Tartara and Berejikian 2012). All fish produced by the programs for release in the watershed would be released as seawater-ready fish (smolts) as a measure to foster rapid emigration seaward, and clearance from watershed area where they may compete with natural-origin fish. Juvenile steelhead produced through the Mad River Hatchery program would be released as smolts in March and April. Few or no Chinook salmon are expected to be present as emergence of fry from the gravel has generally not yet occurred at that time and Mad River Chinook salmon are ocean-type so few yearlings spend a year in the river. Some coho salmon yearlings and age 1+ and 2+ steelhead may overlap spatially with newly released steelhead smolts; however, we expect this overlap to be temporally limited because of the rapid emigration of hatchery smolts and the location downriver from much of the rearing habitat. Additionally, hatchery releases are made during high flow events which results in a lower likelihood of interaction between hatchery and natural juvenile salmonids.

CDFW has included hatchery management measures in the proposed HGMP designed to reduce competition risks to listed fish from hatchery-origin steelhead in the Mad River action area:

- All juvenile steelhead smolts are released in the lower Mad River (river mile 10). The lower river release location limit the duration of hatchery fish presence in freshwater, reducing the duration of interaction – and hence spatial and temporal overlap – with natural-origin fish populations rearing or migrating adjacent to or downstream of the hatcheries.

- Preference would be given to releasing all steelhead from the hatchery into the Mad River as readily migrating fish, in a physiological condition ready for transition to a seawater existence. The practice of releasing only actively migrating smolts that would exit freshwater rapidly would reduce the duration of interaction with natural-origin Chinook salmon, coho salmon, or steelhead in the lower river of a life stage vulnerable to competition for food or space. Only after 7-10 days of volitional release would remaining fish be forced to leave the raceways.
- Juvenile steelhead are released during high flow events to further enhance rapid emigration and reduce temporal and spatial overlap with natural-origin salmonids.

Predation

Risks to naturally produced salmon and steelhead attributable to direct predation (direct consumption) or indirect predation (increases in predation by other predator species due to enhanced attraction) can result from hatchery salmonid releases (NMFS 2012). Hatchery-origin fish may prey upon juvenile naturally produced salmonids at several stages of their life history. Newly released hatchery smolts have the potential to consume naturally produced fry and fingerlings that are encountered in freshwater during downstream migration. Hatchery smolts that do not emigrate and instead take up stream residence near the point of release (residuals) have the potential to prey on rearing natural-origin juvenile fish over a more prolonged period. Hatchery salmonids planted as non-migrant fry or fingerlings, also have the potential to prey upon natural-origin salmonids in the freshwater where they co-occur. In general, naturally produced salmonid populations will be most vulnerable to predation when naturally produced populations are depressed and predator abundance is high, in small streams, where migration distances are long, and when environmental conditions favor high visibility (NMFS 2012).

The risk of hatchery-origin smolt predation on natural-origin juvenile fish is dependent upon three factors: (1) the hatchery fish and their potential natural-origin prey must overlap temporally; (2) the hatchery fish and their prey must overlap spatially; and, (3) the size of the hatchery-origin smolts—prey should be less than 1/3 the length of the predatory fish (NMFS 2012). As such, few natural-origin juveniles would be of a size or have the temporal and spatial overlap with hatchery steelhead smolts that would make them vulnerable to predation.

The proposed program for steelhead would reduce the potential for predation on listed juvenile salmon and steelhead through application of the following measures:

- All hatchery-origin steelhead smolts would be released directly from Mad River Hatchery, which is located in the lower Mad River. This release site reduces the areal extent where any co-occurring natural-origin fish would be exposed to interactions with the hatchery smolts.
- Most hatchery fish would be released as migration-ready smolts that would quickly emigrate from the lower Mad River and disperse into marine waters, minimizing the duration of interaction with any natural-origin salmonids of a size vulnerable to predation.

- There will be few natural-origin fish of any species in the lower portion of the river that would serve as prey for hatchery-origin yearlings when proposed juvenile steelhead smolt releases would occur because they would have either not yet emerged from the gravel or they would be too large to serve as prey.

3.1.6 5(i)(F) The HGMP describes interrelationships and interdependencies with fisheries management.

The Mad River Hatchery steelhead HGMP describes the relationship of the proposed action with fisheries management in section 3.0 of the plan. The specific intent of the Mad River winter steelhead hatchery program is to provide a robust recreational fishery. Hatchery steelhead are adipose fin clipped and only clipped fish are allowed to be retained in the fishery. CDFW uses a catch card system to monitor harvest of hatchery steelhead and catch and release of natural-origin steelhead. CDFW has committed to submitting a draft Fishery Management and Evaluation Plan to NMFS for consideration under the 4(d) rule within one year of completion of this HGMP.

3.1.7 5(i)(G) Adequate artificial propagation facilities exist to properly rear progeny of naturally spawned broodstock, to maintain population health and diversity, and to avoid hatchery-influenced selection and domestication.

Water sources and facilities that would be used to collect and hold steelhead broodstock, incubate eggs, and rear and release juvenile fish are described in sections 4 and 5 of the Mad River Hatchery winter steelhead HGMP (CDFW 2016). Included in those sections are assessments of ecological and genetic risks to listed salmonids, and descriptions of measures that would be applied to minimize the likelihood for adverse effects on listed fish while the fish are maintained in hatchery facilities for propagation.

The water sources and facility that would be used to propagate Mad River winter steelhead salmon has been successfully operated to produce steelhead since 1967. As described in sections 4 and 5 of the Mad River Hatchery steelhead HGMP, the hatchery facilities used to implement the conservation program have the necessary surface and groundwater sources, fish trapping and holding facilities, egg incubation and fish rearing vessels, and fish release facilities that would ensure proper rearing of the progeny of natural- and hatchery-origin steelhead broodstock collected from adult returns to the Mad River. The HGMP also describes how the fish would be reared to maintain fish health through implementation of fish health policy protocols (CDFW 2014; CDFW 2016). Those protocols have proven adequate to protect salmon and steelhead from fish disease transfer and amplification effects in practice in the Mad River Hatchery. As indicated in sections 8 and 9 of the Mad River Hatchery winter steelhead HGMP (CDFW 2016), the program has a demonstrated record of maintaining high survival rates for each steelhead life stage under propagation (i.e., green to eyed egg; eyed egg to fry; and fry to smolt release). High survival rates for the various steelhead life stages are consistent with goal rates identified for well-run hatchery programs (Fuss and Ashbrook 1995). Measures that would be implemented to protect the genetic diversity of the listed steelhead population while under propagation are proposed in HGMP sections 6 through 10 (CDFW 2016).

3.1.8 5(i)(H) Adequate monitoring and evaluation exist to detect and evaluate the success of the hatchery program and any risks potentially impairing the recovery of the listed ESU.

Adequate monitoring and evaluation actions are proposed in the HGMP to evaluate the performance of the program in meeting Mad River salmonid and fishery augmentation objectives. Adequate monitoring and evaluation actions to identify hatchery-related effects on ESA-listed fish are also proposed. These actions are summarized in Section 1.10, and are further described in Section 11.0 of the HGMP ("Monitoring and Evaluation of Performance Indicators"). Included in section 1.10 of the HGMP are descriptions of monitoring and evaluation measures that would be implemented to assess plan benefits and risks addressing hatchery program performance indicators. Monitoring and evaluation objectives and responsive actions that would be implemented under the HGMP are summarized below.

The primary monitoring and evaluation objective for the HGMP is assessment of the status of the Mad River salmonid populations. Monitoring and evaluation actions that would be implemented to determine whether this objective is met include adult monitoring issuing DIDSON/ARIS technology and hatchery escapement monitoring to determine total steelhead, Chinook salmon, and coho salmon return abundances to the Mad River and the hatchery. The number of marked and unmarked steelhead and Chinook salmon and coho salmon escaping to the watershed each year would be monitored to determine the status of the natural- and hatchery-origin salmon returns relative to goal levels identified in recovery plans. Adult fish return abundance, timing, age class, sex ratio, and fish health condition data would be collected at the hatchery to monitor the effects of the program and maintaining the run traits of populations. Juvenile fish outmigrant data collected through annual operation of a downstream-migrant trap in the mainstem Mad River would allow for assessment of the natural spawning success of the salmon populations and would provide data regarding abundance by species and origin, and salmon migrational behavior (seasonal timing, migration rate, and migration duration). These data would be essential for identifying salmonid survival and productivity, and the effects of the hatchery program (if any) on natural populations and progress towards recovery.

The demographic and ecological effects of the program on listed salmon and steelhead populations in the Mad River are also monitored. The primary objective would be to determine whether the program is harming juvenile and adult Chinook salmon, coho salmon, or steelhead as a result of operation of the hatchery, collection of broodstock, and the production of juvenile fish that would return as adults. In general, actions taken at the hatchery to meet this objective would include monitoring of water withdrawal and effluent discharge to ensure compliance with permitted levels; monitoring of broodstock collection, egg take, fish survival rates, and smolt release level to determine compliance with program goal; and fish health monitoring and reporting in compliance with Fish Health Policy requirements.

In summary, hatchery-related monitoring and evaluation actions proposed in the HGMP that would be implemented to meet program objectives would include:

- Counting and sampling (scale, mark) and identification of age class distribution and sex ratio of adults returning to the hatchery and escaping to spawn naturally to assess fish species status and origin;
- Mark and genetic tissue sampling of adult steelhead returning to the hatchery to enable evaluation of hatchery program performance in reducing divergence between hatchery- and natural-origin steelhead and effects on natural-origin fish;
- Marking of all fish released through the hatchery programs to allow for assessment of hatchery-origin adult contributions to total returns to the river and natural spawning; productivity of naturally spawning salmon and steelhead; post-release migration behavior of hatchery fish in the river; hatchery- and natural-origin fishery information; and survival of program-origin fish from smolt release to adult return to the river;
- Documentation of fish cultural techniques used for steelhead propagation to gauge whether the program is meeting objectives and to identify the need for adjustment to adequately safeguard the listed fish, including: broodstock collection and handling procedures, fish and egg condition at time of spawning, fertilization procedures, incubation methods/densities, temperature unit records by developmental stage, egg shocking methods, fungus treatment methods for eggs; start feeding methods, rearing/pond loading densities, feeding schedules and rates; fish release locations and methods; and fish mortality levels by life stage;
- Sampling and monitoring of fish health for all species under propagation consistent with Fish Health Policy procedures.

In sum, measures for monitoring HGMP performance and for determining the effects of the programs on recovery of the CC Chinook Salmon ESU, SONCC Coho Salmon ESU, and NC Steelhead DPS are proposed for implementation, and the plans are consistent with this criterion.

3.1.9 5(i)(I) The HGMP provides for evaluating monitoring data and making any revisions of assumptions, management strategies, or objectives that data show are needed.

The HGMP describes the intent to evaluate monitoring data, and apply results to adjust hatchery actions, as needed, to improve performance or reduce unanticipated adverse effects on listed fish. The HGMP identifies objectives and actions needed to determine hatchery program performance in meeting stated objectives for the steelhead that are the focus of the HGMP (HGMP sections 1.10), and effects on target and non-target natural-origin fish populations in the Mad River watershed. In compliance with this 4(d) Rule criterion, the HGMP would apply adaptive management and risk management approaches in their implementation of hatchery and research actions. These approaches are applied in response to uncertainties regarding the effects of hatchery actions, the pace of recovery of critical habitat needed to sustain the species, and salmon and steelhead recovery needs.

Under the HGMP, data collected relating to hatchery program performance and effects would be evaluated by CDFW to determine whether program was meeting objectives. As identified in Section 1.10 of the HGMP, monitoring and evaluation results would be used to determine whether performance standards addressing program benefits and risks (performance and effects)

were met. The CDFW indicates in the HGMP that funding and staff resources would be committed to monitor and evaluate the program through at least annual review by a technical committee that includes staff from CDFW and NMFS.

Primary information that would be available through the adaptive management framework regarding program performance and effects would be provided through evaluation of adult salmon return data. All juvenile hatchery-origin salmon released through the Mad River Hatchery program would be marked. Mass marking of all juvenile hatchery-origin steelhead would allow for their differentiation from natural-origin fish, and identification and recovery as returning adults at the hatcheries, in the recreational fishery, and on the spawning grounds. These adult fish recovery data would be applied by CDFW and NMFS for making hatchery program effect and natural salmon population viability status determinations, and identifying the need to adjust the program to meet objectives.

Consistent with Implementation Terms that would be issued as part of the NMFS 4(d) decision, annual reports for the programs submitted by CDFW would be jointly reviewed by the CDFW and NMFS to document program results, and determine if the program's assumptions, management strategies, or objectives need to be adjusted. Under a NMFS ESA determination for the proposed programs, these reports would be completed by April of each year, and would be displayed on the NMFS West Coast Region website with the HGMP for public information purposes.

3.1.10 5(i)(J) NMFS provides written concurrence of the HGMP which specifies the implementation and reporting requirements.

Written concurrence with the HGMP is a requirement specific to Limit 5 of the 4(d) Rule. With the current document, NMFS has documented its determination. NMFS will notify the CDFW of our determination and of implementation and reporting requirements specified herein [50 CFR 223.203(b)(5)(J)].

The Implementation Terms and Reporting requirements include:

- CDFW must complete a draft Fishery Management and Evaluation Plan (FMEP) for either the Mad River specifically or a regional FMEP that includes the Mad River within one year of the approval of the Mad River HGMP.
- CDFW shall convene a hatchery team consisting of NMFS and CDFW personnel that will meet on at least an annual basis to discuss the annual reports and any other technical or HGMP-related issues.
- CDFW must ensure monitoring is adequate to detect changes in spawner to recruitment ratio, which is a surrogate for take, such that productivity doesn't fall below 1.0 for four consecutive years.
- In 5 years, CDFW will convene a hatchery expert panel to develop a metric for genetic impacts of hatchery steelhead on natural steelhead populations in the Mad River watershed. If the developed metric is accepted by CDFW and NMFS, CDFW must ensure monitoring is adequate to comply with the developed metric.

- Unless NMFS concurs with the above, developed metric, CDFW must also ensure monitoring is adequate to calculate the Proportionate Natural Influence (PNI) such that PNI does fall below 0.67[2]. PNI should be calculated using the proportion of natural origin broodstock (pNOB) at MRH, and the proportion of hatchery origin spawners (pHOS) passing the DIDSON/ARIS sonar station, minus the number of hatchery origin spawners culled at MRH and harvested by anglers. Further refinement of the accuracy of the pHOS estimate may be made by calculating pre-spawn mortality and implementing other monitoring methods that improve the accuracy of the estimate. PNI is calculated as pNOB/(pNOB +pHOS).
- By July 1 of each year, CDFW must send annual reports on (1) the Mad River HGMP monitoring, evaluation, and research results; (2) spawner:recruit analysis, and (3) PNI estimate (or the adopted metric proposed by the hatchery expert panel).
- CDFW must take the greatest care when handling listed species including minimizing handling, using anesthesia, salt, ice, and slime maintenance chemicals, as necessary. Any mortalities or injuries must be quantified and submitted to NMFS in the annual report.
- CDFW must ensure implementation of the hatchery programs as described in the submitted HGMP. NMFS must be notified in advance of any change in hatchery operations that would potentially result in increased take of ESA-listed species.

In addition to these required Implementation Terms and Conditions, NMFS recommends CDFW also carry out the following:

- Develop strategies to reduce the effects of domestication (e.g., reducing rearing densities);
- Develop a strategy to rehabilitate kelts (spawned, natural-origin steelhead) to promote iteroparity;
- Assess the potential for increasing homing fidelity of hatchery steelhead to the Mad River Hatchery ladder;
- Improve monitoring to better assess PHOS, steelhead genetics, and steelhead demographics.

3.1.11 5(i)(K) The HGMP is consistent with plans and conditions set within any Federal court proceeding with continuing jurisdiction over tribal harvest allocations.

There are no plans or conditions set within Federal court proceedings, including memorandums of understanding, court orders, or other management plans, that direct operation of the proposed Mad River steelhead hatchery programs with respect to tribal harvest.

2 For the 1st 12 years, PNI may be less than 0.67, but must be >0.5.

4 NOTICE OF PENDING RECOMMENDATION

As required by Limit 5 of the 4(d) Rule, the Secretary sought comment from the public on the draft environmental assessment (EA) and the Mad River Hatchery Steelhead HGMP prepared by CDFW (81 FR 17143, March 28, 2016). No comments were made that required edits to the EA. Because the comments applied primarily to the HGMP, the responses to the comments are included in Appendix 13 of the HGMP (CDFW 2016); our final analysis considered any changes made to the HGMP by CDFW as a result of comments received.

5 DETERMINATION

NMFS has reviewed the HGMP provided by CDFW pursuant to limit 5 of the 4(d) Rule, and evaluated them together against the requirements of the 4(d) Rule. Based on this review and evaluation, NMFS' determination is that activities implemented as described in the HGMP would not appreciably reduce the likelihood of survival and recovery of ESA-listed CC Chinook salmon, SONCC coho salmon, or NC steelhead, that the plans address all of the criteria specified in Limit 5 of the 4(d) Rule, and so recommends that the HGMP be approved. If the Regional Administrator concurs with this recommended determination, take prohibitions would not apply to activities implemented in accordance with the HGMP in the Mad River watershed and Implementation Terms described by NMFS.

6 REEVALUATION CRITERIA

NMFS will reevaluate this determination if: (1) the actions described by the HGMP are modified in a way that causes an effect on the listed species that was not previously considered in NMFS' evaluation; (2) new information or monitoring reveals effects that may affect listed species in a way not previously considered; or (3) a new species is listed or critical habitat is designated that may affect NMFS' evaluation of the HGMP.

7 REFERENCES

7.1 Federal Register Notices

70 FR 37160. June 28, 2005. Final ESA listing determinations for 16 ESUs of West Coast salmon, and final 4(d) protective regulations for threatened salmonid ESUs.

81 FR 17143. March 28, 2016. Notice of availability for public review of, and request for comments on, a hatchery plan and related draft environmental assessment: Mad River steelhead hatchery program.

7.2 Literature Cited

Busack, C.A., and K.P. Currens. 1995. Genetic risks and hazards in hatchery operations: Fundamental concepts and issues. Pages 71-80 in H. L. Schramm, Jr. and R. G. Piper, editors. Uses and effects of cultured fishes in aquatic ecosystems. American Fisheries Society Symposium 15, Bethesda, MD.

California Department of Fish and Game (CDFW). 2014. California Department of Fish and Wildlife fish health policy for anadromous fish hatcheries. February 19, 2014.

California Department of Fish and Game (CDFW). 2016. Hatchery and genetic management plan for Mad River Hatchery winter-run steelhead. Prepared for the National Marine Fisheries Service.

California Hatchery Scientific Review Group (California HSRG). 2012. California Hatchery Review Statewide Report. Prepared for the US Fish and Wildlife Servie and Pacific States Marine Fisheries Commission. April 2012. 100 pp.

Fuss, H.J., and C. Ashbrook. 1995. Hatchery operation plans and performance summaries. Volume I, Number 2, Puget Sound. Assessment and Development Division. Hatcheries Program. Washington Department of Fish and Wildlife. Olympia, Washington. 300 p (approx).

Hard, J.J., R.P. Jones, M.R. Delarm, and R.S. Waples. 1992. Pacific salmon and artificial propagation under the Endangered Species Act. U.S. Dept. Commer., NOAA Tech. Memo. NMFS F/NWC-2. 56p.

HSRG (Hatchery Scientific Review Group). 2004. Hatchery reform; principles and recommendations of the Hatchery Scientific Review Group. Long Live the Kings. Seattle, Washington. Available from: http://hatcheryreform.us/hrp_downloads/reports/hsrg_princ_recs_report_full_apr04.pdf.

McElhany, P., M.H. Ruckelshaus, M.J. Ford, T.C. Wainwright, and E.P. Bjorkstedt. 2000. Viable salmonid populations and the recovery of evolutionary significant units. U.S. Dept. Commer., NOAA Tech. Memo. NMFS-NWFSC-42, 158p.

NMFS (National Marine Fisheries Service). 1999. A conceptual framework for conservation hatchery strategies for Pacific salmonids. T.A. Flagg and C.E. Nash (editors). U.S. Dept. Commer., NOAA Tech. Memo. NMFS-NWFSC-38. 46p.

NMFS. 2003. Hatchery broodstock summaries and assessments for chum, coho, and Chinook salmon and steelhead stocks within evolutionarily significant units listed under the Endangered Species Act. Salmon and Steelhead Hatchery Assessment Group (SSHAG). NMFS, Northwest Fisheries Science Center. Seattle, Washington. 326p.

NMFS 2012. Effects of hatchery programs on salmon and steelhead populations: reference document for NMFS ESA hatchery consultations. Craig Busack, Editor. March 7, 2012. NMFS Northwest Regional Office, Salmon Management Division. Portland, Oregon. 50p.

NPPC (Northwest Power Planning Council). 2001. Performance standards and indicators for the use of artificial production for anadromous and resident fish populations in the Pacific Northwest. Portland, Oregon. 19 p.

SIWG (Species Interaction Work Group). 1984. Evaluation of potential interaction effects in the planning and selection of salmonid enhancement projects. J. Rensel, chairman and K. Fresh editor. Report prepared for the Enhancement Planning Team for implementation of the Salmon and Steelhead Conservation and Enhancement Act of 1980. Washington Dept. Fish and Wildlife. Olympia, Washington. 80p.

Spence, B. C., E. P. Bjorkstedt, J. C. Garza, J. J. Smith, D. G. Hankin, D. Fuller, W. E. Jones, R. Macedo, T. H. Williams, and E. Mora. 2008. A framework for assessing the viability of threatened and endangered salmon and steelhead in the north-central California coast recovery domain. U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Southwest Fisheries Science Center: NOAA-TM-NMFS-SWFSC-423.

Tartara, C.P., and B.A. Berejikian. 2012. Mechanisms influencing competition between hatchery and wild juvenile anadromous Pacific salmonids in fresh water and their relative competitive abilities. Environ Biol. Fish. 94:7–19.

Westley, P.A.H., T.P. Quinn, and A.H. Dittman. 2013. Rates of straying of hatchery-produced Pacific salmon (*Oncorhynchus* spp.) and steelhead (*Oncorhynchus mykiss*) differ among species, life history types, and populations. Can. J. Fish. Aquat. Sci 70:735-746.

Williams, T.H., B. Spence, W. Duffy, D. Hillemeier, G. Kautsky, T.E. Lisle, M. McCain, T. Nickelson, E. Mora, and T. Pearson. 2008. Framework for assessing viability of threatened coho salmon in the Southern Oregon/Northern California Coasts evolutionarily significant unit. NOAA Technical Memorandum NMFS-SWFSC-432. U.S. Department of Commerce, NOAA, NMFS, Southwest Fisheries Science Center Santa Cruz, California. 113 pp.

Williams, T.H., B.C. Spence, D.A. Boughton, R.C. Johnson, L. Crozier, N. Mantua, M. O'Farrell, and S.T. Lindley. 2016. Viability assessment for Pacific salmon and steelhead listed under the Endangered Species Act: Southwest. 2 February 2016 Report to National Marine Fisheries Service – West Coast Region from Southwest Fisheries Science Center, Fisheries Ecology Division 110 Shaffer Road, Santa Cruz, California 95060. 182 p.

7.3 Personal Communications

Michael Sparkmann. May 9, 2016. Email communication with Dan Free, NMFS, regarding recent salmon and steelhead monitoring in the Mad River. California Department of Fish and Wildlife, Arcata, CA.