2018/2019 MOKELUMNE RIVER HATCHERY CALIFORNIA CENTRAL VALLEY STEELHEAD TROUT SPAWNING AND RELEASE PROTOCOL

Background

The lower Mokelumne River provides spawning and rearing habitat for California Central Valley (CCV) steelhead trout (*Oncorhynchus mykiss*) (steelhead) Distinct Population Segment (DPS). This DPS of steelhead was listed as threatened in 2006 under the federal Endangered Species Act (USDC NOAA 2006). The Mokelumne River Hatchery (MOK) conducts artificial propagation of CCV steelhead to enhance steelhead fisheries in the Mokelumne River. The steelhead broodstock used by the MOK were genetically identified as CCV steelhead (Pearse and Garza 2015) and were included in the recent five-year threatened species federal review (NMFS 2016).

Camanche Reservoir is the upper limit of anadromous fish migration in the Mokelumne River. East Bay Municipal Utility District (EBMUD) initiated construction of Camanche Reservoir in 1963. As mitigation for blocking access to spawning grounds for salmonids, EBMUD provided funding for the original construction of the MOK in 1964. The MOK is located on the south bank of the Mokelumne River at the base of Camanche Dam. While EBMUD provides funding for steelhead production, the California Department of Fish and Wildlife (CDFW) administers and operates the hatchery. The Commercial Salmon Stamp Fund provided funding for an additional MOK building built in 2002 which is used during steelhead incubation and rearing. The annual MOK steelhead production goal supported by mitigation funding is 250,000 steelhead yearlings (Mitigation Element). The MOK also sporadically receives requests from researchers to produce steelhead for special studies (Special Studies Element). Special Studies Element production is separate from the Mitigation Element, are generally relatively small in quantity or may not occur if enough steelhead are not available due to low production quantities.

1.0 California Central Valley Steelhead Trout Production Release Size Goals

The 2018-2019 spawning season steelhead production prioritized goals for MOK are as follows:

> Steelhead Mitigation Element: Up to 249,700 yearlings, 1.8 fish per kilogram (4 fish per pound)
>
> Steelhead Mitigation Element: Up to 300 catchable size, 0.45 fish per kilogram (1 fish per pound)
>
> Steelhead Special Studies Element: Up to 300 juveniles, 150-300 millimeters fork-length

The MOK is intending to produce and release 250,000 steelhead this season. To meet this goal a total of 400,000 eggs will be needed. Survival from the egg take to release at

the MOK is approximately 65 percent. A 35% buffer of 150,000 eggs will account for mortality that occurs during incubation phases and allow the MOK to produce the projected number of 250,000 steelhead.

2.0 California Central Valley Steelhead Trout Broodstock Collection and Spawning

2.1 Gathering Broodstock

A fish weir will be installed on the first Monday in October, in the Mokelumne River directly below the MOK by CDFW staff. The weir will be placed perpendicular from bank to bank to span the entire river channel. The fish weir will encourage migrating steelhead toward a permanent fish ladder on the south bank of the river which guides fish toward the MOK. Once steelhead ascend the ladder they enter a fish trap on the MOK premises where staff will have the ability to collect, enumerate, evaluate for ripeness and then distribute fish to holding raceways. Unripe steelhead will be kept in holding raceways and allowed to ripen prior to spawning while ripe steelhead will be spawned as soon as possible. The holding raceways will have adequate space, water temperatures and flow rates and ripening fish will be evaluated and treated for disease as needed.

Of the steelhead that enter the hatchery, males and females with a fork length less than 45.7 centimeters (cm) (18 inches) will not be selected as broodstock (California HSRG 2012). These smaller steelhead will receive an external mark for identification purposes and released back to the river, downstream of the hatchery. The external mark being applied this year will be a hole punch to the upper lobe of the caudal fin.

Other broodstock to be spawned at the MOK in the 2018/2019 season include 180 females gathered from the prior (2016/2017) spawning season. These “holdover” females were spawned last season, reconditioned and held for a year in a naturalized raceway on hatchery premises. Mature holdover females will be incorporated into the 2018/2019 broodstock and spawned in tandem with females that arrive this season. All these females are greater than 45.7 cm.

2.2 Broodstock Identification

Both resident (rainbow trout) and anadromous (steelhead) *Oncorhynchus mykiss* (*O. mykiss*) are considered the same species although different races, runs, stocks, and life history patterns are recognized. Many studies (Behnke 1972, Allendorf 1975, Allendorf and Utter 1979, Wilson et al.1985) have concluded that *O. mykiss* cannot be separated taxonomically by immigration timing or their tendency for anadromy versus residency life history strategies. Rather than the different life-history forms comprising distinct taxa or populations, studies and observations indicate that *O.mykiss* can form a single, panmictic population in stream systems where there is access to the ocean. These populations are comprised of individuals with different life-history traits and a continuum of migratory behaviors, the two extremes being anadromy (migratory) and residency (non-migratory).

Genetic studies comparing rainbow trout and steelhead within individual river basins have consistently suggested polyphyletic origins for these two life histories resulting from parallel evolution rather than two distinct life-history lineages (Phelps et al. 1994; McCusker et al. 2000; Docker and Heath 2003). Lack of genetic differences provides additional evidence that anadromous and non-anadromous life-history types both contribute to smolt production and can form a single interbreeding population within the anadromous reaches of a stream system.

Three fish ladders have been constructed to provide for fish passage around Woodbridge Irrigation Dam (WID), which is an impoundment in the Mokelumne River 39 river kilometers (rkm) (24 river miles (rm)) downstream of MOK. Two ladders provide passage during the WID dam-out condition under high and low flows, and the other ladder provides passage during the WID dam-in condition. The dam-in ladder has a digital video camera operated by EBMUD that obtains complete migrant counts under nearly all flow and operating conditions during the WID dam-in condition, which encompasses the entire steelhead migration period. Real time adult migrant counts provided by EBMUD allow for forecasting migrant arrival timing to the MOK which in turn assist in planning hatchery spawning operations.

2.3 Broodstock Collection and Spawning Goals

Adult CCV steelhead enter fresh water to start their spawning migration in August, with peak migration occurring in late September through October (McEwan 2001). According to historical MOK steelhead run timing records, migrants typically start arriving at the MOK in mid-October, peaking in mid-December and concluding in early March. Steelhead broodstock in the river will be selected from those fish that enter the MOK when the hatchery ladder is open; from October 1 through March 1. Though unlikely due to historical run timing information, the ladder may remain open after March 1 if a significant number of migrants are still in the river attempting to reach the hatchery, thus ensuring that eggs are collected from the entire run.

All steelhead entering the hatchery will be enumerated by sex and evaluated for ripeness by MOK staff. Only ripe fish will be used during spawning and will be spawned as soon as possible. In the case that steelhead are not ripe when they arrive to the MOK, they will be placed in holding ponds at the MOK facility, frequently evaluated for ripeness and spawned as soon as possible upon ripening. Spawning fish as soon as they are ripe imitates natural spawn timing in a river environment; spawning of steelhead at the MOK will be conducted in a manner that represents spawn timing in the Mokelumne River throughout the entire natural spawning period.

Based on historical information gathered at the MOK, on average a female may provide 2,500 eggs. With this average in mind, an estimated 160 female steelhead and an even number of males (320 combined females and males) will be needed to meet the annual egg take goal of 400,000 green eggs. However, a larger number of females than needed to reach this goal will be spawned if possible, including using the holdover females, so that a greater number of families are represented in the offspring. This will maximize effective population size and reduce the potential for inbreeding in future generations.

Ripe adult steelhead broodstock that arrive to the MOK this season (2018/2019) will be spawned using a 1 male: 1 female ratio by conducting factorial spawning as described in Fiumera et al. 2004 and recommended in the 2012 California HSRG. During this process, the eggs from one female will be will be split into two equal parts and will be fertilized by two different males. Each male will be spawned twice to ensure equal family sizes.

Steelhead will be examined by MOK staff for the presence or absence of an adipose fin (see section 4.0 Marking and Tagging) and MOK staff will record those observations. MOK staff assumes fish without an adipose fin to be hatchery-origin and fish with an intact adipose fin to be natural-origin. To reduce chances of inbreeding, MOK staff will attempt to incorporate natural-origin broodstock to the extent possible based on their availability. Hatchery-origin fish will be preferentially mated with natural-origin fish; hatchery-origin with hatchery-origin

matings are considered least desirable (California HSRG 2012). All steelhead will be tallied and recorded while spawning occurs as; male or female, and adipose fin intact or adipose fin removed. All parings of natural-origin and hatchery-origin fish will be recorded and will be described in the Mokelumne River Hatchery annual report.

Steelhead broodstock that entered the hatchery this season (2018/2019) will be spawned by MOK staff alongside outdoor raceways where the broodstock are held. To facilitate manual spawning and to ease the process for fish, prior to spawning steelhead are placed in an anesthetic solution of 10 grams (g) Tricane methanesulfonate (MS-222) to one liter (L) of fresh raceway water. Eggs and milt will be collected using the “dry method”, where water is not introduced while eggs and sperm are being collected and mixed. Gametes will be thoroughly mixed and left undisturbed for approximately 30 seconds, rinsed with fresh water and then disinfected with an iodine solution. The dry spawning protocol used by the MOK is provided in the appendices section of this document.

The holdover female broodstock gathered during the 2016/2017 and 2017/2018 seasons and held in raceways at the MOK will be spawned with male broodstock that arrived at the MOK this season (2018/2019). One male will be used to fertilize eggs from one holdover female as well as one female from this season. The holdover fish will be spawned as part of the regular steelhead broodstock program to maximize the total number of female broodstock. Mixing of gametes will be the same as the “dry method” described above, where gametes will be taken from broodstock alongside raceways.

After spawning, steelhead broodstock will be made available to CDFW Central Valley Tissue Archive (CVTA) for sampling. From every fish used as broodstock, the CVTA will collect a genetic sample from the upper lobe of the caudal fin, a scale sample from the dorsal area, and record fork length and gender. After this process, broodstock will be reconditioned in holding ponds on the MOK premises.

The reconditioning process will begin with treating fish with a solution of one milliliter (mL) Vidalife (Western Chemical Inc.) to 15 L fresh water for a period of approximately 30 seconds immediately after spawning. Vidalife is commonly used in hatchery settings because it preserves a fish’s mucus layer which is a critical mechanism to protect from and repair external abrasion. The post spawn broodstock will be placed in holding ponds dedicated to reconditioning of broodstock. During reconditioning, the broodstock will be given # 4 crumb brood feed (“Bio-Oregon” brand, “BioBrood” feed) by hand as needed, which will allow MOK staff to closely evaluate health and vigor of broodstock during reconditioning. The reconditioning process will require 21 days, as this is generally enough time for a fish to fully recover but also ensures that any anesthetics used during the spawning process have fully flushed from the broodstock (Leitritz and Lewis 1980).

After the reconditioning period, male broodstock will be loaded into a transport tank and released to the Mokelumne River at New Hope Landing. Some female broodstock that entered the hatchery this season will be similarly reconditioned and released at New Hope Landing. The MOK will retain up to 150 ‘holdover’ females from this season (2018/2019) and retain up to 50 of the original 180 females that were held from last season (2017/2018). These combined 200 females will be held in naturalized raceways on the hatchery premises to supplement the broodstock during next year’s spawning season.

2.4 Egg Tracking

Up to 400,000 steelhead eggs from across the spawning season are needed to meet the release goal of 250,000 steelhead yearlings. The target of 400,000 green eggs allows for a 35 percent buffer against mortality or disease during incubation phases. Eggs will be gathered and put into inventory batches at the MOK according to when eggs were fertilized. All fertilized eggs taken on a single day are identified as an egg lot and assigned a lot number. The eggs gathered from the holdover females and the eggs gathered from females that arrived at the hatchery this season will be kept separate. Keeping these lots separate will allow hatchery staff to observe differences in egg viability, swim-up success and other egg performance disparities.

There is no anticipated set amount of eggs that will be culled this season; culling will only occur as needed if egg take goals are exceeded. If culling is necessary due to excess egg take, excess eggs will be culled in a manner that attempts to equalize representation across families and temporal segments of the run. Surplus or culled eggs will be transported to a local landfill.

2.5 Egg Incubation and Juvenile Rearing

Immediately after spawning, fertilized eggs with be rinsed of milt and ovarian fluid. The eggs will be placed in buckets containing a solution of nine liters of ultraviolet (UV) treated water to 150mL polyvinylpyrrolidone for a period of 20 minutes. Eggs will then be placed in pure UV treated water for two hours to allow for water hardening of the egg membrane. The eggs will be inventoried and placed in three liter upwelling jars containing circulating UV treated water. When the eggs reach 270 temperature units (TU), eggs will be gently stirred inside the jars by MOK staff. When the eggs reach 500 TU, they will be addled by manual siphoning. On the following day all the remaining live eggs will be counted using Jensorters and placed into vertical stack incubators. When 90% of the fish in incubation stacks have buttoned-up, they will be transferred to indoor rearing troughs.

For a period of 10 days, fry will be hand fed Bio-Oregon fish feed mash to satiation every morning and multiple times throughout the work day. After this 10 day period, fry will be switched to #1 crumb until they reach the size of 181 juveniles per kilogram (kg). After fry reach 181 fish/kg, they will be fed as follows; #2 crumb at 181-91 fish/kg, 1.2 millimeter (mm) pellet at 90-57 fish/kg, 1.5mm pellet at 56-27 fish/kg and 2.0mm pellet at 26-20 fish/kg. When fry reach 4-5 fish/kg they will be put on a maintenance diet, where fry are fed for four days consecutively then not fed for three consecutive days.

2.6 Pathology Protocol

The MOK will employ measures to prevent introduction, spread, or amplification of fish pathogens to natural stocks using widely accepted disease control and prevention techniques (IHOT 1995). During spawning, ovarian fluid samples from adult females will be collected by CDFW Fish Pathology Lab staff to monitor for disease. To reduce the potential for spreading pathogens and to increase survival of fertilized eggs, a standardized process using polyvinylpyrrolidone and UV treated water to disinfect eggs will be employed (Wedemeyer, 2001). During this process eggs will be drained of ovarian and milt fluid reducing chance of exposure to disease causing coelomic fluids, placed in buckets with nine liters UV treated water to 150 mL polyvinylpyrrolidone for 20 minutes and then placed in UV treated water for two hours to water harden.

The Hatchery Building water supply will be manipulated to maintain temperatures between 10 and 12.8° Celsius (50 - 55° Fahrenheit) during the spawning and egg incubation period. This

temperature range will help minimize egg loss due to coagulated yolk disease, cold water disease bacterial (*Flavobacterium psychrophilum*) infection, and infection by other mixed motile *Aeromonas* bacteria. Disease that may occur during egg incubation or juvenile rearing will be evaluated by the CDFW Fish Pathology Laboratory. The laboratory will offer treatment recommendations to the MOK if disease is observed. Disease observations, fish pathology reports and disease treatment will be described in the Mokelumne River Hatchery annual report.

National Pollution Discharge Permit (NPDES) conditions prohibit disposal of hatchery spawned carcasses in the Mokelumne River. In the case there are any mortalities of adult steelhead at the MOK this season, carcasses will be transported to a landfill.

3.0 California Central Valley Steelhead Trout Production Release Strategy

Release strategies have implications on juvenile survival, fishery contribution and adult stray rates. The Mokelumne River Hatchery Coordination Team (HCT) meets regularly throughout the year to discuss external marking practice and specific release strategies including release locations, release logistics, and equipment needs. Major considerations and goals for MOK steelhead releases include:

1. Juvenile steelhead are released as yearlings and at a minimum size of 1.8 per kilogram (kilo) (4 per pound) to mimic the size of naturally produced emigrating smolts based on best available information (Jonasson et al. 1995; Viola and Schuck 1995; Hausch and Melnchuk 2012; Clark et al. 2013).
2. Juvenile steelhead are released in the Mokelumne River to reduce straying when they return as adults in subsequent years.
3. When possible, juvenile steelhead are released during periods that coincide with higher Sacramento and San Joaquin River flows to encourage out migration.
4. Juvenile steelhead are released during the months of February, March and April to coincide with the annual closing of the Delta Cross Channel Gates, February 1 through May 20 (SWRCB 1999).

Batches of juvenile steelhead will be released when they reach target size; projected release timing and location is provided in Table 1. Weight counts will be taken as fish are being loaded into transport tanks and recorded on release receipts following standard hatchery practices. Salt will be added to a level of ten parts per thousand to transport tanks prior to loading juvenile fish for transport. Transport equipment will not contact receiving water to prevent the spread of aquatic invasive species, as outlined in the Hazard Analysis and Critical Control Point Plan (Anderson and Smith, 2011).

Table 1. - Production goals, release timing and release location for steelhead trout production at the Mokelumne River Hatchery in the 2018/2019 season.

Number of Juveniles	Release Site	Average Size	Release Timing	Production Element
249,700	Feist Ranch or New Hope Landing (in-river locations)	1.8 fish per kilo (4 fish per pound)	February through April	Mitigation
300	Lake Lodi (in-river location)	0.45 fish per kilo (1 fish per pound)	First week of June	Mitigation
300	Special Studies	150-300mm	n/a	Special Studies

3.1 California Central Valley Steelhead Trout Release Locations

Most steelhead yearlings will be released at one or both locations: Feist Ranch (rkm 33 / rm 20.5) or New Hope Landing (rkm 16 / rm 10). The Feist Ranch release location will be preferred as it is accessed through private property which allows the juvenile steelhead time to acclimate to a river setting after being released and being targeted by anglers. Additionally, the Feist Ranch release location is further upstream from New Hope Landing, giving juveniles more time to become acclimated to a natural environment prior to entering to the Delta. Wet or muddy soils at Feist Ranch can hinder ability to reach the river with a transport tank, so conditions will require MOK staff to evaluate access prior to sending a transport tank. The release location at New Hope Landing has a boat ramp which will facilitate transport tank access to the river. Should weather or soil conditions be poor, CDFW may delay or expedite the release dates to the extent possible when conditions are more conducive for transport tank operation. Time of plant, temperature of receiving water and transport tank water, and the condition of the fish during release will be recorded on planting receipts. Steelhead releases are expected to occur from the beginning of March through the end of April.

A third release location and smaller release group of 300 juvenile steelhead will occur in the Mokelumne River at Lake Lodi (rkm 40 / rm 24.5). Lake Lodi is formed by WID and is wide spot in the Mokelumne River creating a popular angling destination. Steelhead for this release group will be grown to the size of 0.45 per kilo (1 per pound). To identify these 300 fish from other release groups, every fish will be given both an adipose fin clip and a pelvic fin clip. The steelhead will be released in the first week of June, prior to the 2018 Annual Youth Fishing Derby at Lake Lodi. Some of the released steelhead will be caught and kept during the fishing derby, or thereafter by other anglers. Because Lake Lodi is part of the Mokelumne River, releasing steelhead in this area does not contrast with release location strategies suggested in the California HSRG 2012. More information about the free fishing derby for children can be found at the following website: https://www.visitstockton.org/events/18th-annual-youth-fishing-derby-at-lodi-lake/

3.2 Special Studies California Central Valley Steelhead Trout Production Releases

Occasionally fishery researchers conducting special studies may request MOK produced steelhead eggs or juveniles. Requests for numbers of fish or eggs do not change prioritized production goals and are produced in excess of Mitigation Element goals. Egg and fish requests

for special studies conducted by stakeholders other than CDFW or EBMUD are due to CDFW August 1 of each year. Special studies allocation requests are made to the CDFW statewide hatchery coordinator and if approved are provided for review by regional CDFW fisheries biologists as well as the Mokelumne River HCT.

□ This season a total of 300 steelhead may be produced by the MOK for special studies being conducted by stakeholders other than CDFW or EBMUD. These stakeholders, their respective studies, requested allotments and requested sizes are listed below.

- California Department of Water Resources; Ongoing evaluations of State Water Project (SWP) export facility losses (300 steelhead; 150-300mm)

A new study occurring at the MOK this season will be performed by geneticists from National Marine Fisheries Service (NMFS) to generate desired experimental families by tracking the mating of steelhead that arrived this season (2018/2019) with broodyear 2016/2017 and 2017/2018 holdover steelhead (Appendix 6.3). Offspring from these parings will be reared at MOK following facility rearing protocol. Fish involved with the experiment will be given a uniquely numbered external anchor tag (Floy tag) and a uniquely numbered internal Passive Integrated Transponder tag (PIT tag). A portion of these experimental fish will be kept in a separate raceway at the MOK for future NMFS project broodstock. In addition, a subset of these eggs with known genotypes will be taken to the NMFS-Southwest Fisheries Science Center-Santa Cruz lab for captive experimental rearing; no fish used in this experiment will be released.

4.0 Marking and Tagging

In general, hatchery steelhead are externally marked to allow for real-time visual identification of hatchery-origin juveniles and adults (hatchery versus non-hatchery origin), estimation of natural origin and hatchery origin escapements and estimation of the proportion of hatchery origin fish in natural spawning areas. As recommended in the 2016 California HSRG, the MOK along with all other California Central Valley steelhead production programs will externally mark steelhead production at a rate of 100% with a clipped adipose fin prior to release. No internal tagging (e.g. coded wire tags) will be applied to MOK produced steelhead in this production year. The small group of 300 steelhead to be released at Lake Lodi will additionally receive a pelvic fin clip at a rate of 100%. This release group occurring at Lake Lodi will not receive any internal tags.

5.0 References

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6.0 Appendix

6.1 Mokelumne River Hatchery Dry Method Spawning Protocol for California Central Valley Steelhead Trout

- It will take a team of 4 or 5 hatchery staff to be the most successful at dry spawning: one person will to hold the sun or rain shield, one person to towel the water from the fish and hold the fish for milking, one person to milk the fish and help towel the fish dry, and one person to hold the collection cup and document the sample.
- The whole collection process will be done under the shade as sun light and u.v. rays will kill sperm and eggs. Similarly when raining the process will be done under shelter as rain (excess water) may ruin the spawning attempt by prematurely activating sperm and eggs,
- Once a fish has been gathered by net, will be placed in an anesthetic solution of 10 grams Tricane methanesulfonate (MS-222) to one liter of fresh raceway water.
- When the fish is sufficiently anesthetized, remove the fish from the MS-222 and rinse the fish in fresh water.
- Check for an adipose fin (intact signifies natural origin or clipped signifies hatchery origin).
- Check the fish for ripeness; if unripe, place back in holding pond. If ripe, gamete collection may continue.
- Dry the vent area of the fish using a towel.
- Males and females will then be milked, the milking of ether the male or the female should not take more than 15 to 20 seconds per fish.
- One male or one female per cup; the sample is documented.
- A genetic sample from broodstock will be taken and documented.
- The fish will be placed in a solution of one milliliter of Vidalife (Western Chemical Inc.) to 15 liters fresh water for a period of approximately 15-30 seconds.
- The spawned fish will then be released to a holding pond specific for reconditioning status fish and allowed to recover in fresh flowing water.
- To reduce concentrations of MS-222, steelhead need a 21 day holding period in the hatchery prior to release to the Mokelumne River, below the hatchery.

6.2 California Hatchery Scientific Review Group (California HSRG 2012) Recommendations for the Mokelumne River Hatchery

Recommendations for All Mokelumne River Hatchery Programs

- Broodstock for the program should only come from native, locally adapted stocks. Out-of-subbasin importation of eggs, juveniles or adults should not occur, even if it means juvenile production targets will not be achieved in some years. Work with water managers to improve conditions for migrating juveniles and adults.

- Transporting and releasing juveniles to areas outside of the Mokelumne River should be discontinued. Juvenile fish should be released at the hatchery, or if not possible, as far upstream in the Mokelumne River from the confluence of the Sacramento River as possible to reduce adult straying and increase the number of adult fish returning to the hatchery. Consider necessary facility modifications or equipment purchases that will facilitate on-site releases.

- Release locations for steelhead may take into consideration ecological and predation effects on other fish populations but should not compromise homing of adults to the hatchery.

- Performance standards for each phase of the fish culture process should be established and tracked annually. Summaries of data collected with comparisons to established targets must be included in annual hatchery reports.

- Managers should investigate the feasibility of collecting natural-origin adult fish at alternate locations. The existing trapping location is very limited in its ability to capture fish representing the entire spectrum of life history diversity. Only fish that migrate to the furthest upstream reaches are susceptible to capture.

- A Monitoring and Evaluation Program should be developed and implemented and a Hatchery Coordination Team formed for the program. Implementation of these processes will inform hatchery decisions and document compliance with best management practices defined in this report.

- CDFG should develop and promulgate a formal, written fish health policy for operation of its anadromous hatcheries through the Fish and Game Commission policy review process. Hatchery compliance with this policy should be documented annually as part of a Fish Health Management Plan. The current CDFG fish health policy is inadequate to protect native stocks.

- CDFG should develop an updated Hatchery Procedure Manual which includes performance criteria and culture techniques presented in IHOT (1995), Fish Hatchery Management (Wedemeyer 2001) or comparable publications. The fish culture manual (Leitritz and Lewis 1976) is outdated and does not reflect current research and advancements in fish culture.

Mokelumne California Central Valley Steelhead Trout Program

The integrated steelhead program at Mokelumne has a goal to release 250,000 yearling steelhead at 4fpp. The program has been experimenting with small releases (less than 2,000 fish) of two-year-old steelhead juveniles using a “natures” rearing strategy (i.e., presence of structure, low rearing density, shallow pond depth, cover and colored raceways). All steelhead are released from February through March and are marked with an adipose fin clip. Steelhead are released at New Hope Landing, approximately 10.5 miles downstream from the confluence of the Mokelumne and Consumes rivers.

Mokelumne River California Central Valley Steelhead Trout Major Program Recommendations

The major recommendations of interest to resource managers for the Mokelumne steelhead hatchery program are provided below. Those selected for presentation may represent major changes in operations, changes in approach or outcomes toward achieving harvest or conservation goals, or will require substantial investment of resources. The California HSRG’s evaluation of program compliance with standards and guidelines and the group’s comments about this program are presented in their entirety in Appendix VIII.

- Non-anadromous (resident) or unmarked fish typically should not be used as broodstock

and the current 16-inch minimum length for broodstock should be continued.

- Hatchery-origin adult steelhead returns to the hatchery should be treated as follows: (1) unspawned males should be extended reconditioned and released; (2) unspawned females should be stripped of eggs, extended reconditioned and released; and (3) spawned fish should be removed from the system, or extended reconditioned and released.

- Natural-origin adult steelhead returns to the hatchery, whether spawned or unspawned, should be released. Fish may be reconditioned prior to release.

6.4 Implementation of 2012 California Hatchery Review Group Report Recommendations at the Mokelumne River Fish Hatchery

The Mokelumne River HCT used the following criteria to rank all of the recommendations presented in the California Hatchery Review Report that pertained to MOK. Prioritization was based on the following criteria applied to each recommendation:

High priority: Would substantially improve program performance in a critical area. Effects would be immediate or may take some time to realize, but have long-term implications to program success. And/or, implementation is crucial for authorization of HGMP for the program. Implementation is necessary to meet program purpose and goals.

Medium priority: Would moderately improve program performance in an important, if not critical, program area. Effects may be immediate or may take some time to realize, and may or may not have long-term implications to program success. And/or, implementation is not crucial for authorization of HGMP for the program, but would add to program justification. Implementation adds to progress toward program goals, but is not essential to meeting them.

Low priority: Implementation would not substantially improve program performance in any critical or important area, but would add to the program. And/or, implementation is not specifically necessary for authorization of HGMP for program, nor would it add to program justification under the HGMP. And/ or, effect of implementation is very uncertain or logistically difficult or is otherwise infeasible.

The major CA HSRG (2012) recommendations for Mokelumne River Fish Hatchery and programs the Mokelumne River HCT review of those recommendations are listed below.

No.[1]	**CA HSRG Recommendation**	**Priority to Review Recommendation** (high, med, low[2])	**Estimated Timeline (Years)**	**Comment**
All Mokelumne River Hatchery Programs				
1	Clear goals should be established for the program.	High (Implemented)	<1	HCT prepared draft document in 2015
2	Broodstock for the program should only come from native, locally adapted stocks.	High (Current practice)	>5	Fall Chinook salmon broodstock comes from fish trapped at the hatchery.

	Out of sub basin importation of eggs, juveniles, or adults should not occur, even if it means juvenile production targets will not be achieved in some years. Work with water managers to improve conditions for migrating juveniles and adults.	Low (Current practice) High	<1 >5	Steelhead broodstock comes from fish trapped at the hatchery. The origin of the broodstock was from eggs transferred from Feather River Hatchery, and hatched at MOK, and reared and released by MOK personnel.
3	Transporting and releasing juveniles to areas outside of the Mokelumne River should be discontinued. Juvenile fish should be released at the hatchery, or if not possible, as far upstream in the Mokelumne River from the confluence of the Sacramento River as possible to reduce adult straying and increase the number of adult fish returning to the hatchery. Consider necessary facility modifications or equipment purchases that will facilitate on‐site releases. Release locations for steelhead may take into consideration ecological and predation effects on other fish populations but should not compromise homing of adults to the hatchery.	High	>5	Juvenile fish are released at locations and methods determined by CDFW and EBMUD personnel and described in an annual operation agreement.
4	Performance standards for each phase of the fish culture process should be established and tracked annually. Summaries of data collected with comparisons to established targets must be included in annual hatchery reports.	High/Medium	1-5	Data is collected by hatchery personnel but is not summarized due to lack of staffing.
5	Managers should investigate the feasibility of collecting natural origin adult fish at alternate locations. The existing trapping location is very limited in its ability to capture fish representing the entire spectrum of life history diversity. Only fish that migrate to the furthest	Low	<1	Current spawning habitat is limited to approximately 15 miles downstream from Camanche Dam. There is no evidence to support the thesis that either fall Chinook salmon or steelhead trapped at the hatchery are genetically different from fish that spawn in the river.

	upstream reaches are susceptible to capture.			Look at carcass survey to determine if there is any significant difference below the hatchery
6	A Monitoring and Evaluation Program should be developed and implemented and Hatchery Coordination Team formed for the program. Implementation of these processes will inform hatchery decisions and document compliance with best management practices defined in this report.	High Low (Implemented) High	1-5 <1 >5	EBMUD personnel conduct monitoring and evaluations of the hatchery and river fish populations. A HCT has been formed to assist with hatchery decisions and document compliance with BMPs. The Constant Fractional Marking Program lacks effective monitoring and reporting.
7	CDFW should develop and promulgate a formal, written fish health policy for operation of its anadromous hatcheries through the Fish and Game Commission policy review process. Hatchery compliance with this policy should be documented annually as part of a Fish Health Management Plan. The current CDFG fish health policy is inadequate to protect native stocks.	Low (Implemented)	<1	CDFW personnel have prepared a formal, written fish health policy. A copy is attached (Appendix B).
8	CDFG should develop an updated Hatchery Procedure manual that includes performance criteria and culture techniques presented in IHOT (1995), Fish Hatchery Management (Wedemeyer 2001) or comparable publications. The fish culture manual (Leitritz and Lewis 1976) is outdated and does not reflect current research and advancements in fish culture.	Medium	1-5	Members of the CDFW Hatchery Management Committee are preparing procedure manuals for anadromous fish hatcheries.
Steelhead Program				
13	Nonanadromous (resident) or unmarked fish typically should not be used as broodstock and the current	Low	<1	Current practice is to only fish >16 inches are used as broodstock and hatchery personnel attempt to

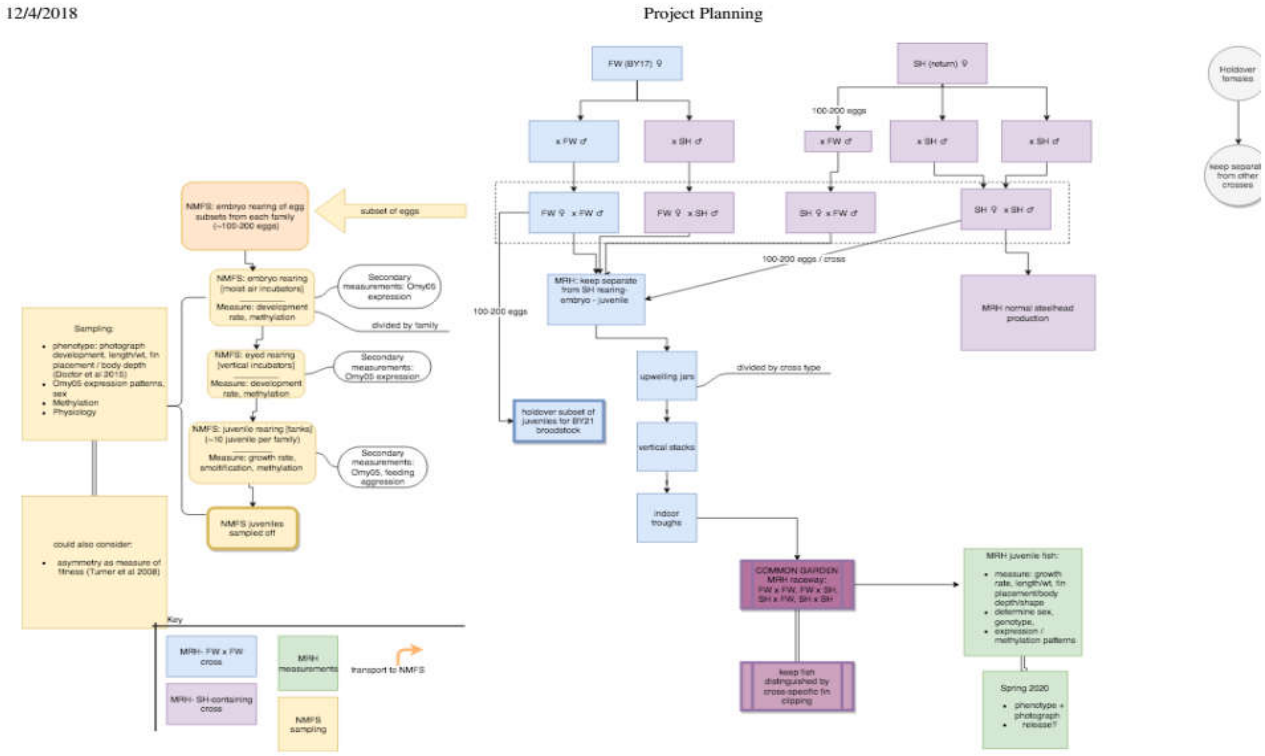
	16-inch minimum length for broodstock should be continued.			eliminate resident trout from the broodstock. Hatchery does incorporate natural fish >16" and at rate less than 5% Plans are to only use male fish >18 inches to enhance possibly of incorporating anadromous fish in broodstock.
14	Hatchery origin adult steelhead returns to the hatchery should be treated as follows: (1) unspawned males should be extended reconditioned and released; (2) unspawned females should be stripped of eggs, extended reconditioned and released; and (3) spawned fish should be removed from the system, or extended reconditioned and released.	Low	<1	Current practice is to recondition all artificially spawned steelhead and release the fish back to the river. Hatchery does not do 1 or 2, but we do 3. Unused males are reconditioned and release
15	Natural origin adult steelhead returns to the hatchery, whether spawned or unspawned, should be released. Fish may be reconditioned prior to release.	Low	<1	Due to low numbers of returning adult steelhead, all fish trapped are artificially spawned. All kelts are reconditioned prior to release.

[1] Numbers do not reflect any priority listing of recommendations.
[2] High priority: Would substantially improve program performance in a critical area. Effects would be immediate or may take some time to realize, but have long-term implications to program success. And/or, implementation is crucial for authorization of HGMP for the program. Implementation is necessary to meet program purpose and goals.

Medium priority: Would moderately improve program performance in an important, if not critical, program area. Effects may be immediate or may take some time to realize, and may or may not have long-term implications to program success. And/or, implementation is not crucial for authorization of HGMP for the program, but would add to program justification. Implementation adds to progress toward program goals, but is not essential to meeting them.

Low priority: Implementation would not substantially improve program performance in any critical or important area, but would add to the program. And/or, implementation is not specifically necessary for authorization of HGMP for program, nor would it add to program justification under the HGMP. And/ or, effect of implementation is very uncertain or logistically difficult or is otherwise infeasible.

Appendix 6.3 National Marine Fisheries Service Controlled Mating of California Central Valley Steelhead Trout Broodstock Breeding Matrix



https://drive.google.com/drive/u/2/folders/1EAZeee2yU5sRsLPsEc9Gwd6d7hus8u1k 1/1