DWR OROVILLE FACILITIES RELICENSING PROJECT (FERC PROJECT NO. 2100)

ENVIRONMENTAL WORK GROUP
DRAFT STUDY PLAN

SP-F9. EVALUATION OF THE FEATHER RIVER HATCHERY EFFECTS ON NATURALLY SPAWNING SALMONIDS

FEBRUARY 28, 2002 DRAFT

1.0 INTRODUCTION

The California Department of Water Resources (DWR) constructed the Feather River Hatchery (FRH) to mitigate for the loss of salmonid spawning habitat lost when Oroville Dam was closed in 1967. Since the late 1960s, the FRH, operated by the California Department of Fish and Game (CDFG), has released millions of spring and fall chinook salmon fry, fingerlings, smolts and yearlings, and yearling steelhead to fulfill DWR's Oroville Federal Energy Regutory Commission (FERC) license mitigation responsibility. The FRH releases provide significant contributions to ocean commercial and recreational fisheries (chinook salmon) and inland recreational fishery (chinook salmon and steelhead) (Dettman and Kelley 1987 and Cramer 1992). Spawning escapement data (Reynolds et al. 1993) indicate that the FRH has apparently met its implicit mitigation responsibility in that runs of fall and spring chinook and steelhead to the Feather River have been numerically greater, on average, than runs seen in the years immediately before construction of Oroville Dam.

As defined in this study plan the Feather River Hatchery includes the fish diversion dam below Oroville Dam, the fish ladder, holding tanks, hatchery buildings and raceways. A separate fish rearing facility, the Salmon Stamp funded Thermalito complex, is also included in this evaluation because chinook salmon reared in this enhancement program are derived from gametes taken at the main hatchery and production is mixed with that from the main hatchery for release in San Pablo Bay. Hatchery activities included in this study plan include spawner selection, egg take and fertilization, rearing practices (including disease control) and release strategies, including release site.

The FRH is one of five major Central Valley hatcheries producing and releasing fall chinook, one of three producing and releasing steelhead rainbow trout and the only hatchery producing and releasing spring chinook. An examination of the effects of FRH operations and facilities must consider any impacts in the context of the past and present practices of the entire Central Valley complex of hatcheries. Although there may be late fall chinook in the Feather River (B.Cavallo, DWR, personal communication) this study focuses on fall and spring chinook and steelhead.

The study plan will focus on several potential impacts of hatchery operation on naturally spawning salmonids. These potential impacts include (adapted from NRC, 1966):

- Effects on harvest – both commercial and recreational for chinook salmon and recreational for steelhead. A concern is that production from the FRH and other hatcheries has lead to the mixed stock fisheries that can overfish depleted natural stocks.
- Genetic effects – Hatchery operations can potentially cause problems with interbreeding depression and loss of genetic diversity within and among stocks.
- Domestication – Hatchery practices can lead to genetic adaptation to the hatchery, an adaptation that can reduce overall population fitness.

The plan will also identify the positive aspects of hatchery operation such contributions to commercial and recreational harvest and resulting economic contributions to society.

The general approach to the study involves completing several tasks involving: 1) an examination of past and present hatchery practices and other Central Valley hatcheries; 2), documenting the results of genetic analyses of chinook salmon and steelhead from the FRH and other Central Valley streams and hatcheries; 3), compiling the results of extensive tagging studies to estimate the contribution of FRH fall chinook production to ocean and recreational fisheries, escapement and to straying, and, 4) for steelhead, evaluate in-stream rearing, and possible competition, between hatchery produced and naturally produced fish. In addition, the study will examine potential changes in hatchery practices, such as releasing production spring run juveniles directly in the Feather River. The information derived from these, and from other study elements in the FERC process will be organized into a final comprehensive evaluation of the benefits and concerns about hatchery operations.

Hatchery evaluations as part of the FERC process will be coordinated with take and other issues associated with hatchery operations as part of DWR and CDFG obligations pursuant to provisions of the federal Endangered Species Act.

The following paragraphs provide a brief background on the mitigation goals of the FRH and some of the complications expected to be addressed in the hatchery evaluation process.

The actual mitigation goals for the FRH are defined in terms of the numbers of eggs taken each year for rearing and the numbers to be released as smolts or yearlings. CDFG (1999) has the following goals by race or species:

For Mitigation

Race or species	number of eggs to be taken	number and stage at release
Spring chinook	up to 7,000,000	5,000,000 smolts
Fall chinook	up to 12,000,000	6,000,000 smolts
Steelhead	up to 1,000,000	400,000 yearlings

For Ocean Enhancement – Salmon Stamp facilities at Oroville

Fall chinook	from egg take above	2,000,000 smolts

For Ocean Enhancement – Salmon Stamp facilities on the Mokelumne River

Fall chinook	up to 4,000,000 eggs from above fall chinook egg take

Chinook salmon and steelhead eggs, adults, and juveniles from the FRH have been used at other hatcheries (Nimbus Hatchery on the American River and the Mokelumne River Fish Facility) when spawning escapement to the hatcheries, or other conditions, limited their production. In addition, for more than three decades researchers have used tagged and externally marked juveniles from the FRH to help address such important questions as (1) the rate at which juvenile salmon enter water diversions; (2) the importance of the Yolo Bypass to salmon production and; (3) the survival of juvenile chinook salmon through the Sacramento-San Joaquin Delta. These uses of eggs and juveniles complicate the hatchery evaluation by adding additional release points (with increased straying potential) for FRH produced fish.

Evaluation of the FRH as a DWR mitigation facility is also complicated somewhat by some non-mitigation aspects of the take and rearing of eggs from Feather River chinook salmon spawners. With support from California's Salmon Stamp Program, chinook salmon embryos from the FRH are used at the Thermalito Annex to rear and release juveniles beyond DWR's mitigation responsibilities (so-called "enhancement production"). Eyed eggs from the FRH have been taken to CDFG's Mokelumne Fish hatchery for rearing in a similar Salmon Stamp supported ehancement program. (In recent years escapement to the Mokelumne River has been adequate to satisfy mitigation and enhancement needs and there have been no egg transfers from the FRH.) Juvenile chinook salmon from the Feather River have also been used to stock inland reservoirs (including Lake Orvoville and Lake Almanor above the hatchery) to provide cold-water sports fishing opportunities.

For purposes of the FERC process, the hatchery evaluation is limited to the mitigation aspects of the FRH. In reality, the evaluation must include all aspects of the hatchery operation and the mitigation portions subsequently sorted out. For example, mitigation and enhancement juveniles are routinely moved between the FRH to the Thermalito facilities for disease control and other purposes and the enhancement and mitigation production are mixed for transport to San Pablo Bay. Some juvenile chinook salmon planted in Oroville Reservoir may leave the reservoir during flood periods, move to the ocean and possibly return to spawn.

A final complication in analyzing the impacts of the hatchery involves changing hatchery practices over the past three plus decades. For example into the nineties, planting surplus fry in many Central Valley streams was a common hatchery practice. The 1999 hatchery operations plan (CDFG 1999) stipulates that this practice will no longer occur. At various times FRH chinook salmon have been planted in the Feather River as fry, fingerlings, smolts and yearlings. Since the mid 80s most of the production has been planted in San Pablo Bay. Also the length of time it takes to plant production chinook has changed from April through September to April through July – mainly due to the use of larger capacity transport vehicles. There are some indications that changes in release timing may have changed the straying rates (S Cramer, personal communication).

The early 1960s, when CDFG and DWR agreed to construct and operate the FRH, was a period when hatcheries were deemed appropriate mitigation for habitat loss. In recent years salmon biologists have come to recognize that hatcheries can affect natural salmonid runs (for example, Reisenbichler 1997), especially when operated without taking into account potential effects of

hatchery releases on wild fish. For example, successful efforts by FRH hatchery staff to reduce instream and Delta mortality by trucking production to San Pablo Bay has resulted in some adults returning to other streams (a behavior called straying). Straying into other streams, in particular to those streams containing threatened wild spring run, can result in interbreeding that may reduce the genetic fitness of wild spring run. Effects on spring run, which formerly spawned high in the watershed, may be compounded further by the presence of Oroville Dam, forcing spring run to spawn in the same area as fall run. When combined with hatchery practices that potentially result in interbreeding of spring and fall run straying may pose a hazard to the genetic fitness of wild spring run and naturally spawning fall run. Using microsatellite markers, Hedgecock et al. 2001 found only one genotype in naturally spawning and hatchery chinook in the Feather River and that genotype was distinct from spring chinook on Deer, Mill and Butte creeks – looking more like fall chinook. If spring and fall chinook were genetically distinct, one would expect at least two genotypes, and perhaps even distinct natural and hatchery genotypes.

In a recent draft report, the National Marine Fisheries Service (NMFS) and CDFG (NMFS and CDFG 2001) reviewed practices in Central Valley hatcheries operated by CDFG, including the FRH. The report identified three principal hazards of hatchery operations to listed winter and spring chinook and steelhead:

- Genetic hazards caused by reducing genetic diversity in depressed natural populations;
- Ecological hazards to natural populations caused by straying, including competition for spawning sites and disease transmission; and
- Management hazards caused by the inability to differentiate hatchery from wild stocks. (This inability may be masking declining productivity of natural populations.)

The report further cautioned that managers should be concerned about management and genetic hazards because they have high risks of occurrence. The hazards are particularly troublesome because they include the risk of extirpation of natural stocks. Several times in the main report and in an appendix (Appendix 1 “Off-site Release and Straying Subcommittee Report”) the authors referred to straying as a “significant problem” and mentioned the present practice of releasing production in San Pablo Bay as a particular concern. The report included a recommendation to tag (and fin clip) and release all FRH spring production in the Feather River and consider the same release strategy for fall run production.

NMFS and CDFG recommended that all Central Valley hatcheries prepare Hatchery and Genetics Management Plans (HGMPs) to minimize the risks to threatened and endangered salmonids. NMFS developed a detailed format for the HGMP, intended to provide a single comprehensive source of hatchery information for planning and satisfy permitting requirements under the federal Endangered Species Act (ESA). In a recent evaluation of the Coleman National Fish Hatchery (CNFH) and the Livingston Stone National Fish Hatchery (LSNFH), the U.S. Fish and Wildlife Service (USFWS) used the HGMP template for their biological assessment (USFWS 2001).

Steelhead present somewhat of a special case with respect to the effects of hatchery operations on naturally spawning salmonids. This special case is because:

- Relative to chinook salmon, the FRH produces few juvenile steelhead.
- All juvenile steelhead are released as yearlings in the Feather River.
- For the past few years all juvenile steelhead produced in Central Valley hatcheries must have external marks (adipose fin clips) to distinguish from wild fish. In addition FRH production is coded wire tagged.
- Juvenile steelhead may spend one or two years in freshwater before migrating to the ocean, and in some cases may not migrate at all. Outmigrants are relatively large compared to emigrating chinook salmon – 150 - 200 mm total length for steelhead compared to 40 – 120 mm for chinook salmon.
- In contrast to chinook salmon some steelhead survive spawning and may return to the ocean, spawning again in subsequent years.
- There is no commercial fishery for steelhead and the freshwater anglers are only allowed to keep hatchery (adipose clipped) fish. In addition, it appears that significant numbers of immature fish ("half pounders") are taken in freshwater – many in the Feather River.

As summarized by McEwan (2001) the complex life history (including sampling difficulty) and the lack of commercial importance have resulted in less relatively little information about this Central Valley steelhead. The documentation leading to listing the Central Valley steelhead Evolutionary Significant Unit (NMFS 1996 and 1997, and Busby and others 1996) resulted in the compilation of much of the available information on west coast steelhead – compilations that will form the basis of this evaluation. For example, Busby and others used allozyme analyses to demonstrate that the genetic structure of steelhead from the Coleman National Fish Hatchery, the FRH and wild fish from Mill and Deer creeks and the Stanislaus River was similar and did not resemble the genetic structure of coastal populations. On the other hand, the genetic structure of steelhead from the Nimbus Hatchery and the American River resembled that of their founding stock from the Eel River.

2.0 OBJECTIVES

The objectives of this study plan are to:

(1) determine the ongoing and future impact of the FRH's Oroville mitigation activities; and

(2) develop information to be used in identifying and assessing the feasibility of potential protection, mitigation and enhancement measures.

To achieve these objectives , the plan will:

- Determine if operations at the FRH impact the genetic composition of spring and fall chinook and steelhead runs in the Feather River.
- Determine if operations of the FRH impact the genetic composition of spring and fall chinook and steelhead runs to other Central Valley streams;
- Estimate the contribution of Feather River chinook salmon production to ocean and inland fisheries and to escapement to the Feather River and other Central Valley streams;
- Evaluate the effects of FRH steelhead plants in the Feather River on naturally spawning steelhead in the Feather River.
- Determine how hatchery operations might be modified in light of findings presented in this and interrelated studies.

3.0 RELATIONSHIP OF THE STUDY PLAN TO RELICENSING PROJECT PROCESS/NEED FOR STUDY

The FRH is an integral component of the Oroville complex, and its operation has the potential to adversely affect naturally spawning salmonid runs. As mentioned previously a 2001 draft report by CDFG and NMFS suggests that the FRH practice of planting hatchery production in San Pablo Bay (instead of in-river) may have caused increased straying. This increased straying may have impacted chinook salmon and steelhead runs in other streams, in particular those with wild spring run (for example Mill, Deer and Butte creeks). The report also suggested that hatchery practices have co-mingled spring and fall chinook in the hatchery and impacted the threatened spring run.

On the positive side, the FRH has released millions of juvenile salmon in the past 30 plus years and there are more steelhead, and chinook salmon returning to the Feather River each than prior to construction of the Oroville Dam. These fish appear have made significant contributions to the ocean and inland commercial and recreational fisheries and escapement to the Feather River. After almost 30 years of operation, and with new thinking on the roles of hatcheries, it is time to evaluate the hatchery, its mitigation responsibility and operational practices.

Identification and quantification of project effects on fish and fish habitat has been recognized as an issue by relicensing stakeholders including stakeholders with mandatory conditioning authority and is a FERC requirement. Evaluation of project effects on wildlife resources is also required for CEQA/NEPA compliance.

Listings of the spring run as threatened pursuant to the federal and state endangered species acts and steelhead as threatened under the federal Endangered Species Act require that the State obtain take authorization in order to operate the hatchery. Although the fall run is not listed (but is a candidate species) under the federal ESA, there is considerable concern about the effects of hatcheries on naturally spawning fall chinook runs in the Feather River and other Central Valley streams. As mentioned previously, NMFS may require that hatcheries affecting listed species, such as the FRH, prepare hatcheries genetic management plans. Information collected and reported in this evaluation can form the basis for such a plan for the FRH.

These and other issues about hatchery operation must be addressed in the FERC relicensing process and, in light of the results of this study and analyses, the new FERC license may stipulate changes in hatchery practices.

Section 4.51(f)(3) of 18 CFR requires reporting certain types of information in the FERC application for license of major hydropower projects, including a discussion of fish, wildlife and botanical resources in the vicinity of the project. The discussion needs to identify the potential impacts of the project on these environmental resources, including a description of any anticipated continuing impact for any on-going and future operation. This study fulfills these requirements by evaluating potential project effects on anadromous salmonids and their habitat in Feather River below the Fish Barrier Dam.

4.0 SCOPE – STUDY AREA

This study plan is designed to evaluate the impact, if any of FRH released salmonids on natural spawning salmonids in the Feather River and other Central Valley streams. In addition this study will evaluate whether the FRH has satisfied DWR's mitigation requirements, including supplementing chinook salmon harvest in the ocean commercial and recreational fisheries. The study area thus includes:

- the hatchery site (including the fish barrier dam and ladder);
- the Thermalito facilities
- the Feather River from the fish barrier dam to its confluence with the Sacramento River;
- the Sacramento River to its confluence with the San Joaquin River;
- the Sacramento-San Joaquin Delta;
- the San Francisco Bay;
- and the coastal ocean from southern California to British Columbia (the area where juvenile chinook salmon released from the FHR may be harvested in commercial and recreational fisheries.

Study plans approved by the Environmental Work Group define the limits of the study area. If initial study results indicate that the study area should be expanded or contracted, the Environmental Work Group will discuss the basis for change and revise the study area as appropriate.

5.0 GENERAL APPROACH

Evaluation of the FRH impacts will be based on review and synthesis of the vast amounts of information collected about the hatchery, the Feather River and other locations in the Central Valley and the Pacific Ocean. Of particular importance is the review of the recent biological assessment of the effects of the CNFH on salmonids (USFWS 2001) and the NMFS guidelines for a Hatchery Genetics Management Plan (HGMP, see USFWS 2001 for components of HGMP.

In addition to compilation and analysis of existing data and literature, the hatchery evaluation will include additional field data collection and analysis. Much of this evaluation will be based on a hatchery marking study began in 1994. In each year of the study from 1 to 1.5 million production fish have been marked with adipose fin clips and magnetic coded wire tags implanted. Most of these tagged fish were released in San Pablo Bay but each year control groups, consisting of 200,000 tagged fingerlings and 100,000 tagged yearlings were released in the Feather River below the Thermalito outlet. The allocation of tags between putative hatchery spring and fall runs varied each year. Some of the tagged fish were subsequently recovered and the tags decoded in sampling at the Delta pumps, in midwater trawls at Sacramento and Chipps Island, in the ocean fisheries, in the inland fishery, during spawning ground surveys and at the FRH and other Central Valley hatcheries.

As mentioned previously, all juvenile steelhead produced at the FRH are tagged and externally marked. Although all steelhead produced at other Central Valley hatcheries have the external marks, almost none of them are tagged. (The exception is that a few experimental fish from the Coleman National Fish Hatchery have been tagged. Jim Smith, personal communication.) The IEP has provided portable tag detectors to crews at the hatcheries and other field locations. If a marked fish has a tag, the fish is to be sacrificed and the tag decoded. This information can provide an idea of movement, including straying of Feather River steelhead. A caveat is that the relatively small number of releases (the production is 400,000 yearlings) and the difficulty in capturing steelhead may not produce sufficient tag returns to provide a statistically useful sample size.

In addition to tagging the production fish, through other funding a three-year study used coded wire tags to compare the survival of juvenile chinook salmon released in San Pablo Bay directly from transport trucks versus placed in floating net pens and towed towards mid Bay for release. Since net pen releases are now a standard operational practice, the comparison will provide an examination of the effects of this release strategy on ocean contribution and escapement.

The fishery contribution rates and straying are being estimated by use of cohort analysis (Cramer 1992). Ocean and recovery data are now available through 2000 and inland recoveries through 1997. The cohort analysis will be updated as additional marked fish are recovered in the ocean and inland fisheries, on the spawning grounds and in the hatcheries. Preliminary analyses indicate that field sampling for marked fish on the spawning grounds is not adequate, thus additional recovery efforts will be designed, funded and conducted in the fall of 2002. Some additional tissues may be needed to verify the genetic identity of Central Valley salmonids, in particular fall run on the Mill and Deer creeks and adult chinook returning to the Feather River in the spring/early summer.

The conceptual foundation for the evaluation is found in the attached conceptual model. In summary, the model is as follows.

- The FRH rears steelhead and chinook salmon to mitigate for the loss of salmonid spawning and rearing habitat lost when Oroville Dam was constructed.
- Releases of the juvenile steelhead and salmon in the river, in other streams and in San Pablo can result in straying to other streams and interbreeding of wild and hatchery fish.
- This interbreeding can depress the fitness of wild chinook and steelhead.
- Hatchery practices that select for certain traits (time of arrival at the hatchery, size, fecundity, etc.) as well as the general hatchery rearing conditions (feeding methods and diseases) may reduce the overall fitness of chinook salmon and steelhead and this reduced fitness may be transferred from generation to generation.
- In the past few years a combination of a successful hatchery, an in-Bay release strategy, reduced ocean harvest, good ocean conditions, and spawners being drawn to the river channel immediately below the barrier dam has resulted in spawning runs that exceed the available spawning area. The large number of spawners competing for a relatively small area results in redd superimposition and may be affecting productivity of natural spawners.

- Central Valley chinook salmon, including those in the Feather River, suffer from a variety of diseases. The occurrence and intensity of disease outbreaks can be intensified by intensive culture practices used in hatcheries and the diseases, in turn, may affect natural populations.
- Drawing water from Oroville Reservoir to meet temperature requirements for hatchery operation may result in river temperatures that differ from historic conditions. The changed water temperature regime may affect naturally spawning and rearing salmonids.

It must be kept in mind that this is an abbreviated conceptual model and that conceptual models are used to make hypotheses and assumptions explicit. The analyses being conducted are to help validate or refute the model with the goal of having a better model when the evaluation is complete.

If initial study results indicate that the methods and tasks should be modified, the Environmental Work Group will discuss the basis for change and revise the study plans as appropriate.

METHODOLOGY AND ANALYSIS

Task 1 – Evaluate the Genetic Effects of FRH Practices on In-river Populations of Spring-run and Fall-run Chinook Salmon and Steelhead

The gates to the fish ladder leads to FRH are generally open from about September 1 through the end of March. The early entries are ready for spawning in October. Through the mid-nineties fish entering the hatchery after October 1 were generally classified as fall-run. There is concern that this hatchery practice may have genetic effects on the in-river populations of chinook salmon and steelhead (see for example Hedgecock et al. 2001). In addition, spring and fall chinook now spawn in the same general time period in the area just downstream of the fish barrier dam. This co-mingling of spawners also increases the chances that spring and fall chinook are interbreeding. In 1999 DFG developed a hatchery operations plans (CDFG 1999) which modified and standardized processes to minimize chances of interbreeding spring and fall chinook. The new procedures specify only those fish entering the hatchery between September 1 and September 15 will be considered spring run. Chinook salmon entering the hatchery after September 15 will be considered fall run. In addition, no eggs will be taken for spring run production after October 7, even if the fish had entered the hatchery before September 15.

DWR began studies in 1994 and 1995 to help address genetic issues. The 1994 tagging studies, described previously, involved tagging both nominal spring and fall chinook in the hatchery. The time of tagging (and race as defined by hatchery staff) will be compared to the time the tagged adults return to the hatchery 2 or 3 years later. Previous studies (Brown and Greene 1994) have shown that fish called one race in the hatchery may return as another. (For example, the progeny of a spring run female spawned on October 1 may return and be spawned in early November and would be called a fall run.) The 1995 studies were part of a major effort by UC Davis scientists to determine the genetic diversity of Central Valley chinook salmon populations. Small tissue samples were collected from adult chinook salmon from major spawning streams and hatcheries and analyzed through use of a series of micro-satellite markers. (See Banks et al 2000 for a complete description of the methods used.)

Completing this task will require the following activities:

- Review and synthesize information related to the use of microsatellite markers and allozymes to determine the genetic composition of the three anadromous salmonid runs in the Feather River; collect and analyze additional tissue as needed.
- Review and synthesize past, present and projected hatchery practices to determine the founding broodstock for each run and how broodstock selection procedures may be impacting genetic integrity of the three runs.
- Compile available information on production and outplanting of chinook salmon at the FRH.
- Compile and synthesize information about hatchery practices geared to increase production of FRH including predator control, food and feeding, movement of fish between Thermalito and the main hatchery and egg take and early incubation.
- Review and synthesize run timing and spawning location data to determine if the Feather River fall and spring runs are segregated in time or space.
- Review coded wire tag data to determine the fidelity of putative FRH spring and fall run production when they return to the hatchery two to four years after release.

Task 2 – Evaluate the Effects of FRH Production on the Genetic Integrity of Spring-run and Fall-run Chinook Salmon of Naturally Spawning Chinook Runs in Other Streams

This task, based upon a literature review on genetic effects of salmon straying, available tag recovery data and modeling, attempts to address the question of what are the effects, if any, of FRH production on the genetic integrity of the spring and fall runs of Central-Valley chinook salmon. Elements of this review will include:

- Reviewing literature on straying and genetic effects from other areas and in particular from Central Valley streams;
- Review and synthesize physiological and morphometric information collected by NMFS and USFWS staff on FRH smolts with the goal of assessing any apparent reduction in fitness associated with hatchery rearing;
- Examine genetic data developed in Task 1 to help determine if Feather River Hatchery produced fish are altering the genetic structure of runs to other Central Valley streams, and in particular to spring chinook in Mill, Deer and Butte creeks;
- Use cohort analyses of tag recovery data to estimate the straying rates of production releases to other Central Valley streams; (see Cramer (1992) for details;)
- Use simple statistics to show the numbers of tagged FRH releases that have been recovered in other streams;
- To correct a significant undersampling of tagged chinook and steelhead, conduct a “tag collection blitz” in the fall of 2002 and perhaps in 2003 to recover the maximum numbers of tags from Central Valley streams with particular attention to the Mill, Deer and Butte creeks and the mainstem Sacramento River between Red Bluff and Keswick Dam. This

subtask would be contingent on securing funding from the Interagency Ecological Program, CALFED, and/or the Andromous Fish Restoration Program.

Task 3 – Evaluate the Contribution of FRH Chinook Salmon Production to the Ocean and Inland Harvest and Escapement to the Feather River

The tagging studies and cohort analysis described earlier will also provide estimates of contribution of Feather River Hatchery produced fish to the fisheries and escapement. For the past several years, DWR through the Interagency Ecological Program, has supplemented CDFG's ocean tag recovery efforts so that the agency samplers would be looking at about 20% of the fish being landed in the ocean fisheries off California. In a separate effort, the US Department of Interior's Comprehensive Analysis and Monitoring Program has funded DFG to estimate the numbers of chinook salmon harvested in the inland recreational fishery. The inland samplers have also been recovering some tags and the tags sent to CDFG's Healdberg laboratory for decoding.

This task will include:

- Use the cohort analysis to estimate contribution rates;
- Review and synthesize information about ocean and inland harvest rates to determine if there are trends in these fisheries;
- Estimate and contrast the contributions of FRH salmonid production and of naturally produced salmonids to harvest by the ocean and inland sport and commercial fisheries;
- Review available data to determine changes in contribution rates due to changes in hatchery practices such as: release location (in-river, the Delta, San Pablo Bay); size at release (fingerling, smolt or subyearlings); and release method (directly from transport trucks, from net pens); and
- As data permit, compare individual survival estimates for fish traveling from the Feather River to Chipps Island collected over the past two decades to determine if there are any trends. This analysis will be supplemented by in-river survival information from Battle Creek releases of tagged fish from the Coleman National Fish Hatchery. The objective is to determine if in-river has changed over the past two decades and if this change would affect hatchery production release strategies.

Task 4 – Evaluate the effects of FRH steelhead planted in the Feather River on naturally spawning steelhead in the Feather River.

The significant differences in the biology and life history of chinook salmon and steelhead dictate that many aspects of the steelhead evaluation be handled in a separate task. Completing this task will require coordination between the in-river ecological project and integration of the results of these two components in the final synthesis report. Specific elements of this task include:

- Review applicable literature on the effects of steelhead conservation and production hatcheries.
- Summarize hatchery spawning and production for the period of record.
- Compile and assemble information collected in the Feather River pertaining to rearing and outmigration of juvenile steelhead. These data will include habitat use, food habits, catches of steelhead in rotary screw traps and other sampling methods.
- Examine tag return data to determine if they are adequate to describe the movement of FRH juvenile steelhead.
- Summarize information from DFG's recreational angler surveys to estimate harvest rate on hatchery steelhead**.**

Task 5 – Evaluate the potential benefits and impacts of planting a significant portion, if not all of the spring run production in the Feather River.

In their 2001 draft report, NMFS and DFG proposed to consider planting all of the spring run production directly in the Feather River. If implemented, this proposal could affect the stream's ability to support naturally reproducing salmonid populations. A basic premise of Task 6 is that planting spring chinook in the Feather River should only occur after a thorough review of what we know and, if implemented, should employ an adaptive management approach – ie a graduated release schedule accompanied by extensive data collection and analysis. Elements of this task include:

- Through SP F10 and other efforts assemble the available information on habitat use, condition factor, food use, food electivity and food composition in the Feather River from the barrier dam to the confluence with the Sacramento River.
- Work with DFG and NMFS biologists to determine the numbers, size and locations of possible spring run releases into the Feather River. These discussions would be based in part on emigration patterns of natural spawning and estimated survival of hatchery spring chinook to Chipps Island and the ocean fishery.
- As a special study in the springs of 2002 and 2003, increase releases of tagged hatchery spring chinook in the Feather River to help assure a statistically valid sampling size is available from recaptures at Chipps Island, the ocean fishery and on the spawning ground. In 2002 there will be three releases of 100,000 each. After reviewing these results DFG/NMFS/DWR would recommend the sample size and release timing for 2003.
- Consider adding a rotary screw trap, or other juvenile salmonid sampling device, nearer to the mouth of the Feather River. This sampling could provide additional information regarding emigration of juveniles from the Feather River.

Task 6– Prepare final report synthesizing the information from the above tasks in combination with information from other elements of the Oroville Project evaluation.

All the information related to this study plan will be compiled into a narrative report, with the report organized along the general format of a Hatchery Genetics Management Plan. Using this approach presents the information in a format readily used by DFG and NMFS in preparing the HGMP for the FRH. Specific FERC-related study elements expected to provide information for the final hatchery evaluation report are:

- SP-W1, Water quality, specifically with regard to the effects of hatchery produced fish on nutrients and disolved oxygen in the river.
- SP-W6. Water quality, specifically the effects of the hatchery operation on stream temperature.
- SP-F10, In-river fish ecological assessments
- SP-F2, Disease studies

6.0 RESULTS, PRODUCTS/DELIVERABLES, AND SCHEDULE

RESULTS/PRODUCTS/DELIVERABLES

The information compiled in the above tasks will be assembled into a series of task specific reports. Where possible and informative, data will be organized and analyzed and presented in a series of figures and tables – the tables and figures forming the basis of many of the tasks reports. The ultimate deliverable will be the synthesis report that evaluates the overall effects of the hatchery on naturally spawning salmonids. The synthesis report will based on a combination of data directly related to the FRH and information gleaned from similar analyses of the effects of other hatcheries.

Review will be a key element of the reporting process. The authors of the task reports will submit drafts to appropriate technical and policy reviewers. Any comment will be addressed before the reports are made final.

SCHEDULE

The synthesis report will be completed by June 30, 2004. Individual tasks will be completed in time to meet the final report schedule but in most all cases, the task reports should be completed by March 1, 2003 to allow incorporation in the final report and sufficient opportunity for review. For some discrete components of the individual tasks, the deadlines are:

- Initial results of cohort analysis to estimate contribution and straying rates - April1, 2002 – part of Tasks 2, 3 and 6;
- Results of mark recovery blitz – January 31, 2003 – part of Tasks 1, 2, 3 and 6.
- Second cohort analysis using additional tag recovery data – April 30, 3002 – part of Tasks 2, 3, and 6.
- Literature reviews – December 31, 2003. Part of all tasks.
- Complete chinook salmon modeling development – March 1, 2003 – Task 5.
- Analysis of effect of hatchery operation on stream temperature – August 31, 2003 – Task 4.

- Complete additional analyses of genetic tissue – October 31, 2003 – part of Tasks 2 and 3.

7.0 STUDY PLAN COORDINATION

COORDINATION WITH OTHER RESOURCE AREAS/STUDIES
Coordination with other FERC relicensing studies, including those addressing fish disease (SP-F2), salmoids in the Feather River (SP-F10), water quality (SP-W1 & SP-W6), and interbreeding of salmon stocks (E&O SP-5).

Evaluate the Likelihood Transmission of Disease from Hatchery to Wild Fish
SP-F2 – Effects of Project Operations on Fish Diseases:

SP-F2 will provide information crucial to the evaluation of stocking practices and artificial production as it pertains to management of fish resources at Oroville facilities.

Many bacteria, virus and protozoa are known to cause various diseases to both wild and hatchery Pacific salmonids (e.g., the bacterium *Renibacterium salmoninarium* that cause bacterial kidney disease (BKD), the rhabdovirus causing infectious haematopoietic necrosis (IHN), the myxosporean parasite *Ceratomyxa shasta* that is lethal to most strains of rainbow trout). It is a current concern to catalogue and assess the incidence of diseases at FRH and evaluate the probability of spreading them to wild fish populations. Activities included in this task are detailed below.

- Review report by Scott Foote 2000 on similar concern about release of chinook from the Coleman National Fish Hatchery (CNFH);
- Review incidence of diseases at the FRH and CNFH to determine their similarities and if the conclusions from the Foote report can be applied to the Feather River; and
- Work with DWR's fish disease consultant to synthesize data.

Evaluate the Effect of HatcheryProduced Fish on Naturally Spawned Salmoids
SP-F10 Evaluation of Project Effects on Anadromous Salmoids and their Habitiat

Evaluate the Effects of the FRH on Water Quality in the Feather River
Project Effects on Water Quality Designated Beneficial Uses for Surface Waters (Task SP-W1)

- Review the existing and newly acquired data to estimate the water quality effects of the decomposition of spawned salmon of hatchery origin that have returned to the Feather River.

Evaluate the Effect of Hatchery on Water Temperatures
SP-W6 Project Effect on Water Temperatures

ISSUES, CONCERNS, COMMENTS, TRACKING/COMPLIANCE REQUIREMENTS

This study would address the project-related effects of the Feather River Hatchery on naturally spawning salmonids. The following specific issues will be addressed: (The list identifies if the issues are directly or indirectly addressed in the study plan. Some of the more complex issues are in both categories. The underlined sentence or clause is the one that is best identified with each category);

Directly

FE31 Several fish hatchery issues need resolution, such as the relationship between the hatchery and restoration of a natural ecosystem, straying and genetic impacts, harvest rates, and disease;

FE87 Introgression occurring between various runs of Chinook salmon and between hatchery and wild salmon and steelhead. This includes direct, indirect and cumulative impacts from hatchery practices, project facilities and operations, lack of adequate spawning habitat and impassable migration barriers that exclude access to historic spawning habitats;

FE88 Impact of hatchery facilities and/or operations on anadromous salmonids. This includes the direct, indirect and cumulative impacts of hatchery product on anadromous salmonids and the direct, indirect and cumulative impacts of hatchery facilities and operations on salmonids and their habitats;

FE93 Introgression occurring between fall-run and spring-run Chinook populations in the Feather River due to hatchery practices and impassable migration barriers;

FE99 The Feather River Hatchery was constructed to mitigate for losses of upstream habitat when the Oroville facilities were constructed. There is a body of evidence suggesting that improperly planned hatchery practices can adversely impact native and non-native species including anadromous species. The effects of hatchery practices on naturally reproducing/self-sustaining anadromous populations should be examined as part of the fishery investigations. These evaluations should examine alternative practices that would lead to increased naturally reproducing/self-sustaining anadromous populations. Improper hatchery practices can also lead to transmission of serious fish diseases, and impact overall susceptibility of naturally reproducing populations to diseases.

W13 Effects of existing and future hatchery operations on water quality and water temperatures in the Feather River and Afterbay;

WE33 Relationship between hatchery and water quality.

Indirect

FE95 The lower Feather River provides habitat to support a variety of anadromous fish species including Chinook salmon, steelhead, striped bass, American shad and sturgeon. Potential changes in license conditions could adversely impact habitat supporting these species. Habitat investigations should evaluate the existing quality and quantity of habitat and determine alternative improvements for the various life history needs of anadromous species including flow, water temperature, instream and riparian cover, substrate and spatial area;

FE87 Introgression occurring between various runs of Chinook salmon and between hatchery and wild salmon and steelhead. This includes direct, indirect and cumulative impacts from hatchery practices, project facilities and operations, lack of adequate spawning habitat and impassable migration barriers that exclude access to historic spawning habitats;

FE96 The lower Feather River provides habitat to support a variety of resident native and resident introduced species including coldwater species such as rainbow, brook, and brown trout, and warm water species such as bass, catfish, bluegill, green sunfish, carp and others. Potential changes in license conditions could adversely impact habitat supporting these species or upset habitat conditions such that less desirable species are favored. Habitat investigations should evaluate the existing quality and quantity of habitat and determine alternative improvements for the various life history needs of these resident native and non-native species including flow, water temperature, instream and riparian cover, substrate and spatial area;

8.0 REFERENCES

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