CALIFORNIA DEPARTMENT OF FISH AND GAME

NATIONAL MARINE FISHERIES SERVICE SOUTHWEST REGION

JOINT HATCHERY REVIEW COMMITTEE

FINAL REPORT ON ANADROMOUS SALMONID FISH HATCHERIES IN CALIFORNIA

December 3, 2001

TABLE OF CONTENTS

EXECUTIVE SUMMARY

Between September 1999 and December 2000, the California Department of Fish and Game (DFG) and National Marine Fisheries Service (NMFS) conducted a joint review of California's anadromous fish hatcheries. A Joint Review Committee (Committee) was established and met in various locations over the course of about a year. The review was initiated primarily in response to the listing of California salmon and steelhead populations under the federal Endangered Species Act (ESA) and the need to identify and evaluate the effects of hatchery operations on listed species. The primary goals of the review were to: (1) identify and discuss programs, policies and practices that are likely to arise as important issues in permitting hatchery programs under the ESA; (2) identify opportunities to use hatcheries to help recover listed salmon and steelhead populations; and (3) discuss emerging views on the operation and management of hatcheries for the purpose of recovering depressed natural stocks.

California's anadromous fish hatcheries, constructed to mitigate for the salmon and steelhead production lost as a result of dam construction, provide a substantial fraction of the harvest of California chinook salmon. In supplying fish for commercial and recreational use, California's hatcheries are to be operated in such a way that the populations and genetic integrity of salmon and steelhead stocks are maintained, with management emphasis placed on natural stocks. The twin goals of replacing large amounts of lost production while maintaining the abundance and genetic integrity of the remaining populations are not easily accomplished.

Numerous studies have been published describing the genetic and ecological risks that artificial production may pose for naturally spawning fish populations. However, in assessing the risks to any particular population, it is usually difficult to demonstrate conclusively that adverse effects are actually occurring, and, if they are demonstrated, how serious they are. In assessing the status of stocks proposed for listing under the ESA, NMFS found the effects of artificial propagation to be among the most difficult and controversial to incorporate into risk analyses.

The Committee reviewed information that was available relative to these risks and effects of hatcheries in California, reached conclusions, and made recommendations based upon them. Subcommittees were formed on the following topics: 1) off-site release and straying, and 2) Klamath-Trinity issues. These subcommittees presented their results to the full Committee for consideration; their written reports are attached as Appendices I and II, respectively.

Many recommendations are contained in the body of this report. The following are considered of major importance or interest:

1. Feather River Hatchery spring run chinook salmon should be released "in-river" and not trucked to distant down stream sites. The DFG should also explore all alternatives to reestablish a discrete run of spring run in the Feather River.

2. The production of fall run chinook salmon at Feather River and Nimbus Hatcheries should be considered for "in-river" release instead of being trucked downstream.

3. Hatchery "in-river" releases and water management practices (including water exports from the Sacramento-San Joaquin Delta) should be coordinated so that emigration survival is maximized.

4. A formal process should be identified for the periodic review and assessment (e.g., every 6-9 years or 2-3 brood cycles) of hatchery production levels. It should include consideration of changing ocean or freshwater regimes, new information on hatchery/natural fish interactions, and changes in ESA status of salmonid populations.

5. All agencies should pursue efforts to establish a constant fractional marking program at all hatcheries.

6. All agencies should pursue efforts to develop adequate sampling programs to recover marked fish in the Central Valley. The DFG should establish a process to coordinate and oversee the methodologies for estimating salmon escapements to the Central Valley.

7. Hatchery and Genetics Management Plans should be developed for each hatchery.

Changes made in response to the above recommendations (and others included in the report, including those at individual hatcheries) must be accompanied by evaluation and monitoring programs. The Committee is aware that implementation of some of the recommendations contained in this report would require funding that is not yet available.

Finally, it is recognized that implementation of the recommendations in this report cannot solve all future concerns about salmon or steelhead populations or hatchery operations. Hatchery production in California was not the root cause of the decline in salmon and steelhead populations to the point that they require protection under the California Endangered Species Act and the ESA. Minimizing and reversing the effects of habitat blockages, logging and agricultural activities, urbanization and water withdrawals in the river drainages that support California salmon and steelhead, will require continuing attention and effort. During its activities and deliberations, the Committee was cognizant of the biological and societal benefits that California's hatchery system provides. These benefits have to be considered when any changes are proposed to the hatchery system.

I. NEED FOR THE REVIEW

A. Introduction

In September 1999, the California Department of Fish and Game (DFG) and National Marine Fisheries Service (NMFS) began a joint review of California's anadromous fish hatcheries. A Joint Review Committee (Committee) was established and met in various locations over the course of about a year. The review was initiated primarily in response to the listing of certain California salmon and steelhead populations under the federal Endangered Species Act (ESA), and the resulting requirement that the effects of hatchery operations on listed species be evaluated and, if necessary, authorized under the ESA. The review is timely because of the consideration being given to hatcheries in other forums and processes, such as the DFG status review of Central Valley spring chinook, requirements to double natural salmon populations under the Central Valley Project Improvement Act (CVPIA), NMFS' ESA recovery planning process, the federal Tribal Trust Review of Trinity River Hatchery, and the upcoming relicensing of the Klamath River Project (including the Iron Gate Dam and Hatchery).

Over the past century, hatcheries have been built to compensate for the loss of spawning and rearing habitat of anadromous salmonids. Construction of barrier dams began on most of California's important chinook salmon spawning streams in the late 19th century and continued through the 1960s. In some years, the production from state and federal hatcheries provide over half of the harvest and escapement of California chinook salmon[1], and the offspring of hatchery origin adults, spawning in natural spawning areas, may contribute a significant portion of the remaining fish. It is likely that salmon exist in some areas of the State due entirely to the presence and operations of hatcheries in those areas. In the Central Valley, only 5-18 percent of the historic spawning habitat is still accessible to fall-run fish, and the percentage available for spring-run chinook and steelhead is even lower (CDFG 1993, Yoshiyama et al. 1996). In the Klamath-Trinity system, less that half of the historic salmon and steelhead spawning and rearing habitat is still available to spawning fish, and in all areas where dams have been build, the remaining habitat is marginally productive for naturally spawning fish.

Failure to resolve the basic problems responsible for the decline of salmon and steelhead has frequently left artificial propagation as the only available means of providing harvest opportunity and lessening the impacts of the wide fluctuations in survival rate of naturally spawning fish. Other potential benefits from hatchery programs include preserving genetic resources (e.g., through a captive breeding program), recovering depressed stocks (by increasing survival through critical life history stages), and providing fish for reintroductions where native runs have been extirpated.

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1. The U.S. Fish and Wildlife Service estimates that the average contribution rate of Coleman fall chinook to the ocean harvest south of Point Arena was 20% for the years 1990 through 1998 (USFWS 2001). Coleman accounts for almost 1/3 of the salmon released from California hatcheries. If contribution rates for other hatcheries are similar, this would suggest an overall hatchery contribution approaching 60%.

For the years 1995 through 2000, the DFG Ocean Salmon Project reported that 2.1%, 4.4%, 5.1%, 6.6%, 7.7%, and 2.9% of the sampled ocean catch were marked (M. Palmer-Zwahlen DFG personal communication 2001). For these years the marking rates for all hatchery-produced salmon have not exceeded 10%, suggesting hatchery contribution rates between 20% and 77%.

As some west coast salmon populations have declined to alarming levels in the past 20 years, the role of hatcheries in managing the resource has increasingly been questioned. In response, biologists and hatchery managers have sometimes felt their hatchery operations were becoming scapegoats for any and all failures to successfully manage salmon and steelhead.

Numerous studies have been published describing the effects of hatchery-produced fish on naturally spawning fish populations (e.g. Hindar et al. 1991; Waples 1991; NFHRP 1994; ISG 1996; NRC 1996; Brannon et al. 1999; Waples 1999). Although the potential genetic and ecological risks of artificial production are matters of concern, it is often difficult, in any particular case, to demonstrate conclusively that adverse effects are actually occurring, and if so, how serious they are. Advocates of hatchery programs are reluctant to support changes in programs solely on the basis of potential risk, particularly when proposed changes conflict with the mitigation goals for which the hatcheries were originally constructed or would result in fewer fish being produced and, therefore, available for harvest. Hatchery critics assert that it is too dangerous to wait for conclusive studies proving harm to natural populations when listed species are involved.

The Committee recognized that hatchery production in California is not the root problem that brought salmon and steelhead populations to the point where they require protection under the California Endangered Species Act (CESA) and the ESA – and that these root problems require continuing attention and effort. However, it was deemed appropriate to review the State's hatchery program and to assess its risks to natural salmonid populations; in doing so, the Committee strived to maintain an objective view of the biological and societal benefits the hatchery system does provide.

B. Goals of the Review

In the course of the hatchery review, many topics related to California's hatchery programs were discussed. While the review was motivated by the requirement to evaluate and authorize some hatchery activities under the ESA, the review is not considered part of the formal ESA permitting process. The primary goals of the review were to: (1) identify and discuss programs, policies, and practices that are likely to arise as important issues in permitting hatchery programs under Section 7, 10, or 4(d) of the ESA; (2) identify opportunities for integrating hatcheries into the process of recovering listed salmon and steelhead populations; and (3) discuss emerging views on the operation and management of hatcheries for the purpose of recovering depressed natural stocks.

C. Listed Salmonids and Artificial Propagation

Most west coast salmon and steelhead populations have been declining for decades. Since 1990, NMFS has listed 26 distinct population segments of west coast salmon and steelhead as threatened or endangered species under the ESA. Ten of these listed populations are in California. The California Fish and Game Commission has listed three populations of California salmon under the CESA (coho salmon south of San Francisco, Sacramento River winter chinook and Sacramento River spring chinook) and has accepted a petition to list a fourth (coho salmon north of San Francisco).

Salmon and steelhead are unique among threatened or endangered species in that large scale artificial propagation programs annually release millions of individuals into the wild, where they may interact with listed natural populations. The ESA recognizes that conservation of threatened and endangered species can be facilitated by artificial propagation, and captive breeding programs are part of recovery planning efforts for a number of listed species (including Pacific salmon). Potential benefits of artificial propagation for listed species include supplementing natural populations to speed recovery and/or re-establishing natural populations in suitable but currently vacant habitat. Salmon hatchery programs can be consistent with the ESA if they do not impede progress towards recovery. Production hatchery programs designed to produce fish for harvest may be compatible with ESA recovery provided that adverse effects on listed natural populations are avoided or kept below certain thresholds, as yet undefined. These effects can be genetic, ecological, or incidental (e.g., bycatch of natural fish in fisheries targeting more abundant hatchery populations).

Concern regarding the effects of hatchery fish on natural populations centers largely on the loss of genetic factors important for survival of naturally spawning fish. If hatchery fish interbreed with natural populations, the genetic structure of the natural population may be affected if genetic differences exist between the hatchery and natural populations. In the extreme case, if fish from outside the basin have been imported and used as hatchery brood stock, there are likely to be genetic differences between the hatchery and natural populations. Even if the hatchery population is of local origin, however, some level of genetic change relative to the natural population is likely to occur in time due to the fact that hatchery rearing can change the mortality profile of a population. The resulting genetic changes, if transmitted to naturally reproducing fish, are unlikely to be beneficial to them.

Other expressed concerns are: (1) naturally spawning hatchery fish can have effects on natural populations, even if they leave few or no surviving offspring, by competing with natural populations for holding and spawning habitat, (2) hatchery and natural juvenile populations may compete with one another for limited freshwater and estuarine resources, (3) hatchery production may mask declines in productivity of natural stocks, and (4) the presence of unidentifiable hatchery fish in natural populations can lead to substantial uncertainty in evaluating the status of the natural populations.

D. Authorizing Hatchery Activities under the ESA

NMFS is responsible for administering the provisions of the ESA with regard to west coast salmon and steelhead. The ESA allows listing of "distinct population segments" of vertebrates, as well as named species and subspecies. An ESU (evolutionarily significant unit) is a population of salmon determined by NMFS to meet the definition of a "distinct population segment" for purposes of listing under the ESA.

Table 1 lists the salmon and steelhead ESUs found in California. Under the ESA, it is illegal for any person – whether a private entity or a federal, state, or local government – to "take" endangered salmonids without federal authorization. The take prohibitions do not automatically apply to threatened species. NMFS may apply the take prohibitions to threatened fish, for specific activities, through a Section 4(d) rule, either at the time of listing or subsequently. "Take" is defined to mean harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or attempt to engage in such conduct. “Harm” is defined to mean an act which actually kills or injures fish or wildlife. Such an act may include significant habitat modification or degradation which actually kills or injures fish or wildlife by significantly impairing essential behavioral patterns, including, breeding, spawning, rearing, migrating, feeding, or sheltering. For hatchery operations, take may be intentional, such as collection of broodstock, or incidental, such as interactions between hatchery and listed fish that might impair essential behavioral patterns.

Table 1. List of California salmon and steelhead ESUs.

ESU and Status (E-Endangered, T-Threatened, C-Candidate, NW-Not Warranted)	4(d) Take Prohibitions In Place	HGMP Exception Available	Geographic Distribution
S Oregon/N California Coast coho (T)	Yes	No	Cape Blanco (OR) to Punta Gorda (CA)
Central California Coast coho (T)	Yes	No[1]	Punta Gorda to San Lorenzo River
Sacramento River winter chinook (E)	Yes[2]	No	Sacramento River drainage
Central Valley spring chinook (T)	No	No[1]	Sacramento River drainage
California Coastal chinook (T)	No	No[1]	Redwood Creek (Humboldt County) to Russian River
Central Valley fall/late fall chinook (C)	NA		Central Valley
Upper Klamath-Trinity Rivers chinook (NW)	NA		Trinity and Upper Klamath River Basins
Southern California Coast steelhead (E)	Yes[3]	No	Santa Maria River to San Mateo Creek
South-central California Coast steelhead (T)	Yes	Yes	Pajaro River to Santa Maria River
Central Valley steelhead (T)	Yes	Yes	Sacramento and San Joaquin rivers
Central California Coast steelhead (T)	Yes	Yes	Russian River to Soquel Creek
Northern California steelhead (T)	No	No[1]	Redwood Creek (Humboldt County) to Gualala River
Klamath Mountains Province steelhead (NW)	NA		Elk River (OR) to Klamath and Trinity rivers

1. NMFS expects to promulgate a 4(d) rule HGMP take exception in 2001. 2. Section 9 take prohibitions automatically apply to endangered species; no 4(d) rule is required.

The take of listed salmon and steelhead can be authorized under Sections 7 and 10 of the ESA. NMFS may also, through a Section 4(d) rule, apply the take prohibitions for threatened species, but except certain programs or activities, such as hatchery operations or recreational fisheries, if they meet requirements specified in the rule. A federal agency is required to enter into Section 7 consultation if it determines that an action which is authorized, funded, or carried out by the agency may affect listed species or critical habitat. Only incidental take of a listed species can be authorized through a Section 7 consultation. The obligation to enter into Section 7 consultation applies to federal agencies that operate hatcheries, such as the U.S. Fish and Wildlife Service (USFWS), as well as to agencies such as the U.S. Bureau of Reclamation (USBR) and U.S. Army Corps of Engineers), that fund hatcheries operated by the DFG.

The intentional take of listed species by a federal or non-federal project is illegal unless it is authorized through a Section 10(a)(1)(A) permit or the take is not prohibited by a 4(d) rule. A Section 10(a)(1)(A) permit authorizes the intentional take of listed species for research or propagation that furthers necessary or desirable scientific purpose or enhances the propagation or survival of the listed species. Incidental take by a non-federal entity may be authorized through a Section 10(a)(1)(B) permit. This would apply if listed species were incidentally captured and released during broodstock collection or if listed species were adversely effected by artificially-produced fish through ecological interactions, including disease, competition for food and habitat, and reduction of genetic integrity from breeding with artificially-produced fish. ESA compliance for hatcheries is dependent upon the species being propagated, as well as individual hatchery operations. For example, Livingston Stone Hatchery, a federally funded and operated hatchery which propagates Sacramento River winter chinook, was issued an incidental take permit under Section 7 regarding the effects of winter chinook propagation on other listed species and a Section 10(a)(1)(A) permit to allow the intentional take of winter chinook for its own program.

NMFS has published a 4(d) rule for Central Valley, Central California Coast, and South-Central California Coast steelhead ESUs which provides exceptions to Section 9 take prohibitions for certain activities. NMFS expects to publish a similar 4(d) rule for other threatened salmon ESUs in 2001. Under the rule, hatchery operations conducted in accordance with a Hatchery and Genetics Management Plan (HGMP) approved by NMFS are excepted from the application of ESA take prohibitions. An HGMP must (1) specify the goals and objectives for the hatchery program, (2) specify the donor population's "critical" and "viable" threshold levels, (3) prioritize broodstock collection programs in a manner that benefits listed fish, (4) specify the protocols that will be used for spawning and raising the fish in the hatchery, (5) determine the genetic and ecological effects arising from the hatchery program, (6) describe how the hatchery operation relates to fisheries management, (7) ensure that the hatchery facilities can adequately accommodate listed fish if they are collected for the program, (8) monitor and evaluate the HGMP to ensure that it accomplishes its objectives, and (9) be consistent with tribal trust obligations. The 4(d) rules do not remove the responsibility of a federal agency to consult under Section 7 of the ESA.

E. ESA Recovery Planning

The ESA and NMFS' recovery planning guidelines require that recovery plans be developed that evaluate the current status of the listed population or species, assess the factors affecting the species, identify recovery (delisting) goals, identify the entire suite of actions necessary to achieve these goals, and estimate the cost and time required to carry out those actions. The Southwest Region, NMFS, will be initiating formal ESA recovery planning efforts for listed salmonids in four areas of California: the southern Oregon/northern California coast, the north-central California coast, south-central California coast, and the Central Valley. NMFS anticipates that recovery planning will include evaluation of the use of artificial propagation for conservation and recovery of listed populations.

II. REVIEW PROCESS

A. Format

The Committee began meeting in September 1999 and met for one or two days monthly or bi-monthly until December 2000. Ten meetings (covering 17 days) were held.

The Committee compiled, presented, and discussed information on various topics, including specific details about each California hatchery; hatchery roles in salmon stock management, restoration, and recovery in the context of laws and policies; potential hatchery impacts on listed/candidate salmonids; and the need for ESA authorization of hatchery operations.

During the review, the Committee created several subcommittees which met independently. Topics considered by subcommittees included Warm Springs Hatchery, off-site release and straying, and issues related to hatchery operations in the Klamath-Trinity River system. The subcommittees reported their findings to the full Committee for its consideration. The off-site release and Klamath-Trinity subcommittees reports are attached to this report as Appendices I and II, respectively.

Finally, the Committee developed conclusions and recommendations which are included in this report. Following internal agency reviews, the report will be provided to the public for review and comment before it is finalized and submitted for approval to the Director, DFG, and the Regional Administrator, Southwest Region, NMFS.

B. Participants and Materials

The review was initiated as a joint NMFS and DFG undertaking. Early in the process it was agreed that meetings would be open to anyone wishing to attend, however efforts were not made to publicly announce the meetings. Participants in the review included DFG, NMFS, the U.S. Fish and Wildlife Service, the Yurok Tribe, and the Hoopa Valley Tribe. Members of the Committee and other attendees who were at two or more meetings are shown in Appendix III. A list of the major documents or reports handed out at the meetings is shown in Appendix IV.

Several handouts related to facts about individual hatcheries have been combined into one reference attached as Appendix V.

C. Public Review and Comment

Through press releases on July 13, 2001, the public was notified that copies of the draft report were available at DFG and NMFS web sites. An original deadline for receipt of comments of August 17, 2001 was extended to September 14, 2001. Sixteen individuals responded. A summary of the comments can be found in appendix VI (along with the Committee's responses to some issues).

III. ANADROMOUS FISH HATCHERIES IN CALIFORNIA

A. History

Anadromous fish hatcheries have been present in California since the first one was established on the McCloud River in 1872 by the United States Fish and Fisheries Commission. The initial purpose of this effort was to obtain Pacific salmon eggs for introductions into eastern U.S. waters to replace depleted Atlantic salmon stocks. The founders of this early hatchery reported that there had already been a great demand on the salmon stocks of the Sacramento River, and, because of heavy placer mining operations in the headwaters, the major spawning grounds on the Feather, Yuba, Bear, and American rivers had been destroyed.

With one exception, the nine State-operated anadromous fish hatcheries (see Figure 1 for locations) currently in operation in California were constructed, and are now operated, to mitigate for the loss of spawning habitat above dams - the hatcheries were expected to produce fish equal

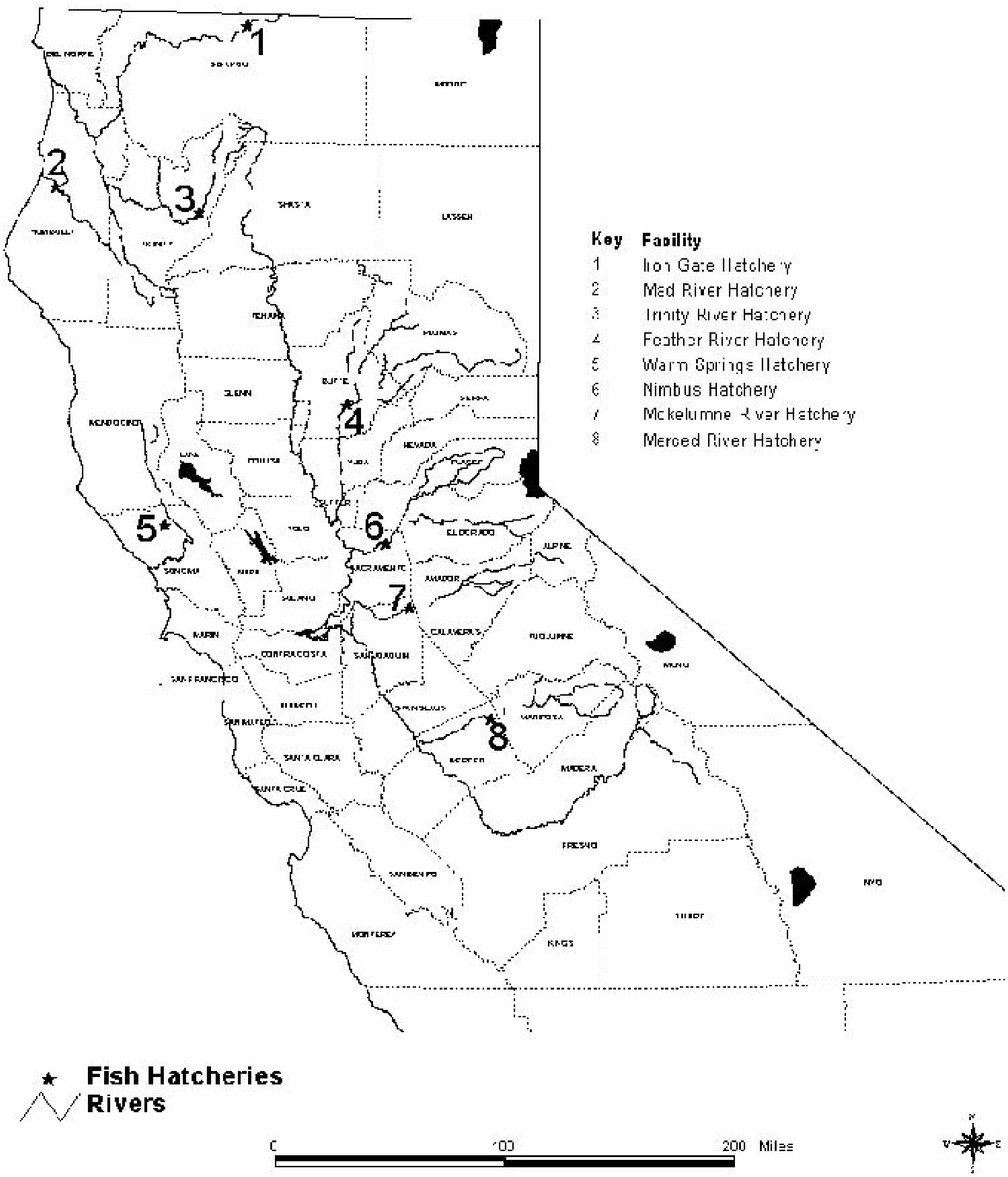

Figure 1. California Department of Fish and Game Anadromous Fish Hatcheries

to what would have been produced upstream before the dams were built. Some mitigation hatcheries also produce additional fish for ocean enhancement, for use in studies to assess the effects of water operations on out-migrating salmon, and as mitigation for fish entrained at Delta pumping facilities. The exception, Mad River Hatchery, was constructed to produce fish that would augment natural production and support recreational and commercial fisheries in the Northern California coastal area.

B. State Statutes and Policies on Anadromous Hatcheries

Formal statutes and policies relating to the management of anadromous salmonids, including artificial propagation, are found in the Fish and Game Code (Code) and the policies of the Fish and Game Commission (Commission), respectively. The statutes in the Code result from legislation passed by the legislature and signed by the Governor. The policies are established by the Commission and reviewed about every 5 years. In general terms, the statutes and policies make the following statements relating to anadromous salmonid hatcheries in California:

(1) In the mix of artificial and natural production of anadromous salmonids, we are at the maximum percentage that should occur artificially. Preference should be given to increasing natural production when both artificial and natural production are feasible; this increase should be done primarily through stream habitat restoration and improvement.

(2) Artificial production shall not be considered appropriate mitigation for future loss of anadromous fish habitat.

(3) Salmon and steelhead shall be managed to protect, restore, and maintain the populations and genetics of all stocks.

(4) The State can participate in support of cooperative rearing programs, but the goal of increasing natural production takes precedence over these programs.

Consistent with legislative or Commission policies, policies and procedures relating to the operations of anadromous fish hatcheries have also been established by the DFG. They are included in "goals and constraints" documents for each hatchery. They include topics such as the source and use of appropriate brood stock; mating protocols; when to allow fish to enter the hatchery (and when to spawn them); what to do with excess adults, eggs, and fry. These topics are discussed in this report separately or when referring to individual hatcheries.

C. Description of State Hatchery Operations

The State-managed hatcheries included in this review are: Iron Gate (Klamath River), Trinity (Trinity River), Mad (Mad River), Warm Springs (Russian River), Feather (Feather River), Nimbus (American River), Mokelumne (Mokelumne River), and Merced (Merced River). The DFG also manages artificial production programs on the Noyo and Eel rivers. A supplementation hatchery is being planned for establishment in the San Joaquin River system, but it is being discussed and reviewed through existing interagency efforts and it was not included in the current review. Recent statistics relating to each of the hatcheries in the review are included in Appendix V. Funding sources for the nine State hatcheries are summarized in Table 2.

D. Description of Cooperative Rearing Programs

The DFG began its Cooperative Fish Rearing Program in 1973 with the goal of increasing salmon and steelhead populations on a broad geographic scale. The program has involved partnerships with nonprofit groups and corporations, service clubs, counties, Indian tribes, and many individuals to produce salmon and steelhead for the benefit of fisheries and the enjoyment of

California's citizens. There are currently 12 projects, from San Luis Obispo to the Smith River. Nine of the projects receive Salmon Stamp Funding, a self-imposed dedicated fee sponsored by commercial fishermen on ocean salmon landings and as a supplemental license stamp. Some programs collect fish for broodstock, while others rely on the DFG for fish. All of the projects are required to operate with a current 5-year plan, which must be approved by a DFG district biologist (the Cooperative Rearing Project Coordinator).

Table 2. Purposes and funding of DFG managed hatcheries

Hatchery	Purpose	State	Federal	Other
Iron Gate	Mitigation			Pacific Corp
Trinity River	Mitigation		USBR[1]	
Mad River	Augmentation	DFG		
Warm Springs Coyote Valley	Mitigation Enhancement		USCOE[2]	SCWA[3]
Feather River	Mitigation Enhancement	DWR[4] 4-Pumps[5]		Salmon Stamp
Nimbus	Mitigation		USBR	
Mokelumne	Mitigation Enhancement			EBMUD[6] Salmon Stamp
Merced	Supplementation Mitigation	DFG		4-Pumps

[1]U.S. Bureau of Reclamation [2]U.S. Army Corps of Engineers [3]Sonoma County Water Agency [4]California Dept. of Water Resources [5]Delta Pumps Fish Protection Agreement (DWR) [6]East Bay Municipal Utility District

E. Description of Federal Hatchery Operations

Coleman National Fish Hatchery, located on Battle Creek in the upper Sacramento River, is a federal hatchery operated by the USFWS. The Service also operates an artificial propagation program for Sacramento River winter chinook, intended to aid in the recovery of the population, at Livingston Stone National Fish Hatchery. Coleman is undergoing its own review and assessment through an ESA Section 7 consultation. Although the hatchery and that effort were discussed in Committee meetings, the Committee did not make any recommendations on the operations at Coleman.

IV. SPECIFIC ISSUES DISCUSSED BY THE REVIEW COMMITTEE - Including conclusions and recommendations where appropriate

A. Interactions between Hatchery and Natural Populations - Hazards and Risks

In California, dams and water diversions have substantially reduced stream flows during winter and spring, modified downstream flow patterns, and blocked access to spawning areas. Estimates of the available spawning and holding habitat for salmon in the Central Valley range from 5-18% of that which was originally available (CDFG 1993, Yoshiyama et al. 1996). Hatcheries, constructed to replace the lost production, provide substantial fractions of the California chinook salmon harvest.

In supplying fish for commercial and recreational use and mitigating for lost spawning and rearing areas, California hatcheries are to be operated in such a way "that the populations and genetic integrity of all identifiable stocks of salmon and steelhead rainbow trout be maintained, with management emphasis placed on natural stocks" (Fish and Game Commission policy). The twin goals of replacing large amounts of lost production while maintaining the abundance and genetic integrity of the remaining populations are not easily accomplished. For example, although a spring run of chinook continues to return to the Feather River, the present evidence, based on allozyme data, suggests that the hatchery and natural populations of spring chinook are not genetically distinguishable from the fall run. Banks et al. (2000) used DNA microsatellites to study the population structure of Central Valley chinook. Genetically distinct populations of winter chinook, Butte Creek spring chinook, Mill/Deer Creek spring chinook, and fall/late fall chinook continue to exist in the Central Valley. However, they found few differences among fall chinook populations, in striking contrast with other fall chinook ESUs, where genetic structure corresponds closely to geographic structure of watersheds.

If the goal of maintaining the abundance and genetic integrity of natural populations is to be realized, the hazards associated with the interactions of hatchery and natural populations must be considered. The evaluation of risks is not an easy task: "We have found that the effects of artificial propagation are among the most difficult and controversial to incorporate into risk analyses for our ESA status review. Both direct and indirect evidence indicates that, in general, there is ample reason for concern about the effects of hatchery fish on natural populations, but seldom is there sufficient information to determine the magnitude of the effects or their long-term consequences. Nevertheless, the enormous scale of hatchery programs for anadromous Pacific salmonids guarantees that any risk analysis that ignores artificial propagation will be incomplete." (Wainwright and Waples 1998). The Committee accepted the statements in Waples (1999) that "substantial uncertainties remain about every major issue...", however "...in spite of the major uncertainties, every major concern raised about hatcheries has some empirical basis." The discussion to follow on hazards is presented in that light.

In the following discussion, a hazard is the potential adverse consequence of some action and a risk is the probability that a hazard will be realized. See the attached off-site release and straying subcommittee report (Appendix I) for a fuller description of the genetic, ecological and management hazards associated with artificial propagation.

1. Genetic Hazards

The potential risks of reducing genetic diversity in depressed natural populations through the constant infusion of hatchery fish have received much attention recently (Waples 1991, Adkison 1995, Currens and Busack 1995, Busack and Currens 1995, Campton 1995, Grant 1997, and Utter 1998). If the genetic differences observed among spawning populations of the same species have developed through selective adaptation to local environments, a loss of genetic diversity could result in a loss of productivity and long term viability of salmon populations. The apparent collapse of many Columbia River basin hatchery and natural stocks has generated concern regarding the short term effects that straying and interbreeding of hatchery populations with natural population may have on the fitness of the natural populations.

Population genetic theory and some empirical studies suggest that artificial propagation causes rapid genetic changes in a hatchery stock relative to the natural stock from which it was initiated. The hatchery environment is very different from a stream, with two important consequences: first, breeding practices in hatcheries propagate adults without respect to the genetic factors that would have provided a reproductive advantage (or disadvantage) in streams, and second, the factors that govern mortality (natural selection) of fish raised in a hatchery are quite different from those in the natural environment, resulting in what is called domestication selection (Waples, 1991; Busack and Currens, 1995). Several studies, including those of Reisenbichler and McIntyre (1977), Reisenbichler (1997), and Reisenbichler and Rubin (1999), provide evidence that the fitness for natural spawning and rearing can be reduced by artificial propagation.

The straying of hatchery fish, and the resulting hybridization of hatchery and natural populations, pose two types of genetic hazards to natural populations: 1) if straying of hatchery populations occurs over a wide geographic range, a reduction in the genetic variation among populations may occur; and 2) genetic changes that occur in hatchery populations will be transferred through straying hatchery fish to natural populations, causing reduced fitness and productivity of the natural population.

2. Ecological Hazards

Straying by hatchery fish could pose a variety of ecological hazards to natural populations in other streams, such as competition for redd sites and redd superimposition, reduced productivity of natural fish breeding with hatchery fish, and disease transmission. These ecological interactions can also have genetic consequences because they alter the selective pressures operating on naturally produced fish (Waples, 1991).

Hatchery-origin fish spawning in the wild compete with natural fish for spawning habitat, and their offspring also compete for rearing habitat. Competition is probably most significant in streams with hatcheries (Battle Creek, Feather River, American River, Mokelumne River, Merced River), and in these cases, wild-spawning hatchery fish might only be considered strays because they have been denied access to their hatchery. In other streams, however, carrying capacities are generally unknown, and it is possible that all available habitat would be fully utilized by wild spawners and their progeny. In this case, hatchery strays could effectively reduce the carrying capacity for natural fish. Competition could also be important at population levels below carrying capacity if fish compete for the best spawning and rearing habitats. Similarly, competition between hatchery and natural fish could also occur in streams with hatcheries; in these cases, natural-spawning hatchery fish that didn't enter the hatchery could compete with natural fish.

3. Management Hazards

Competition between hatchery and naturally produced salmonids will occur under conditions where they require the same limiting resources. The strategy of releasing hatchery reared salmon and steelhead as smolts is intended to reduce competition. However, in areas where fish become concentrated, such the migratory corridor, estuarine and near shore environments, physical and nutritional resources may become limiting. During periods of low ocean productivity, competition may occur between hatchery and natural fish in the ocean, with the result that endangered salmon, whose populations are at historic lows, experience density-dependent mortality (Levin et al. 2001).

Effective management of California's salmonid resources requires adequate abundance estimates. Significant numbers of unmarked hatchery fish in natural spawning areas make population assessments difficult if not impossible. The CVPIA Anadromous Fish Restoration Plan, for example, mandates doubling (from a prescribed time period) of natural populations, which requires that natural populations be accurately enumerated. The accuracy of most Central Valley escapement estimates are currently unknown and may not be sufficient to meet management needs, CalFed or CVPIA requirements (see section below on monitoring and evaluation).

Another major concern is that hatchery production (and straying) is masking declining productivity of natural populations. For example, many Central Valley streams have roughly stable spawner counts over the past 20 years. Some fraction of these spawners were of hatchery origin. Because the reproductive success of hatchery fish spawning in natural areas is largely unknown, the trends in productivity of naturally spawning stocks are also unknown; they may be self sustaining or declining (at a rate proportional to the fraction of fish that are of hatchery origin).

In the absence of adequate population assessments, the risk of making wrong management decisions could be high and the consequences serious. For example, if one overestimates the production of natural populations by underestimating the contribution of hatchery strays to natural production, one might set harvest rates at levels that are not sustainable for many natural populations.

Ocean fisheries are managed by the Pacific Fishery Management Council (PFMC) based on two Central Valley salmon stocks: Sacramento River winter chinook, an endangered species, and Sacramento River fall chinook. Winter chinook is the more constraining of the two as far as ocean fisheries are concerned. The current federal biological opinion requires a 31 percent increase in the spawning escapement of the species compared to the base years. This affects ocean fisheries south of Horse Mountain, near Shelter Cover in southern Humboldt County. The very large spawning escapements seen in the Central Valley in recent years have likely stemmed from ocean fishery restriction to protect these fish. The annual spawning escapement goal for Sacramento River fall chinook is 122,000-180,000 adult fish, which does not differentiate between hatchery and natural fish. Escapement goals in the PFMC area are usually based on natural spawners. There is no escapement goal for naturally produced Sacramento River fall chinook because of the lack of information on their contributions to the fisheries and the runs (LB Boydstun, personal communication, 2001). There is no solid data base at present upon which to project the natural escapement of any race of Central Valley chinook for the coming year.

4. Assessing Risk

Managers should be most concerned about serious hazards that have high risks of occurrence. Two hazards are of particular concern based on this standard. First, the management hazards posed by the masking effect are worrisome because masking is definitely occurring, and the odds of making management mistakes because of this are high. The masking problem could be solved with constant fractional marking of all hatchery production (Hankin 1982, Hankin and Newman 1999), and careful genetic and behavioral studies of naturally-spawning fish. Representative marking, with coded wire tags, of all hatchery release groups is also needed to partition the hatchery runs into their various age classes and to estimate their age-specific contributions to the ocean and river fisheries.

Second, the genetic hazards posed by large numbers of straying hatchery fish in natural spawning areas are a cause for more serious concern. While the probability of genetic failure is unknown, the long time-frame of hatchery programs certainly increases the risk. More importantly, the hazards are extremely serious, since they include extirpation of natural stocks and loss of significant genetic diversity, consequences that are not easily reversible.

The only way to minimize these risks is to minimize interactions between hatchery and natural stocks. The three obvious ways of reducing interactions are 1) reducing hatchery production, 2) minimizing the straying of hatchery stocks to areas where natural populations are relatively uninfluenced by hatchery production, and 3) minimizing the spawning of hatchery fish in natural spawning areas where hatcheries are located. Encouraging hatchery fish to enter the hatchery should be part of the program.

B. Programs Affecting Interactions Between Hatchery and Natural Populations

The Committee identified and discussed four practices that had the potential of increasing undesirable gene flow between populations.

1. Inter-basin Transfers of Stocks

Until the early 1980s, California's hatcheries occasionally used brood stock from other basins or moved fry to other basins (although it was only rarely done between Coastal and Central Valley basins). It can be done now only on an exception (permission required from DFG Regional and Headquarters managers) basis. Such transfers could affect the genetic resources in fish naturally occurring in the receiving basins. Transfer of diseases is another possible risk of this activity.

<u>Conclusions</u>: The DFG policy to restrict inter-basin transfers except in very limited circumstances is appropriate. Out-of-basin brood stock should only be permitted when the genetic characteristics of those fish are very similar to the genetic characteristics of the fish in the area of the hatchery, and when local origin fish are not available in sufficient numbers to meet hatchery objectives.

<u>Recommendations</u>: Adhere to the policy. Discontinue the transfer of steelhead or chinook salmon from the Nimbus or Feather River Hatchery to the Mokelumne River Hatchery.

2. Off-site Releases

Significant numbers of Central Valley hatchery-reared salmon are transported by truck to the San Francisco Bay and released. For example, in 1999 Feather River Hatchery released 78% (5.88 of 7.52 million) of its fall chinook smolts downstream of the Delta; Nimbus Hatchery released 100% of its 3.8 million fall-run there; and Mokelumne River Hatchery released 57% (1.72 of 3.04 million) there. In the same year, Feather River Hatchery released 100% (2.12 million) of its spring chinook smolts in San Pablo Bay.

Transporting hatchery fish downstream of the Sacramento-San Joaquin Delta improves their survival and contribution to fisheries as well as avoids competition of those fish with naturally-produced fish. However, off-site release also increases the straying rate of returning salmon from their hatchery of origin. Both the DFG and NMFS have expressed concern regarding the effects of straying hatchery fish on natural populations. The attached subcommittee report on off-site releases and straying (Appendix I) provides a detailed discussion of the topics.

Because of the lack of reliable estimates of CWT marked fish in Central Valley spawning ground and creel surveys, the few published estimates of Central Valley stray rates have relied on recoveries of tagged fish at hatcheries. For example Dettman and Kelley (1987) extrapolated the recovery of Feather River Hatchery chinook at other Central Valley hatcheries into the associated river populations and estimated 92% of returning Feather River Hatchery fish released at the hatchery returned to the Feather River whereas 46% of returning Feather River Hatchery fish released in the Delta returned to rivers other than the Feather.

The USFWS recently developed a straying index for groups of fish released at varying distances from CNFH (USFWS, 2000). The index assumes that the effects of release location are limited primarily to 1) the survival rates of smolts to recruits and 2) the stray rates of returning adults. If release location affects neither ocean distribution nor catch rates, defined as

ocean recoveries/(ocean recoveries + hatchery recoveries + unknown strays)

then two release groups from the same broodyear should generally experience similar catch rates. Differences in observed catch rates would presumably be due to differences in the straying rate. The number of strays were estimated as the number of additional strays necessary to produce equal catch rates for the two release groups. The stray index is calculated as

number of strays/(number of strays + hatchery recoveries)

Note that the number of unknown strays for groups released at CNFH are not estimated. As a result, the stray *index* for on-site releases is zero, but represents some positive, unknown, stray rate for fish released at the hatchery. Figure 2 presents the stray indices associated with different release sites.

These paired releases also showed that ocean fishery contribution rates from releases made in the western Delta were generally higher than ocean contribution rates for releases made at the hatchery or in the upper Sacramento River; and that during some years, minimum brood stock needs at the hatchery could be met only by releasing fish at the hatchery, because the apparent increase in survival did not fully compensate for the high rates of straying associated with Delta-released fish.

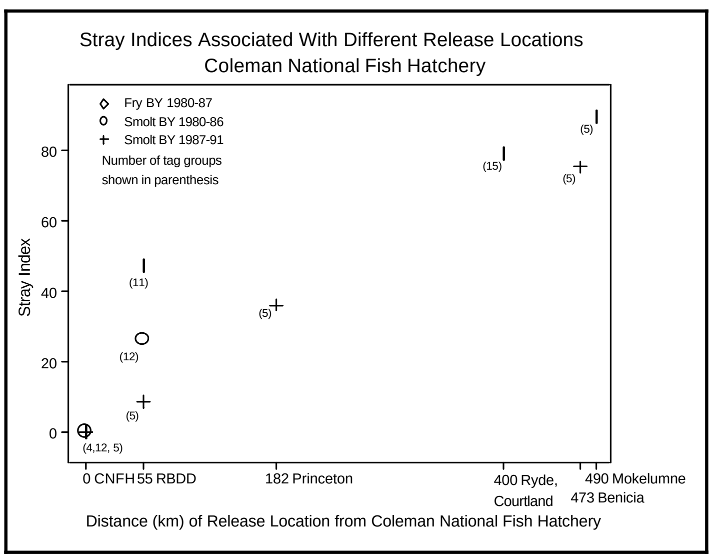

Figure 2 Stray indices plotted against distance downstream from Coleman National Fish Hatchery (from Table 2 of Straying Subcommittee report, Appendix I)

Results of experiments by the DFG also showed that returns of adult salmon to ocean fisheries could be increased by releasing fish in the Delta, in some cases dramatically (e.g., three- to four-fold increases have been observed). Figure 3 shows ocean recovery rates for paired groups of fish released at the hatchery and at Rio Vista.

There was disagreement among members of the Committee over the relative benefits and risks of trucking hatchery fish to the Delta. The debate reflected scepticism regarding the importance of conserving (or attempting to restore) genetic diversity among the remaining Central Valley natural fall-run populations as well as a reluctance to make changes to hatchery operations that would likely reduce their effectiveness in preserving the salmon fishing industry. Those in favor of continued off-site release point out that locally adapted fall-run populations may no longer exist in the Central Valley. The lack of clear genetic differentiation among Central Valley fall chinook populations sampled to date supports this view, and is not surprising, given a hundred and fifty years of habitat destruction, intensive harvest, large scale fall chinook hatchery production with associated straying, and the "highly modified" hydrology of the valley. It is not clear to what extent genetic differentiation among local salmon populations reflects specialized adaptions to particular environments and how much is simply due to reproductive isolation resulting from homing to natal streams. Therefore, the lack of genetic differentiation among Central Valley fall chinook populations is not necessarily an indication of decreased stock productivity resulting from interbreeding with hatchery fish. There is no guarantee that ending the practice of trucking, by itself, will be sufficient to increase the genetic variation in Central Valley fall chinook.

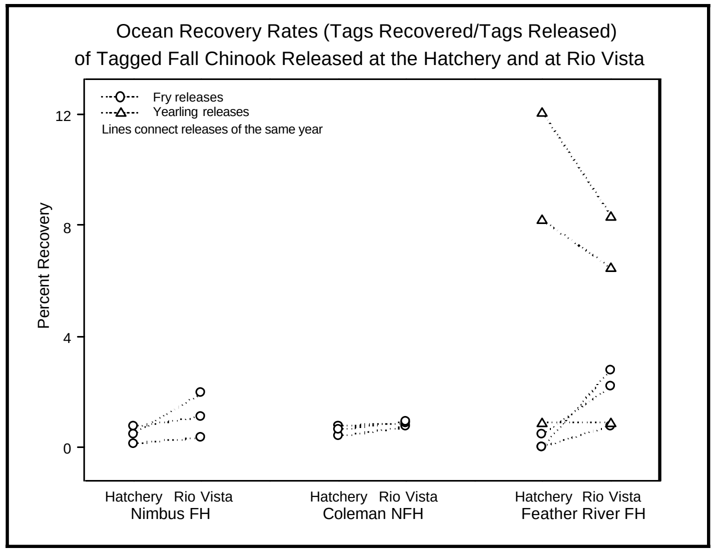

Figure 3 Recovery rates from ocean fisheries of tag groups released at the hatchery and at Rio Vista (from Table 3 of Straying Subcommittee report, Appendix I)

Those opposed to planting fish in the Delta acknowledged the uncertainty regarding the risks of interbreeding between hatchery and natural populations and the resulting "dilution" of locally adapted genetic resources. They argued, however, that although there may be uncertainty regarding the actual levels of gene flow from hatchery to natural stocks or the efficiency of natural selection in maintaining the genetic makeup of natural populations, the critical status of most naturally spawning populations of salmon on the west coast and in California strongly argue in favor of precautionary approaches. A release strategy which substantially increases the rate of straying of returning hatchery fish has a high likelihood of increasing interbreeding between natural and hatchery populations of different watersheds, of exacerbating whatever negative effects hatchery populations have on natural populations, and is not in keeping with a goal of "maintaining the genetic integrity of all identifiable stocks of salmon." The high stray rates associated with trucking also make the assessment of naturally spawning populations more difficult. The need to truck fish is especially questionable during periods when there is no apparent shortage of hatchery reared fish. The escapement of hatchery-produced salmon to the Central Valley has been so great in recent years that proposals have been made to reestablish commercial salmon fishing in San Francisco Bay.

Conclusions:

1. Artificial propagation of salmon poses management, ecological, and genetic hazards to natural salmon populations. The risk of these hazards is increased by high rates of straying of hatchery populations.

2. Off-site release results in increased rates of straying of hatchery reared salmon relative to fish released on-site (at or near the hatchery). Published reports and the recent analysis of CNFH returns suggest that release in the lower estuary or San Francisco Bay results in stray rates exceeding 70%. Straying rates vary substantially among natural populations, and rate estimates vary depending on the definition of straying and study design. Determining an "acceptable" or "natural" rate of straying is difficult and probably not particularly useful. However, the available estimates of stray rates for hatchery populations released at the hatchery indicate that the increase in the rate of straying of fish released west of the Delta is substantial.

3. The mortality associated with transiting the Delta can be eliminated for hatchery fish by transporting and releasing production west of the Delta. As a result, transported fish contribute to ocean fisheries at higher rates compared to fish released upstream or at the hatchery. Results from paired studies (hatchery release vs. downstream release) varied considerably, but overall recovery rates to ocean fisheries and inland returns were 30% higher for downstream releases.

4. In the Klamath-Trinity Basin, experiments with off-site hatchery releases demonstrated some increased contribution rates to fisheries. However, in deciding whether to permanently implement off-site releases, the improved survival and resulting harvests did not seem to justify the potential negative effects of the increased rates of straying associated with the releases.

5. Water management practices within the Central Valley, including flow regimes below dams, temperature of reservoir releases, flow direction in some Delta channels and SWP/CVP exports in the south Delta, negatively affect juvenile salmonid emigration success and the ability of adults to home to natal streams. These problems exist for hatchery-produced and natural fish.

Recommendations:

1. The DFG should evaluate the genetic, management, and ecological risks associated with the substantial increase in straying of hatchery fish released off-site and weigh the risks against the benefits of increased survival and reduced interactions with naturally spawning stocks in waters adjacent to the hatchery.

a. Feather River Hatchery spring chinook should be released "in-river", not trucked to San Pablo Bay. The straying of Feather River Hatchery spring chinook may pose hazards for the few remaining natural spring chinook runs in the upper Sacramento, which are listed under the state and federal ESA.

b. Feather River Hatchery fall chinook should be considered for release "in-river", rather than being trucked to San Pablo Bay. The fall chinook production is large and probably introgressed with the spring run. Straying of these fish may pose hazards to the long term productivity of naturally spawning fall-run populations in the Central Valley.

c. Nimbus Hatchery fall chinook should be considered for release "in-river", rather than being trucked to San Pablo Bay. Straying of these fish may pose hazards to the long term productivity of naturally spawning fall-run populations in the Central Valley.

d. Mokelumne Hatchery fall chinook should be considered for release "in-river", rather than being trucked to San Pablo Bay. Straying of these fish may pose hazards to the long term productivity of naturally spawning fall-run populations in the Central Valley.

Note: "Consider" to the Committee means further study on and evaluation of the issue, the exploration of alternatives and options on the trucking subject, on other ways to reduce straying, and further findings on the genetics of Central Valley salmon. It could also involve experiments or pilot studies on specific, related issues.

Various ongoing studies, designed to investigate the relationship between juvenile salmon survival and flows and water export rates, require the transport and release of tagged hatchery salmon at locations in the San Joaquin and Sacramento rivers and throughout the Delta. The Committee understands the need for such studies, but the increased straying of "study" fish released off site should be considered in their design and duration.

2. Hatchery releases and water management practices (including SWP/CVP exports) must be coordinated so that emigration survival is maximized. Flow patterns or poor water quality must be managed so not to impede normal migration of adult salmon and steelhead, lead to lengthened or aborted migration pathways, or to result in large numbers of downstream migrants being drawn to the pumping plants.

Because water management practices have already been adjusted to meet the needs of other fish species - e.g., winter and spring chinook salmon, Delta smelt, striped bass - it will be a challenging task to make further adjustments for hatchery fish. DFG and NMFS should meet in the near future with DWR and USBR representatives to determine a process (there are several existing State/federal efforts relating to fish and water exports) through which to proceed.

3. The DFG should continue the present policy of on-site release of salmon and steelhead produced in Klamath-Trinity Basin hatcheries.

3. Inland Salmon Program

Following earlier experiments, in the 1970's the DFG began stocking chinook salmon in various California lakes or reservoirs to increase fishing opportunities. At first, out-of-state sources of eggs were used. Subsequently, because none of these sources could provide disease-free eggs, eggs that were in excess of DFG hatcheries' needs were used. In the past 3 years, more than 600,000 young chinook salmon were introduced into 12 different reservoirs. The Committee discussed the possibility of salmon, in many cases from out-of-basin stocks, escaping downstream from the lake where they were planted, subsequently returning as adults into that stream, and the possibility of genetically mixing with adult salmon from that stream.

Conclusions: Some salmon released under the program, in many cases from out-of-basin stocks, could escape downstream from the lake where they were planted, and subsequently return as adults into that stream and interbreed with local stocks.

Recommendations: 1) Fish being planted under the inland waters stocking program should be sterilized to ensure that no genetic transfers will occur inadvertently. The capability to produce triploid (sterile) fish exists and is expected to be tested and evaluated this year, and 2) a monitoring program should be implemented to determine that this has been an effective measure.

4. Fry Release Program

Since 1982, fisheries management staff of the DFG's Sacramento Valley and Central Sierra Region have used hatchery-produced fry or fingerling fall-run chinook salmon to plant in selected tributaries of the Feather, Sacramento, American, and San Joaquin rivers. These fish were planted to re-establish runs where they were presumed to no longer occur. There was no formal evaluation procedure to measure either the success of the program or any negative effects (e.g., straying of returning adults) from it.

Conclusions: No formal evaluation procedure exists to measure either the success of the program or any negative effects (e.g., straying of returning adults) from it. This program could result in fish being planted over remnants of natural runs and thereby impacting those runs.

Recommendations: Suspend this program unless, 1) there is a better-defined need for the program and stated reasons for stream selections, and 2) there is a specific evaluation/monitoring component built into it.

C. Monitoring and Evaluation

1. Central Valley

The Committee discussed the DFG's program to evaluate the feasibility of implementing a constant fractional marking program in the Central Valley (see Hankin 1982, Hankin and Newman 1999, and Zajanc and Hankin 1998 for a discussion of the benefits of constant fractional and representational marking). Under such a program, all or a constant fraction of salmonids released from Central Valley hatcheries would be uniquely marked according to site of origin and site and date of release. The relatively low and variable proportion of chinook salmon that are currently marked at Central Valley hatcheries results in a lack of reliable data on which to base management decisions. In addition, both DFG and NMFS expressed concern regarding the inadequacy of Central Valley fresh water CWT recovery programs. Small sample sizes and non-random sampling may bias CWT expansions and subsequent estimates of the contribution rates of hatchery fish to naturally spawning populations and to freshwater recreational fisheries. A DFG/DWR workshop on escapement estimation methodology (UC Davis, June 22, 2000) highlighted the fact that the accuracy of most Central Valley escapement estimates are unknown and may not be sufficient to meet federal and state management needs, CalFed or CVPIA requirements. Within the DFG, there is presently no forum for the review, discussion, or oversight of salmon escapement estimates.

The lack of adequate marking and sampling of Central Valley hatchery fish has several consequences.

1) An approved HGMP must evaluate, minimize and account for the propagation program's genetic and ecological effects on natural populations, including disease transfer, competition, predation and genetic introgression caused by straying of hatchery fish. Without effective monitoring and evaluation of returning hatchery populations, the effects of hatchery rearing and release strategies cannot be fully evaluated. Similarly, approved Fishery Management and Evaluation Plans, associated with the 4(d) rules, must include effective monitoring and evaluation programs to assess compliance and effectiveness.

2) There is currently no estimate of an exploitation rate for any Central Valley salmonid population. The lack of an exploitation rate estimate for Central Valley fall chinook substantially impairs NMFS' ability to assess fishery impacts on listed stocks that may share similar ocean and river distributions and vulnerability to harvest. None of the biological opinions that authorize the incidental take of listed salmon in ocean fisheries off California have been able to specify the amount of incidental take that occurs in ocean fisheries. This is a serious problem.

3) The impact of straying hatchery fish on natural populations is a key federal ESA concern. Without adequate marking and monitoring of hatchery populations, the estimation of straying rates between watersheds and the genetic exchange between hatchery and naturally producing stocks will remain a matter subject to speculation.

4) Substantial effort and resources are being expended on improving the spawning and migration habitat for Central Valley salmonids. The CVPIA mandates doubling of natural populations and assessment of the progress toward meeting the goal. Evaluating the success of restoration actions and the impact of changes in water operations is difficult or impossible without adequate monitoring and evaluation of the populations the actions are intended to benefit.

Conclusions:

A constant fractional marking program and complementary inland monitoring program would allow the DFG to differentiate between natural and hatchery fish spawning in streams, clarify the abundance and distribution of hatchery fish in the system, determine their relative contribution to commercial and sport harvests, and evaluate factors affecting fish survival. The Committee agreed that such programs should be developed and implemented, but did not discuss or agree upon a specific time table.

Recommendations:

1. All agencies should pursue efforts to establish a constant fractional marking program at all hatcheries. Specific studies should be designed to determine how hatchery fish interact with naturally produced fish so that the effects of hatchery practices on population genetics and dynamics can be accurately determined.

2. All agencies should pursue efforts to develop adequate sampling programs to recover marked fish in the Central Valley. Sampling needs to occur in recreational fisheries, in hatcheries, and in the watersheds with, and adjacent to, hatcheries.

3. The DFG should establish a process to coordinate and oversee the methodologies for estimating salmon escapements to the Central Valley. The process should: 1) establish standardized techniques for estimating the size and age-composition of spawning runs; 2) standardize the training of stream crews to ensure the goals of CWT sampling are met; 3) develop strategies for improving the recovery rate of CWTs in the river recreational fishery.

2. Klamath-Trinity Basin

A time series of accurate estimates of the contribution of hatchery fish to spawning escapement would be a valuable indicator of the status of naturally spawning populations. Variable marking rates of hatchery production make estimation of the proportion of hatchery fish in the run difficult. A constant fractional marking program has been implemented at TRH. If the proportion of hatchery fish in the Klamath-Trinity Basin are to be accurately estimated, adults would need to be sampled as they entered the Klamath River and a coordinated constant fractional marking program between TRH and IGH would be necessary. Weirs (or other appropriate monitoring methods) on the major tributaries to the Klamath and Trinity would be necessary for sub-basin estimates of hatchery contributions.

<u>Conclusion and Recommendations</u>: The Committee endorses the concept of constant fractional marking in the Klamath-Trinity Basin and representational marking of all lots of smolt and yearling chinook releases at both IGH and TRH, recognizing that concerns regarding the logistics of counting and marking a substantial fraction of the IGH fall chinook production would need to be addressed. The benefits of more accurate assessments of the proportion of hatchery fish in the Klamath-Trinity Basin spawning escapement would need to be assessed with respect to costs of additional marking and monitoring.

D. Determining Production Goals

The objectives of salmon and steelhead hatchery operations in California fall into three major categories: 1) mitigation (replacement) of production lost by water project development and the associated permanent loss of habitat above dams; 2) enhancement production aimed at supporting higher levels of harvest in ocean and river fisheries; and 3) supplementation production aimed at starting or boosting populations where lack of spawning adults has been identified as the limiting factor. Most mitigation goals were specified during the authorizing process for the construction and operation of the hatchery. Enhancement production has been limited by hatchery capacity and available funds. The production objectives of DFG operated hatcheries are expressed in numbers of fish released (see Appendix V).

The listing of salmon and steelhead stocks under the ESA has resulted in restrictions which prevent ocean and inland fisheries from fully harvesting available hatchery fish. (See previous discussion about management hazards.) Hatchery stocks are typically more productive than natural stocks in that they produce more recruits per spawner; as a result, the commercial and recreational harvest of hatchery fish in mixed-stock ocean fisheries at harvest rates which naturally produced stocks can sustain will usually result in the “underharvest” of hatchery fish. Returns of hatchery fish to the Central Valley have increased substantially in recent years, as well as the levels of in-river recreational harvest. Because modern production hatcheries are so successful in supplying salmonids to the pool of harvestable fish, it is almost impossible to separate management of the fisheries from management of the hatcheries. Certain hatchery programs in California are directly funded by voluntary contributions from the salmon fishing industry. Hatchery production and harvest management must both be compatible with the survival of naturally produced stocks. Therefore, it may be appropriate to review hatchery enhancement and mitigation goals in light of changes in ESA status of salmon and steelhead populations, changes in fishing effort, or new information on the effects of hatchery operations on naturally spawning populations. Performance measures linked to existing or modified production goals would also be appropriate.

<u>Conclusions</u>: It is appropriate to review hatchery enhancement and mitigation goals and performance in light of changes in the CESA or ESA status of salmon and steelhead populations, changes in fishing effort, ocean or river conditions, or new information on the effects of hatchery operations on naturally spawning populations.

<u>Recommendations</u>: A process should be identified for the periodic (e.g., every 6 to 9 years or 2 to 3 brood cycles) review of hatchery production levels that would assess production at state operated hatcheries in light of any changes in ocean or freshwater harvest regimes or new information on the effects of hatchery operations on natural populations below impassable dams. Specific performance measures for each hatchery should be articulated, assessed annually, and discussed in the periodic review process.

E. Brood Stock Collection and Mating Protocols

Hatchery spawning operations require the selection of adults to be used to produce the coming years’ generation of fish (brood stock collection) and procedures for combining the gametes of the selected adults (mating protocols). In the wild, the processes of natural selection normally decide which genotypes will produce the next generation, and ensure that populations remain well adapted to their environments. By necessity, the production of salmonids in hatcheries eliminates many of the selective pressures that would act on naturally spawning populations and replaces them with different sets of pressures. The effects of mating behavior, age and size, which appear to be determinants of spawning success in natural populations, are not relevant in the hatchery. Unintentional selection of certain traits may occur, even when relatively large numbers of spawners are available. For example, the age of maturation in males has been shown to be an inherited trait; in addition, older and larger males are reported to be more successful in competing for mates (Hankin et al. 1993; Baxter 1991). If 2-year old maturing males (jacks) are spawned in the hatchery in proportion to their occurrence in the population, the expected result would be a bias in the reproductive success of younger maturing fish relative to naturally spawning populations. The amplification of this trait in hatchery populations may have negative consequences for ocean fisheries, for which older and larger fish have greater value, as well as for locally spawning natural stocks, if the trait is passed on to the population by naturally spawning hatchery adults.

The procedure for brood stock collection used in California’s hatcheries is to only use fish volitionally entering the hatchery, with the goals of maintaining genetic diversity and the retention of natural characteristics. Departures from that approach would occur in the case of depressed or listed populations.

Issues related to those goals include the following: 1) What brood stock selection and mating protocols should be used to make the hatchery production as representative as possible of the natural population and, specifically, what fraction should naturally spawned fish make up of the brood stock sample? Conversely, what fraction should hatchery-produced fish be? This question is most urgent with steelhead; the DFG has started a 100% marking plan and the deliberate infusion of naturally-produced fish will be possible.

2) Should brood stock selection take place in a way that is neutral compared to any measurable characteristic (e.g., run timing, size, color); or should some attempt be made to enhance some characteristic? In the past, brood stock selection has resulted in substantial changes in run characteristics (primarily shortening of run timing). A related question is whether there should be some attempt to spawn jacks at the proportion in which they occur in the run.

The DFG has not established standardized mating protocols; hatchery managers develop protocols they believe to be best suited to the runs they manage. The protocols vary primarily with respect to the numbers of fish used: between 1 and 7 pairs of spawners. Most hatcheries use a 1:1 sex ratio. Many Committee members expressed concern regarding the use of jacks as broodstock and the issue received considerable discussion; however, the Committee did not make a recommendation on their use. A recent summary by Fitzgibbons and Hankin (2001) shows considerable variation among west coast salmon hatcheries with respect to the spawning of jacks.

Conclusion: Mating protocols should be constructed to maximize the effective population size (in terms of genetic diversity) and to prevent divergence of natural and hatchery stocks.

Recommendations: We recommend that with large numbers (>500) of breeders, simple one-on-one breeder pairs are acceptable. For small populations (200-500), females should be split into multiple egg lots and fertilized with different males. Males should not be pooled for fertilization. For very small populations (<200), where the goal would be to maximize genetic diversity, a full factorial spawning design matching all adults with one another is suggested. For very small populations, preservation (through freezing) of male gametes is suggested.

If natural stocks are not limited (or not listed), the Committee encourages the use of natural fish as brood stock. If they are limited, further analysis should occur; if they are listed, ESA authorization of prohibited take is necessary.

Because there could be needs for hatchery-specific brood stock and mating protocols, the Committee decided that those details should be addressed in individual hatchery HGMPs.

F. Hatchery Programs and Recovery of Weak and Listed Stocks

The Committee heard a presentation on work being conducted at the NMFS Northwest Fisheries Science Center on conservation hatchery strategies for Pacific salmonids. With the emphasis on natural fish required under the ESA, there is opportunity to modify the role of certain hatcheries from production to conservation. A conservation hatchery would operate on the concept that fish behaviorally and physiologically similar to natural cohorts can be produced if reared under conditions that simulate the natural rearing environment of each particular species under culture. A conceptual framework for doing so is presented in Flagg and Nash (1999). The efficacy of the concept merits further study.

Conclusions and Recommendations: NMFS is committed to working with the DFG to develop a role for hatcheries in the recovery of ESA listed salmonids and the conservation of non-listed stocks through the NMFS recovery planning process.

G. ESA Authorization of Hatchery Programs

Conclusions:

1. Most DFG anadromous hatcheries directly or incidentally "take" salmonids that are listed under the ESA. Section 4(d) take exceptions for hatchery programs operating under an approved HGMP are presently available only for Central Valley and Central California Coastal steelhead. However, NMFS is working towards having 4(d) hatchery exceptions available for all threatened salmonids in California. Whether under Section 4(d) rules (using HGMPs) or under Section 10 of the ESA, issuance of take authorizations will be contingent on provision of the same types of information and analyses.

2. The 4(d) rules do not remove the responsibility of a federal agency to consult under Section 7 of the ESA. Section 7 of the ESA requires that federal agencies, such as the Bureau of Reclamation, the Army Corps of Engineers, and the Federal Energy Regulatory Commission, consult with NMFS on activities they authorize, fund, or carry out to ensure they are not likely to jeopardize the continued existence of listed species or destroy or adversely modify their critical habitat. NMFS urges federal agencies involved in programs under this limit to work closely with the DFG and with NMFS so that sufficient information is provided with the 4(d) documentation for a concurrent section 7 consultation. In the case of federally operated or funded hatcheries which request exception to take prohibitions under the 4(d) rule, the ESA section 7 consultation will serve as written concurrence of the HGMP, and will specify the implementation and reporting requirements.

3. A primary goal of the joint hatchery review was to discuss and identify programs, policies, and practices that are likely to arise as important issues in permitting anadromous hatchery programs under Section 7, 10, or 4(d) of the ESA. The conclusions and recommendations of this report reflect the general agreement of NMFS, DFG, and Tribal representatives on most of the substantial hatchery issues. While the review was motivated by the need to evaluate and permit hatchery activities under the ESA, the review is not part of the formal ESA permitting process. During the formal permitting process, additional issues may arise that require resolution.

Recommendations

1. HGMPs should be developed for all state anadromous hatchery programs, either by the DFG, or by the entity which funds the programs. Priority should be given to those hatcheries that propagate listed species for which take prohibitions currently exist, however the HGMPs should address the take of all listed species. The NMFS will provide as much assistance and guidance as

possible in the development of HGMPs to ensure that information and analytical requirements are clearly defined and the approval criteria and processes are understood. NMFS and DFG recognize that certain provisions of the 4(d) HGMP exception, such as specification of the donor population's "critical" and "viable" threshold levels, or the determination of the genetic and ecological effects arising from the hatchery program, require information that is not presently available and that monitoring programs will need to be developed to supply the necessary information.

2. The conclusions and recommendations of this report should serve as interim guidelines for hatchery operations while the DFG proceeds with the development of HGMPs and NMFS completes the 4(d) regulatory process of applying take prohibitions and HGMP take limits to all threatened salmonids in California.

H. Cooperative Rearing Program

As with State hatcheries, cooperative hatcheries can be permitted to take threatened species under ESA Section 10 permits. The HGMP process also could apply to the non-State cooperative hatcheries if those hatcheries can be tied to a State program. NMFS has proposed that the DFG consider a strategy under which the State oversight of cooperative hatcheries might provide a basis for a single HGMP or permit. This could allow NMFS to expedite approval of all cooperative hatchery activities in a faster process.

The issue is whether the DFG and NMFS can develop a strategy to facilitate the approval of cooperative hatchery activities.

<u>Conclusions and Recommendations</u>: It is agreed that it would be desirable to facilitate action on cooperative hatcheries' activity proposals or permits. However, it has not been clearly articulated how this could be done or the potential benefits to the State and the resources. It may be that a strategy can be developed that would not increase the liability or workload of the State, but options have not been clearly stated or evaluated. NMFS needs to provide additional information to describe the details of its proposed approach and to indicate the extent to which NMFS staff would assist in all aspects of the approach such that the DFG workload would not be increased significantly. NMFS and the DFG should continue to discuss this issue. In the meantime a Section 10 permit is needed for each operation.

I. Issues at Specific Hatcheries

1. Warm Springs Hatchery (WSH)

In 1999, a consultation under Section 7 of ESA was initiated between the U.S. Army Corps of Engineers (the funding agency for the hatchery) and NMFS. Central California steelhead, coho salmon, and chinook salmon are all listed as threatened under the ESA. They occur in the Russian River and have been produced at WSH. DFG operates the hatchery. The issues are how should the hatchery be operated so that it doesn't jeopardize the continued existence of listed salmonids and how can WSH participate in efforts to recover listed fish.

Conclusions and Recommendations: The Committee formed a subcommittee to address interim operations at the hatchery. Their findings (proposed interim operations) are: "All agreed that current data are lacking to decide now how WSH should eventually be used to restore the runs of coho, chinook, and steelhead in the Russian River system. Specifically, questions about the genetic make-up of fish returning to the hatchery and those found in the "wild" need to be answered. The question of what best represents, or is closest to, the "founding stock" for these species needs to be explored. It was suggested that in addition to sampling fish from various locations, archived or museum specimens should be sought for genetic examination.

"In the context of doing genetic studies soon, agreement was reached as follows:

Steelhead - spawn only marked fish at WSH and Coyote, throughout the season as now. Relocate unused adults as follows - marked fish at WSH to the main stem Russian and those at Coyote to the West Fork below Mumford Dam; unmarked fish at WSH would be moved to Dry Creek or other selected tributaries, unmarked fish at Coyote would be placed in the West Fork near Forsythe Creek or above Mumford Dam.

Coho salmon - No hatchery production. Since virtually no coho have been produced at WSH during the last 3 years, no marked fish are expected to return to the hatchery. Unmarked fish arriving at the hatchery will be released in Dry Creek tributaries or at other sites deemed acceptable by DFG biologists.

Chinook salmon - No hatchery production. Relocate any adults returning to WSH to Dry Creek and those at Coyote to the Russian main stem (Mendocino Co.) or the West Fork as soon as logistically convenient.

"To reiterate, it was a strong feeling of the group that much genetic work remains to be done before final operations (production and restoration) can be decided for WSH. A large contract has recently been given by Sonoma County Water Agency to Bodega Marine Laboratory to fund such work. DFG is committed to continue collecting samples for these studies. In addition, NMFS is now prepared to run genetic samples at its Santa Cruz laboratory. Both sources of laboratory analyses should be used to the fullest extent."

2. Mad River Hatchery (MRH)

Construction of this hatchery was completed in 1971. It is the only existing salmon and steelhead hatchery built by the DFG exclusively for enhancement purposes. Currently, MRH raises 250,000 yearling steelhead for release in the Mad River. Because chinook salmon production goals (4,000,000 smolts and 1,000,000 yearlings) have not been achieved, the hatchery capacity has been used to rear some chinook, coho, and steelhead for restoration in the DFG's Central Coastal Region, coastal cutthroat trout for restoration and enhancement, and resident rainbow trout for stocking in local waters. Some chinook salmon have also been raised for the Inland Salmon Program

Conclusion: Very few coho and chinook are currently spawned at MRH. Consideration should be given to using the hatchery more for restoration of salmonid stocks (e.g., could it become a captive rearing facility?)

Recommendations: The DFG should cease spawning chinook and coho salmon at MRH. As needs arise, advantage should be taken of the capacity of MRH to rear salmonid stocks for recovery purposes.

3. Feather River Hatchery (FRH)

FRH was built by the California Department of Water Resources to mitigate for the loss of habitat upstream of Oroville Dam. The facility is the only Central Valley hatchery that rears spring chinook. Naturally spawning populations of Central Valley spring chinook are listed as threatened under CESA and ESA.

Interbreeding of spring and fall runs may have occurred in the Feather River prior to the construction of Oroville Dam, as a result of early hydro power and agricultural diversions blocking access to spring-run habitat in the upper watershed (DFG 1998). Attempts in 1968 and 1969 to allow spring chinook to enter the hatchery as soon as they arrived in the river (as early as April and May) resulted in significant pre-spawning mortality. Since 1970, hatchery policy has been to exclude spring run entry to the facility until onset of spawning, the period August through October. This practice has resulted in the inability to clearly identify spring chinook based on their adult upstream migration timing, which historically has been described as occurring between late February and June. Since the hatchery program's inception, practices have fostered this intermixing of fall run and spring run in the Feather River and within the hatchery. However, the spring-run pheno-type continues to occur in the system.

The Committee discussed the following issues:

a. Does the off-site release and resulting increase in straying of FRH spring chinook pose a significant risk to listed populations of Central Valley spring chinook? FRH spring chinook are currently planted in San Pablo Bay. The planting protocol likely results in straying of the hatchery population with potential for interbreeding with naturally spawning spring run populations in other basins. This is because the FRH spring run continue to return to the system during the normal migration of naturally produced fish.

b. Should efforts be made to reestablish a discrete run of spring chinook in the Feather River and if so, are there techniques or management options for better segregating the fall and spring runs to allow for a selection of brood stock that best represents the spring-run type?

Conclusions: The off-site release and resulting increase in straying of FRH spring chinook could pose a significant risk to listed populations of Central Valley spring chinook. FRH spring chinook are currently planted in San Pablo Bay. The planting protocol likely results in straying of the hatchery population with potential for interbreeding with naturally spawning spring run populations in other basins. Efforts should be made to reestablish a discrete run of spring chinook in the Feather River. The DFG should explore techniques or management options for better segregating the fall and spring runs to allow for a selection of brood stock that best represents the spring-run type.

Recommendations:

1. All the spring-run produced at FRH should be tagged for identification in fisheries, spawning surveys, and in hatchery returns.

2. FRH spring-run should be released "in-river", not trucked to San Pablo Bay. This recommendation is one step beyond that recommended by the subcommittee on off-site releases (they recommended that the DFG should consider such action). "In-river" means at or as close to the hatchery as is feasible, taking into account any environmental or ecological concerns (e.g., low flows, high water temperatures, competition with natural fish).

3. The DFG should continue to explore options to separate returning spring-run adults from fall-run adults. It should include follow up on the idea of a physical barrier in the Feather River to separate the races based on run timing.

4. Iron Gate and Trinity River Hatcheries

Naturally spawning populations of coho salmon in the Klamath-Trinity Basin are listed as threatened under the ESA. Coho returning to the Trinity River are overwhelmingly of hatchery origin. The hatchery stock is considered part of the Southern Oregon/Northern California coho ESU but is not listed; however, NMFS considers the hatchery population important to recovery. Retention of coho has been prohibited in ocean fisheries off California since 1994 and in fresh water recreational fisheries in the Klamath-Trinity Basin since 1997.

The Committee discussed the following issues:

a. Because there appears to be essentially no natural production of coho in the Trinity River, the hatchery stock of coho produced at Trinity River Hatchery will likely play an important role in coho recovery in the ESU. The DFG, Tribes and NMFS will need to consider how the coho program at TRH should best be utilized in the recovery of Trinity Basin coho.

b. The current document of operational goals and constraints for IGH stipulates the volitional release of chinook salmon smolts when the average size of the entire production reaches 90 per pound with a release date window of June 1 - 15. This time period often coincides with a reduction in the flow of water released by the Bureau of Reclamation into the Klamath River. The resulting low flows and deterioration of water quality reduces the rearing and migration habitat available for both natural and hatchery reared fish. Are alternative release strategies available that might reduce competition for limited habitat between hatchery and natural stocks?

c. Over the past 10 years, steelhead have returned to Iron Gate Hatchery in very low numbers. Coincident with the poor returns, hatchery staff have observed that the returning fish more resemble trout in size and coloration. Recoveries of tagged fish also suggest that the hatchery steelhead stock has "residualized"; that is, it has lost the propensity to migrate to the ocean, becoming a resident rainbow trout population. How should the problem be corrected?

d. Two issues were discussed with respect to practices which may delay the run timing of TRH spring chinook: 1) effects of the yearling program, and 2) adequacy of the two week closure of gates currently used to separate spring and fall chinook entering the hatchery.

The Goals and Constraints at Trinity River Hatchery require an annual production of one million spring chinook fingerlings (June release) and 400,000 yearlings (October release). Progeny from fish spawned earlier are ponded first and consequently are more likely to reach the target fingerling release size of 90 fish/lb by the June release date. The fish from earlier spawning therefore tend to be utilized for the smolt releases and, until recently, the yearling production was often dominated by eggs which were collected towards the end of the hatchery recovery period (lots spawned in late September through early October). Yearlings generally experience higher survival rates from release to maturity than do subyearlings (Hankin 1990). Spring chinook are spawned in the hatchery as they mature. If time of entry to the hatchery, and maturation and spawning, is correlated with time of river entry, it is possible that this kind of rearing and release practice may provide a selective advantage (but a bias) for later-returning spring chinook salmon.

For the past 3 years, fish for spring yearlings have been selected as smolts just prior to marking by the Hoopa Valley Tribe. Smolts for the spring yearling releases are selected from approximately the middle of the year's production for the following reasons. For an accurate inventory, fish need to be about 100-150/lb. Fish that are larger than that, and subsequently released as yearlings, tend to have a large percentage of precocious males that will remain at the hatchery and fail to migrate downstream. Therefore larger (earlier ponded) fish are avoided for use in the yearling program. Smolts are inventoried by the standard practice of determining size of fish per pound then total number of pounds needed for the yearling production goal.

Although the spawning periods of the spring and fall run chinook do overlap, their spawning habitats were historically different, providing spatial separation of spawning populations. The spring run accessed higher streams and the fall run utilized lower mainstem and tributaries. Because the historical spawning habitat of the spring run is no longer accessible, the potential for interbreeding of the two races is high. The Committee recognizes and supports continued efforts to maintain a separation between spring and fall runs of chinook at the TRH. Hatchery personnel report that run timing and phenotypic characteristics appear to provide good separation between fall and spring runs. There is currently a 2 week gap between spring and fall collection, during which fish cannot enter the hatchery.

See Appendix II for the report of the Klamath-Trinity Basin subcommittee.

<u>Conclusions and Recommendations</u>:

A process should be identified for the periodic (on the order of 6-9 years) review of hatchery production levels that would assess coho production at TRH and IGH in light of any of the following: (1) changes in ocean or freshwater harvest regimes, (2) new information on the effects of hatchery operations on natural populations below impassible dams, (3) recommendations coming out of tribal trust reviews, (4) changes to mitigation goals resulting from the upcoming FERC relicensing process in the Klamath Basin, or (5) changes in ESA status of Klamath Basin salmon and steelhead populations . The process would include the DFG, agencies responsible for mitigating of salmon production, the Tribes, and NMFS (if ESA issues were applicable). As recovery efforts proceed under the ESA, the Tribes, DFG, and NMFS will need to consider how the coho program at TRH should best be utilized in the recovery of Trinity Basin coho.

Little information is available on either the status of natural coho populations or the extent of straying of hatchery reared coho into natural spawning areas. Although the operation of weirs throughout the entire run time of coho can be difficult or impossible, there may be certain tributaries where flows would allow an adult census. Where possible, monitoring strategies should be identified that would provide better information on the status of naturally spawning coho in the Klamath-Trinity Basins. Additional efforts to genetically characterize hatchery and natural coho stocks within the Klamath-Trinity Basins would be useful for any future decisions regarding the use of hatchery stocks or non-hatchery brood stock in recovery efforts.

Iron Gate Hatchery Fall Chinook Releases

Two changes in release strategy were identified that potentially could reduce competition between hatchery releases of IGH fall chinook and natural populations. Prior to implementing any major changes in rearing or release protocols, monitoring programs should be identified and implemented that will provide information on the effects of changes in the release dates, or size at release, on the interaction of hatchery and natural populations during the release period.

1. The release of chinook smolts from IGH should be accomplished by releasing each production group of chinook as they reach 90 per pound. Hatchery records show this begins around May 1st. This advancing (currently June 15th) of the release window should result in a more volitional release with lower numbers of hatchery fish entering the Klamath River at any given time. Fish released in May should experience lower temperature and higher water flows. This modification of release strategy is intended to reduce impacts on naturally produced stocks and improve the survival of hatchery-produced smolts by allowing access to the lower water temperature and higher water flows available in late May.

Methods should be identified for warming the water used at IGH in the egg incubation process in order to advance the hatching date for later lots of eggs. This would enable hatchery management to get the last group of chinook fingerlings closer to the 90 per pound smolt release size by the first week of June - when water conditions are likely to be more suitable.

2. DFG should consider the desirability of expanding the chinook yearling program at IGH and reducing the chinook smolt production. Releasing fewer smolts and more yearlings would relieve some of the hatchery-natural interactions that occur during the low-flow and poor water quality conditions present in the Klamath River during June and July. The time of the yearling release from IGH occurs during October 15 – November 15, which coincides with flow release increases from Iron Gate Dam, increased precipitation in the Klamath Basin, and substantially improved water quality conditions in the Klamath River. Interactions between hatchery and natural chinook would be minimized as a result of improved water quality and because most natural chinook would have already left the Klamath Basin.

Iron Gate Hatchery Steelhead

A lack of indicators of ocean residence of hatchery “steelhead” in combination with the very low return numbers have raised concerns that the Iron Gate Hatchery “steelhead” program is producing rainbow trout and few, if any, steelhead. However, recent observations of smoltification characteristics (backing down in the rearing pond and shedding scales) of a portion of the yearling steelhead production, as well as recovery of hatchery-marked adults by fisheries staff of the Yurok Tribe, indicate that some portion of IGH-reared steelhead are anadromous. The subcommittee recommended that the DFG continue efforts to identify the issues that have led to residualization of the steelhead population and determine whether measures need to be taken to reverse this trend. If the problem continues, a Committee (including, but not limited to, the DFG, NMFS, and the Tribes) should be formed to discuss the appropriate measures to address the problem. One option may be to find an appropriate, naturally spawning, population of steelhead in the Klamath Basin from which brood stock could be taken to reinitiate a steelhead program at IGH.

Trinity River Hatchery Chinook

Spring and Fall Run Separation - DFG should conduct an analysis of coded wire tag (CWT) recoveries from the early portion of the fall run to assess the presence of spring chinook and during the late portion of the spring run to assess the presence of fall run, in the respective pools of fish available for spawning. In addition, data should be gathered on whether CWT marked fish were used or rejected for spawning, based on phenotypic characteristics used by hatchery personnel to distinguish the two races. The analysis would then provide estimates of 1) the presence of fall run during spring brood stock collection; 2) the presence of spring run during fall run brood stock collection; and 3) how well phenotypic characteristics such as color serve to distinguish the races.

Spring Yearling Program - For both spring and fall chinook, the numbers of fish held for release as smolts and as yearlings should reflect the numbers of fish returning at different times of the run, in the same way that eggs are selected from all components of the run.

5. Noyo River Egg-taking Station

This egg-taking station was constructed in 1962. The goals of the program, developed prior to the federal and state listing of coho, include developing and maintaining an escapement of 1,500 adult coho to the station as well as providing up to one million coho eggs annually for selected DFG and private coastal area programs. Adult coho salmon are trapped and spawned and the resulting eggs/fry are reared at Mad River Hatchery (and formerly at Warm Springs Hatchery). Smolts are stocked in the Noyo River and in other selected coastal streams to maintain and restore coho runs there.

Conclusions: The program, which has the potential to be integrated into ESA recovery efforts for coastal coho, requires a Section 10 permit. The Noyo River, the egg-taking station, and Jackson State Forest land provide an opportunity to explore many issues related to hatchery/wild concerns, distribution and monitoring, land use and restoration. The system is large enough to be considered an important component of the northern California coho spawning habitat but small enough that it can be monitored with a reasonable amount of effort. The DFG and the SWFSC Santa Cruz are presently collaborating on several projects in the south fork Noyo, including adult coho spawner and carcass surveys that are able differentiate between hatchery and naturally spawned fish, and summer juvenile surveys (single pass snorkel counts of juvenile steelhead and coho).

Recommendations: Artificial production and stocking of Noyo coho should occur in the context of addressing the factors that led to the decline in the population of coastal coho. Present goals, which specify that 75% of the run will be taken for hatchery propagation, should be reviewed to ensure that sufficient numbers of spawners are passed above the station for natural propagation. Mating protocols should be developed that maximize the effective population size and specify the extent to which naturally spawned broodstock will be incorporated into the hatchery stock. An assessment plan should be developed for evaluating the genetic and ecological effects of stocking Noyo coho in the Noyo and other coastal streams.

6. Van Arsdale Fisheries Station

Operations at this facility on the Eel River began in the 1920s. Its original purpose was to take steelhead and salmon eggs for transfer to other waters in California and elsewhere. It has also maintained adult fish counts since the early 1930s. It continues to collect fish run data, and chinook and steelhead eggs have been taken for rearing elsewhere (MRH and WSH); smolts are imprinted and released back into the Eel River to rehabilitate the runs there.

The activities of the Van Arsdale station are similar in many respects to those of the Noyo station and require Section 10 authorization.

7. Mokelumne River Hatchery

In September 1999, the Southwest Acting Regional Administrator wrote to the Director expressing concerns about, and offering some recommendations for changes to, the design features for planned renovation of Mokelumne Hatchery. Among other things, the Regional Office proposed consideration of designing rearing containers that facilitate volitional release of juveniles, that have options for habitat complexity to produce fish that are more wild-like in appearance and behavior, and that have options for applying anti-predatory conditioning. The principal theme was that there should be more focus on design changes that could improve the quality and survival of hatchery-reared juveniles and that could lessen the genetic and ecological impacts of hatchery-reared salmon on natural stocks. Subsequent meetings involving NMFS, DFG and East Bay Municipal Utility District personnel resulted in agreement on some design features that move in this direction.

Conclusions: As a result of the meetings, East Bay Municipal Utility District (EBMUD) and DFG agreed to incorporate design elements that allow for the volitional release of juveniles and addition of coloration matched to the natural river substrate to the concrete for the construction of two raceway series. Additionally, EBMUD and DFG have agreed to support and conduct scientific studies that incorporate all of NMFS suggested design elements. These studies will determine the feasibility and efficacy of rearing fish under more natural conditions and provide future direction for hatchery design.

Recommendations: The effects of these design features should be monitored and evaluated for future adjustments. Also, see the second recommendation for Nimbus Hatchery.

8. Nimbus Salmon and Steelhead Hatchery

Nimbus Hatchery began operations in 1955. It was built by the Bureau of Reclamation as mitigation for Nimbus Dam on the American River. Its production goals are 4,000,000 fall chinook smolts and 430,000 steelhead yearlings. It also produces chinook fingerlings for the fry release program (see prior discussion).

The Committee discussed the following issues:

a. Trucking of chinook smolts to San Pablo Bay (dealt with under the off-site release/straying section of this report).

b. Interbasin transfer of steelhead eggs to Mokelumne River Hatchery.

c. Release of steelhead yearlings in the Sacramento River.

d. The origin (Eel River) of the current stock of steelhead.

Conclusions: Transport and release of chinook smolts in the western Delta increases the straying of Nimbus Hatchery production to rivers throughout the Central Valley. Interbasin transfer of steelhead eggs to Mokelumne River Hatchery is an inappropriate exemption of existing policy.

Release of steelhead yearlings in the Sacramento River should be discontinued.

Recommendations:

1. Consider releasing chinook smolts at the hatchery (see off-site subcommittee report) during periods when flow releases can be obtained to maximize smolt survival through the delta.

2. Discontinue supplying steelhead eggs to Mokelumne River Hatchery.

3. Continue to look for steelhead planting sites in the American River instead of in the Sacramento River. Sites in the American River should be downstream of major salmon spawning areas.

4. Participate as appropriate following the development of a genetic evaluation plan for steelhead. This plan, being developed by the DFG, will identify and designate new sources of steelhead brood stock for Nimbus Hatchery. The new brood stock would eventually replace the current brood stock, which is of Eel River origin.

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