State of California

Memorandum

To : Mr. A. Petrovich, Jr.
Deputy Director

Date : September 19, 1997

From : Department of Fish and Game

Subject: Mass-Marking of Hatchery Steelhead

Attached is an Issue Paper regarding mass-marking of steelhead at California anadromous fish hatcheries. We previously provided a draft to the Regions and other interested parties, and have incorporated pertinent comments into this final paper.

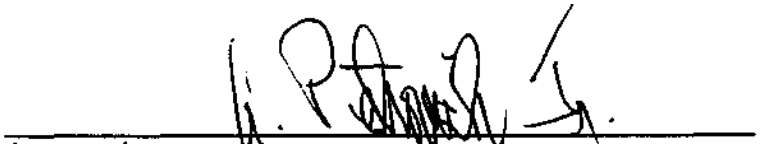
We have submitted a BCP for FY 1998/99 to establish a steelhead marking program on a permanent basis. However, as stated in the Issue Paper, we believe it is necessary to begin a marking program immediately, prior to the release of juvenile steelhead this winter and next spring. Because of the recent National Marine Fisheries Service decision to list Central Coast steelhead under the Endangered Species Act and the critical need to obtain information on Central Valley naturally-produced steelhead populations, we believe the highest priority is to mark steelhead at Warm Springs Hatchery and the four Central Valley steelhead hatcheries.

Actions needed for implementation of a marking program for 1997/98 include:

- Warm Springs Hatchery has the necessary funds within their existing FY 97/98 budget, and will begin marking their current steelhead production upon approval.
- The Department of Water Resources has already marked and coded-wire tagged the entire 1997 steelhead production at Feather River Hatchery.
- We will begin discussions soon with the Fish and Wildlife Service to determine the feasibility of marking the steelhead production at Coleman National Fish Hatchery. We may require that this be a condition for release.
- We will redirect money currently within the IFD budget to provide funds for marking steelhead at Nimbus and Mokelumne River hatcheries. We estimate this will cost approximately $15,000.
- We are prepared to temporarily re-direct Mr. Terry Jackson, IFD Associate Biologist, to oversee and coordinate marking at these two hatcheries.

for Timothy C. Farley, Chief
Inland Fisheries Division

cc: (see page two)



Approved.

Attachment

cc: Regional Managers, Regions 1, 2, 3, 4, 5
Mr. Terry Jackson, IFD

MCEWAN:lg

September 1997

ISSUE: MASS-MARKING OF HATCHERY STEELHEAD

BACKGROUND

Approximately 5.8 million steelhead are produced annually in California hatcheries and rearing projects. Of these, approximately 5.6 million are produced at seven Department of Fish and Game (DFG) operated anadromous fish hatcheries and one U. S. Fish and Wildlife Service hatchery (Table 1), and 0.24 million are produced in eight Cooperative Rearing Projects (Table 2). Because of concerns that artificial supplementation can cause impacts to naturally-produced (wild) stocks of anadromous fish, several Pacific states and British Columbia have implemented programs to mark artificially-produced steelhead so that they can be differentiated from naturally-produced steelhead. Recent studies indicate adverse genetic interactions, competitive exclusion, and disease proliferation among wild stocks of anadromous salmonids can result from unconstrained artificial supplementation programs *(see* McEwan and Jackson 1996). In addition, harvest rates and angling regulations that are established primarily according to hatchery production can lead to over-harvest of natural stocks (Hilbom 1992).

Table 1. Anadromous fish hatcheries and steelhead production in California.

Facility	Production Goal (yearlings)	Annual Production'		BY 97 Currently on hand
		Fingerlings[2]	Yearlings	
Iron Gate Hatchery	200,000	13,500	201,135	42,000
Mad River Hatchery	250,000	359,348	533,729	343,500
Trinity River Hatchery	800,000	0	636,715	850,000
Coleman National Fish Hatchery	700,000 to 800,000	287,220	644,839	583,000
Feather River Hatchery	400,000 to 450,000	308,980	434,646	408,000
Nimbus Hatchery	430,000	436,368	320,061	400,000
Mokelumne River Fish Installation	100,000	109.820	242,562	126,000
Warm Springs Hatchery[3]	460,000 to 500,000	632,773	391,222	631,000
Silverado Field Operations Base	n.a.	12,910	4,703	0
All Hatcheries		2,160,919	3,409,612	3,383.500

'Average annual production: from 1984-85 through 1993-94 for Iron Gate. Mad River, and Trinity River hatcheries; from 1986/87 through 1996/97 for all others.

[2] Includes fry, advanced fingerlings, and sub-yearlings.

[3] Includes production at Coyote Dam Steelhead Facility.

Table 2. Cooperative rearing facilities and steelhead production in California.

Facility	River System	1995 Production
Gualala River Steelhead Project	Gualala River	3,500
Louisiana Pacific Corporation	Russian River	21,947
Monterey Bay Salmon and Trout Project	San Lorenzo River	57,075
	Scott Creek	3,087
Pacific Lumber Company	Yager Creek (Van Duzen River)	6,500
Rowdy Creek Fish Hatchery	Rowdy Creek (Smith River)	121,680
Salmon Restoration Federation of Calif.	Ten Mile River	14,850
Napa River Steelheaders	Napa River	7,000
Casa Grande U.S. (United Anglers)	Adobe Creek	560
All Facilities		236,199

The Department's *Steelhead Restoration and Management Plan for California* (Steelhead Plan) (McEwan and Jackson 1996) recommends that all artificially-produced steelhead be marked prior to release so that they can be differentiated from naturally-produced fish. The Steelhead Plan states:

> "All steelhead produced in DFG hatcheries and Cooperative Rearing Projects will be marked so that they can be differentiated from wild fish. Despite evidence that hatchery supplementation programs can negatively affect wild stocks, we have no reliable means to differentiate hatchery from wild fish, hence we do not have a solid foundation to begin managing to protect wild stocks. Determination of origin based on fin erosion or scale analysis is not reliable or is impractical. The only reliable, practical means of identifying hatchery-produced steelhead is to fin-clip or otherwise mark them."

Mass-marking of hatchery steelhead is implemented for two principal reasons: to allow collection of biological and angling information necessary to manage natural steelhead stocks; and to facilitate the implementation of hatchery and fisheries management practices to fully utilize hatchery stocks and conserve natural stocks. Specific reasons include:

<u>Information Capture and Assessment</u>

1) Collection of life-history, distribution, and other biological information pertaining to natural stocks so that proper management and recovery activities can be implemented.

2) Collection of angler and harvest information to properly manage angling so that over-harvest of wild stocks does not occur.

3) Assessment of survival of hatchery steelhead, effectiveness of hatchery practices, and potential impacts of hatchery programs on natural stocks.

Fisheries Management

4) Determination of origin of fish used for broodstock for artificial supplementation programs.

5) Differentiation of hatchery from wild fish so that selective harvest angling regulations can be implemented.

For California steelhead, the first two reasons described above are the most relevant: specifically, there is an urgent need to determine the relative abundance and distribution of natural stocks in specific areas and the number of wild fish harvested statewide.

INFORMATION NEEDS

Klamath/Trinity

Existing Information. All steelhead production at Trinity River Hatchery (TRH) was marked for a six-year period from 1989 to 1995. Information pertaining to life history, migration, survival, and harvest of wild steelhead in the Trinity River system was investigated *(see* Zuspan et al. 1995; Zuspan and Sinnen 1996; Sinnen and Hanson 1996). The study concluded that:

- The proportion of naturally-produced and hatchery-produced adult steelhead run in the Trinity River above the Willow Creek confluence is approximately equal.
- Naturally-produced steelhead runs have been fairly stable at about 2.000 fish for the years 1992 through 1996 Hatchery-produced runs for this same time period have shown more variation, ranging from about 1,400 to 8,500 fish.
- Essentially all adult steelhead entering TRH are of hatchery origin.
- A substantial number of hatchery-produced steelhead spawn naturally in the Trinity River system.
- Harvest rates for naturally-produced and hatchery-produced steelhead are approximately equal.
- There is little straying of TRH hatchery-produced adult steelhead into the South Fork Trinity River (Barry Collins, DFG, pers. comm.).
- Naturally-produced steelhead in the Trinity River have a more protracted run than hatchery-produced steelhead.

Information Needs. The steelhead run into Iron Gate Hatchery (IGH) on the Klamath River has declined considerably over the past several years. Possible reasons for the decline are low survival of juveniles in the mainstem Klamath River and residualization of hatchery juveniles in the river below the hatchery, these latter fish may be returning to the hatchery to be spawned as broodstock (Mark Pisano, DFG, pers. comm.). The status of natural stocks of winter- and fall-run steelhead in the Klamath River is unknown.

Information could be collected through existing monitoring efforts on the Klamath River, with modifications, if a mass-marking program is implemented. Constant fractional marking could also be used, but cost- and labor- savings may not be significant because of the increased effort that would be needed to obtain accurate estimates of the total number of fish released. Existing projects and information that could be obtained are described below

- The U.S. Fish and Wildlife Service (USFWS) operates a rotary screw trap on the mainstem Klamath River at Big Bar (near Orleans) to monitor emigrating juvenile chinook salmon. The traps are operated March through July, and several hundred juvenile steelhead are captured during this period (Tom Kisanuki, USFWS, pers. comm.). A substantial portion of the outmigration period could be sampled, and relative abundance of natural- and hatchery-produced outmigrants could be obtained, if the trap is operated into the fall period. There is a substantial number of juvenile steelhead that emigrate during the winter, but this is typically a difficult period to sample due to high flows.

- DFG Klamath River Project monitors adult immigration into important Klamath River tributaries such as the Scott and Shasta rivers and Bogus Creek. The primary focus of this study is on chinook salmon escapement, however, some steelhead are observed (Mark Pisano, DFG, pers. comm.). Project personnel are currently evaluating the use of video equipment to monitor adult salmonid immigration into the Shasta River. If this proves feasible, it would allow for greater assessment of steelhead escapement, including relative numbers of naturally-produced adults that immigrate into the Shasta River and assessment of the degree of straying of hatchery-produced adult steelhead.

- The Klamath River Project also conducts an angler survey from August through October along the lower Klamath River to assess recreational catch of chinook salmon. Few adult steelhead are observed in the catch. By extending this survey through March, valuable steelhead harvest information, including numbers and percentage of naturally-produced adults harvested, could be obtained (as well as harvest information for coho and late-running chinook).

Central Valley

Existing Information. Naturally-produced steelhead juveniles (determined by location, size, and appearance of fish) are observed in routine monitoring activities in the American and Feather rivers (Bill Snider, DFG, pers. comm.; Deborah McEwan, Dept, of Water Resources, pers. comm.). Some steelhead smolts are also observed in rotary screw traps on Mill and Deer creeks (Colleen Harvey, DFG, pers. comm.). Hallock et al. (1961) estimated the composition of

naturally-produced steelhead in the Sacramento River system in the late 1950's was 88%. Current composition of naturally-produced adults in the annual runs, survival, and recruitment of juveniles to the adult population is unknown, however.

Peak steelhead smolt migration into the Sacramento-San Joaquin delta/estuary occurs January through March, based on fish salvage data obtained at the State Water Project and Central Valley Project fish screening facilities in the south delta. Because this coincides with outmigration of winter-run chinook salmon smolts, the California Department of Water Resources (DWR) has concluded that steelhead would be protected by existing pumping restrictions and other efforts to protect winter-run chinook salmon from adverse impacts caused by water export operations (DWR 1997). However, this time period also coincides with yearling steelhead releases from the hatcheries, and peak salvage rates at the fish facilities could be the result of hatchery release timing. Hallock et al. (1961) report that peak outmigration of naturally-produced smolts in the Sacramento River system occurs in spring, with a lesser peak occurring in the fall. Hallock et al. (1961) also state that "... hatchery-reared steelhead... usually move downstream rapidly", which could account for their appearance at the fish facilities shortly after their release from the hatcheries.

Information Needs. We have little information on natural steelhead stocks in the Sacramento and San Joaquin river systems. Large-scale hatchery production in the Central Valley (four hatcheries, approximately 2.8 million juveniles produced annually) may be masking a decline of natural stocks in this system. The greatest information need for the Central Valley is: 1) document presence and determine distribution of naturally-produced steelhead; 2) determine when outmigrating naturally-produced smolts migrate through the Sacramento-San Joaquin delta/estuary; and 3) estimate harvest of wild adults.

Delta water export operations have been identified as a major impact to many Central Valley fish species and current and proposed efforts to modify operations to protect aquatic biota are ongoing and sensitive. Timing of movement of wild steelhead smolts into the delta/estuary is unknown, hence impacts to natural steelhead stocks from water export operations cannot be determined and measures to provide protection to natural stocks cannot be implemented.

If a mass-marking program was implemented for steelhead in the Central Valley, information could be collected through existing and proposed salmon and steelhead monitoring efforts in the Sacramento River system, with some modifications. These existing programs and information that could be obtained are described below:

- DWR has recently initiated an anadromous fish study on the Feather River. Capture of steelhead fry in their downstream migrant traps (rotary screw traps) indicates natural production occurs in this system, yet it is unknown if captured smolts are of hatchery or natural origin. Marking steelhead production at Feather River Hatchery would allow them to make this distinction, and estimates of natural production, relative to hatchery production, could be obtained.
- DFG's Environmental Services Division has been assessing anadromous fish populations in the American River for several years. They operate downstream migrant

traps and conduct routine beach seining. Three groups of juvenile steelhead are captured in the traps: naturally-produced fry, hatchery-produced subadults, and naturally-produced subadults (Snider and Titus 1995). Origin of subadults is determined by degree of fin erosion. Marking hatchery-produced juveniles would allow for a more definitive determination of origin of captured juvenile steelhead.

- Environmental Services Division is assessing anadromous fish production in the Sacramento River at Knights Landing and in the upper Sacramento River near Jelly's Ferry by capturing downstream migrants in rotary screw traps. steelhead are observed in the traps at both locations. Presence/absence, relative abundance, and emigration timing of naturally-produced steelhead could be estimated if Coleman National Fish Hatchery (CNFH) steelhead are marked.
- The USFWS conducts year-round monitoring of juvenile salmonid migration at the Red Bluff Diversion Dam as part of the evaluation of the research pumping plant at the Tehama-Colusa Canal headworks. They capture substantial numbers of juvenile steelhead at this site (Jim Smith, USFWS, pers. comm.) in four rotary screw traps. Marking CNFH steelhead production would allow them to distinguish naturally-produced from hatchery-produced steelhead, and estimates of natural production, relative to hatchery production, could be obtained. Also, emigration timing of naturally-produced juveniles could be determined.
- The USFWS conducts mid-water trawl and beach seine surveys in the lower Sacramento River and estuary to monitor juvenile chinook salmon emigration. They frequently observe steelhead in their catch (Pat Brandes, USFWS, pers. comm.). Because all steelhead produced in the Sacramento system (natural and hatchery) must pass through the lower Sacramento River, this study could give much insight into total system-wide production of natural steelhead, timing of emigration, and survival estimates for hatchery-produced fish.
- Steelhead are collected in substantial numbers at the State Water Project (SWP) and Central Valley Project (CVP) fish screening facilities in the south delta. Marking hatchery steelhead would allow the sampling program at the fish screening facilities to readily determine relative abundance and emigration timing of naturally-produced juveniles.
- DFG is moving forward with a proposal to implement a new long-term program to monitor salmon and steelhead harvest in Central Valley streams, as part of the Comprehensive Assessment and Monitoring Program of the Central Valley Project Improvement Act. This survey could yield valuable information regarding numbers and percentage of naturally-produced adults harvested.

Angling

Existing Information. The steelhead Trout Catch Report-Restoration Card (steelhead report card) was implemented by DFG in 1993 to capture statewide angler and harvest

information. Statewide harvest estimates for adult steelhead for 1993 and 1994 are 40,485 and 52,826, respectively (Jackson 1997). Given our present statewide estimate of approximately 250,000 adult steelhead, this yields a harvest rate between 16% and 21%.

Information needs. The statewide harvest estimates generated by the steelhead report card data are greater than was initially thought. More important, we do not know what percentage of these fish are of natural origin. We have no current information regarding wild adult steelhead harvest on any system other than the Trinity River. If a mass-marking program was implemented, modifying the report card to collect catch information on wild (unmarked) steelhead would be a relatively easy task, and would allow us to estimate total statewide harvest of wild fish (Terry Jackson, DFG, pers. comm.). This type of information is captured on both the Washington and Oregon catch report cards.

POTENTIAL FISHERIES MANAGEMENT ACTIONS

Selective Harvest

Angling Regulations. Mass-marking is often used to facilitate implementation of differential angling regulations for naturally- and hatchery-produced fish, such as a selective harvest of hatchery steelhead and a reduced or zero bag limit for wild steelhead. Selective harvest regulations allow for greater protection of wild stocks by requiring anglers to release wild fish, while allowing harvest of hatchery fish to continue, thus reducing the impact of protective angling regulations on angling opportunities. Implementation of selective harvest regulations requires that anglers can readily distinguish wild from hatchery-produced fish.

Reduced or zero bag limits for wild steelhead have been implemented in many drainages in Washington and British Columbia and statewide in Oregon and Idaho. Prior to implementation of a mass-marking program, Washington, Oregon, and Idaho used dorsal fin criteria to enforce selective harvest regulations. Anglers determined the origin of caught fish by examining the shape and configuration of the dorsal fin: if the longest dorsal fin rays measured 2 inches or greater, it was defined as a wild fish and was required to be released. However, dorsal fin height is not a completely reliable method of distinguishing wild from hatchery-produced fish (Washington Dept, of Fish and Wildlife 1988; Oregon Dept, of Fish and Wildlife 1988) and all of these jurisdictions now fin clip 100% of their hatchery steelhead production.

The Steelhead Plan states:

> "Based on the limited harvest estimates that are available, a statewide selective harvest regulation does not appear to be warranted at this time. However, this conclusion is tenuous, and should be reevaluated when information from the Steelhead Trout Report-Restoration Card becomes available. Sport harvest needs to be evaluated on rivers and streams other than the Klamath and Trinity systems and, if necessary, a selective harvest regulation on a system-by-system basis should be instituted."

Information from the Steelhead Report Card indicates that statewide steelhead harvest in California may be greater than initially thought, and we may need to reevaluate the need for a statewide selective harvest requirement. In addition, there are individual stream systems where there is a plentiful hatchery run, but regulations are restrictive due to the need to protect wild stocks in the system (e.g., the American River).

Endangered Species Act Considerations. The National Marine Fisheries Service (NMFS) has recently listed some California steelhead populations under the Endangered Species Act (ESA). They have identified six Evolutionarily Significant Units (ESU) in California; two of which were listed as *threatened* (Central California Coast and South-Central California Coast) and one that was listed as *endangered* (Southern California). They deferred decisions for six months for the remaining ESU's (Klamath Mountains Province, Northern California, and Central Valley). The majority of steelhead sport angling occurs in streams within those ESU's that were listed or proposed as *threatened* (for example, the Smith, Klamath, Trinity, Eel, Russian, and San Lorenzo rivers) although a substantial amount also occurs in the Sacramento River, which is proposed to be listed as *endangered.*

Endangered Species Act prohibitions on take could impact steelhead angling in California. However, NMFS is proposing to list only naturally-reproducing steelhead, which may exclude hatchery-maintained populations (which support the majority of sport angling in California) from the ESA take prohibitions. However, NMFS will examine the relationship between hatchery and natural populations of steelhead and will assess whether any hatchery population is part of a listed ESU and essential to its recovery, which may result in the inclusion of specific hatchery populations in a listed ESU.

Because NMFS deferred decisions for the North Coast and the Central Valley, only one Department hatchery has been affected by the recent final listing decision: Warm Springs Hatchery on the Russian River system. NMFS determined that the Dry Creek steelhead stock raised at Warm Springs Hatchery was not part of the Central Coast ESU, thereby excluding them from listing.

NMFS could also include non-listed hatchery fish in protective ESA regulations under Section 4(e) of the ESA because they "closely resemble" the protected native steelhead. Section 4(e), also known as the "look-alike clause," allows NMFS to extend ESA protections to non-listed species if:

> "such species so closely resembles in appearance . . .a species which has been listed . . . that enforcement personnel would have substantial difficulty in attempting to differentiate between the listed and unlisted species [and] the effect of this substantial difficulty is an additional threat to an endangered or threatened species"

Implementation of a mass-marking program would allow for the differentiation of natural and hatchery stocks and could reduce the impact to anglers from protective ESA measures to recover listed stocks. Implementation of a selective harvest for hatchery fish within a listed ESU would likely require an incidental take permit, due to potential hooking mortalities of caught and released listed (wild) fish.

Hatchery Management

A periodic infusion of genetic material from natural stocks is necessary to maintain genetic variability in hatchery stocks (Allendorf and Phelps 1980; Hynes et al. 1981). The Steelhead Plan recommends that wild fish be used for broodstock whenever possible to minimize the loss of genetic variability and to maximize fitness of the hatchery stock. Some Cooperative Rearing Projects use wild fish solely as their broodstock and are able to determine origin of adult fish by fin clipping their production. If DFG hatcheries are to adopt the practice of including some wild fish as broodstock, hatchery-produced fish will need to be marked prior to release.

The USFWS is currently allowing adult steelhead to pass the barrier dam on Battle Creek. It is assumed that these fish are predominantly of CNFH origin. To insure that only wild steelhead are moved above the barrier at the hatchery, they would need to be distinguishable from hatchery-produced adults.

Modification of Water Operations

The effect of SWP and CVP water export operations on Central Valley natural steelhead stocks is unknown. The Interagency Ecological Program for the Sacramento-San Joaquin Estuary (IEP) has recently begun a real-time monitoring project to monitor fish populations and movement so that immediate modifications to water export operations can be made to reduce impacts. In addition, steelhead entrainment into the water export facilities is monitored at the SWP and CVP fish screening facilities in the south delta. Peak salvage rates at the DWR fish screening facility occur in March. This coincides with the release of yearling steelhead from the Central Valley hatcheries, which may indicate that the majority of these fish are of hatchery origin. If naturally-spawned steelhead are distinguishable from hatchery fish, then determinations could be made (based on observations made at real-time monitoring stations or at the fish facilities) regarding impacts on natural stocks caused by south delta water export operations, and water export operations could be modified accordingly.

ANALYSIS AND IMPLEMENTATION

Mark

Mass-marking programs for steelhead that have been implemented in other states and British Columbia primarily use a single adipose fin clip (Ken Johnson, Pacific States Marine Fisheries Commission, pers. comm.). This is a relatively simple type of mark to implement and, of all the fin removal possibilities, has the least effect on survival (PSMFC Subcommittee on Mass Marking 1992). For steelhead, adipose fin clipping is not sequestered for the use of identifying coded-wire tagged fish as it is with chinook salmon. Removal of a single ventral (pelvic) fin is second to the adipose fin clip in having the least effect on survival, although there is a wide range of mark-related mortality estimates reported in the literature (PSMFC Subcommittee on Mass Marking 1992).

Another method of marking is to spray-dye juvenile fish using florescent dye. This is a standard method of marking fish for evaluation purposes, but is not currently used in mass-marking programs to identify hatchery-produced fish. However, its utility as a mass mark is currently being evaluated by the Washington Department of Wildlife (WDFW) (Ken Johnson, pers. comm.)

The WDFW is evaluating a prototype automated fish handling machine that is currently under development by Northwest Marine Technology, Inc. This machine can adipose fin clip (and coded-wire tag) at a rate of 50,000 fish per day. When fully developed, Northwest Marine plans to make this device available to hatcheries for marking on a cost-per-fish basis. One of the guiding principals in the development of this machine is that the cost-per-fish is less than the cost associated with the current manual marking methods (Guy Thornberg, Northwest Marine Technology, Inc., pers. comm.).

Operations

The marking window for steelhead is constrained by water temperatures and planting schedules, and will vary by hatchery. However, because steelhead are raised to a larger size, there is a much longer marking window than there is for chinook salmon. The marking window for the coastal hatcheries (Mad River, Irongate, Trinity River, and Warm Springs) is approximately six months because high water temperature is typically not a problem, and the beginning of the planting period is relatively late (February through May). For the Central Valley hatcheries (Coleman, Feather River, Nimbus, and Mokelumne), the marking window is much shorter, due to potentially high water temperatures until late fall and the relatively early planting times (January and February). For some Central Valley hatcheries, the marking window could be as short as two months in some years. If MS222 is used as an anesthetic, there is a 21-day holding requirement that will need to be considered in the scheduling of marking activities.

One Fishery Biologist position will be needed for six months (probably more during the first two years of operation) to plan, coordinate, and oversee the marking activity This position will be responsible for equipment procurement and preparation, hiring and training of seasonal crew, and coordination with the hatcheries.

We believe the best approach to implementation is to have two marking crews: one team to mark fish at the four coastal hatcheries, and another to mark fish at the four Central Valley hatcheries. This has the advantage of reducing equipment costs, eliminating the need to hire a new seasonal aide crew for each hatchery (which can be time consuming), and would increase quality and efficiency of work by having an experienced crew. A disadvantage would be increased travel costs. Headquartering the crews in Weaverville and Sacramento would alleviate the need to pay travel costs for marking fish at the two largest production facilities (Trinity River and Nimbus/Mokelumne hatcheries). Another approach would be to provide or secure additional funds for each hatchery and have the hatchery or regions be responsible for marking.

Approximately 55 work days (2.8 months) would be needed for an eight-person marking crew to mark all the steelhead at the coastal hatcheries. Approximately 51 work days (2.6 months) would be required for the Central Valley hatcheries. Marking at the coastal and Central

Valley hatcheries would take place concurrently, so two sets of equipment would be needed. Schedule of marking at hatcheries within the two areas would be determined by hatchery operations and other factors.

Cost and Labor Estimates

Based on personnel needs and costs associated with marking juvenile chinook salmon (Hopelain 1992; DFG 1993) it is estimated that total first year costs (startup, coordination, and operating) to mark all steelhead at DFG hatcheries and CNFH would be $202,209. This estimate, which does not include steelhead raised at Cooperative Rearing Facilities, is based on the following:

- Single fin clip.
- Mark yearling production only.
- Modified and updated startup and operating costs from Hopeiain (1992).
- 4000 fish marked per person per day (Hopelain 1992; Mark Zuspan, DFG, pers. comm.).
- Two marking crews consisting of eight seasonal aides each.

Total first year costs, which include administrative overhead, are shown in Table 3. Cost and labor breakdown by hatchery and by crew is shown in Table 4 (see Appendix for fiscal detail)

Labor costs could be reduced if volunteers are recruited. There is interest to do this type of work among members of angling organizations and several marking programs on the north coast have utilized this type of labor Most recently, 70,000 steelhead smolts at Mad River Hatchery were marked over a two day period by 10 volunteers. One of the coordinating duties of the project biologist should be to recruit volunteers.

Table 3. Estimated total cost of marking steelhead production at DFG and USFWS anadromous fish hatcheries.

Planning and Coordination		$59,727
Operating		
Equipment	$8,071	
Labor (includes travel)	$134,411	
Total Operating		$142,482
TOTAL FIRST YEAR COST		$202,209

Table 4. Estimated labor cost per hatchery and total estimated cost per crew to mark steelhead with a single fin-clip at DFG and USFWS anadromous fish hatcheries.

COASTAL CREW	No. days required [1]	Cost ($)
Labor		
Iron Gate	6.3	10,120
Mad River	16.7	26,855
TRH	19.9	12,315
Warm Springs[2]	12.3	19,992
Subtotal-Labor	55.2	69,212
Planning and Coordination		29,864
Equipment		4,035
Total- Coastal Crew		103,111
CENTRAL VALLEY CREW		
Labor		
Coleman	20.2	32,446
Feather R	13.6	21,870
Nimbus	10.0	6,191
Mokelumne	7.6	4,692
Subtotal-Labor	51.4	65,199
Planning and Coordination		29,864
Equipment		4,035
Total-Central Valley Crew		99,098
GRAND TOTAL	106.6	202,209

1 Based on a crew of 8 markers and 4.000 fish per marker per day

2. Includes Silverado Base and Coyote Dam Steelhead Facility

Potential Funding Sources

Water and Power Development Agencies. Agencies or companies that fund hatcheries as mitigation for their water development or power generation facilities (all hatcheries except Mad River Hatchery) should be approached to provide funds to implement a marking program at their hatchery. This could be considered appropriate mitigation, and funded as part of the operating responsibilities of the hatchery.

Steelhead Catch Report-Restoration Card. This program could provide some money for marking on a yearly basis, but because this is a rather small fund (approximately 5150,000 per year) and this money is used for other steelhead restoration, education, and monitoring projects, it

is not a good candidate to provide total funding for the marking program on a continual basis. Nonprofit sponsors of Cooperative Rearing Projects can also apply for money from this fund to mark steelhead raised at Cooperative Rearing facilities.

Proposition 204. A bond act recently approved by California voters, the *Safe, Reliable Water Supplies for Cities, Farms, and the Environment Act of 1996,* provides a total of $995 million, of which $623 million can be used for Central Valley (including the Trinity River) aquatic and riparian habitat restoration and protection.

CALFED. The CALFED program controls $60 million to fund commitments from Proposition 204, commonly referred to as "Category III" funds. Category III was designed to fund non-flow related actions to benefit fish species dependant on the Sacramento-San Joaquin Bay-Delta Estuary. At a recent meeting to discuss Category III funding for restoration options on the lower American River, the consensus of the group was that marking fish at Nimbus Hatchery should be given a high priority.

Central Valley Project Improvement Act (CVPIA). The Comprehensive Assessment and Monitoring Program of the CVPIA has been established to assess the biological results and effectiveness of actions implemented pursuant to the CVPIA. This program is administered by the U.S. Fish and Wildlife Service.

RECOMMENDATIONS

1. Of the five political jurisdictions that have steelhead hatchery programs (California, Oregon, Washington. Idaho, and British Columbia), only California does not have a mass-marking program. Consequently, we know little about our natural steelhead stocks in most areas of the state. The most critical need for information regarding natural steelhead stocks is in the Central Valley. A mass-marking program implemented at the four Central Valley hatcheries could yield valuable information about distribution, relative abundance, movement, and contribution of natural spawners to total Central Valley steelhead spawning escapement. This information will be necessary before measures to recover natural stocks of Central Valley steelhead can be identified and implemented, and could be collected at existing salmon and steelhead research and monitoring projects. For these reasons, and because of the ESA listing of the Central Coast ESU and the potential for ESA listing in the Central Valley, we recommend that a steelhead mass-marking program be implemented immediately for Warm Springs Hatchery and the four Central Valley hatcheries that rear steelhead. Reduced steelhead angling opportunities due to the ESA are likely, and we believe that this can be ameliorated if naturally-produced fish are discernable from hatchery-produced fish. This necessitates that a mass-marking program be initiated in the fall of 1997 to mark juvenile steelhead currently on hand at these hatcheries (approximately 2.1 million fish).

2. The second most critical need is to estimate statewide harvest rates of naturally-spawning steelhead to determine if they are being over-harvested. For this purpose, it will be necessary to mark all steelhead produced in hatcheries and Cooperative Rearing Projects statewide. Information could be recovered through the steelhead Catch Report-Restoration Card program.

3. Objectives of a mass-marking program could be met by utilizing a single adipose fin clip, and this would have the least impact on survival of marked fish. However, because some existing studies are currently marking and releasing steelhead, the potential for mark duplication exists when a mass-marking program is implemented. Also, several tagging programs use an adipose fin clip to identify coded-wire-tagged steelhead. To alleviate confusion, all tagging programs will need to be coordinated through the DFG steelhead tagging coordinator, who will assign the proper fin clip. We recommend that the adipose fin clip be sequestered for use as a generic mark to identify all steelhead reared at hatcheries or cooperative rearing facilities for the purposes stated above, and other programs and tagging studies requiring an identifying mark use a single ventral fin clip, alone or in combination with an adipose fin clip.
4. Water development agencies who fund the mitigation hatcheries should be approached to augment the operating budgets of their hatcheries to mark the steelhead produced at that hatchery.
5. A Budget Change Proposal for FY 98/99 should establish a steelhead mass-marking program on a permanent basis. One Biologist (M/F) position should be created to oversee and coordinate the program. It is estimated that duties pursuant to this program would account for at least six months of work annually, but the position could include other duties relating to steelhead restoration and protection, as specified in the Steelhead Plan.
6. Because of the added expense, effort, and difficulty to mark the 2.2 million steelhead fry that are produced by California hatcheries annually, we recommend that they not be included in a mass-marking program. Instead, all hatcheries and rearing programs should be following the guidelines published in the DFG Operations Manual, which state that steelhead should be at least 10 to the pound (approximately 6.5 inches in length) at time of release. Also, four of the eight hatcheries are meeting or exceeding their yearling production goals without the fry plants (Table 1), and stocking of hatchery steelhead in excess of production goals may cause adverse impacts to natural stocks. In addition, release of hatchery steelhead less than 6 inches leads to increased residualization in fresh water, which further impacts the natural stocks and leads to poor returns of adults to the hatchery (Reavis 1996). Cessation of stocking steelhead fry would alleviate the need to mark these fish.

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APPENDIX

Fiscal Detail

HATCHERY	YEARLING PROD	# fish per mrk. day	mrkrs/ crew	#mrkd per day	#days	# months
Iron Gate	201135	4000	8	32000	6.3	0.3
Mad River	533729	4000	8	32000	16.7	0.8
TRH	636715	4000	8	32000	19.9	1.0
CNFH	644839	4000	8	32000	20.2	1.0
Feather R	434646	4000	8	32000	13.6	0.7
Nimbus	320061	4000	a	32000	10.0	0.5
Moke	242562	4000	8	32000	7.6	0.4
WarmSpr	391222	4000	a	32000	12.2	0.6
Silverado	4703	4000	8	32000	0.1	0.0
TOTAL	3409612					

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PERSONNEL AND EQUIPMENT COSTS (modified from Hopelain 1992)

I. PLANNING, SET-UP. AND COORDINATION

Personnel	PM	SAL/MO	Cost	
BIOLOGIST (M/F)				
Wage	6	2306	13836	
staff ben (©28%)			3920	
General Exp. (inc. travel)			6600	
Vehicle			18000	
SCIENTIFIC AID				
Wage	6	1443	8658	
staff ben (@7.66%)			663	
Subtotal			51678	
Admin Overhead (@23.9% -exc. vehicle)			8049	
TOTAL				59727

II. OPERATING

A. Equipment

	1992 cost		
Marking shelter	750		
Aprons, rain gear, boots	500		
pans(16XS20)	320		
Tally counters (8XS15)	120		
Dip nets -small	80		
Dip nets - long handle	100		
Electric pump for live tank	500		
Chemicals (MS222. disease treatment)	600	5300 per	nil fish)
Clippers (20@ $10)	200		
Misc.	150		
Subtotal (1992 cost)	3320		
Subtotal (adj for 1996 cost)		4035	
TOTAL EQUIPMENT (per crew)		4035	
TOTAL (X 2 crews)			8071

B. Labor (per hatchery)

IRON GATE

Personnel	PM	SAL/MO	Cost
Sea Aid			
Wage	2.5	1160	2916
staff ben (@7.66%)			223
Per diem (@$100/dy)			5028
Subtotal			8168
Admin overhead			1952
TOTAL			10120

MAD RIVER

Personnel	PM	SAL/MO	Cost
Sea Aid			
Wage	6.7	1160	7739
staff ben (@7.66%)			593
Per diem (@$100/dy)			13343
Subtotal			21675
Admin overhead			5180
TOTAL			26855

TRINITY RIVER

Personnel	PM	SAL/MO	Cost
Sea Aid			
Wage	8.0	1160	9232
staff ben (@7.66%)			707
Per diem (@$l00/dy)			0
Subtotal			9940
Admin overhead			2376
TOTAL			12315

WARM SPRINGS (inc Silverado)

Personnel	PM	SAL/MO	Cost
SeaAid			
Wage	4.9	1160	5741
staff ben (@7.66%)			440
Per diem (@$100/dy)			9896
Subtotal			16079
Admin overhead			3843
TOTAL			19922

COLEMAN

Personnel	PM	SAL/MO	Cost	
Sea Aid				
Wage	8.1	1160	9350	
staff ben (@7.66%)			716	
Per diem (@$100/dy)			16121	
Subtotal			26187	
Admin overhead			6259	
TOTAL			32446	

FEATHER RIVER

Personnel	PM	SAL/MO	Cost	
Sea Aid				
Wage	5.4	1160	6302	
staff ben (@7.66%)			483	
Per diem (@$100/dy)			10866	
Subtotal			17651	
Admin overhead			4219	
TOTAL			21870	

NIMBUS

Personnel	PM	SAL/MO	Cost	
Sea Aid				
Wage	4.0	1160	4641	
staff ben (@7.66%)			355	
Per diem (@$l00/dy)			0	
Subtotal			4996	
Admin overhead			1194	
TOTAL			6191	

MOKELUMNE

Personnel	PM	SAL/MO	Cost	
SeaAid				
Wage	3.0	1160	3517	
staff ben (@7.66%)			269	
Per diem (@$100/dy)			0	
Subtotal			3787	
Admin overhead			905	
TOTAL			4692	
TOTAL LABOR				134411
EQUIPMENT				8071
PLANNING AND COORDINATION				59727
GRAND TOTAL (First Year Cost)				202208