II-097

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July 28, 1997

Ms. Kate Hansel
CALFED Bay-Delta Program
1416 Ninth Street, Suite 1155
Sacramento, California 95814

Re: Merced Irrigation District
1997 Category III

Dear Ms. Hansel:

Enclosed are ten copies of an "Inquiry" submittal on behalf of Merced Irrigation District. Pursuant to my discussion with Jeff Phipps of your staff, this submittal has been sent regular mail rather than delivering it prior to the 4 p.m., July 28, 1997 deadline for proposals.

We look forward to your comments assisting Merced Irrigation District in proceeding with submitting a proposal in November 1997. Please call if you have any questions.

Sincerely,

MURRAY, BURNS and KIENLEN

By: Marc Van Camp
Marc Van Camp

Enclosures
cc: Mr. Ross Rogers
Mr. Ken Robbins

I-097

Merced Irrigation District
Inquiry Submittal to

CALFED Bay-Delta Program

Murray, Burns and Kienlen, on behalf of Merced Irrigation District (Merced) is making this "Inquiry" submittal in response to CALFED's Request for Proposals; Ecosystem Restoration Projects and Programs.

Merced and the Department of Fish and Game (DFG) have been discussing, for approximately five years, the need and biological justification for increased instream flows and other factors affecting the chinook salmon within the Merced River. The discussions with DFG are ongoing at this time. The results of these discussions may result in ten years of various studies conjunctively pursued by Merced and DFG. The purpose of the studies is to provide sound scientific data to base critical decisions for improving the chinook salmon fishery of the Merced River.

The cost of the overall study plan is currently estimated to be approximately $4 million. The attached study descriptions represent those determined to be of high priority by Merced.

Merced requests CALFED to provide comments on the attached study descriptions to provide Merced insight for the November 1997 funding cycle. Send comments to:

Ross Rogers, Manager
Merced Irrigation District
P.O. Box 2288
Merced, CA 95344-0288

and

Murray, Burns and Kienlen
Attn: Marc Van Camp
1616 29th Street, Suite 300
Sacramento, CA 95816

Merced Irrigation District
Study Descriptions

ADULT CHINOOK SALMON LIFE PHASE (MIGRATION)

Title: Chinook Salmon Attraction into the Merced River

Study Element: A-1

Purpose: Evaluate potential benefits of attraction of adult chinook salmon into the Merced River by flow augmentation.

Background: During the early fall (e.g., mid October), adult chinook salmon may stray into areas unsuitable for salmon reproduction (e.g., Mud and Salt Sloughs off the mainstem San Joaquin River located upstream of the Merced River confluence). In the past, CDFG partially mitigated this problem by installing fish traps in these localities, captured salmon and relocated the fish to areas where successful reproduction could occur. These actions were considered by CDFG as temporary measures until a long-term solution to the problem could be developed and implemented. Fish trapping and transport are generally undesirable because of potential stress related pre-spawning morality. More recently, CDFG has installed physical and behavioral barriers at the Merced River confluence with the San Joaquin to guide salmon into the Merced River. This latter measure was performed in concert with flow augmentations above mandated instream flows (via water transfers) which CDFG believes was beneficial to early returning Merced River chinook salmon and has essentially resolved the straying problem.

Study Approach: Instream flows in the Merced River will be augmented above existing FERC and Davis-Grunsky Agreement levels as shown in Exhibit B. Pursuant to a mitigation agreement, the positive barrier in the mainstem San Joaquin at the Merced River confluence will be installed by DFG/DWR by late September in each of the study years. Depending on water clarity and physical constraints, a second fish counting weir will be installed in the lower Merced River to allow enumeration of upstream migrating salmon on a daily basis during the flow augmentation. The efficacy of capturing and tagging upstream migrants will be assessed in the first two years of operation of the counting weir. The fish counting weir will be designed to prevent delay or injury to upstream migrants. Fish trapping will not occur ir riverine conditions (e.g., warm water) may harm adult salmon. An earlier extension of DFG's spawning ground surveys (Study Element A-2) will also be used to assess the timing of fish to key spawning areas. In addition, the use of hydro-acoustics and weekly snorkel surveys may be used as evaluation techniques. Incubating eggs at the Merced Hatchery will be monitored to note any unusual mortality and disease. These data will be used to evaluate the benefits of the increased flows and to better time the specific flow regimen to benefit salmon attraction into the Merced river (e.g., early October versus mid-October).

Study Duration: October 1997 through 2006

ADULT CHINOOK SALMON LIFE PHASE (SPAWNING)

Title: Empirical validation of DFG's instream flow recommendations for salmon spawning.

Study Element: A-4

Purpose: To determine if salmon spawning utilization in the Merced River corresponds to the instream flows recommended by DFG to improve spawning habitat.

Background: DFG recently completed a study and draft report on Merced River instream flows for spawning salmon. The study used the USFWS's Instream Flow Incremental Methodology (IFIM) to model potential salmon spawning habitat under varying flow regimes. The specific component of the IFIM used in the study integrated intensive field measurements of water velocities, depth, and substrates at selected spawning areas in the Merced River with expected salmon "preferences" for those characteristics. Physical habitat for spawning salmon was simulated (modeled) by computer (PHABSIM) over a range of flows. The field study, IFIM, and PHABSIM were used a as partial basis by CDFG to develop the instream flows recommended by the agency in Exhibit B.

Study Approach: Site-specific chinook salmon spawning utilization at or near selected DFG IFIM study sites will be evaluated by comparing empirical measurements of velocity, depths, and substrates where salmon spawn with the modeled PHABSIM results. These data will be used to determine if the study results accurately reflect maintenance of habitat and salmon utilization in those localities where salmon are expected to spawn according to the flow at the site where spawning occurs.

Study Duration: October - November, 1997- 1999

Lead: MID with DFG assistance.

Cost: $10,000/year

CHINOOK SALMON EGG INCUBATION LIFE PHASE

Title: Monitoring of water temperatures during salmon egg incubation.

Study Element: E-1

Purpose: To monitor and evaluate water temperatures at sites and times when chinook salmon eggs are incubation in the Merced River and at Merced River Fish Hatchery.

Background: Chinook salmon eggs require cold water during incubation. Optimal water temperatures during egg incubation are generally considered by the fishery agencies to be in the range of 42°F - 56°F. Water temperatures of 62°F and higher can cause up to 100 percent mortality. Because the Merced River is the southern-most range for chinook salmon, water temperatures during the early fall could be a significant factor limiting spawning success in the river, particularly for those fish returning to spawn early in the season. With planned flow augmentation for study purposes to potentially meet the needs of early returning salmon into the Merced River, it will be important to assess if water temperatures are suitable for those fish that spawn early in the season (e.g., October). By early to late-November in most years, ambient air temperatures cool the river water down to levels acceptable for salmon egg incubation.

Study Approach: Continuously recording (hourly) thermographs will be placed in the Merced River near chinook salmon spawning areas during late September through March to monitor water temperatures. Information from DFG's annual spawning ground surveys will be used to determine the onset, peak, and end of chinook salmon spawning and egg deposition in the river gravels. DFG's annual egg take at Merced River Hatchery and the "fertility" fraction of each egg lot will be documented. Past information on run timing, egg lot fertility, disease incidence, thermograph data, and water project operations will be summarized. The thermal history of eggs deposited in river gravels and taken at the hatchery will be monitored during incubation to determine developmental history. Two computer models (egg mortality and egg development) will be used to evaluate the extent of potential mortality attributable to lethal temperatures and the expected time of emergence of salmon fry from the gravel. The extent of egg mortality will be assessed as to the potential resultant effects on early spawning fish in the river. The information on egg thermal history for those fish not exposed to lethal conditions will be used to estimate times of early, peak, and late emergence of fry from river gravels. This latter information will be useful to improve timing of instream flows for fry rearing and prevent potential dewatering of salmon eggs.

Study Duration: October - March, 1997 - 2006.

Lead: MID with DFG coordination.

Cost: $5,000/year

Title: Evaluation of Chinook Salmon Spawning Substrate.

Study Element: E-2

Purpose: To qualify the characteristics of spawning substrate conditions in the Merced River as

related to salmon survival.

Background: Incubating salmonid eggs cannot tolerate large quantities of fine particles (i.e., sand and silt) within the redd. Once laid in the river gravels, eggs and larvae must receive sufficient supply of oxygenated water of suitable temperature and free from toxic contaminants. After water hardening, the egg capsule allows for diffusion of oxygen molecules to the embryo but is impervious to water molecules. The delivery rate of oxygen to the egg is a function of intragravel water velocity and the concentration of oxygen. Heavy siltation on the eggs can reduce intragravel water flow to lethal levels (Wickett 1954). Fine sediment has a large influence on gravel permeability; finer sediments can be more effective in reducing intragravel flow than coarser sediments (Cooper 1965). Of particular concern are fines smaller than 1 mm in diameter (Beschta and Jackson 1979). However, it is also important to note that larger fine particles (e.g., coarse sand) can obstruct movements of alevins within the gravel at the time of emergence (Hausle and Coble 1976). The principal benefits resulting from adequate water velocity to incubating salmonid embryos are the concurrent functions of transferring sufficient dissolved oxygen to the surface of the egg membrane and the removal of the egg's metabolic waste products (Brannon 1965; Hausle and Coble 1976). Lisle and Eads (1991) state that the threshold of concern for fine sediment content in salmonid spawning gravel vary between species and grain size of fine sediment, but most commonly is around 20 percent. The California Department of Fish and Game's threshold of concern for fines in spawning gravel is 15 percent Synoptic observations of streambed substrate at important chinook salmon spawning riffles in the lower Merced River suggest that there may be very high levels of fine particles in the spawning gravels which can be deleterious to salmonid egg incubation.

Study Approach: Past information collected on salmon spawning substrate conditions in the Merced River will be summarized. Where data are lacking, a variety of field techniques and equipment will be used to assess spawning substrate conditions in the Merced River. Utilization of sampling devices such as core samplers, infiltration bags, freeze cores, and intragravel permeability measuring devices will allow for a through evaluation to determine if the level of fines on the spawning grounds are adversely impacting wild salmon in the Merced River. The MTAC will determine appropriate sampling protocols, experimental design, sample locations and sizes, etc.. A comprehensive evaluation will be made to determine how results obtained within the Merced River compare with similar data collected in other northern California anadromous salmonid rivers and streams. Depending on results from this study, it is expected that the MTAC may develop a scope of work for a larger-scale project to evaluate Merced River substrate issues such as substrate depletions, bedload movements, and a long-term spawning substrate "budget".

Study Duration: October - March, 1997 - 1999

Lead: Mid with DFG assistance

Cost: $20,000/year

CHINOOK SALMON JUVENILE REARING LIFE PHASE

Title: Empirical validation of DFG's instream flow recommendations for juvenile salmon rearing.

Study Element: R-3

Purpose: To determine if juvenile salmon rearing utilization in the Merced River corresponds to the instream flows recommended by DFG to improve rearing habitat.

Background: DFG recently completed a study and draft report on Merced River instream flows. The study used the USFWS's Instream Flow Incremental Methodology (IFIM) to model potential salmon habitat under varying flows regimes. The specific component of the IFIM used in the study integrated intensive field measurements of water velocities, depth, and substrates, and cover at selected areas in the Merced River with expected salmon "preferences" for those characteristics. DFG is in the process of improving or expanding the database for juvenile rearing preferences. Physical habitat for rearing salmon will be simulated (modeled) by computer (PHABSIM) over a range of flows. The field study, IFIM, and PHABSIM will be used as a partial basis by CDFG to develop the instream flows recommended for the salmon rearing life phase.

Study Approach: Site-specific juvenile chinook salmon rearing utilization at selected DFG IFIM study sites will be evaluated by comparing empirical measurements of velocity, depths, substrates, and cover where salmon rear with the modeled PHABSIM results. These areas will be stratified by habitat types to ensure uniformity among comparisons. These data will be used to determine if the study results accurately reflect salmon utilization in those localities where salmon are expected to rear according to the flow at the site where rearing actually occurs.

Study Duration: February - May, 1998 - 2000

Lead: MID with DFG assistance

Cost: $25,000/year

CHINOOK SALMON DOWNSTREAM MIGRATION LIFE PHASE

Title: Abundance of natural salmon production in the Merced River

Study Element: 0-1

Purpose: To quantify and evaluate the numbers of out migrant chinook salmon leaving the

Merced River on a daily basis.

Background: Young chinook slamon may migrate downstream from Merced River and the mainstem San Joaquin into the Sacramento-San Joaquin Delta as pre-smolts (fry and parr) and as smolts. EPA (1994) describes a smolt as "...a salmon in the process of acclimating to a change from a fresh water environment to a slat water environment. This occurs when young salmon migrate downstream through the Delta to the ocean.". Although this definition is accurate, it is simplistic because there are complex morphological, physiological, and behavioral changes associated with the transformation of parr salmon to smolt salmon.

The many variables and interactions between variables associated with the migratory behavior of young salmon are complex and not well understood (Kreeger and McNeil 1992). Abiotic factors which may have primary influence on young salmon migration include photoperiod/date, water temperature, and flow. Other abiotic or biotic factors which may affect migration include barometric pressure, turbidity, flooding, rainfall, wind, species, stock (e.g., fall-run or spring-run), life history stage, degree of smoltification, parental origin (e.g., hatchery or wild), size of juveniles, location (e.g. distance from the ocean), food availability, etc. (Burger 1991, as cited by Kreeger and McNeil 1992). The specific timing of natural smolt migration depends on the physiological state of the fish.

A review of the scientific literature on the topic by Kreeger and McNeil (1992) provides valuable insight into migratory characteristics of young salmonids. The time and speed of juvenile salmon migration area seceded with age and size of the fist as well as with them. Older and larger smolts tend to migrate faster as compared to younger and smaller smolts. Early migrating smolts tend to migrate more slowly than late migrating smolts. Temperature is an important factor affecting smoltification - warmer temperatures can stimulate smoltification up to a threshold where smoltification is inhibited (Kreeger and McNeil 1992). Temperature influences the onset of smoltification through growth and regulates the magnitude and duration of the smolting process (Burger 1991, as cited by Kreeger and McNeil 1992).

Growth rate of juvenile salmon in freshwater influences the age at which juveniles enter the ocean. With low water temperatures in upper river reaches, growth of rearing fry may be less than optimal causing a delay in time of out migration through the Delta. After evaluation 13 years of data on Atlantic salmon smolts, Emolaev (1989) found that the initiation of migration was determined by "the rate of warming of the river, not by the absolute temperature of the water." (Emolaev 1989, as cited by Kreger and McNeil 1992). In some rives and streams in the Central Valley, the potential may exist to purposefully accelerate young salmon smoltification, downstream migration, and adaptability to seawater. Kasahara et al. (1989) found that accelerating growth of young masu slamon hastened the onset of smolting development and seawater adaptability."

The timing for downstream migration of Merced River salmonids is influenced by factors such as

time of egg deposition, water temperatures during egg incubation, water temperatures during juvenile rearing, stream flows, turbidity, food supply, and other factors previously discussed. It can be expected that the period of downstream migration would be considerably protracted. The period could extend from late January (fry dispersal) to April, May, or June (smolt out migration). Sufficient instream flows are necessary to provide the fish safe passage as they migrate downstream to the Bay-Delta estuary.

Study Approach: Downstream migrant salmon traps have been successfully used to quantify downstream passage of fish on a daily basis. When those traps are properly operated, maintained, and calibrated estimates of total salmon production in a tributary can be approximated. This information will be invaluable to assess annual production trends and to help evaluate the success (or failure) of river management actions and the effects on salmon.

Beginning in January, rotary fish traps will be installed at locations in the lower Merced River and possible in the upper reaches of the Merced River immediately downstream from the primary nursery areas. Trapping will be calibrated (using hatchery or naturally produced salmon) to account for variation in river conditions and fry migration behavior to allow estimation of fry and juvenile abundance throughout the period of trapping. Replicated mark and conditions to improve calibrated estimates. It is expected that trp calibrations will be performed at least weekly by releasing a known amount of marked fist (e.g., 1,000 slamon) upstream of the trap site and recapturing a portion of the marked fish in the fish traps. The numbers of fish recaptured will provide an indication of sampling efficiencies. Trapping will begin mid-January and traps will be checked for fry, maintained, and cleaned daily during use. Sampling frequency may be more often when large fish catches occur and/or heavy riverine debris is present. Daily fish catches will be identified to species and enumerated. A sample of captured fish (30=-50 fish) will be mildly sedated in buffered TMS-222 to minimize handling stress measured for lengths and weights, and revived and released downstream from each trapping location daily. Fulton's condition factor will be calculated from length and weight data to track general condition of the fish during the season. Local daily weather data will be compiled. Water turbidity (e.g., nephelometric turbidity units) will be measured daily at the trap site. All data will be recorded on data sheets and entered into computer data files.

Study Duration: January - June, 1998-2007

Lead: Co-lead DFG and MID

Cost: $80,000/year

Title: Survival of salmon migrating out of the Merced River

Study Element: 0-4

Purpose: To estimate the survival of outmigrant chinook salmon leaving the Merced River.

Background: Information on specific survival rates of outmigrant salmon in distinct river reaches within the Merced River, the San Joaquin River, and through the Delta would provide indications where problems areas for salmon survival may exist during their outmigrant life phase. These data would allow resource managers to focus more attention to the potentially most significant causal factors for salmon mortality.

Study Approach: During April and May, rotary fish traps will be installed at a location in the lower Merced River. Additional trapping will be performed by DFG near Mossdale and by the USFWS near Chipps Island in the Delta. Groups of coded-wire tagged chinook salmon will be released in the Merced River at the Merced River Fish Facility and in the river several miles upstream of the rotary fish traps. In addition, DFG will release additional coded-wire tagged salmon in downstream areas (e.g., mainstem San Joaquin, Tuolumne, and Stanislsus Rivers) in coordination with the Merced River fish releases. The tagged fish releases will be performed during various river flows during April and May of each year. Tagged or marked hatchery fish release strategies for the survival studies will emulate natural smolt densities, where and when feasible. Paired tagged fish releases will be performed near the same times under the same riverine conditions. A series of replicate releases of tagged/marked smolts should be med each year to provide for confidence intervals around smolt survival estimates in the Merced River. Trapping will be calibrated (using hatchery or naturally produced salmon) to account for variation in river conditions and salmon migration behavior to allow estimation of juvenile abundance migrating past the traps during the tests. Replicated mark and recapture calibration studies will be performed during night and daylight under a variety of river conditions to improve calibrated estimates. It is expected that trap calibrations will be performed at least weekly by releasing a known amount of marked fish (e.g., 1,000 salmon) upstream of the trap site and recapturing a portion of the marked fish in the fish traps. The numbers of fish recaptured will provide an indication of sampling efficiencies. It is estimated that 450,000 Merced Hatchery smolts (for survival tests) plus 30,000 fish (for trap calibrations) will be required annually for this study element. Trapping will begin prior to the first release of test fish and continue on a daily basis until one week following the last fish release. Fish traps will be checked for tagged fish, maintained, and cleaned daily during use. Sampling frequency may be more often when large fish catches occur and/or heavy riverine debris is present. Daily fish catches will be identified to species and enumerated. Captured tagged fish will have their tags extracted to determine tag code and release site. Differences in tag recoveries will help evaluate salmon survival within specific river reaches. Additional data on survival rates for each fish release will be obtained from tag recoveries from adult fish (ocean and freshwater recoveries several years following the releases).

Study Duration: April - May 1998 - 2007

Lead: DFG with MID assistance

Cost: $1000,000/year

WATER TEMPERATURE MANAGEMENT

Title: Temperature Management Reconnaissance Study

Study Element: T-1

Purpose: Compile and summarize pertinent physical project specifications, operating strategies and requirements, related agreements, and existing thermal and flow information and biological monitoring activities.

Background: During the early fall, spring and summer months water temperatures in the lower Merced River and at Merced River Hatchery can be outside acceptable ranges for chinook salmon spawning, egg incubation, larval and juvenile growth. Adult salmon entering the Merced River and Merced River Hatchery and spawning in October and November are exposed to warm (13.3°C or 56°F) water that reduces the survival of eggs and larvae to emergence.

Water temperatures outside the range of 42-65°F is also a concern. Colder water slows egg maturation and juvenile growth which can delay the time of migration to the Sacramento/San Joaquin River Delta and the period of saltwater entry into the Pacific Ocean. These delays may result in lower survival of the offspring and lower returns as adults. Temperatures higher than this range increases metabolic rates and may cause juveniles to expend most the food energy consumed, thus retarding growth. Smaller, less fit individuals generally do not survive as well and do not contribute to the fisheries and subsequent spawning escapements as well.

Warm water temperatures create conditions in the natural and hatchery environment that are conducive to many salmon pathogens resulting in many types of diseases or infections that reduce fitness or cause mortality. This is most evident in hatchery populations but can occur in the Merced River as well. In many years, production at Merced River Hatchery is impaired by warm water temperatures in the fall, late spring and summer months. Effective measures that avoid these impacts of warm water temperatures in the Merced Rive and at Merced Hatchery have the potential to measurably improve chinook salmon production.

Study Approach: The initial study will compile all pertinent physical and biological data and analyses regarding MID's Merced River Project and water temperature in the fall, spring and summer months. Information developed for Fish and Game's temperature model, MMID's reservoir characteristics and operations plan(s) and models, and all associated physical information, requirements and agreements that need to be considered will be compiled into a Reconnaissance Study Report. Any additional information needs that will hinder progress in Study Element T-2 should be identified in this report to ensure the parties actively pursue this

information in a timely manner to avoid delays in Study Element T-2.

Study Duration: October 1997 - September 1998

Lead: MID with DFG assistance

Cost: $25,000/year