

Distribution and Relationship of Resident and Anadromous Central Valley Rainbow Trout

Project Information

1. Proposal Title:

Distribution and Relationship of Resident and Anadromous Central Valley Rainbow Trout

2. Proposal applicants:

Kathleen Perry, California Department of Fish and Game
George Edwards, CDFG

3. Corresponding Contact Person:

Kathleen Perry
CDFG
Native Anadromous Fish and Watershed Branch
1807 13th Street, Suite 104, Sacramento, CA 95814
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4. Project Keywords:

Anadromous salmonids
At-risk species, fish
Fisheries Biology

5. Type of project:

Research

6. Does the project involve land acquisition, either in fee or through a conservation easement?

No

7. Topic Area:

At-Risk Species Assessments

8. Type of applicant:

State Agency

9. Location - GIS coordinates:

Latitude:

Longitude:

Datum:

Describe project location using information such as water bodies, river miles, road intersections, landmarks, and size in acres.

Multi-regional project.

10. Location - Ecozone:

Code 15: Landscape

11. Location - County:

Calaveras, Sacramento, San Joaquin, Stanislaus, Tehama, Tuolumne, Yuba

12. Location - City:

Does your project fall within a city jurisdiction?

No

13. Location - Tribal Lands:

Does your project fall on or adjacent to tribal lands?

No

14. Location - Congressional District:

CA, 5th

15. Location:

California State Senate District Number: 4,5,6,12

California Assembly District Number: 2,4,5,10,25

16. How many years of funding are you requesting?

3

17. Requested Funds:

a) Are your overhead rates different depending on whether funds are state or federal?

Yes

If no, list single overhead rate and total requested funds:

Single Overhead Rate:

Total Requested Funds: **\$158,756**

b) Do you have cost share partners already identified?

Yes

If yes, list partners and amount contributed by each:

CDFG \$58,386

c) Do you have potential cost share partners?

No

d) Are you specifically seeking non-federal cost share funds through this solicitation?

No

If the total non-federal cost share funds requested above does not match the total state funds requested in 17a, please explain the difference:

18. Is this proposal for next-phase funding of an ongoing project funded by CALFED?

Yes

If yes, identify project number(s), title(s) and CALFED program (e.g., ERP, Watershed, WUE,

Drinking Water):

#99-N12 Central Valley Steelhead Genetics Evaluation ERP

Have you previously received funding from CALFED for other projects not listed above?

No

19. Is this proposal for next-phase funding of an ongoing project funded by CVPIA?

Yes

If yes, identify project number(s), title(s) and CVPIA program (e.g. AFRP, AFSP, b(1) other).

#11332-9-J027 Central Valley Steelhead Genetic Evaluation AFRP

Have you previously received funding from CVPIA for other projects not listed above?

No

20. Is this proposal for next-phase funding of an ongoing project funded by an entity other than CALFED or CVPIA?

No

No

Please list suggested reviewers for your proposal. (optional)

21. Comments:

Environmental Compliance Checklist

Distribution and Relationship of Resident and Anadromous Central Valley Rainbow Trout

1. CEQA or NEPA Compliance

a) Will this project require compliance with CEQA?

Yes

b) Will this project require compliance with NEPA?

Yes

c) If neither CEQA or NEPA compliance is required, please explain why compliance is not required for the actions in this proposal.

2. If the project will require CEQA and/or NEPA compliance, identify the lead agency(ies).

If not applicable, put "None".

CEQA Lead Agency: CDFG

NEPA Lead Agency (or co-lead:) None

NEPA Co-Lead Agency (if applicable): None

3. Please check which type of CEQA/NEPA documentation is anticipated.

CEQA

☒Categorical Exemption

-Negative Declaration or Mitigated Negative Declaration

-EIR

-none

NEPA

-Categorical Exclusion

-Environmental Assessment/FONSI

-EIS

☒none

If you anticipate relying on either the Categorical Exemption or Categorical Exclusion for this project, please specifically identify the exemption and/or exclusion that you believe covers this project.

The CDFG believes this study falls within the Class 6 categorical CEQA exemption and that no other CEQA environmental document will need to be prepared. Class 6 exempts activities that consist of “basic data collection, research, experimental management, and resource evaluation activities which do not result in a serious or major disturbance to an environmental resource....” NEPA Categorical Exclusion by definition - category of actions which do not individually or cumulatively have a significant effect on the human environment and which have been found to have no such effect in procedures adopted by a Federal agency [...] and for which, therefore, neither an Environmental Assessment nor an Environmental Impact Statement is required [40 CFR 1508.4].

Steelhead in the Central Valley, California (CVC), are listed as threatened under the Federal Endangered Species Act (ESA). The National Marine Fisheries Service issued a final ESA 4(d) rule on July 10, 2000 that authorized scientific research activities permitted or conducted by the

states. This study will contribute to conservation of the species and NMFS has determined that added protection through federal regulation is not necessary and advisable for the conservation of CVC steelhead. NMFS has determined that the activities permitted or carried out by the states will not jeopardize the species. That is, they will not appreciably reduce the likelihood of survival and recovery of the steelhead in the wild. Because the CDFG is exempt from take prohibitions through the ESA 4(d) rule, we believe that no other action is required pursuant to NEPA.

4. CEQA/NEPA Process

a) Is the CEQA/NEPA process complete?

No

b) If the CEQA/NEPA document has been completed, please list document name(s):
Categorical Exemption.

5. Environmental Permitting and Approvals *(If a permit is not required, leave both Required? and Obtained? check boxes blank.)*

LOCAL PERMITS AND APPROVALS - None required.

Conditional use permit

Variance

Subdivision Map Act

Grading Permit

General Plan Amendment

Specific Plan Approval

Rezone

Williamson Act Contract Cancellation

Other

STATE PERMITS AND APPROVALS - None required.

Scientific Collecting Permit

CESA Compliance: 2081

CESA Compliance: NCCP

1601/03

CWA 401 certification

Coastal Development Permit

Reclamation Board Approval

Notification of DPC or BCDC

Other

FEDERAL PERMITS AND APPROVALS

ESA Compliance Section 7 Consultation

ESA Compliance Section 10 Permit

Rivers and Harbors Act

CWA 404

XOther – ESA Compliance Section 4(d) Rule

PERMISSION TO ACCESS PROPERTY – See comments.

Permission to access city, county or other local agency land.

Agency Name:

Permission to access state land.

Agency Name:

Permission to access federal land.

Agency Name:

Permission to access private land.

Landowner Name:

6. Comments.

In order to perform field collections, access will be from or across public lands. Specific access points need to be determined and documentation of permission, if necessary, will be provided to CALFED within 30 days of notification of approval.

Land Use Checklist

Distribution and Relationship of Resident and Anadromous Central Valley
Rainbow Trout

1. Does the project involve land acquisition, either in fee or through a conservation easement?

No

2. Will the applicant require access across public or private property that the applicant does not own to accomplish the activities in the proposal?

No

3. Do the actions in the proposal involve physical changes in the land use?

No

If you answered no to #3, explain what type of actions are involved in the proposal (i.e., research only, planning only).

Research only.

4. Comments.

Conflict of Interest Checklist

Distribution and Relationship of Resident and Anadromous Central Valley Rainbow Trout

Please list below the full names and organizations of all individuals in the following categories:

- Applicants listed in the proposal who wrote the proposal, will be performing the tasks listed in the proposal or who will benefit financially if the proposal is funded.
- Subcontractors listed in the proposal who will perform some tasks listed in the proposal and will benefit financially if the proposal is funded.
- Individuals not listed in the proposal who helped with proposal development, for example by reviewing drafts, or by providing critical suggestions or ideas contained within the proposal.

The information provided on this form will be used to select appropriate and unbiased reviewers for your proposal.

Applicant(s):

Kathleen Perry, California Department of Fish and Game
George Edwards, CDFG

Subcontractor(s):

Are specific subcontractors identified in this proposal? Yes
If yes, please list the name(s) and organization(s):

Dr. Christian E. Zimmerman U.S.G.S., Alaska Science Center

Helped with proposal development:

Are there persons who helped with proposal development?
Yes

If yes, please list the name(s) and organization(s):

Dennis McEwan, CDFG

Rob Titus, CDFG

Comments:

Budget Summary

Distribution and Relationship of Resident and Anadromous Central Valley Rainbow Trout

Please provide a detailed budget for each year of requested funds, indicating on the form whether the indirect costs are based on the Federal overhead rate, State overhead rate, or are independent of fund source.

-Federal Funds – State Funds - Independent of Fund Source

YEAR 1												
Task No.	Task Description	Direct Labor Hours	Salary (per year)	Benefits (per year)	Travel	Supplies & Expendables	Services or Consultants	Equipment	Other Direct Costs	Total Direct Costs	Indirect Costs	Total Costs
1	Collection of otoliths	440	12,423	2,983						15,406	2,311	17,717
2	Analysis of otoliths						33,534				5,030	38,564
3a	Collect water samples	72	2,033	488						2,521	378	2,899
3b	Analysis of water samples	6	200	48			2,250			2,497	37	2,535
4	Quarterly reports	32	904	217						1,121	168	1,289

YEAR 2												
Task No.	Task Description	Direct Labor Hours	Salary (per year)	Benefits (per year)	Travel	Supplies & Expendables	Services or Consultants	Equipment	Other Direct Costs	Total Direct Costs	Indirect Costs	Total Costs
1	Collection of otoliths	440	12,423	2,983						15,406	2,311	17,717
2	Analysis of otoliths						67,068				10,060	77,128
3a	Collect water samples	72	2,033	488						2,521	378	2,899
3b	Analysis of water samples	6	200	48			2,250			2,497	37	2,535
4	Quarterly reports	32	904	217						1,121	168	1,289

YEAR 3												
Task No.	Task Description	Direct Labor Hours	Salary (per year)	Benefits (per year)	Travel	Supplies & Expendables	Services or Consultants	Equipment	Other Direct Costs	Total Direct Costs	Indirect Costs	Total Costs
2	Analysis of otoliths						33,534				5,030	38,564
4	Quarterly reports	8	226	54						280	42	322
5	Final Report	352	9,938	2,387						12,325	1,849	14,173
Total			41,281	9,914			138,636			55,695	27,800	217,630

Comments.

CDFG cost-share is \$58,888. The Service Contract, for which CALFED funding is requested, is \$154,256 which includes USGS overhead rate of 44% (See budget justification form). The CDFG administrative overhead for this Service Contract is 15%. CALFED funding is also requested for the water chemistry analysis which will total \$4,500.

Budget Justification

Distribution and Relationship of Resident and Anadromous Central Valley Rainbow Trout

Direct Labor Hours. Provide estimated hours proposed for each individual.

Associate Biologist – 1,448 hours.
Senior Environmental Scientist – 12 hours

Salary. Provide estimated rate of compensation proposed for each individual.

Associate Biologist - \$40,881.32 (\$4,969 per month at 176 hours per month).
Senior Environmental Scientist - \$399.14 (\$5,854 per month at 176 hours per month)

Benefits. Provide the overall benefit rate applicable to each category of employee proposed in the project.

Associate Biologist benefits at 24.016% (Tier 1).
Senior Environmental Scientist at 24.016% (Tier 1).

Travel. Provide purpose and estimate costs for all non-local travel.

Travel to and from collection sites is included in direct labor hours and costs.

Supplies & Expendables. Indicate separately the amounts proposed for office, laboratory, computing, and field supplies.

Supplies and expendables are minimal and included in direct labor costs.

Services or Consultants. Identify the specific tasks for which these services would be used. Estimate amount of time required and the hourly or daily rate.

Analysis of otolith microchemistry to be performed by Dr. Christian Zimmerman, USGS.
Preparation of otoliths - \$63 per sample*1,150 samples=\$72,450
Microprobe time - \$450 per day, 25 samples per day=\$20,700 USGS
Indirect Costs at 44% = \$40,986
CDFG Indirect Cost at 15% = \$20,120
TOTAL = \$154,256

Analysis of water chemistry (strontium and calcium) is to be performed by CDFG's Water Pollution Control Lab.

\$125 per sample*36 samples=\$4,500
TOTAL = \$4,500

Indirect costs (e.g. equipment wear and tear) are included in this cost.

Equipment. Identify non-expendable personal property having a useful life of more than one (1) year and an acquisition cost of more than \$5,000 per unit. If fabrication of equipment is proposed, list parts and materials required for each, and show costs separately from the other items.

No acquisition of equipment. Included in Service Contract.

Project Management. Describe the specific costs associated with insuring accomplishment of a specific project, such as inspection of work in progress, validation of costs, report preparation, giving presentations, response to project specific questions and necessary costs directly associated with specific project oversight.

Project management will be overseen by the Senior Biologist Specialist. The time for oversight is expected to be minimal and not included in cost share details. The Associate Biologist is responsible for collection, quarterly reports and final reports. Time is allotted for each of these tasks and cost share details are shown in the budget.

Other Direct Costs. Provide any other direct costs not already covered.

None

Indirect Costs. Explain what is encompassed in the overhead rate (indirect costs). Overhead should include costs associated with general office requirements such as rent, phones, furniture, general office staff, etc., generally distributed by a predetermined percentage (or surcharge) of specific costs.

CDFG overhead costs (15%) cover administrative costs, rent, phones, furniture, and utilities.

Executive Summary

Distribution and relationship of resident and anadromous Central Valley rainbow trout.

Project description: The decline of Central Valley steelhead is well-documented. In 1998 the species was listed as threatened under the Endangered Species Act. Both the CALFED Bay-Delta Program and Central Valley Project Improvement Act (CVPIA) have initiated recovery actions for this species, yet relatively little is known about its life history, particularly the relationship between the anadromous and non-anadromous life history forms. Ecological theory of marginal populations suggests that phenotypic variation may be necessary to maintain population persistence in highly variable environments such as the Central Valley. Recent microchemical analysis of otoliths of adult rainbow trout from the Central Valley provides evidence that the progeny of resident rainbow trout contribute to the population of anadromous rainbow trout and anadromous rainbow trout contribute to the population of resident rainbow trout. In addition, recent microchemical analysis of otoliths of juvenile rainbow trout from the Central Valley provides evidence that resident and anadromous rainbow trout are sympatric. This project will examine the occurrence and distribution of anadromous and non-anadromous rainbow trout populations and the relationship between the life history types.

Geographic location: This project is multi-regional and encompasses the Sacramento Region, San Joaquin Region and Delta Region. Primary sampling locations include the Sacramento River mainstem, Deer Creek, Lower Yuba River, Lower Mokelumne River, Calaveras River and the Lower Tuolumne River.

Project type: Research

Project Objective: Evaluate the distribution and relationship of resident and anadromous life history types of rainbow trout in the Central Valley.

Approach to implement the proposal: A maximum of 250 adult and 900 juvenile rainbow trout otoliths (total of 1,150) from anadromous stream reaches will be subjected to microchemical analysis. Collections will be made by standard methods (beach seine, electrofishing, rotary screw trap, fyke net, hook and line). Life-history of individual fish will be determined by comparing Sr/Ca ratios across a transect of the otolith. Otolith regions are classified as primordia, freshwater growth region and saltwater growth region. The Sr/Ca ratios of the different otolith regions will be compared. The primordia will have a Sr/Ca ratio determined by maternal origin. Individual fish will be determined to be of anadromous maternal origin if the Sr/Ca ratio in the primordia is significantly higher than in the freshwater growth region based on unpaired one-tailed t-test with $\alpha = 0.05$.

Hypothesis and related uncertainties: What is the distribution of resident and anadromous rainbow trout in the Central Valley? Where are resident and anadromous rainbow trout sympatric and allopatric? Do progeny of resident rainbow trout contribute to the adult

population of anadromous rainbow trout and do anadromous rainbow trout contribute to the population of resident rainbow trout in the Central Valley?

Expected outcome: This project will provide valuable information on the distribution, occurrence and relationship of resident and anadromous Central valley rainbow trout. Knowledge of the life history of this species will assist in identifying the most appropriate stock to use as donors for reintroduction of rainbow trout to stream systems where they are thought to be extirpated or where the anadromous form is depleted. The information will also assist in determining which restoration actions are necessary for the recovery of the species.

Relationship to CALFED Ecosystem Restoration Plan (ERP) goals or CVPIA goals: This proposal addresses Strategic Goal 1 of the ERP which is to achieve recovery of at-risk native species and reverse downward population trends. The proposal also addresses Strategic Goal 3 of the ERP that addresses harvestable species. The goal is to maintain and/or enhance populations of selected species for sustainable commercial and recreational harvest. Steelhead are an important sport fish and their recovery is dependent on fully understanding their life history. The knowledge gained from this project will be valuable to the CVPIA Anadromous Fish Restoration Program (AFRP). It will allow a more complete evaluation of ecosystem restoration actions and will assist in determining what future actions may be effective in efforts to double the production of steelhead.

Summary of significant revisions: The proposal has been expanded in scope both in terms of the hypothesis and the design. In addition to the analysis of adult rainbow trout otoliths, we will analyze juvenile rainbow trout to evaluate the freshwater ecology of sympatric resident and anadromous rainbow trout. We have revised the Work Schedule to reflect the increased time for the collection phase, analysis of an increased number of otoliths, analysis of water samples, and additional reporting. Collections will occur over two years in order to obtain sufficient numbers of adult and juvenile rainbow trout. The maximum number of samples has been increased from 600 to 1,150. We have provided more detail on the sampling design, such as the selection of sampling locations and specific numbers of samples per location. Information showing that the method has been validated in Oregon and California has been incorporated into the proposal. In addition, we have proposed conducting water chemistry analysis for each sampling location to ensure that water chemistry does not interfere with the identification of maternal origin based on Sr/Ca ratios. The budget has been revised to reflect the expanded scope of the study and the costs associated with each task. We have provided information on the coordination of this study with other proponents of proposals 15 (CDFG) and 123 (S.P. Cramer and Associates, Inc.). Further, we have contacted interested parties including other agencies, fishing groups, consultants and steelhead researchers to enlist their support and to coordinate sampling with them. We plan to provide periodic updates on this study for interested parties at through a variety of channels, such as meetings, workshops, and by news release.

Proposal

California Department of Fish and Game

Distribution and relationship of resident and anadromous
Central Valley rainbow trout.

Kathleen Perry, California Department of Fish and Game
George Edwards, CDFG

A. PROJECT DESCRIPTION

1. Problem - The substantial decline of Central Valley steelhead, due primarily to loss of spawning and rearing habitat, is well-documented (McEwan and Jackson 1996; McEwan 2001; Busby et al. 1996; CALFED 2000). This decline prompted the National Marine Fisheries Service (NMFS) to list Central Valley steelhead under the Endangered Species Act (ESA) in 1998. Despite the listing and the fact that steelhead are a popular game fish, relatively little is known about their biology, status, and life-history (Interagency Ecological Program (IEP) Steelhead Project Work Team 1999; Comprehensive Monitoring, Assessment and Research Program (CMARP) Steering Committee 1999; McEwan 2001). This lack of information has hampered our ability to manage and recover this species.

In response to the decline of steelhead and other Central Valley aquatic species, considerable planning efforts have begun recently to bring about recovery of anadromous fishes and other elements of Central Valley aquatic ecosystems. The two most notable planning efforts are the Central Valley Project Improvement Act (CVPIA) and the CALFED Bay-Delta program. Both of these programs have outlined recovery measures for steelhead on a basin-wide level. What has been lacking in the outlined recovery measures and current monitoring and research programs is a comprehensive baseline analysis of Central Valley steelhead genetics and population structure. In response to this, the California Department of Fish and Game (CDFG) submitted a proposal to CALFED and CVPIA Anadromous Fish Restoration Program (AFRP) in 1999 for a comprehensive Central Valley Steelhead Genetic Evaluation. The primary purpose of this study is to elucidate the genetic profile of native Central Valley rainbow trout¹ and to compare with other rainbow trout stocks both within and outside the Central Valley. The proposal was accepted for funding as is currently underway.

The goal of this project is to examine the occurrence and distribution of anadromous and non-anadromous rainbow trout. It is designed to complement the previously funded Central Valley Steelhead Genetic Evaluation. We propose to use otolith microchemistry to identify progeny of anadromous (steelhead) and non-anadromous (resident) rainbow trout in streams throughout the Central Valley as described by Zimmerman and Reeves (2000; 2002). Otolith microchemistry can be used to identify maternal origin (resident vs. anadromous) based on examination of the ratio of strontium (Sr) to calcium (Ca) within the otolith. Strontium, an element with binding characteristics similar to calcium, is substituted for calcium in the calcium carbonate matrix of the otolith at levels relative to the ratio of Sr/Ca in the environment (Kalish 1990). Since the ratio of Sr/Ca is generally greater in seawater compared to freshwater, analysis of Sr/Ca ratios across the otolith of a fish can describe the migrational history of that fish (Kalish 1990). Further, comparison of Sr/Ca ratios in the primordia and freshwater growth region can be used to determine maternal origin (resident or anadromous) based on the assumption that primordia composition reflects the environment in which yolk precursors develop (in the ocean

¹ In this proposal, the term 'rainbow trout' refers to the biological species *O. mykiss* regardless of life-history or migratory behavior. The term 'non-anadromous' is used to refer collectively to all life-history types other than anadromous.

for anadromous forms) (Kalish 1990; Volk et al. 2000; Zimmerman and Reeves 2002). This ability provides a powerful tool for studying the freshwater ecology of sympatric resident and anadromous salmonids. Zimmerman and Reeves (2002) conducted breeding and rearing experiments to validate this method for steelhead and resident rainbow trout and found that Sr/Ca ratios were significantly higher in primordia of steelhead progeny than in progeny of resident rainbow trout with no overlap in the distribution of Sr/Ca ratios between steelhead and resident rainbow trout reared under laboratory conditions.

Zimmerman and Reeves (2000) examined the population structure of steelhead and resident rainbow trout populations in the Deschutes River, Oregon through the analysis of the timing and location of spawning and analysis of maternal origin determined with otolith microchemistry. An additional group of steelhead and resident rainbow trout from the Babine River, British Columbia were included in the otolith analysis. Zimmerman and Reeves (2000) tested the hypothesis that adult steelhead and resident rainbow trout were reproductively isolated by examining the proportion of steelhead and resident rainbow trout progeny in the adult populations of steelhead and resident rainbow trout. They argued that if the two populations were not reproductively isolated, the life history variation was a result of phenotypic polymorphism and progeny of steelhead would be found in the adult population of resident rainbow trout and progeny of resident rainbow trout in the adult population of steelhead. In the Deschutes River, populations of steelhead and resident rainbow trout appear to be reproductively isolated based on the timing and location of spawning and the apparent inheritance of life history. Neither steelhead adults of resident rainbow trout maternal origin nor resident rainbow trout adults of steelhead maternal origin were identified based on the otolith analyses. On the other hand, steelhead of resident rainbow trout maternal origin and adult resident rainbow trout of steelhead maternal origin were identified in the Babine River, suggesting that life history type, at that location, is to some degree a result of phenotypic variation.

In the Central Valley there is limited evidence that rainbow trout are polymorphic. In March 2000 three adult rainbow trout from the Calaveras River were found with spent gonads indicating they had recently spawned. The three trout included a female (64 cm FL) and two males (39.5 and 44.5 cm FL). Analysis of Sr/Ca ratios in otoliths extracted from these three fish found that the female was a steelhead and was the progeny of a steelhead female; one was a non-anadromous male (but whose scale-circuli showed accelerated growth that may be indicative of having undertaken an estuarine migration) that was the progeny of a steelhead female; and one was a non-anadromous male that was the progeny of a non-anadromous female (Titus 2000). In addition, analysis of otoliths from rainbow trout smolts captured from Dry Creek (Placer County) show that progeny of both steelhead and resident rainbow trout are sympatric. Of the 11 smolts analyzed, there was evidence of two being progeny of a steelhead female, while the other nine appeared to be progeny of resident females (Rob Titus, DFG, pers. comm.). As with the Dry Creek data, juvenile otoliths analyzed from rainbow trout captured in Clear Creek (n=9), Stanislaus River (n=7), and the Upper Sacramento River (n=4) show evidence of both resident and steelhead maternal heritage (Rob Titus, DFG, pers. comm.). The collection of smolts indicates that they have the potential for anadromy. However, in order to determine whether or not the population is polymorphic or whether it exhibits reproductive isolation, analysis of adult otoliths is necessary.

This basin-wide project will examine the occurrence of the progeny of anadromous and non-anadromous rainbow trout throughout the Central Valley. In many streams of the Central Valley, the occurrence of anadromous rainbow trout has not been documented in recent years, but reports from anglers and others suggest that they are present. Identifying the distribution of anadromous and non-anadromous rainbow trout is an important metric needed for the management and restoration of rainbow trout populations. The relationship between non-anadromous and anadromous rainbow trout is uncertain, yet may play an important role in the persistence of both life history forms.

Combined with the genetics study and other efforts to examine age and life history of rainbow trout, this study will provide valuable and timely information concerning rainbow trout in the Central Valley. This information will assist biologists, managers and decision-makers in the protection, recovery and management of Central Valley rainbow trout. The information is necessary for restoration planning for the AFRP and CALFED programs and ESA recovery efforts.

Hypothesis/Question: What is the distribution of resident and anadromous rainbow trout in the Central Valley? Where are resident and anadromous rainbow trout sympatric and allopatric? Do progeny of resident rainbow trout contribute to the adult population of anadromous rainbow trout in the Central Valley and vice versa?

2. Justification (including conceptual model, hypotheses and selection of project type) -

Little is known about the distribution of steelhead and resident rainbow trout or about the relation of the two life history forms within the Central Valley. The presence of both steelhead and resident rainbow trout in a river system may play an important role in the persistence of rainbow trout in that system. Segregation into resident and migratory life history morphs can act as a buffer against extinction in species inhabiting unstable environments. A species that covers a wide range of aquatic environments by partitioning into resident and migratory forms may be in a better position for long-term survival where conditions are dynamic and unpredictable (Northcote 1992). Life history variation may, therefore, provide an important mechanism for preserving small populations of salmonids in marginal habitats.

In rainbow trout populations, it is probable that the presence of both resident and migratory components of a population serves to spread the risk of extinction. If unpredictable environmental conditions lead to high mortality or complete loss of one component of the population, maintenance of the species in that location is ensured by the other component. For example, drought conditions could lead to extirpation of resident fish within a watershed. The anadromous component of that population is not affected by the same environmental conditions in the ocean. Thus, the species is not completely extirpated from the stream. Nielsen et al. (1997) suggest that southern California streams that are no longer connected to the ocean due to water withdrawal may serve as refugia for residual rainbow trout that have recent anadromous lineage but are now nonanadromous. Restoration of steelhead is expected from these populations with improvements to the freshwater habitat and reconnection to the sea. Where steelhead and resident rainbow trout are reproductively isolated, such as in the Deschutes River,

restoration of steelhead from resident populations is not as likely. Conservation and restoration of steelhead and resident rainbow trout is critically tied to the relation between life history forms. Recognition of this relationship and further investigation is needed if we are to maintain the range of life history found in Central Valley rainbow trout.

The conceptual model for this study is based on limited scientific data from sympatric steelhead and resident rainbow trout that occur in the Central Valley (i.e., Calaveras River, Dry Creek, Clear Creek, Stanislaus River, and Upper Sacramento River). It recognizes the phenotypic plasticity of rainbow trout; life history of individuals may vary stream by stream and, therefore, the conceptual model may also vary stream by stream. The project is designed to answer the following questions, “What is the distribution of resident and anadromous rainbow trout in the Central Valley? Where are resident and anadromous rainbow trout sympatric and allopatric? Do progeny of resident rainbow trout contribute to the adult population of anadromous rainbow trout and do anadromous rainbow trout contribute to the population of resident rainbow trout in the Central Valley?”

The method we will use to answer these questions is the analysis of the otolith microchemistry of rainbow trout collected at key sampling locations throughout the Central Valley. This is the best available technique to discriminate the progeny of sympatric anadromous and non-anadromous Central Valley rainbow trout and it has been used successfully in California, Oregon and British Columbia (Zimmerman 1999, 2000, 2002; Zimmerman and Reeves 2000).

This proposal is considered “Targeted Research” (as shown in Figure 2 of the Draft Stage 1 Implementation Plan). The information we obtain from this research will allow us to develop an accurate population model for Central Valley steelhead. Knowledge of the life history of this at-risk species is necessary to improve its management and to determine which restoration actions will benefit the species.

3. Approach - This project is multi-regional and encompasses the Sacramento Region, San Joaquin Region and Delta Region as defined by the Ecosystem Restoration Plan (ERP) geographic scope. Otoliths will be collected from a maximum of 250 adult rainbow trout and 900 juvenile rainbow trout from anadromous stream reaches and subjected to microchemical analysis. Otoliths will be obtained first from CDFG archives and from incidental mortalities and lastly from sacrificed adults. Gravid adults will not be sacrificed for otoliths. Actual number of otoliths analyzed will depend upon availability.

Primary sampling locations include the Sacramento River mainstem, Deer Creek, Lower Yuba River, Lower Mokelumne River, Calaveras River and the Lower Tuolumne River. Alternate sampling locations include Mill Creek, Feather River, Lower Stanislaus River, Battle Creek, Lower Clear Creek and Cosumnes River. These locations were selected to complement the existing Central Valley Steelhead Genetics Evaluation and completed genetics studies (Table 1). A maximum of 250 adult rainbow trout otoliths will be sampled from six locations over two seasons (i.e., 20/location/season). Sampling of adults will generally occur opportunistically (e.g., incidental mortalities), therefore, this number represents what can realistically be collected.

Table 1. Proposed sample locations for both the Central Valley Steelhead Genetic Evaluation (in progress) and the proposed otolith microchemistry study.

Primary Sample Location	Tissue	Otolith	Comments
1. Sacramento River mainstem below ^a Keswick Dam	✓	✓	Collection will focus on ‘river trout’ to determine if they are differ genetically from steelhead and are reproductively segregated
2. Cottonwood Creek	✓		Self-sustaining stocks in headwaters within steelhead historical range
3. Mill Creek	✓	X	These streams represent one of the last remaining intact and accessible small stream systems in the Sacramento River system, and have healthy, self-sustaining populations, hence are good candidates to examine population structure of relatively unimpacted populations
4. Deer Creek, downstream of lower falls. ^a	✓	✓	
5. Stony Creek	✓		Self-sustaining stocks in headwaters within steelhead historical range
6. Putah Creek	✓		Self-sustaining stocks above Lake Berryessa
7. Feather River	✓	X	low flow channel
8. Feather River Hatchery	✓		
9. Lower Yuba River	✓	✓	below Englebright Dam
10. Upper Yuba River	✓		between Englebright and New Bullards Bar dams.
11. Lower American River	✓		below Nimbus Dam
12. M.F. American River	✓		below Rubicon River confluence
13. Nimbus Fish Hatchery	✓		
14. Lower Mokelumne River		✓	below Camanche Dam (otolith only rainbow trout tissues have been analyzed)
15. Calaveras River	✓	✓	below New Hogan Dam
16 Lower Stanislaus River	✓	X	below Goodwin Dam
17 Upper Stanislaus River	✓		below Beardsley Dam
18. Lower Tuolumne River	✓	✓	below La Grange Dam

^a Tissue collection and analysis may not be necessary pending outcome of the U.S Fish and Wildlife Service genetic evaluation for upper Sacramento River steelhead and resident rainbow trout. If re-analysis is necessary, then genetic material from these locations will be obtained from the DFG tissue archive.

Primary Sample Location	Tissue	Otolith	Comments
19. Upper Tuolumne River	✓		between New Don Pedro Reservoir and Yosemite National Park Boundary
20. Kings River	✓		Self-sustaining stocks in headwaters within steelhead historical range
Alternate Sampling Locations			
1. McCloud River	✓		Self-sustaining stocks in headwaters within steelhead historical range
2. Pit River	✓		Self-sustaining stocks in headwaters within steelhead historical range
3. Battle Creek	✓	X	Self-sustaining stocks above CNFH and within steelhead historical range
4. Coleman National Fish Hatchery (CNFH) ^a	✓		
5. Antelope Creek	✓		below confluence of north and south forks
6. Lower Clear Creek ^a	✓	X	Below Whiskeytown Dam
7. Upper Clear Creek ^a	✓		tributaries above Whiskeytown Reservoir
8. Thomes Creek	✓		Self-sustaining stocks in headwaters within steelhead historical range
9. Cache Creek system	✓		Below Clear Lake
10. Putah Creek	✓		Between Monticello and Putah Div. dams
11. Cosumnes River	✓	X	
12. Upper Mokelumne River	✓		between Pardee Reservoir and Electra Powerhouse
13. Lower Merced River	✓		Below Crocker Diversion Dam
14. Upper Merced River	✓		Self-sustaining stocks in Merced or N.F. Merced within steelhead historical range
15. Upper San Joaquin River	✓		between Millerton Lake and Kerckhoff Dam
X = alternate otolith collection site			

A maximum of 900 juvenile otoliths will be sampled at six locations over two seasons (i.e., 75/location/season). However, in order to determine proportional differences between the life-history forms a minimum sample size of 150 is necessary (C. Zimmerman, USGS, pers. comm.). To maintain flexibility in the sampling design and to take advantage of larger sample sizes when and if available, we may obtain all 150 samples at a particular location in one season.

Collections will be made by standard methods (beach seine, electrofishing, rotary screw trap, fyke net, hook and line). Specific sampling site data includes stream, latitude and longitude of sampling site, collection method, time, air and water temperature, and general site description. Data recorded for individual fish includes fork length, life stage, sex, maturity code, adipose fin clip, tissues taken, field preservation method, and photo.

CDFG will be assisted in these collections by other agencies, fishing groups, consultants and steelhead researchers (see also sections B 2 and C). We have already approached these groups for their assistance and all of them have indicated their interest in this study and have agreed to cooperate. In terms of public outreach, we will continue to work with these groups and provide them with periodic updates on the progress of this study through presentations, news releases or informal contact.

Life-history of individual fish will be determined by comparing Sr/Ca ratios across a transect of the otolith. Otolith regions are classified as primordia, freshwater growth region and saltwater growth region. The Sr/Ca ratios of the different otolith regions will be compared. The primordia will have a Sr/Ca ratio determined by maternal origin. Otolith preparation and microchemical analysis will follow Zimmerman and Reeves (2000). Individual fish will be determined to be of anadromous maternal origin if the Sr/Ca ratio in the primordia is significantly higher than in the freshwater growth region based on unpaired one-tailed t-test with $\alpha = 0.05$. For detailed information on data analysis see Zimmerman and Reeves (2000; 2002).

Identification of maternal origin based on Sr/Ca ratios can be confounded by high Sr/Ca ratios in freshwaters. For example, Rieman et al. (1994) cautioned that the utility of otolith microchemistry is highly dependent on the variation in chemistry of freshwaters. As a result, Rieman et al. (1994) suggested the analysis of water chemistry in future application of otolith microchemistry. We have revised this study to include chemical analyses (Ca and Sr) of water for all sampling locations. Water samples from each location will be collected three times throughout each year (July, November, and March) for two years for a total of 36 samples.

The CDFG's Water Pollution Control Lab will analyze Sr using Graphite Atomic Absorption Spectrophotometry (AAS) and Ca by Flame or Graphite AAS. Previous analyses of Sr/Ca ratios in the freshwater growth regions of rainbow trout from throughout the Central Valley suggest that freshwater values of Ca and Sr will not limit the utility of this method (Zimmerman, unpublished data). Mean Sr/Ca ratios in the freshwater growth region of 26 rainbow trout otoliths from the Central Valley ranged from 0.0006 to 0.0014, values much lower than that typically found in the saltwater growth regions of steelhead (0.019 to 0.0025). These data in combination with the proposed water chemistry analysis will address any concerns regarding validation of the method.

4. Feasibility - The approach is both feasible and appropriate. The analysis of otolith microchemistry patterns when used in conjunction with genetic analysis can provide much needed information on the genetic and ecological relationship between non-anadromous and anadromous rainbow trout. Recent analysis of rainbow trout otoliths collected from the Central

Valley indicates that this approach is capable of describing the life history of the individual fish and its maternal origin.

The project can be completed in the time allotted (See Work Schedule). We have revised the Work Schedule to accommodate the expanded study which now includes juvenile rainbow trout collections and water chemistry analysis. Adult migration occurs during most months of the year, but peaks between September and March. Spawning occurs from December through April. Juveniles emigrate from December through August, but peak emigration occurs between January and June. Collections are scheduled to coincide with migration, spawning, and emigration time periods. We have allotted sufficient time for preparation of otoliths, scheduling and use of equipment and data analysis and do not anticipate any delays in completing this part of the study. We have allotted sufficient time for the preparation of a final report.

The collection of specimens is permitted through the Endangered Species Act 4(d) Rule that authorizes the CDFG and its designees to conduct monitoring and research activities for steelhead and spring-run Chinook salmon in the Central Valley. No additional incidental take permits or environmental documents will be required for this study.

5. Performance Measures - Project performance will be evaluated regularly through the submittal of quarterly reports. These reports will describe the activities performed during the quarter and will update progress towards the goal. In addition, presentations at formal or informal meetings or workshops will be considered upon request. The final report will describe the results of the study. The information gained from this study will improve our knowledge of the life history of Central Valley rainbow trout and our results for each of the rivers considered will be useful to researchers and decision-makers (e.g., flow release from reservoirs to maintain appropriate over-summer habitat conditions for Central Valley steelhead). We also intend to pursue publication of the study results in a peer reviewed journal.

6. Data Handling and Storage - Data on fish will be entered, stored, and managed in a database (e.g., Microsoft Access). Data on otolith microchemistry will be managed in spreadsheet format.

7. Expected Products/Outcomes - The following products will be prepared under this proposal and eventual contract:

- ▶ Collection Schedule - year 1 and 2
- ▶ Quarterly Reports - year 1, 2 and 3
- ▶ Final Report - year 3
- ▶ Project Presentations (e.g., CALFED conferences or workshops, upon request)
- ▶ Peer reviewed publication (e.g., Trans. Am. Fish. Soc., Calif. Dept. Fish Game, Fish Bull.)

8. Work Schedule - The work schedule for the proposed research is shown in Table 2.

Table 2. Work Schedule

Task	Start	Completion
1. Collection of otoliths	July 2003	July 2005
2. Analysis of otolith microchemistry	January 2004	October 2005
3. Collection & analysis of water samples	July 2003	March 2005
4. Prepare quarterly reports	October 2003 through	October 2005
5. Final Report		December 2005

B. APPLICABILITY TO CALFED ERP AND SCIENCE PROGRAM AND IMPLEMENTATION PLAN AND CVPIA PRIORITIES

1. ERP, Science Program and CVPIA Priorities.

ERP - This proposal addresses Strategic Goal 1 of the Ecosystem Restoration Program, At-Risk Species - to achieve recovery of at-risk native species and reverse downward population trends. In order to achieve the goal of recovery of Central Valley steelhead we need to first understand the life history of the species. Priorities for restoration of this at-risk species are found in draft Stage 1 PSP priorities of the ERP. For the multi-regional Bay-Delta areas this proposal addresses priority MR-6, "Ensure recovery of at-risk species by developing conceptual understanding and models that cross multiple regions." Central Valley steelhead migrate through and use multiple regions within the Central Valley. Successful management, protection, and restoration requires knowledge of their life history and the relationship between non-anadromous and anadromous life history forms. Similarly, the proposal addresses priority SR-7 (Sacramento Region), "Develop conceptual models to support restoration of river, stream and riparian habitat." This priority encompasses the need to understand and compare steelhead life histories, needs of the species and responses to restoration. As described in the draft Stage 1 PSP priorities, the CALFED Science Conference summary noted that there are differences between Chinook salmon and steelhead life histories and environmental requirements. These differences need to be examined to fully understand their causes and the implications. This proposal also addresses priority SJ-4 (San Joaquin Region) which states that a priority focus for the life history studies should be to build knowledge of the status and needs of steelhead in the San Joaquin Region.

The proposal also addresses Strategic Goal 3 of the Ecosystem Restoration Program - Harvestable Species - maintain and/or enhance populations of selected species for sustainable commercial and recreational harvest. Steelhead are an important sport fish, however, due to the declining population the sport fishing regulations currently allow the retention of hatchery steelhead only. Beginning with brood year 1997, all hatchery steelhead have been adipose fin-clipped. The information from this study will be used to assist in restoration of the species.

Recovery of the species will provide a valuable public resource and may eventually lead to harvest of both hatchery and naturally spawned steelhead (i.e., progeny of hatchery fish that spawn in river and wild fish that spawn in river).

This project will also result in progress towards meeting the research milestones identified in the ERP-Multi Species Conservation Strategy. Specifically, it will provide necessary information to assess the population structure of Central Valley steelhead and identify suitable donor stock for reintroduction or rebuilding of depleted populations.

Science Program - The goal of CALFED's Science Program is "to progressively build a body of knowledge that will continually improve the effectiveness of restoration actions." One of the priorities of the Science Program is to "build population models for at-risk species." To accomplish this requires knowledge of life history, environmental requirements and biology of at-risk species, and ultimately developing a population model. This project directly addresses this priority. The Science Program includes implementation of the Comprehensive Monitoring, Assessment and Research Program (CMARP). CMARP identifies six major knowledge gaps that "require either new monitoring and assessment programs or enhancements to ongoing anadromous fish monitoring programs". One of these gaps concerns the genetic and population structure of Central Valley steelhead. This proposal in conjunction with the currently funded Central Valley Steelhead Genetics Evaluation addresses this knowledge gap.

CVPIA - The goal of the Central Valley Project Improvement Act's (CVPIA) Anadromous Fish Restoration Plan (AFRP) is to develop and implement a program to double the natural production of Central Valley steelhead. The knowledge gained from this study of the life history and population structure of steelhead will be valuable to the AFRP. It will allow a more complete evaluation of ecosystem restoration actions and will assist in determining what future actions may be effective in efforts to double the production of steelhead. AFRP has provided partial funding for the Central Valley Steelhead Genetics Evaluation. These funds are allocated to a Service Contract with the geneticist performing the analyses.

2. Relationship to Other Ecosystem Restoration Projects.

This proposal is independent, with its own goals and objectives, but it is closely related to the Central Valley Steelhead Genetic Evaluation. It is also closely related to the CALFED funded study (FY98) by the U.S. Fish and Wildlife Service titled, "Genetic comparison of stocks considered for re-establishing steelhead, *Oncorhynchus mykiss*, in Clear Creek, a tributary to the Upper Sacramento River."

This proposal is also related to previously funded studies on the life history of Central Valley steelhead (e.g., Yuba County Water Agency's "Life History and Stock Composition of Steelhead Trout" in the Yuba River).

We have coordinated the collection phase of this revised and expanded proposal with the proponents of Proposals 15 (CDFG) and 123 (S. P. Cramer and Associates, Inc.). Collections of juvenile rainbow trout samples are now proposed and these collections can be coordinated with

other entities involved in juvenile outmigrant trapping. This coordination will reduce the likelihood of duplication of effort and will reduce the impact to the species. Specifically, we will obtain juvenile rainbow trout incidental mortalities from the rotary screw trap monitoring on the lower Yuba River approximately 6 river miles east of Marysville (Proposal 15, Task 2). We will obtain juvenile rainbow trout from the existing Calaveras River monitoring conducted by S. P. Cramer and Associates, Inc., under contract to Stockton East Water District (Doug Demko, pers. comm.). Collections of both adult and juvenile rainbow trout may be obtained from the Stanislaus River (an alternate sampling site) at several sites. Adult rainbow trout incidental mortalities may be obtained from the Stanislaus River Weir Project funded by the Anadromous Fish Restoration Program (Doug Demko, pers. comm.). We may also obtain incidental mortalities of juvenile rainbow trout from the lower Stanislaus River rotary screw trapping at Oakdale and Caswell. The sampling at both locations is being conducted by S. P. Cramer and Associates, Inc., under contract with Tri Dam, South San Joaquin Irrigation District, and Oakdale Water District (Oakdale site) and the U.S. Fish and Wildlife Service (Caswell site). Field sampling protocols for collection of rainbow trout for this study will include the collection of scale samples. Scale samples will be archived for later scale analysis by CDFG or by S. P. Cramer and Associates, Inc, for their proposal (Proposal 123). In addition, field sampling protocols will be available to scientific collectors that are permitted through the State's Scientific Collecting Permit authority. CDFG has directed all researchers permitted under the Department's 4(d) Rule limit to collect and retain all steelhead carcasses that they find or kill incidentally and to provide them to us. This will be another source of rainbow trout otolith samples for this study.

Several Central Valley watershed conservancies have received CALFED funds to develop watershed management plans that will benefit from the information obtained in this study. Past and future restoration actions involving barrier modification and removal projects within the Central Valley, such as the U.S. Fish and Wildlife Service's improvements to the upstream ladder and barrier weir at Coleman National Fish Hatchery on Battle Creek, will help to restore naturally spawning steelhead runs to tributaries of the Central Valley. This study will provide important population structure information for all restoration projects.

3. Requests for Next-Phase Funding.

The Central Valley Steelhead Genetic Evaluation is a previously funded project (FY 1999). It is funded by both CALFED and CVPIA AFRP. It is currently underway and will be completed by the end of December 2002. The final study plan, developed as Task 1 of the genetics study, included an additional objective of analyzing population structure using otolith microchemistry. This proposal addresses this objective and is expected to enhance the genetics study and provide a more comprehensive evaluation of genetic and population structure of Central Valley steelhead. This project should be considered as "next-phase" funding. A brief description of the project and its current status is summarized in Attachment 1.

4. Previous Recipients of CALFED Program or CVPIA funding.

As described above, the CDFG is the recipient of previous funding from CALFED (Project #99-N12) and CVPIA (Cooperative/Grant Agreement #11332-9-J027) for the Central Valley Steelhead Genetic Evaluation (See Attachment 1).

5. System-Wide Ecosystem Benefits.

The information obtained from this project and the Central Valley Steelhead Genetic Evaluation will assist in identifying the most appropriate stock to use as donors for reintroduction of rainbow trout to stream systems where they are thought to be extirpated or where the anadromous form is depleted. The information will also assist in determining which restoration actions are necessary for the recovery of the species. For example, analysis of anadromous rainbow trout downstream of barriers and of non-anadromous rainbow trout upstream of barriers will assist in prioritizing which barriers are considered for removal as part of the "Fish Migration Barrier Removal Evaluations" in the "Integrated Storage Investigation".

Individual watershed restoration/management plans will be guided by the information gained from this project. In some cases, existing habitat restoration plans do not include actions to protect, maintain or enhance the existing steelhead population due to limited information on their status in a particular watershed (e.g., Habitat Restoration Plan for the Lower Tuolumne River Corridor 2000). In other cases, habitat restoration plans include actions to protect salmon and steelhead, but will benefit from the information obtained on the genetic and population structure of steelhead in that watershed (e.g., Deer Creek Watershed Conservancy's Watershed Management Plan). Some restoration actions have already occurred (e.g., removal of McCormick-Seltzer Dam on Clear Creek), yet information on the status of steelhead populations within the watershed is limited. This project will provide useful information in further restoration planning.

The Environmental Water Account was established to provide water for the protection and recovery of fish beyond water available through existing regulatory actions related to project operations. Decisions regarding the acquisition, banking, transfer and conveyance of water will benefit from increased understanding of the distribution and relationship of life history types of steelhead in Central Valley watersheds.

6. Additional Information for Proposals Containing Land Acquisition.

Not applicable.

C. QUALIFICATIONS

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Ms. Kathleen Perry obtained a B.Sc. (Honors Ecology) from University of Manitoba, Canada, and a M. Sc. (Biology) from California State University San Diego. She has 12 years of experience with the Department of Fish and Game, including 10 years of experience with native anadromous fish of the Central Valley. Her responsibilities as the Statewide Steelhead Coordinator include program support, development, planning, implementation, and oversight for recovery of federally-listed steelhead populations throughout California. Ms. Perry provides technical and policy guidance to various planning processes currently underway, such as CALFED, the Central Valley Project Improvement Act, NMFS Biological Opinions, and ESA Section 7 and 10 consultations and negotiations. Ms. Perry is the project lead for the Central Valley Steelhead Genetic Evaluation.

Ms. Perry will be oversee all aspects of this study: project management, collection protocols, identification of target populations, preparing and managing contracts, communicating with contractors, ensuring that timelines are met, data analysis and interpretation, and preparation of the quarterly and final reports.

Co-Investigator:

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Mr. Edwards has his B.Sc. and M.Sc. from the University of Mississippi. He has 11 years of experience with CDFG. Since February 2002, Mr. Edwards has been working with the Native Anadromous Fish and Watershed Branch, on the Central Valley Steelhead Project. Mr. Edwards will be responsible for the collection of samples, transmittal of samples to the contract lab, and preparing the quarterly and final reports. He will ensure that collections are coordinated with other agencies, fishing groups, and consultants.

Collaborator/Subcontractor:

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Dr. Zimmerman is a research fishery biologist at the Alaska Science Center of the U.S. Geological Survey. Dr. Zimmerman obtained his Ph.D. and M.S. in Fisheries Science from Oregon State University. His doctoral dissertation was titled, “Ecological relation of sympatric steelhead and resident rainbow trout in the Deschutes River, Oregon.” His Master’s thesis was titled, “Population structure of coastal cutthroat trout (*Oncorhynchus clarki clarki*) in the Muck Creek basin, Washington.” Dr. Zimmerman obtained his B.S. in Fisheries from Humboldt State University.

Dr. Zimmerman has extensive experience in fisheries science. He specializes in population biology of salmonids. Dr. Zimmerman’s previous research includes: detailed studies on the relationship of resident rainbow trout and steelhead (Zimmerman 2000; Zimmerman and Reeves 2000; 2002). These studies included analysis of the timing and location of spawning, identification of maternal origin based on otolith microchemistry, laboratory experiments of behavior in juvenile *O. mykiss*, diel variation in habitat use by juvenile *O. mykiss*, and determination of timing of emergence by steelhead and resident rainbow trout. Dr. Zimmerman has also conducted analyses of migration in sockeye salmon returning to the Deschutes River (Zimmerman and Ratliff 1998) and is working on a study of migration and precocial maturation in hatchery produced chinook salmon in the Umatilla River, Oregon (Zimmerman et al. in prep.). Dr. Zimmerman examined the genetic population structure of coastal cutthroat trout in the Muck Creek basin on the Fort Lewis Army base in Washington State (Zimmerman 1996; Zimmerman et al. 1997). Dr. Zimmerman has collaborated with the California Department of Fish and Game on otolith studies of steelhead and resident rainbow trout since 1998 (Zimmerman 1999; Titus et al. in prep). In addition, Dr. Zimmerman has conducted forensic analyses of steelhead for the Law Enforcement Division of the National Marine Fisheries Service in central and southern California. Dr. Zimmerman has conducted studies to improve the precision and accuracy of microelemental analysis using wave-dispersive spectroscopy, the method used to determine strontium and calcium concentration in otoliths (Zimmerman and Nielsen in prep). Dr. Zimmerman’s international activities include description of migration in steelhead and rainbow trout in Kamchatka and in native fishes of New Zealand. Dr. Zimmerman is chair of the Scientific and Technical Committee to the Arctic/Yukon/Kuskokwim Sustainable Salmon Initiative, a committee responsible for research planning and implementation of a 5-year salmon research effort in western Alaska.

D. COST

1. Budget. The total budget has been revised to reflect the expanded scope of this study and is shown in Table 3. CALFED funds are needed for a Service Contract with Dr. Christian Zimmerman to conduct the otolith microchemistry analysis (Task 2) and for CDFG’s analysis of

water chemistry (Task 3(b)). The budget for the water chemistry analysis and the Service Contract are shown in Tables 4 and 5, respectively.

2. Cost-Sharing. CDFG will provide cost share funds for the collection of otoliths (Task 1), collection of water samples and staff time for analysis of water samples (Task 3 (a)), the preparation of Quarterly reports and the Final Report (Task 4 and 5). The budget for the cost-share is shown in Table 3.

E. LOCAL INVOLVEMENT

Organizations and agencies that are aware of this proposal and have shown an interest include: the National Marine Fisheries Service, the U.S. Fish and Wildlife Service, Department of Water Resources (Environmental Services Office), Jones and Stokes Associates, S. P. Cramer and Associates, Inc., and several fishing groups or professional fishing guides. There has been no opposition to this project. No third party impacts are anticipated.

F. COMPLIANCE WITH STANDARD TERMS AND CONDITIONS

The Department of Fish and Game will comply with the standard State and Federal contract terms described in Attachments D and E.

Table 3. Total budget for the proposal, “Distribution and Relationship of Resident and Anadromous Central Valley Rainbow Trout.”

Task	Direct Labor Hours	Direct Labor Salary and Benefits	Service Contracts	Overhead and Indirect Costs (@15%)	Total Cost
1. Collection of otoliths ¹	(1) Assoc. Biol. (5 pm ²)	\$30,812		\$4,622	\$35,434
2. Analysis of otoliths ³			\$134,136	\$20,120	\$154,256
3. (a) Collection & Lab Time for Water Samples ¹	(1) Assoc. Biol. (.8 pm ²)	\$5,042		\$756	\$5,798
	(1) Sr. Env. Sci. (.07 pm ²)	\$495		\$74	\$569
(b) Analysis of Water Samples ³			\$4,500 ⁴		\$4,500
4. Quarterly Reports ¹	(1) Assoc. Biol (.41 pm ²)	\$2,526		\$379	\$2,905
5. Final Report ¹	(1) Assoc. Biol. (2 pm ²)	\$12,325		\$1,849	\$14,174
Total Cost					\$217,636
CDFG Cost-Share					\$58,880
CALFED Cost-Share					\$158,756

1 Funds for this item will be provided by CDFG as a cost-share for the project.

2 Personnel-month

3 Funds for this item will be provided by CALFED

4 Amount includes indirect costs (i.e., equipment wear and tear)

Table 4. Budget for water chemistry analysis.

Task	Rates	Total
Water Chemistry Analysis for Sr and Ca	\$125/sample * 36 samples	\$4,500

Table 5. Budget for Service Contract.

Task	Rates	Total
Otolith preparation	\$63/sample * 1,150 samples	\$72,450
Microprobe time	\$450/day, 25 samples/day	\$20,700
USGS Overhead	@44%	\$40,986
CDFG Overhead	@ 15%	\$20,120
Total Cost		\$154,256

G. LITERATURE CITED

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Zimmerman, C.E., and G.H. Reeves. 1999, 1998, 1997, 1996. Steelhead and rainbow trout early life history and habitat use in the Deschutes River, Oregon: Annual Reports. USFS PNW Research Station, Corvallis, Oregon.

Zimmerman, C.E. 1999. Maternal origin and life history of *Oncorhynchus mykiss* in California streams based on otolith microchemistry. Progress report to California Department of Fish and Game per Work Service Order No. 2645.

Zimmerman, C.E., and D.E. Ratliff. 1998. Maternal origin of sockeye salmon (*Oncorhynchus nerka*) returning to the Pelton Fish Trap, Deschutes River, Oregon in 1997. Report prepared for Portland General Electric. Oregon State University, Department of Fisheries and Wildlife, Corvallis, Oregon.

- Zimmerman, C.E. 1998. Maternal origin of rainbow trout (*Oncorhynchus mykiss*) collected from Apanolio and Pilarcitos Creeks, California. Report prepared for Thomas R. Payne and Associates, Arcata, California. Oregon State University, Department of Fisheries and Wildlife, Corvallis, Oregon.
- Zimmerman, C.E. 1996. Population structure of coastal cutthroat trout (*Oncorhynchus clarki clarki*) in the Muck Creek basin, Washington. M.S. Thesis. Oregon State University.

ATTACHMENT 1

Summary of Existing Project Status

CENTRAL VALLEY STEELHEAD GENETIC EVALUATION

Project Description: The Central Valley Steelhead Genetic Evaluation is a previously funded project (FY 1999). It is funded by both CALFED and CVPIA AFRP. The goal of the project is to conduct a comprehensive baseline genetic analysis of Central Valley rainbow trout. The objectives include a comparison of rainbow trout stocks both within and outside the Central Valley, a description of the genetic profiles of Central Valley hatchery steelhead populations and a comparison to naturally-spawning anadromous and non-anadromous rainbow trout, an analysis of the genotypes of Central Valley rainbow trout populations that are presently isolated above artificial barriers to determine their phylogenetic relationship to anadromous rainbow trout populations below barriers.

Rainbow trout tissues are being collected from approximately 20 locations throughout the Central Valley watershed including anadromous stream reaches, non-anadromous stream reaches above artificial barriers, and anadromous fish hatcheries. Collections made above artificial barriers are below historical natural barriers and within the historical range of steelhead. Fish from each sampling location are being collected from throughout a continuous reach (so that there are no barriers between actual collection sites within each sampling location) and to minimize collection of sibling groups.

Scientific Merit: The present taxonomic classification of coastal rainbow trout recognizes the extreme polymorphism that occurs among rainbow trout populations. The genetic and ecological relation between non-anadromous and anadromous rainbow trout has been the subject of much debate, but has been little studied. The question we are attempting to answer is, do steelhead and resident rainbow trout represent genetically distinct, reproductively isolated populations or do they represent phenotypic polymorphisms of a single population? Evidence to-date suggests that there is not a single model that describes this relationship, rather it varies among locations.

The genetic and population information that will be generated from this evaluation will have several beneficial uses: it will assist in determining those populations that may be native and the extent of introgression of non-native alleles from introduced hatchery stocks, it will describe the structure and genetic variation within and among Central Valley steelhead populations and it will identify the most appropriate steelhead stock to use as donors for reintroduction of steelhead to stream systems where they are thought to be extirpated. The clarification of the phylogenetic relationship of natural stocks with hatchery stocks will allow managers to assess whether hatchery practices are having unintended genetic effects on the natural populations, such as introgression and loss of genetic variation, and to assess whether hatchery populations are significantly different from the natural populations from which they were founded.

Current Status: The CALFED contract was not executed until May 2000, which put the project behind schedule. In addition, a CDFG staff transition resulted in further delay. However, the project is back on track and we have requested and received a 6 month extension from CALFED extending the project through December 2002 (the same request is in process for the CVPIA AFRP contract).

Data Collection: Tissue collection began in May 2001 and is progressing at all locations throughout the Central Valley. Tissues are being processed through the CDFG 's Tissue Archive. In June 2001 a contract was executed with Dr. Jennifer Nielsen (U.S. Geological Survey), the geneticist performing the analyses.