Assessment of Life-History Characteristics and Genetic Composition of Oncorhynchus mykiss Throughout California

Project Information

1. **Proposal Title:**

   Assessment of Life-History Characteristics and Genetic Composition of Oncorhynchus mykiss Throughout California

2. **Proposal applicants:**

   Doug Demko, S.P. Cramer & Associates, Inc.

3. **Corresponding Contact Person:**

   Doug Demko
   S.P. Cramer & Associates, Inc.
   P.O. Box 247 Mi Wuk Village, CA 95346
   209 586-5020
   demko@dcs-chico.com

4. **Project Keywords:**

   At-risk species, fish
   Fish Genetics
   Fishery Assessment

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:**

   Private for profit

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.

Although the geographic extent of the project will encompass the six evolutionary significant units of Oncorhynchus mykiss in California, the analysis will be conducted at our field office in Oakdale. The program will involve visiting volunteer and long-term monitoring collection sites throughout the ESUs. The sites are undetermined at this time. Longitude and latitude (above) was left blank because the project is independent of specific site.

10. **Location - Ecozone:**

    Code 15: Landscape

11. **Location - County:**

    Stanislaus

12. **Location - City:**

    Does your project fall within a city jurisdiction?

    Yes

    If yes, please list the city: City of Oakdale is the location of the field office

13. **Location - Tribal Lands:**

    Does your project fall on or adjacent to tribal lands?

    No

14. **Location - Congressional District:**

    18

15. **Location:**

    California State Senate District Number: 12

    California Assembly District Number: 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?

       No

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

Single Overhead Rate: 0

Total Requested Funds: $698,730

b) Do you have cost share partners already identified?

No

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?**

No

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?**

No

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

Yes

If yes, identify project number(s), title(s) and CVPIA program.

11332-9-j010	**Evaluate the use of radio-tagged juvenile chinook salmon to identify cause and location of mortality**	**AFRP**
11332-0-M007	**Juvenile salmon outmigration monitoring at Caswell**	**AFRP**
Funds direct from BOR	**Evaluation of Smolt Survival**	**AFRP (Funds Direct from Burea of Reclamation)**

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

    No

    Please list suggested reviewers for your proposal. (optional)

21. **Comments:**

    Information listed above applies to the location of the field office where the research will be conducted. The data will be analyzed in Oakdale, but will be obtained from numerous undetermined locations throughout the state. The data will be collected by other on-going projects and volunteer angling programs, therefore, information about county, city jurisdiction, districts, etc. reflect the location of the field office.

Environmental Compliance Checklist

Assessment of Life-History Characteristics and Genetic Composition of Oncorhynchus mykiss Throughout California

1. **CEQA or NEPA Compliance**
   a) Will this project require compliance with CEQA?

      No
   b) Will this project require compliance with NEPA?

      No
   c) If neither CEQA or NEPA compliance is required, please explain why compliance is not required for the actions in this proposal.

      This project is a research project and will not require compliance with CEQA or NEPA.

2. **If the project will require CEQA and/or NEPA compliance, identify the lead agency(ies).** *If not applicable, put "None".*

   CEQA Lead Agency: none
   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
   Xnone

   NEPA
   -Categorical Exclusion
   -Environmental Assessment/FONSI
   -EIS
   Xnone

   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.

4. **CEQA/NEPA Process**
   a) Is the CEQA/NEPA process complete?

      Not Applicable

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

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

LOCAL PERMITS AND APPROVALS

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

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 Required

Rivers and Harbors Act

CWA 404

Other

PERMISSION TO ACCESS PROPERTY

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.**

Land Use Checklist

Assessment of Life-History Characteristics and Genetic Composition of Oncorhynchus mykiss Throughout California

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?**

   Yes

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).

   The proposed project is research only.

4. **Comments.**

Conflict of Interest Checklist

Assessment of Life-History Characteristics and Genetic Composition of Oncorhynchus mykiss Throughout California

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):

Doug Demko, S.P. Cramer & Associates, Inc.

Subcontractor(s):

Are specific subcontractors identified in this proposal? No

Helped with proposal development:

Are there persons who helped with proposal development?

Yes

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

Andrea Phillips S.P. Cramer & Associates

Ray Beamesderfer S.P. Cramer & Associates

Steve Cramer S.P. Cramer & Associates

Chrissy Sonke S.P. Cramer & Associates

Dillon Collins S.P. Cramer & Associates

Comments:

Budget Summary

Assessment of Life-History Characteristics and Genetic Composition of Oncorhynchus mykiss Throughout California

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.

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 Cost**
1.1	Establish technical work group	160	12880	320	0	0	0	0	100	13300.0	0	13300.00
1.2	Establish network of volunteer groups	200	17100	400	10500	600	0	0	0	28600.0	0	28600.00
1.3	Develop scale sampling plan for each ESU	220	19360	440	2300	0	0	0	200	22300.0	0	22300.00
1.4	Establish and maintain information distribution system	230	13130	420	0	800	0	0	200	14550.0	0	14550.00
2.1	Obtain scales from six ESUs using volunteer program	130	4760	140	0	1000	0	0	750	6650.0	0	6650.00
2.2	Obtain scales from long-term monitoring stations	50	2040	60	2300	0	0	0	0	4400.0	0	4400.00
2.3	Collect reference scales from agency sources	50	2040	60	0	0	0	0	0	2100.0	0	2100.00
2.4	Analyze age and growth patterns from scales	3220	116960	3440	2880	1500	0	22000	500	147280.0	0	147280.00

2.5	Validate scale analysis using outside laboratory	0	0	0	0	100	7000	0	100	7200.0	0	7200.00
2.6	Analyze genetic attributes of scales	0	0	0	0	100	12500	0	100	12700.0	0	12700.00
		4260	188270.00	5280.00	17980.00	4100.00	19500.00	22000.00	1950.00	259080.00	0.00	259080.00

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 Cost**
1.1	Manage technical workgroup	120	9660	240	0	0	0	0	0	9900.0	0	9900.00
1.2	Manage network of volunteer groups	180	15240	360	7200	0	0	0	0	22800.0	0	22800.00
1.3	Modify scale sampling plan for each ESU	100	9400	200	2300	0	0	0	0	11900.0	0	11900.00
1.4	Maintain information distribution program	165	8985	290	0	500	0	0	0	9775.0	0	9775.00
2.1	Obtain scales from six ESUs using volunteer program	130	4760	140	0	1000	0	0	600	6500.0	0	6500.00
2.2	Obtain scales from long-term monitoring locations	50	2040	60	2300	0	0	0	0	4400.0	0	4400.00

2.3	Collect reference scales from agency sources	50	2040	60	0	0	0	0	0	2100.0	0	2100.00
2.4	Analyze age and growth patterns from scales	3180	113740	3360	0	1000	0	0	500	118600.0	0	118600.00
2.5	Validate scale samples using outside laboratory	0	0	0	0	100	7000	0	100	7200.0	0	7200.00
2.6	Analyze genetic attributes of scales	0	0	0	0	100	12500	0	100	12700.0	0	12700.00
		3975	165865.00	4710.00	11800.00	2700.00	19500.00	0.00	1300.00	205875.00	0.00	205875.00

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 Cost**
1.1	Manage technical workgroup	120	9660	240	0	0	0	0	0	9900.0	0	9900.00
1.2	Manage network of volunteers	180	15240	360	7200	0	0	0	0	22800.0	0	22800.00
1.3	Modify scale sample plan for each ESU	60	5080	120	2300	0	0	0	0	7500.0	0	7500.00
1.4	Maintain information distribution system	165	8985	290	0	500	0	0	0	9775.0	0	9775.00
2.1	Obtain scales from six ESUs using volunteer program	130	4760	140	0	1000	0	0	600	6500.0	0	6500.00

2.2	Obtain scales from long-term monitoring locations	50	2040	60	2300	0	0	0	0	4400.0	0	4400.00
2.3	Collect reference scales from agency sources	50	2040	60	0	0	0	0	0	2100.0	0	2100.00
2.4	Analyze age and growth patterns from scales	3180	113740	3360	0	1000	0	0	500	118600.0	0	118600.00
2.5	Validate scale analysis using outside laboratory	0	0	0	0	100	7000	0	100	7200.0	0	7200.00
2.6	Analyze genetic attributes if scales	0	0	0	0	100	12500	0	100	12700.0	0	12700.00
3.1	Determine behavioral and genetic relationships among ESUs	380	31440	760	0	0	0	0	100	32300.0	0	32300.00
		4315	192985.00	5390.00	11800.00	2700.00	19500.00	0.00	1400.00	233775.00	0.00	233775.00

Grand Total=<u>698730.00</u>

Comments.

Total budget is for analyzing scales from all six California Steelhead ESU's. If only the Central Valley is funded, the cost would be 1/6 of the total cost which is $116,455.00 ($38,818.33 per year).

Budget Justification

Assessment of Life-History Characteristics and Genetic Composition of Oncorhynchus mykiss Throughout California

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

Task 1.1 will require 200 Biologist II hours and 200 Biologist III hours over 3 years. The first year's hours will be used for coordination purposes, while the remainder will be used for meetings in years 2 and 3. Task 1.2 will require 180 Bio II and 380 Bio III hours for the three years and will consist of initial and quarterly meetings and other communication necessary for project coordination and administration. Task 1.3 for three years will require 120 Bio II, 160 Bio III, 100 Senior Consultant. The first year's hours will be used for plan coordination, while year 2 and 3 hours will be used for quarterly meetings with other project managers. Task 1.4 will require 120 technician, 340 Bio I, 80 Bio II, and 20 Bio III hours over 3 years. Technician hours will be used to aid in data entry and report copying and binding. Bio I hours will be used for database creation in year 1, followed by data entry and database maintenance in years 2 and 3. Bio II and III hours will be used for sampling plan and report composition. Task 2.1 will require 360 hours of technician time (120 hours per year)and 30 Bio II hours for sample collection from anglers and data entry. Task 2.2 will require 120 technician hours (40 per year)and 30 Bio II hours for sample collection from long-term monitorong sites. Task 2.3 will require 120 technician hours (40 per year)and 30 Bio II hours for sample collection of reference scales. Task 2.4 will require 9000 techician, 300 Bio I, and 200 Bio II, and 80 Bio III hours for fish scale imaging and analysis and equipment maintenance. Tasks 2.5 and 2.6 will be completed through outside service contracts. Task 3.1 will be accomplished in year 3 only and will require 60 Bio I, 120 Bio II, 120 Bio III, and 80 Principal Scientist hours for data analysis and report composition.

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

The amounts listed for salary are SPCA's billing rates minus the benefit rates listed below. The billing rates include actual pay rates plus all overhead for each category of employee for each hour worked. Besides the employee pay and benefits, the billing rate includes all costs associated with operation of the company which includes Project administration (invoicing, payroll, etc.), office rental, electricity, basic phone charges, internet connections, copy machine rental, employee taxes, company insurance for office and equipment, office supplies and furniture, salary employee bonuses, all overhead associated with each employee (disability insurance, workman's comp, vacation pay, holiday pay, etc.),company truck lease, etc. The following rates apply to the each category of employee listed in the project: Technicians $34/hr Bio I $58/hr Bio II $68/hr Bio III $93/hr Senior Consultant $108/hr The actual employee pay is approximately 45% of the above billing rates plus the benefits listed below.

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

Technicians receive $1/hour for insurance benefits and all other employee categories above receive $2/hour for insurance benefits.

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

Travel costs consist of mileage reimbursement for drivers, airline fares, food and lodging per diem, and vehicle rental. Mileage for trips to be made by car were estimated by finding the approximate roundtrip mileage from the city of Chico, CA to a major city or town in the central part of each of five of the six California steelhead ESU's and is summarized here: Central California Coast (San Francisco) 360

miles Central Valley (Sacramento) 190 miles Northern California (Arcata) 440 miles Klamath Mountains (Crescent City) 600 miles South-Central Coast (Monterey) 560 miles Trips to the Southern California ESU will be made by plane. Travel costs for Task 1.2 are estimated to be $24,900 over 3 years. Year 1 costs total approximately $10,500 and include trips to the 6 ESU's for a total of 36 planning, coordination, and quarterly meetings. The total number of driven miles is approximately 12,900 miles for $5,400. This includes an approximate 5% cushion to allow for travel to and from specific meeting sites, which have yet to be determined. Per diem and lodging costs total $3,000 for six overnight trips to each of five of the ESU's. Airfare is estimated to be $300 round trip for one person between Sacramento and Los Angeles and will total $1800 for year 1. Car rental while in Southern California is estimated to be $50/day and will total $600 for the six 2-day trips in Year 1. Year 2 and 3 travel costs for this task drop to $7,200 per year, as only quarterly meetings to each ESU will be necessary. Tasks 1.3 and 2.2 will require travel to and within each ESU. Project meetings are proposed to be held at each sampling project that contrbutes scales once a year. This will require an estimated $2,300 per year, per task for the two tasks. This per-task total includes $1200 for mileage costs, $300 for airfare, $700 per diem, and $100 car rental. The mileage estimate was increased approximately 40% from $860 for travel to and from the five driveable ESU destinations to allow for travel to various sampling project locations within each ESU. Task 2.4 will require a total of $2,880 for travel, which will only take place in year 1. This includes $80 in mileage costs for travel to and from UC Davis for training, $200 per diem and lodging for two people while at Davis, $2000 for estimated round trip airfare to an east coast location to be determined later for image analysis software training, and $600 per diem and lodging for two while at the 3-day training.

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

The total cost for supplies for this project is $5,900. Estimated laboratory costs total $3,500 for various lab supplies such as microscope slides and covers, glassware, cleaning supplies, acetate sheets, and other miscellaneous items over 3 years. Office supplies total $1,500 and include paper, binding supplies, toner, and other materials necessary to create reports and other documents. Field supplies total $600 and include knives, sample envelopes, waterproof paper for data sheets, etc. Computing supplies include $300 for the purchase of software and other items needed for web-site creation.

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.

An estimated total of $58,500 will be spent on outside services. This includes $21,000 to be paid to UC Davis for the quality assurance testing of up to 300 scale samples at an estimated $61 per sample plus additional lab and equipment fees. Also included here is $37,500 to be paid for DNA analysis of approximately 540 scale samples at $70 per sample.

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.

Equipment costs for the project will total $22,000 and will include the components necessary to put together a scale imaging and analysis system. The pieces of equipment that will be purchased include the following: Leica compound microscope $13,000 imaging software $4,000 laboratory press $2,300 digital camera for microscopy $2,700

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 presentatons, reponse to project specific questions and necessary costs directly associated with specific project oversight.

The project management aspects are included in each of the tasks as supervision by Bio I, II or III. The cost of quarterly project reports is built into the billing rates as part of the project admimistration.

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

Other direct costs are communication costs required for project. These costs are the costs not included in overhead such as long-distance charges, field cell phone charges, and conference call charges. Task 2.1 involves contacting each participating angler in the state on a monthly basis. This is estimated to cost $4,500 over the project period (about $125 per month). An additional $450 ($150 per year)was added for this task to cover shipping costs for scale samples. Communication and shipping costs for Tasks 2.5 and 2.6 are estimated to be $600 total over the 3-year period. Other direct costs include an allowance of $500 per year for maintenance of image analysis equipment.

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.

All indirect costs are included in our billing rates and are described above under salary rates. The billing rates include salary + benefits.

Executive Summary

Assessment of Life-History Characteristics and Genetic Composition of Oncorhynchus mykiss Throughout California

This proposed project is to assess life-history characteristics and genetic composition of anadromous steelhead and resident rainbow trout populations (Oncorhynchus mykiss) throughout California. The geographic extent of this assessment will encompass the six evolutionarily significant units (ESU) of O. mykiss in California including the Klamath Mountains Province, Northern California Coast, Central California Coast, Central Valley, South-Central California, and Southern California. The information gained from this project will provide managers with a comprehensive understanding of O. mykiss populations throughout the state, but will be most beneficial to populations within the San Francisco Bay-Delta Region. This three-year research project has the following three primary objectives: (1) establish project coordination, implementation, and communication components, (2) compile reliable database of O. mykiss information from six California ESUs, and (3) determine behavioral and genetic similarities and differences between California steelhead trout populations based on analysis of scales. The approach used to implement this project will be to collect and analyze O. mykiss scales for age structure, growth patterns, and genetic similarities. Scales from O. mykiss will be obtained from several sources including archived scale collections, ongoing monitoring programs, and a volunteer sport-angler scale collection program. The analysis of anadromous steelhead and resident rainbow trout life-history and genetic patterns, in combination with abiotic data, will help determine their critical life stages; limiting factors; relatedness among tributaries, watersheds, and ESUs; relationships between genetic and life-history differences; and factors responsible for determining habitat suitability. This information will substantially improve the biological basis for identifying O. mykiss management units, assessing stock status, and evaluating restoration or management alternatives. Although the exact number of scales interpreted for life-history characteristics will be determined by biologists and statisticians prior to the start of sampling, we anticipate that we will collect and read between 100 and 150 samples from each sampled stream each year. Up to 10 streams will be sampled in each of the 6 ESUs, which could yield 18,000 to 27,000 samples over the course of the 3 year study. We anticipate needing at least 30 genetic samples (obtained from the same scales used to evaluate life-history) per year from streams within each ESU for a statistically robust sample, which would yield approximately 540 samples analyzed over the 3 year study period.

Proposal

S.P. Cramer & Associates, Inc.

Assessment of Life-History Characteristics and Genetic Composition of Oncorhynchus mykiss Throughout California

Doug Demko, S.P. Cramer & Associates, Inc.

Assessment of Life-history Characteristics and Genetic Composition of *Oncorhynchus mykiss* Throughout California

A. PROJECT DESCRIPTION

1. PROBLEM

Oncorhynchus mykiss biology is considered to be among the most complex of any salmonid (Shapovalov and Taft 1954, Barnhart 1986) and many aspects of the life history of this species are poorly understood. *O. mykiss* have received relatively little study compared to salmon yet have been assumed to respond to environmental stressors in the same way. This assumption may be having a detrimental effect on populations since life history patterns for *O. mykiss* can often differ significantly from salmon. For example, freshwater rearing periods for juvenile *O. mykiss* may vary from one to four years, as opposed to most chinook which emigrate from their natal stream within their first year of life. Ocean residence may vary from a few months to several years for *O. mykiss* and several different life history strategies may exist in the same watershed or even within the same population of *O. mykiss*. These different strategies potentially reflect habitat-mediated expressions of behavior and/or underlying genetic differences among populations. Furthermore, many streams contain both anadromous (steelhead) and resident (rainbow trout) forms of *O. mykiss*. These different forms may represent distinct units that do not intermix or represent different life-history strategies for the same population.

Steelhead can further be divided into two basic reproductive ecotypes based on their state of sexual maturity at the time of river entry (Burgner et al. 1992). Some steelhead populations enter freshwater in a sexually immature condition and require several months to mature and spawn (i.e., stream maturing ecotype). Other populations enter freshwater with well-developed gonads and spawn shortly after freshwater entry (i.e., ocean maturing ecotype). In rivers where the two ecotypes co-occur, they are often separated by a seasonal hydrologic barrier, such as a waterfall. Rainbow trout populations typically spawn and reside in their natal stream. However, some rainbow trout populations display fluvial behavior patterns where juveniles migrate downstream but mature in freshwater before returning upstream to spawn Although the anadromous and non-anadromous forms of *O. mykiss* are taxonomically classified within the same species, the exact relationship between the two forms is not well understood. In coastal populations it is unusual for the two forms to co-occur, however, co-occurrence in inland populations is more common. Where the two forms co-occur, "it is possible that offspring of resident fish may

migrate to the sea, and offspring of steelhead may remain in streams as resident fish" (Burgner et al. 1992, p. 6; see also Shapovalov and Taft 1954, p. 18). Mullan et al. (1992) found evidence that temperatures could produce a resident life history in *O. mykiss* regardless of whether they were the progeny of anadromous or resident parents.

For steelhead populations, the extended residence period of juveniles makes them extremely vulnerable to environmental stressors and slow to respond to recovery efforts. Also, unlike anadromous salmon which die upon spawning, steelhead may spawn multiple times potentially affecting their population genetic structure. The extreme variability in *O. mykiss* life-history strategies greatly complicates protection, recovery, and management efforts. Resident and anadromous juveniles are difficult or impossible to distinguish from each other making it difficult to identify limiting factors and critical habitats for steelhead. For example, it is unknown whether recently modified habitat conditions are benefitting the targeted anadromous form or are preventing effective restoration of anadromous salmonids. The benefits of watershed restoration and protection, streamflow augmentations, restored access to headwaters, and hatchery programs are currently difficult to discern without better information regarding life-history characteristics and genetic composition of *O. mykiss* populations.

From a review of existing life-history information and with consideration of two ongoing *O. mykiss* projects, we identified several "working hypotheses," as follows:

- Central Valley *O. mykiss* populations may differ genetically from coastal and southern populations, but environmental factors, not genetics, are responsible for variations in life-history strategies.

- Central Valley *O. mykiss* populations utilize different life-history strategies than coastal and southern populations.

- Anadromy and residency life-history strategies can be turned "on" or turned "off" by environmental factors.

Two CalFed *O. mykiss* studies are currently underway; one to evaluate life-history characteristics in the Yuba River and the other to evaluate Central Valley genetic characteristics. The Yuba study is only looking at life-history characteristics within the Yuba River, not the in the entire ESU or between ESU's, as we are proposing to do. We would rely on the existing Yuba project to provide information on that river, and focus our efforts on other streams within the ESU. The other CalFed *O. mykiss* project involves genetic analyses within the Central Valley ESU by Dennis McEwan and CDFG. Our proposed project would also build on the work

being conducted by providing additional genetic samples from streams not sampled by CDFG, and over a longer period of time (3 years). Similar to CDFG, we are proposing to use Dr. Jennifer Nielsen for the genetics work, so data from both studies would be evaluated together. The majority of our effort is to read scales to evaluate life-history characteristics in all ESU's, which is beyond the scope of the CDFG project.

2. JUSTIFICATION

Currently, there is limited information regarding *O. mykiss* biology. Many key questions related to *O. mykiss* life-history can be resolved by analysis of their scales. Scale deposition patterns can provide information on relative growth rates in both fresh and saltwater, ages of migration and spawning, periods of freshwater and ocean residence, frequency of repeat spawning, and life history diversity within and among populations. Many of these characteristics may also be compared to environmental patterns, habitat conditions, and habitat modifications to identify potential population risks and beneficial measures that can be implemented.

Based on DNA extracted from scales, genetic population characteristics can also be determined. These genetic characteristics can be used to distinguish population patterns and management units. Although some genetic relationships between different populations of steelhead have been determined (Busby et al. 1996; NMFS 1997), few detailed studies have been done on the relationship between resident and anadromous *O. mykiss* found in the same location. Some genetic studies have shown that rainbow trout and steelhead from the same area may share a common gene pool, at least over evolutionary time periods. However, there may also be substantial genetic divergence between resident and anadromous fish in areas where resident populations have been isolated by long-standing natural barriers. Although data is scarce, it is also thought that progeny of non-anadromous *O. mykiss* can be anadromous, and that anadromous *O. mykiss* can produce nonanadromous progeny.

This project proposes to collect information on *O. mykiss* populations throughout the state, not just in the San Francisco Bay-Delta Region, CalFed's priority region, because a thorough understanding and successful management of Central Valley populations is dependent on as broad a geographical comparative analysis as possible. Meaningful information for restoration and management requires an evaluation of *O. mykiss* behavior and genetics in relation to different environmental and geographical levels. In the Central Valley region, for instance, *O. mykiss* are known to exist from the upper Sacramento River to as far south as the Merced River, a distance of over 400 miles. Anadromous individuals from populations inhabiting this geographical range access the ocean through the same

body of water, yet they inhabit very different ecological regions. Due to substantially different climates it's possible that steelhead in the San Joaquin Basin share more behavioral or genetic characteristics with populations in the southern portion of the state, than with populations in the Sacramento basin, even though the Sacramento and San Joaquin populations are geographically closer.

Evidence indicates that below migration barriers in California most *O. mykiss* populations consist of interbreeding individuals, not reproductively separate populations of anadromous and resident fish. This suggests that anadromy may be a behavioral trait which could be turned "on," or turned "off," and possibly by modifying habitat or other environmental factors. If this is so, management strategies could be implemented that favor a particular life-history strategy over another.

3. APPROACH

We propose the following study plan to test the hypotheses presented in section 1. A quick-reference step-down diagram of all objectives and tasks is presented on the next page (Figure 1).

Objective 1: Establish project coordination, implementation, and communication components.

Task 1.1 Establish a technical workgroup consisting of government agencies, private consultants, and conservation groups.

The purpose of this project is to analyze scale data collected from *O. mykiss* throughout California and to use this data to aid future management decisions, especially with regard to Central valley populations. Due to potential future management applications, this project will be conducted as a cooperative effort and will utilize the expertise of government and private biologists, and fisheries conservation groups. Therefore, a technical working group will be established to oversee development of a comprehensive and statistically rigorous sampling plan that will include the establishment of appropriate angler scale collection techniques and identification of priority analyses. The technical workgroup will also provide regular review and oversight of activities on a quarterly basis and will serve as advisors to facilitate project implementation and expedite information transfer into management applications. The technical working group will include one regional manager from each ESU (either a government or private biologist); a representative biologists from CDFG, NMFS, USBR, and USFWS; and representatives from conservation groups such as CalTrout, Federation of Fly Fishers, and Trout Unlimited.

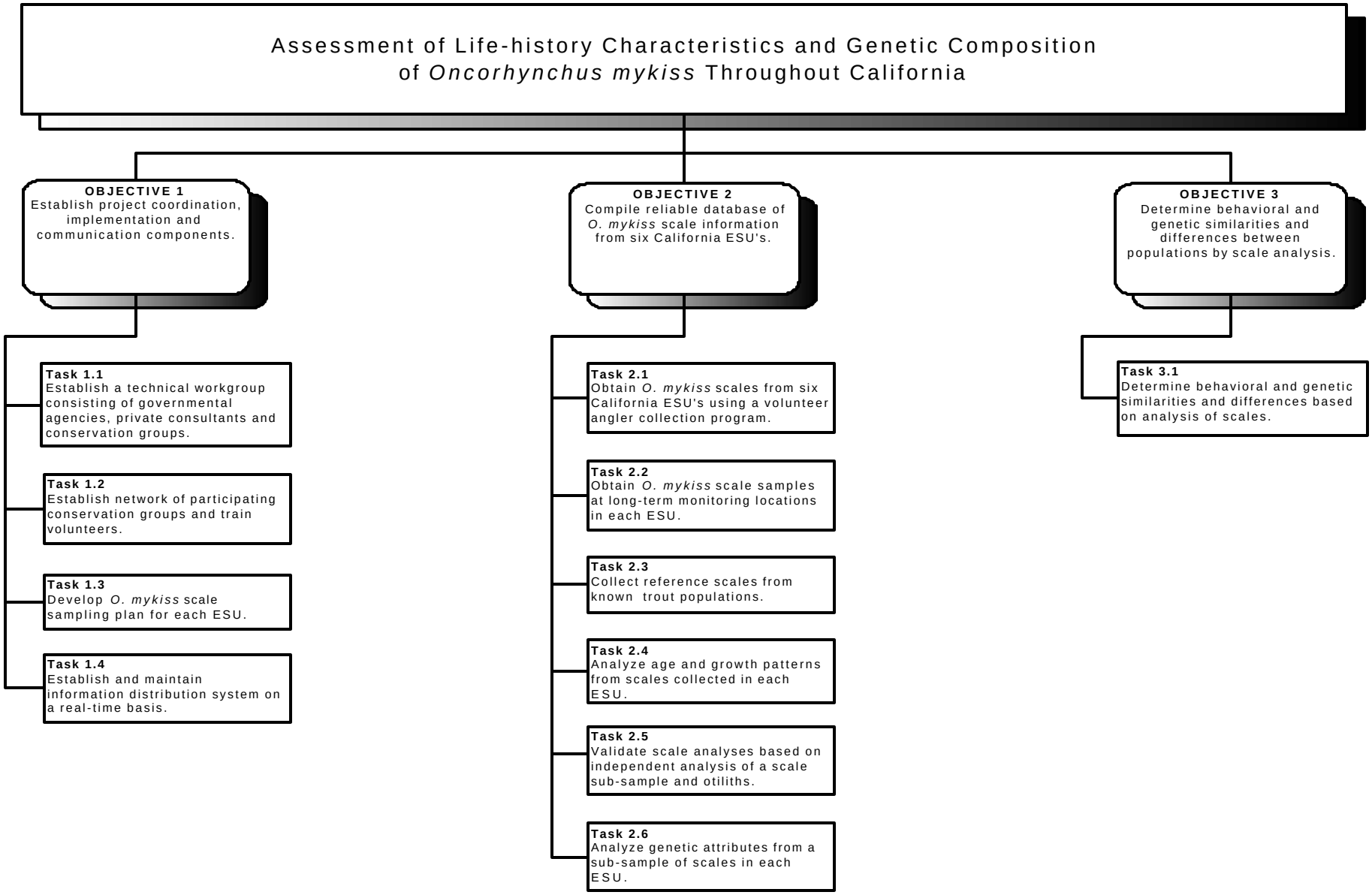


Figure 1. Step-down diagram illustrating all objectives and tasks for the proposed project.

Task 1.2 Establish network of participating conservation groups and train volunteers.

A volunteer sport-angler collection program (Volunteer Program) will be created according to a similar program conducted by the Oregon Department of Fish and Wildlife (ODFW). Participating anglers will be recruited from organized constituent groups such as CalTrout, Federation of Fly Fishers, and Trout Unlimited, and other flyfishing clubs. Each ESU will have a separate Volunteer Program, and each ESU will be represented by a volunteer ESU Coordinator. ESU Coordinators will be individuals that are selected for their ongoing participation in conservation efforts, angling skills and understanding of biology, and demonstrated leadership capabilities. ESU Coordinators will act as the primary contacts within each ESU, help organize local expert anglers to collect scales using proper collection techniques, and will verify each anglers skills with regular field visits.

In addition to regular field visits and supervision by ESU Coordinators, we will meet with each ESU group quarterly to ensure that proper field procedures are being followed and that accurate records are maintained and passed on. During quarterly visits we will meet with the entire ESU group, as well as with some of the volunteers in the field. Time will not permit us to verify each anglers collection skills on each quarterly visit, but records will be kept to insure that each angler demonstrates their scale and data recording proficiency annually. Quarterly visits will be timed such that they correspond to local activities, such as flyfishing club meetings, which we anticipate many of our volunteers will belong to. Timing our visits with these events will help minimize time requirements on volunteers and ensure that we meet with as many volunteers as possible each quarter.

We anticipate that we will be able to meet statistical sample size requirements with only 10 to 20 anglers per ESU group. The exact number of volunteers in each group will depend on the number of streams identified in the sampling plan as scale sources, the geographical distribution of streams within each ESU, and the number of days volunteers fish in each ESU. We will attempt to keep each ESU volunteer group as small as possible for quality control purposes, but we also want enough volunteers such that each volunteer will only take scale samples on some outings. Further, we don't want each volunteer taking scales from every fish captured. By limiting scale samples to a portion of the fish captured we minimize any potential detrimental impact any one angler could have (if not following procedures, for instance), and we also increase the time and geographic separation between samples, which is desirable and will help ensure we obtain an accurate depiction of species characteristics.

Task 1.3. Develop *O. mykiss* scale sampling plan for each ESU.

O. mykiss scales will be obtained through existing archived scale collections, during existing monitoring programs, and through a volunteer angler program. Reference scales will be obtained from known anadromous and resident hatchery and natural populations. Archived scales are available from CDFG.

Scales will be collected from *O. mykiss* that are captured during established rotary screw trap, seining, trawling, and other long-term monitoring programs located in each ESU. Currently,

considerable sampling efforts are underway by state and federal agencies, consultants, and conservation groups where *O. mykiss* are occasionally encountered. We will identify each sampling activity in each ESU with the potential for capturing *O. mykiss.* Program managers will be contacted and measures will be implemented to obtain scale samples from a portion of the *O. mykiss* captured at each location. The sampling plan will use catch data from past years at each program to recommend the proportion of catch sampled for scales. Managers will be contacted each quarter to obtain data and make sure that common procedures are being followed. We will make one field visit to each sampling station at the start of each season to insure that proper procedures are implemented and followed. Since the vast majority of these sampling locations are run by agency biologists, less supervision of techniques will be required than for the volunteer angler program.

A Volunteer Program will likely be the most efficient scale collection method for adult *O. mykiss* since adults are typically difficult to capture by other means; adults located in high flows can be difficult to sample, and, unlike salmon, carcasses are rarely observed after spawning. Scales will be collected for a three-year period to optimize sample sizes for each California ESU. Sampling locations within each ESU and a detailed sampling plan will be developed with assistance of the technical workgroup at the start of the project.

We anticipate needing at least 30 genetic samples per year from streams within each ESU for a statistically robust sample, which would yield approximately 540 samples analyzed over the 3 year study period. Samples will be analyzed from multiple streams within each ESU to account for variation within an ESU. This information will be combined with genetic data already collected by the CDFG, NMFS and others, so the dataset used for comparisons will include data from many more samples than we propose to analyze.

Although the exact number of scales interpreted for life-history characteristics will also be determined by biologists and statisticians prior to the start of sampling, we anticipate that we will collect and read between 100 and 150 samples from each stream each year. Up to 10 streams will be sampled in each of the 6 ESU's, which will yield 18,000 to 27,000 samples over the course of the 3 year study. Although this is a large number of scales requiring substantial effort to interpret, the large sample size is necessary to make meaningful conclusions among and between streams and ESU's, due to the behavioral diversity in *O. mykiss* populations. The large sample size is also necessary to be able to determine how behavioral characteristics relate to often confounding environmental factors.

Task 1.4 Establish and maintain information distribution system to keep volunteer anglers and resource managers informed of project status on a real-time basis.

During development of sampling plan, we will distribute, via e-mail, a draft sampling plan, meeting announcements, and meeting notes to the technical team, our volunteer network, and the public.

Upon initiation of fieldwork, we will distribute, via e-mail, bi-monthly progress reports detailing all field activities to members of the technical workgroup, our angling volunteer network, and the

public. We will also provide updates to various Central Valley salmonid work groups via presentations and our presence at meetings. Furthermore, we will maintain a website with all work products and a discussion board to encourage feedback and participation.

At the end of the study, we will prepare a technical report detailing our results. The report will be distributed to participating agency biologists via hardcopy and will be made available to the public via our website. A separate report, prepared by Dr. Jennifer Nielsen, will describe the results of the DNA analysis, and will include comparisons to existing DNA data.

Objective 2: Compile reliable database of *O. mykiss* scale information from six California ESU's.

Task 2.1 Obtain *O. mykiss* scales from six California ESU's using a volunteer angler collection program.

O. mykiss scales will be obtained from trained recreational fly-fishers participating in the Volunteer Program. The Volunteer Program will be designed, with the assistance of the technical workgroup, according to a similar program conducted by the Oregon Department of Fish and Wildlife. The ODFW Volunteer Program has been proven to be an effective, efficient, and inexpensive way to collect numerous scale samples from a large number of geographically isolated rivers. Other collection methods are not as successful due to the difficulty of capturing adult *O. mykiss* in traditional fishery monitoring gear (i.e., seines, rotary screw traps, etc), and unlike salmon, *O. mykiss* carcasses are rarely observed after spawning. The cooperative implementation of this program with participants from organized angling groups will have the added benefit of fostering communication and enhancing relationships among fishery managers and key stakeholders.

Recreational fly-fisher volunteers will be selected from organized fishing associations, such as CalTrout, Federation of Fly Fishers, and Trout Unlimited, and will be trained in proper scale and data collection techniques, particularly the collection of scale samples without causing injury. During legal angling seasons, these trained volunteers will collect scale samples through catch-and-release fishing in streams throughout California and will comply with state and federal regulations regarding *O. mykiss* angling. All anglers will use barbless, artificial lures (flies), and will collect scales during their normal, recreational pursuit of trout. Anglers will be specifically instructed to not conduct any angling adventures for the specific purpose of collecting scales. Rather, the sampling plan will be designed to obtain an adequate number of scale samples from well distributed geographic locations by incorporating angler preferences and habits into the planning process. We will have frequent contact with each ESU Coordinator and the volunteer anglers to ensure that the study plan is being implemented correctly and only the necessary number of scales are being collected. A Fisheries Technician will contact each volunteer angler by phone once per month to ensure adequate supervision.

At the end of each month every angler will send or fax to us data sheets summarizing the number and locations of scale samples. This information will be entered into a GIS database so that each month will update the total number of scales collected from each stream. We will

compare the total number of fish sampled at the end of each month with the recommendation in our sampling plan to determine our progress. This ongoing evaluation of the program will ensure that we do not collect more scales than necessary, and will allow us to add anglers or increase the proportion of fish sampled if collection numbers are low. The GIS map will enable us to evaluate the spatial distribution of samples within each stream to ensure that we are obtaining samples from adequately dispersed habitats. All information will be summarized and placed on the internet website.

State officials in Oregon discovered that angler participation in volunteer programs can wain over time, and recommended creating an information loop to protect against participant atrophy. This process presents each angler with the results of the specific scales he or she collected, and helps inspire continued participation by creating "ownership" with specific information. We will develop a tracking system such that scale results can be summarized according to the person that collected them. This information will be presented to each angler when we meet with ESU groups. In addition to maintaining angler participation, this will also serve as additional quality control by looking for "irregular" results among anglers.

Task 2.2 Obtain *O. mykiss* scale samples at established rotary screw trap, seining, trawling, and other long-term monitoring locations in each ESU.

O. mykiss juveniles are encountered in a variety of monitoring, evaluation, and sampling programs conducted throughout California. Scale samples may be obtained from these sources with minimal additional effort and costs. The detailed sampling plan developed with assistance of the technical workgroup will incorporate specific monitoring, evaluation, and sampling programs that can contribute scales, as well as any other relevant data.

Some monitoring gear, such as rotary screw traps, may provide valuable information since they catch juveniles migrating downstream that are presumably migrating to the Delta or Ocean. In the Delta, fish captured in trawling gear or in the state and federal diversion facilities may also provide representative data for the composite steelhead run. Fish sampled from these locations will provide a valuable comparison to age 1 and age 2 samples taken by anglers, which may be more representative of resident *O. mykiss*.

Task 2.3 Collect reference scales from known anadromous and resident, hatchery and natural *O. mykiss* populations.

Scales collected from known anadromous and resident, hatchery and natural rainbow trout populations are necessary for establishing scale reading criteria that are consistent with identifying various life history characteristics. For instance, saltwater growth check appearance can be ascertained from known steelhead populations. Resident rainbow trout pattern appearance can be verified using scales collected from O. mykiss that do not have access to the ocean.

Task 2.4 Analyze age and growth patterns from scales collected in each ESU.

According to standard protocols, scale impressions will be made on acetate film, then magnified and viewed under a microfiche reader. Images will be stored electronically to provide a comprehensive reference collection for future use. An experienced scale reader will determine fish age, and residence time in freshwater, the estuary, and/or the ocean. These characteristics are determined by the number of annuli present and the relative spacing between them. Age at ocean entry can be estimated from the number of circuli present prior to occurrence of a scale "check" that is formed at ocean entry. The scales radius at the check also provides an estimate of fish size at ocean entry.

Task 2.5 Validate scale analyses based on independent analysis of a sub-sample of scales and, if possible, comparative analysis of otoliths.

Experienced scale readers from one laboratory will analyze all scales to ensure consistency in scale reading. A sub-sample of scales read by the primary laboratory will be sent to an independent laboratory for verification of results. This independent analysis will be performed to ensure repeatability in scale reading and will be conducted blind to provide an accurate control.

As a further validation measure, we will also collect and interpret otoliths as opportunities arise. Our network of anglers and biologists will be alert for opportunities when otoliths can be obtained from fish legally harvested by others. In such instances, our trained anglers or biologists will request the head and scale samples of the harvested O. mykiss. The otoliths will subsequently be removed from the head for analysis and will be compared to the results derived from scale analysis.

Task 2.6 Analyze genetic attributes from a sub-sample of scales in each ESU.

A percentage of collected scale samples will be sent for genetic analysis to Dr. Jennifer Nielsen of the USGS in Anchorage, Alaska. Dr. Nielsen is a recognized expert in Pacific salmonid molecular genetics and stock identification, and has done a considerable amount of work elucidating the genetic and population structure of coastal rainbow and steelhead trout. DNA from scales collected throughout California will be compared to other Central Valley samples to evaluate stock relatedness. Since Dr. Nielsen is experienced with California stock analyses, she will prepare a report detailing her findings at the end of the three-year collection period.

Objective 3: Determine behavioral and genetic similarities and differences in different California O. mykiss ESU populations based on analysis of scales.

Basic summaries of *O. mykiss* age, growth patterns, length of residence in freshwater and saltwater, and genetic structure will be compared among and between populations to identify life history and genetic diversity patterns within California. Discriminant analyses will be explored to facilitate pattern discrimination and stock identification. These summaries will also be compared with basic habitat and environmental information to identify potential correlates that may explain life history and genetic patterns. For instance, results can be used to test the current hypothesis that temperature-mediated capacity for growth determines whether habitat is suitable for resident or anadromous life histories of *O. mykiss*.

4. FEASIBILITY

The proposed approach for implementation of this project is both feasible and appropriate. The collection of scales by personnel at existing monitoring stations will be conducted in conjunction with ongoing sampling programs and will be governed by existing monitoring permits. Scale collection by volunteer anglers will be conducted during legal angling seasons and in legally accessible locations (i.e., public lands where fishing is allowed). In addition, volunteer anglers will use established catch-and-release and non-detrimental scale collection protocols, and will obey all state and federal regulations regarding steelhead/rainbow trout angling.

A Section 10 permit will be needed for the volunteer angler program, which is in process. NMFS and other agencies have expressed sincere desire for the information collected by this program, and have suggested that the permitting process will be expedited.

5. PERFORMANCE MEASURES

The performance measures used to assess the project's success in relation to its objectives include development of a detailed scale sampling plan, data reports, publications, and presentations. An organized steering committee will oversee all aspects of the study, such that there will be ongoing evaluation of the procedures and any necessary changes can be during the course of the study.

During development of sampling plan, we will distribute, via e-mail, a draft sampling plan, meeting announcements, and meeting notes to the technical team, our volunteer network, and the public. All of our physical work products, including data and results of the scale reading, will be posted on the internet on a real-time basis.

Upon initiation of fieldwork, we will distribute, via e-mail, bi-monthly progress reports detailing all field activities to members of the technical workgroup, our angling volunteer network, and the public. We will also provide updates to various Central Valley salmonid work groups via presentations and our presence at meetings. Furthermore, we will maintain a website with all work products and a discussion board to encourage feedback and participation.

At the end of the study, we will prepare a technical report detailing our results. The report will be distributed to participating agency biologists via hardcopy and will be made available to the public via our website. A separate report, prepared by Dr. Jennifer Nielsen, will describe the results of the DNA analysis, and will include comparisons to existing DNA data.

6. DATA HANDLING AND STORAGE

An index file will be created as samples are received from collectors. Each sample will be given an ID number, and the data recorded on the collection envelope will be entered into the index file. This file will allow us to keep track of how many samples have been obtained from different locations on a real-time basis and will serve to double check that all samples have been read at the end of the project.

Scale images will be captured electronically and saved to a dedicated hard drive for future reference. All data from the reading of these images will be recorded onto data sheets and then entered into a database such that electronic summaries can easily be generated. Data sheets will be organized by stream of sample collection and kept in binders. Copies of data sheets will be provided if desired.

Dr. Jennifer Nielsen will be responsible for the initial handling and storage of data from the genetic analyses. Electronic files will be sent to us for cross-reference with the data from scale reading. Sample ID numbers will allow us to easily cross-reference data collected from scale reading and genetic analyses.

7. EXPECTED PRODUCTS AND OUTCOME

The expected outcome of this project is a greater understanding of life-history expression and genetic relatedness of California *O. mykiss* populations for the successful management and recovery of the species. The thorough database of life-history and genetic data that will be created by this project, will provide the foundation from which greater understanding of the needs of *O. mykiss* can be derived. The information gathered will also provide the scientific information necessary to resolve arguments over the geographical boundaries of the ESUs, where steelhead exist, and how life-history expression and survival may be affected by environmental factors.

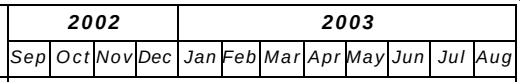
8. WORK SCHEDULE

We propose to begin work in September 2002 and complete the project in August 2005. Table 1 presents the proposed annual work schedules for the duration of the project.

Bi-Monthly:	Summaries of progress e-mailed and posted to website
Quarterly:	Reports to CalFed ERP
July 31, 2005	Draft Report & Database
August 31, 2005	Final Report

Table 1. Proposed annual work schedules.

Year 1	Task	Start	Finish
1	Objective 1 1.1 Establish technical workgroup	09/01/02	10/01/02
2	1.2 Establish volunteer scale collection network	10/01/02	12/01/02
3	1.3 Develop scale sampling plan in each ESU	09/01/02	11/01/02
4	1.4 Establish/ maintain information distribution system	09/01/02	08/31/03
5	Objective 2 2.1 Obtain scales from volunteer groups	11/01/02	08/31/03
6	2.2 Obtain scales from monitoring projects	11/01/02	08/31/03
7	2.3 Collect reference scales from known trout populations	11/01/02	08/31/03
8	2.4 Analyze scales for age and growth data	11/01/02	08/31/03
9	2.5 Validate scale analyses	07/01/03	08/31/03
10	2.6 Analyze genetic attributes of sub-sample of scales	07/01/03	08/31/03



Year 2	Task	Start	Finish
1	Objective 1 1.1 Manage technical workgroup	09/01/03	08/31/04
2	1.2 Manage volunteer groups	09/01/03	08/31/04
3	1.3 Modify sampling plans if needed	09/01/03	08/31/04
4	1.4 Maintain information distribution system	09/01/03	08/31/04
5	Objective 2 2.1 Obtain scales from volunteer groups	09/01/03	08/31/04
6	2.2 Obtain scales from monitoring projects	09/01/03	08/31/04
7	2.3 Collect reference scales from known trout populations	09/01/03	08/31/04
8	2.4 Analyze scales for age and growth data	09/01/03	08/31/04
9	2.5 Validate scale analyses	07/01/04	08/31/04
10	2.6 Analyze genetic attributes of sub-sample of scales	07/01/04	08/31/04

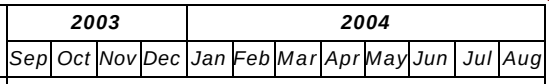


Table 1. continued

Year 3	Task	Start	Finish	2004 Sep	Oct	Nov	Dec	2005 Jan	Feb	Mar	Apr	May	Jun	Jul	Aug
1	Objective 1 1.1 Manage technical workgroup	09/01/04	08/31/05												
2	1.2 Manage volunteer groups	09/01/04	08/31/05												
3	1.3 Modify scale sampling plans if needed	09/01/04	08/31/05												
4	1.4 Maintain information distribution system	09/01/04	08/31/05												
5	Objective 2 2.1 Obtain scales from volunteer groups	09/01/04	05/30/05												
6	2.2 Obtain scales from monitoring projects	09/01/04	05/30/05												
7	2.3 Collect reference scales from known trout populations	09/01/04	05/30/05												
8	2.4 Analyze scales for age and growth data	09/01/04	06/30/05												
9	2.5 Validate scale analyses	05/01/05	07/01/05												
10	2.6 Analyze genetic attributes of sub-sample of scales	05/01/05	07/01/05												
11	Objective 3 3.1 Determine behavioral and genetic relationships among ESU's	07/01/05	08/31/05												

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

1. ERP, SCIENCE PROGRAM AND CVPIA PRIORITIES

ERP Strategic Goals

The proposed study will provide new information necessary for many of the CALFED ERP strategic goals to be reached. First, considerable uncertainty exists about why at-risk species are in decline, and how to best facilitate the recovery of these species. The strategic goals state that "ERP actions must address the immediate needs of at-risk species as well as gain additional information about how they respond to modifications to ecosystem functions and processes." The strategic goals recognize that we must maximize opportunities that improve our understanding of the best methods for restoring at-risk species and their habitat to achieve recovery of at-risk native species. With the limited understanding of genetic and behavioral differences between and within California *O. mykiss* ESUs, insufficient information exists to identify what is needed for recovery. By collecting scales through existing monitoring programs and angler catch, the project

will maximize existing opportunities to collect needed information to facilitate the identification and implementation of measures to ensure species recovery.

CALFED Science Program Goals in relation to the ERP

A basic premise of the CalFed Program is that five interconnected applications of science must progress together. These are 1) adaptive management, 2) monitoring, 3) interdisciplinary knowledge of critical unknowns, 4) improving the scientific basis of water management and 5) broad communication of science knowledge and scientific activities. The proposed project will help these applications progress in unison by providing information key to the adaptive management of *O. mykiss* populations. Presently little is known about the genetic relatedness of California *O. mykiss* populations, their abundance, the rates of expression of different lifehistories, nor how environmental cues may influence these rates and their survival.

Implementation Plan Priorities

The proposed project addresses three implementation plan priorities, one of multi-regional scale, one specific to the Sacramento Region and one specific to the San Joaquin Region. Priorities SJ4 and MR6, recognize the need to gain a deeper understanding of the needs of at-risk species, both regionally and throughout the Bay-Delta system. This requires studies designed to increase knowledge of the life-history dynamics of at-risk species. From the limited data that exists for Central Valley *O. mykiss*, we know that 3 life-history types exist; resident, fluvial and anadromous. Information is needed to identify the distribution, genetic relatedness and needs of each life-history strategy, and to determine the effects of environmental conditions on each. Further, there is a need to determine if environmental factors may influence the expression of anadromy or residency.

CVPIA and AFRP Goals consistent with the ERP

Section 3402 states the purpose and goals of the CVPIA. Two of these goals relate directly to the ERP and to the proposed project. The first is to protect, restore and enhance fish, wildlife and associated habitat in the Central Valley and Trinity basins. In order to reach this goal we must first develop an understanding of how to protect the and restore populations and their habitat. In the case of *O. mykiss*, this requires an understanding of how environmental factors such as flow and temperature may affect life-history expression and survival. The second goal of the CVPIA is to evaluate the effects of the CVP on fish and wildlife. New findings may support changes in operations to benefit all *O. mykiss* lifehistories equally.

Under section 3406(b)(1) the CVPIA authorizes the Anadromous Fisheries Restoration Program (AFRP) to develop within 3 years of enactment and implement a program which makes all reasonable efforts to ensure that, by 2002, natural production of anadromous fish in Central Valley rivers and streams will be sustainable, on a long-term basis, at levels not less than twice the average levels attained during the period of 1967-1991. Some of the objectives identified by the program to meet this goal are directly addressed by the proposed project.

First, the project seeks to improve habitat for all lifestages of anadromous fish by providing flows of suitable quality, quantity and timing and improved physical habitat. In order for this to occur we must first identify what life-history strategies are expressed, if the rate of expression is affected by environmental conditions and how the environment affects their survival. This requires that a second goal, to collect fish and habitat data, be addressed to provide the information needed to determine what is "suitable" for the optimum survival of the population and each life-history strategy within it.

2. RELATIONSHIP TO OTHER ECOSYSTEM RESTORATION PROJECTS

The San Joaquin River Management Program was established to develop comprehensive and compatible solutions to water supply, water quality, flood control, fisheries, wildlife habitat, and recreational needs in the San Joaquin River. This project will provide information to accurately describe *O. mykiss* behavior in the San Joaquin River and its tributaries, a necessity for the success of each of this program.

CALFED has funded many ecosystem restoration projects specifically focused on steelhead, including an assessment of life-history and stock composition in the Yuba River, a genetic comparison of the Clear Creek population to Mill Creek, Deer Creek and the Upper Sacramento River, and an evaluation of Central Valley Steelhead genetics. We propose to build on these projects by 1) providing genetic samples for comparison amongst all California *O. mykiss* populations, and 2) by providing life-history information for all populations.

The Salmon, Steelhead Trout, and Anadromous Fisheries Program Act directs the CDFG to implement measures to double the numbers of steelhead present in the Central Valley over 1988 population levels (DFG 1993, 1996). Again, without greater understanding of *O. mykiss* life-history strategies, the most effective measures needed to reach this goal cannot be identified.

3. REQUESTS FOR NEXT PHASE FUNDING

No request for next phase funding.

4. PREVIOUS RECIPIENTS OF CALFED PROGRAM OR CVPIA FUNDING

S.P. Cramer and Associates received CVPIA funding (AFRP and B2) for juvenile salmon outmigrant sampling on the Stanislaus River at Caswell State Park from 1997 through 2001. Funding was also received from the AFRP in 1999 for an evaluation of the use of radio-tagged juvenile chinook salmon to identify cause and location of mortality, and from B2 in 1999 for an evaluation of smolt survival in the Stanislaus River.

5. SYSTEM-WIDE ECOSYSTEM BENEFITS

The proposed project complements numerous completed and on-going projects throughout the Central Valley and the state of California, by providing new information about *O. mykiss* life-history and the genetic relationships within and between populations. Genetic data exists for samples collected in many areas by NMFS and CDFG, however not all streams are represented

and the number of samples analyzed is insufficient to draw meaningful conclusions. Life-history analysis has recently been conducted on the Yuba River, but is needed in other streams throughout the state to identify the most effective restoration measures for species recovery. Since the project builds upon existing monitoring programs, these analyses will complement information already being collected.

The scope of this project as proposed will not only provide information which will benefit the Bay-Delta system, but other California O. mykiss populations throughout the state. By studying all ESUs we will be able to compare genetics between all populations to further evaluate whether the current boundaries of the ESUs appropriately reflect the similarities and differences that exist between populations. Further, by evaluating life-history expression rates in multiple areas throughout the state we will likely gain a deeper understanding of this phenomenon in a shorter period of time because we will be sampling populations experiencing a wider range of environmental conditions.

6. ADDITIONAL INFORMATION FOR PROPOSALS CONTAINING LAND ACQUISITION

The proposed project does not involve land acquisition.

C. QUALIFICATIONS

Key Personnel:

Doug Demko, a Fisheries Biologist and Juris Doctor, will manage and coordinate the proposed project activities within SPCA and between the cooperating parties, and will supervise data analysis, interpretation and report preparation activities. Doug has worked in the Central Valley since 1990. He has led a variety of field sampling projects and has gained the respect of state and federal fisheries biologists as an expert in migrant fish sampling. His experience in the Sacramento-San Joaquin system is extensive, and includes leading research projects such as screw trapping, smolt survival studies, radio tracking, predator surveys, resident trout population estimates, habitat surveys, and limiting factors analyses. Additionally, he recently obtained a law degree which has furthered his understanding of water law and endangered species issues. The trust, respect and understanding of the issues he has gained by representing both stakeholders and the resource agencies, equips Doug with the skills to facilitate communication between diverse participants.

Andrea Phillips will coordinate and supervise field personnel and data collection activities and assist in data analysis and report preparation. Since 1995 she has assisted Doug in the coordination of field research activities on the Stanislaus River and other tributaries to the San Joaquin River which has required considerable networking and coordination with state, federal and local government personnel, private consultants, landowners and recreational groups.

Ray Beamesderfer will conduct the statistical analysis and provide expertise to the interpretation of the data. Ray has conducted original research and analyzed applied problems of fish biology for almost 20 years. He has extensive experience with salmon, steelhead, sturgeon, warmwater

sportfish, and nongame species; has published numerous scientific articles on fish sampling, population dynamics, and species interactions; and has special expertise in the use of statistics and computer modeling to solve difficult fish questions. He recently joined us from the Oregon Department of Fish and Wildlife where he analyzed Columbia River fish and fishery information to forecast runs, regulate sport, commercial and Treaty Indian fisheries, and assess Endangered Species impacts and risks.

Selected Project:

Status and Dynamics of Steelhead in California. Association of California Water Agencies (1994-95). SPCA was retained to lead a team of fisheries consultants throughout California to assemble and analyze available information on all steelhead populations in the state. We quantified several life-history characteristics of hatchery and wild stocks, and compared them to genetics data to identify Evolutionary Significant Units. We examined several indices of ocean survival of steelhead, including dam counts, hatchery returns, angler catch, diver counts, and juvenile densities. We produced two reports that were submitted to NMFS for their status review of steelhead as a candidate for ESA listing. The first was on the structuring and trends of steelhead populations throughout the state, and the second was on recommendations for restoring steelhead populations.

Corporate Qualifications:

S.P. Cramer & Associates, Inc. (SPCA) was established in 1987 to provide innovative problem solving on issues relating to salmon and trout on the Pacific Coast. We are reputed for our investigative work in determining why fish populations have or may change in response to specific actions. The core of the firm is composed of three Senior Fisheries Consultants, each with over 20 years of noteworthy experience. Our support staff includes a Biologist Project Leader, four Biologist Assistant Project Leaders, a Computer Applications Specialist, a Statistician, a Fisheries Facilities Engineer, a GIS specialist and a seasonal staff of 10 to 18 Fisheries Technicians.

SPCA has been conducting research within the Sacramento-San Joaquin Basin for public and private water rights holders, CAMP, and AFRP since 1990, and are therefore very familiar with basin issues, key watershed participants, and the actions necessary to conduct the proposed project. SPCA has conducted numerous fisheries investigations, monitoring and assessments in the Sacramento-San Joaquin basin. Past and on-going fisheries work include, but are not limited to annual monitoring of juvenile chinook outmigration, adult migrant trapping, radio tracking and electrofishing, analyses of hatchery contribution rates and a status review of west coast steelhead.

D. COST

The total cost for the 3 year project as proposed is $698,730. Should it be determined that CalFed would only fund this effort within the bounds of the Central Valley ESU, the project price would be $187,790. We caution however, that limiting the project to the Central Valley ESU will

limit the power of the analysis, though the insight obtained from this new information will still be of great value.

In comparison to similar projects underway, our proposed cost is reasonable. A project funded by CalFed on the Yuba River to evaluate life-history and genetics cost about $299,584 for a 3 year study. We will be conducting a very similar study but rather than limiting the focus to a single stream, our project as proposed will provide the same information for up to 60 streams throughout the state.

A similar project being conducted by CDFG was funded for approximately $175,000. Approximately $66,000 of their budget is for obtaining the samples to be analyzed, with samples collected from each location only once rather than over a period of time. We are seeking $215,950 to collect samples in all six California ESU's, which translates to approximately $36,000 per ESU, nearly one-half of CDFG's cost. This savings is made possible by using volunteers and existing monitoring programs to obtain the samples.

E. LOCAL INVOLVEMENT

Many fly fishing groups, CalTrout, Federation of Fly Fishers, Trout Unlimited, and other environmental activist groups are in support of the proposed project. Local involvement is a key component of the proposed project as we will rely on a network of private individuals, consultants and government agencies throughout the state to provide samples. We recently met with Dennis McEwan, CDFG statewide steelhead coordinator and the manager of the Central Valley steelhead genetic evaluation, to discuss the proposed project. He expressed support for the concept, including the need to study all California ESU's to better understand their relationship to the Central Valley, the expression of various life-history strategies, and the basic needs of *O.mykiss*.

F. COMPLIANCE WITH STANDARD TERMS AND CONDITIONS

The proposed project has been developed in compliance with all of CalFed's standard terms and conditions presented in Attachment D of the August 2001 PSP. The applicant has reviewed and will comply with CalFed's terms and conditions. The applicant also understands that the contract terms will apply to any sub-contracts that may be entered into to complete the proposed work. There are no conflicts of interest in performing this work.

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