Test and Demonstrate a Portable Alaskan Weir to Count and Characterize Runs of Anadromous Salmonids in the Stanislaus River

Project Information

1. **Proposal Title:**

   Test and Demonstrate a Portable Alaskan Weir to Count and Characterize Runs of Anadromous Salmonids in the Stanislaus River

2. **Proposal applicants:**

   Steve Felte, Tri-Dam Project

3. **Corresponding Contact Person:**

   Jason Reed
   Tri-Dam Project
   P.O. Box 1158 Pinecrest, CA 95364
   209 965-3996
   jason@tridamproject.com

4. **Project Keywords:**

   Anadromous salmonids
   Monitoring
   Salmon/Steelhead 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:**

   Local Agency

9. **Location - GIS coordinates:**

Latitude:	37.665
Longitude:	-121.238
Datum:	

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

The weir will be located on the Stanislaus River upstream of the confluence with the San Joaquin. The project site has not been positively identified, but will be located between Riverbank and the confluence with the San Joaquin on the Stanislaus River. Coordinates above are for a possible site 1/4 mile upstream of confluence.

10. **Location - Ecozone:**

    13.1 Stanislaus River

11. **Location - County:**

    San Joaquin, Stanislaus

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:**

    18

15. **Location:**

    California State Senate District Number: 12, 5

    California Assembly District Number: 25, 17

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: 659,590

b) Do you have cost share partners <u>already identified</u>?

Yes

If yes, list partners and amount contributed by each:

Tri-Dam Project $25,000 + in-kind services

c) Do you have <u>potential</u> 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**

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:**

Environmental Compliance Checklist

Test and Demonstrate a Portable Alaskan Weir to Count and Characterize Runs of Anadromous Salmonids in the Stanislaus River

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.

      The actions undertaken in the proposed project are for research only and will not require CEQA/NEPA compliance. The project will not be using any fill to complete the project, therefore, it should not require any CEQA/NEPA permitting.

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	Required, Obtained
CESA Compliance: 2081	
CESA Compliance: NCCP	
1601/03	Required
CWA 401 certification	Required
Coastal Development Permit	
Reclamation Board Approval	
Notification of DPC or BCDC	
Other	

FEDERAL PERMITS AND APPROVALS

ESA Compliance Section 7 Consultation	Required
ESA Compliance Section 10 Permit	Required
Rivers and Harbors Act	Required
CWA 404	Required
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.**

5. All permits that have been checked may not be required to complete the project, but as a precaution they were factored into the proposal. The actual site has not been selected yet, therefore, we do not know what type of permission will be necessary to access the land. We would like to select a site that is owned by the Army Corps. of Engineers and we are in the process of obtaining maps of their property in the lower part of the Stanislaus River.

Land Use Checklist

Test and Demonstrate a Portable Alaskan Weir to Count and Characterize Runs of Anadromous Salmonids in the Stanislaus River

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

Test and Demonstrate a Portable Alaskan Weir to Count and Characterize Runs of Anadromous Salmonids in the Stanislaus River

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):

Steve Felte, Tri-Dam Project

Subcontractor(s):

Are specific subcontractors identified in this proposal? Yes

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

Doug Demko	S.P. Cramer & Associates
Andrea Phillips	S.P. Cramer & Associates
Ray Beamesderfer	S.P. Cramer & Associates

Helped with proposal development:

Are there persons who helped with proposal development?

Yes

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

Chrissy Sonke S.P. Cramer & Associates

Dillon Collins S.P. Cramer & Associates

Comments:

Budget Summary

Test and Demonstrate a Portable Alaskan Weir to Count and Characterize Runs of Anadromous Salmonids in the Stanislaus River

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 steering committee	160	11980	320	0	100	0	0	0	12400.0	0	12400.00
2.1	Construct and install weir	420	22000	600	300	1000	0	30000	0	53900.0	0	53900.00
2.2	Determine number of upstream migrating chinook	1520	56140	1660	26000	8000	0	0	0	91800.0	0	91800.00
2.3	Determine number of upstream migrating steelhead	720	26710	790	12000	3000	0	0	0	42500.0	0	42500.00
3.1	Determine time of river entry by species and age	132	4956	144	0	50	0	0	0	5150.0	0	5150.00
3.2	Estimate age and life-history from scales	212	7676	224	0	50	0	15000	0	22950.0	0	22950.00
3.3	Determine stock and marked-group composition	12	876	24	0	50	0	0	0	950.0	0	950.00
3.4	Catalogue scale samples for genetic analysis	12	876	24	0	50	0	0	0	950.0	0	950.00
3.5	Estimate smolt per spawner and smolt to adult rates	12	876	24	0	50	0	0	0	950.0	0	950.00
4.1	Record and describe construction and maintenance	20	1520	40	0	0	0	0	0	1560.0	0	1560.00

4.2	Record and describe logistical requirements	20	1520	40	0	0	00	0	0	1560.0	0	1560.00
4.3	Provide full account of costs and manpower	20	1520	40	0	0	0	0	0	1560.0	00	1560.00
5.1	Compare the accuracy of estimates	36	3368	72	0	50	0	0	0	3490.0	0	3490.00
5.2	Identify differences in imformation between methods	36	3368	72	0	50	0	0	0	3490.0	0	3490.00
5.3	Compare costs and effort for both methods	20	1520	40	0	50	0	0	0	1610.0	0	1610.00
6.1	Distribute weekly progress reports	80	4840	160	0	0	0	0	0	5000.0	0	5000.00
6.2	Distribute annual reports	20	1610	40	0	300	0	0	0	1950.0	0	1950.00
6.3	Prepare presentations and findings	160	15680	320	0	100	0	0	00	16100.0	0	16100.00
		3612	167036.00	4634.00	38300.00	12900.00	0.00	45000.00	0.00	267870.00	0.00	267870.00

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**
2.1	Instal weir	136	7448	192	300	1000	0	0	0	8940.0	0	8940.00
2.2	Determine number of upstream migrating chinook	1520	56140	1660	26000	8000	0	0	0	91800.0	0	91800.00

2.3	Determine number of upstream migrating steelhead	720	26710	790	12000	3000	0	0	0	42500.0	0	42500.00
3.1	Determine time of river entry by species and age	132	4956	144	0	50	0	0	0	5150.0	0	5150.00
3.2	Estimate age and life history from scales	212	7676	224	0	50	0	0	0	7950.0	0	7950.00
3.3	Determine stock and marked-group composition	12	876	24	0	50	0	0	0	950.0	0	950.00
3.4	Catalogue scale samples for genetic analyses	12	876	24	0	50	0	0	0	950.0	0	950.00
3.5	Estimate smolt per spawner and smolt to adult rates	12	876	24	0	50	0	0	0	950.0	0	950.00
4.1	Record and describe construction and maintenance	40	2180	80	0	0	0	0	0	2260.0	0	2260.00
4.2	Record and describe logistical requirements	20	1520	40	0	0	0	0	0	1560.0	0	1560.00
4.3	Provide full account of costs and manpower	20	1520	40	0	0	0	0	0	1560.0	0	1560.00
5.1	Compare the accuracy of estimates	36	3368	72	0	50	0	0	0	3490.0	0	3490.00

5.2	Identify differences in iformation between methods	36	3368	72	0	50	0	0	0	3490.0	0	3490.00
5.3	Compare costs and effort for both methods	20	1520	40	0	50	0	0	0	1610.0	0	1610.00
6.1	Distribute weekly progress reports	80	4840	160	0	0	0	0	0	5000.0	0	5000.00
6.2	Distribute annual reports	20	1520	40	0	300	0	0	0	1860.0	00	1860.00
6.3	Prepare presentations and findings	160	15680	320	0	100	0	0	0	16100.0	0	16100.00
		3188	141074.00	3946.00	38300.00	12800.00	0.00	0.00	0.00	196120.00	0.00	196120.00

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**
2.1	Install weir	136	7448	192	300	1000	0	0	0	8940.0	0	8940.00
2.2	Deetermine number of upstream migrating chinook	1520	56140	1660	26000	8000	0	0	0	91800.0	0	91800.00
2.3	Determine number of upstream migrating steelhead	720	26710	790	12000	3000	0	0	0	42500.0	0	42500.00
3.1	Determine time of river entry by species and age	132	4956	144	0	50	0	0	0	5150.0	0	5150.00
3.2	Estimate age and lifehistory from scales	212	7676	224	0	50	0	0	0	7950.0	0	7950.00

3.3	Determine stock and marked-group composition	12	876	24	0	50	0	0	0	950.0	0	950.00
3.4	Catalogue scale samples for genetic analyses	12	876	24	0	50	0	0	0	950.0	0	950.00
3.5	Estimate smolt per spawner and smolt to adult rates	12	876	24	0	50	0	0	0	950.0	0	950.00
4.1	Record and desribe construction and maintenance	20	1520	40	0	0	0	0	0	1560.0	0	1560.00
4.2	Record and describe logistical requirements	20	1520	40	0	0	0	0	0	1560.0	0	1560.00
4.3	Provide full account of costs and manpower	20	1520	40	0	0	0	0	0	1560.0	0	1560.00
5.1	Compare the accuracy of estimates	36	3368	72	0	50	0	0	0	3490.0	0	3490.00
5.2	Identify differences in information between methods	36	3368	72	0	50	0	0	0	3490.0	0	3490.00
5.3	Compare costs and effort for both methods	20	1520	40	0	50	0	0	0	1610.0	0	1610.00
6.1	Distribute weekly progress reports	80	4920	80	0	0	00	0	0	5000.0	0	5000.00
6.2	Distribute annual reports	20	1610	40	0	300	0	0	0	1950.0	0	1950.00

6.3	Prepare presentation of findings	160	15680	320	0	100	0	0	0	16100.0	0	16100.00
		3168	140584.00	3826.00	38300.00	12800.00	0.00	0.00	0.00	195510.00	0.00	195510.00

Grand Total=659500.00

Comments.
The total cost of Task 1.2 will be paid for by Tri-Dam Project and is not included in the budget. Objective 3 includes collection of data and analyses to dramatically improve our life-history understanding of chinook and steelhead in the river. Objective 3 is not crucial to evaluating the ability of the weir to enumerate escapement and determine run timing. If necessary, Objective 3 (task 3.1-3.5) can be eliminated without affecting the integrity of the project, and would result in a reduction of total project cost.

Budget Justification

<u>Test and Demonstrate a Portable Alaskan Weir to Count and Characterize Runs of Anadromous Salmonids in the Stanislaus River</u>

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

A total of 7,470 technician hours, 588 Bio I hours, 520 Bio II hours, 514 Bio III hours, 48 Senior Consultant hours and 48 Principal Scientist hours have been budgeted for this 3-year project. Should objective 3 be eliminated, the required direct labor hours would be reduced to 6510 technician hours, 568 Bio I hours, 500 Bio II hour and 494 Bio III hours.

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 costs associated with operation of the company such as Project administration (invoicing, payroll, et.), 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 Principal Scientist $123/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/hr for insurance and all other categories receive $2/hr for insurance.

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

Travel costs include vehicle expense for traveling between the field site and SPCA's Oakdale office. Since the exact project location has not been determined we used the furthest distance possible. Travel costs reflect 60 miles per field visit at an average of 1.5 visits per day over the project period, times 7 days per week for 40 weeks each year. A small amount has also been included for travel and lodging needed by the Bio III during annual weir construction.

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

The project total for supplies and expendables is $38,500. Maintenance and replacement of field equipment such as buckets, nets, waders, thermometers, weir cleaning supplies, warning signs, locks, batteries, etc. will cost approximately $8,400 per year. Office supplies for the project are expected to cost approximately $2,000 per year and will include materials for report creation and distribution, data sheet organization and storage, copies, toner, etc. Communication costs associated with long-distance calls (including conference calls) and cellular phone usage are expected to cost approximately $200 per month ($2,400 per year). The year 1 budget calls for an extra $100 for communications cost incurred during establishment of the steering committee.

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.

All budgeted costs are for S.P. Cramer & Associates to complete this project as a subcontractor to the Tri-Dam Project. Tri-Dam Project's costs for project administration will be provided as a cost share.

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.

We estimate it will cost approximately $30,000 for the materials construct the weir. This is a one-time cost in year 1 and is estimated based on the costs incurred by operators of similar weirs in Alaska and will include such items as PVC piping, steel railing, miscellaneous attachment devices, stakes, plastic sheeting, and other equipment. Fifteen thousand dollars ($15,000) has been budgeted under objective 3 for scale reading equipment including image analysis software, a laboratory press, a digital camera, and miscellaneous other items. Should this objective be eliminated, this equipment will not be needed.

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.

Objective 6 consists of project management activities to be provided by SPCA and includes the composition of progress reports, presentations, and annual project reports. A total of 180 Bio I hours, 210 Bio II hours, 150 Bio III hours, 40 Senior Consultant hours, and 40 Principal Scientist hours have been budgeted for this objective for a total of $22,650 per year. Tri-Dam Project will provide their administrative services for additional project management as a cost share.

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.

All indirect costs are included in the billing rates and are explained in detail above under salaries. The billing rates include salary + benefits.

Executive Summary

Test and Demonstrate a Portable Alaskan Weir to Count and Characterize Runs of Anadromous Salmonids in the Stanislaus River

This project is a three year study to test and demonstrate the practicality of using a portable resistance board weir to (1) determine the total chinook salmon and steelhead escapement in the Stanislaus River, (2) allow for the collection of data on chinook salmon and steelhead currently not being collected, and (3) serve as a measure of accuracy of traditional carcass survey estimates in the Stanislaus River and on other Central Valley tributaries. Adult chinook salmon escapement in most Central Valley tributaries is currently inferred using conventional carcass mark-recapture methods (Boydstun 1994, Law 1994). Carcass-based abundance estimates require a series of underlying assumptions regarding random distribution of tagged carcasses and tag recovery effort, carcass visibility, and tag retention. Assumptions are largely untested but can substantially affect the accuracy of abundance estimates (Ricker 1975, Seber 1982, Cavallo 2000). Portable resistance board weirs (a.k.a. Alaskan weirs) are an alternative to carcass surveys that can provide direct, reliable counts of salmon and steelhead. These weirs are used by state and federal agencies in Alaska and are widely accepted to be an effective and efficient method of enumerating upstream migrants, even during periods of substantial flow fluctuations and debris loading. However, Alaskan Weirs have never been evaluated in California, even though there is considerable uncertainty regarding the accuracy of traditional carcass survey techniques used on most Central Valley tributaries. The Stanislaus River is an excellent location to evaluate weir performance for many reasons, including: the chinook stock is of natural origin with only little outside hatchery influence; juvenile chinook and rainbow trout/steelhead outmigration data has been collected in the basin since 1993, and thus excellent juvenile data is available and accurate adult returns would provide data for stock recruitment analyses; the weir is the only method capable of catching upstream migrating steelhead, which dont die after spawning and are not counted in traditional carcass surveys, and thus the weir could confirm their presence, abundance, and run-timing in the San Joaquin Basin; if steelhead are captured, the weir would be an excellent source of data to identify both ocean-run and possible estuary-run fish, which would aid future management and recover efforts in the San Joaquin Basin; the controlled releases of water from upstream reservoirs and the relatively low spring flows would allow for continuous operation of the weir; and matching funds by Tri-Dam Project, South San Joaquin Irrigation District, Oakdale Irrigation District, and Stockton East Irrigation District have provided funds for the early initiation of the permitting process, such that the weir could be operational as soon as CalFed funds were available, possibly by the start of upstream migration in September 2002.

Proposal

Tri-Dam Project

Test and Demonstrate a Portable Alaskan Weir to Count and Characterize Runs of Anadromous Salmonids in the Stanislaus River

Steve Felte, Tri-Dam Project

TEST AND DEMONSTRATE A PORTABLE ALASKAN WEIR TO COUNT AND CHARACTERIZE RUNS OF ANADROMOUS SALMONIDS IN THE STANISLAUS RIVER

A. PROJECT DESCRIPTION: PROJECT GOALS AND SCOPE OF WORK

1. PROBLEM

Accurate estimates of adult salmon escapement are key to valid assessments of stock status and effective protection or recovery efforts. Biased estimates of abundance can result in significant errors in fishery management and faulty assessments of the needs for water management, habitat restoration, or other measures (Walters and Ludwig 1981, Rivard 1989, Hilborn and Walters 1992, Hinrichsen 2001). Uncertainty in fish status can also necessitate more conservative management to buffer the risks associated with the uncertainty, especially for sensitive fish stocks protected by the Federal Endangered Species Act (ESA). Costs associated with errors and uncertainty in stock assessment can be significant. In recent years, large amounts of effort and money have gone into salmonid restoration throughout the state. However, the effectiveness of restoration actions is difficult to judge because there is no way to directly enumerate adult salmon in most California tributaries where hatcheries do not exist.

Adult chinook salmon escapement in most Central Valley tributaries is currently inferred using conventional carcass mark-recapture methods (Boydstun 1994, Law 1994). This method involves recovering spawned-out carcasses, marking with jaw tags, and distributing back into the stream. The streams are then surveyed weekly during the spawning season, and the rate of disappearance from the previous week's tagged carcasses is used to estimate sampling efficiency. Total abundance is estimated from carcass surveys based on observed numbers of marked and unmarked carcasses.

Carcass-based abundance estimates require a series of underlying assumptions regarding random distribution of tagged carcasses and tag recovery effort, carcass visibility, and tag retention. Assumptions are largely untested but can substantially affect the accuracy of abundance estimates (Ricker 1975, Seber 1982, Cavallo 2000). The accuracy of the estimates is influenced by factors such as surveyor experience, weather, flow, turbidity, canopy cover, time of day, pool to riffle ratio, sinuosity, water depth, density of fish, channel morphology, fish behavior, and other biases that cannot be assessed. It is also unclear how the technique for placing carcasses back in the stream affects the probability of disappearance before the next survey. Surveyors release the marked carcasses in the middle of the stream to mimic a dying fish, but carcasses naturally tend to collect in specific locations in each stream and whether tagged carcasses re-lodge in the stream in a manner similar to dying fish is problematic. The time between each survey can also affect the recapture rate of carcasses, and most statistical techniques recommend more frequent surveys (every 3-5 days), which can be difficult to accomplish and expensive. In addition, this technique does not provide the most accurate data concerning the run timing chinook on the Stanislaus. In recent years adult fish have been seen spawning in the Stanislaus as early as August, significantly sooner than when carcass surveys begin, and in 2000 there were reports that adults were present near Knights Ferry as early as June.

The Stanislaus fall chinook population is large and consists almost entirely of natural origin fish. Excellent return data is widely available in other systems where hatcheries are present, but escapement estimates in wild systems are often confounded by the extended duration of the spawning season and dispersed but nonrandom spatial distribution patterns. Escapement estimates and potential biases in estimates using carcass mark-recapture estimates are heavily dependent on the incidence of hatchery strays. Results in systems where hatchery fish comprise a significant portion of the run may not be applicable to predominately wild systems.

At a recent Central Valley spawner escapement workshop, representatives from CDFG, NMFS, and DWR agreed that they have low confidence in the accuracy of spawning surveys (by current methods), and new systems are urgently needed that will enable managers to confidently estimate run sizes. The accuracy of abundance estimates based on carcass mark-recapture can be estimated by comparison with known numbers of fish (Simpson 1984; Shardlow et al. 1987). If accuracy could be estimated and biases were detected, correction factors could be developed for application to future sampling and also to historic data. However, published studies describing the accuracy of mark-recapture estimates of salmon escapement are scarce (Cousens et al. 1982).

Portable resistance board weirs (a.k.a. Alaskan weirs) are an alternative that can provide direct, reliable counts of salmon and steelhead, which can be compared to escapement estimates to determine their accuracy. These weirs are used by state and federal agencies in Alaska and are widely accepted to be an effective and efficient method of enumerating upstream migrants, even during periods of substantial flow fluctuations and debris loading. We are requesting funding for a three-year study that would test and demonstrate the value of using a portable resistance board weir to determine the total chinook escapement in the Stanislaus River, measure the accuracy of carcass surveys, and gather biological data from the fish.

2. JUSTIFICATION

Working Hypotheses Being Tested

We have identified eight "working hypotheses" that the described study plan would address. These hypotheses are important to salmon and steelhead management in the Stanislaus River, San Joaquin Basin, and many other Central Valley tributaries.

Table 1. Working hypotheses addressed by the proposed study.

1	Alaskan weirs can be installed and fished seasonally with limited manpower and maintenance to provide full counts of adult salmon and steelhead migrating to spawning areas.
2	Run sizes determined at the weir can be used to evaluate biases in traditional carcass surveys, and to estimate correction factors that can be applied to historic and future carcass surveys.
3	Assumptions required to estimate run size from carcass surveys, such as representative sampling of the population either at tagging or tag recovery, equal visibility of tagged and untagged carcasses, tag retention, and opportunity to complete sampling throughout the spawning season, are often violated and affect the accuracy of abundance estimates.
4	Traditional carcass survey techniques provide inaccurate data on run-timing of chinook in some years, and provide no data on the abundance or timing of steelhead in the river.
5	Sampling of lengths, scales, and entry timing of steelhead at the weir will provide conclusive information on the timing, number, and rearing life-history of steelhead migrating into the Stanislaus River. Although snorkel surveys are able to identify large rainbow trout adults, they cannot conclusively determine life-history of the fish observed.
6	Sampling of lengths and scales from chinook salmon at the weir will provide conclusive information on the timing, and number of fish at each age and from each brood year that enters the river. On the other hand, scale samples from carcasses provide a biased estimate of size and age distribution, because larger carcasses have a higher probability of recovery

7	Accurate adult chinook salmon counts, combined with accurate juvenile outmigration estimates already available, will allow us to quantify density dependent survival for adult-to-outmigrant and outmigrant-to-adult life segments, and to detect the effect of flow, temperature or other environmental factors on survival during these life segments.
8	Operation of an Alaskan Weir near the mouth of the Stanislaus River will allow managers to accurately evaluate the effects of fall attraction flows on river entry of fall chinook, thus providing information which will aid future resource management.

Direct counts provided by a weir would allow us for the first time to accurately determine adult salmon escapement in the Stanislaus River. Direct counts would provide a means of validating carcass survey results, estimating the uncertainty in those estimates, and developing a correction factor for estimates, should there be differences in actual and estimated abundance. All estimates of naturally spawning salmon in California are estimated based on carcass survey techniques. Thus, the evaluation of the carcass survey techniques as used on the Stanislaus would provide a basis for evaluating state-wide procedures. If there were a large discrepancy between the actual count and the carcass estimate in the Stanislaus River, managers elsewhere would be alerted to possible problems with their own estimates. Conversely, if Stanislaus escapement techniques are found reliable, similar techniques could continue to be used elsewhere, or at least serve as evidence that other estimates are valid.

Since each fish could be handled we could obtain sex and length frequency data, determine the number of jacks (age 2 fish), and look for evidence of disease and previous trauma, such as scarring. In addition, weir counts would also allow us to collect other critical information on sample sizes which are not provided by carcass surveys, including detailed information on steelhead occurrence, coded wire tags, fish movement patterns, stray rates, survival rates, recruitment rates, and the relative effects of in-basin habitat, water management, and ocean conditions.

This weir project is the only method capable of answering questions concerning the abundance of steelhead in the San Joaquin Basin. Unlike salmon, steelhead do not die after spawning and therefore do not show up in carcass surveys, and as a result are not enumerated each year. Although snorkel surveys are able to identify large rainbow trout adults, without direct observation and scale analysis it is impossible to conclusively determine life-history. Weir operation, on the other hand, will provide the timing and number of steelhead migrating into the Stanislaus River. Further, through scale collection and analysis we can determine the life history of each fish captured, and evaluate the relatedness of fish captured in the Stanislaus to stocks in other basins. A representative sample of scales could be collected from steelhead, as well as chinook, which could be used to estimate age and growth rates. Also, DNA obtained from scales could be used to determine genetic similarity to other San Joaquin and Sacramento basin stocks.

Recently, a CDFG and NMFS Joint Hatchery Review Committee conducted a review of state-wide hatchery practices in California, and made specific recommendations to improve management of Central Valley stocks. One recommendation identifies the need to recover marked fish, and to accurately assess current escapement procedures, and reads:

> *All agencies should pursue efforts to develop adequate sampling programs to recover marked fish in the Central Valley. The CDFG should establish a process to coordinate and oversee the methodologies for estimating salmon escapements to the Central Valley.* (CDFG and NMFS 2001)

The recovery of CWT's in the Stanislaus is currently low. The weir would allow us to estimate the number of CWT's in the run based on the presence of adipose fin clips and to increase recovery rates of CWT's which will in turn increase our ability to estimate survival and stray rates and to relate those rates to specific factors. Likewise, the number of fin-clipped steelhead entering the basin could be determined.

Weir Description

Resistance board weirs are an array of rectangular panels that consist of evenly spaced polyvinyl chloride (PVC) pickets that are aligned parallel to the direction of stream flow. The upstream end of each panel is hinged to a rail that is anchored in the stream bottom, and the downstream end is held at the water surface by a resistance board that planes upward in flowing water (Figure 1). When the panels are installed, the barrier inhibits upstream adult salmonid migration while allowing water to pass.

Resistance board weirs are portable and a relatively new alternative to other weirs. They are capable of consistently providing reliable information in streams that experience debris- laden high water periods (Tobin 1994). Resistance board weirs are more capable than traditional weirs of withstanding high and fluctuating flows, and will temporarily submerge when pressure created by debris loading reaches a point that would wash a traditional weir downstream. Small downstream- floating debris which is impinged against the weir is removed on a daily basis, whereas most larger debris passes over the weir due to its ability to lay down under pressure. Once the debris passes over the weir it returns to its normal operating position. A small proportion of fish may pass over the weir during brief periods that debris causes it to lay down, but this number can be estimated by marking fish at the weir and later determining the proportion of fish upstream that are unmarked.

One or more openings in the weir allow fish to be directed into a containment area, or permits them to be counted as they pass through (Figure 2). As a result of our experience with fluctuating flows and periods of high debris loading on the Stanislaus, we believe this type of structure would work well for the purposes described in this proposal.

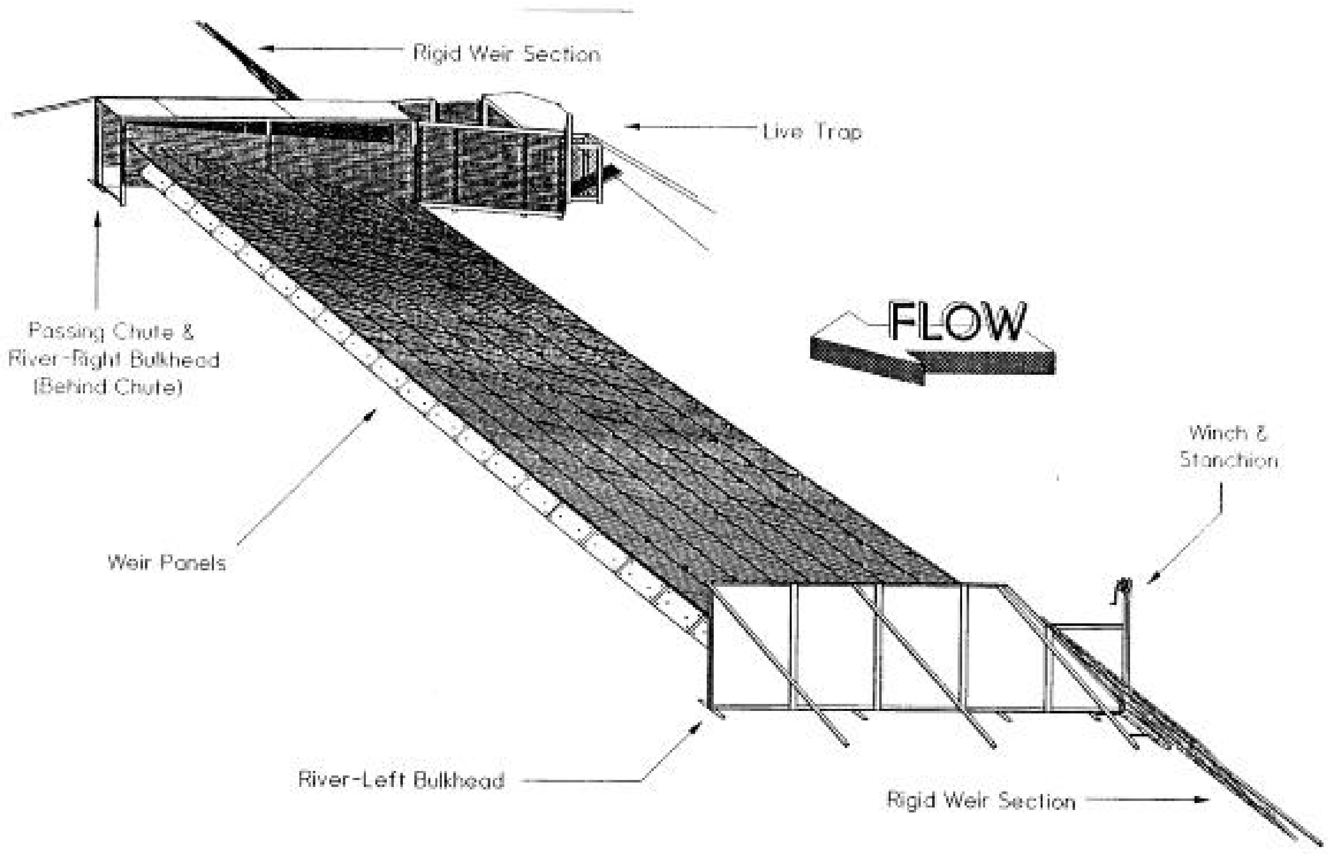

Figure 1. Example of a resistance board weir used by the USFWS in Alaska. (Diagram reproduced from Tobin 1994)

Figure 2. Photographs of two resistance board weirs in Alaska.

3. APPROACH

To accomplish this project, we have defined six objectives and then described the set of tasks necessary to accomplish each (Figure 3). The descriptions follow.

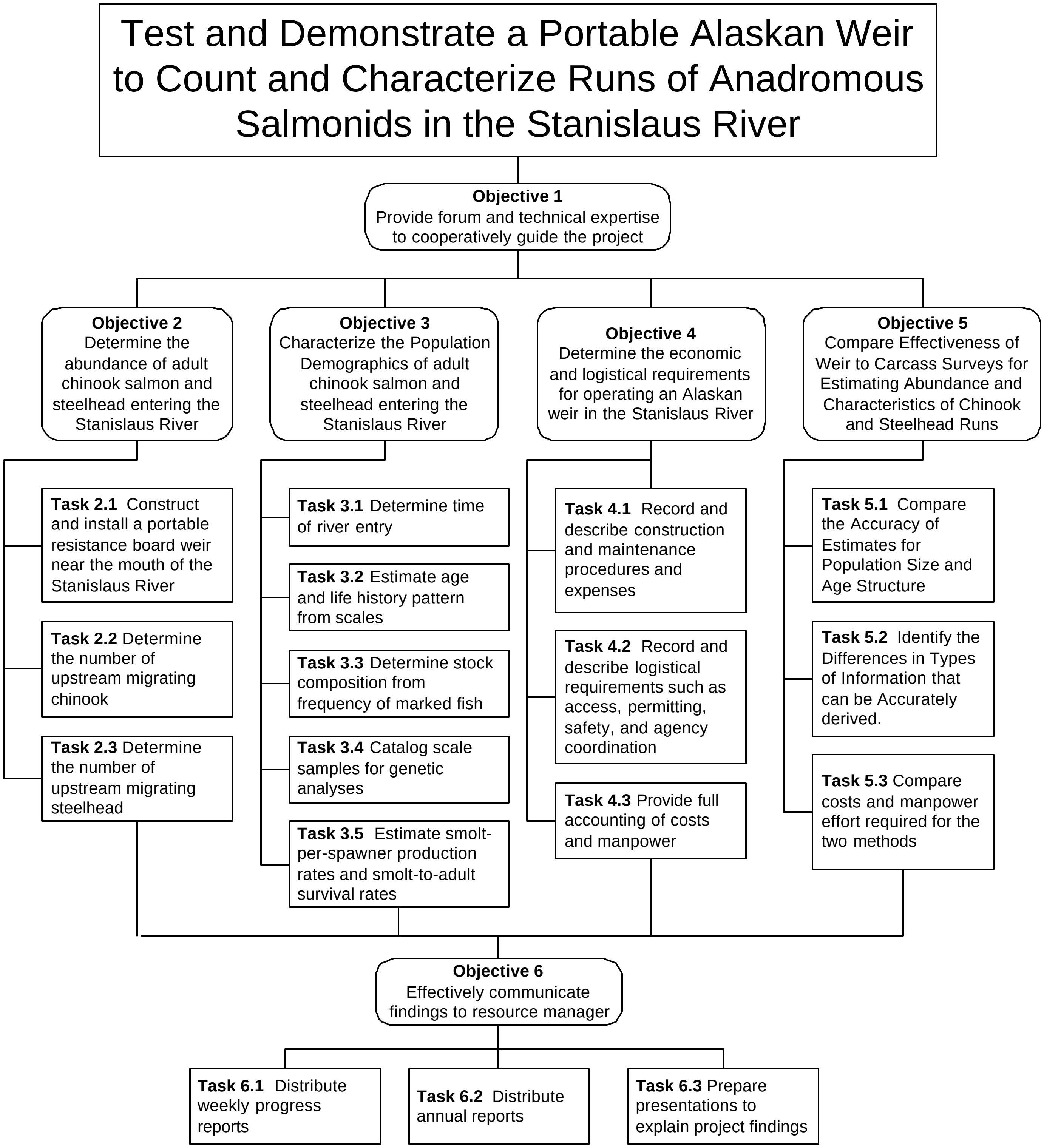

Figure 3. Step-down diagram of project objectives and tasks.

Objective 1. Provide forum and technical expertise to cooperatively guide the project and perform logistical tasks necessary to construct and operate a weir in the Stanislaus River.

Task 1.1 Establish Stanislaus River weir project steering committee.

Since this project will be the first of its kind in California, we will establish a technical steering committee consisting of agency and private biologists to oversee all aspects of the project. Since the project is designed to evaluate chinook escapement, the newly formed Central Valley Escapement Project Work Team would be the logical choice to serve as the steering committee. The leader of the group has suggested that this would be an ideal role for the group. In addition to the escapement team, we will make sure that at least one representative from CDFG Region IV participates on the steering committee. The group will be responsible for reviewing operation practices, including the final weir design and project implementation plan, as well as ongoing monitoring efforts. In addition to weekly e-mail project summaries, we will present quarterly progress reports to the escapement group and the Stanislaus Fish Group.

Task 1.2 Obtain the necessary state and federal permits to operate the weir and conduct public outreach.

Permitting

Issues of concern associated with the installation and operation of the Stanislaus weir include impacts on endangered and/or threatened species in the area affected by the project, the hindrance of navigation by boat, alteration of the river bottom and shoreline, and the destruction or removal of riparian vegetation. The permitting process to address these issues has already been initiated with NMFS and USACE to ensure that we will have permits at the proposed start date of September 2002. Funding for the permitting process was provided by Tri-Dam Project and is being factored in as part of their "matching funds" contribution. No stumbling blocks in gaining the necessary permits from NMFS and USACE have been encountered.

Public Outreach

Through the permitting process of the weir project environmental and river use alteration concerns may be raised. Although these concerns can be dealt with through the proper agency notifications, consultations, and approvals, the public will remain a key player in the process. A public meeting will be scheduled upon project approval where landowners, fishermen, recreational river users, and other concerned parties will be informed of project functions, goals, and implications. Participants will be given the opportunity to voice concerns and meet with project leaders. Information regarding who uses the river in and around the project location, how often the site is accessed by users, and what type of vessels users are operating, will be collected from meeting participants via a written survey. This data will be used during the process of USACE Section 10 permitting and will allow project leaders to properly choose mitigation options that will allow for normal river usage.

Objective 2. Determine adult chinook salmon and steelhead run timing and abundance in the Stanislaus River.

Task 2.1 Construct and install a portable resistance board weir near the mouth of the Stanislaus River.

Resistance board weir sites are similar to sites described by Clay (1961) and Tobin (1994), and are characterized by wide, shallow stream areas with stable substrate. A site with laminar flow which is relatively straight is preferred, to minimize wear on the weir and prevent bank and bottom erosion.

We have surveyed the lower Stanislaus River and have located several suitable locations to install the weir. One sight at river mile 0.3 (Figure 4), is well-suited for several reasons. First, the site is approximately 110 feet wide with a uniform bottom that is a constant depth of 3 feet at 495 cfs. In addition to making fabrication and installation easier, the uniform depth prevents fish from passing under or over the weir by allowing for a uniformly shaped weir that interfaces well with the river bottom. The level river bottom also minimizes problems that can be caused by scouring, which is encouraged by irregular bottoms and securing devices that are necessary in less suitable locations. Recent work conducted on the Noyo River by CDFG suggests that sandy river bottoms may be unstable at high flows, so measures may be necessary to stabilize the weir or prevent scouring when the river rises. The wide river location would help maintain weir integrity and enable it to operate during high flow events by reducing river elevation changes (Figure 5). Further, the location's width would provide adequate area to construct a recovery sight where, after processing, fish can rest and resume their migration at will.

In addition to the site at river mile 0.3, we have identified several other possible sites upstream as far as river mile 9. Each of the sites is conducive to weir construction, with some providing better vehicle access and possible amenities such as electrical power and telecommunication access. One significant factor in final site selection is boat traffic. Although the boats will be able to pass over the weir, it is desirable to locate it in an area where boat traffic is minimal, such as immediately upstream from a log-jam. Final site selection is currently underway, and is dependent on different issues with several agencies. For instance, the USACE has suggested that by using their land for river access, we could bypass traditional landowner concerns, such as liability. Further, other agencies would view this as support of the project, which could help with permitting requirements.

Resistance board weirs are common in Alaska and therefore have been field tested and modified repeatedly. We will use the latest design which will enable boat traffic and large debris to pass over the weir. Although we will use the latest USFWS weir design as a template, the weir will be constructed locally and modified to suit the particular stream site. Although the majority of the weir is made of flexible PVC pipe, some of the critical structural components are made of steel and aluminum. To fabricate these metal parts we will use a machine shop located in Oakdale that has done specialized design and fabrication for us since 1993. Because the shop is located in the river's vicinity, the designers can inspect and conduct repairs on location. The ability to make repairs to equipment (e.g. screw traps) without removing them from the river has saved us considerable time and labor in the past.

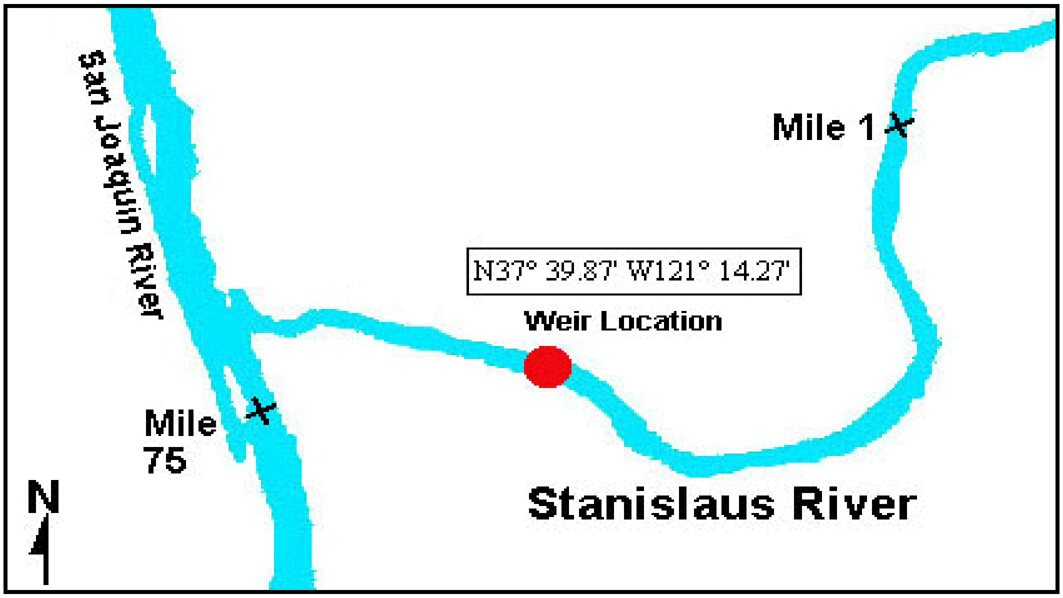

Figure 4. Map of Stanislaus River showing possible weir location relative to the confluence with the San Joaquin River.

Figure 5. Photograph of Stanislaus River at a possible weir location site. Note the wide river channel and uniform flow and banks.

Task 2.2 Determine the number of upstream migrating chinook as they enter the Stanislaus River.

The weir design will be such that we will be able to capture and contain all upstream migrating fish. The weir will be operated throughout the primary migration time for adult chinook salmon from September through December. Fish will be contained in a large area with flowing water and will be processed for release upstream several times per day. To ensure no undue migrational delays the weir will be staffed in the evening and early morning periods, when adults are believed most active, and fish will be processed as they arrive in the containment area. During high abundance periods we will increase staffing to 24 hours per day to ensure that fish are not subject to undue delays or a crowded environment, which could cause unnecessary stress. To help ensure that the weir is operating at full efficiency we will conduct weekly SCUBA and snorkel surveys of the weir to make sure it is structurally sound.

Handling procedures will be similar to those developed by the USFWS in Alaska. Prior to the capture of any fish, it will be documented in writing and distributed to local fisheries agencies and the steering committee for review. At the earliest opportunity we will host a field trip such that agencies can independently evaluate the weir and procedures. In case there are periods when fish are too numerous to handle without delay, or for some other reason we wish to count the fish but not handle them, the design will then be modified so that fish can move upstream through a narrow passage. If injuries are being sustained, we will see signs of physical harm on fish during our processing, and take appropriate action to reduce or eliminate the cause.

During the first year of the three-year operation we will also explore methods of enumerating fish which do not require handling, and which could also reduce future labor costs. Underwater video recording is one method which may allow for accurate counts without handling fish, and which may prove valuable at other locations with threatened or endangered species. Use of video equipment to record fish passage could make it possible to trap and handle fish only a portion of the time for a systematic sampling of scales, tags or other biological data.

Since some researchers have documented the reluctance of some species to move upstream through narrow constrictions and enter containment areas, it may be necessary to modify the weir passage opening, or enlarge the containment area. To reduce the risk of migration delays we will evaluate different weir passage and containment devices and select the ones that are most appropriate to conditions and species found in the Stanislaus River. At the onset of build-up and operation, we will conduct daily snorkel surveys and count any fish below the weir. If an obvious substantial delay of fish occurs, we will open the weir and allow the fish to pass, then modify the weir to try to reduce migration delays. We recognize that this could be a problem and will have back-up passage and containment plans ready for implementation.

Some researchers have also noted that complete weir counts can be difficult to obtain, especially if high flows prevent the operation of the weir for substantial periods of time. With the steering committee we will consider the value of marking adult chinook (not steelhead) that pass the weir such that mark recovery rates during carcass surveys could serve as a means of evaluating the effectiveness of the weir at catching fish.

Task 2.3 Determine the number of upstream migrating steelhead as they enter the Stanislaus River

Recently, fishery managers have expressed interest in operating the weir through spring to enumerate and collect biological information from steelhead, which may migrate upstream as late as April. Therefore, we will operate the weir from December through April to count steelhead and fluvial rainbow. Enumerating steelhead in the Stanislaus River is considered a priority issues by many fishery managers, since unlike chinook, steelhead do not die after spawning and therefore cannot be counted in the river. Because of this, there is currently no information on the number or timing of steelhead entering the Stanislaus River. Operation of the weir will be as described in the previous task for chinook. Operation during December may produce counts of both steelhead and chinook, but low numbers of both, so procedures will remain the same as other months.

Objective 3. Characterize the population demographics of adult chinook salmon and steelhead entering the Stanislaus River.

We understand that there are serious management issues which need to be addressed when working with naturally-produced chinook salmon and ESA protected steelhead. Therefore, fish handling and data collection procedures will be determined prior to weir operation during a facilitated process with CDFG, NMFS, USFWS, and the steering committee. We present different possibilities here to relate the unique opportunity to collect a substantial amount of biological information from a stock of chinook salmon which has had little hatchery influence, and on steelhead, a species which almost nothing is known about its abundance or life-history characteristics in the San Joaquin Basin.

Objective 3 includes collection of data and analyses to dramatically improve our life-history understanding of chinook and steelhead in the river. Objective 3 is not crucial to evaluating the ability of the weir to enumerate escapement and determine run timing. If necessary, Objective 3 (task 3.1-3.5) can be eliminated without affecting the integrity of the project, and would result in a reduction of total project cost.

Task 3.1 Determine the timing of river entry by species and age.

Timing of river entry will be established by counting and passing fish upstream daily throughout the runs of chinook and steelhead. The weir will be installed low in the river, so that time of passage approximates the time of river entry. Run timing often varies by age and sex, so the time-frequency distributions over which fish enter the river will be determined separately for each age and sex of each species.

Since the weir will be operating near the mouth of the river, we will be able to monitor the response of salmonids to fall attraction flows and other environmental variables.

Task 3.2 Estimate age and life-history pattern from scale samples.

In order to determine the life-history of returning adults we will sample scales, determine sex, and measure lengths from a systematic subsample of the run. Significant information can be obtained through scale analyses, including age, length at age, length and date at ocean entry, age at ocean entry, and annual growth rates. Age at maturity differs between the sexes, so we will identify sex of the fish sampled, based on external characteristics. Although some scales are recovered during carcass surveys, large carcass have a greater chance of being recovered, so all size classes are not sampled equally. Because the weir will capture all sizes of fish equally, systematic sampling over time should produce a representative sample of all age groups. The exact proportion of chinook that will be sampled for scales will be determined by the steering committee, will fluctuate with run size, and will likely be in the neighborhood of 20% of the run in an average year. Sample rates will be designed to provide statistical power for analyses consistent with desired confidence levels.

Few, if any scales have ever been collected from steelhead in the Stanislaus River. Since scales would provide valuable information for our understanding of the life-history characteristics and future management of the species, and run sizes are expected to be small, we will sample a larger fraction of the population, perhaps up to 50%. The proportion sampled will be determined through consultations with NMFS and the steering committee.

Several life histories of rainbow/steelhead maybe present in the river, including (1) fish that remain close to their natal area throughout their life, (2) fish that migrate substantial distances up and down the river to find advantageous habitat in freshwater, and (3) fish that migrate to the ocean and then return to spawn. All three life histories might be generated from the same population. It is currently unclear to what extent steelhead are produced by the system and how resident rainbow trout and steelhead populations are related. Scale and DNA samples collected at the weir will provide a systematic quantitative basis for resolving these questions. Further biological markers such as sea lice will be observed and can confirm that the fish reared saltwater.

Task 3.3 Determine stock and marked-group composition from frequency of marked fish.

All fish processed at the weir will be examined for any type of external marking, including fin clips, scarring, and presence of parasites. Scarring from marine mammal attacks or presence of marine parasites can be used to confirm that fish reared in the ocean (this is an issue with large rainbow that could be either fluvial or anadromous). The presence of a clipped adipose fin will indicate hatchery fish that have been injected with a coded wire tag (CWT) . If the steering committee and sampling permits agree that some CWT fish should be sacrificed, we will be able to determine the specific marked group to which these fish belong. We can then estimate stray rates and origin of fish from other stocks.

Coded wire tags are currently placed in a subsample of smolts released from hatcheries throughout the Central Valley. Analysis of coded wire tag recovery data is often limited by sample sample sizes but weir operation will maximize opportunities to sample CWT fish. Postponing recovery until carcass sampling allows the fish to spawn but can substantially reduce sample sizes, because not all carcasses are recoverable. At the very least, we will be able to determine the number of adipose-clipped salmon passing the weirs. Decisions to sacrifice CWT fish at the weir will be made by the steering committee. If CWT's are not released inbasin, then all CWT fish would be strays and could be sacrificed without impacting the native stock. If the run is large, CWT fish might also be sampled without impacting net production. Alternatively, only males might be sacrificed because they are typically in surplus and do not limit net production.

CWT recoveries from other sources provide information on populations which contribute to the Stanislaus population. Comparisons of tag rates in the Stanislaus with tag rates in the source population provide an estimate of what proportion of the run includes strays from a given source. Straying information indicates to what degree the natural population is self-sustaining and helps provide a complete accounting of hatchery contributions in other hatchery evaluations.

CWT recoveries from release groups made within the Stanislaus Basin would provide the means of evaluating the adult contribution of various life-history stages. For instance, recovery rates of fry and smolt migrants could be compared to determine if pre-smolt migrants survive in significant numbers or if the population is driven by smolt numbers. These results would have significant implications for habitat and water management in the system.

Task 3.4 *Catalog chinook and steelhead scale samples for genetic analyses.*

Genotypes of fish from each species can be determined by extracting DNA from scale samples. Thus, genetic samples will be obtained from the same set of fish used to determine age and life-history composition. Genetic analyses are costly and not crucial to the integrity of this project, so samples will only be collected and catalogued, not analyzed. DNA genotypes can be used to evaluate relatedness to other Central Valley stocks and to distinguish any genetic uniqueness of all or part of the run. One open question that can be tested is whether anadromous rainbow are genetically similar to resident and fluvial rainbow.

Task 3.5 *Estimate smolt-per-spawner production rates and smolt-to-adult survival rates*

Once weir operation begins, both the number of adults entering the river and juveniles leaving the river will be known. Screw traps have been used to collect data on outmigrating juvenile chinook and rainbow trout since 1993. Since 1998 traps have operated at both Oakdale (river mile 40) and Caswell (river mile 8) from late December through June. This extensive sampling period, coupled with frequent trap efficiency tests at both locations, has enabled managers to estimate the number of juvenile chinook that migrated past each trapping site, each year.

Adult and juvenile abundance estimates for the Stanislaus River would provide detailed status information on salmon and steelhead populations at various points in the life cycle. Partitioning of status by life stage makes it easier to identify the effects of limiting factors including freshwater rearing habitat, survival during outmigration, and ocean survival. The Stanislaus populations can serve as useful indicator stocks for other salmon and steelhead populations in the San Joaquin Basin.

Comparisons of numbers of spawners and smolts or other juveniles produced by that cohort of spawners provides information on the productivity and capacity of the freshwater rearing habitat. Density-dependent relationships between spawners and recruits and the relative importance of environmental variation can be identified with a time series of this data. Stock-recruitment relationships can potentially be derived for use in identifying optimum escapement levels and appropriate harvest levels. Smolt-per-spawner data can also be related to environmental conditions including flow and temperature management to provide an empirical basis for evaluating the benefits of various alternatives.

Comparisons of smolt numbers and adults produced at various ages by that smolt cohort provides information on downstream migration and ocean survival conditions. Corresponding estimates of smolt-to-adult survival rate allow us to determine the extent to which conditions outside the basin affect the population, and to project the benefits of in-basin activities which affect the number of smolts produced.

Objective 4. Determine the economic and logistical requirements for operating an Alaskan weir in the Stanislaus River.

Task 4.1 Record and describe construction and maintenance procedures and expenses.

Since this will be the first resistance board weir constructed and implemented in California, we will go to considerable lengths to document the entire building process including the materials needed, their costs, and the labor required to construct the weir and monitor it throughout the season. This detailed documentation of the process will help other managers plan and implement a similar project successfully in the future.

The detail of the design will include schematic diagrams of the weir such that the weir can be reproduced with the exact materials and to the exact dimensions. Digital photographs will be taken of the design, construction, and completed weir, including an itemized equipment list with the cost of each item. All information will be posted on the internet on a real-time basis, so that managers can track the progress and expenses of the project as it occurs. The information will also be included in a written report at the completion of the project.

Task 4.2 Record and describe logistical requirements such as access, permitting, safety, and agency coordination.

All logistical requirements that go along with fabricating, installing, and maintaining the weir will be recorded and described. This information will be useful to others who want to consider installing a weir in another stream.

Task 4.3 Provide full accounting of costs and manpower.

We will fully account for all costs, including permitting, fabricating, installing, monitoring and maintaining the weir. The full cost accounting will be useful for determining if the information gained is worth the cost of operating a weir.

Objective 5. Compare effectiveness of weir operation to carcass surveys for estimating abundance and characteristics of chinook and steelhead runs.

Because this is a demonstration project, we will provide full documentation of the information gained and costs incurred, so that others can judge if this method of sampling would be cost effective for their particular need. Cost effectiveness must be determined from a combination of the data accuracy, range of topics addressed, and costs. Each of these components of effectiveness is identified as a Task.

Task 5.1 Compare the accuracy of estimates for population size and age structure.

We will compare the estimates of population size, run timing and life-history composition obtained from sampling with the weir to that from sampling spawner carcasses. Since the weir will allow boats and debris to pass, but will block the entire river to upstream migrating salmon, our catch rate should be nearly 100%, and will serve as a total count of adult salmon entering the Stanislaus River. We also have the option of marking a subsample of adults at the weir and using recaptures from carcass survey counts to determine the weir efficiency. By operating the weir over different environmental conditions, we may be able to determine what environmental factors are responsible for the difference in actual count and estimates abundance from carcass surveys. This may enable us to develop a calibration factor for future carcass estimates. This calibration factor may also allow us to validate past escapement estimates.

Task 5.2 *Identify the differences in types of information that can be accurately derived from the two sampling methods.*

Each method of sampling to estimate abundance of anadromous fish runs has its advantages and disadvantages. For example, carcass surveys also provide information on spawning distribution, while a weir provides unique information on timing of river entry. These differences in types of information gained will be described.

Task 5.3 *Compare costs and manpower effort required for the two methods.*

The information from Task 4.3 will be used in this task for comparison to carcass surveys.

Objective 6. Effectively Communicate Findings to Resource Managers.

Task 6.1 *Distribute weekly progress reports to keep other fisheries resource managers informed*

Our experience has taught us that there are significant benefits of keeping others informed of our progress on a regular basis. We will distribute written e-mail reports 1-2 pages long which explain important events and document the biological data. The weekly progress reports will also be kept on an internet site such that they can be viewed by anyone with internet access.

Regular progress reports also require that quality control be exercised continuously. Daily fish count and individual fish data will be entered into a computer database and entry will be verified. Consistent formats will be applied among years and documented to facilitate analysis. This data set will be available for distribution to agency, academic, or other parties for application to other analyses and syntheses.

Task 6.2 *Distribute annual reports to inform resource managers of full project findings.*

Annual reports will present full analysis and findings from sampling each year. They will make liberal use of tables and graphs to present data in a readily understandable format. Annual reports will be sufficient to stand alone as explanations of the full project and its findings to date.

Task 6.3 *Prepare audio-video or computer-aided presentations to explain project findings to interested groups.*

Audio-visual aides will be prepared for use both by the project biologist and participating agencies. These aides will be useful at symposiums, workshops and public meetings to report key findings of the project.

4. FEASIBILITY

The Stanislaus River is an ideal location for this work because suitable weir sites are available, its fall chinook are primarily of wild origin, a long time series of adult and juvenile data exists, and other ongoing activities will increase the quantity of information that will be provided by weir operations. The low gradient and contained channel of the lower Stanislaus River provide a number of suitable sites where a weir can effectively sample nearly the entire anadromous adult run through its duration. Sites allow for weir operation under varying flows, so even year-round sampling is feasible.

Resistance board weirs are known for their ability to withstand significant flow fluctuations, and are designed just for that purpose. Based on average snowpack we expect that flows will be relatively low through fall and winter, although storm events can cause significant changes in flow, and early storms could change forecasted dam operations. However, the weir will be designed to operate at a flow range from approximately 300 to 2,500 cfs, well within the range of expected flows, and within the range of flows experienced in the Stanislaus during the last 3 years.

Since several tentative project sites have already been identified, and we are currently working with the USACE on final site selection, and the permitting process is well underway, we do not anticipate there will be any implementation delays, even if project approval is close to the start of fall migration. Our Central Valley office is staffed with 4 Fish Biologists and 14 Fisheries Technicians, and includes the tools necessary to complete all aspects of the project.

<u>Permitting</u>

Permitting and other requirements are also described elsewhere in this proposal. Tasks 2.1, 2.2, and 2.3 may require CDFG scientific collecting permits; CESA compliance; 1603 Streambed Alteration Notification; USACE Rivers and Harbors Act Section 10 Permit; and Federal ESA consultation.

To ensure that we will be ready to begin sampling at the onset of project approval, which we expect would be near the time of the 2002 adult migration season, we have already begun the permitting process. Funds for this activity are being provided by Tri-Dam Project, Oakdale Irrigation District, and South San Joaquin Irrigation District. Funds provided by these entities are sufficient to allow us to continue with the permitting process up to the time of project implementation.

Should there be unexpected delays, either with the permitting process or in the CalFed funding process, implementation of this project could be postponed until fall 2003 and continue through 2005.

5. PERFORMANCE MEASURES

The function and general success of the Stanislaus Weir will be evaluated in the following ways:

<u>*Comparison of weir counts to CDFG carcass survey estimates*</u> Since CDFG will perform carcass

surveys in the Stanislaus River similar to past years, weir counts will be immediately comparable to CDFG estimates. Further, a comparison of time of river entry for chinook will be compared to upstream sightings to determine if upstream sightings are an accurate depiction of actual river entry.

Testing of weir efficiency using mark-recapture methods The catch efficiency of the Stanislaus Weir can be tested using mark-recapture studies that work in conjunction with CDFG carcass surveys. A subsample of adult chinook passing the weir can be marked in such a way that the proportion of marked and unmarked fish relocated in CDFG surveys will help determine the percentage of the population that was effectively sampled at the weir.

Costs of construction, operation and maintenance We will fully account for all costs, including permitting, fabricating, installing, monitoring and maintaining the weir. The full cost accounting will be useful for determining if the information gained is worth the cost of operating a weir.

Amount and types of novel information obtained Operation of the weir is expected to provide information that is not reliably available by other common methods for characterizing the run of fish entering a river. Such information includes the unbiased size at entry, age-specific timing of river entry, composition of the run be age and species. This project will reveal if these types of information can be reliably obtained, and what new insights such information will reveal. This project is the only method of accurately estimating steelhead abundance and run timing in the Stanislaus River.

Frequency and type of conditions that cause the weir to lay down If the weir is frequently laying down (due to clogging or high velocity) for extended periods during typical flow years, then data accuracy may be compromised.

Delays at weir. Regular underwater inspection of weir structure and streambed condition, with accompanying condition reports will help monitor the physical performance of the weir and how it might affect streambed features.

Weekly e-mail project summaries and quarterly progress reports Summaries updating project activities and outcomes will be submitted to agency personnel and other interested parties within the weir project steering committee and the Stanislaus Fish Group.

Continuous oversight of weir activities by Central Valley Escapement Project Work Team and CDFG As the project steering committee, the CVEPWT, along with representation from CDFG Region IV, will oversee the project from the final planning stages through the monitoring efforts. This will help ensure the integrity of the project as a whole, making sure that CalFed goals remain top priority throughout the process.

Recovery of coded-wire tags As CWT recoveries are currently low in the San Joaquin Basin, significant increases would be expected through the use of a sampling technique that is as complete as the use of a weir. A large increase in CWT recoveries at the weir would help verify the usefulness of such a device.

6. DATA HANDLING AND STORAGE

Data will be collected by field personnel, entered into a Microsoft Access database, and error checked before being released to interested parties. Data will be made accessible on a near real-time basis to agency personnel, watershed management groups, and the public via a web site that will be created prior to the beginning of 2002 sampling. Consistent data file formats will be applied among years to provide for accurate and efficient analysis.

7. EXPECTED PRODUCTS/ OUTCOMES

Table 2 lists the products and outcomes that will result from successful implementation of the Stanislaus weir project.

Table 2. Products and outcomes of the Stanislaus River weir project.

1	Known number of chinook salmon and steelhead, and run-timing, into the Stanislaus River for the three year project period.
2	Determination of the accuracy of Stanislaus River carcass surveys, as well as an indication of the accuracy of similar carcass survey methods used throughout the state.
3	Statistical models for the calibration of traditional carcass estimates in the Stanislaus River, which would improve the accuracy of future abundance estimates without the operation of the weir.
4	Determination of the, abundance, run-timing and life history composition of steelhead in the Stanislaus River and San Joaquin Basin.
5	An easily-accessible database containing the most complete life-history and population data available to date on Stanislaus chinook and steelhead, which will be used to build population models in the future.
6	Combined with outmigration data collected by local irrigation districts and the USFWS, accurate information for stock recruitment and limiting factors analyses, which are urgently needed on the Stanislaus.
7	A thorough evaluation, including weekly and final reports concerning project progress and the value in using of a portable resistance board weir to enumerate of anadromous salmonids Central Valley rivers.
8	A group of agency and private biologists that is educated in the use of an alternative method of anadromous salmonid monitoring and that may be able to provide technical assistance in the planning and implementation of similar projects on other rivers.
9	Direct and accurate evaluation of the extent fall attraction flows encourage the upstream migration of salmonids, which would aid future resource management.

8. WORK SCHEDULE

Table 3 contains a breakdown of key objectives listed above, including anticipated start and completion times and primary products. Most tasks associated with the objectives are not listed separately, as they will be accomplished within the same time frame and/or are dependent upon one another. Please note that due to the time required for permitting actions and to allow for any unforeseen complications in this process, initial contact regarding permitting procedures has begun under separate funding. Anticipated start and completion dates are based on the assumption that CalFed funds may be received in the summer of 2002. Actual dates are contingent on receipt of funding.

Table 3. Summary of anticipated start and completion times for project objectives

Objective/Task	Start	Completion	Product(s)
Objective 1			
Task 1.1	Aug. 1, 2002	Aug. 31, 2002	technical oversight body
Task 1.2	Sept. 2001	August 2002	agency approvals
Objective 2 (all tasks)	Sept. 02, 03, 04	Jul. 03, 04, 05	portable weir and salmonid escapement estimates
Objective 3 (all tasks)	Sept. 2002	Jul 2005	characterization of salmonid runs
Objective 4 (all tasks)	Sept. 2002	Jul. 2005	descriptions of construction, operation and costs
Objective 5 (all tasks)	May 2003	Jul. 2005	comparison of weir data to carcass data
Objective 6			
Task 6.1	Sept. 2002	Jul. 2005	weekly progress reports
Task 6.2 and Task 6.3	May 03, 04, 05	Jul. 03, 04, 05	annual reports and presentations

* In progress under separate funding.

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

1. ERP, SCIENCE PROGRAM AND CVPIA PRIORITIES

The installation and operation of a structure like the Stanislaus weir is a major action that will provide the means for the collection of data that will more accurately reflect the status of Stanislaus River chinook and steelhead populations. The collection of life-history and population data is recognized by the Ecosystem Restoration Program (ERP), the Science Program, and the Central Valley Project Improvement Act (CVPIA) as an important tool in the planning and evaluation of restoration efforts. Evaluation of restoration efforts based on accurate data is key to the successful implementation of adaptive management programs.

ERP Goals

At the heart of the ERP are six Strategic Goals. Each of the goals address a different aspect of the restoration of the Bay-Delta Watershed. Two of these, Strategic Goal 1 and Strategic Goal 3 would be contributed to by the successful implementation of the Stanislaus Weir project. Goal 1 refers specifically to the recovery of at-risk species that rely on the Delta as a critical component of their life-histories. Goal 3 provides for the maintenance and/or enhancement of populations of certain harvestable species, including chinook salmon and steelhead trout.

Implement actions to improve understanding of at-risk species in the region. Based on the successful implementation of numerous portable resistance board weir programs in Alaska, we believe the Stanislaus Weir will serve as an effective, efficient, and replicable means of enumerating Chinook salmon returns to this part of the San Joaquin Watershed. Successful implementation of this pilot project will serve to provide a foundation for a new standard for the monitoring of anadromous salmonid returns.

In addition, the biological and environmental data collected at the weir will aid in the identification of Central Valley salmonid life-history and environmental requirements. Key to this aspect of the project is the collection of steelhead abundance and life-history data. As in the majority of Central Valley rivers and streams, accurate data from which the current status and needs of Stanislaus River steelhead can be inferred is in dire need of collection, as management decisions are currently made using incomplete information about the population.

<u>Science Program Goals</u>

As stated in the August 2001 ERP Draft Stage 1 Implementation Plan, the CALFED Science Program's long-term goal is to build, over time, "a body of knowledge that will continually improve the effectiveness of restoration actions, allow the CALFED Program to track restoration progress and allow ever-increasing understanding of the implications of interrelated CALFED Program actions." A set of short-term goals have been established by the Science Program to aid in the realization of this ultimate goal. Many of these are met, wholly or in part, by the Stanislaus Weir project.

Build population models for at-risk species. The most important ingredient in the building of reliable population models of any species is accurate data. Through the use of the weir proposed here, we will be able to collect the most accurate biological data that has been collected from live, adult chinook and steelhead in the Stanislaus River. In addition, important life-history information will be gained as a result of accurate run timing assessment and the drawing of correlations between fish migratory behaviors and environmental conditions such as flow and water temperature and turbidity. All of this data will be on hand and available for the future development of chinook and steelhead population models.

Advance the scientific basis of regulatory activities. At issue on the Stanislaus River, as with all of the major rivers of the Sacramento-San Joaquin Delta watershed, are practices that take advantage of the hydrological and biological resources within each watershed. The impoundment of water and subsequent regulation of flow have effects that are very meaningful to ecological processes in and around waterways and so must be managed in such a way to allow for the effective continuation of these processes. The same is true for angling. Over-harvest or the take of certain species such as chinook during critical life stages can devastate populations that already exist in a fragile balance between proper and improper water management. From mid-October through December all angling is prohibited on the Stanislaus River to help allow for the successful upstream migration of chinook salmon. In addition, river flows are increased periodically for the purpose of attraction. Management activities such as changing dam releases and enforcing special angling regulations require agency and utility resources. In order for management practices such as these to be most effective, the most up-to-date and comprehensive information about target species is necessary. The Stanislaus Weir project will be a source of such information.

Coordinate and extend existing monitoring. The Stanislaus chinook population is currently estimated using carcass mark-recapture surveys. The population census that would take place at the Stanislaus Weir could be coordinated with these surveys in such a way that the true status of the population in terms of number of individuals could be more closely determined. While the weir could theoretically provide for 100% catch of upstream- migrating fish, this outcome is not likely. It is conceivable, though, that the combination of direct counts at the weir and CDFG carcass surveys could account for population estimates that approach the level of accuracy that is obtained by other relatively accurate sampling methods such as 24-hour video monitoring of fish ladders.

At the same time, existing monitoring of chinook will be extended greatly through the operation of the Stanislaus weir. Now, only rough population estimates and DNA collection are possible on the river using current methods. Through this project monitoring will be further developed to include accurate information obtained from live adult fish, including sex and length frequencies, the relative number of jacks in the run, and general physical condition. In addition, a program will be in place that will be able to accomplish the only active steelhead monitoring activities on the Stanislaus. Meanwhile, the need for the testing of a new salmonid monitoring approach will be met.

Take advantage of existing data. Extended time series of adult and juvenile sample data are available from the Stanislaus River. Continuous adult data is available since 1940. Juvenile trap data is available since 1993. Direct abundance estimates and other information that could be obtained with a weir would significantly increase our ability to interpret and apply information from these historic data sets.

CVPIA Goals

The Central Valley Project Improvement Act (CVPIA) states as one of its goals that it is meant to "protect, restore, and enhance fish, wildlife, and associated habitats in the Central Valley...of California". Part of this goal is achieved through authorization of the Anadromous Fish Restoration Program (AFRP). The goal of the AFRP is to develop and implement a program that attempts to ensure that the natural production of anadromous fish in the Central Valley will be double that of average levels reached between 1967 and 1991 and that the new production levels will be sustainable over the long term. One objective set forth by the AFRP is the collection of fish population, health, and habitat data. Without this reference data, specific target levels of production and general population condition would not be able to be developed in a manner that would accurately reflect the levels historically attained in a specific watershed.

Accurate and complete reference data takes much of the guesswork out of management decisions based on evaluations of restoration actions. The success of restoration activities can only be judged through the monitoring of population trends that are based on the most complete data available. This is especially crucial in the management of at-risk species because these populations are more sensitive to change than are more stable groups. Monitoring of at-risk salmonids at the Stanislaus Weir will provide solid information that will help in the evaluation of Stanislaus River restoration activities, such as the various gravel replenishment projects of the past few years.

2. RELATIONSHIP TO OTHER ECOSYSTEM RESTORATION PROJECTS

In order for the CALFED Program to be successful in its attempts to set the Bay-Delta Region on a path to ecological recovery, it is necessary that a research and monitoring program be complimentary to some of the other restoration efforts that have been funded or may be funded in the future. Due to the broad dataset and body of knowledge that will be obtained concerning salmon and steelhead, the project promises to compliment nearly any other project that focuses on gaining information on these species or on restoration of salmonid populations.

On the Stanislaus specifically, various gravel restoration projects have been funded. These projects have been carried out over the past few years by Carl Mesick Consultants and CDFG. Accurate adult escapement data collected at the weir will help aid future efforts to evaluate the success of adding spawning gravel to the river, as increases in adult returns as a result of the projects would likely be seen during the 3-year sampling effort.

3. REQUEST FOR NEXT PHASE FUNDING

No next-phase funding is required.

4. PREVIOUS RECIPIENTS OF CALFED PROGRAM OR CVPIA FUNDING

Tri-Dam received funding from the AFRP in 1999 for an evaluation of the use of radio-tagged juvenile chinook salmon to identify cause and location of mortality. Tri-Dam was the fiscal agent for this project and the study was completed under subcontract to SPCA.

5. SYSTEM-WIDE ECOSYSTEM BENEFITS

One of the most powerful benefits of accurate adult abundance and age composition is the ability to quantify production in terms of recruits per spawner and smolt-to-adult survival rates. These rates (like hatchery CWT groups) enable us to determine what conditions are correlated to good and bad survival, and thus help identify beneficial and detrimental management practices, which is a key aspect of adaptive ecosystem management across the Bay-Delta Region. Accurate escapement estimates would also improve our understanding of juvenile chinook behavior and life history characteristics, which is especially important since the majority of tributaries supporting anadromous salmonids now have screw traps to collect juvenile outmigration data during most of the spring. Accurate adult escapement indices are also the basis for determining ocean harvest rates. This information is difficult to come by for wild stocks, and if successful, the Stanislaus chinook population could be used as a valuable wild stock indicator population.

6. ADDITIONAL INFORMATION FOR PROPOSALS CONTAINING LAND ACQUISITION

Implementation of the Stanislaus weir project will not require land acquisition.

C. QUALIFICATIONS

Tri-Dam Project (Tri-Dam) is a partnership between two public agencies: the Oakdale Irrigation District and the South San Joaquin Irrigation District. Both irrigation districts were formed in 1909 to provide reliable irrigation. Since the early 1990's, Tri-Dam has taken an active role in fisheries monitoring, protection and enhancement on the lower Stanislaus River through the funding of several fisheries monitoring programs. Tri-Dam has retained S.P. Cramer & Associates (SPCA) since 1993 to provide fisheries consulting services related to the above activities. Tri-Dam has funded annual rotary screw trap monitoring since 1993, radio tracking in 1998-99, studies involving outmigrant responses to pulse-flows and annual advisory funding for SPCA to attend meetings in order to keep them up-to-date on all fisheries issues. Tri-Dam will extend its existing contract with SPCA to conduct the proposed project activities.

Steve Felte is the general manager of Tri-Dam and will serve as contract manager and will be responsible for quality assurance and control throughout the project. As general manager of the Tri-Dam, Steve manages all of Tri-Dam's daily operational activities and is therefore, very capable of administering the contract.

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 on the Stanislaus River for private water rights holders, CAMP, and AFRP since 1993, and are therefore very familiar with basin issues, key watershed participants, and the actions necessary to conduct the proposed project. Since we have been involved in Stanislaus River issues for so long, we have had the opportunity to work with a number of different watershed interests, including agency biologists, private researchers, and the public. SPCA has been Tri-Dam's primary fisheries consultant since 1993 and has conducted numerous fisheries investigations, monitoring and assessments of the upper and lower Stanislaus River fisheries resources. Past and on-going fisheries work include annual monitoring of juvenile chinook outmigration, adult migrant trapping, radio tracking and electrofishing.

<u>Key Personnel</u>:

Doug Demko will manage and coordinate the proposed project activities within SPCA and between the cooperating agencies, and will supervise data analysis, interpretation and report preparation activities. Doug has worked in the Stanislaus Basin since 1993. 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 Stanislaus River is more extensive than most researchers, 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. Since Doug has been a key watershed participant since 1993, he has had the opportunity to build trusting relationships with key watershed participants which will prove valuable to the successful implementation of this project.

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. Her contacts within the basin and her knowledge of Stanislaus River research and recreational activities are an invaluable asset to the project.

D. COST

The total estimated cost to implement the weir project is $684,590 of which we are requesting $659,590 from CalFed. All budgeted tasks and objectives, except objective 3 are necessary for the completion of the project. Objective 3 includes collection of data and analyses to dramatically improve our life-history understanding of chinook and steelhead in the river. Objective 3 is not crucial to evaluating the ability of the weir to enumerate escapement and determine run timing. If necessary, Objective 3 (task 3.1-3.5) can be eliminated without affecting the integrity of the project, and would result in a reduction of total project cost to $596,740.

Funding for permitting process actions by weir project coordinators is being provided by the Tri-Dam water management group at an estimated cost of $25,000. The CDFG conducts carcass surveys which are necessary for the comparative analysis. Additionally, rotary screw trap sampling in the Stanislaus River is already funded under existing contracts. The outmigration data provided by the traps is helpful in combination with the upstream migrant data for stock recruitment and limiting factors analyses.

E. LOCAL INVOLVEMENT

In preparation of this proposal and implementation of the permitting process we have established relationships with many stakeholder, government, and conservation groups. We have been working with these groups to ensure that public concerns and needs are appropriately address prior to the actual implementation of the project. Many of the groups have provided letters of support for the project and many have provided verbal support. Some of the groups we have approached about the project and will continue working with include: San Joaquin River Management Project, San Joaquin County, Stanislaus County, San Joaquin River Exchange Contractors, South Delta Water Agency, SWRCB, City of Oakdale, City of Ripon, USBR, NMFS, CDFG, US Army, USACE, Friends of the River, CalTrout, Trout Unlimited, DWR, San Joaquin Basin Salmonid Work Team, Central Valley Salmonid Escapement Project Work Team, UC Davis, SSJID, SEWD, OID, and the East and West Stanislaus Resource Conservation Districts.

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.

G. LITERATURE CITED

Boydstun, L.B. 1994.Analysis of two mark-recapture methods to estimate the fall chinook salmon (*Onchorynchus tshawytscha*) spawning run in Bogus Creek, California. California Fish and Game 80 (1): 1-13.

Cavallo, B. 2000. A critique of Central Valley salmon spawning surveys. California Department of Water

Resources, Environmental Services Office, unpublished.

CDFG and NMFS. 2001. Final report on anadromous salmonid fish hatcheries in California. June 27, 2001.

Clay, C.H. 1961 Fences (or weirs) and barrier dams. Pages 157-183 in C.H. Clay. Design of fishways and other facilities. Queen's Printer, Ottawa.

Cousens, N.B.F., G.A. Thomas, C.G. Swann, and M.C. Healy. 1982 A review of salmon escapement estimation techniques. Canadian Technical Report of Fisheries and Aquatic Sciences 1108.

Hilborn, R., and C. J. Walters. 1992. Quantitative fisheries stock assessment - choice, dynamics and uncertainty. Chapman and Hall, New York.

Hinrichsen, R. A. 2001. High variability in spawner-recruit data hampers learning. Canadian Journal of Fisheries and Aquatic Sciences 58:769-776.

Law, P. M. 1994. Simulation study of salmon carcass survey capture-recapture methods. California Fish and Game 80:14-28.

Mesick, Carl. 2001. Task 3 Pre-Project Evaluation Report, Knights Ferry Gravel Replenishment Project. Report to CALFED and Stockton East Water District.

Ricker, W. E. 1975. Computation and interpretation of biological statistics of fish populations. Bulletin of the Fisheries Research Board of Canada 191.

Rivard, D. 1989. Overview of the sytematic, structural, and sampling errors in cohort analysis. Pages 49 to 65 in E. F. Edwards and B. A. Megrey. Mathematical analysis of fish stock dynamics. American Fisheries Society Symposium 6.

Shardlow, T., R. Hilborn, and D. Lightly. 1987. Components analysis of instream escapement methods for Pacific salmon (*Oncorhynchus* spp.). Canadian Journal of Fisheries and Aquatic Sciences 44:1031-1037.

Seber, G. A. F. 1982. The estimation of animal abundance and related parameters. Griffin, London.

Simpson, K. 1984. The accuracy of mark-recapture estimates of escapements. Pages 209-225 in P.E.K. Symons and M. Waldichuck, editors. Proceedings of the workshop on stream indexing for salmon escapement estimation. Canadian Technical Report of Fisheries and Aquatic Sciences 1326.

Tobin, J. H. 1994. Construction and performance of a portable resistance board weir for counting adult salmon in rivers. USFWS, Kenai, Alaska.

Walters, C. J., and D. Ludwig. 1981. Effects of measurement errors on the assessment of stock-recruitment relationships. Canadian Journal of Fisheries and Aquatic Sciences 38:704-710.