Development of Aquatic Biological Stressor Metrics for the Sacramento River Watershed and Tributaries

Project Information

1. **Proposal Title:**

   Development of Aquatic Biological Stressor Metrics for the Sacramento River Watershed and Tributaries

2. **Proposal applicants:**

   Robert Holmes, Central Valley Regional Water Quality Control Board
   Lori Webber, Central Valley Regional Water Quality Control Board
   Jim Harrington, California Department of Fish and Game
   Pete Ode, California Department of Fish and Game
   Michael Johnson, University of California Davis John Muir Institute
   Don Huggins, University of California Davis John Muir Institute

3. **Corresponding Contact Person:**

   Robert Holmes
   Central Valley Regional Water Quality Control Board
   3443 Routier Rd. Suite A Sacramento, California 95827-3098
   916 255-0749
   holmesr@rb5s.swrcb.ca.gov

4. **Project Keywords:**

   Aquatic Ecology
   Bioindicators and Biomonitoring
   Water Quality Assessment & Monitoring

5. **Type of project:**

   Research

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

   No

7. **Topic Area**:

   Ecosystem Water and Sediment Quality

8. **Type of applicant:**

   Joint Venture

9. **Location - GIS coordinates:**

Latitude: 39.2512

Longitude: -121.692

Datum:

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

Sierra Nevada Foothills and Great Valley Ecoregions, as described in "Ecological Subregions of California", USDA, Forest Service, 1997. Document number R5-EM-TP-005. Located online at: http://www.r5fs.us./ecoregions/toc.htm. Project will cover those portions of eastside and westside tributaries of the Sacramento River Watershed located within the Sierra Nevada Foothill and Great Valley Ecoregions.

10. **Location - Ecozone:**

    3.1 Keswick Dam to Red Bluff Diversion Dam, 3.2 Red Bluff Diversion Dam to Chico Landing, 3.3 Chico Landing to Colusa, 3.4 Colusa to Verona, 3.5 Verona to Sacramento, 4.2 Cow Creek, 4.3 Bear Creek, 4.4 Battle Creek, 5.2 Lower Cottonwood Creek, 6.1 Stony Creek, 6.2 Elder Creek, 6.3 Thomas Creek, 6.4 Colusa Basin, 7.1 Paynes Creek, 7.2 Antelope Creek, 7.3 Mill Creek, 7.5 Big Chico Creek, 7.6 Butte Creek, 7.7 Butte Sink, 8.1 Feather River, 8.2 Yuba River, 8.3 Bear River and Honcut Creek, 8.4 Sutter Bypass, 9.1 American Basin, 9.2 Lower American River, 10.1 Cache Creek, 10.2 Putah Creek, 10.3 Solano, 10.4 Willow Slough

11. **Location - County:**

    Butte, Colusa, El Dorado, Glenn, Nevada, Placer, Sacramento, Shasta, Solano, Sutter, Tehama, Yolo, Yuba

12. **Location - City:**

    Does your project fall within a city jurisdiction?

    No

13. **Location - Tribal Lands:**

    Does your project fall on or adjacent to tribal lands?

    No

14. **Location - Congressional District:**

    1,2,3,4,5,7,11

15. **Location:**

    California State Senate District Number: 1,4,5,6,7

    California Assembly District Number: 2,3,4,5,8,9,10,11

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:	32% and 24% (See Note Below)
Total Requested Funds:	$3,653,287.00

    b) Do you have cost share partners already identified?

       No

    c) Do you have potential cost share partners?

       No

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

       No

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

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

    No

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

    No

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

    No

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

    No

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)

Ken Cummins	**Humboldt State University Coop Fisheries Unit**	**(707) 826-3208**	**kwc7002@humboldt.edu**
Peter Husby	**US EPA Region 9**	**(510) 412-2331**	**husby.peter@epa.gov**
Val Connor	**State Water Resources Control Board**	**(916) 341-5573**	**connorv@dwq.swrcb.ca.gov**

21. **Comments:**

17a. Overhead rates are same regardless if funds are State or Federal. However, coapplicants for this project individually have different overhead rates. State employess (Regional Board and Fish and Game) is 32% overhead. UC employees (UC Davis) have a 24% overhead rate. Note: Formal Budget process through the University of California (a co-applicant) if project is approved for funding.

Environmental Compliance Checklist

Development of Aquatic Biological Stressor Metrics for the Sacramento River Watershed and Tributaries

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

      No
   b) Will this project require compliance with NEPA?

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

      This project will not involve any physical alterations to land or other actions that require CEQA and/or NEPA permits.

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

   CEQA Lead Agency:
   NEPA Lead Agency (or co-lead:)
   NEPA Co-Lead Agency (if applicable):

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?

      None

   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

CESA Compliance: 2081

CESA Compliance: NCCP

1601/03

CWA 401 certification

Coastal Development Permit

Reclamation Board Approval

Notification of DPC or BCDC

Other

FEDERAL PERMITS AND APPROVALS

ESA Compliance Section 7 Consultation

ESA Compliance Section 10 Permit

Rivers and Harbors Act

CWA 404

Other

PERMISSION TO ACCESS PROPERTY

Permission to access city, county or other local agency land. Agency Name:	Required
Permission to access state land. Agency Name:	Required
Permission to access federal land. Agency Name:	Required
Permission to access private land. Landowner Name:	Required

6. **Comments.**

Scientific collection permits will be obtained through California Department of Fish and Game which will be funneled through the National Marine Fisheries Service and the United States Fish and Wildlife Service. Obtaining the collection permit and permission to access property are tasks in the project proposal.

Land Use Checklist

Development of Aquatic Biological Stressor Metrics for the Sacramento River Watershed and Tributaries

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).

   Project proposal is for sampling of aquatic biota. Land will not be changed.

4. **Comments.**

   Selection of sampling sites is part of proposal request. It is unknown at this time where these sites will be. If access to private or across private land is required either we will obtain permission - or if not possible - select another backup sampling site.

Conflict of Interest Checklist

Development of Aquatic Biological Stressor Metrics for the Sacramento River Watershed and Tributaries

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):

Robert Holmes, Central Valley Regional Water Quality Control Board
Lori Webber, Central Valley Regional Water Quality Control Board
Jim Harrington, California Department of Fish and Game
Pete Ode, California Department of Fish and Game
Michael Johnson, University of California Davis John Muir Institute
Don Huggins, University of California Davis John Muir Institute

Subcontractor(s):

Are specific subcontractors identified in this proposal? Yes

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

Larry Brown	U.S. Geological Survey
Jason May	U.S. Geological Survey
Donna Knifong	U.S. Geological Survey

None	None
None	None
None	None
None	None

Helped with proposal development:

Are there persons who helped with proposal development?

No

Comments:

U.S.G.S. staff will be involved with data analyses and interpretation task.

Budget Summary

Development of Aquatic Biological Stressor Metrics for the Sacramento River Watershed and Tributaries

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	Technical Advisory Group meetings	520	11,120.00	2,474.00	1,100.00		16,222.00			30916.0	7,951.00	38867.00
2	Obtain Collection Permits	200	4,240.00	1,234.00						5474.0	1,424.00	6898.00
3	Analyze Existing Stressor Data	1,000	33,000.00	10,560.00						43560.0	11,330.00	54890.00
4	Perform Cumulative Effects Assessment	3,000	92,600.00	22,200.00		3,000.00				117800.0	29,670.00	147470.00
5	Determine and Confirm Random Sample Locations in Sierra Foothill Region	2,000	54,000.00	17,280.00						71280.0	18,540.00	89820.00
6	Field Sample Macroinvertebrates and Conduct Habitat Assessment (Sierra Foothill Region)	10,000	282,000.00	90,240.00						372240.0	96,820.00	469060.00
7	Field Sample and Identify Periphyton (Sierra Foothill Region)	6,000	96,800.00	23,200.00	39,655.00	3,000.00	6,000.00	20,000.00		188655.0	31,220.00	219875.00
8	Field Sample and Process Fish (Sierra Foothill Region)	6,000	96,800.00	23,200.00	39,655.00	14,752.00		5,248.00		179655.0	31,220.00	210875.00
16	Quarterly Progress Reports	620	13,772.00	3,826.00						17598.0	9,822.00	27420.00
18	Project Administration	3,360	77,462.00	20,096.00					12,500.00	110058.0	41,112.00	151170.00
		32700	761794.00	214310.00	80410.00	20752.00	22222.00	25248.00	12500.00	1137236.00	279109.00	1416345.00

Year 2												
Task No.	**Task Description**	**Direct Labor Hours**	**Salary** ***(per year)***	**Benefits** ***(per year)***	**Travel**	**Supplies & Expendables**	**Services or Consultants**	**Equipment**	**Other Direct Costs**	**Total Direct Costs**	**Indirect Costs**	**Total Cost**
1	Technical Advisory Group meetings	520	11,120.00	2,474.00	1,100		16,222.00			30916.0	7,951.00	38867.00
2	Obtain Collection Permits	200	4,240.00	1,234.00						5474.0	1,424.00	6898.00
3	Analyze Existing Stressor Data	1,000.00	33,000.00	10,560.00						43560.0	11,330.00	54890.00
4	Perform Cumulative Effects Assessment	3,000	92,600.00	22,200.00						114800.0	29,670.00	144470.00
5	Determine and Confirm Random Sample Locations in Valley Floor Region	2,000	54,000.00	17,280.00						71280.0	18,540.00	89820.00
9	Macroinvertebrate Sample Analyses in Sierra Foothill Region						52,800.00			52800.0		52800.00
10	Field Sample Macroinvertebrates and Conduct Habitat Assessment (Valley Floor Region)	10,000.00	282,000.00	90,240.00						372240.0	96,820.00	469060.00
11	Field Sample and Identify Periphyton (Valley Floor Region)	6,000.00	96,800.00	23,200.00	39,655.00	4,500.00	6,000.00			170155.0	31,220.00	201375.00
12	Field Sample and Process Fish (Valley Floor Region)	6,000.00	96,800.00	23,200.00	39,655.00	4,500.00				164155.0	31,220.00	195375.00
14	Data Analysis and Interpretation	1,240.00	34,560.00	8,280.00			17,045.00			59885.0	11,146.00	71031.00
15	Annual Report and Presentations	1,440	41,160.00	10,392.00						51552.0	18,656.00	70208.00
16	Quarterly Progress Reports	620	13,772.00	3,826.00						17598.0	9,822.00	27420.00
18	Project Administration	3,360	77,462.00	20,096.00					12,500.00	110058.0	41,112.00	151170.00

		35380	837514.00	232982.00	80410.00	9000.00	92067.00	0.00	12500.00	1264473.00	308911.00	1573384.00

Year 3												
Task No.	**Task Description**	**Direct Labor Hours**	**Salary** ***(per year)***	**Benefits** ***(per year)***	**Travel**	**Supplies & Expendables**	**Services or Consultants**	**Equipment**	**Other Direct Costs**	**Total Direct Costs**	**Indirect Costs**	**Total Cost**
1	Technical Advisory Group meetings	520	11,120.00	2,474.00	1,100		16,222.00			30916.0	7,951.00	38867.00
4	Perform Cumulative Effects Assessment	3,000.00	92,600.00	22,200.00						114800.0	29,670.00	144470.00
13	Macroinvertebrate Sample Analyses in Valley Floor Region					5,000.00	52,800.00			57800.0		57800.00
14	Data Analysis and Interpretation	1,240	34,560.00	8,280.00			17,045.00			59885.0	11,146.00	71031.00
15	Annual Report and Presentations	1,440	41,160.00	10,392.00						51552.0	18,656.00	70208.00
16	Quarterly Progress Reports	620	13,772.00	3,826.00						17598.0	9,822.00	27420.00
17	Final Report	1,840	54,300.00	14,616.00						68916.0	33,676.00	102592.00
18	Project Administration	3,360	77,462.00	20,096.00					12,500.00	110058.0	41,112.00	151170.00
		12020	324974.00	81884.00	1100.00	5000.00	86067.00	0.00	12500.00	511525.00	152033.00	663558.00

Grand Total=3653287.00

Comments.

Please see Budget Justification and description of Tasks in Proposal for breakdown of hours for each Task.

Budget Justification

Development of Aquatic Biological Stressor Metrics for the Sacramento River Watershed and Tributaries

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

Jim Harrington 120 Pete Ode 2,120 Michael Johnson 6,000 Don Huggins 6,000 Robert Holmes 2,840 Lori Webber 240 Jennifer Nickell 1,560 Five Consultants (Task 1) 600 Environmental Scientist II's 20,200 Post Graduate Researcher II's 19,700 Field Supervisors (ES III) 4,000 Post Graduate Researcher V's 13,560

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

Jim Harrington $38.00/hr Pete Ode $33.00/hr Michael Johnson $37.50/hr Don Huggins $37.50/hr Robert Holmes $33.00/hr Lori Webber $33.00/hr Jennifer Nickell $17.35/hr Five Consultants (Task 1) $33.00/hr Environmental Scientist II's $27.00/hr Post Graduate Researcher II's $15.40/hr Field Supervisors (ES III) $33.00/hr Post Graduate Researcher V's $17.60/hr

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

Jim Harrington 32% Pete Ode 32% Michael Johnson 24% Don Huggins 24% Robert Holmes 32% Lori Webber 32% Jennifer Nickell 24% Five Consultants (Task 1) 32% Environmental Scientist II's 32% Post Graduate Researcher II's 24% Field Supervisors (ES III) 32% Post Graduate Researcher V's 24%

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

Travel (Field Sampling Crews) Travel is calculated on the assumption that personnel will be in the field for 150 days per year. Per diem is $30/day/person and lodging is $40/day/person. Total cost per person for the field season is ($30 x 150) + ($40 x 150) = $10,500. Travel to and from the field requires two heavy duty vans at $785/mo x 8 months = $6,280 + the cost of gasoline. Gasoline per vehicle is based on the assumption of 30 weeks per year in the field, 250 miles per week with a mileage estimate of 10 miles per gallon and a cost of $2.50 per gallon = $1875 per field season. Total travel cost is $6,280 + $1,875 = $8,155. Travel (Technical Advisory Group Meetings) Travel costs for Technical Advisory Group Meetings is $50.00 per a person/per a year for co-applicant people traveling from outside of the Sacramento Area. This estimate includes $30.00/day/person per diem and $20.00 for gasoline costs. Travel for five (to be determined) consultants (preferably 2 USGS Research Biologists, 1 Fluvial Geomorphologist/Hydrologist, 1 Aquatic Ecologist, and 1 Water Quality Regulatory person) was estimated at $1,000.00 per a year divided among the five individuals. It is anticipated some individuals will be traveling from outside of the area and therefore may incur higher costs than those traveling from closer areas. Per diem is $30/day/person and lodging is $40/day/person. Travel (Annual Report and Presentation) Travel costs for annual reports and presentation is estimated at $600.00 divided among three persons. Presentations would include national professional meetings. Per diem is $30/day/person and lodging is $40/day/person.

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

Year 1(Task 4) $3,000.00 is requested for a single computer to be used in the analyses of all project data. Year 1(Task 7) Supplies requested includes periphyton samplers (40 @ $722 per 10). Year 1(Task 8) Supplies requested includes a Gateway Solo 3450 notebook computer for data logging ($2,199), Hydrolab Quanta multi-parameter water quality instrument ($3,995), BioDevices Aqua 2002 dissolved Oxygen data logger ($2,500), and a Marsh-McBirney Flo-Mate model 2000-21 flow meter and top setting metric wading rod ($4,185). Additional supplies requested include waders, neoprene booties, dip nets, aerators, net pens, measuring boards, Garman GPSMAP 175 GPS unit, Ohaus Navigator Electronic Balance, rechargeable batteries and recharging units, 30m nylon bag seines, 30m nylon block seines, Keson 100m measuring tape, and miscellaneous sampling gear such as envelopes for scale storage, vials, ethanol, chemical disposal costs, slides, forceps, totes, buckets, film, tools. Year 2, Tasks 11 and 12: $9,000.00 is requested for field supplies include miscellaneous sampling gear such as envelopes for scale storage, vials, ethanol, chemical disposal costs, slides, forceps, totes, buckets, film, tools.

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.

Years 1,2, and 3(Task 1) $16,222.00 is requested to subcontract five consultants to participate in the Technical Advisory Meetings. The five members would preferably include: 2 Research Biologists from the USGS, 1 Fluvial Geomorphologist/Hydrologist, 1 Aquatic Ecologist, and 1 Water Quality Regulatory person. It is anticipated that 40 hours of time would be required from each consultant per a year for participation at Technical Advisory Meetings. Estimated time includes preparation of materials for meetings, participating at meetings, and follow-up on action items from each meeting. Salary is based upon Environmental Scientist III wages ($33.00/hour). Year 1(Task 7) $6,000.00 is requested to subcontract a laboratory to perform QA/QC taxonomic analyses on 10% of periphyton samples collected from Sierra Foothill Region. Year 2(Task 9) $52,800.00 is requested to subcontract a laboratory to perform taxonomic analyses on macro invertebrate samples. Included in estimate is QA/QC at 10% rate of samples. Forty sites = 160 samples per a region and 16 samples for QA/QC work. Each macro invertebrate sample costs $300.00 for analyses. Task 11 (Year 2) $6,000.00 is requested to subcontract a laboratory to perform QA/QC taxonomic analyses on 10% of periphyton samples collected from Sacramento Valley Region. Task 13 (Year 3) $52,800.00 is requested to subcontract a laboratory to perform taxonomic analyses on macro invertebrate samples. Included in estimate is QA/QC at 10% rate of samples. Forty sites = 160 samples per a region and 16 samples for QA/QC work. Each macro invertebrate sample costs $300.00 for analyses. Task 14 (Years 2 and 3) $17,045.00 is requested each of two years to subcontract 2 USGS Research Biologists (Larry Brown and Jason May) and 1 GIS specialist (Donna Knifong) to aid in data analyses and interpretation. The time involvement anticipated is as follows: Larry Brown - 80 hours, Jason May - 80 hours, Donna Knifong - 40 hours per a year. Hourly rates are as follows: Larry Brown - $46.91, Jason May - $26.72, Donna Knifong - $30.88 per a year. A 48% overhead rate, Center Assessment Rate, Division Assessment Rate, and Facility and Science Support Assessment are included in requested funds.

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.

Year 1(Task 7) Requested equipment includes an Olympus phase contrast microscope with video ($20,000) for use in periphyton identification. Additional costs are tax and shipping. Year 1(Task 8) Equipment requested includes Smith Root LR-24 backpack electrofisher and batteries ($5,248).

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.

Task 18 (All years) All costs are related to the labor it takes to insure accomplishment of this project and are necessary for specific project oversight. A PGR II is requested as a database manager. We have a current study involving multiple sample locations, multiple sample times, and multiple sample types and we have learned that a database manager is essential to maintain the integrity and quality of the data. Michael Johnson and Don Huggins will be responsible for this task with the data they are collecting. Robert Holmes will be responsible for these tasks for the overall project. This will include tracking and documenting subcontracting duties and responsibilities, record keeping, and handling invoice payments.

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

Task 18 (All years) $12,500.00 is requested for off-campus laboratory facility rental, which allows for reduced overhead rate from 48.5% to 26.0%.

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.

Overhead rates for all applicants include all general office requirements including rent (excluding UC applicants), utilities, upper management support (excluding UC applicants), accounting, administrative services, and office supplies. Overhead costs are the same regardless if funds are State or Federal.

Executive Summary

Development of Aquatic Biological Stressor Metrics for the Sacramento River Watershed and Tributaries

This research project identifies and ranks the relative magnitudes of stressors acting upon the aquatic biota in surface waters of the Sacramento River Watershed. Aquatic macro invertebrates, periphyton, and fish assemblages will be assessed at wadeable and non-wadeable sites in the Sierra Foothill and Central Valley Regions of the Sacramento River Watershed. Environmental Monitoring and Assessment Program (EMAP) procedures will be followed for selection of sampling sites, collection of biological data, and quantitative aquatic habitat measures. The established EMAP probalistic framework enables a nonbiased assessment of the ecological condition of surface waters across a large geographic area, allows identification of relative risk of potential stressors, and is particularly well suited for the West. Biological data will be used to classify, or partition, waterbodies into classes of waterbody types that are relatively homogeneous with regard to physical, chemical, and biological attributes. Classification using biological data is necessary to partition and subsequently reduce natural variability across this large region. It is hypothesized that physical classification of waterbodies will not accurately describe aquatic biota of the region. Regional stressor specific metrics, or metrics characteristic of the aquatic biota that change in some predictable way with increased human influence, will be developed and calibrated. Included is development of flow augmentation stressor metrics, or metrics that assess aquatic assemblage response to flow manipulations. Anthropogenic flow manipulations are ubiquitous throughout the region. Multivariate and univariate statistical analyses will be used for identification of waterbody classes and association of stressors. The primary goal of this project is to determine the extent to which regional waters support their designated beneficial uses for aquatic life. Uncertain is the relative magnitudes of causes of nonsupport or the associated range of natural variability across the region. The primary objectives of this project are to identify and develop regional biological stressor specific metrics and determine relative magnitudes of each major stressor. Identification of stressor metrics provides the ability to target resources towards regions in most need of restoration. The information gained from this project is critical to the CALFED Science Program for further development of models that describe existing conditions in the Sacramento River Watershed, development of stressors specific metrics, and for establishment and evaluation of restoration targets.

Proposal

Central Valley Regional Water Quality Control Board

Development of Aquatic Biological Stressor Metrics for the Sacramento River Watershed and Tributaries

Robert Holmes, Central Valley Regional Water Quality Control Board
Lori Webber, Central Valley Regional Water Quality Control Board
Jim Harrington, California Department of Fish and Game
Pete Ode, California Department of Fish and Game
Michael Johnson, University of California Davis John Muir Institute
Don Huggins, University of California Davis John Muir Institute

A. Project Description: Project Goals and Scope of Work

The extent to which waters of the Sacramento River Watershed support their designated aquatic life beneficial uses is poorly understood. The type, distribution, and magnitude of stressors acting upon the aquatic environment are also poorly understood in the Sacramento River Watershed.

Aquatic life use is a beneficial use designation identified by the State of California in which a waterbody provides suitable habitat for the survival and reproduction of desirable fish, shellfish, and other aquatic organisms. Beneficial use designation is a management objective defining desirable uses that a waterbody should support, such as spawning, migration, warmwater or cold water habitat. Biological assessments, using aquatic organism assemblages such as fish, benthic macroinvertebrates, or periphyton, are currently the only water quality management tool available that allow direct measurement of the biological state of a waterbody. However, although biological assessments are vital tools to detecting impairment, they do not individually identify cause or causes of impairment (US EPA, 2000).

The ability to accurately identify the cause or causes of impairment to the aquatic environment is dependent upon identifying stressors acting on the aquatic environment. The development of biological indicators of stressors is lacking in many water quality management programs (Yoder and Rankin, 1998; US EPA 1996). Erman (1997) indicated that aquatic macroinvertebrates, widely used as indicators of anthropogenic activities, have not been well studied in most of California's Sierra Nevada. Furthermore, the relative magnitude of stressors acting upon the aquatic environment have not been comprehensively studied in the Sacramento River Watershed.

To this date, biological assessments using aquatic macroinvertebrates in the Sacramento River Watershed have been conducted in a relatively scattered, disjointed fashion. Aside from multiple small-scale citizen monitoring projects, there have been five macroinvertebrate biological assessment projects conducted in the Sacramento River Watershed. Although each had different goals, four of the five studies are similar in that each were conducted primarily to identify the biological communities at specific sites and track changes in biological composition over time (CVRWQCB, unpublished data; DWR, unpublished data; REMAP, unpublished data; and LWA, 2001). The fifth study was research oriented and described the relationship between macroinvertebrate assemblages and environmental conditions in both the Sacramento and San Joaquin River Basins (Brown and May, 2000). However, how all of these data "measure up" to a desired or best attainable comparable regional site is unknown. Furthermore, these projects were not focused on identifying stressor specific biological indicators. In addition, fish and especially periphyton, have been studied to an even lesser extent than macroinvertebrates using biological assessment in the Sacramento River Watershed.

The range of natural variability within the Sacramento River Watershed is poorly understood, which limits the applicability of biological assessments.

Previously conducted biological assessments in the Sacramento River Watershed are limited for two reasons. First, there is no regional reference or "benchmark" conditions from which to compare against the data. To fill this critical void the Central Valley Regional Water Quality Control Board (CVRWQCB), State Water Resources Control Board (SWRCB), Sacramento River Watershed Program (SRWP), and the California Department of Fish and Game (CDFG) have initiated a reference condition study project to begin Fall 2001. The proposed project would build upon and is a necessary addition to the reference condition study by identifying biological indicators of stressors to the aquatic environment.

Second, and posing the most urgent problem, biological assessment data in the Sacramento River Watershed are limited in that there is no information available to address the natural variability within the region (LWA, 2001). Without such information, interpretation and application of bioassessment data is limited solely to identification trends over time at a site. Therefore, it is impossible to interpret and apply bioassessment data between sites and especially between sub-basins and catchments within the same watershed. Reducing natural variation within a region requires classification of waterbodies using biological attributes (Barbour et al., 1999). Examples of potential classes of waterbodies include natural, constructed, alluvial, confined, supply, or drain water. Modified, and even natural, waterbodies can exist as several physical classes from origin to end.

Biological classification of waterbodies is a necessary step for aquatic bioassessment (Gerritsen and Barbour, 2000). Geographic classes, such as ecoregion provinces are frequently used as a classification framework for conducting bioassessments (Omernick, 1995). However, such large-scale regionalizations (which are based on terrestrial vegetation), if used alone to specify expected biotic conditions, have severely limited the use of bioassessment (Hawkins et al., 2000). A central focus of the proposed project is to describe the natural variability that exists within two ecoregions of the Sacramento River Watershed, and to identify biological stressor indicators.

Variability exists both within and between waterbodies. Effective monitoring requires characterization and partitioning of several discrete classes of waterbodies within each region. For example, the upper parts of the Sacramento River could be physically classified as fluvial, where as the lower parts are considered confined. Mount (1995) documented the extent of anthropogenic modification of California's rivers. The Sacramento River Watershed and the San Joaquin River Watershed, the two main waterbodies of the Central Valley, are similar in both systems are highly modified from that of a natural state. Increasing the usefulness of biological monitoring in the Central Valley would provide CALFED a valuable tool for implementing and tracking watershed efforts in the Ecosystem Restoration Program.

The goals of this project are to:

1) Estimate the current condition of biological assemblages within two important regions of the Sacramento River Watershed.
2) Improve the usefulness of bioassessment in the Sacramento River Watershed and provide CALFED a valuable monitoring and assessment tool for restoration and other activities.

The following objectives will allow us to achieve our goals:

1) Classify aquatic systems according to biological resources within the Sacramento River Watershed.
2) Correlate data from this project with current available water quality data and reference condition data from the ongoing reference condition project.
3) Modify existing stressor indices to allow better assessment of the current biotic condition of the Sacramento River Watershed.
4) Produce a relative ranking of the major stressors that affect stream biological integrity within the Sacramento River Watershed.

Hypotheses to be tested are as follows:

1) There are a range of biological classifications in the Sacramento River Watershed.
2) Each biological classification in the Sacramento River Watershed can be described by examination of the relative influence of stressors on each class of aquatic environment.

2. Justification

Conceptual model. Figure 1 summarizes the conceptual model of potential aquatic life stressors and identifies the framework for determining biological condition of the Sacramento River Watershed.

The Sacramento River Watershed serves as catchment for waters draining over 16 million acres of many different types land uses including agriculture, urban, forestry, resource extraction, and water augmentation. Land use, as well as other physical, chemical, and biological factors, collectively influence and shape the aquatic environment (Karr, 1994). Aquatic biotic communities shift in response to stressors. Given the large watershed and diverse land use, a strategy must be developed to understand how aquatic communities have adapted to past and existing conditions or stressors in the Sacramento River Watershed.

This project is targeted research that will describe existing conditions, identify, and rank the relative magnitude of aquatic life stressors. Understanding the current biological condition of the region and stressor influence is critical to understanding ecosystem structure and function in the Sacramento River Watershed, and for setting accurate biological restoration targets.

The underlying basis for the proposed work is that the biological condition of the region is largely unknown, as is the amount of natural variability within biological communities. Identification of the range of natural variability within aquatic systems has not been addressed in

any previously conducted biological research or monitoring project, and remains critical to development of an understanding for past and future biological data from the region.

The essential first step in that strategy is to partition or classify regional waterbodies into relatively homogenous groups with respect to not only physical and chemicals attributes, but also biological (Barbour et al., 1999). Figure 2 indicates the process for classification of waterbodies using biological attributes. It is hypothesized that the waterbodies of the Sacramento River Watershed are not biologically uniform. Such information is critical for interpretation of past and future biological data form the region.

Adaptive management – All aspects of this project incorporate the process of adaptive management. First, the overall strategy of this project is constructed from the most recent information gathered and lessons learned. Second, this project is designed to provide a valuable information loop that can be used by management to better understand the current condition of our biological resources and gain insight to the outcome of manipulation of aquatic stressors.

3. Approach

The primary goal of this project is to determine the extent to which regional waters support their designated beneficial uses for aquatic life. The principal objectives of this project are to identify biological indicators of environmental quality and to develop stressor specific metrics which can be used to measure the relative magnitudes of each stressor.

Biological data will be used to classify, or partition, waterbodies into classes of waterbody types that are relatively homogeneous with regard to physical, chemical, and biological attributes. Classification using biological data is necessary to partition and subsequently reduce natural variability across this large region. It is hypothesized that physical classification of waterbodies will not accurately describe aquatic biota of the region.

An indicator of environmental quality can be defined as a parameter that characterizes the condition, quality, integrity, or health of ecosystems (e.g., Hellawell 1986). Numerous environmental monitoring and assessment programs rely on indicators to provide critical information about the status of biological resources. Indicators are often developed by comparing the values of large numbers of biological or chemical parameters at reference sites and at contaminated sites. Parameters demonstrating clear differences between the two categories of sites are potential indicators.

Once appropriate biological indicators have been identified, regional stressor specific metrics, or metrics characteristic of the aquatic biota that change in some predictable way with increased human influence, will be developed and calibrated. Included in this project is development of flow augmentation stressor metrics, or metrics that assess aquatic assemblages in response to flow manipulations. Anthropogenic flow manipulations are ubiquitous throughout the region. Multivariate and univariate statistical analyses will be used to aid in identification of stream classes and association of stressors.

Environmental Monitoring and Assessment Program (EMAP) will be the primary procedures followed for selection of sampling sites, collection of biological data, and quantitative aquatic habitat measures. The procedures for identifying sampling sites, collecting samples, and measurement of habitat variables were developed by EMAP, and published in Lazorchak et al., (1998). The EMAP procedures were designed to determine the current status, extent, changes and trends in the condition of our nation's ecological resources on regional and national scales. The EMAP biological sampling techniques render biological data comparable with biological data collected using the California Department of Fish and Game's California Stream Bioassessment Procedures (Harrington and Born, 1999) – which are a regional modification of the EPA procedures.

The proposed study area is shown in Figure 3. The proposed study area is divided among two large ecological region (ecoregions) boundaries of California: The Sierra Nevada Foothill Ecoregion and the Central Valley Floor Ecoregion (USDA Forest Service, 1997) and the Sacramento River Watershed boundary. The proposed project area was selected because these ecoregions cover an area of the Sacramento River Watershed that is subject to multiple anthropogenic stressors, both urban and rural. Furthermore, a reference conditions study (see Section A, above) is being conducted in this area as pilot for the rest of California. The reference condition study would aid the proposed project by providing a benchmark for comparison of current waterbody condition and relative magnitude of stressors for aquatic biological conditions.

The information gained from this project would be valuable to the CALFED Science Program for further development of models that describe existing conditions in the Sacramento River Watershed, development of stressors specific metrics, and for establishment and evaluation of restoration targets.

The procedures for identification of stressors will follow the EPA's Office of Water, and Office of Research and Development, Stressor Identification Document (US EPA, 2000). The stressor identification process is an iterative process beginning with the observation of biological impairment (Figure 4). Decision-maker and stakeholder involvement is particularly important in defining the scope of the investigation and listing candidate causes. Coordination with the Sacramento River Watershed Program will be important element at this stage of the process. At any point in the process of identifying stressors, a need for additional data may be identified. The accurate characterization of the probable cause(s) allows managers to identify appropriate management action to restore or protect biological condition.

The core process of the stressor identification process consists of three main steps:

1. Listing candidate causes, or stressors, for impairment.
2. Analyzing new and previously existing data to generate evidence for each candidate cause.
3. Producing a causal characterization using evidence generated in Step 2 to draw conclusions about the stressors that are most likely to have caused the impairment.

Analyses of multiple biological assemblages is necessary to obtain objectives of this project. Multiple assemblages provide a greater accuracy in detecting water resource quality impairment, and substantially decrease uncertainty in the assessment.

Forty sites will be selected and sampled in each region. EMAP procedures are designed for a one-day visit by a crew of four persons to sampling sites. Forty sites were selected because it a manageable number of sites that can be assessed in the summer months, and provides an acceptable regional level of sampling uncertainty. Invertebrates will be sampled using kicknets in wadeable sites. Snags will be sampled for invertebrates in deepwater sites. Periphyton samples will be collected from snags in wadeable and deep water sites. Fish will be electro shocked by backpack shocker in wadeable sites and by boat in deep water sites.

Sampling efforts will be focused on one region at a time. During year one the Sierra Nevada Foothills Ecoregion will be sampled. During year two the Central Valley Ecoregion of the Sacramento River Watershed will be sampled. The biological sampling, or index, period will be roughly April through September. Sampling during the summer months reduces seasonal variability and provides optimal accessibility of the assemblages. Sampling will always start with the southern most sites and progress north within each region.

In addition to water chemistry measurements and stream discharge measurements a quantitative assessment of habitat will be conducted at each sampling site. Included in the habitat measurements are thalweg profiles, large woody debris measurement and tally, slope and bearing, substrate size and channel dimensions, bank characteristics, canopy cover measurements, riparian vegetation structure, instream fish cover, human influence, riparian "legacy" trees, invasive alien plants, channel constraints, debris torrents, and recent major floods.

All project activities will follow the procedures outlined in a Quality Assurance Protection Plan that will be developed for this project prior to initiation of any proposed field and laboratory activities. Field activities (collection of chemical, physical and biological data) will include a pre-season training exercise and will be audited at a rate of 10% random events throughout the field season. Laboratory activities will include written verification of internal QA/QC procedures and an external sample validation rate of 10%. All QA/QC procedures will follow those developed and used during the EMAP.

Quality assurance/quality control procedures will be applied to the biological data at a rate of 10% of samples following procedures developed by DFG for assessing macroinvertebrate taxonomic data. In this procedure, all identified taxa are sorted and stored separately, then all taxa identified from 10% of samples are re-identified by an taxonomist not affiliated with the project. Taxa lists from each analysis are then compared for discrepancies. This procedure will be followed for both macroinvertebrate and periphyton analyses, while voucher collections will be used for QA/QC of fish identifications since these identifications will be performed in the field.

Task 1. Technical Advisory Group Meetings

The Technical Advisory Group Meetings will convene annually to discuss the status of project including strategy for field sampling, currently available aquatic stressor information for the Sacramento River Watershed, and other scientific information pertinent to this project. The group will consist of co-applicants of this project including representatives from Fish and Game,

Regional Water Quality Control Boards, and UC Davis. In addition, funds are requested to include two U.S. Geological Survey Aquatic Ecologists that have extensive knowledge of the study area, one Hydrologist, one Fluvial Geomorphologist, and One Water Quality Regulator. The technical advisory group will also coordinate with the Biological and Habitat Subcommittee of the Sacramento River Watershed Program (SRWP). Each attendee will need approximately forty hours per a year to prepare for and attend these meetings, except two Regional Board attendees that will require 80 hours a year due to additional coordination responsibilities.

Task 2. Obtain Collecting Permits

DFG will be responsible for obtaining scientific collection permits for the described sampling events. Collection permits will be obtained from: National Marine Fisheries Service (NMFS) for federally listed anadromous fish, and US Fish and Wildlife Service (USFWS) for federally listed non-anadromous species of fish. The Department of Fish and Game employees do not need scientific collecting permits for state listed species. The Department of Fish and Game has a cooperative agreement with the USFWS that allows collection of species under their jurisdiction. The collection of Coho is covered by a 10A1a permit issued by NMFS to the Department of Fish and Game. The collection of Steelhead is covered under the 4(D) monitoring rule issued by NMFS. A 10A1a permit application has been submitted to NMFS for the 2002 collection season to cover all federally listed anadromous species collections for EMAP. Non-anadromous species collections will still be covered under the cooperative agreement with USFWS for the 2002 season. One Environmental Scientist and one Post Graduate Researcher will need approximately 100 hours each to complete this task for each of the two regions in the study area.

Task 3. Analyze Existing Stressor Data

Analysis of existing stressor data will be performed using geographical information systems software (ArcGIS and the ArcView Spatial Analyst extension). The first step in analyzing stressor data will entail gathering environmental data layers from a wide range of federal, state, university and other sources. Current data layers are available for land use (30 meter resolution) from the USGS, streams (EPA RF3 and current National Hydrography Dataset), mine locations (USGS), road crossings (Teale Datacenter). Other data sources include pesticide application data, grazing activity and logging activity in the region. All data sources will be projected into Teale Albers specifications and analyzed using the ATtILA land use analysis extension for ArcView developed by the EPA-Nevada.

We will use these data layers to assess the degree of potential impact from each stressor by calculating the proportion of areas in each region with each of several different land uses. This will be done using two different area calculations: 1) the total area upstream of each location will be evaluated for percentage of different stressor categories and 2) the area circumscribed by a riparian buffer zone (50 meter) on each side of the location will be evaluated for percentages of the different stressor categories. Both calculations will be used for both the Sierra Foothill and Valley Floor regions of the Sacramento River drainage to map areas indicating potential for known stressors. One Environmental Scientist III from CDFG (Pete Ode) will be responsible for this task and will require approximately 1000 hours to complete each of the two regions in this project.

Task 4. Perform Cumulative Stressor Effects Assessment

Canter (1999) provides a review of cumulative effects assessment (CEA) and provides 11 steps for CEA and several rules-of-thumb for working through the steps. In general, these steps involve identifying the geographic and temporal scope of the analysis (watersheds, period required for reversal of effects), characterizing the resource(s) subject to impact (salmonids), characterizing stressors (see above), developing baseline condition (viable populations), identifying cause and effect relationships (indicator ROC curve analysis), and estimating the magnitude of the direct and indirect cumulative effects (multivariate analyses). Final steps involve identifying alternatives to avoid, minimize, or mitigate the effects, and monitor the effects of the selected projects and adapt management accordingly. Therefore, as we perform the research for this project, we will in essence be performing a cumulative effects assessment. Michael Johnson, Don Huggins, and one Post Graduate Researcher V will each require 1000 hours for each of the three years of the proposed project.

Task 5. Determine Random Sample Locations in each Region

Initial site verification will be accomplished using GPS, Topographic Maps, and/or local contacts. Two Environmental Scientists from CDFG will be responsible for determining random sample locations using EMAP procedures and will each require 1000 hours per each of the two regions in this project. Responsibilities will include researching property ownership at assessor's office and field confirmation of sites.

Tasks 6,7,8. Field Sample Macroinvertebrates, Periphyton, and Fish in Sierra Foothill Region and Conduct Habitat Assessment (and Tasks 10,11,12 in Central Valley Region)

Field sampling will be conducted in the Sierra Nevada Foothill Region during year one and in the Valley Floor during year two. Sampling will be a cooperative effort between the University of California and CDFG, and will consist of two teams of four individuals (either four Environmental Scientist II's or Post Graduate Researcher II's) and one supervisor each. One team will sample macroinvertebrates and assess habitat, while the other team will sample periphyton and fish. Fish will be released after identification, enumeration, and visual assessment. Periphyton analyses are to be conducted by University of California staff in a University of California laboratory. It is estimated each sampling crew member will need 2000 hours to sample each of the two regions (Foothill and Valley Floor). Taxonomic analyses of the periphyton are included in estimated hours of periphyton field crew.

Benthic Macroinvertebrates

Benthic macroinvertebrates are organisms measuring at least 1 millimeter in size that spend at least a portion of their life cycle at the bottom substrates (benthos) of freshwater habitats. They are widely used as indicators of environmental integrity in streams because; a) they are ubiquitous and affected by environmental perturbations in many different types of aquatic systems, b) the large number of species involved offers a spectrum of responses to environmental stresses, c) their sedentary nature allows effective spatial analysis of pollutants or disturbance effects, d) they have variable life cycles (a month to four years) which allows accurate interpretation of temporal changes caused by perturbations, and e) the taxonomy of many groups is well known (Harrington and Born, 1999).

Sampling for benthic macroinvertebrates will follow established EMAP procedures as described in Lazorchak et al.(1998) and Peck et al., (draft report). Sites are initially verified using GPS, Topographic Maps, and/or local contacts. Once the site has been accessed, an "X-spot" is established. Water chemistry field measurements (Specific Conductivity, DO, and Temp) and samples are taken. Weather conditions (%cloud cover, precipitation, previous 24hr precipitation, and air temperature) are recorded. The reach is delineated according to the average wetted width at the "X-spot". The reach is defined by 40 stream widths with a minimum reach length of 150m. Five sampling transects are established below the "X-spot", and 5 above at evenly spaced intervals. Random sampling points are established at each transect systematically throughout the reach using Left, Center, and Right as designations. At each sampling point, the dominant substrate is categorized as fines/sand, gravel, course, or other. Benthic macroinvertebrates are sampled at each transect.

The following physical habitat data are collected at each transect: presence and type of fish cover, stream bank measurement, canopy cover, visual riparian estimates, thalweg profile, woody debris tallies, slope and sinuosity of reach, constraining feature of channel, riparian "Legacy" trees and invasive alien plants, and torrent evidence assessment. At a reach-wide or watershed level the following physical habitat data are collected: stream discharge, using the velocity/area method (taken at a point along the reach that is favorable for laminar flow conditions), watershed activities and disturbances observed, dominant land use, waterbody character (pristine/appealing), presence of beaver signs and any flow modifications as a result, and rapid habitat assessment (Kaufmann et al., 1999).

Periphyton

Periphyton is the community of microscopic animals and plants some of which have macroscopic grown forms associated with the surfaces of submerged objects. While algae can often dominant the periphyton, fungi, bacteria and protozoa are common members of this aquatic community. Periphyton have a long history of use as indicators of stream and water quality because of their short life cycles, sensitivity to anthropogenic disturbances, ease of collection, and ubiquitous occurrence in aquatic ecosystems.

We will use sampling and analysis procedures as outlined in Hill (1998) with some slight modifications as suggested by (Hill unpublished). Methods for the determination of ash-free dry weight and plant pigments are similar to those listed in *Standard Methods* (APHA 1995) while sample preparation and taxonomic procedures follow those of Stevenson and Bahls in Barbour et al. (1999) and Hill (1998).

Periphyton samples will be collected from the dominant habitat type (erosional or depositional) located at each of 11 stream transects established within the sampling reach. Beginning with a randomly selected position (left bank, middle of channel or right bank) on the first transect a single periphyton sample will be collected with a tube delimiter as described by Hill (1998) and each preceding sample will be take in a rotational manner so that samples will be taken in ordered sequence to the left position of the first sample. For example, if the first sample selected was at the right bank then the next transect sample would be from the middle position then the next would from the left bank and the process repeated until all 11 transects are sampled. The

samples are then pooled to create a composite sample that generally is about 500 ml in total volume. This "index" sample is then used to obtain the subsamples to be prepared for pigment and biomass analysis, taxonomic identications and polysatuated fatty acid analysis.

Three different types of laboratory samples are prepared from the composite index sample: an identification/enumeration sample, a pigment/biomass sample and a fatty acid sample. The identification sample is used to determine taxonomic composition and relative abundance of algae. This sample consists of a 50 ml aliquot preserved with 10% formalin (2 ml addition). The pigment/biomass sample is both the filtrate and filtered material obtained by filtering 25 to 50 ml of index sample through a glass-fiber filter. The filtrate is analyzed for chlorophyll *a* and pheophytin *a* according to method 10200H in the 19th edition of Standard Methods (APHA 1995) and ash-free dry weight obtained from the filtered residue following method 10200I of APHA 1995). Plant pigment and biomass concentrations are calculated using total sample area, composite sample volume and final filter volume adjusted for extraction volume. Determination of primary polysaturated fatty acid constitutes is made from a known filtered amount of periphyton following the procedures of (Stottrup and Jensen 1990, Brett and Müller-Navarra 1997, Müller-Navarra 1995).

Aquatic Vertebrates

While fish are the primary focus of the vertebrate collection and analysis efforts of the project, both amphibians and crayfish will also be surveyed. Sampling efforts will included the use of both electrofishing apparatuses and seines with backpack electrofishing equipment used as the primary sampling gear. Except for extremely rare taxa, the sampling design and effort will allow investigators to collect a representative sample form the study segment. Collecting and field processing methods as well as identification procedures follow those of McCormick and Hughes (1998) and Barbour et al. (1999).

The procedures and activities to be used by the 4-member fish team in this project vary slightly from those used in the eastern EMAP-SW project as outlined by McCormick and Hughes (1998). Deviations from the prior EMAP procedures include separate tallies and records for aquatic vertebrates collected in each inter-transect area. These are the areas occurring between the 11 cross-channel transects established for the periphyton, macroinvertebrate and other sample collections. Additionally, all crayfish will be identified and counted for each inter-transect area but external anomalies on fish and fish lengths will not be recorded.

The entire channel within the study reach is sampled uniformly by distributing the timed sampling effort through the use of the inter-transect areas as a sampling unit. Prior experience in the EMAP program suggest that a electrofishing collection time between 45 minutes and 3 hours for the entire reach should be sufficient to obtain a representative sample. Seining will be used in conjunction with electrofishing regardless of stream conditions but seining efforts will assume greater importance in streams with high turbidity and specific conductance (e.g. valley floor streams). Multiple short seine hauls within each inter-transect area will be used to reduce potential fish mortalities. About 240 minutes (4 hours) of seining time will be allotted to each reach and the seining efforts will be roughly distributed equally between transect areas.

Every effort will be made to minimize fish holding and handling times by identify and counting individuals at the shoreline every 10 to 20 minutes. Rapid processing will be facilitated by using one member to process fish from one sampling container while other team members continue to sampling and deposit fish and other organisms in a second container. Team members will be taxonomic trained and experienced with local fish fauna, amphibians and crayfish. Voucher specimens will be retained for all but salmonid species when identifications of small specimens or questionable species are encountered. Voucher specimens will be verified by an outside specialist and retained until the end of project. Every effort will be made to place specimens in museum collection when appropriate.

Tasks 9 & 13. Benthic Macroinvertebrate Sample Analyses for Sierra Foothill and Central Valley Regions

Macroinvertebrate samples will be processed by CDFG's Aquatic Bioassessment Laboratories in Rancho Cordova and Chico following procedures used for the EPA's EMAP program. A subsample of 500 macroinvertebrates will be removed from the surrounding matrix of benthic detritus, and identified to the lowest practical taxonomic level (generally to genus or species level) using standard taxonomic keys.

Task 14. Data Analysis and Interpretation

Data analysis and interpretation will involve all applicants of this proposal as well as subcontracted aid by the U.S. Geological Survey, and will be coordinated by the CVRWQCB. Univariate and multivariate statistical analyses will be used to aid in indentification of distinct biological classes of waterbodies and examine linkage of potential stressors. A multimetric approach, standard to biological assessment data analyses, may also be employed. It is estimated that Michael Johnson (UCD) and Don Huggins (UCD) will each require 320 hours per a year for years two and three of the proposed project. A Post Graduate Researcher V (UC) will also assist in the analysis at 600 hours per a year for the final two years of the proposed project.

Task 15. Annual Reports and Presentations

Annual reports will be the responsibility of CVRWQCB staff. Presentations will be the responsibility of CVRWQCB and UCD. At least one oral presentation will be given at a professional meeting annually such as at the North American Benthological Society or at other meetings, such as the CALFED Science Conference. Michael Johnson (UCD) and Don Huggins (UCD) will each require 320 hours per a year for years two and three of the proposed project to prepare reports and present presentation. A Post Graduate Researcher V (UC) will also assist in the preparation of reports and presentations at 600 hours per a year for the final two years of the proposed project. It is estimated that Robert Holmes (CVRWQCB) will require 200 hours per a year during the final two years of the proposed project to direct and compile annual reports and assist in presentations.

Task 16. Quarterly Progress Reports

The CVRWQCB and UCD will prepare quarterly progress reports. It is estimated that one Post Graduate Researcher V (UCD) will require 320 hours per a year, one Post Graduate Researcher II will require 100 hours per a year, and Robert Holmes (CVRWQCB) will require 200 hours per a year to prepare quarterly progress reports.

Task 17. Final Report
The CVRWQCB with assistance from UCD will prepare the final project report. Michael Johnson (UCD) and Don Huggins (UCD) are each requesting 320 hours along with a Post Graduate Researcher V at 600 hours for preparation and assistance in the final report. Robert Holmes (CVRWQCB) will be the lead in preparation of the final report and will require 600 hours.

Task 18. Project Administration
The CVRWQCB will be responsible for the overall project administration, tracking, and any necessary subcontracting. This includes tracking expenditures, deliverables, keeping track of timelines, and coordinating the Technical Advisory Group meetings. The CVRWQCB will also be responsible for producing meeting minutes and maintaining coordination between TAG members. The CVRWQCB will also be responsible for reporting project status to meetings of the Biological and Habitat Subcommittee of the SRWP. Project Administration is also requested for the UCD staff to direct and maintain a database of all field data. Michael Johnson (UCD), Don Huggins (UCD), and Jennifer Nickel (UCD) are requesting 320, 320, and 520 hours for project administration related to data collection activities. Robert Holmes (CVRWQCB) and Lori Webber (CVRWQCB) are requesting 300 hours each for overall project administration.

4. Feasibility

The proposed project is feasible. The applicants of this project (see qualifications) are experts in the field of aquatic ecology and understand the limitations and concerns involved in implementing and carrying out a project of this magnitude. Guidance from the Technical Advisory Group will also assist in directing project practicability.

5. Performance Measures

Performance measures for research project activities and outcomes generally include both the quarterly reports to CALFED, and also the generation of peer-reviewed publications. Unfortunately, the time frame of this project will not allow for the publication of manuscripts in scientific journals and the performance measures will simply be the submission of reports documenting the data collection and analysis. In addition, a Quality Assurance Project Plan will be developed prior to beginning any of the proposed work.

6. Data Handling and Storage

For the proposed research, all field samples (e.g., scales, periphyton, macroinvertebrates), field measurements (e.g., flows, habitat measurements), and laboratory measurements (e.g., PUFA content) will be marked with a bar code tag that can be affixed to sample vials, field and laboratory data sheets. This will insure that all samples are assigned to the correct location. All field samples other relevant data are catalogued with a chain-of-custody form at time of collection.

All data for the project will be kept in either an ArcView GIS database and/or an ACCESS database. The ACCESS database is already developed and will contain information on every aspect of the project including raw data, manipulated data, and results of statistical analyses. Additionally, the database contains SOPs for every field or laboratory sampling technique used in the project, digital photos for documentation, all publications and poster presentations, and cross references to GIS coverages maintained in ArcView. The ArcView database contains all of the coverages generated by the project. Most of the actual raw data generated by the project are included in the ArcView files as attributes.

7. Expected Products/Outcomes

The outcome of this project is to identify biological indicators of aquatic ecosystem stressors that account for natural variability within the Central Valley and Sierra Foothills Ecoregions of the Sacramento River Watershed. Based on this research, stressor specific metrics will be developed that can be used as performance measures for ecosystem restoration projects, as well as overall aquatic health (beneficial use) assessment. The proposed project will also generate information that can be used to gain insight into the biological condition and relative magnitude of stressors in the San Joaquin River, due to the regional similarities of potential aquatic life stressors.

Furthermore, the expected product from any research project is new knowledge. The key is to determine how this new knowledge can most efficiently be communicated with the appropriate groups. We will submit quarterly and annual reports of all activities to CALFED. Quarterly reports will consist of the activities performed during the quarter, and the annual reports will consist of an evaluation of the status of the project, any refocusing or redirection of efforts, and preliminary results of the research.

8. Work Schedule

Table 1. Schedule of proposed work.

	Year 1				Year 2				Year 3			
Task	Oct-Dec 2002	Jan-Mar 2003	Apr-Jun 2003	Jul-Sep 2003	Oct-Dec 2003	Jan-Mar 2004	Apr-Jun 2004	Jul-Sep 2004	Oct-Dec 2004	Jan-Mar 2005	Apr-Jun 2005	Jul-Sep 2005
1) Technical Advisory Group Meeting		X				X				X		
2) Obtain Collection Permits	X											
3) Analyze Existing Stressor Data	X	X			X	X						
4) Perform Cumulative Stressor Assessment	X	X	X	X	X	X	X	X	X	X	X	X
5) Determine Random Sample Locations in each Region		X	X			X	X					
6,7,8) Field Sample Macroinvertebrates, Periphyton, and Fish (Sierra Foothill Region)			X	X								
9) Sample Analysis (Sierra Foothill Region)					X	X						
10,11,12) Field Sample Macroinvertebrates, Periphyton, and Fish (Valley Floor)							X	X				
13) Sample Analysis (Valley Floor)									X	X		
14) Data Analysis and Interpretation							X	X	X	X	X	
15) Annual Report and Presentation				X				X				X
16) Quarterly Progress Report	X	X	X		X	X	X		X	X	X	
17) Final Report											X	X
18) Project Administration	X	X	X	X	X	X	X	X	X	X	X	X

B. Applicability to CALFED ERP and Science Program Goals and Implementation Plan and CVPIA Priorities

1. ERP, Science Program and CVPIA Priorities.

This project will support ERP Strategic Goals 2 (Ecological Processes), 4 (Habitat), and 6 (Water and Sediment Quality) by providing a "measurement tool" to assess the ecological integrity of streams of the Sierra Foothill and Central Valley Ecoregions within the Sacramento River watershed. This "measurement tool" will consist of biological metrics describing the aquatic organism assemblages (fish, algae and benthic macroinvertebrate) that exist in relatively unimpacted ("reference") to highly impacted streams.

This project will address Science Program Goals MR-6 (conceptual understanding and models that cross multiple regions), SR-3 (adaptive management experiments in regard to natural and modified flows) and SR-7 (conceptual models to support restoration) by developing biological metrics for use as both restoration performance measures and stressor identification tools. For example, the success of a stream restoration project can be measured by comparing the biological metrics of the site with the "reference" conditions for the stream classification where it is located. The biological metrics will describe conditions specific to each stream classification, but will be comparable within and across the two ecoregions (e.g. a "good" ranking for the a Central Valley stream will be equivalent to a "good" ranking for a Sierra Foothills stream - even though the two streams may have very different ecological conditions). The project will investigate the relationship between salmonid stressors, such as flow regulation, and aquatic organism assemblages to determine which biological metrics are the best indicators of stressor impacts. The two ecoregions in this study contain portions of Battle, Deer, Mill, Butte, Big Chico and Antelope creeks, which are identified in Goal SR-7 as priority streams for studies of salmonid stressors and their effects.

2. Relationship to Other Ecosystem Restoration Projects.

The biological data produced through this study can be used to evaluate existing and future stream restoration projects in both the Central Valley and Sierra Foothills Ecoregions of the Sacramento River watershed.

3. Requests for Next-Phase Funding.

This proposal is not a request for next phase funding.

4. Previous Recipients of CALFED Program or CVPIA Funding.

The applicants involved in this proposal have not been the recipients of previous CALFED Program or CVPIA funding.

5. System-Wide Ecosystem Benefits.

The benefits from this project would apply throughout the Sierra Foothill and Central Valley Ecoregions of the Sacramento River watershed. This would include improved methods for stressor identification and proposed restoration site evaluation, as well as performance measures of stream restoration projects. The methods developed in this study can be implemented in other ecoregions within the Sacramento and San Joaquin watersheds.

6. Additional Information for Proposals Containing Land Acquisition.

This proposal does not contain land acquisition.

C. Qualifications

James M. Harrington, M.S., State Water Quality Biologist for the California Department of Fish and Game (DFG), Water Pollution Control Laboratory Jim received his B.S. in Fisheries and M.S. in Watershed Management from Humboldt State University in Arcata, California. He has worked for DFG since 1987 and for DFG's Water Pollution Control Laboratory since 1991. His duties include investigating biological effects of toxic spills, designing water quality monitoring projects for DFG and various government agencies and supporting DFG's regional water quality biologists. Jim established DFG's Aquatic Bioassessment Laboratory in 1993 and since then have been supervising efforts in developing techniques, conducting projects and promoting the use of biological indicators for use in California water quality regulation.

Dr. Peter Ode, State Water Quality Biologist for the California Department of Fish and Game (DFG), Water Pollution Control Laboratory received his undergraduate degree in biology at Allegheny College and a doctoral degree in Entomology from Cornell University in Ithaca, NY. Under the instruction of Dr. Barbara Peckarsky, he studied behavioral interactions among mayfly larvae in the beautiful East River valley in the West Elk Range of the Rocky Mountains in Colorado. He moved to California in 1995 and has worked as a stream insect ecologist for the California Department of Fish and Game (DFG) since his arrival. As the head taxonomist of the DFG's Aquatic Bioassessment Laboratory, he is actively involved in developing taxonomic resources for bioassessment in California and developing and promoting bioassessment throughout the state.

Dr. Michael L. Johnson is an Associate Research Ecologist in the John Muir Institute of the Environment at the University of California, Davis. Michael received a Ph.D. from the University of Kansas in 1984 and worked with the Kansas Biological Survey on projects related to the effect of agriculture on the aquatic ecosystems of Kansas. He moved to UC Davis in 1992 where he is now the Director of the University of California Toxic Substances Research and Teaching Program's Lead Campus Program in Ecotoxicology. He has worked on a number of projects related to stressor identification and effects on ecosystems, steelhead ecology on the North Coast, and modeling of population dynamics. He is the PI of the Navarro River Watershed project, a $3.5 million multidisciplinary project to identify the stressors on steelhead populations in a North Coast watershed.

Dr. Donald G. Huggins is a Visiting Research Ecologist at the JMIE at UC Davis. Don has over 30 years of experience as an aquatic ecologist at the Kansas Biological Survey where he is the Director of the Aquatic Ecotoxicology Program. He is also the Director of the Central Plains Center for Bioassessment in EPA Region VII, a center whose goal is to develop numerical criteria for nutrients and the biological condition of aquatic systems. Dr. Huggins is currently assisting Dr. Johnson on the Navarro River project. His appointment can be extended and he can remain at UCD if this project is funded.

Robert Holmes, M.S., Environmental Scientist, CVRWQCB: Robert graduated from California State University Sacramento with a B.S. in Conservation Biology, and from Humboldt State University with a M.S. in Natural Resources. Robert is currently managing and directing biological research investigation contracts at the CVRWQCB that are focused on waterbodies of the Sacramento River Watershed.

Lori Webber, M.S., Environmental Scientist, CVRWQCB: Lori graduated from Indiana University with a M.S. in Environmental Science. Lori is currently directing a bioassessment study of effluent dominated waterbodies in the Sacramento River Watershed. Lori also currently works with and advises local watershed groups in the Sierra Foothills Region on their biological assessment and monitoring programs.

D. Cost

1. Budget.

The detailed budget for each year of requested support and budget justification are included in the web forms.

2. Cost Sharing.

Other direct funding commitments have not been identified for this project.

E. Local Involvement

This project will be coordinated with the Sacramento River Watershed Program's Monitoring Subcommittee and Biological and Habitat Subcommittee.

F. Compliance with Standard Terms and Conditions

All applicants will comply with standard State and Federal contract terms.

G. Literature Cited

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Figure 1: Conceptual Model

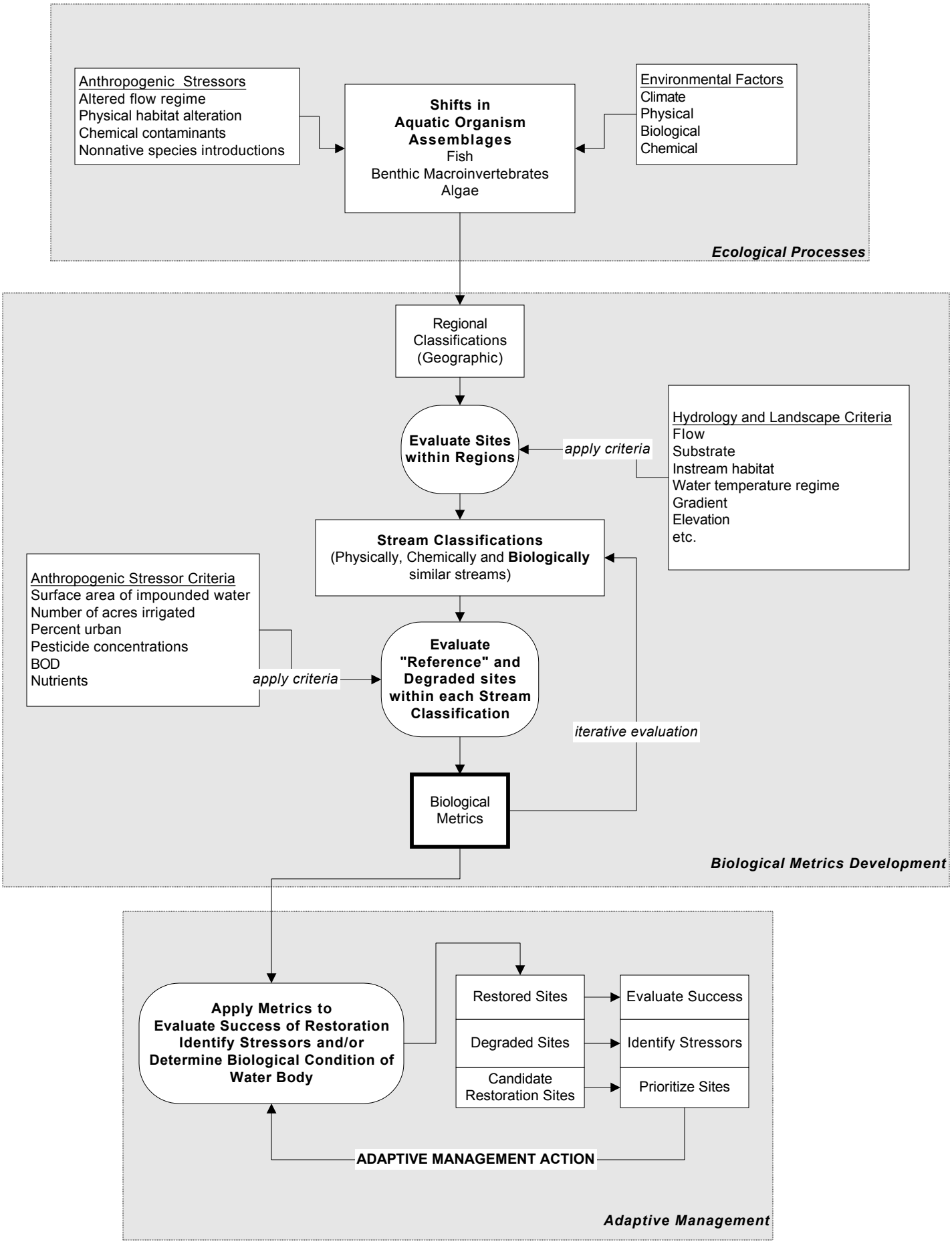

Figure 2: Process for Classification of Water Bodies (modified from Barbour et al. [1999])

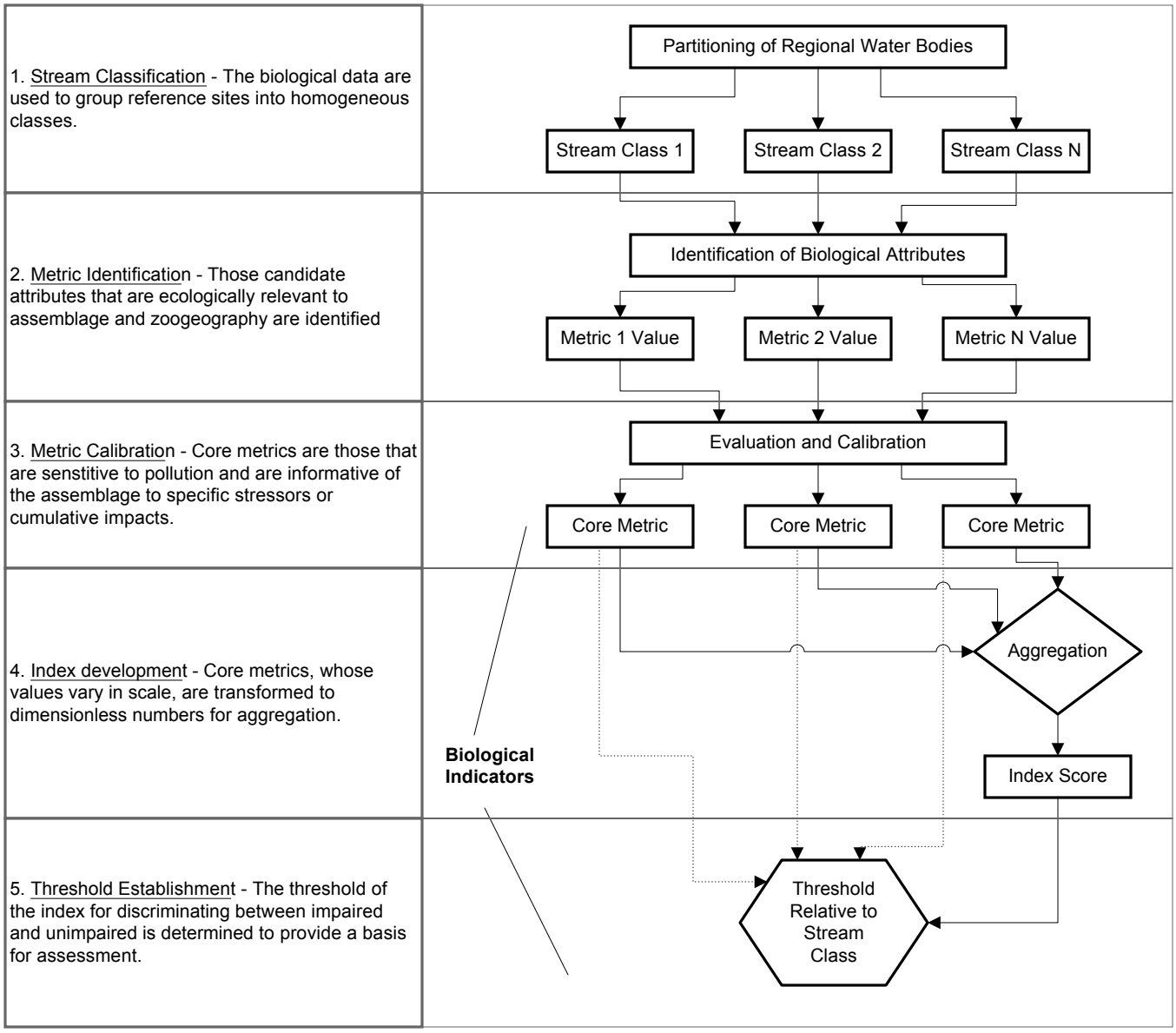

Figure 3: Map of project area

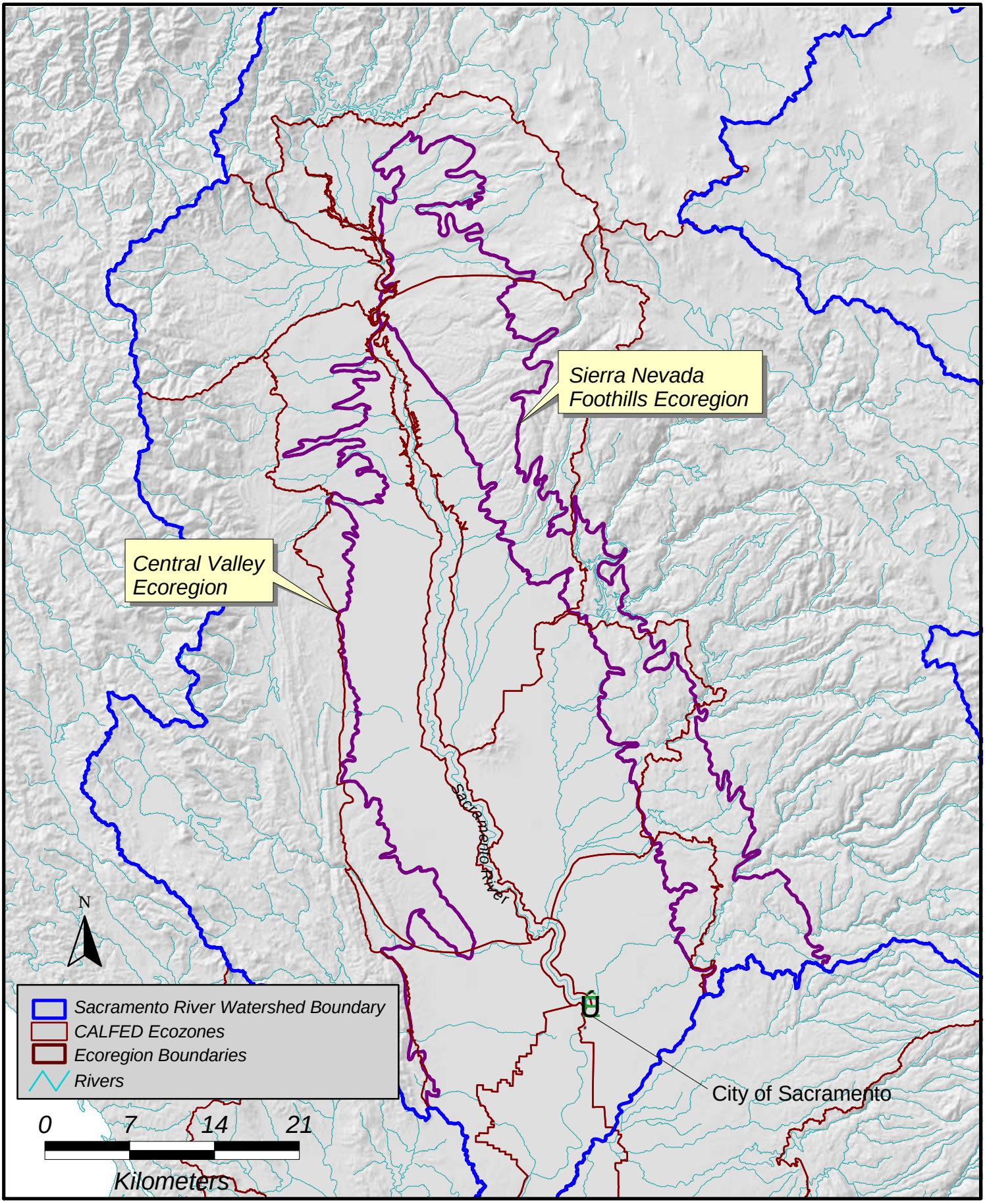

Figure 4: The Stressor Identification and Adaptive Management Process to Restore and Protect Biological Condition (Modified from EPA, [2000])