A taxonomic and ecological classification of riparian plant community types for management, conservation, and restoration purposes

Project Information

1. **Proposal Title:**

   A taxonomic and ecological classification of riparian plant community types for management, conservation, and restoration purposes

2. **Proposal applicants:**

   Michael Barbour, University of California, Davis

3. **Corresponding Contact Person:**

   Ahmad Hakim-Elahi
   Regents of University of California
   One Shields Ave., Office of Research Sponsored Programs, 118 Everson Hall Davis, CA 95616
   530 752-2075
   vcresearch@ucdavis.edu

4. **Project Keywords:**

   Habitat Evaluation
   Habitat Restoration, Riparian
   Riparian Ecology

5. **Type of project:**

   Research

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

   No

7. **Topic Area**:

   Riparian Habitat

8. **Type of applicant:**

   University

9. **Location - GIS coordinates:**

   Latitude:

   Longitude:

   Datum:

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

This is a multi-regional proposal, with project study sites in every region and ecozone.

10. **Location - Ecozone:**

    Code 15: Landscape

11. **Location - County:**

    Alameda, Amador, Butte, Colusa, Contra Costa, Fresno, Glenn, Lassen, Madera, Mariposa, Merced, Napa, Placer, Plumas, Sacramento, San Joaquin, Solano, Sonoma, Stanislaus, Sutter, Tehama, Tuolumne, 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:**

    3

15. **Location:**

    California State Senate District Number: 4

    California Assembly District Number: 8

16. **How many years of funding are you requesting?**

    2

17. **Requested Funds:**
    a) Are your overhead rates different depending on whether funds are state or federal?

       Yes

       If yes, list the different overhead rates and total requested funds:

State Overhead Rate:	10
Total State Funds:	498,689
Federal Overhead Rate:	48.5
Total Federal Funds:	667,187

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)

Todd Keeler-Wolf	**California Department of Fish and Game**	**916-324-68857**	**tkwolf@dfg.ca.gov**
Ellen Bauder	**California State University, San Diego**	**619-594-5032**	**ebauder@sunstroke.sdsu.edu**
Wayne Ferren, Jr.	**University of California, Santa Barbara**	**805-893-2506**	**ferren@lifesci.lscf.ucsb.edu**
Keith Loague	**Stanford University (Earth Sciences Dept.)**	**650-723-3090**	**keith@pangea.stanford.edu**

21. **Comments:**

Environmental Compliance Checklist

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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.

      No modifications to the environment are planned. Our survey will visit many sites but only for the purpose of recording species presence and describing the habitat.

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?

      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

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: The Nature Conservancy	Required, Obtained
Permission to access state land. Agency Name:	
Permission to access federal land. Agency Name:	
Permission to access private land. Landowner Name: various	Required, Obtained

6. **Comments.**

We have obtained general plant collecting permits from the state. Several riparian study areas we plan to visit are under the control of TNC, and we have successfully worked with TNC for access. Most riparian areas we intend to visit are under private ownership, the owners of which we know and are favorably disposed to granting us access (Nevertheless, we obtain formal permissions from them several months prior to scheduled visits.). After the study starts we will identify state and federal lands which may contain riparian ecosystems we will want to study. We will follow standard contact proceedures (we will obtain formal permissions from the designated state and federal land managers prior to scheduled visits)with the appropriate governmental agencies, prior to trespass.

Land Use Checklist

A taxonomic and ecological classification of riparian plant community types for management, conservation, and restoration purposes

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).

   We will do research activities only on the study sites. 10 sites will receive greater amounts of research activity, but no sites will change land use because of our study.

4. **Comments.**

   No land acquisition or change in land use is proposed by this project, nor is the success of this project dependent on land acquisition or change in use.

Conflict of Interest Checklist

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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):

Michael Barbour, University of California, Davis

Subcontractor(s):

Are specific subcontractors identified in this proposal? No

Helped with proposal development:

Are there persons who helped with proposal development?

Yes

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

Rod Macdonald independent consultant

Comments:

Budget Summary

A taxonomic and ecological classification of riparian plant community types for management, conservation, and restoration purposes

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.

State Funds

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**
Ia	vegetation, preparation for field				4530	1300	18750	3500		28080.0	2458	30538.00
Ib	vegetation, field work		8000	2000	19970	1300	42000			73270.0	7327	80597.00
Ic	vegetation data entry		675	10						685.0	69	754.00
Id	vegetation, analyses		675	10	2200	1300	32250			36435.0	3644	40079.00
IIa	ecology, preparation for field		4640	113	5430	11600	15000	4000	1207	41990.0	3678	45668.00
IIb	ecology, field work		4640	113	5430		30000		1207	41390.0	4018	45408.00
IIc	ecology, data entry		4640	113					1208	5961.0	475	6436.00
IId	ecology, analyses		4640	113	1600		15000		1208	22561.0	2135	24696.00
		0	27910.00	2472.00	39160.00	15500.00	153000.00	7500.00	4830.00	250372.00	23804.00	274176.00

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**
Ia	vegetation, preparation for field				4530	1000	18750			24280.0	2428	26708.00
Ib	vegetation, field work		8000	2000	19970	1000	24750			55720.0	5572	61292.00
Ic	vegetation, data entry		675	10						685.0	69	754.00
Id	vegetation, analyses		675	10	2200	1000	49500			53385.0	5339	58724.00
IIa	ecology, preparation for field		4732	115	5430		7500		1232	19009.0	1778	20787.00
IIb	ecology, field work		4732	115	5430	3700	7500		1232	22709.0	2148	24857.00
IIc	ecology, data entry		4733	115					1232	6080.0	485	6565.00
IId	ecology, analyses		4733	116	1600		15000		1232	22681.0	2145	24826.00
		0	28280.00	2481.00	39160.00	6700.00	123000.00	0.00	4928.00	204549.00	19964.00	224513.00

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**
		0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Grand Total=<u>498689.00</u>

Comments.

Budget Justification

A taxonomic and ecological classification of riparian plant community types for management, conservation, and restoration purposes

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

Only three individuals are paid hourly: 1) Two field assistants to the vegetation team in the field will be hired through a public search: These individuals will have experience with the Californian vegetation and will be paid $12/hr for 8 hr/day (approximately) for 40 days, a combined total of 666 hr each year. 2) One undergraduate student will be paid $9/hr as a lab helper for a total of 150 hr each year.This individual will perform curation duties in the UCD Tucker Herbarium. Such a student will be hired in an open search and will normally be experienced i the identificqation of Californian plants.

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

1) All faculty members are donating their time to this project. 2) 1 Graduate student RA receives a salery of $18,559 for 9 mo. at 50% time + 3 mo. at 100% time (first yr). The graduate student RA receives $18,930/yr in the second year, with 9mo. at 50% time + 3 mo. at 100% time.

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

1) No benefits for faculty contributions of time. 2) 1 Graduate student RA receivvs 1.4% benefits while 50% time and 4% while 100% time. 3) The 2 field assistants will receive 25% benefits. 4)The undergraduate student will receive 1.4%. 5) The 5 Consultants will receive no benefits.

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

1) Field travel from UCD to all research study sites will be by UCD motor pool vehicles, charged $57.45 per day, plus 12 cents/mi. Task 1 (Vegetation study/releeves) requires 40 days and 5,850 miles. Task 2 (Ecological assessment) requires

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

1)OFFICE SUPPLIES include Task 1 map printing, duplication costs, photo developing $2000 (yr1), and $2000 (yr2), Task 2 Duplicating, map and photo making $1000 (yr1), and $700 (yr2). 2)LABORATORY SUPPLIES include Task 2 $2000 (yr1) and $2000 (yr2) for geology map, gov't aerial photographs, satalite data, and topo data to be used in lab phase of "Ecology Assessment". 3) COMPUTING SUPPLIES include Task 1 $900 for software liscense of TurboVeg and others, and Task 2 $600 for GPS that will interface to computer. 4) FIELD SUPPLIES include Task 1 film, sighting devices, collecting supplies of $1000 (yr1) and $1000 (yr2). Task 2 supplied include 4 categories: Backhoe services are required so that the soil scientists can investigate the soil conditions on 10 selected sites. Backhoe services are $5000 (yr1) and $2000 (yr2). Aerial overflight photography of our study sites will cost $2000 (yr1), and $1000 (yr2). We will outfit 2 crews with PH/EC meters and Hand Augers for $1000 (yr1 only).

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.

Consultants, whether domestic or foreign, will conduct the vegetation field work, working fulltime during the field season; they will also be responsible for data entry, for performing data analyses, for interpreting the analyses, and for contributing towards the completion of manuscripts that will be submitted to peer-reviewed technical journals for publication. Domestic consultants will also be responsible for planning field team routes, necessary supplies, data sheets, and identifying landowners whose permissions will be necessary for access by the team. We estimate that 60 full days of time, including pre-season meetings, field days, data entry days, and work elsewhere, will be required of each domestic consultant. Each such consultant will be paid at the same $250/day rate. Each foreign consultant will be expected to participate in the same activities, except for pre-trip planning meetings, and we estimate that 45 full days will be so occupied; foreign consultants will be paid at the rate of $200/day.

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.

The University of California accounting proceedures identify three items in our budget 1)Tremble Geoexplorer III ($3500), 2) Laser level and sensors ($2500), 3)Digital Video Camera and accessories ($1500), for a total value of $7500 in "Equipment", all in year 1.

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.

Although we have listed "project management" as a budget item, we have not attached any dollars to it per se. Some of the funds to support such management activities as planning meetings among the team are charged to daily consultant fees, and donations of time by UCD faculty. Further "project management" support activities are performed by departmental staff, and this service is included in Overhead costs (10%/state, 48.5%/fed).

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

The Graduate Student used as a RA (Research Assistant) at UCD must have his/her paid by the grant; therefore we show "graduate student fee remission", $4831 (yr1), and $4928 (yr2). Overhead is not charged against such fee remission cost.

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.

The University has a complex partitioning formula for over-head funds received, including the usual categories of physical plant maintenance and staff support as well as opportunity funds that support the research activities of unfunded or underfunded faculty and graduate students.

Executive Summary

A taxonomic and ecological classification of riparian plant community types for management, conservation, and restoration purposes

This two-year, multi-regional, research proposal has two objectives; a classification (Task 1)of all riparian vegetation community types present in northern California central valley river and delta system. The second objective (Task2) is a robust summary model of the environmental factors found within this river and delta system. These envirionmental factors will be linked with the range of vegetation types classified by Task 1. Data on species abundance and abiotic traits will be analyzed with standard ordination and divisive techniques in order to floristically and ecologically define community and habitat types. Soil and Ecology experts will investigate 10 locations in greater detail, and evaluate environment at each vegetation sample plot. We aim for 100 locations and 1000 sample plots in this two year study. Basic vegetation hypotheses are that clusters of species (community types) recur where particular habitats recur and that each type is a predictive indicator of such microenvironmental traits as detailed in Task 2. Expected outcomes include: (1) technical publications in peer-reviewed journals; (2) a more accessible booklet on classification written for resource agency staff and consultants; (3) workshops on the classification scheme; (4) oral presentations about riparian vegetation and ecology given to professional societies, agencies, and stakeholder groups; and (5) lay-oriented news of the project periodically carried by public and private media. This project meets such multi-regional and regional priorities as (MR1-MR6): This study creates a detailed and specific multi-regional classification of all vegetation and environmental conditions. This allows us to understand with precision exacly how invasive plant species fit into the the ecosystem. This classification allows us to determine which native species can displace invasive species, and under exactly what environmental conditions they can do so. Our study will create permanent study plots which will serve to track both vegetation change and environmental change in the future as a result of climatic change, and additional introductions of invasive species in the future. The understanding gained in this study will support the recovery of at risk-species, by allowing us to identify critical vegetation and habitat conditions neccessary to species recovery. The understanding of vegetation types gained in our study will assist in decision making in preservation and restoration activities. The publication of our results will help conservation and management agencies recognize resource opportunities and constraints.

Proposal

University of California, Davis

A taxonomic and ecological classification of riparian plant community types for management, conservation, and restoration purposes

Michael Barbour, University of California, Davis

A. Project Description: Project Goals and Scope of Work

1. Problems

(a) Limited Understanding of Riparian Plant Communities

We propose to study riparian zones of the Central Valley and the Sacramento-San Joaquin Delta, in order to produce a taxonomic and ecological description of vegetation and habitats across the study sites. This study will produce a robust, stable, and detailed classification of the community types present across riparian ecosystems of northern California.

Riparian ecosystems in California are diverse habitats with an equally diverse range of vegetation types, including permanent wetlands, seasonal wetlands, fresh water marshes, moist to mesic shrub communities, levees, multi-storied forests, and woodlands and savannas. The structure of riparian vegetation has important impacts on the aquatic ecosystem. Productivity of the riparian plant community drives, in part, the aquatic food chain. Structure and composition of the plant communities of the riparian zone affect water temperature and water quality conditions, yet the flora of these riparian systems is large and not well characterized.

At present there is no standard classification scheme for riparian community types in California. Classification work has been stymied because the systems are fragmented, degraded, destroyed, or converted by agriculture, water development, and urbanization. The best estimates place the habitat loss at 80% or greater (Sawyer and Keeler-Wolf 1995). Habitat conditions have changed greatly from pre-settlement times through the damming and diversion of water in rivers, thus altering the dominant ecological factors affecting the riparian zone.

Riparian systems occupy dynamic and unstable positions in the landscape. Stream channels shift as a response to climatic changes and watershed alterations. The effects of human alterations add a layer of complexity to understanding the fundamental nature of the vegetation patterns found within the zone. Now is the time to make an extensive survey for the purposes of formally classifying and inventorying the riparian habitats still extant. Most state and federal regulatory agencies have placed a special emphasis on protecting riparian

habitats and on “restoring” and “creating” riparian vegetation communities where possible. Without a detailed knowledge of the natural biodiversity of these systems, we cannot know what we are losing and we cannot accurately target our restoration efforts.

Because there is no standard classification of riparian systems, there are no detailed criteria to determine which community types are most threatened--requiring conservation, restoration, or mitigation measures--and which are least endangered, either because of current abundance or because they are already well protected in existing preserves. As a result, land use managers and agriculturists may receive seemingly diverse, conflicting, and capricious directives from agencies that have jurisdiction over riparian wetlands or protected species.

When riparian ecosystems are impacted by human activities, our laws and governing policies often require that "mitigation” activities create or preserve riparian habitat and ecosystems. At present, in the absence of a state-wide floristic classification, we cannot be precise about the present natural plant communities which are to be destroyed, and we can not be precise about what community types will populate the “restoration” or “enhancement” areas which are created by our mitigation efforts.

(b) Limited Understanding of Fluvial Ecosystem Dynamics

A study of the vegetation community types present in the statewide riparian zones is not predictive or complete without a matching description and interpretation of the physical ecological conditions associated with each vegetation sample. The physical components of the greater riparian zone include many soil types, dynamic topographic gradients and geomorphic surfaces, and a variety of natural and human induced disturbances. The vegetation of the riparian zone is a reflection of soil type, soil moisture status, soil constraints, and natural or human disturbance.

Knowledge of ecosystem-level physical traits such as soil landforms and hydrology are important to the success of restoration attempts for riparian vegetation. To understand and then model the patterns of natural vegetation distribution across riparian landforms, it is necessary to quantify the constraints (and potentials) of the soils because the community best suited to the site is determined by those constraints. If the characterization and potential restoration of the vegetation community of a given riparian system are the objectives, then intensive characterization of soil types, landscape positions, and soil

moisture status and sources is essential. Are the soils depositional, residual, old, young, stable, unstable? With what landforms are the soils associated? How were the soils formed, and from what parent material? Can we characterize the community in landform or soil geomorphic terms? It may be possible to define the riparian zone without using the term "riparian" if biological survey transects are keyed to soil landforms. Successful restoration plans may be guided by models based on geomorphology and soils.

(c) Objectives and Hypotheses

Our first objective is to sample riparian habitats throughout the Central Valley and Delta riverine systems, in order to achieve a classification of community types. Approximately 100 study sites will be selected by a stratified random procedure to represent soil types, topographic positions, microenvironments, and geologic landforms. This approach--called the "gradsect" method--has proven to be an efficient sampling strategy for situations elsewhere that involve large areas, modest budgets, and limited time (Gillison and Brewer 1985). We hypothesize that by using standard, widely accepted methods of vegetation analysis, we will reveal clusters of species that recur where particular habitats recur. We hypothesize that each of the remaining study areas will contain many such community types, and that some will be endemic to one region while others will recur in more than one region. Once defined on a floristic basis, we hypothesize that each type can be used as an indicator of certain microenvironmental conditions, including hydrological regimes and human alterations.

Our second objective is to quantify the dynamic physical factors associated with each study site and community type; that is, to link ecosystem gradients with vegetation gradients.

(d) Project Location

Riparian vegetation will be sampled <u>throughout</u> the CALFED (ERP) area and adjacent areas represented by CVPIA: that is, all four regions and 14 ecozones, including the counties of Alameda, Amador, Butte, Calaveras, Colusa, Contra Costa, Fresno, Glenn, Kern, King, Lake, Madera, Mariposa, Merced, Modoc, Napa, Placer, Sacramento, San Joaquin, San Mateo, Santa Clara, Shasta, Solano, Stanislaus, Sutter, Tehama, Tulare,

Tuolumne, Yolo, and Yuba. UC Davis is strategically located so that all of the study sites may be reached with relative ease and economy.

2. Justification

This is a research project. Almost all existing riparian vegetation survey data in the files of state and federal resource agencies are, in the judgement of knowledgeable botanists, incomplete, out of date, or in error because those who gathered the data had insufficient training. Thus, a simple review of existing data will not resolve the problem. Furthermore, because of the wide range of soil landscapes that support riparian vegetation, a local study will not solve the problem.

Results from this research project will have both restoration and conservation consequences. Our project examines the problem (dearth of knowledge about riparian systems) by accumulating new, region-wide information from which conceptual and quantitative models of riparian vegetation and hydrology can then be created. Such models will make predictions about the composition and distribution of each riparian community type, predictions that can serve as restoration or conservation targets.

Our vegetation task addresses two hypotheses. The first hypothesis--that a finite number of repeatable and recognizable entities called plant communities (or associations) will become apparent--will be tested by using standard vegetation sampling and data analysis techniques widely accepted throughout the world. Some of these techniques, such as releve sampling and ordination and divisive classification software programs within Turboveg and Megatab formats, have been used more extensively outside the US to date; therefore we will require some training. For that reason, the budget requests funds each year to bring to California one-to-two vegetation experts from other parts of the world. In 2001, using Packard Foundation funds, we brought in three experts for similar studies on vernal pool ecosystems. Our very positive experiences with them gives us confidence that future cooperative work will continue to be essential for our results to be accorded the highest measure of acceptance and credibility.

Sample locations will be chosen to most efficiently represent particular combinations of topography, geology, and soil factors. In addition, they must be within a subset of properties available to us (either private lands whose owners give us trespass

permission, or public lands). We anticipate sampling 100 locations and compiling approximately 1000 vegetation samples (releves).

The classification developed from those 100 locations will be tested against riparian surveys taken recently by other researchers in other parts of California. For example, Dr. Steven Talley has taken 100 samples of natural riparian vegetation on the Feather River Audubon Bobelaine Preserve before a 1991 wildfire and has resurveyed the same stands post-fire to detail early successional changes. Our study will include these valuable observations and extend them with our own, which additionally contain detailed physical measures. We will compare our results with all of the detailed vegetation studies published to date (see the entire series of Riparian Conferences published by the University of California's Institute of Ecology). This large data set makes for a more definitive, defensible classification. We will also attempt to crosslink our floristically based units with the physical and hydrologic units of Sawyer and Keeler-Wolf (1995) and of Ferren et al. (1994). Finally, community types will be correlated, when possible, with such physical traits as landscape position, soil development, textural sorting, soil age, soil type, geologic substrate, elevation, latitude and longitude, topographic position, local climate, and nature of existing disturbance.

3. Approach

Our research protocols were developed, tested, and used during 2000-1, with the support of the Packard Foundation for a statewide vernal pool study. The principal and associated investigators of that study will also participate in the design and execution of this proposed riparian study. We have assembled a field team that includes those botanists and ecologists most experienced with California riparian vegetation.

This field team has the critical mass to adequately sample one riparian "gradsect" study area per day. The team will also include two assistants, selected from applicants who possess and demonstrate interest and knowledge in an open interview process. This aspect of the work is designed to train younger people to be the experts of tomorrow. Finally, the team will be joined by two internationally known vegetation scientists who will bring a technical expertise to the sampling and data analyses. A similar combination of individuals was successfully used in the vernal pool study.

The sampling route through the Central Valley will be determined by Drs. Holland, Kelley, Macdonald, and Talley such that a maximum of environmental diversity will be included and that the sampling season will be prolonged for as long as possible. The potential field season is from April through August, each year. Within a given site, replicate releves (quadrat samples) will be positioned in representative places within each distinctive and homogeneous vegetation zone. We expect that some sites may have as many as five zones, and others as few as two, and that each zone might include several replicate releves, meaning that 100 sites would be represented by 1000 releves. Fifty sites will be visited each year.

All field data will be entered into Turboveg (a unique spread sheet format that allows transfer of data into analysis programs much easier than Excel). We are already using these protocols for vernal pool work. Because the best botanical experts are part of the field team, it will be possible to enter complete floristic data on a weekly basis; there is no delay while waiting for specimens to be examined by other experts some distance away. Each day, data sheets will be cleaned, checked for quality, and duplicated. Standard divisive and ordinational methods (e.g., TWINSPAN, Decorana) will be used to define community types.

Ten of the 100 sites will additionally be repeatedly visited for soil and hydrological monitoring. A small Bobcat™ and its operator will be rented to dig a 3-m long x 2-m deep trench in each zone in each site. (Of course, the 10 sites chosen will be those whose public or private owners give permission for such limited disturbance.) Trenches will be examined repeatedly through each year to determine water content, soil taxonomy, the presence of sedimentary layers with unique hydrological traits, and rooting depth. Using both field and laboratory techniques, saturated and unsaturated properties of the soils will be characterized and an assessment of soil landforms occupied by elements of the riparian communities made. Conceptual and numerical models will then be constructed to facilitate the interpretation of field data and to define the necessary ecological conditions to support each riparian community type. Results of the modeling will also prove useful for determining necessary site conditions for creation or restoration of riparian habitat and specific vegetation community types.

The Environmental Horticulture Department at UC Davis has agreed to provide the riparian team with an office and access to computer facilities. The Director of the university herbarium has offered archiving services and space for voucher collections. The campus in

general will provide access to university vehicles, the library, email, the internet, telephone, duplication services, and reprographic services.

4. Feasibility

We have already developed, used, and tested the releve and vegetation-analysis protocols proposed for this study in a study of vernal pools, thanks to support from the Packard Foundation, Caltrans, and the California Department of Fish and Game. We believe that this experience guarantees that the proposed study can be completed on time and with promised results in hand. Two years will be a comfortably adequate time to complete 1000 releves, based on the vernal pool experience.

No permits from government agencies are required for the work proposed. We have communications from The Nature Conservancy and many other landowners that indicate those owners will be agreeable to granting regular access permission to team members on their land. We were very successful in obtaining entry permission to private land during the 2001 Vernal Pool Study field season, using a combination of personal contact, telephone contact, references from county agricultural agents and from farming or ranching organizations, and letters; we expect equally positive results for the proposed riparian work.

5. Performance measures

Two types of performance measures can apply to this project: immediate and ultimate. Examples of each are summarized below.

One immediate measure is actual sampling progress compared to the projected schedule. Prior to the 2003 sampling season we will identify those sites that we want to visit, we will obtain permission to enter from those properties that otherwise would be closed to us, and we will schedule our season-long route. The same protocol would apply for the 2004 season.

Another immediate measure is the timing of data entry. For the vernal pool study, all data were entered within 6 weeks of the close of the field season.

A third immediate measure is the timing of data analysis. For the vernal pool study, we had accomplished preliminary analyses for classification within 10 weeks of the close of the field season, but were not able to refine those data to the point of publishable manuscripts until 6 months after the close of the field season.

Ultimate measures cannot normally be made within the same year that fieldwork occurs. These include: oral presentations at meetings; training workshops led by team members and based on fieldwork and analyses; and publications.

6. Data Handling and Storage

Our vernal pool protocols for vegetation data handling and storage will be continued for this project. Original data sheets are filled in to the extent possible while the team is conducting the releve. Some header data (locational or site-descriptive) is added later. Questionable species are collected in Ziplock™ plastic bags and given provisional names until their identities can be clarified later in the day. At the end of each field day or field week, all data sheets are reviewed by team leaders or a designated member of the team for quality control: a check on correct nomenclature, spelling, site locational information; and a check for unfilled datasheet spaces. Changes are made on the original sheet in such a way as to leave the original notation still legible. Each change is initialed by the person making it. Copies of original data sheets are made later in the season and complete sets are stored in the office. Copies are distributed to those team members who want them.

At UC Davis, vegetation data are entered into Turboveg according to standard protocols developed initially by the software's creator, Dr. Stephan Hennekens of the Netherlands. Only three members of the team will be allowed to transfer data from the data sheets to the electronic databank, in order to keep the process well monitored. Copies of the databank, however, are made available to any team member who wants one.

Soils, geomorphology, and hydrology data are entered electronically in the field, downloaded periodically into larger memory units on campus, and summarized as the data are entered.

7. Expected Products/Outcomes

We expect four publications on riparian vegetation. One will be a classification scheme, including a diagnostic key and full descriptions of every community type that can be statistically defended. The description will include details about hydrology, geology, soil profile, topography, and region in addition to floristic composition. In this way, the phytosociological classification builds on earlier classifications that emphasized physical features. This publication will be in the form of a peer-reviewed journal article. Pre-published copies will be circulated for additional review (and later, reprints sent) to all agencies that have a role in wetland and terrestrial land use in California (e.g., ACE, Caltrans, Fish and Game, Fish and Wildlife Service, and EPA) and to non-governmental conservation groups such as CNPS and TNC.

A second publication will be a general overview of methods, protocols, and objectives of the study, together with sample results. This will be the first publication, and it will be prepared at the end of the first year's field season, for submission to the peer-reviewed journal Madrono in early 2003, for publication by early 2004. Madrono has a regional readership.

A third publication will detail ecological relationships among riparian taxa and ecological factors. Ordination, rather than classification, will be the objective and theme. This will be our definitive paper on community ecology and we plan to submit it to a peer-reviewed journal with an international audience (e.g., Ecology or Journal of Vegetation Science).

A fourth publication will detail the range of annual and seasonal variations in riparian species composition and abundance. This will be in a peer-reviewed journal with national readership, such as the American Journal of Botany. It will be of more interest to basic vegetation scientists than to land-use managers.

We also want to hold training sessions in the field, in the use of the classification keys, for interested agency personnel. We expect to volunteer for informal presentations to other agency staff in their offices. We intend to give at least one formal presentation a year at a national scientific meeting, such as to the Ecological Society of America, the Society for Ecological Restoration, or the Society for Range Management.

Insofar as the ecological articles demonstrate new management implications, reprints will be sent to appropriate colleagues and agencies, and informal presentations at agency

meetings will be given as requested. At least one formal presentation a year will be given at a national scientific meeting.

8. Work Schedule

For simplicity, we have divided the project into two over-arching tasks: vegetation analysis and ecological assessment. (For all intents and purposes, data acquisition, data entry, and data analysis happen simultaneously in intensive bits, even though they have been discussed in this project as though they were isolated in time.) If funding were limited, either ecological assessment or vegetation analysis could be omitted as a task, but in neither case can any subtask be omitted.

Task 1, Vegetation Analysis, Timelines for 2002-3 and 2003-4

1 September through 1 April (2002-3 2003-4)-- Plan sampling route, obtain permissions for trespass as necessary, train new team members (if any), retrain returnees as necessary, obtain new field supplies as necessary, network with local specialists for their assistance, advertise for new assistants as needed, respond to calls from resource agencies for informative presentations, and send off abstracts to program chairs for national meetings that will be held in the summer.

1 April through 1 September (2002-3 and 2003-4) -- Accomplish field work, do quality control on data sheets, replenish supplies, revise sampling route as needed, deposit voucher specimens with UCD herbarium for insect and disease control and later accession.

1 June through 1 November (2003 and 2004) -- Transfer data from corrected field sheets to electronic form.

1 August through 31 December (2003 and 2004) -- Analyze data for both classification and community ecology purposes. Begin the process of designing and writing manuscripts. Present a formal paper at a national meeting.

1 September through 31 December (2004 only) -- Complete the writing and submission of all manuscripts for publication. Complete a final report to CALFED. Network informally and formally with contacts in resource agencies to make them aware of the classification

document, both for advice before the document is finished and for discovering who wants copies of the document, once it is finished.

Task 2, Ecological Assessment, Timelines for 2002-3 and 2003-4

1 March through 1 October 2002. – Make initial field visits to begin process of designing ecological habitat scalers. This process will integrate the current riparian literature with our methods of assessing the environment. The result is a data sheet with appropriate species lists and appropriate "questions" which are answered in the field as a part of each site visit. The environmental descriptions are collectively known as "header data" in our TurboVeg analysis program. The ecological data appear above the midpoint of the printout, and hence are termed header data, while the vegetation information appears in the lower half of the printout.

1 October through 1 May (2002-3 and 2003-4) – Team members will study weather patterns and river stages in order to add ecological data to the sites we plan to visit. Some field checks will be performed during the winter to assess hydrology of some representative study sites. Respond to calls from resource agencies for informative presentations, and send abstracts to program chairs for national meetings that will be held in the summer.

1 July through 1 October (2003 and 2004) -- Complete environmental data acquisition in the field for all sites. Analyze and evaluate data. Begin the process of designing and writing manuscripts. Present a formal paper at a national meeting. Respond to requests from resource agencies to give informal progress presentations.

1 October through 31 December (2004 only) -- Complete the writing and submission of all manuscripts for publication. Complete a final report to CALFED.

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

1. ERP, Science Program, and CVPIA Priorities

Our project meets priorities that are multi-regional and regional.

Multi-regional priority MR1 ("prevent the establishment, and reduce the impact of non-native species in the Bay-Delta estuary and its watersheds"). Our project creates a detailed and specific multi-regional classification of all vegetation and environmental conditions. This classification of vegetation allows us to understand with precision exactly how invasive plant species fit into the ecosystem. This classification allows us to determine which native species can displace invasive species, and under exactly what environmental conditions they can do so. This classification will specify how human activities facilitate the invasion of these non-native species (in many cases), and how human activities could change to favor native species.

Multi-regional priority MR2 ("conduct studies to better understand relationships between farming and wildlife habitat") is supported by our vegetation classification study, by specifying the exact vegetation found in native habitats and its change with the influence of farming and urban activities. In order to "better understand relationships between farming and wildlife habitat" requires a comprehensive, detailed understanding of the vegetation types involved and affected. Our vegetation classification project is the framework which will support this "better understanding" expressed in MR2.

Multi-regional priority MR3 ("implement environmental education actions") is supported by our proposed classification study. The knowledge we will gain in this study will be published in a variety or forums, beginning with the technical, international scientific literature and ending in the publication of stimulating articles and educational materials aimed at the "layperson" audience. Our outreach to educate the public will take place within the Resource Conservation District format. David Kelley has an 8-year history of teaching and supporting this RCD outreach which brings landowners and the general public into symposia and field trips to teach and demonstrate modern, scientifically based land stewardship. This program has benefited many landowners over the last decade. Our study will advance this educational effort in the future.

Multi-regional priority MR4 ("ensure restoration . . . can be sustained under future climatic conditions") is made possible by using our proposed classification study. Our study will create permanent study plots which can (and must) be re-studied in the future. Our study is relevant in three ways: 1) our classification is detailed and specific, so that any vegetation change can be accurately described and measured, so that we can recognize change and stability in the ecosystem. 2) our classification will link the range of vegetation presently existing to the range of environmental conditions presently existing. This allows

us to predict the changes in environmental conditions and vegetation that will result from future climatic conditions. 3) our classification will serve as a "measuring stick" to assess that restoration efforts are succeeding over time into the future.

Multi-regional priority MR5 ("ensure restoration not threatened by degraded environmental water quality") is supported by our development of this proposed vegetation classification. Our study will identify relationship between vegetation and environmental conditions. Our model will identify habitat degradation, and can measure and specify the nature of vegetation change.

Multi-regional priority MR6 ("ensure recovery of at-risk species by developing conceptual understanding and model that cross multiple regions") is the best description of our vegetation and ecology study of the riparian ecosystem. Our project deals with plant and animal species at risk (because their riparian habitat is at risk, via conversion for agricultural or residential purposes). Our project also intends to develop a conceptual understanding of the multiple ecological factors that support riparian vegetation types across multiple regions. Meaningful evaluation of the fate of at-risk species is impossible without a specific and detailed classification of the vegetational matrix that supports these species of special concern. Our model of the vegetation and the environmental will support the study of other components of the ecosystem (such as fish populations, etc.).

2. Relationship to Other Ecosystem Restoration Projects

This project is strongly related to restoration-related grants for vernal pools from the Packard Foundation to Michael Barbour and others (October, 2000-October, 2001), from Caltrans to Graham Fogg and others (October, 2001-October, 2002), and from the California Department of Fish and Game to ICE, Robert Holland, and others (April-July, 2001)--all of which are directed towards improved understanding of California's native vegetation and hydrology. This proposed riparian ecosystem study begins with a fully developed team of taxonomists, ecologists, and analytical tools and methods that are field-proven in the vernal pool study.

3 and 4. Requests for Next-Phase Funding, and Applicants Who Are Previous Recipients

This proposal is not a request for next-phase funding. We have no current funding from either CALFED or CVPIA, nor have we been recipients in the past. This is a new proposal.

5. System-Wide Ecosystem Benefits

Our project has system-wide benefits in the sense that it addresses many multi-regional priorities, and because riparian ecosystems are found within all CALFED regions.

6. Additional Information for Proposals Containing Land Acquisition

This proposal does not seek land acquisition, nor does its success depend upon land acquisition.

C. Qualifications

The riparian ecosystem team members, described below, are committed to this project and are prepared to arrange their calendars of activities so that the proposed tasks can be accomplished on time and successfully. They have no potential conflicts of interest or problems with availability. They include independent consultants and university scientists. The organization of the group is as follows:

Michael Barbour is the Principle Investigator, facilitator, and spokesperson for both tasks; he chairs organizational meetings and he supervises RAs and field assistants who are responsible for acquiring equipment, vehicles, and supplies. He and Rod Macdonald write the first drafts of vegetation research manuscripts.

Carol Witham and Robert Holland are the team leaders for vegetation sampling. They are in charge of quality control for field data, of reference plant collections, of planning the field trip routes, and of taxonomic training.

David Kelley and Steven Talley will outline and coordinate acquisition of soil and geomorphic data (with other team members), and perform fieldwork, train fieldworkers, and help with manuscript production.

Rod Macdonald and foreign specialists are in charge of data entry and analysis.

Biographical sketches are below:

Michael Barbour is a vegetation ecologist with research experience in plant ecophysiology, community dynamics, and community classification in such vegetation types as intertidal marsh, coastal dunes, grassland, deciduous forest, and conifer forest. He has a Ph.D. in plant ecology from Duke University (1967) and has been a faculty member at UCD since then. Awards include Guggenheim and Fulbright fellowships and visiting professorships at Louisiana State University (Baton Rouge), Hebrew University (Jerusalem), and Universidad Complutense (Madrid). He has been Chair of the Vegetation Section of the Ecological Society of America (ESA) and was a founding member of the ESA's Panel of Vegetation Classification.

Robert Holland received his Ph.D. from UCD in 1978 for a biogeographic study of Central Valley vernal pools, and he has continued to make important contributions on that topic to the present. He knows the California flora very well. For some years following graduation he was vegetation ecologist for the California Department of Fish and Game and while in that position he wrote the first comprehensive classification of the terrestrial communities of California (1986). He currently works as an independent consultant specializing in rare plant taxa and communities. In 1994 Robert co-authored “riparian plants” with Phyllis Faber. Robert is the author of many technical research articles on California flora.

David Kelley has an MS in Botany from Texas Tech University and is a candidate in philosophy in plant physiology and soil science at UC Davis. He teaches professional courses on soils, wetlands, trees, and ecological restoration to resource professionals throughout California, and consults on soil, plant, and land-use issues with clients in California and internationally. He has collaborated with Dick Herriman (senior soil scientist, retired from USDA) and Randy Dahlgren, Department of Land, Air, and Water Resources at UCD, to develop and teach professional soil courses to a variety of government agencies and through the University of California University Extension.

Rod Macdonald has been an independent consultant for the past twenty years, since the time he was a doctoral candidate in plant ecology at UCD. He works with many Central Valley ecosystems, particularly vernal pools, grasslands, chaparral, oak woodland, and riparian forests. In his capacity as an Associate with Kelley & Associates Environmental

Sciences, he was instrumental in the acquisition of the 60-acre Wurlitzer Tuscan vernal pool Preserve near Chico ten years ago. He later supervised the creation and monitoring of vernal pools (and natural pools) in that preserve.

Steven Talley received his Ph.D. from Duke in 1974 for a study of the ecology of Santa Lucia fir (Abies bracteata), a narrow endemic conifer in California. He has worked for two decades as an ecological consultant, working with both agricultural systems and native California plant communities. His research interests include the dynamics of riparian ecosystems and the classification of vegetation types. Dr. Talley has studied vegetation dynamics on the American and Feather Rivers. He was a soil specialist during US Army service, and he has spent most of his career building restoration ecosystems to mitigate development and habitat loss. This habitat evaluation and construction puts his research knowledge to the practical test of creating successfully functional mitigation habitats.

Carol Witham has been an independent consultant for the past dozen years, with a specialty in plant taxonomy. She knows the California flora well. She has had contracts with the USDA Forest Service, the California Department of Fish and Game, The Nature Conservancy, and Pacific Gas and Electric Company. She has been active in the California Native Plant Society as a member of the Rare Plant Committee. Currently she is a member of the vernal pool multi-species recovery team for the US Fish and Wildlife Service. She was the lead organizer of a 1996 vernal pool symposium and the senior co-editor of the proceedings volume that resulted.

D. Cost

1. Budget (see forms)

2. Cost-Sharing (none)

E. Local Involvement

Our plan for public outreach has the following elements:

(1) Several of us are active members of the California Native Plant Society, a non-profit lay association with several thousand members. We will publish articles on riparian

systems in the CNPS journal Fremontia and on the CNPS web site. We will initiate a riparian ecosystem website, to be built and maintained by Carol Witham.

(2) We will seek the attention of regional media to publicize our research efforts. As an example, our vernal pool team was interviewed by television stations KOVR, KVIE, and UC Davis, and by regional newspapers to describe study protocols, objectives, and results.

(3) We have opportunities to speak with water users, watershed interest groups, local cattlemen's associations, conservation groups, Resource Conservation Districts, and farmers' groups to spread the word about our research, and we plan to continue to seek such connections in the future.

(4) We will approach local conservation organizations including the Putah Creek Council, The Nature Conservancy, and other related groups. Our networking efforts will include e-mail lists for updates and offers of slide presentations.

F. Compliance with Standard Terms and Conditions

My intention, as PI, is to be in full compliance. At this time I am not aware of any conflicts that my university has with the contract terms. If, at some later time in the submittal process the university notifies me of objections, those objections will be appended to the signature sheet.

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