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Information Systems for
Evaluating Restoration Opportunities

Proposal to CALFED
July 28, 1997

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Proposed contract dates: Dec. 1, 1997 - July 1, 1999

Amount requested: \$338,149

RFP Project Group Type: Other Services

Executive Summary
Information Systems for Evaluating Restoration Opportunities
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Objectives -- The CALFED process embodies a recognition that critical water and related environmental resources and services can only be effectively managed on a watershed-wide basis. Restoration efforts in upstream waterbodies and watershed are an essential complement to water improved water operations, wetlands restoration, fish screens, etc. in the Delta itself, if water quality, fish populations, and related values are to meet the goals of the Bay-Delta Accord.

Hundreds of such efforts are already underway, and many more will be started as a result of the CALFED process. The partially completed California Watershed Projects Inventory (CWPI) and California Environmental Restoration Projects Inventory (CERPI), developed by UC Davis (see <http://ice.ucdavis.edu>) in collaboration with the Resources Agency, the State Water Resources Control Board, the Department of Conservation, and the US EPA, have documented over 200 funded projects with three or more collaborating organizations in the Sacramento River drainage alone. The vast majority involve CALFED member agencies. This assessment was begun to help accountable public agencies evaluate whether project funds were being directed either toward the locales of greatest environmental needs and opportunities, or toward the most effective strategies and technologies. The effort has also fostered cooperation at a local level to an even greater degree, where we have found that the project leaders the same watershed or county have frequently been completely unaware of each other's existence. This experience suggests that CALFED could benefit from an information system to track projects and the resources they address throughout its region of responsibility.

Project Description -- We propose to adapt and expand a variety of geographical databases and analyses currently sponsored by the Biodiversity Council, EPA, USGS, and other collaborating agencies, to meet the analytical needs of the CALFED process. Specifically we propose 8 partially inter-related subprojects, or tasks. A detailed time line is attached:

Task 1. We propose to adapt the inventory databases for watershed and restoration projects (CWPI, CERPI) to treat projects proposed to, funded by, or related to Category III activities, to index them in a way consistent with emerging CBC, CERES and national (e.g., Library of Congress) standards, and make them searchable over the Internet, using an interactive geographical query system (on-line, user-defined mapping). To do so, we will work with CALFED to identify additional variables needed to help evaluate outcomes of restoration activities and to provide accountability to project managers, and incorporate them into the current data system.

Task 2. Similarly, we propose to develop an inventory of relevant data sets and reports. This will build upon the CBC-sponsored effort we help lead to inventory agency datasets using federal metadata standards (FGDC and GILS) and standard vocabularies (e.g., NASA, Library of Congress). We propose to expand the analysis to treat data holding by non-government organizations, published studies, and grey literature.

Task 3. In collaboration with experts on each group, we will generate a biodiversity mapping system to map known occurrences and predict the distributions of native fish, amphibians, migratory birds, and riparian plant species.

Task 4. At present, there are no adequate digital maps of riparian habitats covering the region. We propose to construct riparian GIS coverages from existing regional maps, imagery, soil properties, and historical Mylar maps held by Fish and Game.

Task 5. We will expand the (currently terrestrial) CALTOX database, developed in collaboration with CalEPA, to cover biological effects of hazardous materials on aquatic vertebrates. Combined with the proposed species maps and current hazardous materials coverages (NAWQA, FEMA, CARA), this should permit analysts to identify sites where known toxin levels represent unusually high risks to target fish and amphibian species.

Task 6. The first step toward effective regional monitoring is to agree upon indicator variables. We propose to convene a panel experts to assess the applicability of existing indicator strategies (e.g. IEP, EMAP, TNC, NAWQA) and to develop criteria for both short term target species and habitat analysis, and for long term multi-species multi-habitat conservation efforts.

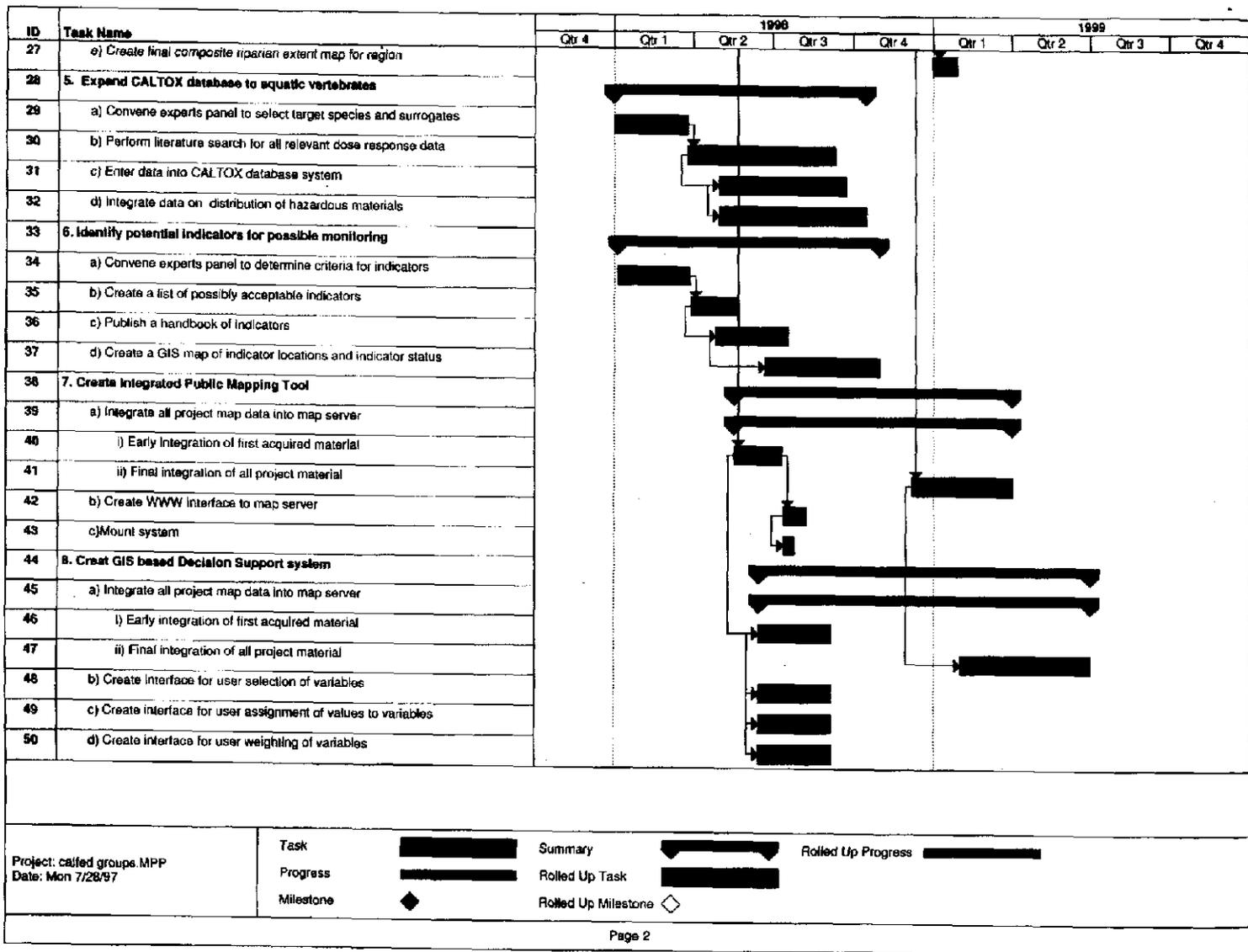
Task 7. The projects, biodiversity, and riparian habitat will be incorporated into a larger GIS system including the most current statewide maps of hydrography, watershed delineations, and impaired waterbody designations (Clean Water Act 303d and 305b), all of which we are developing on other funding. We will also couple the land use, land cover, dams and diversions, management status, facilities, hazardous sites, mercury loads, etc., coverages that we have integrated into the California Rivers Assessment. A new version of our ICEMAPS on-line interactive mapping tool will make custom maps from this system available to any CALFED participants (or other interested parties) at no charge over the Internet.

Task 8. We will develop an easy-to-use ArcView application to permit decision makers to interactive rank habitats for restoration potential and value using user-specified variables, scoring rules (i.e., is being upstream of a dam a plus or a minus?), and weights (i.e. how important are fish vs. mercury?) This decision support tool represents an expansion of a similar tool (CARES) we developed to aid the Wildlife Conservation Board in allocating funds for riparian

Justification — The proposed work will permit CALFED to identify areas of opportunity for management and restoration projects, and to evaluate proposals and projects more cost-effectively. The database and bibliographies will also provide free information and map resources to local projects and contractors, decrease the cost of preparing CEQA and other planning documents, and help projects and managers identify relevant contacts and data sets.

All of the proposed tasks represent value-added adaptations of efforts currently funded and supported by a wide variety of public agencies. All of the data and software developed will be in the public domain, and made freely available over the Internet through the Resources Agency's California Environmental Resource Evaluation System (CERES), Watershed Information Technical System (WITS) and University of California (ICE, Digital Library) sites.

ID	Task Name	1998				1999				
		Qtr 4	Qtr 1	Qtr 2	Qtr 3	Qtr 4	Qtr 1	Qtr 2	Qtr 3	Qtr 4
1	1. Inventory Existing Groups and Projects									
2	a) Identify groups, projects and attributes									
3	i) Identify goals and themes									
4	ii) Identify variables manipulated and effected									
5	iii) Identify sphere of immediate influence									
6	a) Identify geographic scope									
7	b) Identify habitat types and species									
8	2. Inventory of Existing relevant data sets and reports									
9	a) Identify Data									
10	i) Identify agency data holdings									
11	ii) Identify group data holdings									
12	iii) Identify published studies									
13	iv) Identify other "gray" literature									
14	b) Enter metadata into GIS compliant database									
15	c) Provide access to GIS databases via the internet									
16	3. Map known and predicted occurrences of biodiversity									
17	a) Acquire and integrate existing digital maps from collaborators									
18	b) Acquire database of PRBO and other bird surveys									
19	c) Acquire datasets and create databases for amphibian distributions									
20	d) Acquire datasets and create databases for plant species									
21	e) Create composite "biodiversity" maps of region									
22	4. Map known and predicted riparian plant communities									
23	a) Acquire and integrate existing digital maps from collaborators									
24	b) Acquire and integrate soils from existing digital sources									
25	c) Create preliminary composite riparian extent map for region									
26	d) Acquire and digitize existing paper maps and aerial surveys									
Project: called groups MPP Date: Mon 7/28/97		Task Progress Milestone	Summary Rolled Up Task Rolled Up Milestone	Rolled Up Progress Milestone						



Project Description

The state of ecological knowledge does not permit unequivocal evaluations of the priorities and potential efficacy of watershed projects from first principles (see Doppelt, et. al, 1993 for a review). Any effective regional strategy will have to be based on adaptive management, adopting and expanding successful approaches, and modifying those producing unintended consequences. Adaptive management requires adequate information. At very least, the following elements are needed to evaluate projects on a watershed or river basin scale:

- Managers need an overview of the locations, geographical scopes, resources treated, participants, methodologies, and budgets of major projects. Given the hundreds of projects and thousands of actors, all constantly changing, whose activities directly or indirectly affect the bay and delta, in practice this implies an on-line database and mapping system.
- Existing and proposed projects should be superimposed over the distribution of critical resources. It is most important to manage runoff in streams with the most highly modified sedimentation regimes, or to protect spawning habitat in the rivers most critical to the populations of native fishes. The unavailability of water quality assessment (303d, 305b), riparian habitat, or native species distribution maps has considerably hampered efforts by the SWRCB, the EPA, the Wildlife Conservation Board, and others to direct restoration funds to locations where they are most critical
- There must be meaningful monitoring data, with at least core elements collected over multiple projects and locations, to assess the relative effectiveness of different strategies.
- Decision support tools are needed such that decision makers, researchers, advocates, and skeptics, with different mandates and priorities, can view the same data, process it according to their own priorities and values, and evaluate resulting maps of potential priority locations and resources. Ideally, such tools should be available on line or on CDs, such that all sides of a controversy can view the same core resource data.

Our group is involved in interagency projects partially addressing all of these needs. In the Bay and Delta, the Interagency Ecological Program (IEP) has taken a lead in making the needed data available. Upstream, much of the effort is coordinated by the California Biodiversity Council (CBC), with the data disseminated over the Internet by the California Environmental Resource Evaluation System (CERES, see <http://ceres.ca.gov/>), the Watershed Information Technical System (WITS, see <http://ceres.ca.gov/watershed/>) and the California Rivers Assessment (CARA, see <http://endeavor.des.ucdavis.edu/cara/>). Major parts of the technical underpinnings and actual GIS data system of the CBC/CERES were developed by our program at UC Davis (ICE, see <http://ice.ucdavis.edu>), with funding and collaboration from Fish and Game, EPA, NBS/BRD, USGS, BLM, NSF, and others. However there are still many gaps in this information system that limits its current usefulness for the CALFED process.

Proposed Activities

We propose the following tasks to make the system maximally useful in identifying restoration opportunities in the CALFED region (Fig. 1) upstream of the delta, and in providing information for subsequent analysis and adaptive management. They are described in more detail in the Executive Summary and below:

Task 1. Adapt the inventory databases for watershed and restoration projects (CWPI, CERPI) to treat projects proposed to, funded by, or related to Category III activities, to index them according to Federal metadata standards, and make searches and maps available over the Internet.

Task 2. Develop an inventory of relevant data sets and reports., following federal metadata standards.

Task 3. Collaborate with outside experts to create GIS systems to map distributions of native fish, amphibians, migratory birds, and riparian plants.

Task 4. Construct GIS coverages of historical, existing and potential riparian habitat.

Task 5. We will expand the (currently terrestrial) CALTOX database, developed in collaboration with CalEPA, to cover biological effects of hazardous materials on aquatic vertebrates.

Task 6. The first step toward effective regional monitoring is to agree upon indicator variables. We propose to convene a panel experts to assess the applicability of existing indicator strategies (e.g. IEP, EMAP, TNC, NAWQA) and to develop criteria for both short term target species and habitat analysis, and for long term multi-species multi-habitat conservation efforts.

Task 7. The projects, biodiversity, and riparian habitat will be incorporated into the CARA GIS system. This already including the updated maps of hydrography, watershed delineations, and impaired waterbody designations, as well as land use, land cover, dams and diversions, management status, facilities, hazardous sites, mercury loads, etc., coverages.

Task 8. We will develop an easy-to-use ArcView application to permit decision makers to interactive rank habitats for restoration potential and value using user-specified variables, scoring rules.

Methods and Collaborators:

Task 1 — The core of the projects inventory will be an expansion of the partially completed California Watershed Projects Inventory, CWPI (currently ~450 projects in California) and California Environmental Restoration Projects Inventory, CERPI, (~200), we developed in collaboration with the Resources Agency, the SWRCB, the Department of Conservation, and the US EPA (see <http://ice.ucdavis.edu> and Fig. 1). The current system tabulates names, contacts, and attributes of watershed groups and projects, goals and themes, objectives, and geographic scope. Given the voluntary nature of many data sources, it only superficially treats elements critical to CALFED assessment, including restoration methods, monitoring variables, benchmarks for success, and details of habitat types and species treated. We recommend a joint effort with CALFED and the interagency data standards committees convened by CBC to develop a superset of CWPI/CERPI treating reporting elements needed by CALFED for assessment and adaptive management (methods, monitoring, outcomes, budget).

The database complies with the applicable federal metadata standards (GILS, section I of FGDC). With multiple collaborators, we chair working groups developing shared controlled vocabulary elements (such as geographic and keyword "tags"), derived from the Library of Congress USMARC system, shared with systems under development with CERES, the National Biological Information Infrastructure, the State Clearinghouse for CEQA documents. We propose both to assist CALFED (and IEP) develop database elements compliant with these emerging federal standards, and to bring elements particularly needed by CALFED to the attention of standards committees.

All databases will be served to all interested parties from an SQL server (in a distributed system involving ICE, CERES, and the San Diego Supercomputer Center, among other sites). We will couple GILS/Z39.50 server technology (Blue Angel), which will permit the data to be located and retrieved by theme, organization and/or location ("salmon", "Butte") from any other compliant government server (e.g., the White House). Programming tasks will be shared (at no cost to CALFED) with Deanne DiPietro and Quinn Hart at CERES.

Task 2 — The inventory of datasets and literature will follow the form of the data inventory we developed for the Resources Agency (see WITS) and the USGS for coastal salmonid issues. (See <http://ceres.ca.gov/wits/> and <http://ice.ucdavis.edu/wits/>). The database is fully GILS-compliant, and easily accessed on-line or on disk version. Our experience has been that it takes about a graduate student-month to compile records of the one to three hundred most important data sources for fish, water quality, and habitat restoration issues in a hydrologic unit (major watershed). Many valuable surveys and historical records reside in local offices or limited distribution reports, and are likely to be missed by policy makers without a concentrated survey effort. Access will use the same technology, and be available through the same sources as the project databases in Task 1.

Task 3 — With current data, it is difficult to evaluate the relative importance of various sites for protection of particular rare, local, or economically important species. Hard occurrence records (museum records, monitoring sites, NDDDB), cover only a minority of streams in the drainage. Distribution models, such as Fish and Game's Wildlife Habitat Relations (WHR) model may be used to predict critical habitat in unsurveyed areas, but current models do not cover fish or plants. We propose to work with experts in fish, amphibians, birds, and plants, to improve the identification of occupied and potentially restorable habitats for species of concern.

Fish -- In the last year, under Nature Conservancy funding, we (Moyle and students) have completed a map of native fish occurrences at the scale of large polygons (~500 km²), which is now posted on our web site. We proposed to attach these records to individual rivers and streams (the EPA Reach Files) using a combination of sampling records, spatial overlap and ecological rules (substrate types present, position relative to dams, minimum summer flow, presence of exotic predators, etc.) Preliminary efforts to construct such models as part of SNEP produced encouraging fits (Moyle, et al, 1996). We also plan to enter existing census data for several hundred more sampling sites (Moyle, F&G) to the GIS, and use both those data and selective field samples to test the resulting map accuracy. We propose to hire fish biologist Paul Randall, who has several years of experience with these data and as a SNEP researcher, as a half-time postdoc to conduct this work.

Amphibians — WHR has a habitat model for amphibians, but existing data are scattered.

We propose to support USFS biologist Carlos Davidson, now a UCD graduate student, as a half-time research assistant to complete the effort he has begun to convert collections data from FWS, BRD and other herpetologists into a GIS coverage (see <http://ice.ucdavis.edu/aquadv/> and <http://ice.ucdavis.edu/Toads/wwfrog.html> for the current status of the fish and amphibian mapping efforts.) Adequate data also exist for some sites to identify areas with rapid amphibian declines, and to test for statistic associations with potential causes.

Birds — Probably the most extensive and carefully sampled data set on migrant birds using riparian habitat has been gathered by the Point Reyes Bird Observatory as part of the Riparian Habitat Joint Venture (Fig. 3). We propose to work collaborate with PRBO scientists Nadav Nur and Grant Ballard to convert those data to a GIS coverage, and to use range information from the records and WHR, along with the riparian habitat attributes (see below) to construct a critical habitat map for riparian-associated species. Fish and Game biologist Barry Garrison from the WHR program plans to be in residence in our lab for much of the period (on other funding), and will contribute to the analysis, and port the results to WHR. We propose to support 6 person months of the PRBO scientists to conduct the proposed work. (Note that they have proposed related field work to expand sites and test distribution maps in a separate proposal to CALFED.)

Plants — Under a cooperative agreement about to expire, we have been collaborating with Dr. Ann Dennis of the US Forest Service to create CalFlora, a database of California vascular plant occurrences (now numbering over 400,000 records derived from hundreds of collections and other sources.) The immediate application of the project is to document the occurrences of rare and special circumstances plants, with a longer term objective of developing a “WHR for plants” to predict potential habitat for managed species. Using CalFlora and published habitat and altitude preferences, we have produced a preliminary distribution map for about 300 riparian-associated plants (Hunter, et al, submitted). We propose to support Dr. Dennis and a student assistant for 3 months to systematically search out riparian plant lists from the CALFED area to identify areas with high floral diversity, T&E species, or unusual associations, as potential target areas for restoration. The species-specific data will also be used to test and refinement the maps of riparian habitat types described in Task 4.

All data from these efforts will continue to be shared with state and national biodiversity data sites, including WHR, the Heritage Division of Fish and Game, and the USGS National Biological Information Infrastructure.

Task 4 — Despite the acknowledged importance of riparian vegetation for a variety of ecological and water quality roles, strips of riparian vegetation typically fall below the minimum mapping unit (feature size) of vegetation maps, so it is poorly mapped. We have made progress on producing a map of low altitude riparian in the Sacramento basin (Fig. 3), and SNEP mapped some Sierra riparian areas with similar detail. Some kinds of riparian habitat are also shown in the National Wetlands Inventory. Our map shows both potential riparian, judged from geomorphology and soil type, and actual riparian woodland, photointerpreted from high-altitude aeriels. For this task, we propose to complete the coverage along the valley waterways (as defined by the EPA Reach Files) downstream of the major dams, supplemented by higher resolution maps (e.g., Ducks Unlimited and some regional wetlands maps), where available. At this resolution, the analysis requires about a person-days per quad. In addition, if funds are available, we propose to digitize an unused 1:24K resolution Mylar map set for riparian

vegetation, taken from late 1970s imagery covering all of the Sacramento Valley. Comparison of this set with current maps and images is probably the best single available source to estimate the declines in lowland riparian cover over the last 2 decades and to identify potentially restorable riparian sites. In pilot studies, it required about 1.5 days per quad (for 393 quads) to electronically scan the Mylars, then manually correct the scanning errors (most due to hand-written labels on map features.)

Task 5 — All coverages developed above will be incorporated into the California Rivers Assessment GIS system (see Fig. 4), and from there, automatically into CERES, WITS, NBII, etc. The cost of the GIS work will be covered by our current CARA funding. However we propose one month worth of GIS specialist time to support training and special services needed by CALFED personnel.

Task 6 — A completed project between CalEPA and UCD developed software and a database to conduct risk assessments of toxic effects on target terrestrial species. The software is directly applicable to aquatic vertebrates, but it requires several weeks of library work, interpretation, and data entry to assemble a reasonable picture from the toxicological literature of the effects of important toxics (organophosphates, metals, hormone mimics) on a taxon. The current controversy about whether toxic substances actually affect fish populations in the river-delta system is undoubtedly fueled by the decoupling of the available environmental risk data from the ecological studies. We propose to support current CalEPA scientist Julie Yamamoto and a student assistant each for six months to populate the data for the major aquatic vertebrates of concern in the CALFED process. Combined with the distribution data described above, and indications of exposure sites and levels from NAWQA, FEMA and others, it should be possible to identify parts of the river system (if any) where exposures to well-studied OPs, metals and dioxins (at least) rise to levels where they might be locally or regionally harmful to fish and amphibian populations. Results will be produced as maps and made available over the Internet.

Task 7 — The investigators represented in this proposal teach the majority of courses at UC Davis on monitoring methods and indicators, have published extensively on the subject, and are active in national programs (TNC Indicator Conferences, NBII, EMAP) designed to develop widely used monitoring programs and indicator suites. We propose to put together a two-day workshop representing national experts with whom we work on these issues and CALFED participants responsible for coordinating monitoring to discuss integrated monitoring among CALFED projects. Results will be converted into a summary handbook of recommendations. We request \$20,000 to run the workshop on the Davis campus (during the late winter, when it is more pleasant in California than in Washington or Boston), and \$5000 to prepare a handbook (mostly short-term support for a postdoc).

Task 8 — The CARES interactive mapping application we developed for WCB allows users to upgrade or downgrade the priority of each locale (with a resolution of several hundred meters) according to user defined weightings of the possible site attributes. For example, sites for riparian acquisition might receive positive scores for being uncontaminated, having a relatively natural flow regimen, having high plant and bird diversity, and for being on private land, whereas sites promising for decreasing mercury contamination of the delta would score high for

contamination, and for being downstream of major dams. The resulting maps do not prescribe policy decisions, but they highlight the impact of particular assumptions and values, and they can help identify particularly important geographical areas for further analysis. To treat the interests of the much broader CALFED user community, we propose to expand the system from the current 8 GIS coverages to essentially the full set described above, and to develop training materials and a Web-based interface. We estimate that the modification will require about a month of programmer time, and several days of a GIS specialist for each GIS theme added, for a total of three months of support.

Applicant qualifications and relations to other funding

The computer facilities of the Information Center for the Environment (ICE) are supported by the EPA Center for Ecological Health Research (\$1M/year) and are part of the NPACI initiative led by the San Diego Supercomputer Center (\$425K/year to UC Davis). ICE is the main contractor for the California Rivers Assessment CARA, which is the result of a 28 agency agreement to fund a statewide center for GIS information to assess California river environments. The CARA agreement is in its fourth of five years. Approximately 80 statewide, and numerous more localized data themes are part of CARA, many of which will be incorporated into the analyses proposed for CALFED. ICE has 8 existing funded cooperative agreements with California Resources Agency and US Department of the Interior agencies, the Forest Service, and the US MAB program to conduct biodiversity analyses (about \$150K per year). We have contracted with EPA Region 9 to update the Reach File base layer for river mapping, and to convert the Water Quality Assessment database (e.g., 303d and 305b) into GIS tools for EPA, SWRCB, and the regional boards (about \$120K/year). We participate in hydrological and fisheries models of the Sacramento river and estuary system (described in a related proposal by G.T. Orlob and colleagues) and in mercury analysis of the system (described in the proposal by T.S. Suchanek and colleagues), both partially funded by a \$1.3M grant from EPA and NSF. The proposed work with USFS, and CalEPA will be matched approximately 2:1 by funds from those institutions. PRBO has recently received a large grant from the Hewlett foundation, which provides the base facilities for that project. The project inventories have been supported by the Resources Agency, the SWRCB, EPA, and BLM. In the last two months, 24 agencies have agreed to provide in-kind support, and have participated in training exercises.

All of these projects provide data and technical support to various initiative of the California Biodiversity Council. ICE investigators serve on multiple advisory groups to CBC, IEP and USGS programs involving California rivers and watersheds.

Literature Cited

Doppelt, B., M. Scurlock, C. Frissel, and J. Karr, 1993. Entering the watershed: a new approach to save America's river ecosystems. Pacific Rivers Council, Island Press, Washington DC.

Hunter, J. C., K Beardsley, M.C. McCoy, J.F. Quinn, and E. Lehmer, The prospects for preservation and restoration of riparian forests in the Sacramento Valley, California (submitted for publication)

Moyle, P. B., P. J. Randall, and R. M. Yoshiyama, 1996. Potential aquatic diversity management areas in the Sierra Nevada. Sierra Nevada Ecosystem Project, Final Report to Congress, Vol 3, pp. 409-478. University of California, Davis.

Investigators

James Franklin Quinn

James Quinn has degrees from Harvard (A.B. Biology, 1973) and the University of Washington (PhD, Zoology, 1979). He joined the faculty of the University of Pennsylvania in 1979, and moved to the University of California at Davis, where he is now a full professor, in 1981. He has worked on a variety of problems in community ecology and conservation biology, including the effects of habitat fragmentation on species diversity and extinction risk, strategies for inventory and monitoring studies, the design of systems of nature reserves, and estimation of demographic rates for fisheries management, and is the author of more than 60 scholarly publications.

Professor Quinn is a principal investigator for the California Rivers Assessment (CARA), a program to identify and assess the status of critical aquatic resources in California and to provide a database center and access point for environmental data from a variety of collaborating organizations. More than 28 federal, state, and private resource agencies and environmental organizations are partners in the program. CARA works closely and shares computer facilities with the EPA Center for Ecological Health Research. Projects in the Center under Professor Quinn's direction include estimating extinction risks, particularly for fisheries populations, modelling biological effects of hydrological processes in several California rivers and lakes, and developing decision support tools for resource managers.

Professor Quinn also directs the Information Center for the Environment (ICE) at the University of California at Davis. The Center supports and disseminates data and models from the National Park and Man and the Biosphere biodiversity databases, the Rivers Assessment, the Center for Ecological Health Research, and a variety of smaller environmental information projects.

Peter B. Moyle

Peter Moyle is a Professor of Wildlife, Fish, and Conservation Biology. He has been working on the ecology and conservation of native California fishes for about 30 years, subjects upon which he has published widely. His long term research program on Bay-Delta fishes has had significant impacts on water policy, and he headed the Delta Native Fishes Recovery Team. Dr Moyle served as a member of the Sierra Nevada Ecosystem Project team, working on strategies to protect the native aquatic fauna of the Sierra. His current research focuses on devising watershed-oriented strategies for conservation of the native aquatic fauna. His most recent book is "Fish, An Enthusiast's Guide"

Michael McCoy

Mike McCoy serves as Principal Investigator, Co-Principal Investigator or Academic Administrator for \$1.8 million in contracts and grants awarded to projects involving the development aggregation and dissemination of environmental information. Current projects include studies of species distribution, land use planning policy, toxic and hazardous materials risks and data aggregation and distribution problems for the California Resources Agency, the National Park Service, MAB and LTER. These projects currently employ 21 staff. He is also a liaison with Federal, State and Local Government for determining information and education needs of resource and planning agencies, coordinated resource conferences aimed at policy formation and decision support, and has developed long range curriculum plan for professional continuing education in the fields of land use and environmental planning. Mr. McCoy has degrees from University of Illinois, Urbana, (M.A., Communication, 1969) California State University, Sacramento, (B.A., Speech, 1968).

Ann Dennis

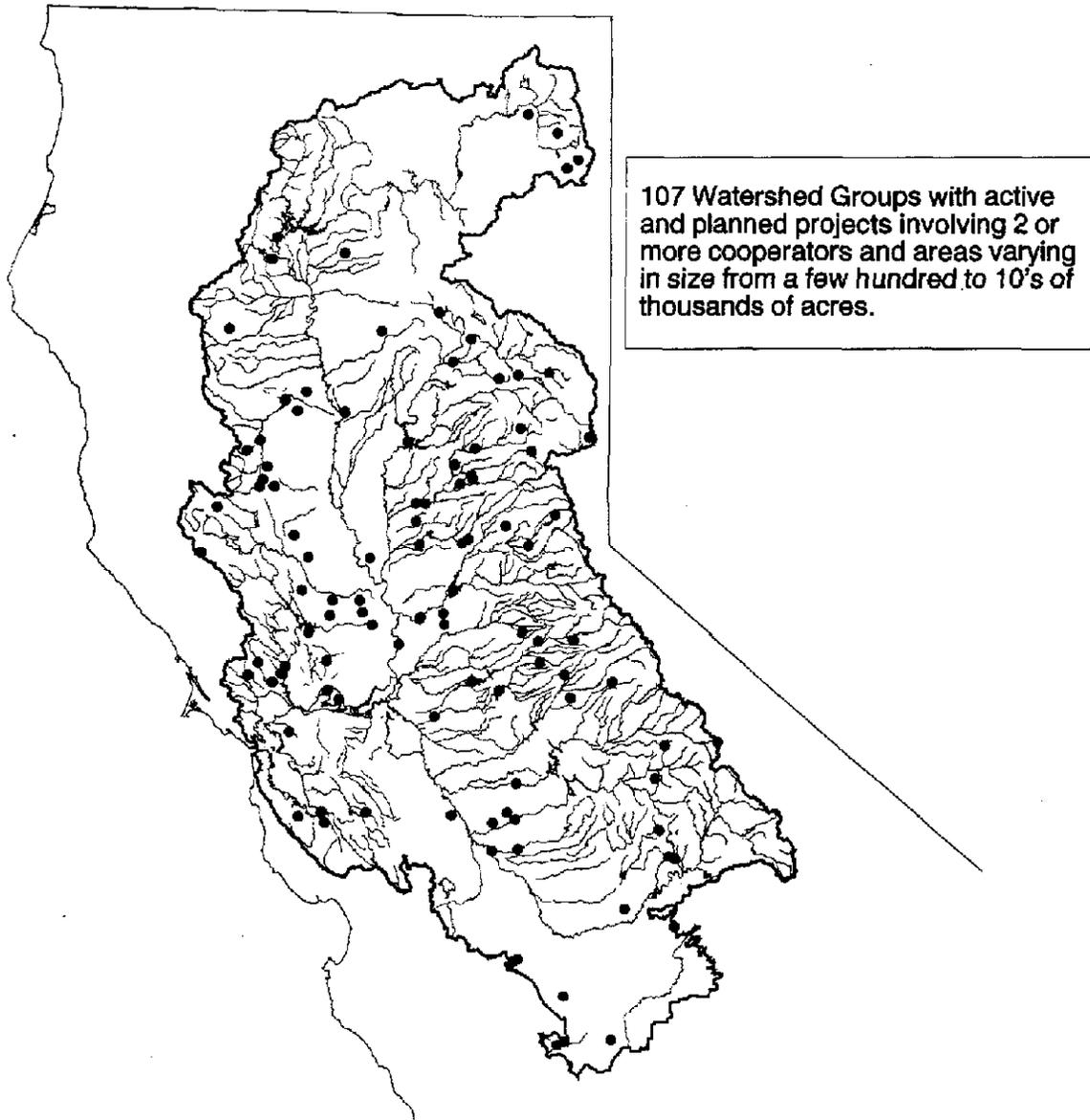
Ann Dennis received her Ph.D. from UC Berkeley, in Wildland Resource Science, and a M.A. from Clark University in Geography. She is currently a Research Plant Ecologist at the USDA Forest Service, Pacific Southwest Research Station. Dr. Dennis is a plant ecologist and botanist, whose work concerns impacts of landuse and land management practices on plant distributions and landscape-scale plant diversity. She currently leads the CalFlora project to develop data resources on Calif. vascular plant distributions as a tool for analyzing impacts of alternative management strategies on floristic diversity.

Nadav Nur

Dr. Nur earned graduate degrees in Zoology (Duke University) and Biostatistics (University of Washington) and has over 19 years experience conducting avian population studies. Dr. Nur specializes in understanding how various natural and anthropogenic factors, such as habitat fragmentation and habitat degradation, affect population parameters, and ultimately population stability. He has been lead investigator for PRBO's Upper Sacramento River Riparian Songbird project for six years. He has carried out population viability analyses on several bird species for the National Biological Service. He has worked closely with the Marbled Murrelet and Snowy Plover Recovery Teams. Dr. Nur is author or co-author on over 35 peer-reviewed scientific papers and book chapters.

Fig. 1

Active Watershed Groups in the CALFED Study Area



- CWPI watershed group locations
- ~ Rivers
- ~ State Boundary
- CALFED Study Area

40 0 40 80
Kilometers

Information Center for the Environment, UCD
Data Provided by: Teale Data Center, US EPA and CALFED Program

Fig. 2
Point Reyes Bird Observatory Monitoring Sites

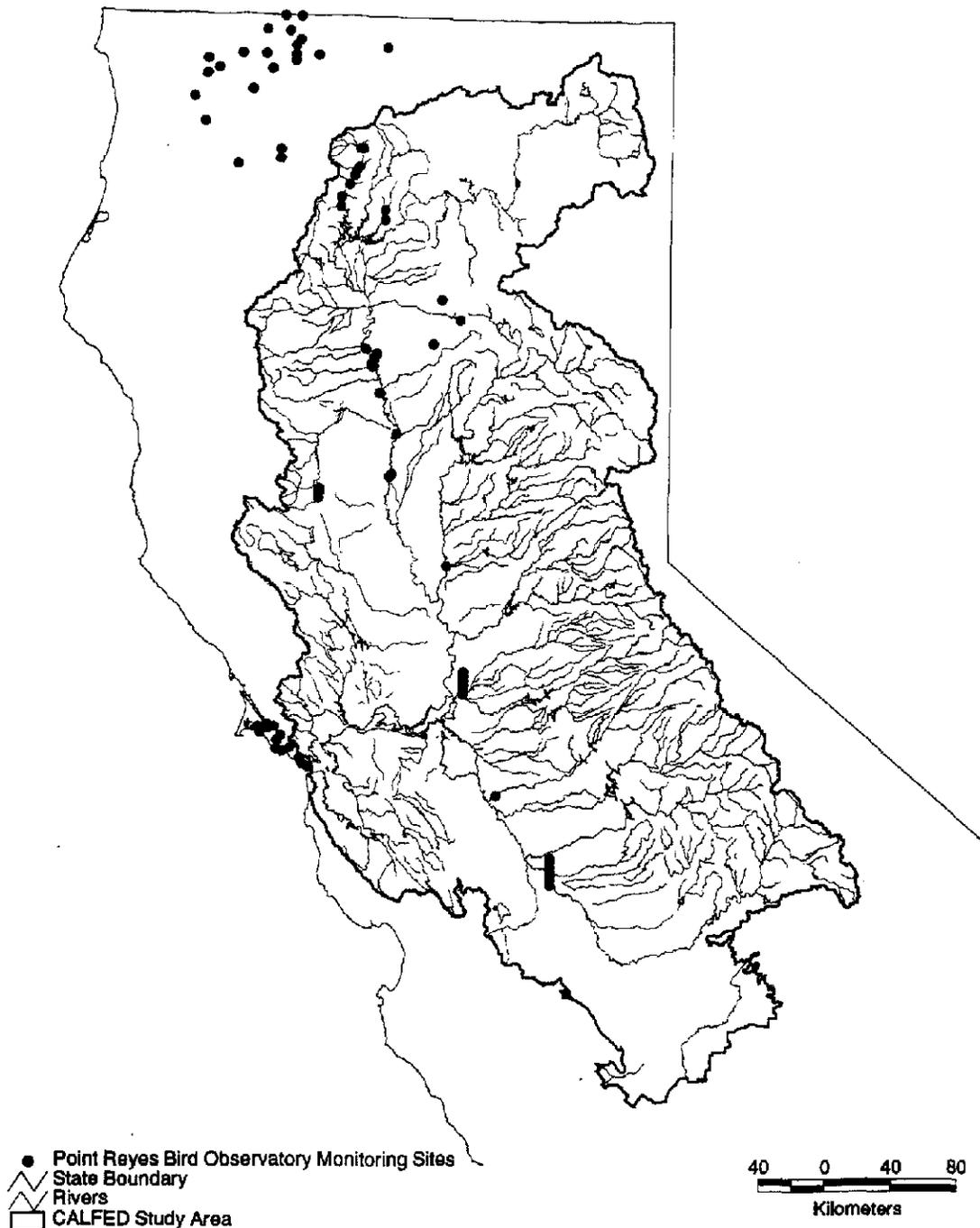
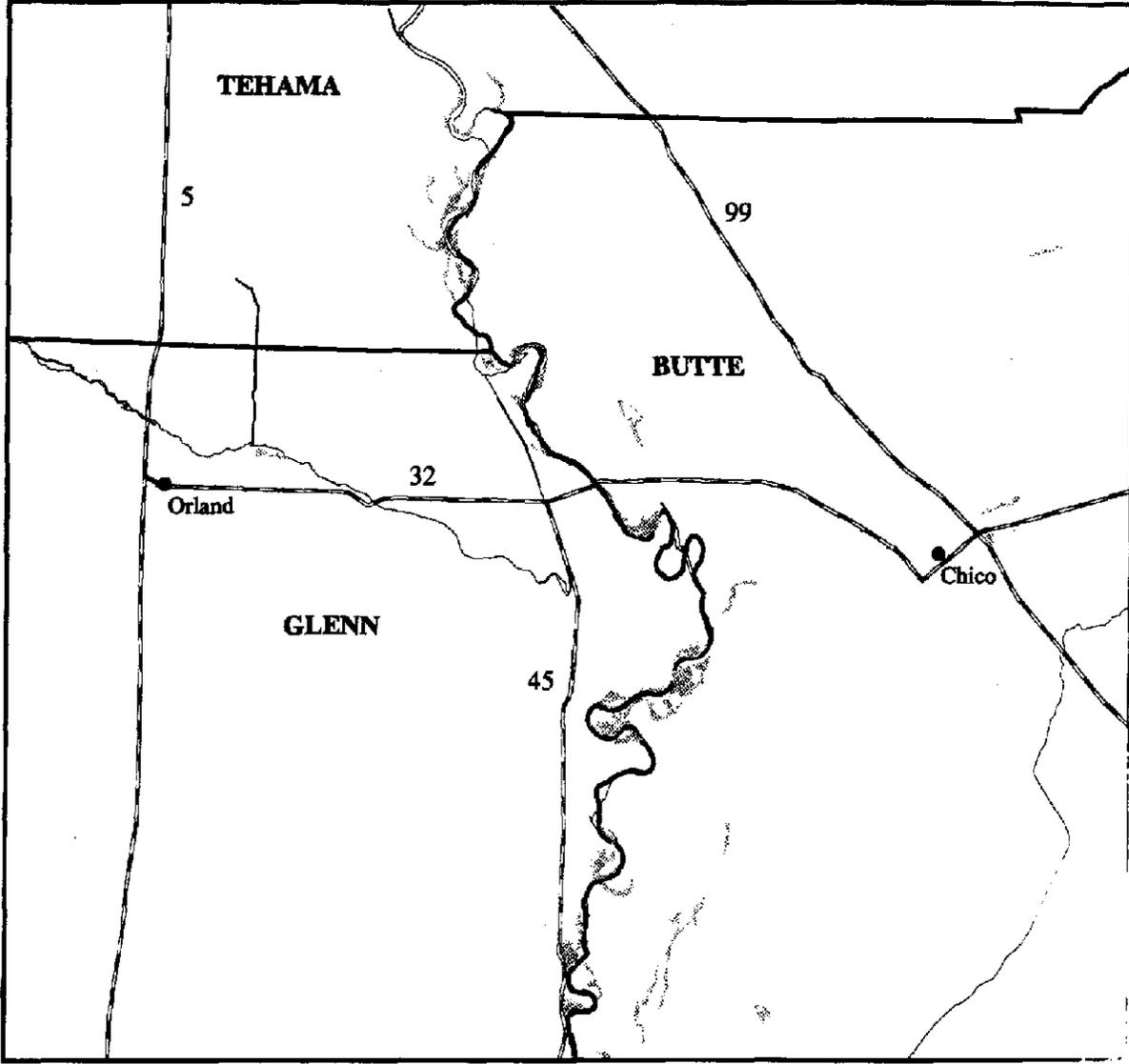


Fig. 3

Large Riparian Patches (NWI) Butte, Glenn and Tehama Counties



Legend:

- Major Cities
- Roads
- ~ Rivers
- Counties
- ▨ Large Riparian Patches (NWI)

Scale:

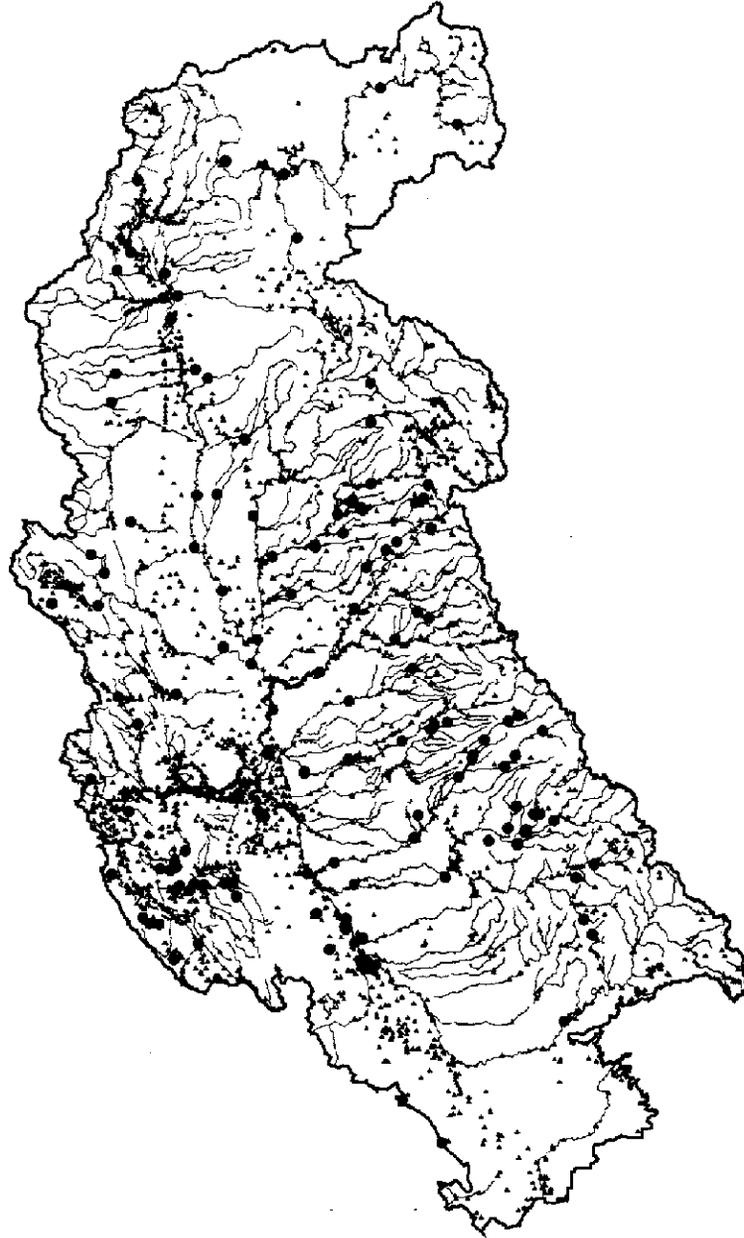
0 4 8 Miles

0 5 10 Kilometers

North Arrow: N

Fig. 4

Existing Possible Indicator Monitoring Sites



- ▲ STORET (Flow, Ph, Temperature, and BOD)
- USGS Gauging Stations
- ∩ Rivers
- CALFED Study Area

40 0 40 80
Kilometers

Information Center for the Environment, UCD
Data Provided by: Teale Data Center, US EPA, USGS, and CALFED Program

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I-006247

Project Phase and Task	Direct Labor Hours	Direct Salary and Benefits	Overhead Labor (General, Admin and fee)	Service Contracts	Material and Acquisition Contracts	Miscellaneous and other Direct Costs	Total Cost
Task 1: Inventory existing groups and projects	1,198	\$25,496	\$2,817		\$1,320	\$1,350	\$30,982
Task 2: Inventory of existing relevant data sets and reports	1,997	\$42,493	\$4,694		\$2,200	\$2,250	\$51,637
Task 3: Map known and predicted occurrences of biodiversity	1,736	\$43,000	\$4,930		\$5,300	\$1,000	\$54,230
Task 4(a,b,c): Map known and predicted riparian plant communities	880	\$26,445	\$3,165		\$4,000	\$1,200	\$34,810
Task 4 (d, e): Digitize existing paper, mylar and aerial maps	3,472	\$53,820	\$5,872		\$4,000	\$900	\$64,592
Task 5: Expand CALTOX database to aquatic vertebrates	2,170	\$41,513	\$4,271			\$1,200	\$46,984
Task 6: Identify potential indicators for possible monitoring	1,018	\$16,997	\$1,878		\$880	\$900	\$20,655
Task 7: Create integrated public mapping tool	434	\$13,223	\$1,572		\$2,000	\$500	\$17,295
Task 8: Create GIS decision support system	434	\$13,223	\$1,542		\$2,000	\$200	\$16,965
Total	13,338	\$276,209	\$30,741	\$0	\$21,700	\$9,500	\$338,149