Arundo donax Eradication and Coordination Program
Development of a Monitoring Protocol

CALFED Monitoring and Evaluation Proposal
Resubmission: May, 2006

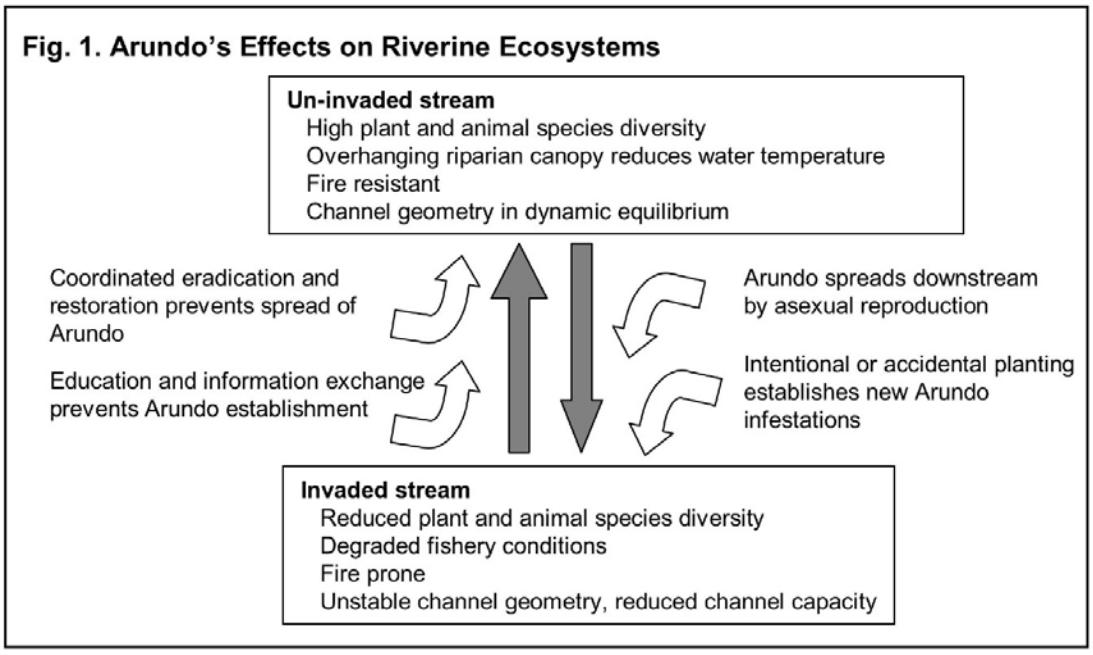
PROJECT DESCRIPTION: PROJECT GOALS AND SCOPE OF WORK

A1. PROBLEM, GOALS AND OBJECTIVES

PROBLEM

1. _Arundo donax_ is a noxious weed that threatens the ecology of riparian areas.

The non-native invasive grass *Arundo donax* (Arundo, giant cane) threatens the ecological integrity of the rivers and streams throughout the California Bay Delta Authority (CBDA) region by altering ecosystem processes and negatively affecting native species (Fig. 1). Arundo's effects on native systems and its modes of reproduction are well documented. These include degrading fish and wildlife habitat (often to a monoculture of Arundo), increasing fire risks, consuming large amounts of water, and creating erosion and flooding problems (Douce, 1993; Iverson, 1993; Dudley and Collins, 1995; Frandsen, 1993; Else, 1996; Bell, 1997; Trumbo, 1998; Boose and Holt, 1999; Gaffney, 2002).



2. Consistent monitoring is difficult for individual programs to achieve.

Collection of quality restoration success monitoring data in a format useful for analysis and compatible with those of other CBDA projects is difficult for individual programs to accomplish. For a variety of reasons from technical challenges to time constraints, weed managers are not consistently collecting and reporting sufficient data to provide for analysis of restoration success within and across programs in the

Bay-Delta region. The recent adoption and improvements made to the Weed Information Management System (WIMS) constitute first steps toward implementing a standard data model and standardizing data collection across organizations. The new version of WIMS has a simpler user interface design and increased functionality, including the ability to collect additional information relevant to project management and to monitor for restoration success. These features make the system more attractive to a broader user group. However, the lack of a peer-reviewed, science-based monitoring protocol specifically for invasive species control projects, and with clear guidelines for application in a variety of vegetation communities remains an obstacle to the collection of high-quality vegetation monitoring data that can be combined and compared across programs.

3. Data collected by eradication practitioners and researchers is difficult to compare.

Due to the different objectives and challenges faced by eradication practitioners and researchers, and their different backgrounds in vegetation science, data collected by these two groups is typically vastly different in structure and content, and therefore impossible to combine and compare. Although WIMS is greatly standardizing how data is collected, stored and analyzed, acceptance of a peer-reviewed monitoring protocol is needed to successfully bridge user communities.

GOALS AND OBJECTIVES

Background

The current Team Arundo del Norte (TAdN) Data Coordination team includes the Sonoma Ecology Center (SEC), The Nature Conservancy (TNC), Information Center for the Environment (ICE) and expert advisors. This team of qualified vegetation monitoring and database professionals was formed in the overlapping period between Phase 1 and 2 of the CBDA funded Arundo donax Eradication and Coordination Program (AECP), and is collaborating on the development of a restructured version of the Weed Information and Management System (WIMS) database, a weed monitoring data capture system.

TAdN/SEC submitted the AECP Monitoring and Evaluation Project Proposal to CBDA in November, 2004, requesting $396,352 to fund weed monitoring protocol and database development, 2 additional years of monitoring for program partners, and several related tasks to be accomplished over a three year period. The proposal was evaluated by the CBDA Selection Panel as a “Reconsider if Revised” and a funding cap set at $111,000, with a time limit of 1 year. The Selection Panel recognized that a uniform monitoring protocol framework is needed and recommended that the resubmitted proposal focus on the objective to “Develop a standard monitoring protocol and data system to support a multi-program monitoring effort.”

This proposal contains four main goals:

- Develop a standard monitoring protocol for use with WIMS to support the Team Arundo del Norte multi-program monitoring effort.
- Develop written guidelines/instructions for implementing the monitoring protocol.
- Provide monitoring protocol training and support for project partners.
- Collect Phase 2 partner monitoring data and evaluate hypotheses.

The use of partner data to test the protocol is dependent on the overlapping timelines of the proposed project and Phase 2. If this project is funded by year end 2006, there will be enough time to develop the protocol, train the partners, collect the data in 2007, and complete the project before the conclusion of

Phase 2 in March 2008. In the absence of partner data, test data will be substituted to test the protocol. This protocol will also be applied to future AECP projects.

How New Monitoring Protocol Differs From Existing One

The existing protocol provides general guidelines for collecting monitoring data. For example, monitored areas are currently delineated at differing sizes across projects with no standardization recommended for types of plant communities. Also, the user is simply instructed to do an ocular estimate of percent cover of the overall vegetation at each site with no supporting information about how to achieve accuracy and repeatability across observers.

The new protocol will be explicit in its methods for collecting data such as: the size of the monitored area to use, the method used to estimate percent cover of the components of the vegetation, and the method of determining species presence/absence. Methods will be appropriate for the type of plant community being monitored and will be based on the scientific literature and protocols currently in use by agencies.

A peer-reviewed protocol will lead to broader acceptance of measurement standards that will enable comparisons across partnering watersheds within the CALFED geographic scope and state-wide. This comparable data will also provide the means for developing treatment guidelines based on geography and possibly other conditions. For example, restoration groups outside CALFED, such as Circuit Rider Productions, have contacted us to share monitoring approaches.

In addition, the project will determine if the current data management system (WIMS 3) is adequate for capture of all data identified in the protocol review. We are confident that the important data elements are already captured in the existing WIMS system. If there are adjustments or additions to be made in WIMS, this project will identify them and outline a plan for modifications. As funding permits, we will make needed modifications to WIMS, or explain how to collect any new data using other methods. Furthermore, the supporting materials for the new protocol will reference WIMS, following the same sequence of data collection and indicating how to use WIMS to store the data collected by the protocol.

Funding Priority of This Proposal

WIMS 3 beta has been released for use by partners and other program testers. The Phase 2 program is funding the current version of the WIMS database and database instructions. Although additional funding is needed for ongoing technical support and updating of the database and for user support, the immediate need for fully developed monitoring protocols takes precedence over additional database testing and development. Furthermore, Team Arundo del Norte partners and Steering Committee members agree that the monitoring protocols are the weak link in the program, and must be improved and standardized to not only generate meaningful data, but also to serve as a useful vegetation management tool.

This program builds upon work completed in Phase 1 and currently in progress in Phase 2 of the Arundo Eradication and Coordination Program (Arundo Program). Phase 1 (funded by CALFED), begun in 2001 and completed in March 2006, provided for eradication and the basic monitoring of eradication success. Phase 2 (funded by CBDA), awarded September 2004 and begun in March 2006, expands upon Phase 1 monitoring by tracking additional weed species and extending the monitoring period to five years *total* for Phase 1 and 2 partners. Five additional partners are added in Phase 2 for a total of ten partners in ten watersheds. For more information on the monitoring protocols used in Phase 1 and Phase

2, see Section A3 below.

Late in Phase 1, The Nature Conservancy's Weed Information Management System (WIMS) was adopted, and in a partnership with The Nature Conservancy and UC Davis' Information Center for the Environment, the application was upgraded. WIMS 3.0 beta has been released and the partners in Phase 2 have received preliminarily training. Individual training with the upgraded system has also begun, and will be more intensive in Phase 2 than in Phase 1 due to our observation that partners require more help in order to collect quality data.

The development of a standard monitoring protocol will be accomplished within the context of the weed management community, and specifically with the guidance of plant community ecologists that are now members of Team Arundo del Norte or who have been asked to participate. The protocol will monitor changes in plant community structure and species composition at and immediately surrounding the sites at which Arundo was eradicated, and will employ standard vegetation description techniques and photo documentation. The protocol and associated instructions will be geared toward use by lay observers and will be designed for maximum repeatability across disparate situations and observers.

The monitoring protocol will be supported by a database application for ease of data collection and control of data quality. Recently, in order to offer the most robust and well-supported weed mapping toolset for Phase 1 and 2 purposes, Team Arundo del Norte teamed up with an existing effort by The Nature Conservancy and its Weed Information Management System, or WIMS, project. This partnership is being joined by others, including the California Department of Food and Agriculture (CDFA), the California Weed Management Areas (CWMA), the California Invasive Plant Council's Weed Mapping Committee, the US Fish and Wildlife Service's Natural Reserve System (USFWS), and the Information Center for the Environment (ICE). Adoption of or interest in the WIMS application by these organizations is due in part to the fact that the system serves many of the data management needs of any weed eradication project. It is also due to the recognition that the common use of one well-designed data system 1) greatly consolidates expensive technical support, and 2) simplifies data sharing and regional data analysis.

This project proposes to incorporate the new monitoring protocol into the data management system (WIMS) and support partners in the use of the modified data capture system for the duration of the Phase 2 project. WIMS modifications proposed herein will be carried out in the context of the WIMS Development Team for a professional quality end product that can be used by multiple agencies.

In the second objective, the project will train users in the collection of high-quality monitoring data using this improved system. Training will be done individually or in workshops that include desktop computer training, as well as field data collection training. The project will provide monitoring and data management assistance to the monitoring partners for the duration of the project, to ensure the data is collected successfully and becomes part of the regional clearinghouse. As a function of Phase 2, communication with the partners will be ongoing through the collection, management, quality check, and interim analysis phases to avoid pitfalls that lead to gaps in data.

During the period funded by Phase 2 of the Arundo Program, Partners will monitor their own Arundo eradication sites according to the protocol developed and supported by this program. Monitoring observations will be made at least once per year at the time of weed mapping and/or treatments. Partners will be able to utilize their own databases to track their progress and make internal management decisions. All required monitoring data collected by partners will be submitted electronically to SEC, where it will be entered into the regional clearinghouse database, quality checked, analyzed, and

reported.

A2. JUSTIFICATION

HYPOTHESES

The objectives of our monitoring and evaluation protocol are to track the efficacy of Arundo donax eradication and the effects of Arundo eradication on plant communities. Below are the hypotheses of the Arundo Eradication & Coordination Program, Phase 2, which the monitoring protocol must support. Specific measurement techniques will be defined in the course of protocol development in concert with our academic advisors.

Hypotheses for support by the proposed Monitoring Protocol:

1. All Arundo donax eradication treatment methods are equally effective.
2. Eradication of Arundo donax leads to a higher ratio of native to non-native vegetation cover at treatment sites.
3. Eradication of Arundo donax results in increased plant species diversity at treatment sites.

Additionally, we propose this more rigorous protocol development under the following hypothesis:

4. An improved data management system and training will result in more consistently collected and higher quality data.

A scientific monitoring protocol will help Arundo eradication efforts by enabling user groups to evaluate vegetation management actions and adapt management methodology as needed. Project partners will measure treatment method success, native and non-native plant species cover, and percent canopy and understory vegetative cover. The new protocol will enable partners to collect comparable data that data managers use to test the proposed hypotheses.

The Phase 2 scope of work also includes an experimental design, which includes the following hypotheses that go beyond the scope of this proposed project's implementation. The Phase 2 Experimental Design is attached as Appendix C.

Hypothesis 1a.	Herbicide formulation and dosage affect Arundo treatment efficacy.
Hypothesis 1b.	The timing of Arundo treatment affects treatment efficacy.
Hypothesis 1c.	The distance of the treatment site from the stream affects treatment efficacy.
Hypothesis 2.	Active revegetation is required to achieve long-term recovery of native riparian vegetation at weed eradication sites.
Hypothesis 3.	Stream channel capacity increases at Arundo removal sites.

A3. PREVIOUSLY FUNDED MONITORING

Arundo Eradication and Coordination Program, Phase 1

Phase 1 included three years of monitoring for original partners. Monitoring was limited to simply tracking Arundo eradication. For all monitoring, partners were to use the Team Arundo del Norte Arundo Surveying and Monitoring Protocol (Appendices A1 and A2). For their initial site survey of all eradication sites, partners used three paper forms and a GPS unit: a Field Workday Metadata Form, a

Site Description Form, and an Arundo Observation Form (Appendices B1, B2, B3). Subsequent monitoring surveys required completion of the same three forms. The intention was that partners would then enter the collected data into an online database once they returned to their offices. However, the database proved less than satisfactory for the following reasons:

1) The forms required certain information be filled out before the user could advance to the next section of the online database. If any data was unavailable, the user could not complete the form and the incomplete data could not be saved, which caused frustration with the system.
2) Some partners had slow dial-up Internet connections that sometimes disconnected partway through an online session, causing data to be lost.
3) The data could not be edited online once it was entered, and so Partners could not fix mistakes themselves, but instead had to call a data manager at the Arundo Program to do this for them.

These obstacles resulted in Partners resisting use of the online database, and in the collection of only partial data with this method. The remainder of the data was collected from the paper field forms submitted by Partners, which was then entered into an off-line version of the same database by data managers at the Sonoma Ecology Center (SEC). Also, the original protocol demanded that Partners collect an unrealistically large amount of data. Most did not have time in the field to do this. This resulted in several versions of the data collection forms, which caused problems with consistent recording across the project time period. In addition, a few Partners made mistakes in recording data data properly (e.g., date and appearance of the Arundo, GPS coordinates, etc.), which caused management staff at the SEC to have to undertake tedious correction of data entry errors.

This phase of the program began in May 2001 with five partner projects located in the California Bay Delta Authority (CBDA) region, including Napa River, Sonoma Creek, San Francisquito Creek, Putah Creek, and Walnut Creek. Since that time, partners have secured permissions for landowner access, conducted initial surveys, mapped the location of Arundo infestations, and done eradication work. Most projects have also conducted some monitoring and active revegetation. All partners have used the surveying and monitoring protocols established by Team Arundo del Norte (http://teamarundo.org). To date, partners have secured permissions on 162 properties, mapped 40, treated at least 70 sites (some sites overlap multiple properties), and conducted monitoring on 107 properties.

Arundo Eradication and Coordination Program, Phase 2

Phase 2, which is currently in year two of its three-year time funding period, includes two additional years of monitoring for original partners and three years of monitoring for new partners. Monitoring of Arundo also includes other non-native species in the vicinity of Arundo eradication sites. As part of its adaptive management approach, the program replaced the monitoring system used in Phase 1, and adopted the Weed Information Management System (WIMS), a robust, tested electronic field data collection and desktop data management system. This new system addresses all of the weaknesses in the former monitoring protocol. It contains clear, easy-to-use forms, reduces the amount of data collected to a more manageable quantity for land managers, directly captures GPS coordinates, and makes possible the direct transfer of data from a hand-held computer to a desktop database, thereby greatly reducing or preventing the collection of incomplete or erroneous data. The revised monitoring program also contains more thorough pretraining for project coordinators, as well as regular site visits and ongoing support for partners, as needed.

In Phase 2 of this program, current partners will continue eradication, post-treatment monitoring, and restoration work. Five new partners will be added to the program and will begin surveying, mapping,

and then eradication work. The new partners are also located in the CBDA region and include Upper Cache Creek, Lower American River, Lindo Channel, San Joaquin River, and Gray Lodge Wildlife Area. We estimate that within the three-year period of Phase 2, a total of approximately 223 acres of Arundo will be eradicated by these ten partner projects.

Current Monitoring and Evaluation Proposal

This proposal seeks to improve monitoring of overall plant community composition and structure, in order to better evaluate restoration success in weed eradication sites.

A4. APPROACH AND SCOPE OF WORK

Based on Selection Panel review comments, program priorities, and the amount of funding available for this proposal, we have scaled down the proposal and are only targeting the following tasks from the original proposal:

1. **Project Management**
   - Project management - administration, communications, meeting facilitation, etc.
   - Task management - planning and implementation
   - Quarterly and final reporting and presentations

2. **Protocol Development**
   - Develop an improved monitoring protocol that includes indicators of restoration success, with input from the TAdN/AECP Steering and Advisory Committees, and selected experts.
     - Describe invasive species program monitoring needs
       - Identify plant community types being monitored for invasive species.
       - Describe requirements of monitoring: types and measures of change for supporting objectives of invasive species control programs.
       - Determine characteristics of different plant communities that will require specific techniques for monitoring change (e.g., scale of plants and stands of plants, rates of change).
     - Review literature
       - Collect and review applicable protocols in use by public agencies.
       - Review vegetation description and monitoring literature.
       - Identify techniques for data collection and analysis specific to invasive species control projects and the plant communities identified in the previous task.
     - Consult with experts
       - Seek advice on monitoring protocol development
     - Draft a monitoring protocol
       - Develop monitoring protocol based on consultations.
       - Develop instructional support materials.
       - Provide working draft to TAdN and partners.
     - Review and revise protocol and data collection system as needed and where feasible
       - Review by selected experts.
     - Test the new protocol with data collection system
       - Test the new protocol in the field at selected sites with WIMS data capture system, documenting missing or inadequate data capture elements.
       - Use test data to demonstrate that protocol addresses project hypotheses.

- Publish protocol
    - Post all materials to Team Arundo del Norte website.
    - Submit paper or poster at Cal-IPC Symposium, peer-reviewed journal, or other appropriate forum.

Products: Monitoring protocol is researched, written, reviewed, tested, and published for peer-review. Recommendations for improving the WIMS system to accommodate the new protocol, if any, are written, reviewed and posted. Improvements to WIMS are made if compatible and feasible within the scope of this project. The protocol is posted on the TAdN website and submitted for publication.

3. **Training Program**

- Provide monitoring protocol training and support for current program partners
    - Develop instructional materials
        - Develop monitoring protocol training materials for use with the WIMS data collection system.
    - Train partners in new protocol
        - Provide group and individual trainings as needed and as funding allows
    - Support partner implementation of monitoring protocol
        - Provide followup support by phone, e-mail, and during scheduled Phase 2 field visits
    - Conduct data collation and quality checks
        - Collate all partner data received during the funding period.
        - Check for accuracy and completeness of submitted data.

Products: Partners are trained to collect and enter data into WIMS according to the protocol.

4. Adaptive Management

- Use monitoring protocol to evaluate partner restoration success and incorporate user feedback into recommendations for improvements.
    - Implement monitoring protocol at partner eradication sites, where feasible
        - Support partners in adapting to changes in monitoring methods
    - Coordinate feedback from partners on protocol and data management system
        - Develop and distribute questionnaire to collect feedback
        - Solicit feedback from partners on protocol and compatibility with WIMS.
        - Provide feedback to protocol development team.
    - Evaluate feedback on monitoring protocol and data management system
        - Identify priorities and get approval from TAdN Steering Committee.
        - Incorporate approved changes where feasible.
        - Develop recommendations for improvements/additions to WIMS data capture system.
        - Provide recommendations to WIMS development team

Products: Partners are using protocol to collect data. Data can be used to evaluate restoration success. Feedback from partners is utilized in the decision-making process to improve the protocol and develop recommendations for improving the data management system. Suggested improvements that can be made to the protocol result in easier/more reliable data collection and/or higher quality data. Partner feedback and quality of data are analyzed to rate the level to which partners are succeeding in implementing the monitoring protocol.

The following tasks are being removed from the proposal because they are lower priority or there is insufficient funding for their implementation.

1. **Implementation**
   Two additional years of monitoring (for phase 2 partners)

4. **Adaptive management**
   Deploy next version of WIMS data management system and update partner databases.

Note: We intend to incorporate as much of the newly developed monitoring protocols into the most current database, WIMS 3. However, protocol changes requiring significant database reprogramming will have to be incorporated after funding is secured for this task.

This proposal seeks to develop an improved monitoring protocol for use with the Weed Information Management System at partner eradication sites. The program intentionally chose not to monitor other measures of restoration success such as water quality, in-stream habitat, or fish and wildlife populations because these metrics are beyond the scope, budget, and timeframe of this project.

The improved protocol will identify specific plant species, both native and non-native, and measure both understory and canopy vegetation cover. Partners will also have the capacity to collect additional site information and data pertaining to their specific management projects.

Within the course of the proposed monitoring protocol development, a list of variables collected by the new protocol and a set of guidelines for the implementing the monitoring protocol will be developed. Use of reference sites, frequency of sampling and other guidelines will be incorporated into the monitoring protocol.

Active revegetation activities will be logged and described along with other treatments to the site, such as eradication of Arundo and other weeds that may be originally present at the site or subsequently spread into the area where Arundo has been removed. The resulting expanded dataset will support analysis for evaluation of Hypotheses 1,2, and 3. Restoration of habitat will be defined as observable trends toward native riparian plant communities. Indicators of these trends are: higher percentages of native plant cover, lower percentages of invasive plant cover, and higher numbers of native species compared to invasive species, or diversity as indicated by diversity index.

To facilitate restoration monitoring, the proposed project will address several problems identified as barriers to complete and timely data collection and delivery. First, the project will fill the need for a plant community monitoring protocol that can be reliably and consistently implemented by weed eradication partners, making it possible for this level of monitoring to become integrated into the eradication work. This new protocol and support system will eliminate the need for a separate data collection team and the additional coordination work associated with gaining access to the eradication sites, many of which are located on private land. The monitoring protocol will be based on accepted quantitative monitoring protocols for riparian plant community characteristics known to affect habitat quality and instream conditions, such as the California Department of Fish and Game California Coastal Salmonid Restoration Monitoring and Evaluation Program's Interim Restoration Effectiveness and Validation Monitoring Protocols (2003), and the vegetation monitoring being implemented as part of the Plan for Monitoring the Effects of Releasing the Saltcedar Leafbeetle, *Diorhabda elongata,* for Biological Control of Saltcedar: *D. elongata,* Vegetation, and Wildlife Research Phase, Stage B, as

prepared by the Insect, Vegetation and Wildlife Subcommittees of the Saltcedar Consortium (Eberts, et.al., 2000).

Protocol documentation will be developed to instruct the partners in techniques for repeatable quantitative evaluation of the plant community and comparable data collection across partners. Within the scope of Phase 2, the project will overcome technical and motivational difficulties with data collection and management through 1) the adoption and deployment of an existing intuitive data management system called Weed Information Management System (WIMS) that assists weed managers in day-to-day project management and weed eradication planning, and 2) intensive support of the partners in the use of WIMS for their monitoring efforts and every stage of data collection, management, and reporting. Finally, the TAdN Data Coordinator will combine, quality check, and analyze the data, and evaluate and share the results after each monitoring season to allow for adaptive management changes to practices, the protocol, and the WIMS data management system.

The following steps will be completed in tandem with Phase 2:
1) the development of the monitoring protocol; 2) decisions regarding the modification of the data management system components needed to implement the monitoring protocol; 3) training of the monitoring protocol users; 4) the analysis of the data; and 5) the sharing of the data. Protocol development and training will be provided by the WIMS Development Team. Training workshops will be open to constituents of these agencies and other interested weed managers.

The process of data collection will be adaptively managed in response to partner feedback to provide for refinements in the data management software and monitoring protocol. Data quality checks will be done close to the time of data collection to allow for the correction of problems. These tasks will address the project's two other hypotheses: 1) Partnership with resource agencies and organizations to co-develop a vegetation monitoring system will result in a superior monitoring system and lead to broader adoption and use, and 2) Improved data management system and increased technical support will result in more consistently collected and higher quality data.

This approach will increase the amount and quality of information collected during and after invasive plant eradication by addressing technical and pragmatic issues that have been problematic in past projects. The multi-organizational development, approval, and adoption of the monitoring protocol and software and support will increase confidence in the method and value of expending the extra effort of doing the monitoring, as well as eliminate problems associated with difficult or ambiguous data collection methods. The information will be useful to the individual project managers in their own day-to-day work, and in their ability to obtain funding from other sources to continue the work, by allowing them to track costs of eradication, acres treated and eradicated, use of volunteer time, public and private land access, and effectiveness of methods. The use of the WIMS system, with its ability to interact with GIS and handheld computers, addresses many requests and criticisms partners had of the former Arundo Survey Database, and the addition of monitoring capabilities within this environment will make the monitoring step a natural extension of the data management process. The growing adoption of WIMS by other weed management programs means that there are more programs with which they can exchange information and compare results. The work proposed herein to improve WIMS will be useful to the other programs already using WIMS, including The Nature Conservancy, USFWS Natural Reserve System, and the California Weed Management Areas. These factors will make the data system more relevant to CBDA-funded partners, and so they will be more motivated to learn it and make it part of their operations. This is necessary for successful flow of monitoring data from the local level to the regional and state level.

At the regional scale the additional information becomes instrumental in the evaluation of region-wide progress and effectiveness of restoration methods in various scenarios across watersheds. Evaluated together with the results of the scientific investigation funded under the Arundo Program's Phase 2 award, a wealth of new information will be made available to guide future efforts of Arundo and other weed eradication projects. This information will include effectiveness of methods under a range of conditions and plant community changes in the context of active revegetation as opposed to natural plant dispersal.

A5. FEASIBILITY

The proposed monitoring and evaluation work is feasible and timely for a number of reasons. First, there is current support from several agencies and organizations to adapt, improve, and implement an advanced weed management system. Feedback we have received at TAdN Steering Committee Meetings, from staff at the Arundo Program's ten partner projects, and from communications with other land managers and restorationists has clearly indicated the need for an improved weed management system that also offers resource management tools. Since the draft protocol and WIMS Database Development Team have already been assembled, the needed improvements and implementation can be completed in the time allotted. Programmatic permitting/environmental compliance, funded in Phase 2, is scheduled to be completed in advance of the proposed project implementation. Natural and operational conditions are not anticipated to present any delays to project implementation.

The timing of currently funded projects may affect the start date of the proposed monitoring task. (A timeline of the proposed work is included in Section IX.) The proposed start date for the two years of additional monitoring may not coincide with the end date of the currently funded project. It may therefore be necessary to amend the actual start date to accommodate the needs of project partners. However, many components of the new monitoring system, including the new protocols, improved database, and equipment, can be adopted at any time. In addition, current project partners either own or have acquired access to restoration sites and currently have regulatory permission to do weed control and revegetation on those sites.

We do not anticipate any opposition or third-party impacts resulting from this proposed project due to proposed monitoring being done on land with current access agreements. Phase 2 partners will develop access agreements on all land containing Arundo that they wish to treat as part of the Eradication Planning process, which is the first step of their project, and so it is anticipated that the monitoring described in this proposal will be feasible at those sites. Property owners potentially involved in this regional project are too numerous to list. However, current partners are watershed-based organizations and agencies actively engaged with local property owners and groups. Opposition to date has been isolated to a few individual property owners, who generally join the program once they see progress on neighboring properties

Several organizations support this proposal to improve the weed monitoring protocols and WIMS database, including CDFA, USFWS, ICE, SEC, and TNC. The only concern some organizations have voiced is whether the task of monitoring will become unwieldy if too many additional parameters are added to an already complex database. The apparent challenge is to provide a monitoring system that yields enough data to indicate restoration success, yet does not overwhelm the user or discourage use.

VI. EXPECTED PRODUCTS AND OUTCOMES

The products and outcomes of this proposed project are summarized below.

- Literature review, bibliography, and compiled input from experts for improved vegetation monitoring protocol
- Vegetation Monitoring Protocol
- Guidelines for implementing vegetation monitoring protocol partners
- Peer review of pilot monitoring protocol
- Draft publication describing protocol
- Individual or workshop trainings for protocol
- Monitoring data collected by partners, assembled in partner databases and in the TAdN master database, and served online on the TAdN mapserver (within the scope and timeframe of Phase 2)
- Reporting of interim and final results to partners, workshop participants, TAdN Steering Committee, and funder (within the scope and timeframe of Phase 2).

VII. DATA HANDLING, STORAGE, AND DISSEMINATION

Data Collection

This proposed project focuses on developing and teaching good practices in data collection and handling as a means by which to succeed in the monitoring of restoration actions. The WIMS 3 application, developed in Phase 2 by The Nature Conservancy, Information Center for the Environment and Sonoma Ecology Center, is a strong platform for managing monitoring data while solving many basic problems of field data collection. The use of handheld computers (PDAs) together with ArcPad GIS and the WIMS data entry forms in the field makes data collection fast and consistent, and eliminates the need to do tedious and error-prone data entry after the field day.

Local Data Management

After collection in the field, data is downloaded to the desktop computer into the WIMS MS Access database, where an array of reports and queries are available to the weed manager for use in project management. The WIMS application includes outputs of weed occurrence, assessment, treatment, and monitoring data to shapefiles, allowing for integration into GIS. Data will be exported by the weed manager and sent to Sonoma Ecology Center for inclusion in the TAdN data clearinghouse. Exports will correspond with the completion of field data collection to allow for quality checks to be done in a manner timely for correction of any problems.

Regional Clearinghouse

WIMS is already equipped with data export and import functionality, making the creation and update of a regional clearinghouse from many partner databases possible. The resulting regional dataset will be managed at Sonoma Ecology Center by the TAdN Data Coordinator and analyzed with guidance from the Science Advisors. Results will be shared in a manner that is timely for performance evaluation and adaptive decision-making. The regional dataset will be made available to the partners and the public through the Arundo mapserver funded in previous CBDA projects. The mapserver will allow users to view, query, and download the data for their own use. Partners will be able to link to their project-specific data from their own websites. Sensitive information, such as landowner names and contact information, will not be posted.

Statewide/Public Coordination and Sharing

Weed occurrence and treatment data and associated monitoring data will be integrated with the Bay/Delta and Tributaries (BDAT) Program by providing reports for inclusion in the BDAT database. During the development of the monitoring data fields and their allowed attributes, BDAT will be consulted for compliance with standards that will facilitate integration with other Bay-Delta data. Metadata will be entered into the Team Arundo del Norte Catalog in the California Environmental Information Catalog housed at CERES. Weed occurrence data will be contributed to the California Invasive Plant Council's statewide mapping project, along with the extensive Bay-Delta Arundo distribution dataset being developed under the second phase of funding for the Arundo Eradication and Coordination Program. These contributions will greatly enhance the current understanding of the distribution of *Arundo donax* in California.

VIII. PUBLIC INVOLVEMENT AND OUTREACH

For the duration of Phase 2, the Arundo Eradication and Coordination Program will continue public outreach through dissemination of our educational materials, comprehensive website information, public presentations, and representation at conferences. Individual partners will continue to publicize their achievements through their local news media. The Arundo Program continues to maintain a comprehensive bibliography of Arundo related research and an archive of ongoing discussions from our listserv. Research related to the development of the monitoring protocol will be added to the on-line bibliography.

Database training materials produced by the new monitoring system development team, will be distributed by TAdN to WIMS trainees, other interested parties, and posted on the TAdN website. Monitoring results will also be posted on the website and disseminated upon request.

IX. WORK SCHEDULE

The work schedule for the project's tasks and deliverables is presented in the table below. Monitoring subtask is dependent upon protocol development and data-capture system compatibility. Modifications to the database system based on user feedback will be made as funding allows within the scope and timeline of the Phase 2 project. Mapserver data posting and management is a task independent of other data management and reporting tasks.

Reporting – documenting performance and development of protocol, distributing it and incorporating it.

Annual and semi annual reports, submit drafts of protocol.

Project Tasks	**Duration**	**Annual timeline: Quarters**			
		1	**2**	**3**	**4**
Project Management					
Contract and task management, quarterly and final reports.	ongoing				
Protocol Development					
Describe invasive species program monitoring needs	1 month				

Literature review	1 month				
Consult with experts for advice on monitoring protocol development.	1-2 months				
Draft a monitoring protocol based on consultations.	1-2 months				
Review and revise protocol and data collection system as needed and where feasible.	2-3 months				
Test the new protocol with data collection system in the field at selected sites.	2-3 months				
Publish protocol. Provide working draft to TAdN and partners, and final draft for peer review	2-3 months				
Training					
Develop instructional materials.	1 month				
Train partners in new protocol.	ongoing				
Support partner implementation of monitoring protocol.	ongoing				
Conduct data collation and quality checks.	ongoing				
Adaptive management					
Implement monitoring at partner eradication sites, where feasible.	ongoing				
Coordinate feedback from partners on protocol and data management system.	ongoing				
Evaluate ability to use WIMS with protocol, provide recommendations to WIMS development team	ongoing				

X. PERFORMANCE MEASURES

The performance measures below reflect the objectives of the proposed project, which are to develop, review, publish, and promote a refined monitoring protocol. It is not the objective of this project to conduct eradication or monitoring work; performance measures for that work are handled under the Phase 2 project. The outcomes, indicators, and performance measures outlined below are designed to guide the work of protocol development for the Phase 2 partners as well as the greater invasive plant management community, and so will require the involvement of representatives of that community. Targets indicate our intention to produce a monitoring protocol that is reviewed and vetted by experts recognized by the invasive plant management community and is subsequently adopted and used by multiple invasive plant management programs, supporting the standardization of invasive plant data and the ability to combine, present, and analyze this kind of data across agencies.

Project Goals	**Desired Outcomes**	**Output Indicators**	**Outcome Indicators**	**Measurement Tools and Methods**	**Targets**
1. Develop a standard Monitoring Protocol for use with WIMS to support the Team Arundo del Norte multi-program monitoring effort.	Standardized, peer-reviewed, science-based monitoring Protocol	No. of experts contacted and asked to review Protocol No. of current partners and asked to review Protocol No. of submittals to conferences and journals.	No. of experts and partners that review the Protocol No. of conferences or journals accepting Protocol for publication.	Responses from reviewers Publication success rate (no. of acceptances to publish or present Protocol)	90 % expert approval. At least one presentation at a conference or one journal publication.
2. Develop written guidelines/instructions for implementing the Monitoring Protocol	Increased acceptance and usage of monitoring Protocol outside of TAdN Program	Completion of updated user manual	No. of users adopting Protocol outside of TAdN Program	User surveys	At least 3 weed management programs outside of the TAdN Program adopting and using the Protocol
3. Provide Monitoring Protocol training and support for project partners.	Increased autonomy of partner users (= decreased dependence on support)	No. of training sessions or workshops provided No. of partners trained	No. of tech support calls and problems reported by users	Records of tech support calls User surveys	50% reduction in tech support calls >50% of survey respondents indicate a significant improvement in Protocol's ease of use, clarity, and credibility >50% of survey respondents indicate that they could understand and use the protocol with a minimum of support
4. Collect Phase 2 partner monitoring data and evaluate hypotheses.	More complete and consistent data collection among TAdN partner users	No. of partners reporting data that is complete according to Protocol	Increase in completeness and quality of data Increased ability to analyze data for vegetation change detection	Analysis of data quality Analysis of vegetation change Confidence level in resulting analysis outcomes	All partner data completed with required elements Quantitative change detection High level of confidence in changes in vegetation shown by data analysis

B. APPLICABILITY TO CBDA ERP GOALS, ERP DRAFT STAGE 1 IMPLEMENTATION PLAN, AND CVPIA PRIORITIES

1. ERP AND CVPIA PRIORITIES

This program directly addresses goals set forth by the CBDA NIS Strategic Plan and the ERP.

The program addresses Goal 5 of the Ecosystem Restoration Program to "reduce negative biological and economical impacts of established non-native species," which is a BR-3 Bay Area priority and MR-1 multi-regional priority of this PSP. Relevant objectives include Objective 6 to "halt the introduction of invasive aquatic and terrestrial plants into Central California" and Objective 7 to "focus control efforts on those introduced species for which control is most feasible and of greatest benefit." The program addresses ERP priorities by improving and increasing aquatic and terrestrial habitats and ecological functions in the CBDA region. The program supports sustainable populations of diverse and valuable plant and animal species by removing a highly invasive plant that displaces these species. Removal of Arundo from stream channels prevents impediments and erosion that disrupt stream flow, cause flooding, and destabilize stream banks. Program objectives correspond with Goals I, II, and III of the NIS Plan to prevent and control the spread of NIS through appropriate management, and reduce their negative ecological and economic impacts. This program addresses the issues (NIS Plan) of leadership, authority and organization; coordination, cooperation, and partnership; and education and outreach by providing the following:

- a base of expertise and a conduit for information exchange
- a single entity for coordination of Arundo eradication projects
- guidance for the best methods of project implementation and monitoring
- continued support of several projects in critical stream locations that would otherwise not monitor projects at the level desired
- feeding new information from on-the-ground eradication, monitoring, and restoration into a shared information pool.

Below is a list of populations of diverse and valuable plant and animal species for Phase 2 partners.

Phase II Eradication Partners

Stream	**Ecological Management Unit**	**Species in Multi-Species Conservation Strategy** (partial list)
Upper Cache Creek*	Flows into 10.1	Northern Spotted Owl critical habitat, CA Red Legged Frog, Foothill Yellow Legged Frog, Central CA Coast ESU Steelhead, CA Freshwater Shrimp, Valley Elderberry Longhorn Beetle, 22 more
Lower American River	9.2	Fall-Run Chinook, Central Valley ESU Steelhead, Valley Elderberry Longhorn Beetle, Western Pond Turtle, Sacramento Splittail, Northern CA Black Walnut
Lindo Channel	7.3, 7.4	Valley Elderberry Longhorn Beetle, Spring Run Chinook, Central Valley ESU Steelhead, Western Pond Turtle
San	12.4	San Joaquin Kit Fox, Bald Eagle, Valley Elderberry Longhorn

Joaquin River		Beetle, Swainson's Hawk, Yellow-Billed Cuckoo, White-Tailed Kite, CA Tiger Salamander, Western Pond Turtle, rookeries of Great Blue Heron and Great Egret
Gray Lodge Wildlife Area	3.3, 7.7	Valley Elderberry Longhorn Beetle, CA Clapper Rail, Swainson's Hawk, Riparian Brush Rabbit, Greater Sandhill Crane, Giant Garter Snake, Western Least Bittern, CA Tiger Salamander

* Site is an Arundo source upstream of major restoration efforts

2. RELATIONSHIP TO OTHER ECOSYSTEM RESTORATION ACTIONS, MONITORING PROGRAMS, OR SYSTEMWIDE ECOSYSTEM BENEFITS

The Team Arundo del Norte (TAdN) Arundo Eradication and Coordination Program (ACEP) employs a regionally coordinated approach to NIS eradication efforts. Phase 2 of the program expands the number of participating partner projects using the TAdN surveying and monitoring protocols from 5 to 10. This means that all projects will be using the same planning tools and outreach techniques, proven treatment methods, and standardized survey and monitoring protocol.

This proposed monitoring and evaluation program significantly expands ties between TAdN and other agencies and organizations involved with ecosystem restoration work. TAdN will be collaborating with an existing weed mapping effort by The Nature Conservancy and its Weed Information Management System, or WIMS, project. Others, including the California Department of Food and Agriculture (CDFA), the California Weed Management Areas (CWMA), the US Fish and Wildlife Service's Reserve System (USFWS), the Information Center for the Environment (ICE), and the Sonoma Ecology Center (SEC), are joining this partnership. The work among all of these groups—to further improve this weed mapping system and to use the same well-designed monitoring protocol—will result in increased coordination throughout the CBDA region by making possible the exchange of data that measures the success of invasive weed eradication and native habitat restoration efforts. By sharing resources, it will also consolidate technical support for all participating groups.

TAdN already cooperates with CDFA and its Weed Management Area (WMA) members. Collaborating with the WMA program provides TAdN a broader NIS and multi-region context. The Program remains closely linked to the California Invasive Plant Council (Cal-IPC), the California Native Plant Society, and the agencies and academic institutions represented by the diverse members of the TAdN Steering Committee. (See Qualifications, Section C.)

C. QUALIFICATIONS

ORGANIZATIONAL STRUCTURE AND RESOURCES

The Arundo Eradication and Coordination Program is managed by **Sonoma Ecology Center** staff located at the Sonoma Valley Watershed Station in Eldridge, CA. The **Coordination Team** consists of Program Manager Mark Newhouser, Data Coordinator Deanne DiPietro, and Information Coordinators Bob Hass and Pat Stiefer, and Data Manager Kasey Allen. This team carries out the central coordination work and communicates on all aspects of the program with the Eradication Partners in their locations in ten different watersheds. The proposed project would provide funds to help continue these positions for the extended time period required to develop the monitoring protocol, assist the partners in the collection and management of monitoring data, and to consolidate, analyze, and report the data.

The **Team Arundo del Norte (TAdN) Steering Committee** (see Appendix D) will continue to guide and advise the Program through its quarterly meetings. Steering committee members are experienced weed managers and invasive species scientists. TAdN was formed to coordinate across organizations and jurisdictions on all matters concerning the control of the noxious weed *Arundo donax*. It also disseminates new scientific research and best management practices and promotes the sharing of information through its website and listserv.

Monitoring Protocol Developers
Deanne DiPietro, GIS & Information Services Program Manager, Sonoma Ecology Center
Kasey Allen, Database Specialist, Sonoma Ecology Center
Jessie Olsen, Restoration Specialist, Sonoma Ecology Center

Data Management System Developers
Deanne DiPietro, GIS & Information Services Program Manager, Sonoma Ecology Center
Kasey Allen, Database Specialist, Sonoma Ecology Center
Barry Lavine, Database Developer (private consultant)

Monitoring Protocol Advisors (draft list)
Marcel Rejmanek, Professor of Ecology, Dept. of Evolution and Ecology, UCD
Michael Barbour, Plant Ecologist, Environmental Horticulture Dept., UCD
David Spencer, Weed Ecologist, USDA ARS
Tom Dudley, Ecologist, UCSB
Josh Viers, Ecologist, Dept. of Environmental Sciences & Policy, UCD
Jim Quinn, Ecologist, Dept. of Environmental Sciences & Policy, UCD

Because the planned data management system development will also affect other organizations using the Weed Information Management System (WIMS), a Multi-Organizational Database Team has been formed to assist with its design and implementation. and to assure that it is useful to all. This team consists of programmers from The Nature Conservancy, California Department of Food and Agriculture, ICE, TAdN, and others. Although the Program has inhouse staff capable of doing most of the database work, we intend to contract with Barry Lavine, Database Specialist with The Nature Conservancy, because he is the original developer of the WIMS database system and a collaborator on the WIMS 3 upgrade, and as such is an important member of the WIMS Development Team.

Within the scope of Phase 2, monitoring data collection will be done by the Eradication Partners at eradication sites in their respective watersheds, in some cases with on-site support from the Program Coordination Team. Periodic uploads of their data, as well as quarterly reports on monitoring activities, will be required from the Partners by the Program Manager. Data and reports will then be reviewed and consolidated by the Coordination Team at Sonoma Ecology Center and included in quarterly reports to the funder. Scientific advisors will be involved in data analysis, and interpretation and presentation of results.

PROGRAM ADMINISTRATION

Program Administrator: Richard Dale, Executive Director, Sonoma Ecology Center. B.A., Environmental Studies, University of California, Santa Cruz., 1982. Sonoma Valley Vintners and Growers Alliance (1999–2003); Sonoma County Vision (2001–2003); Sonoma County Grading Ordinance Working Group (present). John Muir Conservation Award, 1997.

Roles/Responsibilities: Mr. Dale will provide fiscal oversight to the project.

Relevant Experience and Contributions: Mr. Dale has administered over $5 million in grant projects, including 10 years experience coordinating local Arundo eradication efforts. It was the SEC's earliest Arundo project that led to the formation of Team Arundo del Norte, when SEC held a workshop to educate Northern California land managers on the ecological hazards of *Arundo donax* invasion. SEC is known for its watershed research, salmonid restoration, vegetation management/habitat restoration, stakeholder problem-solving, and environmental education.

Program Coordinator: Mark Newhouser, Project Director, Vegetation Management, Sonoma Ecology Center. B.A., Environmental Studies, Conservation and Restoration, Sonoma State University. Board member, California Invasive Plant Council. Team Arundo del Norte Steering Committee Chair.

Roles/Responsibilities: Mr. Newhouser will continue to administer the program, with responsibility for managing its 10 partner projects; preparing quarterly reports, budgets, and partner contracts; facilitating TAdN Steering Committee meetings; acting as liaison with other organizations; and making public presentations.

Relevant Experience and Contributions: Mr. Newhouser has 20 years experience with community project planning and coordination, environmental education and outreach, and volunteer coordination. For the past seven years he has coordinated Arundo eradication efforts in the Sonoma Valley watershed, and since April 2001 has coordinated TAdN's Arundo Eradication and Coordination Program. Specific accomplishments include Arundo Program conceptual development and implementation; development of eradication plan guidelines and partner subcontract; and adaptive strategies for working with private landowners and dealing with access issues, regulatory requirements, water quality considerations, and revegetation needs. Mr. Newhouser is a founding member of TAdN and has facilitated a broad coalition of representatives from government agencies, academic institutions, non-profits and private landowners in the development of the Arundo Eradication Program.
He has coauthored a number of invasive weed publications, including *Controlling Arundo in Your Watershed: A Guide for Organizations* (2000), and *Arundo: A Landowner Handbook* (publication and video, 2000).

Data Coordinator: Deanne DiPietro, GIS and Information Services Manager, Sonoma Ecology Center. B.S., Botany, University of California, Davis, 1984. M.A., Geography; UC Davis, 2002. Thesis: *Mapping the invasive plant Arundo donax and associated riparian vegetation using hyperspectral remote sensing.* Board member and Weed Mapping Committee Chair, California Invasive Plant Council.

Roles/Responsibilities: Ms. DiPietro will coordinate all aspects of the program's data management needs, including monitoring protocol development, modifications to the currently used Weed Information Management System, training and user support, and data clearinghouse management.

Relevant Experience and Contributions: Ms. DiPietro has 10 years experience in environmental data management and information technology solutions. She has been involved in Team Arundo del Norte from the onset as a founding member, webmaster, and data and information consultant or manager. She will continue in her role as data coordinator for the second phase of the Arundo Eradication and Coordination Program. At the California Resources Agency's CERES Program and the UC Davis Information Center for the Environment, Ms. DiPietro has led the development of data management systems intended for multiple users with the goal of consolidating and integrating the data at the regional

scale. Contributions include the development of the original Arundo Surveying Database, database user training and support, the TAdN Website and Arundo Digital Library, and the Arundo Mapserver. In her role as GIS & Information Services Manager for Sonoma Ecology Center, she works closely with regional and national partners in the digital library and geographic information systems community. Relevant publications include the California Weed Mapping Handbook (Schoenig, Johnson, DiPietro, Kelly, Yacoub, and Gendron; 2002), and several works on remote sensing of invasive plants using hyperspectral data analysis

Science Advisor: Dr. Jim Quinn, Professor of Environmental Science and Policy, University of California, Davis; Co-director of the Information Center for the Environment ; Leader of the California Information Node (CAIN) of the National Biological Information Infrastructure. Ph.D., Zoology, University of Washington, 1979; B.A., Biology, Harvard University.

Roles/Responsibilities: Dr. Quinn will advise TAdN in areas of monitoring protocol design, data model design for interoperability, and on appropriate organizations with which to consult or seek partnership. Dr. Quinn also works with the CBDA-funded Lepidium Eradication Program, and will assist with connectivity between these two invasive weed programs.

Relevant Experience and Contributions: Current research interests include environmental applications of Semantic Web technologies, the use of geospatial information systems to assess biodiversity, land use and water quality, international databases and information sharing on invasive species and species in protected areas, watershed and floodplain analysis, and the dynamics and restoration of the San Francisco Bay–Sacramento Delta ecosystem. Past research programs also include work on marine intertidal communities, Pacific Coast marine fisheries, marine protected areas, and conservation biology as applied to parks and nature preserves.

Science Advisor: Joshua H. Viers, Assistant Research Ecologist, Information Center for the Environment, UC Davis. Ph.D., Ecology, UC Davis, 2003. He has published on a variety of subjects, including watershed analysis methods, serpentine endemic plant distributions, riparian vegetation restoration and salmon conservation, land use and river geomorphology, invasive fishes, and most recently alien plants and extinction risk in California flora.

Roles and Responsibilities: Dr. Viers will provide guidance in the areas of data analysis and interpretation.

Relevant Experience and Contributions: Dr. Viers has extensive experience in the design, development, and use of spatial data systems for natural resource management. His experience with data collection on two riparian invasives, perennial pepperweed (*Lepidium latifolium*) and Himalayan blackberry (*Rubus discolor*), will provide meaningful feedback on the proposed data management model. His current research focuses on predictive modeling for resource management. These efforts encompass non-native invasive species, the spatial effects of land use activities on riparian and aquatic habitat heterogeneity, and the integration of high-spatial resolution, hyperspectral data into resource inventories.

D. COST

D1. BUDGET (see attached budget)

All tasks of this proposal are fully integrated, so implementation of portions is not feasible.

Funding for the implementation of this proposal is separate from the currently funded Phase 2 project.

The proposed monitoring protocol and the tasks to complete it are distinct deliverables from phase 2 deliverables, and therefore are budgeted separately.

D2. COST-SHARING

All promised and proposed cost-share is offered as in-kind services to be provided by partnering organizations. The following table includes cost-share commitments for this proposal:

Donor	Deliverable	Cost-Share
Science Advisors	Consultation time and meetings	9,000
TNC, CDFA, and USFWS	Staff time for meetings	17,280
TNC	Data manager	6,000
TNC	WIMS database	150,000
USFWS, TNC	WIMS training curriculum	30,000
USFWS, TNC	Training room and equipment	11,640
WIMS Database Development Team	Input and support	15,000
SEC GIS Lab	System Admin. and equipment	80,000
	TOTAL:	**318,920**

D3. LONG-TERM FUNDING STRATEGY

Restoration success monitoring is anticipated to be a long-term proposition, requiring several more years to ensure successful revegetation of current sites. TAdN strategy for funding further expansion of the TAdN Arundo Eradication Program and ongoing restoration monitoring funding is to diversify funding sources from both public and private sources. TAdN plans to continue to expand partnerships with federal and state agencies, attracting resources and potential funding. We will also continue to request funding from CALFED/CBDA for continuation and expansion of our program.

E. COMPLIANCE WITH STANDARD TERMS AND CONDITIONS

The applicant agrees to comply with all standard State and Federal contract terms.

G. LITERATURE CITED AND SUPPORTING RESEARCH

Agricultural Research, April 2001. Article and photos describing researchers' (UC Berkeley ecologist Thomas L. Dudley, ARS entomologists Raymond I. Carruthers and Alan A. Kirk, and ARS plant pathologist Timothy L. Widmer) search in Nepal for biological control agents for *Arundo donax*, tamarisk, and salt cedar. http://www.ars.usda.gov/is/AR/archive/apr01/path0401.htm

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H. NONPROFIT VERIFICATION

IRS letter verifying nonprofit status is appended to the end of this proposal.