99B-152

4.5 PSP Cover Sheet (Attach to the front of each proposal)

Proposal Title: A Mechanistic Approach to Riparian Restoration in the San Joaquin Basin
Applicant Name: Stillwater Sciences
Mailing Address: 2532 Durant Ave #201, Berkeley CA 94704
Telephone: (510) 848-8098
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Email: jcstella@earthlink.net

Amount of funding requested: $223,666 for 3 years

Indicate the Topic for which you are applying (check only one box).

- ☐ Fish Passage/Fish Screens
- ☒ Habitat Restoration
- ☐ Local Watershed Stewardship
- ☐ Water Quality
- ☐ Introduced Species
- ☐ Fish Management/Hatchery
- ☐ Environmental Education

Does the proposal address a specified Focused Action? X yes ____ no

What county or counties is the project located in? Merced and Stanislaus

Indicate the geographic area of your proposal (check only one box):

- ☐ Sacramento River Mainstem
- ☐ Sacramento Trib: ____
- ☐ San Joaquin River Mainstem
- ☒ San Joaquin Trib: Merced & Tuolumne R
- ☐ Delta: ____
- ☐ East Side Trib: ____
- ☐ Suisun Marsh and Bay
- ☐ North Bay/South Bay: ____
- ☐ Landscape (entire Bay-Delta watershed)
- ☐ Other: ____

Indicate the primary species which the proposal addresses (check all that apply):

- ☒ San Joaquin and East-side Delta tributaries fall-run chinook salmon
- ☐ Winter-run chinook salmon
- ☐ Late-fall run chinook salmon
- ☐ Delta smelt
- ☒ Splittail
- ☐ Green sturgeon
- ☒ Migratory birds
- ☐ Other: ____
- ☐ Spring-run chinook salmon
- ☒ Fall-run chinook salmon
- ☐ Longfin smelt
- ☐ Steelhead trout
- ☐ Striped bass
- ☐ All chinook species
- ☐ All anadromous salmonids

Specify the ERP strategic objective and target (s) that the project addresses. Include page numbers from January 1999 version of ERP Volume I and II:

Strategic Objective For Natural Floodplains and Flood Processes

- Re-establish frequent inundation of floodplains by removing, breaching, or setting back levees and, in regulated rivers, by providing flow releases capable of inundating floodplains. (ERPP Vol I, p. 89)

(continued on back)

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Indicate the type of applicant (check only one box):

☐ State agency	☐ Federal agency
☐ Public/Non-profit joint venture	☐ Non-profit
☐ Local government/district	☒ Private party
☐ University	☐ Other: _____

Indicate the type of project (check only one box):

☐ Planning	☐ Implementation
☐ Monitoring	☐ Education
☒ Research	

By signing below, the applicant declares the following:

1.) The truthfulness of all representations in their proposal;

2.) The individual signing the form is entitled to submit the application on behalf of the applicant (if the applicant is an entity or organization); and

3.) The person submitting the application has read and understood the conflict of interest and confidentiality discussion in the PSP (Section 2.4) and waives any and all rights to privacy and confidentiality of the proposal on behalf of the applicant, to the extent as provided in the Section.

John Stella

Printed name of applicant

John Stella

Signature of applicant

A MECHANISTIC APPROACH TO RIPARIAN RESTORATION IN THE SAN JOAQUIN BASIN

APPLICANT

Company/Agency	**STILLWATER SCIENCES**
Address	2532 Durant Avenue, Suite 201
	Berkeley, CA. 94704
Phone	(510) 848-8098
Fax	(510) 848-8398
E-mail	jcstella@earthlink.net
Contact	**John Stella**
Type of Organization/ Tax Status	Incorporated/Small Business
Tax Identification No.	94-3241861

Applicants:
The Project Team consists of Stillwater Sciences and a Scientific Advisory Team. Stillwater Sciences specializes in developing new scientific approaches and technologies for problem solving in aquatic and terrestrial systems The Scientific Advisory Team consists of internationally recognized experts in the fields of riparian ecology, plant physiology, hydrology, geomorphology, aquatic ecology, and statistics. The proposed project will be an effective tool for implementing long-term restoration of riparian habitat in the San Joaquin Basin. Drs. Stewart Rood and John Mahoney, who have developed and tested the 'recruitment box' model (described herein) of riparian and fluvial systems similar to those in the San Joaquin Basin, will serve as the lead advisors on developing the conceptual framework for this project.

The Project Team will collaborate with the Tuolumne River Technical Advisory Committee, which includes representatives from USFWS, CDFG, Tuolumne and Modesto Irrigation Districts, Tuolumne River Preservation Trust, Friends of the Tuolumne, and the City and County of San Francisco. We have also coordinated closely with the Merced County Planning and Community Development Department, the Stanislaus County Planning and Community Development Department, the U.S. Fish and Wildlife Service's Anadromous Fisheries Restoration Program (AFRP), the Cosumnes Science Consortium, the Natural Heritage Institute, and The Nature Conservancy during the preparation of this proposal.

EXECUTIVE SUMMARY

PROJECT TITLE: **A MECHANISTIC APPROACH TO RIPARIAN RESTORATION IN THE SAN JOAQUIN BASIN**
APPLICANT: **Stillwater Sciences**

PROJECT DESCRIPTION, SIZE AND LOCATION: The proposed project will identify the physical and biological mechanisms affecting establishment of riparian vegetation, in particular Fremont cottonwood and willow communities in the San Joaquin Basin, in order to identify the most cost-effective strategies and sites for riparian protection and restoration. The project addresses a need for *ecologically-based hydrologic models and water management strategies for habitat restoration*, identified as a Focused Action in the 1999 CALFED Proposal Solicitation Package (p. 19). In a phased project, the Stillwater Sciences Project Team proposes to develop a conceptual framework of physical influences on riparian plant establishment (Phase I); develop and validate a *recruitment box* hydrologic and biological model for study sites on the Tuolumne and Merced rivers (Phase II); and apply the model to a 52-mile reach of the Merced River corridor in coordination with an ongoing, CALFED-funded corridor restoration plan (Phase III). Study sites for Phase II will be established in Stanislaus County along the Tuolumne River from La Grange Dam (RM 52) to the San Joaquin confluence (RM 0) and in Merced County along the Merced River from Crocker-Huffman Dam (RM 52) to the San Joaquin River confluence (RM 0) (Figure 1). **This proposal seeks funding for Phases I and II only.**

PRIMARY BIOLOGICAL/ECOLOGICAL OBJECTIVES: The objective of this project is to develop a scientifically tested, mechanistic model of riparian vegetation establishment that can be used at the site and river corridor scales to evaluate long-term restoration potential of riparian ecosystem processes in the San Joaquin Basin. The model will be specifically calibrated to the San Joaquin Basin, and is intended to be used as an implementation tool by resource agencies. Using the model to prioritize large-scale restoration efforts will directly benefit riparian and riverine habitat, instream aquatic habitat, and seasonally inundated floodplain habitat as well as enhance physical and biological interactions between these habitats. Restoration projects guided by this model will also benefit San Joaquin fall-run chinook salmon and steelhead (CALFED priority species), migratory birds, including Swainson's hawk (a CALFED second priority species), and numerous other native species, including several endangered or sensitive species. Riparian zones provide multiple benefits to instream and terrestrial ecosystems and are widely recognized as centers of biodiversity and corridors for dispersal of plants and animals in the landscape (Gregory et al. 1991, Johannson et al. 1996). Because the model considers the physical processes structuring riparian habitats, large-scale restoration of those processes can be expected to provide sustainable ecosystem benefits far into the future.

COSTS: The estimated total cost of Phases I and II of the project is $223,666. Stillwater Sciences will apply to the U.S. Fish and Wildlife Service's Anadromous Fisheries Restoration Program (AFRP) for FY 2000 to fund Phase I of the project ($43,894). Phase I is included in this CALFED proposal in the event that the AFRP does not provide funding. If Phase I is funded by the AFRP, this proposal will seek funding for Phase II only ($179,772). Significant cost savings are incorporated into this proposal because it builds directly upon past and ongoing projects conducted by Project Team members on the Tuolumne and Merced rivers, including the Merced River Corridor Restoration Plan, portions of which were funded by CALFED and AFRP in 1998.

ADVERSE AND THIRD PARTY IMPACTS: The Project Team will collaborate the Tuolumne River Technical Advisory Committee, which includes representatives from USFWS, CDFG, Tuolumne and Modesto Irrigation Districts, Tuolumne River Preservation Trust, Friends of the Tuolumne, and the City

and County of San Francisco, as well as the Merced River Technical Advisory Committee, the AFRP, landowners, and other interested parties to ensure that all potential third party impacts are identified and avoided.

APPLICANT QUALIFICATIONS: The Project Team is composed of Stillwater Sciences and a Scientific Advisory Team. This team has extensive experience in ecological, geomorphic, and environmental research and management issues in the San Joaquin Basin and in public coordination. Projects completed or underway by team members include long-term evaluations of chinook salmon population dynamics and factors limiting production in the Tuolumne River, geomorphic assessments of the Tuolumne and Merced rivers, mapping of riparian vegetation along 55 miles of the Merced River, and design and implementation of river-wide and site-specific monitoring in the Tuolumne River. The scientific advisory team consists of internationally recognized experts in the fields of riparian ecology, plant physiology, hydrology, geomorphology, aquatic ecology, and statistics. Scientific advisors have conducted riparian research projects similar to this proposal on the Truckee River and Dry Creek, CA, the Snake River, ID, and the Oldman and St. Mary's rivers, Alberta.

MONITORING AND DATA EVALUATION: The Project Team will conduct all data collection, evaluation, and management in accordance with CALFED's Comprehensive Monitoring, Assessment and Research Program (CMARP). Phase II of the project includes hypothesis-driven, project-specific data collection and monitoring, for the purpose of developing a mechanistic model to evaluate riparian restoration methods. In addition, the Project Team will coordinate sampling designs, data collection and analyses with the Cosumnes Science Consortium to test the wider applicability of the model to unregulated systems.

LOCAL SUPPORT/COORDINATION WITH OTHER PROGRAMS: The Project Team will collaborate with the Tuolumne River Technical Advisory Committee, described above, as well as the Merced River Technical Advisory Committee, AFRP, and local landowners. All phases of this project will be coordinated with the ongoing Merced River Corridor Restoration Plan (MRCRP) project, jointly conducted by Stillwater Sciences and Merced County, and partially funded in 1998 by CALFED and the AFRP. For example, this proposal will build on, and complement, the riparian vegetation GIS mapping (for 55 miles of the Merced River corridor) and field assessment of geomorphic factors and riparian vegetation composition and stand viability that are currently funded ($58,000) and scheduled for 1999 as part of the MRCRP project. The proposed Phase II riparian recruitment model validation effort will also be coordinated with the Cosumnes Science Consortium's ongoing riparian research on the Cosumnes River.

COMPATIBILITY WITH CALFED OBJECTIVES: The ERPP vision for the East San Joaquin Basin Management Zone includes "restoring and protecting a self-sustaining stream meander corridor and an associated diverse riparian community that provides shade, nutrients, and woody debris to the rivers, as well as habitat for plants and wildlife communities" (ERPP vol. II, p. 417). Additionally, the vision for each of the Stanislaus, Tuolumne, and Merced Ecological Management Units is "to improve habitat for fall-run chinook salmon, late-fall-run chinook salmon, steelhead, riparian vegetation, and wildlife resources" and "restoring important ecological functions and processes that will improve habitat for fall-run chinook salmon, late-fall run chinook salmon, steelhead, native amphibians and reptiles, riparian vegetation and wildlife resources" (ERPP vol. II, p. 418-422). Important measures identified by the ERPP to achieve this vision include restoring Central Valley streamflows and natural floodplain and flood processes (ERPP vol. II, p. 423-424). The proposed project is expected to be compatible with all other CALFED objectives including water quality, water supply reliability, levee system integrity, and other CALFED Programs including Water Use Efficiency, Water Transfers and Watershed Management.

Project Description

BACKGROUND: Since European settlement of California's Central Valley over 150 years ago, riparian ecosystems in the San Joaquin Basin have been severely altered by the cumulative effects of instream mining, dam and levee construction, farming, grazing, and urban encroachment (McBain and Trush 1998, Vick 1995). Fremont cottonwoods and willows once dominated large areas of riparian forest in the basin. Modern-day riparian forests, however, are much more fragmented and scarce than historical forests, and often represent relict communities isolated from the natural floodplain processes that promote their recruitment and sustainability (Strahan 1984, Katibah 1984).

Restoration of San Joaquin Basin riparian forests and the benefits they provide to threatened and endangered species are high priorities for CALFED and other agencies (ERPP 1999, AFRP 1997, SJRMP 1994). Many studies have attempted to correlate vegetation establishment patterns to landscape elements in order to develop prioritization schemes for riparian forest restoration (e.g., Olson and Harris 1997, O'Neill et al. 1997, Toner and Keddy 1997). These models typically rely on observed spatial relationships (which often are legacies of past conditions and events) rather than evaluation of the fundamental physical and biological processes governing riparian stand development: such models, therefore, have only limited ability to predict future vegetation patterns based on current or future conditions and processes. In contrast, the proposed project will identify the physical and biological mechanisms affecting establishment of riparian vegetation, in particular Fremont cottonwood and willow communities in the San Joaquin Basin, in order to identify the most successful and cost-effective strategies and sites for riparian protection and restoration. The proposed model will be a particularly valuable tool in heavily altered systems such as the mainstem San Joaquin River and its tributaries, where few or no reference sites with unaltered natural riparian processes exist.

PROJECT DESCRIPTION: The goal of this project is to develop and test a **mechanistic** model of riparian seedling establishment for the purposes of (1) prioritizing riparian sites for protection or restoration, and (2) evaluating site reconstruction and flow scenarios to facilitate regeneration of self-sustaining riparian forest in the San Joaquin Basin. In this phased project, the Stillwater Sciences Project Team proposes to develop a conceptual framework of physical influences on riparian plant establishment (Phase I); develop and validate a *recruitment box* model—described below—for study sites on the Tuolumne and Merced rivers (Phase II); and apply the model to a 52-mile reach of the Merced River corridor in coordination with an ongoing restoration plan (Phase III) (Figure 1). **This proposal seeks funding for Phases I and II only. The approach and methods in Phase III depend in part on the experience obtained in Phases I and II. Stillwater Sciences has applied to the Anadromous Fisheries Restoration Program (AFRP) to fund Phase I of the project. Phase I is included in this CALFED proposal in the event that the AFRP does not provide funding. If Phase I is funded by the AFRP, this proposal will seek funding for Phase II only.**

A. SCOPE OF WORK

PHASE I: DEVELOP A MECHANISTIC CONCEPTUAL FRAMEWORK OF RIPARIAN PLANT ESTABLISHMENT

In Phase I, the Project Team will develop the conceptual framework for applying the mechanistic *recruitment box* model to processes and conditions in the San Joaquin Basin. The Project Team will coordinate with the Tuolumne River Technical Advisory Committee, the Turlock and Modesto Irrigation Districts, the Merced River Technical Advisory Committee, AFRP, California Department of Fish and Game, and other local agencies and landowners to insure that the general framework and selection of study sites are consistent with local priorities for riparian management and restoration.

The *recruitment box* is the window of optimal conditions for riparian plant establishment defined in space (bank elevation with respect to river stage) and time (period of seed release and viability) (Figure 2). The model, which was developed by Mahoney and Rood (1993, 1998; see Appendix A),

considers the basic hydrological conditions necessary for riparian seedling establishment, an especially vulnerable component of the riparian forest cycle (Braatne et al. 1996). Cottonwoods and willows are pioneer species that release their seeds in spring and early summer and require moist, bare substrates to germinate. As their roots grow they obtain moisture from the water table, which in natural river systems recedes gradually after the spring floods. The characteristic bands of seedlings that establish after floods are constrained on their upper edge by a too-rapidly declining water table, and on the lower edge by scour and inundation. The conceptual framework developed in this phase will incorporate known hydrological and geomorphological mechanisms characteristic of the San Joaquin Basin (Figure 3). The Phase I tasks are outlined below (see Figures 4 and 5 for task schedule).

Task 1: Develop a conceptual framework for riparian processes. The Project Team's scientific advisors have applied the *recruitment box model* to other western North American alluvial river systems. The Project Team will use this research, coupled with additional focused literature review and consultation with local experts, to develop a framework of hydrological and geomorphological controls on riparian species establishment in the San Joaquin Basin.

Task 2: Conduct field reconnaissance in the San Joaquin Basin. The Project Team, scientific advisors and local agency personnel will conduct a preliminary reconnaissance of San Joaquin Basin riparian zones, specifically focusing on the Tuolumne and Merced rivers to identify potential model validation sites and to develop or refine hypotheses to be tested during Phase II. Prior to the field reconnaissance, a focused evaluation of recent and historical aerial photographs and hydrograph data will be undertaken to identify potential study sites to be evaluated during the field reconnaissance.

Task 3: Select model validation sites. In coordination with local agencies, landowners and other ongoing projects, the Project Team will establish approximately 10 study sites on the Tuolumne and Merced rivers to calibrate and test the model. The specific number and distribution of sites will be determined by the physical and biological diversity of system, statistical considerations, and logistical issues such as site ownership and access.

Task 4: Project management. This task will include contract preparation and management, budget management and accounting, and preparation of quarterly reports.

PHASE II: DEVELOP AND VALIDATE A *RECRUITMENT BOX* MODEL FOR STUDY SITES ON THE TUOLUMNE AND MERCED RIVERS.

In Phase II the Project Team will refine and test the mechanistic *recruitment box* model developed in Phase I for Fremont cottonwood, willows, and other riparian species (such as mulefat) on regulated San Joaquin River tributaries. The Phase I conceptual framework will be tested at study sites on the Tuolumne and Merced River by observing seed release timing and developing a detailed topographic and hydrologic river stage model to predict zones of seedling establishment (Phase II, Tasks 1–4); then testing these predictions by documenting actual seedling regeneration patterns in the field (Task 5). The resulting analyses will be used to evaluate the study sites' potential for restoration and the flow regimes that will optimize seedling recruitment (Task 6). See Figures 3–5 and Table 2 for an overview of the Phase II approach and methods. Results of these analyses will enable local entities involved in riparian habitat restoration and management (such as USFWS, CDFG, TRTAC, RCDs) to evaluate the feasibility and potential for success of implementing various restoration options such as land acquisition, levee setbacks, floodplain reconstruction, and flow scenarios.

Task 1: Document seed release patterns for key riparian species. For several months in the spring and summer, the Project Team will document seed release timing for Fremont cottonwood, willows, and other selected riparian plants during regular field visits to the San Joaquin Basin rivers (Figure 4).

Task 2: Survey and map study site topography; document initial conditions. A combination of field-surveyed cross-sections and total field station surveys will be used to map the topography at each site; results will be incorporated into the existing GIS. Transects and sample plots will be established at

each study site to document existing conditions (this task) and seedling establishment after spring flood recession (see Task 5). Ground wells will be established and soil bores taken to evaluate groundwater levels and soil factors that affect site hydrology. Pre- and post-flood data collection (Tasks 2, 3, and 5) will document (1) seedling abundance on plots of known elevation after the first year's flood recession, to test the model predictions; (2) percent cover of existing vegetation, to assess competition for germination sites; (3) seedling mortality (tracked with groundwater and stream surface water levels) through the summer and second flood season, to assess death from summer drought and winter flood scour; (4) substrate texture, and (5) other site factors, such as grazing, to assess their effects on seedling recruitment and survival (see Table 2).

Task 3: Document study site hydrology. Recording staff gauges will be established at each site to monitor stream stage to develop stage-topography relationships. Differences between surface and ground water elevations will be documented using data from ground wells.

Task 4: Predict seedling establishment zones using the *recruitment box* model. Zones of seedling establishment at the study sites will be predicted using the model to integrate known water surface elevation levels and seed release timing (Phase II, Task 1), the detailed study site topography and hydrologic data (Tasks 2 and 3), and documented species tolerances to water table declines (Table 1). The predicted establishment zones will be mapped as a GIS layer for each study site.

Task 5: Test the model's predictions and analyze other factors affecting seedling establishment and survival. Post-flood data will be collected at transects and study plots and compared to data collected during Task 2. These data will be used to test model predictions (see Table 2).

Task 6: Develop resource management recommendations. The Project Team will use the model to prioritize sites for protection and restoration, and to evaluate restoration options for the 3 most promising study sites to determine which scenarios would maximize establishment of native riparian species (e.g., cottonwood and willow). A synthesis report will be produced at the end of Phase II.

Task 7: Project Management. This task will include contract preparation and management, budget management and accounting, and preparation of quarterly reports.

PHASE III: APPLY THE MODEL TO PRIORITIZE RESTORATION SITES AND STRATEGIES WITHIN A LARGE-SCALE RIVER CORRIDOR RESTORATION PLAN.

For Phase III, the Project Team will seek funding to apply the 'recruitment box' model to the entire Merced River corridor from Crocker-Huffman Dam (RM 52) to the San Joaquin River confluence (RM 0). The purpose of this phase is to facilitate restoration site prioritization and evaluation within the entire river corridor using a predictive model. The model will be a particularly valuable tool in heavily altered systems such as the Merced River, where few or no reference sites with unaltered natural riparian processes exist. Using field methods refined in Phase II coupled with remote sensing, the Project Team will document the channel and floodplain topography, develop a hydrologic model, and map inundation zones at various flows. Corridor-scale topographical mapping methods and hydrologic modeling will enable prediction of vegetation 'establishment zones' under different management scenarios. The corridor modeling and resulting GIS and analyses will be developed as a component of the CALFED-funded Merced River Corridor Restoration Plan in coordination with agencies implementing restoration projects on the Merced River. Our eventual goal is to apply this mechanistic process of restoration planning throughout the San Joaquin Basin, and if successful, the rest of the Central Valley.

B. PROJECT LOCATION AND GEOGRAPHIC BOUNDARIES: Model validation sites for Phase II will be established in Stanislaus County along the Tuolumne River from La Grange Dam (RM 52) to the San Joaquin confluence (RM 0) and in Merced County along the Merced River from Crocker-Huffman Dam (RM 52) to the San Joaquin River confluence (RM 0) (Figure 1). The Phase III Merced River Corridor Restoration Plan will focus on the same 52-mile reach of the Merced River.

Ecological/Biological Benefits

ECOLOGICAL/BIOLOGICAL OBJECTIVES: The objective of this project is to develop a scientifically tested, mechanistic model of riparian vegetation establishment that can be used at the site and river corridor scales to evaluate long-term restoration potential of riparian ecosystem processes in the San Joaquin Basin. The model is intended as an implementation tool for federal, state, and local resource agencies, non-governmental organizations, and other entities interested in restoration. Funding for implementation of the restoration options evaluated by the model is not included in this proposal.

Using the model to prioritize large-scale restoration implementation efforts will directly benefit riparian and riverine habitat, instream aquatic habitat, and seasonally inundated floodplain habitat as well as enhance physical and biological interactions between these habitats. Restoration projects guided by this model will also benefit San Joaquin fall-run chinook salmon and steelhead (CALFED priority species), migratory birds, including Swainson's hawk (a CALFED second priority species), and numerous other native species, including several endangered or sensitive species. Because the model will be based on a mechanistic understanding of physical factors constraining establishment of Central Valley riparian plant species, the model can be expected to be applicable to riparian restoration within the greater San Joaquin Basin and Central Valley. Because the model considers the physical processes structuring riparian habitats, large-scale restoration of those processes can be expected to provide sustainable ecosystem benefits far into the future.

Riparian zones provide multiple benefits to instream and terrestrial ecosystems and are widely recognized as centers of biodiversity and corridors for dispersal of plants and animals in the landscape (Gregory et al. 1991, Johannson et al. 1996). Riparian forests benefit fish and wildlife by providing leaf litter to instream food webs, large woody debris and shading for fish habitat, and forage and migratory corridors for wildlife, including threatened and endangered species such as the yellow-billed cuckoo, Swainson's hawk, and riparian brush rabbit. Physical effects of riparian processes include regulating instream temperatures, filtering nutrients and agricultural chemicals from runoff and the groundwater zone, stabilizing banks, attenuating peak flows by increasing floodplain roughness and slowing runoff, and providing cooler, more humid, and less windy microclimates (ERPP vol I, p. 147, 1999; Naiman and Descamps 1997; Mitsch and Gosselink 1993; Malanson 1993).

The 1999 ERPP states that "many wildlife species, including several species listed as threatened or endangered under the State and federal Endangered Species Acts (ESA) and several special-status plant species in the Central Valley, depend on or are closely associated with riparian habitats....Improving low- to moderate-quality SRA habitat will benefit juvenile chinook salmon and steelhead by improving shade, cover, and food," and " Limitations on land suitable or available for restoration will require establishing priorities, with efforts directed at acquiring high-priority, low-cost sites first" (ERPP vol II, p. 439). This project is designed specifically as an evaluation tool for prioritizing riparian sites and implementing restoration actions.

LINKAGES:

Linkage to Past, Current, and Future CALFED Projects – Since 1986, Project Team members have conducted numerous biological, geomorphic and hydrologic analyses on the Tuolumne and Merced rivers. In addition, the Project Team has developed corridor-long Geographic Information Systems (GIS) for both the Tuolumne and Merced for other projects; these GIS will be used extensively for the riparian modeling work.

All phases of this project will be coordinated with the ongoing Merced River Corridor Restoration Plan project, jointly conducted by Stillwater Sciences and Merced County, and partially funded in 1998 by CALFED and the U.S. Fish and Wildlife Service's Anadromous Fisheries Restoration Plan (AFRP). The restoration plan's vegetation mapping and geomorphic analysis will assist the development and validation of the mechanistic riparian model, and the model in return will provide

information for prioritizing restoration sites and strategies.

We are also coordinating with the Natural Heritage Institute and The Nature Conservancy in a 1999 CALFED proposal to develop ecologically-based hydrologic models and water management strategies. Stillwater Sciences is part of the project team on that proposal. That project will provide the larger ecosystem framework for the riparian processes considered in this proposal. Testing the recruitment box model will, in turn, provide data on flow scenarios beneficial to riparian zones.

The Phase II model validation effort will also be coordinated with the Cosumnes Science Consortium's ongoing riparian research on the Cosumnes River, which is the only undammed river in the San Joaquin Basin. The goal of this coordination effort is to understand how the physical processes in more natural systems may constrain vegetation establishment in different ways than in more highly impaired systems such as the Tuolumne and Merced. Coordination efforts will encompass study site selection, sample designs, mapping methods, data analysis and model validation.

Linkage to ERPP Goals and Objectives – This project addresses a need for *ecologically-based hydrologic models and water management strategies for habitat restoration*, identified as a Focused Action in the 1999 CALFED Proposal Solicitation Package (p. 19). The ERPP vision for the East San Joaquin Basin Management Zone includes "restoring and protecting a self-sustaining stream meander corridor and an associated diverse riparian community that provides shade, nutrients, and woody debris to the rivers, as well as habitat for plants and wildlife communities." (ERPP vol. II, p. 417). In addition, the vision for each of the Stanislaus, Tuolumne and Merced Ecological Management Units is "to improve habitat for fall-run chinook salmon, late-fall-run chinook salmon, steelhead, riparian vegetation, and wildlife resources" and "restoring important ecological functions and processes that will improve habitat for fall-run chinook salmon, late-fall run chinook salmon, steelhead, native amphibians and reptiles, riparian vegetation and wildlife resources" (ERPP vol. II, p. 418-422). Important measures identified by the ERPP to achieve this vision include restoring Central Valley streamflows and natural floodplain and flood processes (ERPP vol. II, p. 423-424).

The model developed in Phases I and II will be used in Phase III to evaluate riparian restoration potential along a 52-mile reach of the Merced River, as well as at the specific study sites used in Phase II. Restoration options that the model will consider include *site-specific* measures such as floodplain reconstruction and levee setbacks, and *river-wide* processes, including flow regimes that will result in reestablishment of a functioning riparian zone ecosystem. Components of a functional system identified in the ERPP that will be specifically addressed by the model include (ERPP vol. I, pp. 29-32):

- *functional channel and floodplain configuration* - The modeling effort will develop target floodplain and channel geomorphic surface dimensions and identify and prioritize reaches where floodplain reconstruction and/or levee setbacks will be necessary to establish self-sustaining stands of riparian vegetation.
- *riparian and floodplain habitats* - Application of the model in Phases II and III will identify riparian and floodplain habitat preservation and restoration priorities and flow scenarios that would maximize establishment of self-sustaining riparian forests.

Specific ERPP targets in the San Joaquin and East San Joaquin Basin Management Zones that would be addressed by this project include (ERPP vol. II, pp 400-401, 437, 439):

- *restore floodplain-river interactions in the San Joaquin River between Vernalis and the mouth of the Merced River*
- *restore 50 stream miles of diverse, self-sustaining riparian community*
- *restore and improve opportunities for rivers to inundate their flooplain on a seasonal basis*
- *provide conditions for riparian vegetation growth along sections of rivers in the East San Joaquin Basin Ecological Management Zone*

Central Valley Habitat Joint Ventures goals for the San Joaquin Valley, encompassing the East San Joaquin Basin Management Zone and cited in the ERPP include (ERPP vol. II, p. 439):

- *protect 52,500 acres of existing wetland in perpetuity through fee acquisition or conservation easements*
- *restore and protect in perpetuity 20,000 acres of former wetlands*
- *enhance 120,300 acres of existing wetlands*

Linkage to AFRP Goals and Objectives – The project will address the following action and evaluation items for the mainstem San Joaquin River and its tributaries (Stanislaus, Tuolumne, and Merced) identified in the Revised Draft Restoration Plan for the Anadromous Fish Restoration Program: (1) improve watershed management to restore and protect instream and riparian habitat (Action Item, all rivers) and (2) Identify and implement actions to provide suitable water temperatures for all life stages of chinook salmon, consistent with efforts to maintain adequate flows to provide fish habitat (Evaluation Item, all rivers).

Linkages to the San Joaquin River Management Program (SJRMP) – Our proposed project addresses the following recommended projects, studies, and acquisitions identified in the 1995 San Joaquin River Management Plan: riparian corridor restoration and dual-purpose floodway proposal (Projects); instream flow/riparian corridor relationship and shaded riverine aquatic habitat inventory (Studies); and riparian habitat acquisition (Acquisitions).

SYSTEM-WIDE ECOSYSTEM BENEFITS: Development and application of the mechanistic riparian restoration model and subsequent implementation of restoration projects evaluated by the model will provide ecosystem benefits throughout the San Joaquin Basin. These benefits in combination with terrestrial and vernal pool conservation efforts underway by the East Merced RCD as well as large-scale restoration efforts currently underway in the Tuolumne River (by the CDFG, National Resources Conservation Service, and Tuolumne River TAC), on the Stanislaus River (by the CDFG and USFWS), and on the Merced River (by the CDFG and CDWR) will provide a substantial opportunity to improve riparian habitat and general ecological conditions in the San Joaquin Basin.

COMPATIBILITY WITH NON-ECOSYSTEM OBJECTIVES: The proposed project does not conflict with CALFED's non-ecosystem objectives. It is expected to be compatible with all other CALFED objectives including water quality, water supply reliability, levee system integrity, and other CALFED Programs including Water Use Efficiency, Water Transfers and Watershed Management.

Technical Feasibility and Timing

Many studies have attempted to correlate vegetation establishment patterns to landscape elements in order to develop prioritization schemes for riparian forest restoration (Olson and Harris 1997, O'Neill et al. 1997, Toner and Keddy 1997). These models typically rely on observed spatial relationships (which often are legacies of past conditions and events) rather than evaluation of the fundamental physical and biological processes governing riparian stand development: such models, therefore, have only limited ability to predict future vegetation patterns based on current or expected future conditions and processes. In contrast, the proposed project will take a more mechanistic approach involving identification of the physical and biological mechanisms affecting establishment of riparian vegetation, in particular Fremont cottonwood and willow communities in the San Joaquin Basin, in order to identify the most successful and cost-effective strategies and sites for riparian protection and restoration. This mechanistic approach has been successfully applied by the Project Team's Scientific Advisors (Mahoney and Rood) on the Truckee River in California, the Snake River in Idaho, and the Oldman and St. Mary's rivers in Alberta. The proposed project would adapt, or calibrate, this well-tested approach for application to the ecological conditions and processes affecting San Joaquin Basin riparian systems. This would be the first test of this approach in California west of the Sierra Nevada.

Coordination with the Tuolumne River Technical Advisory Committee, Merced River TAC, and local landowners throughout Phases I and II of the project is intended to identify and address public, stakeholder, and agency concerns early in the project process and foster a public and stakeholder interest in this mechanistic approach to effective prioritization of potential restoration sites and evaluation of alternative strategies for site-specific restoration. Recognizing and addressing public and stakeholder issues and concerns early in the process will help to ensure implementability of restoration recommendations.

The timing of this project depends on the seasonality of flows and seed release. Approval of funding during the CALFED funding cycle in May would allow the Project Team to mobilize in time for study site establishment in 1999, rather than having to wait a full year if funding is not approved until the fall 1999 cycle. Early funding is also important for maximizing the cost efficiencies possible if the Project Team can couple some of the proposed field work with its vegetation mapping and geomorphic assessment field work already scheduled for summer 1999 and funded under the Merced River Corridor Restoration Plan (Phase II, which was funded in 1998 by CALFED). The proposed project is specifically designed to be coordinated with ongoing and planned restoration activities in the Merced River corridor and other efforts underway on the Tuolumne River. Coordination with local landowners will be facilitated by the existing Merced River Stakeholder Group and the Merced River and Tuolumne River TACs, which will help the Project Team streamline the process of obtaining permission from local landowners for access to potential study sites during the 1999 field season.

No CEQA/NEPA or other environmental compliance documents are required for the completion of Phase III of this project. All permits would be acquired and NEPA/CEQA processes would be completed during restoration project implementation. Project implementation is not included in this proposal.

Monitoring and Data Collection Methodology

Biological/Ecological Objectives

The primary biological/ecological objective is to develop and test a mechanistic 'recruitment box' model of riparian plant establishment that will be calibrated specifically to the San Joaquin Basin. The model considers plant physiological processes and basic hydrological conditions necessary for seedling germination and establishment; the 'recruitment box' represents the window of optimal conditions in space (bank elevation with respect to river stage) and time (period of seed release and viability) (Figure 2). After cottonwoods and willows germinate, their roots grow to maintain contact with the water table, which recedes after spring floods. Zones of successful establishment are constrained on their upper edge by a too-rapidly declining water table, and on the lower edge by scour and inundation. Numerous laboratory and field studies document seedling survival thresholds under various rates of daily water table declines (Table 1). The recruitment box model integrates these thresholds with a detailed analysis of a site's hydrology to predict zones of potential germination given a specific flow regime (Figures 2 and 3). If the water table recedes too quickly, seedlings do not establish. These zones also must occur during the period of seed release and viability to promote successful germination and establishment. Seed release timing is measured in the field, and is integrated into the predictions of successful seedling establishment. The recruitment box model has been tested and validated on alluvial rivers with similar riparian species in the Great Plains (Rood and Mahoney, submitted), southwest (Shafroth et al. 1998), and the east slope of California's Sierra Nevada (Gourley et al. 1997). This will be the first test of this approach in the Central Valley.

Monitoring Parameters and Data Collection Approaches

Testing the 'recruitment box' conceptual framework requires the following: observing seed release timing (Figures 3 and 4), constructing a topographic and hydrologic model of river stage decline at each study site, predicting seedling establishment zones at specific flow regimes, and documenting where seedlings actually establish after spring floodwaters recede. The Project Team will sample and evaluate additional data on factors affecting seedling recruitment and survival that are not integrated into the model. Sampling protocols are described in Table 2.

The Project Team will conduct all data collection, evaluation, and management in accordance with CALFED's Comprehensive Monitoring, Assessment and Research Program (CMARP). In addition, the Project Team will coordinate sampling designs and data collection with the Cosumnes Science Consortium, to test the 'recruitment box' model using data from its Cosumnes River study sites. This validation effort on an undammed river system will enable the Project Team to analyze how the effects of river regulation affect seedling establishment and survival processes.

Data Evaluation Approach

After conducting the various analyses listed in Table 2, the Project Team will use the model to compare cottonwood and willow regeneration between riparian sites under specific flow regimes, and conversely predict the flow scenarios that are necessary to maximize regeneration at specific sites. Sampling protocols used will be designed to maximize statistical power, and, to provide a true test of the model, the model validation will use data sequestered from the original calibration efforts.

Quality Assurance and Control: Field data will be manually recorded, copied, and stored in a secure location. All field data will be entered into a database or similar electronic format, checked by independent reviewer, corrected, and re-checked by other independent reviewers. This process will continue until no errors are identified by the reviewer. The master database files will be archived, and staff will perform all queries and data analyses on copy files. Task metadata (type, source, notes) and all reviews and verifications will be recorded. Stillwater Sciences will retain this information and electronic and hard copies of the field data and notes for a period of three years upon project completion.

Local Involvement

Letters notifying the Merced and Tuolumne County Planning Departments and Boards of Supervisors about this proposed project are attached.

The Project Team will collaborate with the Tuolumne River Technical Advisory Committee, which includes representatives from USFWS, CDFG, Tuolumne and Modesto Irrigation Districts, NRCS, Tuolumne River Preservation Trust, Friends of the Tuolumne, and the City and County of San Francisco, as well as the Merced River Technical Advisory Committee and local landowners. All phases of this project will be coordinated with the ongoing Merced River Corridor Restoration Plan project, jointly conducted by Stillwater Sciences and Merced County, and partially funded in 1998 by CALFED and the U.S. Fish and Wildlife Service's Anadromous Fisheries Restoration Plan (AFRP). The Phase II model validation effort will also be coordinated with the Cosumnes Science Consortium's ongoing riparian research on the Cosumnes River.

The Project Team has met with the U.S. Fish and Wildlife Service's Anadromous Fisheries Restoration Program (AFRP), which has expressed interest in the proposed project as a tool for prioritizing and evaluating the potential of riparian sites for restoration. Currently the AFRP is considering acquisition of properties for restoration of riparian and shaded instream habitat. Stillwater Sciences will apply to the ARFP to fund Phase I of this proposal.

During Phases I and II of the project, the Project Team will coordinate with the Tuolumne River Technical Advisory Committee through its Science Subcommittee meetings. The subcommittee has been contacted and has agreed to review study plans and informally advise the Project Team on site selection, study design, and data collection issues. We plan to request the same advisory role of the Merced River Technical Advisory Committee as it develops. Local landowners will be contacted from county title records to request permission for site access. This communication will be coordinated as a component of the public coordination process already underway for the CALFED-funded Merced River restoration planning project, which Stillwater and Merced County are jointly leading.

The Project Team has contacted the Cosumnes Science Consortium to coordinate study design, data collection, and analysis on its Cosumnes River riparian research. Ongoing coordination will occur through data exchange and mutual study plan review, informal meetings, and field visits.

The Project Team will collaborate the Tuolumne River Technical Advisory Committee, as well as the Merced River Technical Advisory Committee, the U.S. Fish and Wildlife Service's Anadromous Fisheries Restoration Program (AFRP), landowners, and other interested parties to ensure that all potential third-party impacts are identified and avoided.

Cost

BUDGET: The estimated total cost of Phases I and II of the project is $223,666. The project budget is provided in Table 3. The quarterly budget is provided in Table 4.

Stillwater Sciences' overhead costs include costs associated with general office requirements (e.g., rent; computer hardware, software, and usage; corporate insurance; field and laboratory equipment; utilities, furniture, and supplies) as well as unbillable labor of support staff. We compute our direct costs and overhead based on our hourly billing rates as follows: direct salary, 33%; benefits, 7%; overhead, 60%.

SCHEDULE: The project schedule indicating milestones and anticipated start and completion dates is shown in Figure 5. Anticipated time to complete Phases I and II is 26 months.

Payment shall be in arrears on a monthly basis. Stillwater Sciences will invoice on a monthly basis, according to percentage of work completed by task.

Cost-Sharing

Stillwater Sciences has applied to the U.S. Fish and Wildlife Service's Anadromous Fisheries Restoration Plan (AFRP) to fund Phase I of the project.

Significant cost-sharing is incorporated into this proposal because it builds directly upon past and ongoing projects conducted by Project Team members on the Tuolumne and Merced rivers, including the Merced River Corridor Restoration Plan, portions of which were funded by CALFED and AFRP in 1998. For example, this proposal will build on, and complement, the riparian vegetation GIS mapping (for 55 miles of the Merced River corridor) and field assessment of geomorphic factors and riparian vegetation composition and stand viability that are currently funded ($58,000) and scheduled for 1999 as part of the Merced River Corridor Restoration Plan project.

Applicant Qualifications

PROJECT TEAM STRUCTURE: The Project Team consists of Stillwater Sciences and a Scientific Advisory Team. Stillwater Sciences will develop and test the riparian model, while the Scientific Advisory Team will provide technical input on model design, data analysis, and testing. Stillwater Sciences will be the CALFED contractee and project manager and will be responsible for payments, reporting, and accounting.

The project management team will be Bruce Orr, John Stella, and Jennifer Vick of Stillwater Sciences. They will be supported by Stillwater's technical staff, all of whom have extensive experience in the San Joaquin Basin. Projects completed or underway by team members include a ten-year analysis of chinook salmon population dynamics and factors limiting production in the Tuolumne River; assessment of geomorphic conditions in the Merced River; and monitoring and evaluation of implemented restoration projects on the Tuolumne, Stanislaus, and Merced rivers.

STILLWATER SCIENCES: Stillwater Sciences is a firm of biological, ecological, and geological scientists. The company specializes in developing new scientific approaches and technologies for problem-solving in aquatic, riparian, and terrestrial systems and has extensive in-house expertise in GIS applications to environmental analyses. Its members have extensive experience in freshwater ecology, fisheries and wildlife biology, riparian and wetland ecology, entomology, botany, and hillslope and fluvial geomorphology. Recent projects include impact assessment and restoration of rivers affected by hydroelectric dams, timber harvest, and irrigation in California and the Pacific Northwest. (Descriptions of representative projects are provided in Appendix B, and resumes of team leaders and staff are provided in Appendix C.)

Bruce Orr, Senior Ecologist and Project Director: Dr. Orr has 20 years of experience in aquatic and terrestrial ecology of California and the western U.S. Dr. Orr has been involved in a variety of studies on the lower Tuolumne River that investigate the impacts of summer flows on the abundance and diversity of aquatic invertebrates and fish. Dr. Orr has managed many complex interdisciplinary projects involving ecological research and natural resource management planning.

John Stella, Riparian Ecologist and Project Manager: Mr. Stella has managed stream restoration projects for several northern California agencies. Mr. Stella has an extensive understanding of riparian plant physiology and community ecology, and the geomorphologic, hydrologic, and nutrient dynamic processes that occur in riparian zones. His areas of technical expertise include vegetation community classification and mapping; plant taxonomy; physiological and community ecology; and stream channel analysis and restoration. He is currently the deputy project manager for the Merced River Corridor Restoration Plan, funded by AFRP and CALFED.

Jennifer Vick, Ecologist/Geomorphologist and Deputy Project Manager: Ms. Vick has conducted geomorphic and hydrologic analyses on the Merced, Tuolumne, and Stanislaus rivers. He completed an extensive analysis of geomorphic trends in the Merced River, including assessment of the hydrologic and geomorphic impacts of dams and instream and floodplain mining. This work involved extensive coordination with state and local agencies, Merced Irrigation District, and local landowners. Ms. Vick is also experienced in project planning and management and has worked on restoration plans for several California streams and rivers. She is currently project manager for the Merced River Corridor Restoration Plan.

Yantao Cui, Civil Engineer: Dr. Cui has extensive experience in modeling sediment dynamics in regulated rivers. His applied research projects have involved investigation of river bank erosion, effects of gravel extraction on fluvial geomorphic processes, and the downstream impacts of reservoir management.

Frank Ligon, Senior Aquatic Ecologist/Geomorphologist: Mr. Ligon specializes in investigations of the role of fluvial processes and morphology in the ecology of stream fish, invertebrates, and plant

communities.

Peter Baker, Mathematical Biologist: Dr. Baker applies mathematics and statistics to aquatic ecology, particularly with the chinook salmon populations of Central California.

Douglas Allen, Geographic Information Systems Specialist and Geomorphologist: Mr. Allen specializes in hillslope and fluvial geomorphology, digital terrain modeling, remote sensing, and GIS. Mr. Allen is currently working with Dr. William Dietrich and Stillwater Sciences as a GIS specialist and geomorphologist to develop state-of-the-art techniques for watershed analysis.

Rafael Real de Asua, Geographic Information Systems Specialist and Image Processing Analyst: Mr. Real de Asua leads Stillwater's GIS team, using the ESRI ARC/INFO, ArcView, ERDAS, and Intergraph/Microstation software systems. Mr. Real de Asua designs and codes programs to automate GIS processes on the ARC/INFO platform for projects involving land use impacts, forest health, fisheries, and groundwater pollution.

Scientific Advisory Team

The Scientific Advisory Team consists of internationally recognized experts in the fields of riparian ecology, plant physiology, hydrology, geomorphology, aquatic ecology, and statistics. Scientific advisors have conducted riparian research projects similar to this proposal on the Truckee River and Dry Creek, CA, the Snake River, ID, and the Oldman and St. Mary's Rivers, Alberta. (CVs for the Scientific Advisory Team are provided in Appendix D.)

Stewart Rood, Plant Physiologist: Professor Stewart Rood of the University of Lethbridge, Alberta, investigates riparian processes with interests in hydrology, fluvial geomorphology, and especially plant ecophysiology. His work has sought to define the environmental conditions essential for the recruitment and survival of riparian plants, and has focused on the impacts of damming and flow regulation on riparian cottonwoods and willows. Dr. Rood supervises an active research group that collaborates with agencies including the US Army Corps of Engineers, US Geological Survey, US Fish and Wildlife Service, and Alberta Environmental Protection; private industries such as Idaho Power Corp.; and numerous private consultants and conservation groups such as The Nature Conservancy.

John Mahoney, Riparian Ecologist: Dr. Mahoney of Alberta Environmental Protection developed the hydrological recruitment model for riparian cottonwoods used in the current proposal. The model was accepted by Alberta Environmental Protection in 1994 to guide operations of the Oldman River Dam Project in southwestern Alberta, Canada, and has been used on a real-time basis under the direction of Dr. Mahoney ever since. Currently Dr. Mahoney is using the model to incorporate riparian plant requirements into instream flow determinations on several rivers, which has led to the refinement of operating rule curves at other water management facilities in southern Alberta.

Joe McBride, Community Ecologist: Dr. McBride is a Professor in the Forest Science Division, Department of Environmental Science, Policy, and Management, at the University of California, Berkeley. He investigates the influence of land use on patterns of forest succession, particularly the influence of stream flow regulation on riparian woodland succession. He has also conducted research on ecophysiological tolerances of woody riparian species.

William Dietrich, Fluvial Geomorphologist: Dr. Dietrich is a Professor in the Department of Geology and Geophysics at the University of California, Berkeley. His research group develops models linking hillslope and fluvial geomorphic processes to aquatic and riparian habitat characteristics. Dr. Dietrich is particularly interested in applying geomorphic research to land use problems involving dams, mines, and timber harvesting.

Mary Power, Aquatic Ecologist: Dr. Power is a Professor in the Department of Integrative Biology, University of California, Berkeley. Her research includes nutrient and energy cycling in aquatic systems and the effects of human disturbance on aquatic and riparian communities.

Terence Speed, Statistician: Dr. Speed is a Professor in the Department of Statistics at the University of California, Berkeley. His work involves statistical design and analysis of environmental data.

Compliance with Standard Terms and Conditions

The applicants have reviewed and are able to comply with the terms and conditions set forth in Attachment D and E of the Proposal Solicitation Package. Additional forms required for submittal with this proposal are provided in Appendix E.

I-015412

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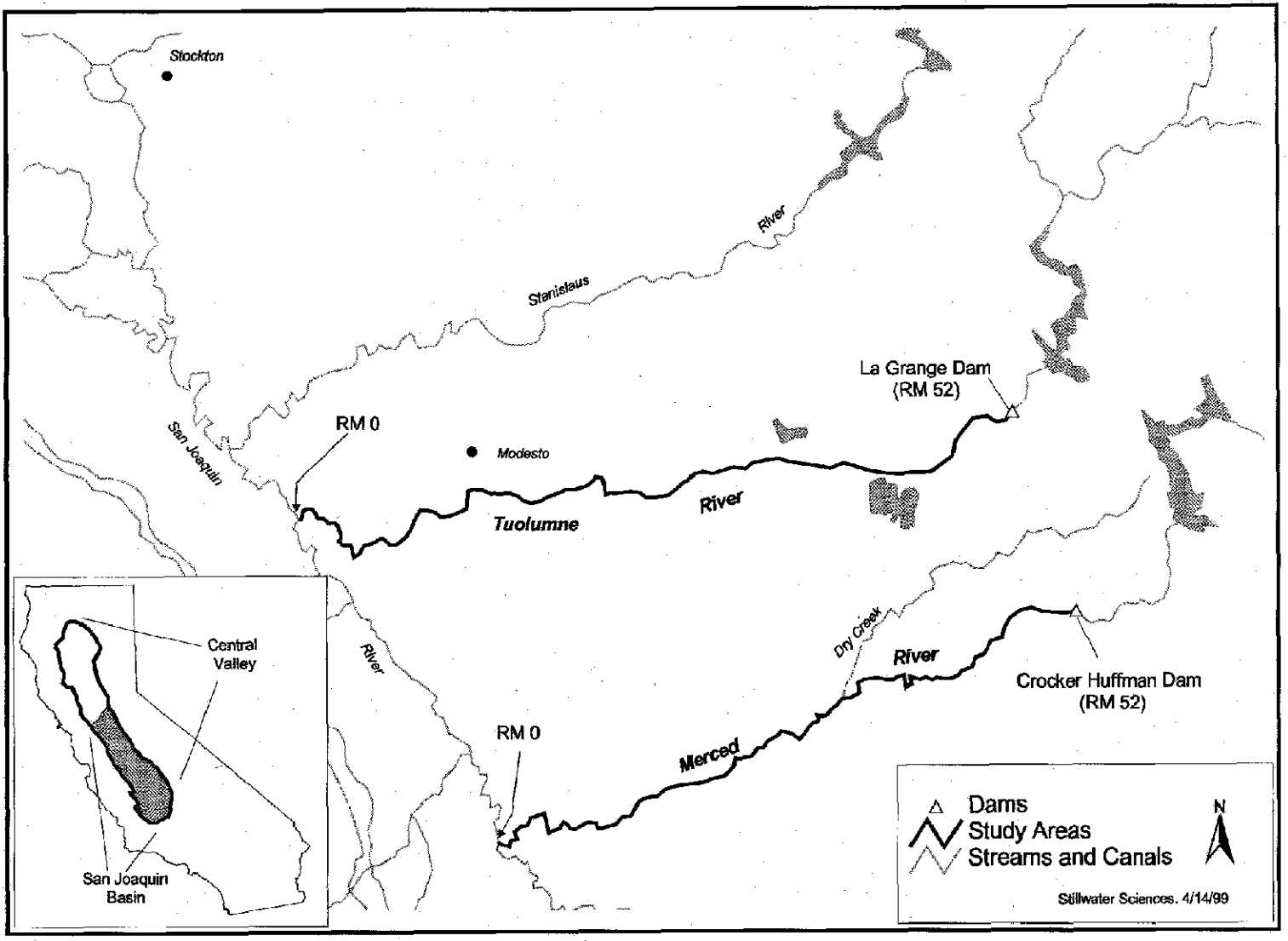

Figure 1. Study Area

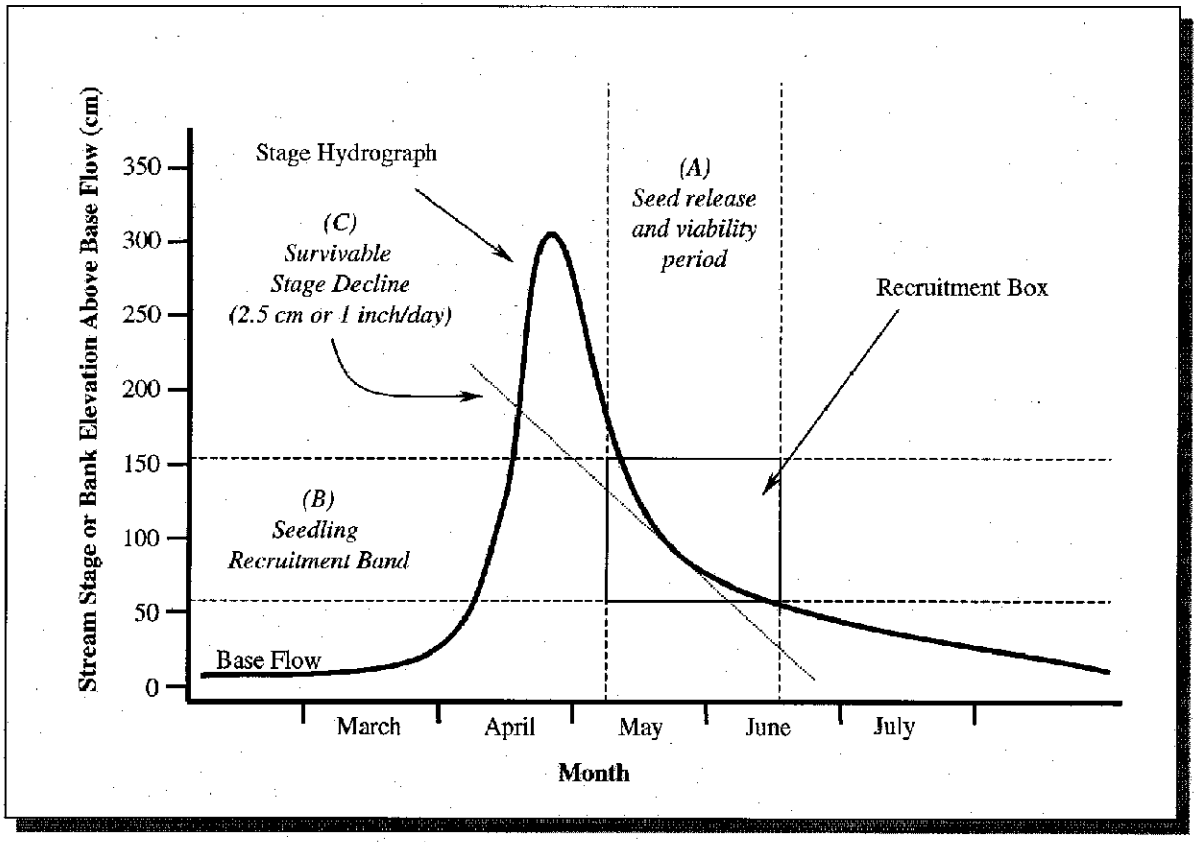

Figure 2. The 'Recruitment Box,' a zone defined in elevation and time in which seedlings of riparian plant species are likely to become successfully established based on stream flow conditions. The graph represents the relationship between the stream hydrograph and the timing of (A) the seed release and viability period for a particular riparian plant species; (B) the range of bank elevations (or stream stages) at which successful seedling recruitment is likely to occur for that species; and (C) the survivable rate of stream stage decline determined by the seedling's ability to maintain functional contact with the receding water table through root elongation.

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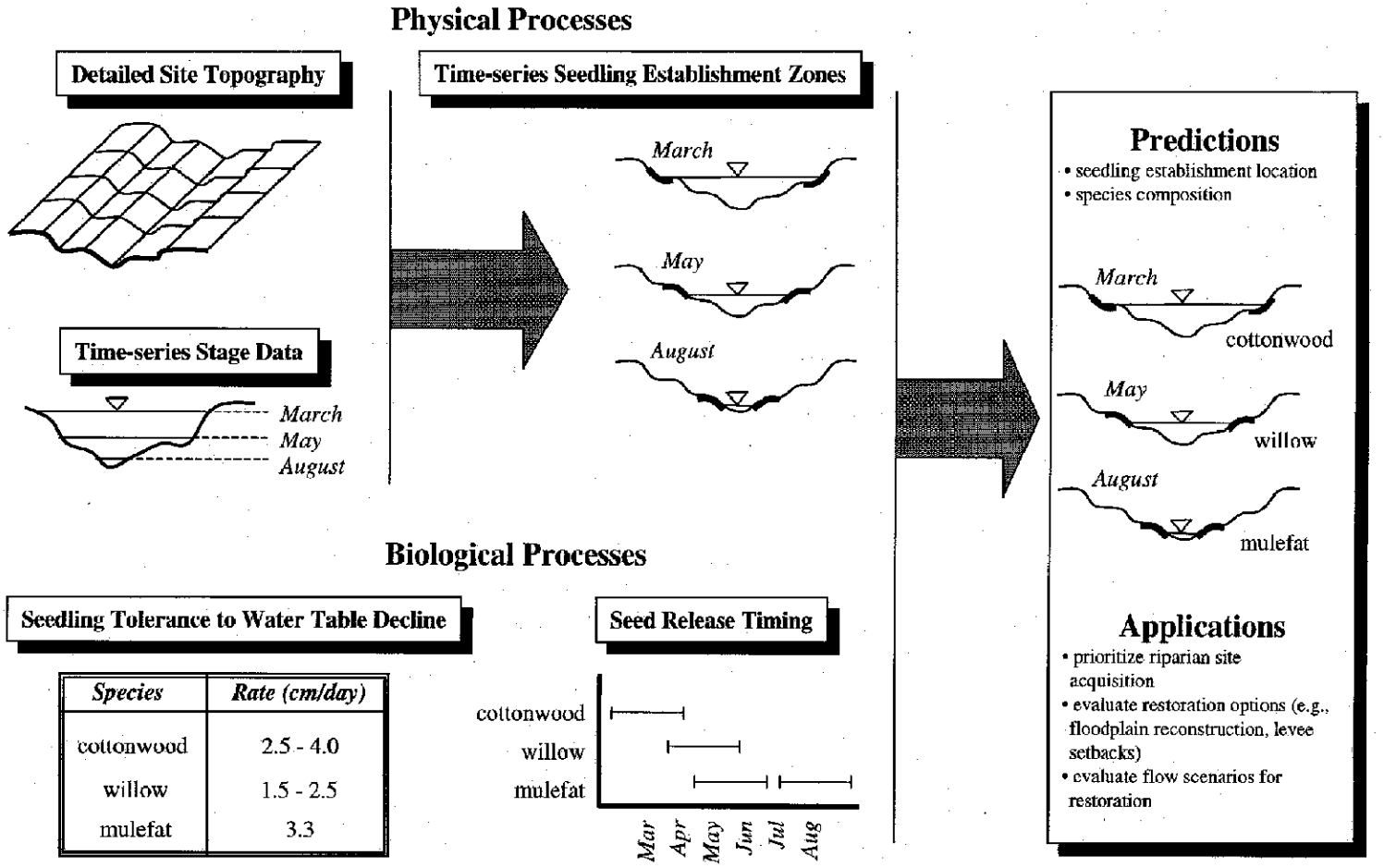

Figure 3. General conceptual framework for application of the recruitment box model.

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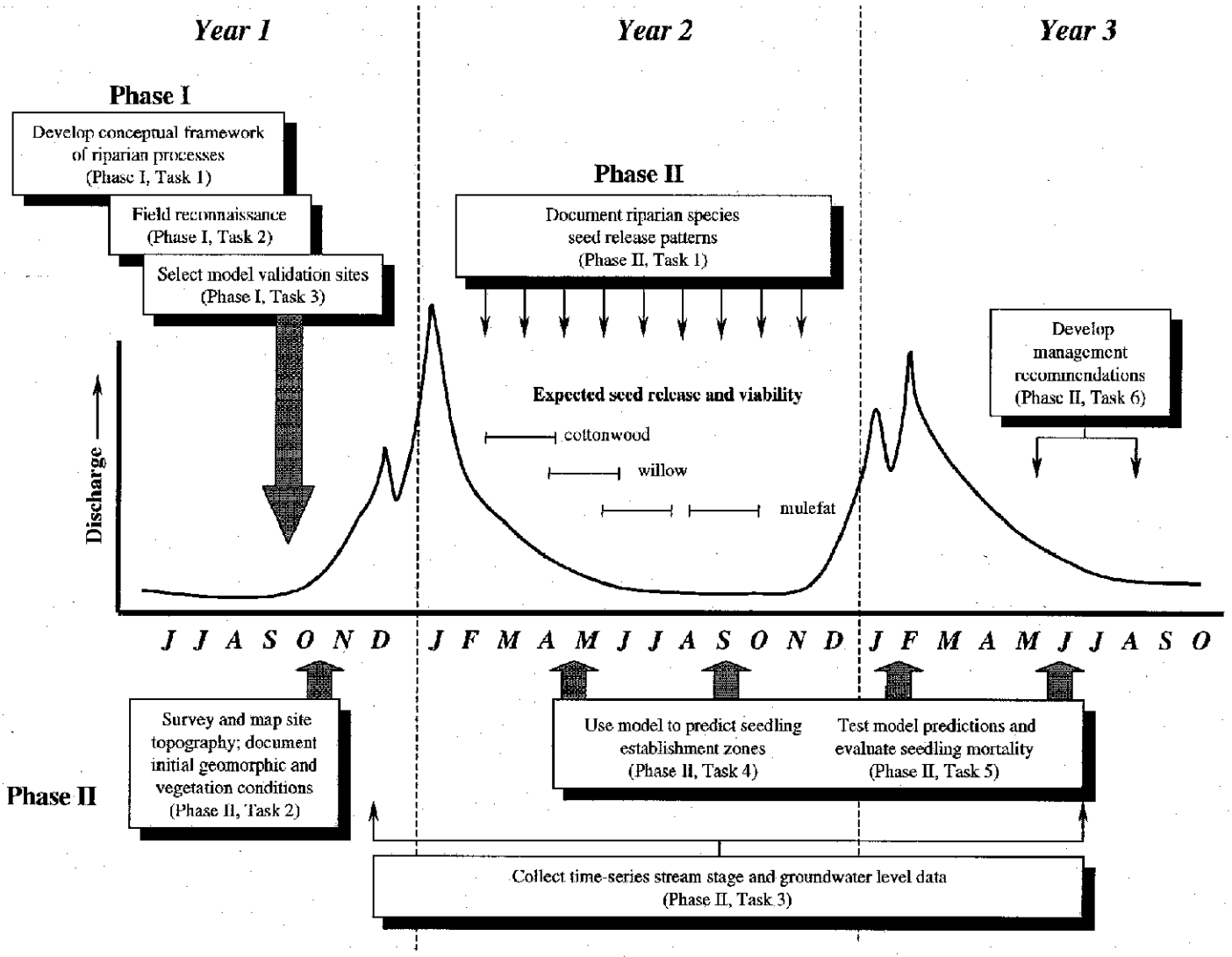

Figure 4. Timing of tasks relative to an idealized hydrograph and typical seed release periods.

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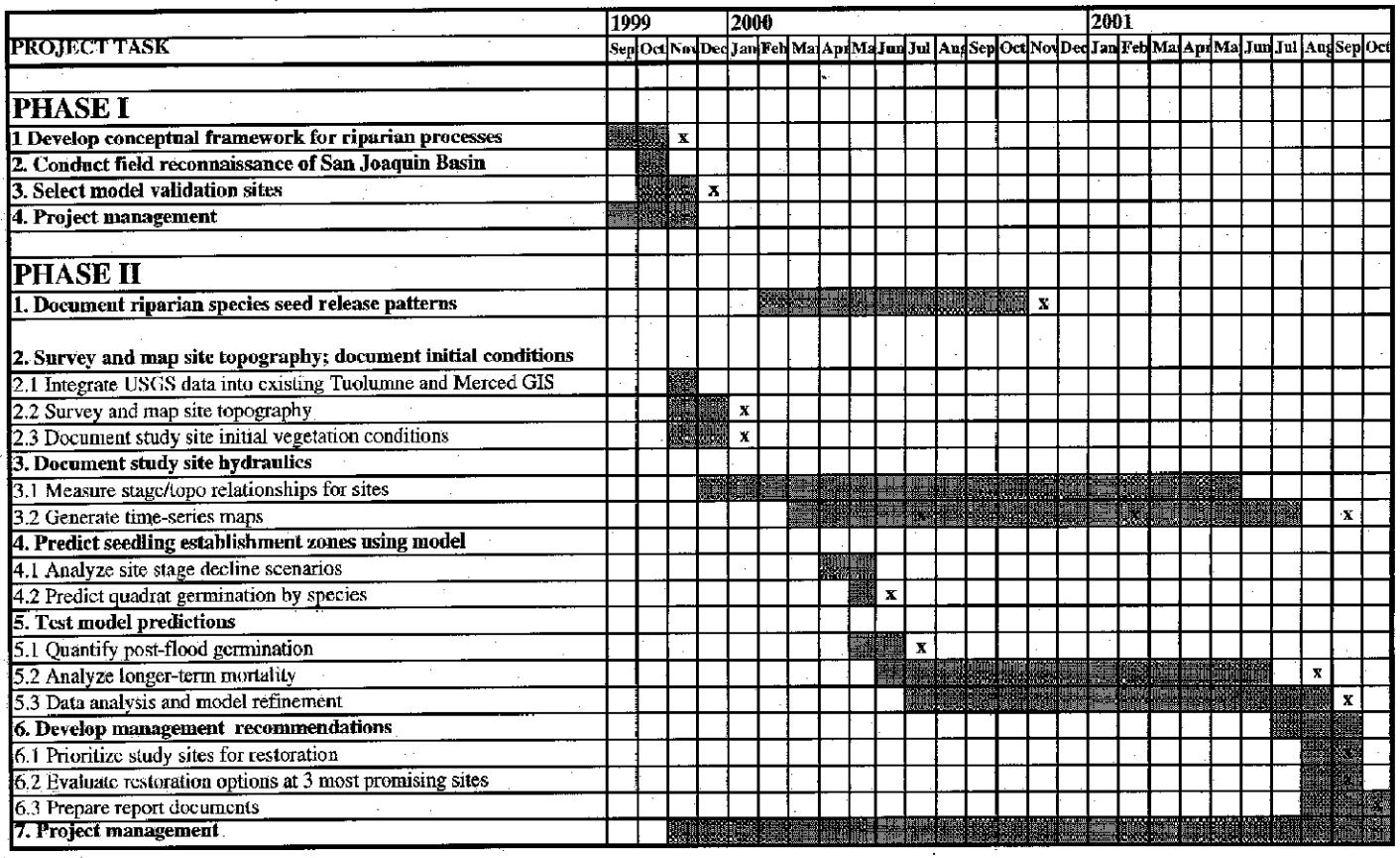

Figure 5. Project Schedule

Table 1. Maximum survivable water table declines during germination and establishment life stages for riparian plant species (from published and unpublished sources).

Species	Maximum Water Table Decline (cm/day)	Study Type	Source
Fremont cottonwood (*Populus fremontii*)	2.5 – 4	recommended ramping rate for successful recruitment	Amlin and Rood (unpublished data)
	2.5	field study, artificial	Mahoney and Rood 1998
	4.4	field study	Shafroth et al. 1998
	< 3	artificial	Segelquist et al. 1993
	<3 – 6	artificial	McBride et al. 1989
	2.5	field study	Gourley et al. 1997; U. S. Army Corps of Engineers 1995
willow (*Salix* spp.)	1.5 – 2.5	recommended ramping rate for successful recruitment	Amlin and Rood (unpublished data)
willow (*S. gooddingii*)	3.1	field study	Shafroth et al. 1998
willow spp. (*S. exigua* and *S. laevigata*)	<3 – 6	artificial	McBride et al. 1989
willow (*S. exigua*)	< 4	field study	Rood and Mahoney (unpublished)
willow (*S. exigua*)	2.5	field study	Gourley et al. 1997; U. S. Army Corps of Engineers 1995
mulefat (*Baccharis salicifolia*)	3.3	field study	Shafroth et al. 1998

Table 2. Methods and approach for Phase II study site evaluation.

HYPOTHESIS/ QUESTION	MONITORING PARAMETERS AND DATA COLLECTION APPROACH	DATA EVALUATION APPROACH	COMMENTS/ DATA PRIORITY
HYPOTHESIS: **Seedling recruitment is controlled by interactions between timing of seed dispersal, water table fluctuations, and scour that can be predicted with the use of a mechanistic model (Tasks 1–6 relate to the development and testing of the predictive model).**	***Task 1: Document riparian species seed release patterns.*** 1.1 Observe and document seed release timing (4–6 locations total at a geographic range of sites; biweekly sampling)	• Plot seed phenology for each species and compare variation within and among species.	A geographic range of sites is necessary to capture seed release timing variability due to microclimate, elevation, and latitude.
	Task 2: Survey and map site topography; document initial conditions. 2.1 Integrate USGS floodplain data into existing Tuolumne and Merced GIS • obtain existing USGS data • digital post-processing 2.2 Survey and map site topography (~5 sites/river) • establish 2–3 transects at each study site; monument transects (~20-30 transects total) • conduct total-station surveys study sites • digitize, map, and georeference study sites and transects • install ground wells to measure water table (1–3 per site) • install recording staff gauges • obtain and analyze soil bores 2.3 Document study site initial vegetation conditions (2–3 transects per site, many contiguous 1-meter quadrats/transects). For each quadrat: • document elevation (from surveys) • quantify/classify substrate surface • document percent cover, by species • count last year's seedlings (cottonwood and willow only) • input data, QA/QC data	• Map and georeference data to existing GIS. • Correlate subsurface water table with river stage. • Evaluate substrate permeability. • Summarize data trends: last year seedling abundance with quadrat parameters.	See Figure 3. Detailed hydrologic, topographic, and *seedling recruitment* data will be used to validate the recruitment box model.

HYPOTHESIS/ QUESTION	MONITORING PARAMETERS AND DATA COLLECTION APPROACH	DATA EVALUATION APPROACH	COMMENTS/ DATA PRIORITY
HYPOTHESIS: **Seedling recruitment is controlled by interactions between timing of seed dispersal, water table fluctuations, and scour that can be predicted with the use of a mechanistic model (Tasks 1–6 relate to the development and testing of the predictive model).**	***Task 3: Document study site hydraulics.*** 3.1 Measure stage/topographic relationships at sites • import staff gauge data	• Generate time-series stage maps for each study site.	
	Task 4: Predict and model seedling establishment success. 4.1 Analyze stage decline rates for zones within plant physiological tolerances • identify potential germination elevations on each transect • predict germination areas by species, biweekly (output = cross sections or maps) 4.2 Predict quadrat germination by species	• Map predicted seedling establishment zones as a coverage in study site GIS. • Predict quadrat seedling species composition.	See Table 1 and Figure 3.
	Task 5: Test model predictions. 5.1 Document post-flood study site conditions. For each quadrat: • recount last year's seedlings (cottonwood and willow) • count this year's seedlings (subsample if appropriate) • establish and sample longer-term mortality plots (quantify seedling abundance 2-3 times within 1.5-year) • data input, QA/QC data 5.2 Data analysis and model refinement	• Evaluate model's predictive power using summary statistics and/or appropriate test of significance. • Plot seedling survival over time, and key to major enviromental factors such as periods of drought and floods. • Test model's predictions for the Cosumnes River using study site data from the Cosumnes Science Consortium.	See Figure 4 for task flowchart.
	Task 6: Develop management recommendations. 6.1 Prioritize study sites for restoration • document predicted establishment; rank sites 6.2 Evaluate restoration options at three most promising sites • redigitize sites to simulate site reconstruction (e.g., floodplain regrading, levee setbacks) • quantify restoration simulation effects on seedling recruitment 6.3 Evaluate selected flow scenarios on all sites • simulate stage/topography relationships for each scenario • quantify flow simulation effects on seedling recruitment	• Quantify predicted area of regeneration for each species and compare among sites. • Quantify and compare predicted area of regeneration at a site under various managment scenarios. • Prepare synthesis report.	

Table 3. Project Budget

PROJECT TASK	DIRECT LABOR HOURS	DIRECT SALARY & BENEFITS	OVERHEAD LABOR	SERVICE CONTRACTS	MATERIALS & ACQUISITION	MISC & OTHER DIRECT COSTS	TOTAL COST
PHASE I							
1 Develop conceptual framework for riparian processes	*124*	$3,938	$5,756	$2,100	0	0	$11,794
2. Conduct field reconnaissance of San Joaquin Basin	*208*	$6,283	$9,183	$3,900	0	$4,222	$23,589
3. Select model validation sites	*56*	$1,739	$2,542	0	0	$240	$4,521
4. Project management	*50*	$1,621	$2,369	0	0	0	$3,990
TOTAL PHASE I							$43,894
PHASE II							
1. Document riparian species seed release patterns	*196*	$5,055	$7,387	0	0	$1,519	$13,961
2. Survey and map site topography; document initial conditions							
2.1 Integrate USGS data into existing Tuolumne and Merced GIS	*24*	$750	$1,096	0	0	0	$1,845
2.2 Survey and map site topography	*468*	$13,130	$19,190	0	$16,000	$5,569	$53,888
2.3 Document study site initial vegetation conditions	*288*	$8,059	$11,778	0	0	0	$19,836
3. Document study site hydraulics							
3.1 Measure stage/topo relationships for sites	*0*	0	0	0	0	0	0
3.2 Generate time-series maps	*168*	$5,217	$7,624	0	0	0	$12,841
4. Predict seedling establishment zones using model							
4.1 Analyze site stage decline scenarios	*32*	$1,048	$1,532	0	0	0	$2,580
4.2 Predict quadrat germination by species	*16*	$446	$652	0	0	0	$1,098
5. Test model predictions							
5.1 Quantify post flood germination	*160*	$4,797	$7,011	0	0	$810	$12,619
5.2 Analyze longer-term mortality	*320*	$9,255	$13,526	0	0	$1,620	$24,402
5.3 Data input; QA/QC	*20*	$507	$742	0	0	0	$1,249
5.4 Data analysis and model refinement	*32*	$981	$1,434	0	0	0	$2,415
5.5 Technical memo	*60*	$1,855	$2,711	0	0	0	$4,566
6. Develop management recommendations							
6.1 Prioritize study sites for restoration	*24*	$747	$1,092	0	0	0	$1,839
6.2 Evaluate restoration options at 3 most promising sites	*72*	$2,086	$3,048	0	0	0	$5,134
6.3 Prepare report documents	*186*	$5,256	$7,682	0	0	0	$12,938
7. Project management	*107*	$3,478	$5,083	0	0	0	$8,561
TOTAL PHASE II							$179,772
PROJECT TOTAL	*2611*	*$76,250*	*$111,438*	*$6,000*	*$16,000*	*$13,979*	$223,666

Table 4. Quarterly Budget

PROJECT TASK	1999		2000				2001				TOTAL
	July - Sept	Oct - Dec	Jan - Mar	April - June	July - Sept	Oct - Dec	Jan - Mar	April - June	July - Sept	Oct - Dec	
PHASE I											
1 Develop conceptual framework for riparian processes	$5,897	$5,897									**$11,794**
2. Conduct field reconnaissance of San Joaquin Basin		$11,794	$11,794								**$23,589**
3. Select model validation sites		$2,261	$2,261								**$4,521**
4. Project management	$1,330	$1,330	$1,330								**$3,990**
PHASE II											
1. Document riparian species seed release patterns			$3,490	$3,490	$3,490	$3,490					**$13,961**
2. Survey and map site topography; document initial conditions		$25,190	$25,190	$25,190							**$75,570**
3. Document study site hydraulics			$2,140	$2,140	$2,140	$2,140	$2,140	$2,140			**$12,841**
4. Predict seedling establishment zones using model				$3,678							**$3,678**
5. Test model predictions				$9,050	$9,050	$9,050	$9,050	$9,050			**$45,250**
6. Develop management recommendations									$9,956	$9,956	**$19,911**
7. Project management		$951	$951	$951	$951	$951	$951	$951	$951	$951	**$8,561**
TOTAL	**$7,227**	**$47,423**	**$47,157**	**$44,500**	**$15,632**	**$15,632**	**$12,141**	**$12,141**	**$10,907**	**$10,907**	**$223,666**

I-015424

Stillwater Ecosystem, Watershed & Riverine Sciences
2532 Durant Avenue Suite 201
Berkeley, CA 94704
Phone (510) 848-8098 Fax (510) 848-8398

April 12, 1999

Robert E. Smith
Director
Merced County Planning and
Community Development Department
2222 M Street
Merced, California 95340

Dear Mr. Smith:

This letter is to inform you that Stillwater Sciences is submitting a proposal this month for the 1999 CALFED funding cycle to develop a quantitative, predictive model for riparian forest restoration in the San Joaquin Basin that will allow local, state and federal agencies to evaluate and prioritize restoration sites and strategies. As you know, the riparian forests in the Central Valley have declined for many years as a result of land use and water regulation, and are impaired in their ability to provide habitat for fish and wildlife and benefit humans. In a phased project, we propose to develop a conceptual model of how physical factors such as floodplain topography and river flow affect the establishment of riparian plants. We will test this model at study sites on the Merced and Tuolumne rivers. The project will be coordinated with the on-going Merced River Corridor Restoration Plan to maximize both projects' efficiency and benefit the development and implementation of the restoration plan. This proposal is being informally coordinated with the AFRP, the California Department of Fish and Game, the Turlock and Modesto Irrigation Districts, and the Tuolumne River Technical Advisory Committee. It is our intention to also coordinate with the Merced River Technical Advisory Committee as it develops. We will not require any additional work from County staff to implement the project.

Please feel free to contact me at (510) 848-8098 to discuss this further. Thank you very much.

Sincerely,

John Stella
Riparian Ecologist

cc: Supervisor Deidre Kelsey, Merced County Board of Supervisors
Desmond Johnston, Merced County Planning and Community Development Department

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Stillwater Ecosystem, Watershed & Riverine Sciences
2532 Durant Avenue Suite 201
Berkeley, CA 94704
Phone (510) 848-8098 Fax (510) 848-8398

April 14, 1999

Supervisor Deidre Kelsey
Merced County Board of Supervisors
2222 M Street
Merced, California 95340

Dear Supervisor Kelsey:

This letter is to inform you that Stillwater Sciences is submitting a proposal this month for the 1999 CALFED funding cycle to develop a quantitative, predictive model for riparian forest restoration in the San Joaquin Basin that will allow local, state and federal agencies to evaluate and prioritize restoration sites and strategies. As you know, the riparian forests in the Central Valley have declined for many years as a result of land use and water regulation, and are impaired in their ability to provide habitat for fish and wildlife and benefit humans. In a phased project, we propose to develop a conceptual model of how physical factors such as floodplain topography and river flow affect the establishment of riparian plants. We will test this model at study sites on the Merced and Tuolumne rivers. The project will be coordinated with the on-going Merced River Corridor Restoration Plan to maximize both projects' efficiency and benefit the development and implementation of the restoration plan. This proposal is being informally coordinated with the AFRP, the California Department of Fish and Game, the Turlock and Modesto Irrigation Districts, and the Tuolumne River Technical Advisory Committee. It is our intention to also coordinate with the Merced River Technical Advisory Committee as it develops. We will not require any additional work from County staff to implement the project.

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Sincerely,

John Stella
Riparian Ecologist

cc: Desmond Johnston, Merced County Planning and Community Development Department

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I-015426

Stillwater Ecosystem, Watershed & Riverine Sciences
2532 Durant Avenue Suite 201
Berkeley, CA 94704
Phone (510) 848-8098 Fax (510) 848-8398

April 15, 1999

Mr. Reagan M. Wilson
Clerk of the Stanislaus County Board of Supervisors
1100 H. Street
Modesto, California 95354

Dear Mr. Wilson:

Stillwater Sciences is a small firm specializing in watershed and river corridor assessment, restoration and management. Our staff has been working in the San Joaquin Basin on the Tuolumne and Merced Rivers for several years and has been instrumental in the completion of the restoration strategy for the Tuolumne River Corridor.

This letter is to inform you that Stillwater Sciences is submitting a proposal this month for the 1999 CALFED funding cycle to develop a quantitative, predictive model for riparian forest restoration in the San Joaquin Basin that will allow local, state and federal agencies to evaluate and prioritize restoration sites and strategies. As you know, the riparian forests in the Central Valley have declined for many years as a result of land use and water regulation, and are impaired in their ability to provide habitat for fish and wildlife and benefit humans. In a phased project, we propose to develop a conceptual model of how physical factors such as floodplain topography and river flow affect the establishment of riparian plants. We will test this model at study sites on the Merced and Tuolumne rivers. This proposal is being informally coordinated with the the Tuolumne River Technical Advisory Committee, the AFRP, the California Department of Fish and Game, and the Turlock and Modesto Irrigation Districts. We will not require any work from County staff to implement the project.

Please feel free to contact me at (510) 848-8098 to discuss this further. Thank you very much.

Sincerely,

John Stella
Riparian Ecologist

cc: Mr. Gordon Dewers, Department of Environmental Resources
Mr. Kirk Ford, Stanislaus County Planning and Community Development

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I-015427

Stillwater Ecosystem, Watershed & Riverine Sciences
2532 Durant Avenue Suite 201
Berkeley, CA 94704
Phone (510) 848-8098 Fax (510) 848-8398

April 15, 1999

Gordon Dewers, Director
Department of Environmental Resources, Stanislaus County
3800 Cornucopia Way, Suite C
Modesto, California 95358

Dear Mr. Dewers:

Stillwater Sciences is a small firm specializing in watershed and river corridor assessment, restoration and management. Our staff has been working in the San Joaquin Basin on the Tuolumne and Merced Rivers for several years and has been instrumental in the completion of the restoration strategy for the Tuolumne River Corridor.

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Please feel free to contact me at (510) 848-8098 to discuss this further. Thank you very much.

Sincerely,

John Stella
Riparian Ecologist

cc: Mr. Reagan M. Wilson, Clerk of the Stanislaus County Board of Supervisors
Mr. Kirk Ford, Stanislaus County Planning and Community Development

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I-015428

Stillwater Ecosystem, Watershed & Riverine Sciences
2532 Durant Avenue Suite 201
Berkeley, CA 94704
Phone (510) 848-8098 Fax (510) 848-8398

April 15, 1999

Kirk Ford
Environmental Coordinator
Stanislaus County Planning and Community Development
1100 H Street, 2nd Floor
Modesto, California 95354

Dear Mr. Ford:

Stillwater Sciences is a small firm specializing in watershed and river corridor assessment, restoration and management. Our staff has been working in the San Joaquin Basin on the Tuolumne and Merced Rivers for several years and has been instrumental in the completion of the restoration strategy for the Tuolumne River Corridor.

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Please feel free to contact me at (510) 848-8098 to discuss this further. Thank you very much.

Sincerely,

John Stella

John Stella
Riparian Ecologist

cc: Mr. Reagan M. Wilson, Clerk of the Stanislaus County Board of Supervisors
Mr. Gordon Dewers, Director, Department of Environmental Resources

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I-015429

APPENDIX A

I-015430

A Model for Assessing the Effects of Altered River Flows on the Recruitment of Riparian Cottonwoods

John M. Mahoney and Stewart B. Rood

Introduction

Riparian cottonwoods (poplars) have declined along many rivers in western North America (Johnson and Haight 1984; Rood and Mahoney 1990; Sands and Howe 1977). The effects of livestock grazing or clearing for agricultural use or domestic settlement have reduced cottonwood abundance directly. Other factors, such as alteration of the hydrological regime, have had an indirect effect on cottonwood abundance (Stromberg et al. 1991). The indirect factors can prevent cottonwood forest replenishment by affecting conditions that are essential for the recruitment of cottonwood seedlings (reviewed in: Rood and Mahoney 1990).

River valley cottonwoods are phreatophytic and obtain moisture from the riparian water table. This saturated zone extends more or less horizontally from the river and fluctuates with the river stage. Cottonwoods are adapted to natural variations in water table level caused by seasonal fluctuations in river flow.

Figure 1 presents a general hydrograph for a western foothills river showing five hydrological elements that are essential for cottonwood seedling establishment and initial survival. Elimination of any of these elements will result in the failure of seedling establishment. Minor changes to only one element may not have a deleterious effect on cottonwood seedlings, but if two or more elements are altered, the cumulative effect may become substantial.

This research was enabled by a research grant from Alberta Public Works Supply and services to S.B. Rood and J.M. Mahoney and supported by a NSERC Strategic Grant to S.B. Rood.

The 'Recruitment Box'

The following model considers the basic hydrological elements that are necessary for the establishment of riparian cottonwood seedlings. Attention is given to seedling recruitment because it is likely to be a particularly vulnerable component of the cottonwood forest cycle. The model does not consider the effects of precipitation, temperature, or other factors that can affect the the success of developing seedlings; nor does the model address the conditions necessary for the maintenance of established cottonwoods.

The hydrological conditions essential for cottonwood seedling success can be defined by river stage and time of year (Figure 2). The river stage identifies a zone along the river bank where cottonwood seedlings can survive. Seedlings that establish above an upper elevation limit will not be able to maintain adequate root growth to tap the deep

John Mahoney is a Research Assistant in Biology at the University of Lethbridge, investigating the effect of water management programs on downstream ecosystems in Southern Alberta. He is working on a doctorate jointly at the the University of Calgary and the University of Lethbridge. **Stewart Rood** is a Professor of Plant Physiology and Chair of theDepartment of Biological Sciences at the University of Lethbridge.

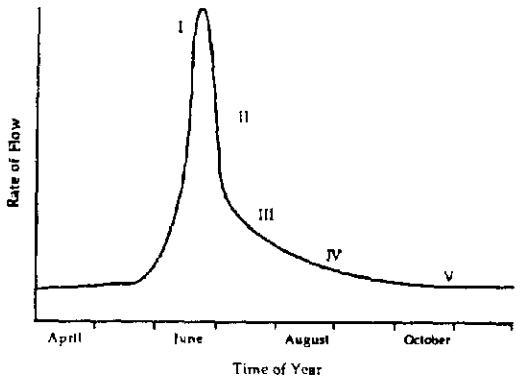

Figure 1. A generalized hydrograph for a river in the foothills of Alberta. The hydrological factors important for cottonwood seedling establishment are:

1. Peak flows to prepare germination sites,
2. Receding flows at time of seed release to expose new germination sites,
3. Gradually declining water table to limit seedling drought stress and prompte root growth,
4. Adequate summer flows to meet high water demands, and
5. Adequate autumn flow to improve plant water balance and over-winter survival

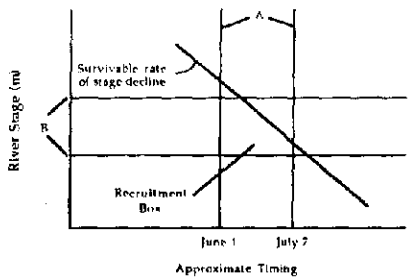

Figure 2. Model framework including the maximum survivable rate of water table decline for cottonwood seedlings in southern Alberta. The annual opportunity for successful seedling recruitment is limited to the 'Recruitment Box'. "A" indicates the period of seed release and viability. "B" indicates the approximate bank elevation for successful seedling establishment.

water table at the end of the growing season. These seedlings will suffer from drought stress and die. A lower bank elevation limit can also be identified for seedling survival. Seedlings that establish below this elevation are likely to be scoured away by ice or flooding, or may be covered with fresh sediment the following year. These upper and lower elevation limits result in the formation of characteristic bands of cottonwoods along river banks of the foothills and western prairies (Bradley and Smith 1986).

A critical period for cottonwood seedling establishment occurs annually. This seedling establishment period starts with the onset of seed release and continues through the period of seed release, typically a four to six week period. The seedling establishment period ends about one week after seed release is complete, when the small cottonwood seeds lose their viability. Inadequate moisture conditions during this period will result in the failure of seedling establishment for that year.

The limits set by upper and lower bank elevations and the availability of viable seeds define an annual opportunity for cottonwood seedling establishment. This opportunity is represented as the 'Recruitment Box' in Figures 2 through 4.

Water Table Decline

A third hydrological component that determines initial seedling survival is the rate of water table decline. The water table must drop gradually enough to allow cottonwood seedlings to maintain root contact with the receding water supply. Greenhouse experiments confirm field studies that indicate that drought stress and drought-induced mortality of seedlings accompanies abrupt rates of water table decline (Mahoney and Rood 1991). A water table decline of 4 cm per day has been found to be the maximum survivable by some cottonwood seedlings (Mahoney and Rood 1991). However, the survivable rate of water table decline varies with cottonwood species and is influenced by the texture of the riparian substrate (Mahoney and Rood 1992).

Figure 3 illustrates hydrological conditions that are potentially ideal for cottonwood seedling establishment. A peak flow precedes seed release to prepare new seed beds. Initial stage decline is fairly rapid, exposing large areas that are moist and barren. The stage decline in the latter part of the critical period is slow enough that roots of the new seedlings are able to maintain contact with the receding water table.

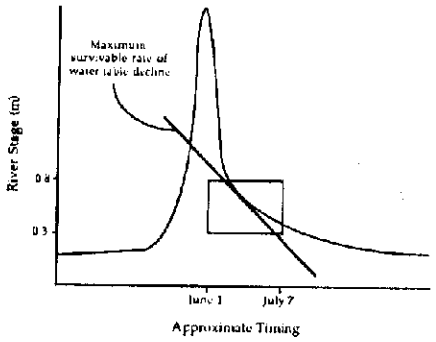

Figure 3. The relationship between a generalized hydrograph for southern Alberta and the 'Recruitment Box' including the survivable rate of water table decline for cottonwood seedlings.

Application of the Model

Seedling Recruitment

This model may explain why cottonwood establishment is not successful every year under natural conditions. Although the elements that define the Recruitment Box are relatively constant, hydrological patterns vary from year to year. If peak flows occur early in the season, flows may taper to low levels before seed release so that seedlings only germinate at low bank elevations. These seedlings are likely to be covered with sediment or scoured away the following spring. In years where peak flows are late, seeds germinating prior to peak flows will be washed away by higher flows that same year. Seedlings that establish following the peak flow will be at bank elevations too high for root growth to the late summer water table. These seedlings will suffer drought stress and die during the first summer. Field studies in southern Alberta indicate that although numerous cottonwood seeds germinate annually, very few survive the initial summer (Virginillo et al. 1991). The poor survival of

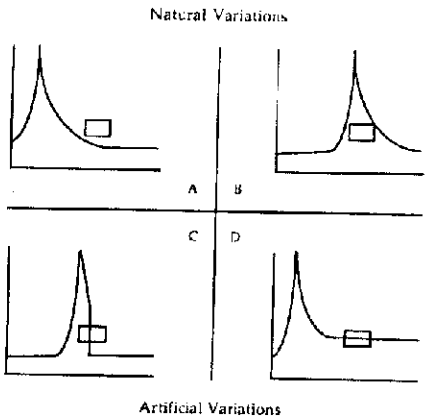

Figure 4. Variations in river flows and their relation to the 'Recruitment Box'.
A. Peak flow receding to minimum levels before the onset of seed release,
B. Peak flow receding to minimum levels after seed germinability has ended,
C. Abrupt reduction of river flows during the period of seed germinability,
D. Constant flow regulation during the period of seed germinability.

seedlings suggests that natural flow patterns are seldom suitable for cottonwood seedling survival in southern Alberta and that new trees may only establish at five or ten year intervals.

Artificial Flow Regimes

The effects of managed river flow patterns on cottonwood seedling establishment may also be predicted with this model. Figure 4c (not included in this paper) illustrates a situation where a dam is closed shortly after peak flow causing an abrupt decline in downstream flows (Rood and Heinze-Milne 1988). In this case the rate of water table decline is too great for the roots to maintain contact with the water supply. Seedlings that germinate under these conditions will suffer drought stress and die.

Constant flow conditions may not affect seedling survival during the first year and may be favorable to existing trees. However, the new seedlings would develop a shallow root system making the them vulnerable to subsequent scouring or flooding. A gradually declining water table is preferable as it encourages deep root development in new seedlings (Mahoney and Rood, 1991). Stabilized flows also permit encroachment of grasses and other vegetation to the river's edge, further limiting the formation of new barren zones essential for cottonwood seedling establishment.

The values applied to each parameter defining the Recruitment Box will vary with the reach of the river being investigated and the regional cottonwood phenology. For rivers in the foothills of southern Alberta, seed release normally occurs from late May to early July. The bank elevation for seedling establishment is about 0.3 m to 0.8 m above natural minimum summer flows with some variation likely between rivers. Experimentation in the greenhouse has shown that natural poplar hybrids can survive a maximal rate of water table decline of about 4 cm day-1 in a gravel/sand substrate typical of southern Alberta floodplains.

Conclusion

The preceding model provides a framework for assessing the effects of existing or proposed flow regimes on seedling recruitment of riparian cottonwoods. Recorded or projected flow patterns for a particular river reach can be evaluated for the critical period of seed release to determine whether river stages and rate of decline fall within the range necessary for seedling establishment. In managed river systems, identification of the hydrological elements that fail to meet these ranges may allow river managers to adjust flow patterns to improve the prospects for the replenishment of riparian cottonwood forests.

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Stromberg, J.C., D.T. Patten and B.D. Richter, 1991. Flood Flows and Dynamics of Sonoran Riparian Forests. Rivers, 2(3):221-235.

Virginillo, M., J.M. Mahoney and S.B. Rood, 1991. Establishment and Survival of Poplar Seedlings Along the Oldman River, Southern Alberta. In; Proceedings of the Biology and Management of Southern Alberta's Cottonwoods Conference. S.B. Rood & J.M. Mahoney (eds.). May 3,4, University of Lethbridge. pp: 55-62.

APPENDIX B

I-015437

Representative Projects

Merced River Corridor Restoration Plan
Client: Merced County Planning and Community Development Department

The sediment supply, hydrologic regime, and floodplain and channel morphology of the lower Merced River have been significantly altered by dams and in-channel and floodplain mining, resulting in loss and degradation of habitat for native species, particularly chinook salmon. Despite general recognition of the degraded condition of the Merced River, no long-term restoration strategy has been developed for the Merced River corridor. With funding from CALFED and the U.S. Fish and Wildlife Service Anadromous Fish Restoration Program, this project will develop a long-term, large-scale restoration and monitoring program that will identify and restore critical geomorphic and ecological processes for the Merced River from Crocker-Huffman Dam downstream to the confluence with the San Joaquin River. Such a strategy will ensure the continuing long-term effectiveness of site-specific restoration projects and provide long-term benefits to ecosystem processes, riverine habitats, and native species. The project is being implemented in two phases: (I) establishing a Merced River Stakeholder Group and Technical Advisory Committee (TAC), (II) analyzing and quantifying current in-channel, riparian, and floodplain conditions and processes. The third phase (not yet funded) will synthesize input from the Stakeholder Group and TAC (Phase I) and results of the geomorphic and ecological baseline evaluations (Phase II) to develop a Merced River corridor restoration and monitoring plan.

Salmon Habitat Enhancement and Watershed Planning on the Tuolumne River
Client: Turlock and Modesto Irrigation Districts

Stillwater Sciences staff designed and supervised a research program on the ecology of chinook salmon in the Tuolumne River below New Don Pedro Dam, and developed a cost-effective salmon enhancement program. The project has included modeling, field research, field testing of management strategies, and reviewing research conducted under the FERC licensing process. Stillwater Sciences' ongoing work includes developing an index of spawning gravel quality for chinook salmon based on *in situ* measurements of substrate permeability, systematically assessing fry and juvenile stranding occurring under recently revised flow requirements and ramping rates, and implementing a pilot-level experiment using innovative marking and analytical methods to quantify smolt survival during outmigration in specific reaches of the Tuolumne River and the relationship of survival to flow magnitude.

In addition, Stillwater Sciences has provided support to the Districts to ensure regulatory compliance with the National Environmental Policy Act and the California Environmental Quality Act for construction of large-scale restoration projects in the Tuolumne River and has developed strategies for the Districts to address the proposed listing of the Central valley fall/late fall-run chinook salmon ESU under the Endangered Species Act.

North Umpqua River Cooperative Watershed Analysis
Client: PacifiCorp

The North Umpqua Hydroelectric Project encompasses eight hydroelectric developments owned by PacifiCorp, which is seeking a new license from the Federal Energy Regulatory Commission to operate the project. Stillwater Sciences has conducted a watershed analysis using available and newly collected data to resolve scientific issues regarding aquatic and terrestrial ecosystems and the impacts of the hydroelectric project and other land use disturbances on these systems. Stillwater Sciences has led interagency scientific subgroups through a collaborative scientific process, and is participating in settlement negotiations involving policy-makers from state and federal agencies and environmental groups. The firm has developed management alternatives that provide for hydroelectric power generation while addressing natural resource concerns, including management strategies for four species of anadromous salmonids (coastal cutthroat trout, coho salmon, spring-run chinook salmon, and summer- and winter-run steelhead), three species of trout (rainbow, brown, and brook), selected amphibians (e.g., red-legged frog), and terrestrial wildlife.

An important component of the North Umpqua Cooperative Watershed Analysis has been the evaluation of management options to maintain and/or restore populations of native anadromous fish species. In particular, Stillwater Sciences has assessed the potential effects on anadromous fish species of providing fish passage at two project dams that currently block fish migrations in the North Umpqua River basin and has evaluated fish passage options in comparison to off-site mitigation strategies. This analysis has been based in part on the use of a reference model describing current and historical physical habitat conditions and carrying capacities for anadromous salmonids to estimate potential smolt production under different management scenarios. Management strategies for anadromous fish have also been evaluated in the context of the Endangered Species Act; the Umpqua coastal cutthroat trout is currently listed as endangered under the ESA.

The North Umpqua Cooperative Watershed Analysis project was explicitly designed to advance the science of watershed analysis. The Stillwater Sciences team includes many of the scientists who were involved in the development of the original Washington DNR watershed analysis methodology, including Kate Sullivan and Jeff Light of Weyerhaeuser Corporation, Dave Montgomery and John Buffington of the University of Washington, and William Dietrich and Mary Power of the University of California at Berkeley. The team has developed a more quantitative, more predictive, and semi-automated (using DTM and GIS) watershed assessment process and expanded the scope of watershed analysis to include the geomorphic and ecological effects of dams, waterways, and related hydroelectric facilities.

South Fork Eel River TMDL Support
Client: U.S. Environmental Protection Agency

The South Fork Eel River has been listed by EPA as an "impaired waterbody" because beneficial uses, including salmonid habitat, have been adversely affected by sediment and temperature. Stillwater Sciences, through Tetra Tech Inc. (the prime contractor) is using a regional watershed analysis approach to develop the technical information that will provide EPA with a basis for setting "Total Maximum Daily Load (TMDL) allocations for the 690 mi^2 river basin. The main elements of Stillwater's work include: 1)

I-015439

Developing Numeric Targets for Sediment. These are based on indicators of habitat quality for spawning, summer rearing and winter rearing. A channel classification system that utilizes a digital terrain model (DTM) will help identify the channel types and their main habitat constraints. 2) *Analysis of Sediment Sources.* This is based on a rapid sediment budget that utilizes a GIS/DTM to stratify the watershed, coupled with intensive field investigation of sediment sources in selected subbasins. 3) *Temperature Assessment and Modeling.* This is based on analysis of a temperature data set from about 75 recording thermographs, together with a heat loading model that makes use of DTM and LANDSAT imagery to calculate riparian and topographic shading, low-flow discharge and channel width. The model is field-calibrated and verified using measurements of canopy shading and measurements relating low-flow discharge to hydraulic geometry.

Integrated Riparian Management Study for Headwater Streams
Client: NCASI (National Council of the Paper Industry for Air and Stream Improvement, Inc.)

Regulatory approaches to the management of riparian areas in the western United States generally recognize that headwater streams provide different ecological functions and values than do larger fish-bearing streams. The regulation of timber harvesting activities in the vicinity of headwater streams, however, is often based on little more than guesswork. This project seeks to improve the scientific basis for headwater riparian area management to protect ecosystem functions and native species. The first phase of this project includes: (1) the development of a conceptual model of headwater stream and riparian ecosystems, focusing on the importance of these areas to amphibian and macroinvertebrate populations; (2) field surveys to test hypotheses about the influence of key habitat and landscape features on the distribution and abundance of amphibians (e.g., tailed frogs and torrent salamanders) and macroinvertebrates; and (3) manipulative experiments of instream habitat characteristics to provide more critical tests of key hypotheses about habitat requirements of headwater stream amphibians and invertebrates. Phase II of this project will explore the effects of forest management on the key habitat features identified during Phase I, including interactions at the watershed or landscape scale, to help in the development of integrated riparian management strategies.

Endangered Species Act Compliance
Client: Portland General Electric

Portland General Electric (PGE) operates several hydropower projects in western Oregon on the Deschutes, Sandy, Clackamas, and Willamette rivers. The projects are located within the ranges of several salmonid species which have been listed or are proposed for listing under the Endangered Species Act (ESA) or are currently undergoing status review. Protection of these species under the Endangered Species Act requires coordination between PGE and the National Marine Fisheries Service (NMFS) for current operations and future Federal Energy Regulatory Commission (FERC) relicensing. Stillwater Sciences is preparing biological assessments for the endangered salmonids that may be affected by PGE's projects, and working with the company and the relevant federal agencies to ensure PGE's compliance with the ESA.

APPENDIX C

Douglas Allen

Geographic Information Systems Specialist and Geomorphologist

Mr. Allen has over 8 years of experience in physical geography, with an emphasis on hillslope and fluvial geomorphology, digital terrain modeling, remote sensing, and GIS. Mr. Allen is currently working with Dr. William Dietrich and Stillwater Sciences as a GIS specialist and geomorphologist to develop state-of-the-art techniques for watershed analysis.

Education

Ph.D. Candidate, Physical Geography, University of California at Berkeley, 1996
Graduate work in Water Resources and Hydrology, University of Arizona, Tucson, 1990
B.S., Physical Geography, University of Leeds, 1987

Professional Experience

Watershed Analysis

Mr. Allen is currently working on several watershed analysis projects. During the past year, he has conducted digital terrain modeling and GIS analysis tasks for the Louisiana-Pacific SYP/HCP and the North Umpqua Watershed Analysis projects, including generation of shallow landslide hazard potential, channel network, channel gradient, CDF watercourse classification, and substrate particle size coverages. He is also involved in field studies regarding hillslope and fluvial geomorphology for these projects.

Geographic Information Systems

Mr. Allen has been working with Dr. William Dietrich's geomorphological modeling research laboratory in the Department of Geology and Geophysics at UC Berkeley. Projects included digital terrain modeling, digital watershed analysis, GIS modeling and analysis of fluvial environments. He has also worked with Dr. John Radke in the Applied Environmental GIS Laboratory in the College of Environmental Design at UC Berkeley. Projects included the East Bay hills emergency fire response project; the Klamath GIS project; Oakland, Orinda/Moraga Hills digital terrain modeling; and the City of Richmond toxic flume analysis.

Geomorphology/ Soils/Hydrology

Mr. Allen has worked on several projects for the Overseas Development Natural Resources Institute (UK). In Belize, he worked with the Soil Survey of Corozal District, conducting field surveys, augering, and soil profile sampling of 6- to 8-foot soil pits. Analyzed remotely sensed information with reference to soil catenas. He also conducted hydrological surveys of the Cayo District in Belize, assessing the agricultural potential of land resources. Tasks included field sampling and measurement of soil hydrological parameters, bathymetric surveys of selected rivers, and meteorological data collection and analysis. At the Shipstern Lagoon Wildlife Reserve in Belize, Mr. Allen performed soil surveying and water quality analyses of a newly established wildlife reserve, for the purposes of designing a management plan for the reserve.

Computer Skills

Mr. Allen is proficient with UNIX, DOS, and Macintosh operating environments; C-programming language; geographic information systems (ARC/INFO, GRASS); CAD (Integraph Microstation); and various statistical packages.

Peter Fritz Baker, Ph.D.

Mathematical Biologist

Dr. Baker has nine years of experience in applications of mathematics and statistics to fisheries biology. His primary experience is with chinook salmon populations of Central California.

Education

Ph.D., Mathematics, University of California at Berkeley, 1987
B.S., Mathematics, University of Kansas (*summa cum laude*, honors in mathematics), 1981

Professional Experience

Mathematical Biology and Statistics

Dr. Baker has prepared or assisted in the preparation of numerous reports on the chinook salmon of the Tuolumne River of California, and on the survival of chinook salmon in the Sacramento-San Joaquin River Delta of California. He is the principal author of a paper on the relationship between water temperature and salmon smolt survival.

Simulation Modeling

Dr. Baker has been responsible for maintenance and continued development of the EACH simulation model for San Joaquin chinook salmon populations since 1989, and has developed or assisted in the development of numerous other models for populations of salmonid fishes in California and Montana. He has developed individual-based models of spawning habitat usage by salmonid fishes. He has extended PHABSIM modeling of chinook salmon habitat in the Tuolumne River to include water temperature considerations.

Professional Affiliations

Bay-Delta Modeling Forum
American Mathematical Society
Mathematical Association of America
Association for Symbolic Logic

Selected Publications and Presentations

Baker, P.F. 1997. The influence of temperature on the survival of chinook salmon smolts (*Oncorhynchus tshawytscha*) migrating through the Sacramento – San Joaquin River of California. Presented at the Bay-Delta Modeling Forum Workshop on Statistical Analysis of Coded-Wire-Tag Data, Sacramento, California, December 4, 1997.

Morhardt, J.E and P.F. Baker. 1997. Downstream challenges to salmon restoration on the Tuolumne River–salmon survival in the Sacramento-San Joaquin Delta. Presented at the 27th Congress of the International Association for Hydraulic Research, San Francisco, California, August 10-15, 1997.

Baker, P.F., T.P. Speed, and F.K. Ligon. 1995. The influence of temperature on the survival of chinook salmon smolts (*Oncorhynchus tshawytscha*) migrating through the Sacramento – San Joaquin River of California. *Canadian Journal of Fisheries and Aquatic Sciences* 52:4 855-863.
article

Yantao Cui, PhD
Civil Engineer

Education

Ph.D., Department of Civil Engineering, University of Minnesota. 1996.
M.E., Department of Hydraulics, Institute of Water Conservancy and Hydro-Electric Power Research (IWHR), Beijing, China, 1987.
B.E., Department of Hydraulic Engineering, Tsinghua University, Beijing, China, 1984.

Professional Experience

Recent Research Topics

- Modeling of river response to landslide and debris flow
- Modeling of reservoir removal
- Modeling of effects of woody debris jams on sediment transport
- Numerical modeling of river response to gravel extraction and addition
- Numerical modeling of grain sorting
- Study of sedimentation in response to mine waste disposal
- Modeling of river bank erosion
- Evaluation of countermeasures for bridge scour
- Study of tailings basin performance
- Design of hydraulic structures

Recent Applied Engineering Projects

- Modeling of countermeasures for river degradation in the Little Wekiva River, Orlando, Florida
- Modeling of aggradation, flooding, and floodplain deposition due to mine-derived sediment in the Ok Tedi River, Papua New Guinea
- Modeling of aggradation, flooding, and floodplain deposition due to mine-derived sediment in the Ok Tedi—Fly River system, Papua New Guinea.
- Modeling of river response to sediment input due to human activities in the Pacific Northwest of the USA.

Professional Affiliations

American Geophysical Union
International Association for Hydraulic Research (IAHR)

Selected Publications

Journal Publications

Parker, G., and Cui, Y. 1998. The arrested gravel front: Stable gravel-sand transitions in rivers. Part I: Simplified analytical solution. J. Hydr. Res., IAHR, 36(1), 75-100.

Cui, Y., and Parker, G. 1998. The arrested gravel front: Stable gravel-sand transitions in rivers. Part II: General numerical solution. J. Hydr. Res., IAHR, 36(2), 159-182.

Cui, Y. and Parker, G. 1997. A quasi-normal simulation of aggradation and downstream fining with shock fitting. International Journal of Sediment Research, IRTCES, Vol. 12, No. 2, 68-82.

Cui, Y., Parker, G, and Paola, C. 1996. Numerical simulation of aggradation and downstream fining. J. Hydr. Res., IAHR, 34(2), 185-204.

Zhi, D. and Cui, Y. 1988. Numerical simulation of spillway tunnel with sharp-edged orifices. J. Hydr. Power (in Chinese).

Cui, Y., Pizzuto, J., Lisle, T., Hansler, M., Reed, J., Almendinger, N. and Parker, G. 1999. Evolution of sediment pulses in gravel-bed rivers. I: Experiments. In preparation for submission to Water Resources Research.

Cui, Y., Pizzuto, J., Lisle, T., Hansler, M., Reed, J., Almendinger, N. and Parker, G. 1999. Evolution of sediment pulses in gravel-bed rivers. II: Numerical modeling. In preparation for submission to Water Resources Research.

Cui, Y. and Parker, G. 1999. A physically based model for evolution of sediment pulses in mountain watersheds. In preparation for submission to Water Resources Research.

Cui, Y., Parker, G., Lisle, T. and Pizzuto, J. 1999. The response of gravel-bed rivers to the removal of dams or debris jams. In preparation for submission to Water Resources Research.

Conference Publications

Cui, Y. and Parker, G. 1997. Linear analysis of coupled equations for sediment transport. Environmental and Coastal Hydraulics: Protecting the Aquatic Habitat--Proceedings of Theme B of the XXVII IAHR Congress, San Francisco, 10-15 August, 1997, 1256-1261.

Parker, G., Cui, Y., Imran, J., Dietrich, W. 1996. Flooding in the lower Ok Tedi, Papua New Guinea due to the disposal of mine tailings and its amelioration. International Seminar on Recent Trends of Floods and their Preventive Measures, Hokkaido River Disaster Prevention Research Center, June 20-21, 1996.

Seal, R., Toro-Escobar, C., Cui, Y., Paola, C., Parker, G. Southard, J.B. and Wilcock, P.R. 1995. Downstream fining by selective deposition: Theory, laboratory, and field observations. The Gravel-bed Rivers IV Workshop--Gravel-bed Rivers in the Environment, Gold Bar, Washington, U.S.A. August 20-26, 1995.

Published Abstracts

Cui, Y. and Parker, G. 1997. Linear and nonlinear analysis of sediment waves in rivers. EOS, Transactions, American Geophysical Union, 1997 Fall Meeting, Vol. 78, No. 46, November 18, 1997/Supplement.

Paola, C., Parker, G., Cui, Y. and Toro-Escobar, C. 1995. Field, laboratory, and theoretical investigation of downstream fining in gravel-bed river systems. EOS, Transactions, American Geophysical Union 1995 Fall Meeting, Vol. 76, No. 46, November 7, 1995 supplement.

Parker, G., Cui, Y., and Paola, C. 1995. The arrested gravel front: Equilibrium gravel-sand transitions in rivers. EOS, Transactions, American Geophysical Union 1995 Fall Meeting, Vol. 76, No. 46, November 7, 1995 supplement.

Technical Reports

Cui, Y., Parker, G. and Paola, C. 1995. Numerical formulation for models of aggradation and downstream fining. External Memorandum, M-244, St. Anthony Falls Laboratory, University of Minnesota.

Parker, G., Cui, Y., Toro, C. and Paola, C. 1994. Modeling of tailings basin performance. Hibbing Taconite Company, Preliminary Report. St. Anthony Falls Laboratory, University of Minnesota.

Cui, Y., Zhou, S., Chen, M. et al. 1992. Modeling of general layout of Zipingpu hydro power project. Department of Hydraulics, IWHR (in Chinese).

Cui, Y., Zhou, S., Chen, M. et al. 1992. Modeling of general layout of Zipingpu hydro power project, Preliminary Report. Department of Hydraulics, IWHR (in Chinese).

Shi, Q., Cui, Y., Zhou, S. et al. 1992. On site investigation of the impact of construction debris to the output of power generation. Department of Hydraulics, IWHR (in Chinese).

Shi, Q., Zhou, S., Cui, Y. et al. 1991. Modeling of sediment deposition and its countermeasures on the navigation channel of Three Gorges Project, Preliminary Report, Department of Hydraulics, IWHR (in Chinese).

Frank Ligon

Senior Aquatic Ecologist, Stillwater Sciences

Mr. Ligon is an aquatic ecologist and geomorphologist specializing in investigations of the role of fluvial processes and morphology in the ecology of stream fish, invertebrates, and plant communities

Education

MS, Wildland Resource Science (Freshwater Ecology/Fluvial Geomorphology), University of California at Berkeley, 1986

BS, Conservation of Natural Resources, University of California at Berkeley, 1982
Magna Cum Laude
Phi Beta Kappa

Professional Experience

Fisheries Ecology

Mr. Ligon managed a 10-year research program on Tuolumne River chinook salmon ecology and management as part of a hydroelectric relicensing project. Studies included: (1) assessment of predation rates by black bass and squawfish on juvenile salmon, particularly in areas where extensive in-river gravel mining has created long, deep lake-like areas, (2) salmon spawning gravel quality studies examining the size distribution of the stream substrate; the rate of intrusion of fine sediments; the amount of fine sediments removed from the gravels by spawning salmon; salmon embryo survival-to-emergence using emergence traps; and the development of a hydraulic gravel cleaning machine, (3) invertebrate studies examining the effect of stream morphology and hydraulic conditions on benthic and drift densities and species composition, (4) juvenile salmonid studies examining distribution, migration, feeding behavior, food preferences, and growth, (5) examination of the influence of channel and floodplain morphology on stranding mortality of juvenile salmon, (6) spawning gravel availability studies in which gravels with suitable hydraulics and substrate for spawning were mapped as part of an assessment of the effects of the distribution and suitability of spawning habitat on redd superimposition, and (7) assessment of the effects of different summer flow regimes on the distribution and abundance of all fish species in the Tuolumne River (~35 species) and on invertebrates. Mr. Ligon has managed a number of other salmon ecology and restoration projects in California, Oregon, and New Zealand.

Geomorphology and Stream Ecology

Mr. Ligon has been working in conjunction with biologists and geomorphologists from UC Berkeley and Humboldt State University to develop a geomorphologically-based approach to protecting and preserving stream biodiversity below dams. He presented this research as an invited speaker at a symposium on the ecology of large rivers at the 1993 annual meeting of the Ecological Society of America and was lead author of an invited paper on this subject for *BioScience*.

Mr. Ligon managed the fluvial geomorphology component of a hydroelectric relicensing project on the McKenzie River in Oregon. He conducted studies on the longitudinal variation in sediment supply and sediment transport capability, historic changes in channel planform and bar topography, determinants of substrate composition, effects of bank protection on channel morphology, and effects of flood control on channel complexity. He determined that the geomorphic response of the river to flood control dams on two tributaries was leading to a reduction in areas having sufficiently low shear stress to allow for

salmon spawning gravel deposition. Mr. Ligon has also conducted research on fluvial geomorphology and stream ecology on the Noyo River, Clavey River, San Pablo Creek, and many other northern California streams, and has managed the fluvial geomorphology component of a hydroelectric relicensing project on the Oconee River in Georgia.

Watershed Analysis

Mr. Ligon is responsible for the fish habitat, stream channel, and riparian components of the watershed analysis conducted by Louisiana-Pacific and the California Department of Forestry for their sustained yield plans (SYPs) and habitat conservation plans (HCPs) in northern California. As part of this project, he is developing models for assessing channel sensitivity in the field that can be extrapolated over large areas using digital terrain modeling (DTM). He is project manager for a 1,000-square mile watershed analysis in the North Umpqua River basin. This project is incorporating hydroelectric dams and facilities into a watershed analysis and is developing a reference model of stream channel morphology and aquatic habitat to aid in channel assessment and the development of management and mitigation strategies for ecosystem restoration and salmon and trout enhancement. The North Umpqua watershed analysis examined the effect of the hydroelectric project on fish passage, instream flows, anadromous and resident fish, amphibians, water quality, geomorphology, reservoir and forebay habitats, and terrestrial habitat connectivity. Mr. Ligon managed a project for the Eldorado National Forest in California to develop a stream channel assessment procedure that would facilitate interpretation of changes in geomorphic processes and morphology in terms of their implications for aquatic biota.

Aquatic Invertebrate and Algal Ecology

Mr. Ligon used aquatic invertebrates to monitor the effects of timber harvesting, post-fire management, and cattle grazing on stream ecology for the US Forest Service. He designed and conducted a study for the California Department of Forestry on the effects of timber harvest activities on stream algal ecology. He participated in a study examining the effects of stream flow regulation on invertebrate drift and benthic communities and their relation to fish populations and feeding preferences. He has assessed food limitations of juvenile salmon using drift and benthic sampling of aquatic invertebrates, stomach content analysis, juvenile salmon growth rates, and bioenergetic modeling.

Professional Affiliations

American Fisheries Society
North American Benthological Society

Selected Publications and Presentations

Ligon, F.K., A.L. Percival, and T.P. Speed. Submitted. The effects of turbidity on largemouth bass feeding rate and implications for salmon management.

Ligon, F.K., W.E. Dietrich, and W.J. Trush. 1995. Downstream ecological effects of dams: A geomorphic perspective. *BioScience*.

Baker, P.F., T.P. Speed, and F.K. Ligon. 1995. The influence of temperature on the survival of chinook salmon smolts (*Oncorhynchus tshawytscha*) migrating through the Sacramento - San Joaquin River Delta of California. *Canadian Journal of Fisheries and Aquatic Sciences*.

Ligon, F.K. and W.E. Dietrich. 1991. River management for floodplain development and salmon—are they compatible? A geomorphological analysis of a cobble-bedded alluvial river ecosystem. Presented at the Fifth International Symposium on Regulated Streams.

Ligon, F.K. 1990. The effects of predation on salmon population dynamics. Presented at the Pacific Fisheries Biologists Annual Meeting.

Erman, D.C. and F.K. Ligon. 1988. Effects of flow fluctuations and fine sediment additions on stream fish and invertebrates below a water filtration plant. *Environmental Management* 12:85-97.

Bruce Orr, PhD
Senior Ecologist

Dr. Orr has 20 years of experience in population and community ecology of aquatic, terrestrial, and wetland environments in the western United States. His areas of technical expertise include natural resources inventory and management planning, wetlands and freshwater ecology, aquatic entomology, and flora and vegetation of the western United States. He is experienced in wetland delineation and functional assessment; threatened and endangered species surveys; plant community classification and mapping; mitigation planning; and environmental impact assessment. Dr. Orr has managed a number of complex, multi-year projects involving interdisciplinary teams conducting natural resource inventories, assessments, and watershed analysis in a variety of habitats; developing natural resource management plans; and producing environmental impact assessment documents.

Education

Ph.D., Entomology (Ecology/Aquatic Entomology), University of California at Berkeley, 1991

Graduate Studies in Ecology (Aquatic and Population Biology), University of California at Santa Barbara, 1979-1982

B.A., Biological Sciences and Environmental Studies, University of California at Santa Barbara (high honors), 1979

Training

CDFG certification in California Wildlife Habitat Relationships (WHR) system, 1995

Applied Fluvial Geomorphology Course, taught by David Rosgen and Luna Leopold, 1993

National Wetlands Science Training Cooperative Certification in Jurisdictional Delineation of Wetlands, 1993

USFWS Habitat Evaluation Procedures (HEP), 1992

Professional Experience

Integrated Natural Resource Analysis and Management Planning

Dr. Orr is an experienced project manager and interdisciplinary team leader for complex projects involving natural resource inventories, integrated natural resource management plan development, and federal and state regulatory processes. He is currently project manager for development of a multi-species Habitat Conservation Plan (HCP), Sustained Yield Plan (SYP) for timber management, and a joint EIS/EIR for the California Department of Forestry and Fire Protection's 50,000 acre Jackson Demonstration State Forest. Dr. Orr recently served as project manager for Louisiana-Pacific's multi-species HCP and SYP project in northern California. This 3-year project involved conducting watershed, fisheries, and wildlife assessments and the development of SYPs and HCPs covering over 300,000 acres of industrial forestlands owned by Louisiana-Pacific, with a total watershed and wildlife assessment area exceeding one million acres. He served as technical manager for a multidisciplinary effort involving natural resource inventories and development of biodiversity and ecosystem management plans for a 28,000-acre watershed master plan project in the San Francisco Bay Area. Dr. Orr has also served as project manager or technical task leader on a variety of other impact assessment projects addressing the regulatory requirements of NEPA, CEQA, and FERC. Dr. Orr served as an instructor in watershed analysis at the 1998 Watershed Academy, which was sponsored by the University of California, and co-sponsored by California Department of Fish and Game, and National Marine Fisheries Services. He has also presented workshops in various aspects of watershed analysis for the EPA,

NRCS, and California Regional Water Quality Control Boards.

Aquatic Ecology

Dr. Orr has a broad background in general limnology and stream ecology. He has sampled aquatic invertebrates in a wide variety of freshwater and brackish-water habitats; conducted limnological surveys to determine physical and chemical characteristics of lakes and wetlands; conducted experimental studies on interactions among predators, zooplankton, and phytoplankton in lentic systems; applied EPA's Rapid Bioassessment Protocols to examine impacts of hydropower development on stream macroinvertebrates in Southern California, and served as co-manager for a long-term study examining the effects of different summer flow regimes on fish and benthic macroinvertebrate communities in the lower Tuolumne River and experimental studies of the influence of turbidity on the predation of juvenile salmonids by black bass. He has conducted studies of the effects of stream flow on riparian vegetation in the Sierra Nevada and is involved in instream and riparian habitat restoration efforts on the lower Tuolumne River.

Wetlands Biology

Experienced in jurisdictional delineation of wetlands. Designed and conducted field surveys, laboratory experiments, and field experiments on interactions among aquatic vegetation, predators, and macroinvertebrates in freshwater wetlands of California. Conducted investigations of historical changes in geomorphology and salt marsh vegetation, and field surveys of plant distributions, in the San Francisco Bay Area. Expertise in biological control of mosquitoes in wetlands. Experienced in the use of wetland assessment techniques. Recent involvement in studies of palustrine, lacustrine, and riparian wetlands in California, Oregon, and Montana, including studies of ecological relationships among hydrology, vegetation, and wildlife for a large freshwater wetland complex in southern Oregon.

Terrestrial Ecology

Dr. Orr is experienced in field survey techniques and identification of terrestrial plants, insects, and vertebrates. Dr. Orr served as task leader or project manager on a variety of studies assessing project impacts on terrestrial vegetation and wildlife, including plant and wildlife surveys in a variety of habitats in California, Oregon, and Montana. He has 6 years of experience teaching college laboratory and field courses in terrestrial ecology and natural history. His recent experience as project manager or technical task leader includes wildlife habitat assessment using HEP and other techniques for extensive studies of riparian and freshwater marsh habitats in southern Oregon; development of an integrated natural resource management plan for Robins AFB, Georgia; vegetation management environmental assessments and ecological unit inventories for the Angeles and Cleveland national forests; development of multi-species HCPs; and impact assessments for a variety of projects in California. He is currently a member of the California Native Plant Society Vegetation Committee.

Surveys for Rare, Threatened, and Endangered Species

Dr. Orr conducted surveys for rare, threatened, and endangered (RTE) plants and animals, and conducted general floristic and faunal surveys in various wetland, aquatic, and terrestrial habitats in California, Oregon, and Montana. He was recently involved in inventory and mitigation studies of RTE species for projects in the western Sierra Nevada, central California, habitat planning for RTE species in northern California forestlands, and ecological studies of headwater amphibians in Oregon and California.

Professional Affiliations

American Institute of Biological Sciences
California Native Plant Society
Ecological Society of America
North American Benthological Society
Society for Ecological Restoration

Selected Publications and Presentations

Olson, C. and B. Orr. 1998. Combining tree growth, fish and wildlife habitat, mass wasting, sedimentation, and hydrologic models in decision analysis and long-term forest land planning. Forest Ecology and Management 110: 1-10. (Paper presented at First Biennial North American Forest Ecology Workshop, Raleigh, NC. June 23-27, 1997.)

Orr., B.K. 1997. Use of a regional watershed analysis approach in long-term forest management planning in California. Watershed Management Council Networker 7 (3): 1, 4-16, 13.

Orr, B.K. 1997. Ecosystem health and salmon restoration: a broader perspective. Invited paper prepared for a special session on "The role of applied ecological research in the management of a regulated river: New Don Pedro Dam and the Tuolumne River," International Association for Hydraulic Research Conference, San Francisco, CA. August 11-15, 1997.

Lacey, L. and B.K. Orr. 1994. The role of biological control of mosquitoes in integrated vector control. American Journal of Tropical Medicine and Hygiene 50(6) Suppl: 97-115 (invited paper).

Smyth, A.P., B.K. Orr, and R.C. Fleischer. 1993. Electrophoretic variants of egg white transferring indicate a low rate of intraspecific brood parasitism in colonial cliff swallows in the Sierra Nevada, California. Behavioural Ecology and Sociobiology 32:79-84.

Orr, B.K. and V.H. Resh. 1992. Influence of *Myriophyllum aquaticum* cover on Anopheles mosquito abundance, oviposition, and larval microhabitat. Oecologia 90:474-482.

Orr, B.K., S. Morhardt, and R.D. Stone. 1991. Influence of drought on the distribution and abundance of montane riparian plants along a western Sierra Nevada stream. Paper presented at the California Riparian Systems Conference III: Progress in Protection and Restoration, Sacramento, California. 16 November.

Orr, B.K., W.W. Murdoch, and J.R. Bence. 1990. Population regulation, convergence, and cannibalism in *Notonecta* (Hemiptera). Ecology 71(1): 68-82.

Orr, B.K. and V.H. Resh. 1989. Experimental test of the influence of aquatic macrophyte cover on the survival of *Anopheles* larvae. Journal of the American Mosquito Control Assoc. 5:579–585.

Collins, J.N. and B.K. Orr. 1989. An ecological overview of the Coyote Hills wetlands, *in* Talk about Wetlands, Proceedings of the Coyote Hills Wetlands Workshop, 10–11 February 1987, Coyote Hills Regional Park, Fremont, California (J. Collins and K. Burger, eds.), pp. 34–42.

Collins, J.N., E.P. McElravy, B.K. Orr, and V.H. Resh. 1988. Preliminary observations on the effects of the intersection line upon predation of *Anopheles* mosquito larvae. Bicovas (Proceedings of the International Conference on

Biological Control of Vectors with Predaceous Arthropods. Loyola College, Madras, India.) 1:1–12.

Orr, B.K. and V.H. Resh. 1987. Interactions among mosquitofish (*Gambusia affinis*), Sago pondweed (*Potamogeton pectinatus*), and the survivorship of *Anopheles* mosquito larvae. Proceedings of the California Mosquito and Vector Control Association 55:94–97.

Orr, B.K. and V.H. Resh. 1986. Spatial-scale considerations in predator-prey experiments. Proceedings of the California Mosquito and Vector Control Association 54:105–109.

Rafael Real deAsua

GIS and Image Processing Analyst

Mr. Real de Asua is a GIS and Image Processing analyst and programmer with 9 years of experience in computerized mapping and GIS and 3 years in image processing. He participates in the analysis, modeling, and execution of the GIS and image processing elements of all projects, using the ESRI ARC/INFO, ERDAS, and Intergraph/Microstation software systems. Mr. Real de Asua designs and codes programs to automate GIS processes on the ARC/INFO platform. He has served as an analyst and programmer for GIS projects for county, state, and federal agencies, including the analysis of land use impacts, forest health, fisheries, ground water pollution, and suitability for residential development.

Education

M.L.A., University of Pennsylvania; Landscape Architecture (GIS specialization); 1990
B.A., Universidad de Zaragoza, Departamento de Geografia, Spain; Physical Geography, with emphasis in Geomorphology; 1983

Professional Experience

Environmental Assessment and Investigation

In support of a Sustained Yield Plan for forests owned by Louisiana-Pacific in California, generated GIS data at a planning watershed level to be used in ecological models of soil erosion, stream channel sensitivity, fish distribution, and hydrology. Tasks included the automation of the production process using ARC/INFO AML language and the determination of a method to automatically calculate stream channel slopes from existing digital data to help in the prediction of fish habitat.

Prepared a GIS for the evaluation of stream channel conditions of various watersheds in Klamath and Eldorado National Forests. Tasks included designing the GIS; transferring data from MOSS to ARC/INFO; generating lattices and contour line maps from USGS 7.5' Digital Elevation Models; supervising data input and performing quality control; and writing software to calculate longitudinal slopes of streams and to automate plotting.

In support of a regional watershed plan, built a regional spatial database at several scales and executed database queries for economic and water quality consultants charged with impact assessments. Wrote software to check and display minimum distances from tax parcels to water bodies to facilitate automating the data entry and reformatting of more than 40,000 records from tax parcel information into the ARC/INFO format, to automate the generation of different buffers for hydrologic elements; to locate land parcels subject to future development; to develop templates for plotting different maps; and to automate the scaling of plots from A size to E size.

For a Remedial Investigation and Feasibility Study of the Passaic River, New Jersey, generated outfall location, bathymetric changes, and chemical sample location maps. Tasks included incorporating all digital and non-digital data, ranging from databases to aerial photographs and surveying maps, into a GIS; generating bathymetric models for 1989 and 1949; map setup; and cartographic production.

To support the development of an environmental plan to locate areas for timber harvesting in the Shasta-Trinity National Forest, developed a GIS; imported MOSS data from 8 mm tape into ARC/INFO format; participated in the determination of sample plots; and coded, queried, analyzed, and plotted point,

line, and polygon features for field maps and final reports.

For the Bureau of Indian Affairs, performed quality control on digitized data, queried and generated reports based on vector and raster queries performed in ARC/INFO to be incorporated in hydrologic models.

For the Los Angeles Department of Water and Power, set up a GIS of the Owens River between Crawley Dam and Pleasant Valley Reservoir to define stream channel conditions for use in different sedimentation analyses. Wrote macros to automate plotting.

For the monitoring of carbon monoxide in the Amazon Basin, proposed a program and an accompanying GIS to be used by several Native American peoples and nongovernmental organizations (NOGS) in Peru, Bolivia, and Ecuador. Traveled to the sites, interviewed the local authorities, assessed existing materials and needs, discussed the possible solutions, and wrote a report with recommendations.

To evaluate the impacts of air pollution, created a model to estimate the number of people and land use properties affected by high, medium, and low concentrations of plutonium and several other contaminants in the air between 1950 and 1990. Wrote software to automate the importation of data from TIGER files (Digital Census Information) into ARC/INFO, to determine the population affected, and to generate the plots. For the siting of residential developments for a science city in Taiwan, built a demonstration in ARC/INFO showing several scenarios using development indexes based on transportation, location, and natural factors.

For the development of a GIS prototype for the island of St. John (U.S. Virgin Islands), participated in the development of a potential erosion test model in ARC/INFO.

For the creation of a regional ground water assessment program, participated in the creation of a land use map based on the Anderson Class II classification, made from aerial photographs; helped in data processing and cleaning coverages. Wrote software to translate data from ARC/INFO to Intergraph/Microstation and vice versa and for data quality control.

Land Cover and Vegetation Classification

For the Georgia Power Company, participated in the image processing and classification of bottomland hardwoods. Advised in the selection of training sites and performed supervised and unsupervised classifications with ERDAS; transferred data between ERDAS and ARC/INFO, and in ARC/INFO between raster and vector modules; processed data in ARC/INFO both in the raster module (GRID) as in the vector module (ARC).

For the Bureau of Indian Affairs, conducted supervised and unsupervised classifications of different types of wetland areas in ERDAS IMAGINE (v. 8.1); transferred data between ERDAS and ARC/INFO, and overlaid the results with other layers from the GIS.

Helped in the classification of 24 types of vegetation cover in Central Spain. Generated a classification of the existing vegetation; advised on the number and types of classes to be classified; selected training areas; and participated in the classification of Thematic Mapper and SPOT images.

Participated in the classification of 22 types of land cover in the Basque Country

(Spain). Designed the classification; classified stereoscopic pairs of aerial photographs; ground-truthed the classification; and wrote a report and documentation.

GIS Inventory

For the East Bay Utility Municipal District (EBMUD), participated in the creation of a natural factor GIS. Participated in the design of the GIS, supervised and performed quality control on different layers of the GIS, analyzed and queried the data, plotted maps at different scales and paper sizes, and backed up, documented, and prepared the information for delivery on 8 mm or 4 mm tapes.

For Robins AFB, Georgia, participated in the incorporation of all available environmental data into an Interstation GIS running on an Intergraph workstation. Prepared data input and analysis modules for all categories of information collected in ARC/INFO.

For the City of Newark, New Jersey, and for West Philadelphia, Pennsylvania, developed a GIS of natural factors . Tasks included database design and building, data input, transfer, processing and analyses, and documentation.

Ecological Planning and Design

For Randolph AFB developed a grounds maintenance plan to be included in the Integrated Natural Resources Management Plan. Tasks included a site visit, discussions with the client to focus on the most viable plan, development of the outline, and report writing.

For Robins AFB participated in the Natural Resources Development Plan. Tasks included the preparation of opportunities and constraints matrix for six proposed alternatives on non-active military areas within the base, and participation in the discussions for the weighting of alternatives.

For the Basque Autonomous Government, at the request of the Department of Agriculture wrote a report criticizing the Proposed General Land Use Plan.

Participated in the ecological design of several zoo exhibits for different zoos in the United States and Canada: Savanna/Waterhole Exhibit in Brookfield Zoo, Chicago; Great Ape Exhibit in Denver; Taiga/Northern Forests Exhibit, Seattle; General Master Plan, Toronto Zoo, Toronto. Participated in the design and preparation of the construction documents for the zoos.

Software Application Development

Programming for conversion of data from IGDS to ARC/INFO format and vice versa. Import and formatting of data from tape (ASCII, EBCDIC, DLG, TIGER) files into ARC/INFO. Created templates for plotting and for re-scaling plots. Programming to check visually the distances between geographic elements. Development of window interfaces in ARC/INFO.

List of Skills

GIS applications: ESRI ARC/INFO in UNIX environment; Intergraph SPAN/SPED in VMS environment and Microstation PC/workstation.

Computer Programming: ESRI Arc Macro language (AML); Intergraph User Commands; AWK; C.

Image Processing and Aerial Photointerpretation: ERDAS; Infrared and True color photointerpretation (orthophotos or stereoscopic).

GIS System Management: Workstation and microcomputer system management and customization in Unix environment.

Fluent in French and Spanish.

Professional Societies

Bay Area Automatic Mapping Association (BAAMA), the Bay Area chapter of the Urban and Regional Information Systems Association (URISA)

California Geographic Information Association (CGIA)

Selected Publications

Leven, A. and R. Real de Asua. 1996. Effective GIS Display for Public Involvement Meetings. Poster. 1996 Soil and Water Conservation Society, Keystone Resort, Colorado.

Real de Asua, R. 1996. Predicting Fish Habitat Using Geographic Information Systems. Poster. 1996 ESRI Users Conference. Palm Springs, California.

Real de Asua, R. 1996. Hayfork AMA Forest Health Analysis. Presentation. 1996 California GIS Conference. San Francisco, California.

Real de Asua, R. and J. Zablotney. 1995. Hayfork AMA Forest Health Analysis. Poster. 1995 ESRI Users Conference, Palm Springs, California. Published in the ESRI Map Book, Volume 11 (1995).

John C. Stella

Riparian ecologist, Stillwater Sciences

Mr. Stella has five years of experience in the ecology, geomorphology, and restoration of riparian, aquatic and terrestrial environments in the western United States. His areas of technical expertise include vegetation community classification and mapping; plant taxonomy, physiological and community ecology of the western United States; rapid bioassessment using macroinvertebrate family biotic indices; and stream channel analysis and restoration using biotechnical methods. Mr. Stella has managed stream restoration projects for several Northern California agencies and has designed a field mapping system for a University of California experimental forest.

Education

M.S., Environmental Science, Policy and Management, University of California at Berkeley, 1998.
Concentration in riparian and stream ecology

B.A., Architecture, Yale University, New Haven Connecticut, 1988.
Cum Laude, Distinction in the Major

Awards

Departmental Fellowship, 1996-97 and 1997-98, University of California, Berkeley

Training

CEQA Workshop for Environmental Planners, California Association of Environmental Professionals, 1998

Watershed Analysis, Stream Restoration Design and Implementation Methodology, Waterways Restoration Institute, 1998

Rapid Bioassessment Protocol using a Family Biotic Index, University of California at Berkeley, 1997

Stream Habitat Assessment, University of California at Berkeley, 1997

Professional Experience

Riparian and Watershed Ecology

Mr. Stella has five years of experience in watershed and riparian ecology. He has implemented a long-term stream habitat and vegetation monitoring plan for the University of California at Berkeley's Blodgett Forest Research Station. As part of that effort, he designed a field-based stream habitat mapping system for monitoring permanent plots on the experimental forest, and conducted forest inventory and riparian vegetation plot surveys. Mr. Stella has extensive understanding of riparian plant physiology and community ecology, and the geomorphologic, hydrologic and nutrient dynamic processes that occur in riparian zones. As part of his Masters work, he organized and led a graduate seminar on the geomorphological and ecological linkages in watershed processes in the Department of Integrative Biology at University of California at Berkeley. Mr. Stella is also trained in the EPA's Rapid Bioassessment Protocols using macroinvertebrate family biotic indices. He has sampled aquatic invertebrates in a wide variety of freshwater and estuarine habitats, and has conducted surveys of urbanized and natural reaches of both perennial and intermittent streams in Northern California.

Stream Channel

I-015458

Restoration and Rehabilitation

Mr. Stella is an experienced project manager on stream channel restoration, rehabilitation and maintenance projects. As a consultant for the Waterways Restoration Institute in Berkeley, CA, he supervised the implementation of stream restoration plans for urban waterways draining to San Francisco Bay. His job responsibilities included coordinating public agencies, construction subcontractors and project designers to ensure that projects met design, regulatory and ecological goals; site surveying, data analysis, implementing soil bioengineering techniques, and supervising a work crew.

As a project coordinator for the East Bay Conservation Corps in Oakland, CA, Mr. Stella developed and managed a wide variety of conservation, restoration and maintenance projects on East Bay streams and flood channels. Projects included a $350,00 annual contract with the Alameda County Flood Control District for vegetation removal and channel maintenance; reach-scale channel restoration projects using soil bioengineering methods for the San Francisco Water Department and the East Bay Asian Development Corporation; and fuel break construction on Alameda Creek for the Alameda County Water Department. Mr. Stella directly supervised 5 site supervisors and their crews of 6-10 employees. Other responsibilities included writing and implementing the agency's field staff training plan and coordinating corpsmember orientation, leadership training, crew on-site education, agency-side community meetings and life skills workshops for 100+ participants and 30 staff.

Professional Affiliations

Ecological Society of America
California Native Plant Society
The Nature Conservancy

Selected Publications

Stella, J.C. 1998. The Greywacke Cover-up. Soil Survey Horizons 39(4): 127-130.

Jennifer C. Vick

Ecologist/Geomorphologist

Ms. Vick has more than ten years experience in ecology and geomorphology. Her areas of expertise include geomorphology, hydrology, sediment transport analysis, and riparian and aquatic ecology. She is experienced in historic geomorphic assessment, sediment transport analysis, hydraulic and hydrologic analyses, and field surveying methods, as well as invertebrate and fish sampling, vegetation analysis, and environmental assessment. Ms. Vick is also experienced in project planning and managing and has worked on restoration plans for several California streams and rivers.

Education

M.L.A., *Environmental Planning*, University of California at Berkeley 1995
Graduate Studies in Marine Biology and Marine Sciences, University of Oregon and University of California at Santa Cruz (1988-1989)
B.S., *Zoology*, University of Georgia, Athens, Georgia, 1988
Magna Cum Laude
Phi Beta Kappa

Professional Experience

Geomorphology and Hydrology

Ms. Vick has conducted geomorphic and hydrologic analyses on the Merced, Tuolumne, and Stanislaus Rivers. She completed an extensive analysis of geomorphic trends in the Merced River, including assessment of the hydrologic and geomorphic impacts of dams and instream and floodplain mining. Her work included field surveys and interpretation, aerial photograph interpretation, digital mapping and analysis, and extensive application of statistical methods to hydrologic data. From her analysis, she proposed three restoration approaches that could be developed for the Merced River. Ms. Vick presented the results of her research at a meeting of the American Geophysical Union in 1995. The University of California Water Resources Center published a summary of her thesis in 1996. This study was the first extensive geomorphic study conducted in this river corridor.

In 1995, Ms. Vick (with Dr. G.M. Kondolf and Timothy Ramirez) evaluated the performance of three reconstructed spawning riffles on the Merced, Tuolumne, and Stanislaus Rivers. She conducted field surveys and hydraulic and sediment transport analyses which documented actual and predicted bed mobility at the riffle reconstruction sites. The results of this research were published by the University of California Water Resources Center and in the Transactions of the American Fisheries Society.

On the Cosumnes River, Ms. Vick conducted the geomorphic component of a large-scale floodplain restoration plan developed for The Nature Conservancy. She assessed historic changes in channel planform and cross section, changes in sediment transport capacity caused by channel incision and levees (floodplain constriction), floodplain sedimentation at restored sites, and hydrology and flood attenuation. Her work included interpretation of historic maps and surveys, planning and interpretation of current channel surveys, interpretation and assessment of watershed geology, sediment transport modeling, and hydrologic analysis.

Ms. Vick has also conducted geomorphic assessments and developed management or restoration recommendations on urban and rural streams in Alameda, Contra Costa, and Santa Cruz Counties. She has also worked extensively on the application of geomorphic, hydraulic, and hydrologic

information to the planning and design of ecological restoration projects.

Ecology

At the University of Georgia, Ms. Vick participated an ecological evaluation of microhabitat partitioning of native fishes in cold-water streams. Her work included invertebrate and fish sampling and identification and processing of benthic macroinvertebrate samples.

Ms. Vick spent four years as an ecologist at the Corps of Engineers. During this time, she evaluated the environmental impacts of a variety of projects and provided technical input to the development of wetland and riparian mitigation and monitoring plans. She developed guidelines for monitoring vegetation and channel morphology at riparian habitat mitigation sites. These guidelines are used by the Corps of Engineers San Francisco District and were adopted by the Texas Department of Parks and Wildlife. She also served on or chaired several technical advisory committees which developed restoration plans for the Salinas River, Russian River, and Carmel River lagoons; Bolinas Lagoon; and Muir Beach (Big Lagoon).

Ms. Vick participated in an analysis of the ecological values of floodplain and terrace aggregate mining pits in central California. With research assistants from the University of California, she sampled riparian vegetation established at these pits and developed relationships between surface slope, soil quality, and vegetation vigor and extent. Results of this research were presented at a meeting of the Society for Ecological Restoration.

Environmental Compliance

Ms. Vick has four years experience in environmental regulation. She has prepared more than fifty environmental assessments and has managed the preparation of three Environmental Impact Reports/Statements. She has also participated in formal and informal endangered species consultations with the U.S. Fish and Wildlife Service and has coordinated with the California Department of Fish and Game, National Marine Fisheries Service, Environmental Protection Agency, and Regional Water Quality Control Board.

Professional Affiliations

American Geophysical Union
Ecological Society of America
Society for Ecological Restoration
Society of Wetland Scientists
California Native Plant Society

Selected Publications

Kondolf, G.M., J.C. Vick, and T.M. Ramirez. 1996. Salmon Spawning Habitat Rehabilitation in the Merced, Tuolumne, and Stanislaus Rivers, California: An Evaluation of Project Planning and Performance. University of California Water Resources Center Report No. 90, Davis, CA.

Kondolf, G.M., J.C. Vick, and T.M. Ramirez. 1996. Salmon Spawning Habitat Rehabilitation in the San Joaquin Valley, California: An Evaluation of Project Planning and Performance. Transactions of the American Fisheries Society 125:899-912.

Vick, J.C. 1995. Channel Change from Dam Construction and Instream Gravel Mining in the Lower Merced River, California: Implications for Restoration of Native Salmonid Populations, EOS Trans AGU, 76(17), Spring Meeting Supplement, S152.

Vick, J.C. 1995. Codornices Creek Restoration Project: Channel Hydraulics and Sediment Transport. Prepared for Andrea Lucas Associates, Berkeley, CA.

Vick, J.C. 1995. Habitat Rehabilitation in the Lower Merced River: A Geomorphological Perspective (Masters Thesis). Center for Environmental Design Research Report Numbers CEDR-03-95 and CEDR-04-95, University of California at Berkeley, Berkeley, CA.

Kondolf, G.M. and J.C. Vick. 1995. Spawning Gravel Resources in the Lower Tuolumne River: Hydrologic and Geomorphic Studies and Review of Existing Information (Draft). Prepared for the Oakridge National Laboratory Environmental Science Division, Oakridge, Tennessee.

Vick, J.C.. 1994. Guidelines for Monitoring Riparian Mitigation Projects. U.S. Army Corps of Engineers, San Francisco District, San Francisco, CA.

Kendall, T.R., J.C. Vick and L. Forsman. 1991. Sand as a Resource - Managing and Mining the Northern California Coast. Proceedings of the Seventh Symposium on Coastal and Ocean Management, ASCE, NY, NY.

Presentations to Professional Meetings and University Classes

"Habitat Rehabilitation in the Lower Merced River: A Geomorphological Perspective" - Guest lecture in Geomorphology in River and Stream Restoration, University of California Extension, (April 1995, 1996, 1997) and Hydrology for Planners (LA 222), University of California, April 1996.

"Wetland Regulatory Process and the Role of Compensatory Mitigation" - Guest lecture in Hydrology for Planners (LA 222), University of California, March 1995 and April 1996.

"Channel Change from Dam Construction and Instream Gravel Mining in the Lower Merced River, California: Implications for Restoration of Native Salmonid Populations" - Presentation to the American Geophysical Union Special Session to Honor the Career of M. Gordon Wolman, June 1995.

"Wetland Mitigation: Policy or Poker Chip?" - Guest lecture in Landscape Architecture and Environmental Planning Colloquium (LA 253), University of California, October 1994.

"Wetland Mitigation - Projects and Policy" - Guest lecture in Restoration of Rivers and Streams (LA 254), University of California, October 1993.

APPENDIX D

I-015463

Short CURRICULUM VITAE
Selected Materials Related to River Valley Resource Management

Name:	Stewart Boone ROOD
Birth:	February 1, 1955, San Francisco, CA, USA
Citizenship:	dual: American and Canadian - naturalized Jan. 5, 1977.

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University of Lethbridge, Lethbridge, Alberta, Canada T1K 3M4
phone: (403) 329-2327home: (403) 320-9601
fax: (403) 329-2082 email: ROOD@ULETH.CA

Education

B.Sc.	(with Distinction) Psychology-Biology, University of Alberta. 1976.
Ph.D.	Plant Physiology, University of Calgary. 1981.

Post-Doctoral Awards:

NSERC Postdoctoral Fellowship, Univ. of Toronto. 1981 to 1983.
NSERC University Research Fellowship, Univ. of Lethbridge. 1983 to 1988.
Dr. E.E. Ballantyne Award For Excellence in Environmental Research. 1989.
From the Alberta Environmental Research Trust.
The C.D. Nelson Award. 1992. Outstanding contributions by a young plant physiologist in Canada, From the Canadian Society of Plant Physiologists.

Employment

1995-1997	- Coordinator, Environmental Science Program, University of Lethbridge
1993-present	- Professor, University of Lethbridge
1991-1994, 1997	- Chair, Department of Biological Sciences, University of Lethbridge
1989 (Fall)	- Royal Society (London) Visiting Research Fellow, Hormone Biochemistry, Long Ashton Research Station, Bristol, England
1989 - 1993	- Associate Professor, University of Lethbridge - Appointed Adjunct Associate Professor, University of Calgary
1988 (Spring)	- Visiting Research Professor, Department of Plant Physiology and Microbiology, University of Tromso, Norway
1983-1988	-NSERC University Research Fellow and Assistant Professor of Biology (Botany), University of Lethbridge
1981-1983	-NSERC Post-Doctoral Research Fellow, Faculty of Forestry, University of Toronto

Selected Publications in Refereed Journals

Kranjcec, J., J.M. Mahoney and S.B. Rood. 1998. The responses of three riparian cottonwood species to water table decline and implications for branch propagation. Forest Ecology and Management 110: 77-87.

Mahoney, J.M. and S.B. Rood. 1998. Streamflow requirements for cottonwood seedling recruitment - an integrative model. Wetlands 15: 634-645.

Rood, S.B., A.R. Kalischuk and J.M. Mahoney. 1998. Initial cottonwood seedling recruitment following the flood of the century of the Oldman River, Alberta, Canada. Wetlands 15: 557-570.

Willms, J., S.B. Rood, W. Willms and M. Tyree. 1998. Branch growth of riparian cottonwoods: a hydrologically sensitive dendrochronological tool. Trees 12:215-223.

1997

Kalishchuk, A.R., L.A. Gom, K.D. Floate and S.B. Rood. 1997. Intersectional cottonwood hybrids are

particularly susceptible to the poplar bud gall mite. Can. J. Bot. 75:1349 1355.

1996

Rood, S.B. and J.M. Mahoney. 1996 River damming and riparian cottonwoods along the Marias River, Montana. Rivers

1995

Rood, S.B., J. M. Mahoney, D. E. Reid and L. Zilm. Instream flows and the decline of riparian cottonwoods along the St. Mary River, Alberta. Canadian Journal of Botany 73:1250-1260

1994

Rood, S.B., C. Hillman, T. Sanche and J.M. Mahoney. 1994. Clonal reproduction of riparian cottonwoods in Southern Alberta. Can. J. Botany. 72:1766-1770.

Tyree, M., K. Kolb, S.B. Rood and S. Patino. 1994. Vulnerability to drought-induced cavitation of riparian cottonwoods in Alberta: A possible role in decline of the ecosystem. Tree Physiology. 14:455-466.

Zanewich, K. and S.B. Rood. 1994. Endogenous gibberellins of alder, aspen and birch. J. Plant Growth Regulation. 13:159-162.

1993

Campbell, J.S., J.M. Mahoney, and S.B. Rood. 1993. A lack of heterosis in natural poplar hybrids from southern Alberta. Can. J. Botany 71:37-42.

1992

Mahoney, J.M. and S.B. Rood. 1992. Response of a hybrid poplar to water table decline in different substrates. Forest Ecol. and Management 54:141-156.

1991

Greenaway, W., S. English, F.R. Whatley, and S.B. Rood. 1991. Interrelationships of poplars in a hybrid swarm as studied by gas chromatography-mass spectrometry. Can. J. Botany. 69: 203-208.

Mahoney, J.M. and S.B. Rood. 1991. A device for studying the influence of declining water table on poplar growth and survival. Tree Physiol. 8: 305-314.

1990

Neuman, D.S., S.B. Rood and B.A. Smit. 1990. Does cytokinin transport from root-to=shoot in the xylem sap regulate leaf responses to root hypoxia? J. Exp. Bot. 41: 1325-1333.

Rood, S.B. and J.M. Mahoney. The collapse of poplar forests downstream from dams in the Western Prairies: probable causes and prospects for mitigation. Environmental Management. 14:451-464.

1989

Rood, S.B. and S. Heinze-Milne. 1989. Abrupt downstream forest decline following river damming in southern Alberta. Can. J. Bot. 67:1744-1749.

Rood, S.B. and Juntilla O. 1989. Lack of influence of photoperiod on the metabolism of gibberellin A_{20} in *Salix pentandra*. Physiol. Plant 75:506-510.

1988

Bate, N.J., S.B. Rood, and T.J. Blake. 1988. Gibberellins and heterosis in poplar. Can. J. Bot. 66:1148-1152.

Rood, S.B., N.J. Bate, L.N. Mander, and R.P. Pharis. 1988. Identification of gibberellins A_1 and A_{19} from *Populus balsamifera* x *P. deltoides*. Phytochemistry 27:11-14.

1986

Rood, S.B., J.S. Campbell, and T. Despins. 1986. Natural poplar hybrids from southern Alberta. I. Continuous variation for foliar characteristics. Can. J. Bot. 64:1382-1388.

1984

Rood, S.B., G. Daicos, and T.J. Blake. 1984. Gibberellic acid induced growth acceleration in *Populus* hybrids. Can. J. For. Res. 14:850-854.

Other Publications

1994

Willms, J. and S.B. Rood. 1994. Instream flows and riparian cottonwoods along the Bow River, southern Alberta. prepared for Alberta Environmental Protection, Edmonton, AB. 54 pp.

1993

Mahoney, J.M. and S.B. Rood. 1993. A model for assessing the effects of altered river flows on the recruitment of riparian cottonwoods. proceedings from: Riparian Management: Common Threads & Shared Interests. Albuqueque, N.Mexico, USDA Technical Report RM-226.pp. 227- 232..

Mahoney, J.M. and S.B. Rood. 1993. The potential effects of an operating plan for the Oldman River Dam on riparian cottonwood forests. prepared for Alberta Public Works, Supply and Services, Edmonton, AB. 108 pp. + 83 pp. appendices.

Rood, S.B. and C. Bradley. 1993. Assessment of riparian cottonwoods along the Bow River downstream from Calgary, Alberta. University of Lethbridge. 63 pages.

Rood, S.B. and J.M. Mahoney. 1993. River Damming and Riparian Cottonwoods: Management Opportunities and Problems. proceedings from: Riparian Management: Common Threads & Shared Interests. Albuqueque, N.Mexico. USDA Technical Report RM-226. pp. 134-143.

1992

Rood, Stewart. 1992. Chinook Country Rivers: Dammed But Not Forgotten. pages 83 to 98 in ÔFlowing to the Future - 1991Õ. edited by G. Hanna, T. Pyrch, and C. V. Smith. University of Alberta (Edmonton).

Rood, S.B. and J.M. Mahoney. 1992. Instream flow needs for riparian vegetation: riparian cottonwood forests. Instream flow neeeds seminar proceedings, Alberta Environment, Edmonton.

1991

Kocsis, M., J.M. Mahoney and S.B. Rood. 1991. Effects of substrate texture and rate of water table decline on transpiration and survival of poplar species. In: S.B. Rood and J.M. Mahoney (eds.) The Biology and Management of Southern Alberta's Cottonwoods. pp. 63-67.

Lee, C., J.M. Mahoney and S.B. Rood. 1991. Poplar seeds and seedlings along the St. Mary, Belly and Waterton Rivers, Alberta. In: S.B. Rood and J.M. Mahoney (eds.) The Biology and Management of Southern Alberta's Cottonwoods. pp. 85-90.

Mahoney,J.M., P. Koegler and S.B. Rood. 1991. The accuracy of tree ring core analysis for estimating the age of riparian poplars. In: S.B. Rood and J.M. Mahoney (eds.) The Biology and Management of Southern Alberta's Cottonwoods. pp. 25-30.

Mahoney, J.M. and S.B. Rood. 1991. A model for assessing the impact of altered river flows on riparian poplars in southwestern Alberta. In: S.B. Rood and J.M. Mahoney (eds.) The Biology and Management of Southern Alberta's Cottonwoods. pp. 99-104.

Rood, S.B. and J.M. Mahoney. 1991. The effects of river damming on cottonwood forests in southern Alberta. In: J. Byrne and C. Fleming (eds.) Proceedings of Irrigation Research and Development Conference - 1990. University of Lethbridge. pp. 469-476.

Rood, S.B. and J.M. Mahoney. 1991. The importance and extent of cottonwood forest decline downstream from dams. In: S.B. Rood and J.M. Mahoney (eds.) The Biology and Management of Southern Alberta's Cottonwoods. pp. 1-9.

Stobbs, K., A. Corbiere, J.M. Mahoney and S.B. Rood. 1991. Influence of rate of water table decline on establishment and survival of hybrid poplar seedlings. In: S.B. Rood and J.M. Mahoney (eds.) The Biology and Management of Southern Alberta's Cottonwoods. pp. 47-53.

Virginillo, M., J.M. Mahoney and S.B. Rood. 1991. Effects and survival of poplar seedlings along the Oldman River, Southern Alberta. In: S.B. Rood and J.M. Mahoney (eds.) The Biology and Management of Southern Alberta's Cottonwoods. pp. 55-61.

1990

Rood, S.B. 1990. The parched Oldman: Vanishing rivers in southern Alberta. In: Flowing to the Future. University of Alberta pp. 131-144. (invited, non-refereed).

Rood, S.B. and J.M. Mahoney. 1990. The collapse of river valley forests downstream from dams in the Rocky Mountain foothills. In: Delisle, C.E. and M.A. Bouchard (eds.) Managing the effects of hydroelectric development. Collection Environment et Geologie, Univ. de Montreal. Can. Soc. Environ. Biol. pp. 417-430. (invited, non-refereed).

1988

Rood, S.B. 1988. Potential impact of the Oldman River Dam on downstream vegetation. In: S.B.Rood and F.J. Jankunis (eds.) Economic, Environmental, and Social Aspects of the Oldman River Dam Project. University of Lethbridge. pp. 137-144. (invited, non-refereed).

Rood, S.B. 1988. The Coalbanks Canal, Lethbridge: A demonstration of multiple-use water management. In: The CAOC Water Conference - Notes from a Canadian Conference. pp. 209-214. (invited, non-refereed).

Other Invited Conference Presentations

1993

Mahoney, J.M. and S.B. Rood. 1993. A model for assessing the effects of altered river flows on the recruitment of riparian cottonwoods. conference: Riparian Management: Common Threads & Shared Interests. Albuqueque, N.Mexico, Feb. 4-6. (poster).

Rood, S.B. and J.M. Mahoney. 1993. River Damming and Riparian Cottonwoods: Management Opportunities and Problems. conference: Riparian Management: Common Threads & Shared Interests. Albuqueque, N.Mexico, Feb. 4-6. (invited oral presentation).

Some Research Grants Recently Held

NSERC Operating Grant - Gibberellins and crop growth regulation. - $44,426 for 1995/6.

NSERC Strategic Grant - Biology and Preservation of River Valley Cottonwoods - $56,000 to $61,500 per year 1995 to 2000

NSERC Partnership Grant - Evaluation of hormone content in Populus species - $10,000 to $20,000 per year 1996 to 1999

Some Research Contracts Recently Held

Alberta Environment. Riparian Cottonwoods and the Operation of the Oldman River Dam. $15,000 for 1993; $10,000 for 194; $10,000 for 1995.

Alberta Environmental Protection. Instream flow needs for riparian cottonwoods along the Bow and South Saskatchewan rivers. $10,000 per year 1994 to 1996.

Alberta Public Works and Services - Contract - Mitigation and Monitoring of the influence of the Oldman Dam on Downstream Poplar Forests - $45,000 for 1991/92.

United States Department of Agriculture - Forest Service - Cooperative Agreement - Role of Xylem Disfunction in the Decline of Riparian Forest Ecosystems. - $14,100 for 1993/94

United States Fish & Wildlife Service. - Instream flows for riparian restoration along the Truckee River, Nevada. $36,000 for 1995.

Partially Revised: Dec. 1998

Dr. JOHN M. MAHONEY, P.Biol.

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SKILLS and ABILITES

- over 15 years experience leading and working effectively within interdisciplinary groups
- postgraduate training in integrated planning augmented with over 11 years experience
- proven delivery of programs within time and financial constraints
- equally able to relate to and deal with, the public, professionals, and elected personnel

EDUCATION

U. of Calgary	Doctor of Philosophy (Riparian Ecology)	1992-96
U. of Calgary	Master of Environmental Design (Environmental Management)	1980-84
U. of Calgary	Bachelor of Science (Animal Biology)	1978-80
U. of Waterloo	Honours Bachelor of Science (Science)	1972-76

AWARDS

University of Calgary Silver Anniversary Graduate Fellowship	1994/95
Province of Alberta Graduate Fellowship, University of Calgary (declined)	1993/94
NSERC Post Graduate Award - University of Calgary	1992 - 1994
Faculty of Graduate Studies Award, University of Calgary	1992 - 1994
Graduate Assistantship (Research) - University of Calgary	1983/84

RELEVANT EXPERIENCE

Current Position:

Senior Environmental Biologist **1993-present**
Alberta Environmental Protection

- member of interdepartmental Oldman River Dam Environmental Monitoring Committee
- co-ordinated Oldman River Dam wildlife monitoring program with regional wildlife biologists to maximize value of studies
- collaborated with Fisheries biologists to integrate mitigation projects and monitoring with Fisheries Management programs to provide an effective overall program
- completed field studies into the environmental effect of the Oldman River Dam (ORD)
- worked closely with Branch engineers and technologists to ensure integration of hydrological requirements for cottonwoods with real time operations in the basin
- assessed compliance of ORD operations with respect to Fish Rule Curve requirements
- reviewed instream projects to ensure compatibility with Fisheries Management objectives

Research Associate **1988-1993**
University of Lethbridge

- developed a program to integrate the needs of downstream riparian ecosystems without impeding the normal operations of onstream dams
- managed and supervised up to 4 seasonal field personnel
- investigated the effect of the Oldman River Dam Project on downstream riparian ecology
- invented a device for testing the effect of dynamic water tables on plants

Professional Affiliations

Alberta Society of Professional Biologists
Canadian Society of Environmental Biologists

Other Interests

Lethbridge Community College - Program Advisory Committee - member for Renewable Resource Management, and Fish and Wildlife Technology Programs, 1997-present

International Canoe Federation - International Judge for Slalom and Wildwater certification
- Canadian Official to Olympic Games, Atlanta, 1996

I-015469

PUBLICATIONS and REPORTS

Doctoral Thesis

Mahoney, J.M., 1996. *How River Hydrology Affects the Establishment and Growth of Riparian Poplars.* Department of Geography, University of Calgary, Alberta.

Masters Degree Project

Mahoney, J.M., 1984. *An Evaluation of Shelterbelt Development in Alberta.* Faculty of Environmental Design, University of Calgary, Alberta.

Refereed Publications

J. Kranjec, J.M. Mahoney & S.B. Rood, 1998. *The Response of Three Riparian Cottonwood Species to Water Table Decline.* Forest Ecology and Management, 110:77-87.

J.M. Mahoney & S.B. Rood, 1998. *Streamflow Requirements for Cottonwood Seedling Recruitment - An integrative model.* Wetlands, 18(4):634-645.

S.B. Rood, A.R. Kalischuk & J.M. Mahoney, 1998. *Initial Cottonwood Seedling Recruitment Following the Flood of the Century of the Oldman River, Alberta, Canada.* Wetlands, 18(4):557-570.

S.B. Rood & J.M. Mahoney, 1995. *River Damming and Riparian Cottonwoods along the Marias River, Montana.* Rivers, 5(3):195-207.

S.B. Rood, J.M. Mahoney, D.E. Reid & L. Zilm, 1995. *Instream Flows and the Decline of Riparian Cottonwoods along the St. Mary River, Alberta.* Canadian Journal of Botany, 73:1250-1260.

S.B. Rood, C. Hillman, T. Sanche & J.M. Mahoney, 1994. *Clonal Reproduction of Riparian Cottonwoods in Southern Alberta.* Canadian Journal of Botany, 72:1766-1774.

J.S. Campbell, J.M. Mahoney & S.B. Rood, 1993. *A Lack of Heterosis in Natural Poplar Hybrids from Southern Alberta.* Canadian Journal of Botany, 71:37-42.

J.M. Mahoney & S.B. Rood, 1992. *Response of Hybrid Poplar to Water Table Decline in Different Substrates.* Forest Ecology and Management, 54:141-156

J.M. Mahoney & S.B. Rood, 1991. *A Device for Studying the Influence of Declining Water Table on Poplar Growth and Survival.* Tree Physiology, 8(3):305-314.

S.B. Rood & J.M. Mahoney, 1990. *The Collapse of River Valley Forests Downstream from Dams in the Western Prairies: Probable causes and prospects for mitigation.* Environmental Management, 14(4):451-464.

R. Bell, R. Coote, M. Copeman, T. Duguid, J. Mahoney, M. McCallum & B. Pitman, 1982. *The Road Not Taken: Transportation planning in Banff National Park.* Alternatives, 11(25 30).

J.M. Mahoney & H.I. Rosenberg. 1981. *Anatomy of the Tail in the Beaver Castor canadensis*. Canadian Journal of Zoology, 59(3):390-399.

Non-refereed Publications and Major Reports

J.M. Mahoney, 1996. *The Effect of the 1995 Oldman River Flood on Riparian Cottonwood Forests*. Canadian Water Resources Association Technical Supplement, Summer. 3p.

J.M. Mahoney & S.B. Rood. 1993. *The Potential Effects of an Operating Plan for the Oldman River Dam on Riparian Cottonwood Forests*. Oldman River Dam Mitigation Program Downstream Vegetation Project Report Volume II. Alberta Public Works Supply and Services. Edmonton. 180p.

C.E. Bradley F. Reintjes & J.M. Mahoney, 1991. *The Biology and Status of Riparian Poplars in Southern Alberta*. World Wildlife Fund Canada and Fish and Wildlife Division of Alberta Forestry, Lands and Wildlife, Edmonton. 101p.

Hardy BBT Limited & University of Lethbridge, 1991. *Riparian Vegetation of St. Mary, Belly and Waterton River Valleys, Alberta*. Planning Division, Alberta Environment, Edmonton. 102 p. plus appendices.

S.B. Rood & J.M. Mahoney, 1991. *The Biology of Riparian Cottonwood Forests in the Oldman River Basin*. Oldman River Dam Mitigation Program Downstream Vegetation Project Report Volume I. Alberta Public Works Supply and Services, Edmonton. 150p.

S.B. Rood & J.M. Mahoney, 1991. *Impacts of the Oldman River Dam on Riparian Cottonwood Forests Downstream*. University of Lethbridge, Biological Sciences. 34p.

S.B. Rood & J.M. Mahoney (eds.), 1991. *Proceedings of the Biology and Management of Southern Alberta's Cottonwoods Conference*. May 3,4, 1990. University of Lethbridge, Alberta. 124p.

J.M. Mahoney & S.B. Rood, 1990. *Developing Operations Rule Curves to Maintain Poplar Forests Downstream from the Oldman River Dam*. Alberta Public Works supply and Services, Edmonton. 6p.

S.B. Rood & J.M. Mahoney, 1989. *River Damming and River Valley Poplar Forests in the Oldman River Basin: Background and initial analysis*. Alberta Public Works Supply and Services, Edmonton. 75p.

J.M. Mahoney, 1985. Pattern Recognition of Remotely sensed Image Data. Alberta Bureau of Surveys and Mapping. LRIS Newsletter, 6(2):5-8.

J.M. Mahoney, 1984. *An Evaluation of Shelterbelt Development in Alberta, (Summary Report)*. Alberta Environmental Research Trust. 41p.

M. McCallum, G. Browning, M. Dehn, J. Mahoney, K. Rothwell, U. Wittkugel & C. Yarmoloy, 1982. *Cutoff Creek Gas Pipeline Corridor Location Study*. Canterra Energy Ltd. 82p.

R. Bell, R. Coote, M. Copeman, T. Duguid, J. Mahoney, M. McCalum & B. Pitman, 1982. *Transportation Planning in Banff National Park: A response to Public Works Canada*. Faculty of Environmental Design, University of Calgary. 62p.

Conference Proceedings and Posters

A.R. Kalischuk, J.M. Mahoney & S.B. Rood, 1997. A Flood of Seedlings. *In*; Wetlands Heritage and Stewardship, Society of Wetland Scientists 18th Annual Meeting, Bozeman Montana.

J.M. Mahoney, 1997. Incorporating Downstream Ecosystem Concerns into reservoir Operations in Southwestern Alberta, Canada. *In*; Wetlands Heritage and Stewardship, Society of Wetland Scientists 18th Annual Meeting, Bozeman Montana.

A.R. Kalischuk, L.A. Gom, J.M. Mahoney & S.B. Rood, 1996. A River Ran Through It: Cottonwood seedling recruitment following the flood of the century in Chinook Country. Western Division, Canadian Association of Geographers Annual Meeting. March 8,9, Lethbridge, Alberta.

J.M. Mahoney, J. Willms & S.B. Rood, 1996. Environmental Control of Shoot Growth of Riparian Cottonwoods along the St. Mary River, Alberta, CANADA. *In*; Proceedings of the Fourth Prairie Conservation and Endangered Species Workshop, Lethbridge, February, 1995. Provincial Museum of Alberta, Curatorial Section, Edmonton. Natural History Occassional Paper No. 23.

S.B. Rood, J.M. Mahoney, K.P. Zanewich & M.F. Wilfong. 1996. River Damming and riparian Cottonwoods in the Western Prairies. *In*; Proceedings of the Fourth Prairie Conservation and Endangered Species Workshop, Lethbridge, February, 1995. Provincial Museum of Alberta, Curatorial Section, Edmonton. Natural History Occassional Paper No. 23.

J.M. Mahoney, J. Willms & S.B. Rood, 1994. Environmental Control of Branch and Annual Ring Growth in Riparian Poplars on the Lower St. Mary River, Alberta CANADA. *In*; Diverse Values: Seeking Common Ground, Northwest Regional Riparian Symposia. December 8-9, Boise Idaho.

J.M. Mahoney, 1993. A Model for Assessing the Effects of Altered River Flows on the Recruitment of Riparian Cottonwoods. *In*; Proceedings of the 30th Annual Department of Geography Conference. University of Calgary. Alberta. Awarded Prize for Best Paper at the Conference.

J.M. Mahoney & S.B. Rood, 1993. A model for assessing the Effects of Altered River flows on the Recruitment of Riparian Cottonwoods. *In*; Riparian Management: Common threads and shared interests, B. Tellman, H.J. Cortner, M.G. Wallace, L.F. DeBano & R.H. Hamre (eds). USDA Forest Service General Technical report RM-226, Albuquerque, NM.

S.B. Rood & J.M. Mahoney, 1993. River Damming and riparian Cottonwoods: Management opportunities and problems. *In*; Riparian Management: Common threads and shared interests, B. Tellman, H.J. Cortner, M.G. Wallace, L.F. DeBano & R.H. Hamre (eds). USDA Forest Service General Technical report RM-226, Albuquerque, NM.

S.B. Rood & J.M. Mahoney, 1992. Instream Flow Needs for Riparian Vegetation Cottonwood forest ecosystems. *In*; Proceedings of the Instream Flow Needs Seminar, Alberta Environment, Agriculture, Forestry Lands and Wildlife, Water Resources Commision, Tourism Parks and recreation, Municipal Affairs, Edmonton.

J.M. Mahoney, P. Koegler & S.B. Rood, 1991. The Accuracy of Tree Ring Analysis for Estimating the Age of Riparian Poplars. *In*; Proceedings of the Biology and Management of Southern Alberta's Cottonwoods Conference, S.B. Rood and J.M. Mahoney (eds). May 3,4, University of Lethbridge. Alberta.

K. Stobbs, A. Corbiere, J.M. Mahoney & S.B. Rood, 1991. The Influence of Rate of Water Table Decline on Establishment and Survival of Hybrid Poplar Seedlings. *In*: Proceedings of the Biology and Management of Southern Alberta's Cottonwoods Conference. S.B. Rood and J.M. Mahoney (eds). May 3,4, University of Lethbridge, Alberta.

S.B. Rood & J.M. Mahoney, 1990. The Collapse of River Valley Forests Downstream from dams in the Rocky Mountain Foothills. *In*: Collection Environnemment et Geologie, C.E. Delisle and A.M. Bouchard (eds). Canadian Society of Environmental biologists, Montreal. 9(21):417-430.

Invited Seminars and Conference Organization

Mahoney, J.M., 1998. Environmental Monitoring of the Oldman River Dam Project. Alberta Society of Professional Biologists, Professional Development Seminar, Calgary.

Mahoney, J.M., 1997. Incorporating Downstream Ecosystem Concerns into Reservoir Operations in Southwestern Alberta, Canada. Society of Wetland Scientists, Bozeman Montana.

Mahoney, J.M., 1996. The Oldman River Dam: Past, Present and Future Environmental Concerns. Department of Geography, University of Calgary.

Mahoney, J.M., 1993. River Hydrology and Riparian Cottonwoods. Biological Sciences, University of Lethbridge.

Co-organizer, 1990. Biology and Management of Southern Alberta Cottonwoods Conference. May 4-6, University of Lethbridge.

Mahoney, J.M., 1990. The Effects of Managing Water Resources on Riparian Poplars in Southern Alberta. Biological Sciences, University of Lethbridge.

Joe R. McBride
Department of Environmental Science, Policy, and Management
and
Department of Landscape Architecture
University of California, Berkeley, CA 94720

Education:

B.S. (Forestry) University of Montana 1960
M.S. (Forestry) - University of California, Berkeley - 1964
Ph.D. (Botany) - University of California, Berkeley - 1969

Employment:

Assistant Professor. Department of Forestry. Iowa State University. 1969-70.
Assistant Professor, Associate Professor, Professor. University of California. 1970-present.
Chair, Department of Forestry, University of California, 1986-89; Chair, Department of Environmental Science, Policy, and Management, University of California, 1996-98; Chair, Forest Science Division, University of California. 1996-present.

Teaching:

Courses in ecological analysis, forest ecology, vegetation management, urban forestry, regional landscape analysis, dendrology, and ecology of the Sierra Nevada

Research:

Studies concerned with urban forestry, the influence of land management on forest succession, regeneration and genetics of California oaks, riparian woodland ecology, and fire history.

Professional Experience:

Worked as a consultant in the fields of urban forestry, vegetation analysis, and management for over 25 years. Served as an advisor to federal, state, regional, county, and city governmental agencies. Registered professional forester in California (license #1306).

Professional Affiliations:

American Association for the Advancement of Science
American Society of Landscape Architects
California Botanical Society
Ecological Society of America
International Society for Landscape Ecology
Society of American Foresters
Society for Restoration Ecology

Awards:

Merit Award for Stanford University Vegetation Management Plan. ASLA. 1983
Resources Preservation Award for San Francisco Presidio Study. National Resources Council. 1987
Distinguished Teaching Award. University of California. 1991
Carl Alwin Schenck Award for Distinguished Teaching. Society of American Foresters. 1992
Honor Award for Sutro Baths Historic Restoration Plan. ASLA. 1993
Donald P. Gasser Award for Distinguished Contributions to Forestry Education. University of California. 1997
Fellow Society of American Foresters. 1997

Publications:

Over 200 articles and research reports

Community Service:

Natural Heritage Advisory Committee, DFG, Sacramento, CA - 1980 to 1982
Blue Ribbon Fire Management Committee, EBRPD, Oakland, CA - 1982 to 1983
Task Force on Prescribed Burning in the National Parks, NPS - 1986 to 1987
Task Force on Biological Diversity, SAF, Washington, DC - 1987 to 1989
Natural Resource Advisor Amazanga Institute, Puyo, Equador - 1991-1994
Advisory Task Force on Vegetation Management in the National Parks of China, Chinese Academy of Forestry, Beijing - 1992-94
California Biodiversity Council, DFG, Sacramento, CA - 1996-97
Science Advisory Committee for the Southwestern Willow Flycatcher, USFWS and US Army Corps of Engineers, Sacramento, CA - 1997 98
Economic-Environmental Advisory Committee, Ningbo, P. R. China 1997 -present

Joe R. McBride
Publications

Last Five Years:

Nowak, D.J. and J.R. McBride. 1992. Differences in Monterey pine pest populations in urban and natural forests. Forest Ecology and Management 50:133-144.

McCreary, S., G.M. Kondolf, J.R. McBride, and R. Twiss. 1992. Independent Review of Environmental Documentation for Petroleum Exploration in Block 10, Oriente, Ecuador. Center for Environmental Design Research. University of California. Berkeley, CA. 79 p.

McBride, J.R. 1993. Managing National Parks. Renewable Resources Journal (Spring, 1993): 29-30.

Nowak, D. J and J. R. McBride. 1993. Testing Microdensitometric Ability to Determine Monterey Pine Urban Tree Stress. Photogrammetric Engineering and Remote Sensing 59 (1): 89-91.

Medbury, S. and J. R. McBride. 1994. Urban forestry and plant conservation. The Public Garden 9(1):14-17, 40-41.

McBride, J. R. 1994. Riparian Woodlands SRM 203. In T.N. Shiflet (ed.) Rangeland Cover Types of the United States. Society for Range Management. Denver, CO. pp. 13-14.

McBride, J. R. and D. Gerhard. 1995. Urban riparian woodland ecology in the San Francisco Bay Area. Proc. Seventh National Urban Forestry Conference. New York City, September 11 to 16, 1995. American forestry Association. Washington. D.C., pp236-239.

Barnhart, S. J., J. R. McBride and P. Warner. 1995. *Pseudotsuga menziesii* (Mirb.) Franco invasion of northern oak woodlands in the Sonoma mountains of California. Madrono 42:295-316.

Sugihara, N. G. and J. R. McBride. 1996. Dynamics of sugar pine and associated species following non-stand-replacing fires in white fir-dominated mixed conifer forests. In: Kinloch, B. B ,Jr., M. Marosy, and M. E. Huddleston (eds.) Sugar Pine: Status, Value, and Roles in Ecosystems: Proceedings of a symposium presented by the California Sugar Pine Management Committee. University of California, Division of Agriculture and Natural Resources, Davis, California. Publication 3362. pp. 39-44.

McBride, J. R., W. Russell and S. Kloss. 1996. Impact of Human Settlement on Forest Composition and Structure. Sierra Nevada Ecosystem Project, Final Report to Congress, Vol. II. Assessments and Scientific Basis for Management Options. Davis: University of California, Centers for Water and Wildland Resources, pp. 1193-1202.
McBride, J. R. et al. 1997. Genetic Architecture of Blue Oak. Proceedings of the California Oak Woodland Conference. California State University, San Luis Obispo, CA. (in press)

McBride, J. R. et al. 1997. Restoration Management of Oregon White Oak Woodlands at Anadel State Park, Sonoma County, CA. Proceedings of the California Oak Woodland Conference. California State University, San Luis Obispo, CA. (in press)

Selected Earlier Publications:

McBride, J.R. and H.F. Heady. 1968. Invasion of grassland by Baccharis pilularis, Jour. Range Mgt. 21:106-108.

McBride, J.R. 1974. Plant succession in the Berkeley Hills, California. Madrono 22:317-329.

McBride, J.R., and V.P. Semion and P.R. Miller. 1975. Impact of air pollution on the growth of ponderosa pine. California Agriculture 29(12):8-9.

McBride, J.R. and R.D. Laven. 1976. Scars as indicators of fire frequency in the San Bernardino Mountains, California. Jour Forestry 74(7):439-442.

McBride, J.R. and D. Jacobs. 1976. Urban forest development: A study, Menlo Park, California. Urban Ecology 2:1-14.

McBride, J.R. and E.C. Stone. 1976. Plant succession on the sand dunes of the Monterey Peninsula, California. American Midland Naturalist 96(1):118-132.

McBride, J.R. 1977. Evaluation of vegetation in environmental planning. Landscape Planning 4:291-312.

McBride, J.R. and D.F. Jacobs. 1978. History of vegetation of Muir Woods. U.S. National Park Service. San Francisco, CA. 81 p.

McBride, J.R. and D.F. Jacobs. 1980. Land use and fire history in the mountains of southern California. Proc. of the Fire History Workshop. U.S.F.S. General

Technical Report RM-81. Ft. Collins, CO. pp. 85-89.

McBride, J.R. 1983. Analysis of tree rings and fire scars to establish fire history. Tree Ring Bulletin 43:35-48.

McBride, J.R. and J. Strahan. 1984. Establishment and survival of woody riparian species on gravel bars of an intermitten: stream. Amer. Midl. Naturalist 112:235-245.

McBride, J.R. and D. Froelich. 1984. Structure and condition of older stands in parks and open space areas of San Francisco, Ca. Urban Ecology 8:165- 178.

Jacobs, D., D. Cole and J.R. McBride. 1985. Fire history and the perpetuation of natural coast redwood ecosystems. Jour. Forestry 83:494-497.

McBride, J.R. and D. Jacobs. 1986. Presettlement forest structure as a factor in urban forest development. Urban Ecology 10:26-52.

Matsuda, K. and J.R. McBride. 1986. Differences in seedling growth morphology as a factor in the distribution of three oaks in central California. Madrono 33:207-216.

McBride, J.R. and P.R. Miller. 1987. Response of American Forests to Photo-chemical Oxidants. In T.C. Hutchinson (Ed.) Proceedings of the Acid Deposition Workshop, Univ. Toronto, May 12-17, 1985. Toronto, CA. Springer-Verlag, NY pp. 217-228.

Matsuda, K. and J.R. McBride. 1989. Germination characteristics of selected California oak species. Madrono 122(1):66-76.

McBride, J.R., N. Sugihara and E. Norberg. 1989. Growth and survival of three riparian woodland species in relation to simulated water table dynamics.Environmental, Health, and Safety Report 009.4-89.3. Pacific Gas and Electric Company. San Ramon, CA. 42p.

McBride, J.R. and A. Mossadegh. 1990. Potential Influence of Climatic change on California oaks. Fremontia 18(3):55-57.

Nowak, O.J., McBride, R. and R.A. Beatty. 1990. Newly planted street tree growth and mortality. J. Arboriculture 16(5): 124-129.

Nowak, D.J. and J.R. McBride. 1991. Comparisons of Monterey pine stress in urban and natural stands. Jour. Environ. Management. 32:383-395.

William Eric Dietrich, Ph.D.
Professor of Geology and Geophysics

Education

Ph.D., University of Washington, 1982
M.S., University of Washington, 1975
B.S., Occidental College, 1972

Honors

National Science Foundation, Presidential Young Investigator, 1985-1990
Gordon Warwick Award, British Geomorphological Research Group, 1986
Fellow, American Geophysical Union, 1992
Fellow, Geological Society of America, 1992
Wiley Award for paper published in Earth Surface Processes and Landforms in 1991 (with Steve Reneau) (given by the British Geomorphological Research Group)
Crosby Lecturer, MIT, 1994
Horton Award, American Geophysical Union, 1995

Professional Experience

Summer intern, Water Resources Technical Division, Washington, State Department of Ecology, 1974
Research Assistant, University of Washington, 1978-1981
Assistant Professor, University of California, Berkeley, 1981-1986
Associate Professor, University of California, Berkeley, 1986- 1990
Occasional consultant on hydrology, fluvial and hillslope geomorphology

Professional Societies

American Geophysical Union
British Geomorphological Research Group
Japanese Geomorphological Union
Geological Society of America
American Geomorphological Field Group

Professional Responsibilities

Member, American Geophysical Union Hydrology Section Unsaturated Zone Committee, 1984-1992 and Erosion and Sedimentation Committee, 1984-present
Chairman, Erosion and Sedimentation Committee of the American Geophysical Union Hydrology Section, 1988-1990
Member, Editorial Board, *Geology*, 1986-1988; 1990-1993
Member, National Science Foundation sponsored Japan-U.S. Cooperative Science Program on Mechanics of River Meanders, 1985-1987
Member, the Commission on Measurement, Theory and Application in Geomorphology, International Geographical Union, 1984-1988
Member, the Erosion Studies Scientific Advisory Committee of the California Department of Forestry and Fire Protection, 1986
Member, Editorial Board, *Catena*, 1986-1992
Editorial Board, Annual Reviews of Earth and Planetary Sciences 1992-1996
Deputy Editor, Water Resources Research, 1993-1996

Academic Responsibilities

Graduate Advisor, 1982-1985; 1990-1992
Undergraduate Advisor, 1986-1988; 1989-1990
Member of Group in Soil Science, 1983-1991
Affiliated Faculty of Energy and Resources Group, 1989-present

Publications

1. Dietrich, W.E., 1975, Surface water resources of San Juan County, *in*, Geology and Water Resources of the San Juans, R.H. Russel (ed.), Water Supply Bulletin No. 46, Washington Department of Ecology, p. 59-125.

2. Dietrich, W.E. and T. Dunne, 1978, Sediment budget for a small catchment in mountainous terrain: Zeit. für Geomorph., Suppl. Bd. 29, p. 191-206.

3. Dunne, T., W.E. Dietrich and M. Brunengo, 1978, Recent and past erosion rates in semi-arid Kenya: Zeit. für Geomorph., Suppl. Bd. 29, p. 130-140.

4. Dunne, T., W.E. Dietrich and M. Brunengo, 1979, Rapid evaluation of soil erosion and soil lifespan in the grazing lands of Kenya: Proc. Internatl. Assoc. Hydrol. Sci., Canberra Symposium on the Hydrology of Areas of Low Precipitation, p. 421-428.

5. Dietrich, W.E., J.D. Smith and T. Dunne, 1979, Flow and sediment transport in a sand bedded meander: Jour. of Geol., v. 87, p. 305-315.

6. Dunne, T., W.E. Dietrich and M. Brunengo, 1980, Simple, portable equipment for erosion experiments under artificial rainfall: Jour. Agric. Engineer. Res., v. 25, p. 1-8.

7. Dunne, T. and W.E. Dietrich, 1980, Experimental study of Horton overland flow on tropical hillslopes: I. Soil condition, infiltration and frequency of runoff: Zeit. für Geomorph., Suppl. Bd. 35, p. 40-59.

8. Dunne, T. and W.E. Dietrich, 1980, Experimental study of Horton overland flow on tropical hillslopes: II. Hydraulic characteristics and hillslope hydrographs: Zeit. für Geomorph., Suppl. Bd. 35, p. 60-80.

9. Dunne, T., W.E. Dietrich, N. Humphrey and D. Tubbs, 1981, Geologic and geomorphic aspects of gravel supply in western Washington, *in*, Proc. on Salmon-spawning Gravels, J.J. Cassidy (ed.), Wash. State Water Res. Center, Report No. 39, p. 75-100.

10. Dietrich, W.E., T. Dunne, N.F. Humphrey and L.M. Reid, 1982, Construction of sediment budgets for drainage basins: *in* Sediment Budgets and Routing in Forested Drainage Basins, F.J. Swanson, R.J. Janda, T. Dunne, and D.N. Swanston (eds.), U.S.D.A. Forest Service General Technical Report PNW-141, Pacific Northwest Forest and Range Experiment Station, Portland, Oregon, p. 5-23.

11. Dunne, T. and W.E. Dietrich, 1982, Sediment sources in tropical catchments: Proc. Soil Erosion and Conservation in the Tropics, Amer. Soc. of Agronomy Symp., Colorado State University, August 1979, Spec. Publ., no. 43, p. 41-55.

12. Dietrich, W.E., 1982, Settling velocity of natural particles: Water Resources Research, v. 18, no. 6, p. 1615-1626.

13. Dietrich, W.E., 1982, Mechanics of a river meander: *in*, Field Trip Guidebook 1982 Conference of the American Geomorphological Field Group, Pinedale, Wyoming, L.B. Leopold (ed.), p. 18-29.

14. Dietrich, W.E., D. Windsor and T. Dunne, 1982, Geology, climate, and hydrology of Barro Colorado Island: *in*, Seasonal Rhythms and the Ecology of a Tropical Forest: Seasonal Rhythms and Long-term Changes, E.G. Leigh, Jr., A.S. Rand and D.M. Windsor (eds.), Smithsonian Institution Press, Washington, D.C., p. 21-46.

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82. Heimsath, A. H., W. E. Dietrich, K. Nishiizumi, and R. C. Finkel, 1997, The soil production function and landscape equilibrium, Nature - July 24 issue.

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Education

B.A., Brown University (Biology), Providence, Rhode Island, 1971
M.S., Boston University Marine Program (Biology), Woods Hole, Massachusetts, 1974
PhD., University of Washington (Zoology), Seattle, Washington, Dec. 1981
"The grazing ecology of armored catfish in a Panamanian stream"

Professional Experience

Visiting Assistant Professor, Division of Entomology and Parasitology, University of California, Berkeley, 1986-1987
Assistant Professor, Department of Zoology, and Integrative Biology, University of California, Berkeley, 1987-1992
Associate Professor, Department of Integrative Biology, University of California, Berkeley, 1992 - 1996
Professor, Department of Integrative Biology, University of California, Berkeley, 1996 - present

Faculty Manager, Angelo Coast Range Reserve, 1989 - present
Chair, Aquatic Ecology Section, Ecological Society of America, 1995-1996
Chair, University-Wide Natural Reserve System Advisory Committee, 1995-1998

Honors and Awards

Sigma Xi, 1971

Phi Beta Kappa, 1971

B.A., magna cum laude 1971

Summer student fellowships, Woods Hole Oceanographic Inst., 1972, 1973

Nobel summer fellowship, Smithsonian Tropical Res. Inst., 1976

Walter Rathbone Bacon Fellowship for Field Biology, Smithsonian Institution, 1978-80

National Science Foundation Dissertation Improvement award 1978-80 ($3300)

National Science Foundation award (Ecology panel), 1983-85: "Multi-level effects of an algae-grazing minnow (Campostoma anomalum) on north temperate streams (with Drs. W.J. Matthews and A.J. Stewart, Univ. Oklahoma ($60,000)

National Science Foundation supplementary award (Ecology panel), 1983-85: "Predators and algae-grazing minnows in north temperate streams: Does the kind of predator matter?" (with Drs. Matthews, Stewart, and R. Cashner) ($10,848)

Jasper Loftus-Hills Prize for Young Investigators, from the American Society of Naturalists, 1985

National Science Foundation Visiting Professorship for Women, 1986-1988: "The role of primary consumers in structuring communities of northern Californian streams ($145,265)

Junior Faculty Award, University of California, Berkeley, 1988

Water Resources Center (California) Award: 1988-90: "Seasonal and hydrologic controls of algal blooms in northern California rivers." ($52,600)

National Science Foundation award (Ecology panel), 1991-1993: "Productivity, plant biomass, and trophic interactions in rivers." ($192,097)

National Science Foundation award (Conservation Biology panel), 1991-1993: "Food web analysis of biodiversity: Application to algal-based river systems." ($100,000)

National Science Foundation award (Ecology panel) (1994-1996): "Disturbance and the structure of river food webs" (with J.T. Wootton and M.S. Parker, $300,000)

Water Resources Center (California) Award: 1993-1995. Effects of stream flow regulation and reduction of scouring floods on trophic transfer of biomass to fish in northern California rivers. ($37,220)

Fulbright Scholar 1994-1995

Teaching Interests

Community ecology, grazing, fish biology, freshwater ecology, food webs

Publications

Power, M.E. 1997. Estimating impacts of a dominant detritivore in a neotropical stream. Review for Trends in Ecology and Systematics 12: 47-49.

Wootton, J.T., M.E. Power, R.T. Paine and C. Pfister. 1997. Nutrients, El Nino Events, and Food Chain Processes in the Rocky Intertidal. Proc. National Academy of Sciences, in press.

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Wootton, J.T., M.S. Parker and M.E. Power. 1996. The effect of disturbance on river food webs. Science 273: 1558-1560.

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Power, M.E. and L. S. Mills. 1995. The Keystone Cops meet in Hilo. Trends in Evolution and Ecology 10: 182-184 (not peer reviewed)

Carpenter, S., T. Frost, L. Persson, M. Power, and D. Soto. 1995. Lakes and rivers. pp. 157-164 In H.A. Mooney and J. Lubchenco. SCOPE Global Biodiversity Assessment, UNEP. (not peer reviewed).

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Power, M.E. and J.H. Todd. 1976. Effects of increasing temperature on social behavior in territorial groups of pumpkinseed sunfish, Lepomis gibbosus. Environ. Pollut. 10: 217-223.

Curriculum Vitae

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1975-82 Professor, Department of Mathematics
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1983-87 Chief, Division of Mathematics and Statistics
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1987- Professor, Department of Statistics,
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1996- Adjunct Professor, School of Mathematical Sciences,
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Membership of Professional Bodies:

Australian Mathematical Society
Statistical Society of Australia
Royal Statistical Society
American Statistical Association (Fellow)
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Biometric Society
International Statistical Institute (Member)
Genetics Society of America
American Society of Human Genetics
Society of Molecular Biology and Evolution
American Association for the Advancement of Science (Fellow)

Current/Previous Memberships:

Australian Statistics Advisory Council (1983-87)
Board of Management, Australian Institute of Criminology (1983-87)
Board of Directors, SIROMATH Pty Ltd (1983-87)
Genome Study Section, National Institutes of Health (1995-1998)

Recent offices held in professional bodies:

Western Northern American Region of Biometrics Society President-Elect (1991-92); President (1992-3); Past President (1993-4)
Institute of Mathematical Statistics: Council Member (1993-1996)

Editorial responsibilities:

Associate Editor: Annals of Statistics (1986-1992); Journal of the American Statistical Association (1988- 1992); International Statistical Review (1987-1991); Journal of Statistical Planning and Inference (1989- 1992); Statistical Science (1991-1994); Journal of Computational Biology (1993-present).

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Terence Paul Speed

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Manuscripts Submitted

1. Comparing DNA-DNA hybridization curves by rates of decay (with R. Guerra) Molecular Biology and Evolution.
2. A decision problem in physical mapping (with B. Yu and D.O. Nelson)
3. Modelling crossover interference using the Poisson skip model (with H. Zhao and K Lange).
4. An algorithm for haplotype analysis (with Shili Lin).

APPENDIX E

I-015505

STATE OF CALIFORNIA

NONDISCRIMINATION COMPLIANCE STATEMENT

STD. 19 (REV. 3-95) FMC

COMPANY NAME
Stillwater Ecosystem, Watershed, & Riverine Sciences

The company named above (hereinafter referred to as "prospective contractor") hereby certifies, unless specifically exempted, compliance with Government Code Section 12990 (a-f) and California Code of Regulations, Title 2, Division 4, Chapter 5 in matters relating to reporting requirements and the development, implementation and maintenance of a Nondiscrimination Program. Prospective contractor agrees not to unlawfully discriminate, harass or allow harassment against any employee or applicant for employment because of sex, race, color, ancestry, religious creed, national origin, disability (including HIV and AIDS), medical condition (cancer), age, marital status, denial of family and medical care leave and denial of pregnancy disability leave.

CERTIFICATION

I, the official named below, hereby swear that I am duly authorized to legally bind the prospective contractor to the above described certification. I am fully aware that this certification, executed on the date and in the county below, is made under penalty of perjury under the laws of the State of California.

OFFICIAL'S NAME
Christine Champe

DATE EXECUTED	EXECUTED IN THE COUNTY OF
15 April 1999	Alameda

PROSPECTIVE CONTRACTOR'S SIGNATURE

PROSPECTIVE CONTRACTOR'S TITLE
President / CEO

PROSPECTIVE CONTRACTOR'S LEGAL BUSINESS NAME
Stillwater Ecosystem, Watershed, & Riverine Sciences

I -015506

I-015506

U.S. Department of the Interior

Certifications Regarding Debarment, Suspension and Other Responsibility Matters, Drug-Free Workplace Requirements and Lobbying

Persons signing this form should refer to the regulations referenced below for complete instructions:

Certification Regarding Debarment, Suspension, and Other Responsibility Matters - Primary Covered Transactions - **The prospective primary participant further agrees by submitting this proposal that it will include the clause titled, "Certification Regarding Debarment, Suspension, Ineligibility and Voluntary Exclusion - Lower Tier Covered Transaction," provided by the department or agency entering into this covered transaction, without modification, in all lower tier covered transactions and in all solicitations for lower tier covered transactions.** See below for language to be used; use this form for certification and sign; or use Department of the Interior Form 1954 (DI-1954). (See Appendix A of Subpart D of 43 CFR Part 12.)

Certification Regarding Debarment, Suspension, Ineligibility and Voluntary Exclusion - Lower Tier Covered Transactions - (See Appendix B of Subpart D of 43 CFR Part 12.)

Certification Regarding Drug-Free Workplace Requirements - Alternate I. (Grantees Other Than Individuals) and Alternate II. (Grantees Who are Individuals) - (See Appendix C of Subpart D of 43 CFR Part 12)

Signature on this form provides for compliance with certification requirements under 43 CFR Parts 12 and 18. The certifications shall be treated as a material representation of fact upon which reliance will be placed when the Department of the Interior determines to award the covered transaction, grant, cooperative agreement or loan.

PART A: **Certification Regarding Debarment, Suspension, and Other Responsibility Matters - Primary Covered Transactions**

CHECK ✓ IF THIS CERTIFICATION IS FOR A PRIMARY COVERED TRANSACTION AND IS APPLICABLE.

(1) The prospective primary participant certifies to the best of its knowledge and belief, that it and its principals:

(a) Are not presently debarred, suspended, proposed for debarment, declared ineligible, or voluntarily excluded from covered transactions by any Federal department or agency;

(b) Have not within a three-year period preceding this proposal been convicted of or had a civil judgment rendered against them for commission of fraud or a criminal offense in connection with obtaining, attempting to obtain, or performing a public (Federal, State or local) transaction or contract under a public transaction; violation of Federal or State antitrust statutes or commission of embezzlement, theft, forgery, bribery, falsification or destruction of records, making false statements, or receiving stolen property;

(c) Are not presently indicted for or otherwise criminally or civilly charged by a governmental entity (Federal, State or local) with commission of any of the offenses enumerated in paragraph (1)(b) of this certification; and

(d) Have not within a three-year period preceding this application/proposal had one or more public transactions (Federal, State or local) terminated for cause or default.

(2) Where the prospective primary participant is unable to certify to any of the statements in this certification, such prospective participant shall attach an explanation to this proposal.

PART B: **Certification Regarding Debarment, Suspension, Ineligibility and Voluntary Exclusion - Lower Tier Covered Transactions**

CHECK__ IF THIS CERTIFICATION IS FOR A LOWER TIER COVERED TRANSACTION AND IS APPLICABLE

(1) The prospective lower tier participant certifies, by submission of this proposal, that neither it nor its principals is presently debarred, suspended, proposed for debarment, declared ineligible, or voluntarily excluded from participation in this transaction by any Federal department or agency.

(2) Where the prospective lower tier participant is unable to certify to any of the statements in this certification, such prospective participant shall attach an explanation to this proposal.

DI-2010
March 1995
(This form consolidates DI-1953, DI-1954, DI-1955, DI-1958 and DI-1963)

PART C: Certification Regarding Drug-Free Workplace Requirements

CHECK ✓ IF THIS CERTIFICATION IS FOR AN APPLICANT WHO IS NOT AN INDIVIDUAL.

Alternate I. (Grantees Other Than Individuals)

A. The grantee certifies that it will or continue to provide a drug-free workplace by:

(a) Publishing a statement notifying employees that the unlawful manufacture, distribution, dispensing, possession, or use of a controlled substance is prohibited in the grantee's workplace and specifying the actions that will be taken against employees for violation of such prohibition;

(b) Establishing an ongoing drug-free awareness program to inform employees about--
(1) The dangers of drug abuse in the workplace;
(2) The grantee's policy of maintaining a drug-free workplace;
(3) Any available drug counseling, rehabilitation, and employee assistance programs; and
(4) The penalties that may be imposed upon employees for drug abuse violations occurring in the workplace;

(c) Making it a requirement that each employee to be engaged in the performance of the grant be given a copy of the statement required by paragraph (a);

(d) Notifying the employee in the statement required by paragraph (a) that, as a condition of employment under the grant, the employee will: --
(1) Abide by the terms of the statement; and
(2) Notify the employer in writing of his or her conviction for a violation of a criminal drug statute occurring in the workplace no later than five calendar days after such conviction;

(e) Notifying the agency in writing, within ten calendar days after receiving notice under subparagraph (d)(2) from an employee or otherwise receiving actual notice of such conviction. Employers of convicted employees must provide notice, including position title, to every grant officer on whose grant activity the convicted employee was working, unless the Federal agency has designated a central point for the receipt of such notices. Notice shall include the identification numbers(s) of each affected grant;

(f) Taking one of the following actions, within 30 calendar days of receiving notice under subparagraph (d)(2), with respect to any employee who is so convicted --
(1) Taking appropriate personnel action against such an employee, up to and including termination, consistent with the requirements of the Rehabilitation Act of 1973, as amended; or
(2) Requiring such employee to participate satisfactorily in a drug abuse assistance or rehabilitation program approved for such purposes by a Federal, State, or local health, law enforcement, or other appropriate agency;

(g) Making a good faith effort to continue to maintain a drug-free workplace through implementation of paragraphs (a) (b), (c), (d), (e) and (f).

B. The grantee may insert in the space provided below the site(s for the performance of work done in connection with the specific grant:

Place of Performance (Street address, city, county, state, zip code)

2532 Durant Ave, Suite 201

Berkeley, CA 94704

Check___if there are workplaces on file that are not identified here.

PART D: Certification Regarding Drug-Free Workplace Requirements

CHECK__IF THIS CERTIFICATION IS FOR AN APPLICANT WHO IS AN INDIVIDUAL.

Alternate II. (Grantees Who Are Individuals)

(a) The grantee certifies that, as a condition of the grant, he or she will not engage in the unlawful manufacture, distribution, dispensing, possession, or use of a controlled substance in conducting any activity with the grant;

(b) If convicted of a criminal drug offense resulting from a violation occurring during the conduct of any grant activity, he or she will report the conviction, in writing, within 10 calendar days of the conviction, to the grant officer or other designee, unless the Federal agency designates a central point for the receipt of such notices. When notice is made to such a central point, it shall include the identification number(s) of each affected grant

PART E: Certification Regarding Lobbying
Certification for Contracts, Grants, Loans, and Cooperative Agreements

CHECK ✓ IF CERTIFICATION IS FOR THE AWARD OF ANY OF THE FOLLOWING AND THE AMOUNT EXCEEDS $100,000: A FEDERAL GRANT OR COOPERATIVE AGREEMENT; SUBCONTRACT, OR SUBGRANT UNDER THE GRANT OR COOPERATIVE AGREEMENT.

CHECK __ IF CERTIFICATION IS FOR THE AWARD OF A FEDERAL LOAN EXCEEDING THE AMOUNT OF $150,000, OR A SUBGRANT OR SUBCONTRACT EXCEEDING $100,000, UNDER THE LOAN.

The undersigned certifies, to the best of his or her knowledge and belief, that:

(1) No Federal appropriated funds have been paid or will be paid, by or on behalf of the undersigned, to any person for influencing or attempting to influence an officer or employee of an agency, a Member of Congress, and officer or employee of Congress, or an employee of a Member of Congress in connection with the awarding of any Federal contract, the making of any Federal grant, the making of any Federal loan, the entering into of any cooperative agreement, and the extension, continuation, renewal, amendment, or modification of any Federal contract, grant, loan, or cooperative agreement.

(2) If any funds other than Federal appropriated funds have been paid or will be paid to any person for influencing or attempting to influence an officer or employee of any agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress in connection with this Federal contract, grant, loan, or cooperative agreement, the undersigned shall complete and submit Standard Form-LLL, "Disclosure Form to Report Lobbying," in accordance with its instructions.

(3) The undersigned shall require that the language of this certification be included in the award documents for all subawards at all tiers (including subcontracts, subgrants, and contracts under grants, loans, and cooperative agreements) and that all subrecipients shall certify accordingly.

This certification is a material representation of fact upon which reliance was placed when this transaction was made or entered into. Submission of this certification is a prerequisite for making or entering into this transaction imposed by Section 1352, title 31, U.S. Code. Any person who fails to file the required certification shall be subject to a civil penalty of not less than $10,000 and not more than $100,000 for each such failure.

As the authorized certifying official, I hereby certify that the above specified certifications are true.

SIGNATURE OF AUTHORIZED CERTIFYING OFFICIAL Christine Champe

TYPED NAME AND TITLE Christine Champe Principal & Vice-President

DATE 15 April 99

I —015509

I-015509

APPLICATION FOR FEDERAL ASSISTANCE

OMB Approval No. 0348-0043

2. DATE SUBMITTED	Applicant Identifier
16 April 1999	N/A
3. DATE RECEIVED BY STATE	State Application Identifier
4. DATE RECEIVED BY FEDERAL AGENCY	Federal Identifier

1. TYPE OF SUBMISSION:

Application	Preapplication
☐ Construction	☐ Construction
☒ Non-Construction	☐ Non-Construction

5. APPLICANT INFORMATION

Legal Name:	Organizational Unit:
Stillwater Ecosystem, Watershed, & Riverine Sciences	N/A
Address *(give city, county, State, and zip code):* 2532 Durant Ave., Suite 201, Berkeley, CA 94704, Alameda County	Name and telephone number of person to be contacted on matters involving this application *(give area code)*: John Stella (510) 848-8098

6. EMPLOYER IDENTIFICATION NUMBER *(EIN):* 94-3241861

7. TYPE OF APPLICANT: *(enter appropriate letter in box)* M

A. State — H. Independent School Dist.
B. County — I. State Controlled Institution of Higher Learning
C. Municipal — J. Private University
D. Township — K. Indian Tribe
E. Interstate — L. Individual
F. Intermunicipal — M. Profit Organization
G. Special District — N. Other (Specify) _____

8. TYPE OF APPLICATION:

☒ New ☐ Continuation ☐ Revision

If Revision, enter appropriate letter(s) in box(es) ☐ ☐

A. Increase Award B. Decrease Award C. Increase Duration
D. Decrease Duration Other *(specify)*:

9. NAME OF FEDERAL AGENCY: Bureau of Reclamation, Department of the Interior

10. CATALOG OF FEDERAL DOMESTIC ASSISTANCE NUMBER: N/A

TITLE:

11. DESCRIPTIVE TITLE OF APPLICANT'S PROJECT: A Mechanistic Approach to Riparian Restoration in the San Joaquin Basin

12. AREAS AFFECTED BY PROJECT *(Cities, Counties, States, etc.)*: Stanislaus and Merced Counties

13. PROPOSED PROJECT		14. CONGRESSIONAL DISTRICTS OF:	
Start Date	Ending Date	a. Applicant	b. Project
9/1/99	8/31/01	#9	#18

15. ESTIMATED FUNDING:

a. Federal	$ 223,666.00
b. Applicant	$ —.00
c. State	$ —.00
d. Local	$ —.00
e. Other	$ —.00
f. Program Income	$ —.00
g. TOTAL	$ 223,666.00

16. IS APPLICATION SUBJECT TO REVIEW BY STATE EXECUTIVE ORDER 12372 PROCESS? N/A

a. YES. THIS PREAPPLICATION/APPLICATION WAS MADE AVAILABLE TO THE STATE EXECUTIVE ORDER 12372 PROCESS FOR REVIEW ON:

DATE _____

b. No. ☐ PROGRAM IS NOT COVERED BY E. O. 12372
☐ OR PROGRAM HAS NOT BEEN SELECTED BY STATE FOR REVIEW

17. IS THE APPLICANT DELINQUENT ON ANY FEDERAL DEBT?

☐ Yes If "Yes," attach an explanation. ☒ No

18. TO THE BEST OF MY KNOWLEDGE AND BELIEF, ALL DATA IN THIS APPLICATION/PREAPPLICATION ARE TRUE AND CORRECT, THE DOCUMENT HAS BEEN DULY AUTHORIZED BY THE GOVERNING BODY OF THE APPLICANT AND THE APPLICANT WILL COMPLY WITH THE ATTACHED ASSURANCES IF THE ASSISTANCE IS AWARDED.

a. Type Name of Authorized Representative	b. Title	c. Telephone Number
Christine Champe	Principal & Vice President	(510) 848-8098
d. Signature of Authorized Representative Christine Champe		**e. Date Signed** 15 April 99

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Prescribed by OMB Circular A-102

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I-015510

OMB Approval No. 0348-0044

BUDGET INFORMATION - Non-Construction Programs

SECTION A - BUDGET SUMMARY

Grant Program Function or Activity (a)	Catalog of Federal Domestic Assistance Number (b)	Estimated Unobligated Funds		New or Revised Budget		
		Federal (c)	Non-Federal (d)	Federal (e)	Non-Federal (f)	Total (g)
1. A Mechanistic Approach to Riparian Restoration in the San Joaquin Basin	—	$ —	$ —	$ 223,666	$ —	$ 223,666
2. —	—	—	—	—	—	—
3. —	—	—	—	—	—	—
4. —	—	—	—	—	—	—
5. Totals	—	$ —	$ —	$ 223,666	$ —	$ 223,666

SECTION B - BUDGET CATEGORIES

6. Object Class Categories	GRANT PROGRAM, FUNCTION OR ACTIVITY (1) Riparian Restoration	(2)	(3)	(4)	Total (5)
a. Personnel	$ 62,606	$ —	$ —	$ —	$ 62,606
b. Fringe Benefits	13,643	—	—	—	13,643
c. Travel	5,000	—	—	—	5,000
d. Equipment	16,000	—	—	—	16,000
e. Supplies	8,979	—	—	—	8,979
f. Contractual	6,000	—	—	—	6,000
g. Construction	—	—	—	—	—
h. Other	—	—	—	—	—
i. Total Direct Charges (sum of 6a-6h)	112,228	—	—	—	112,228
j. Indirect Charges	111,438	—	—	—	111,438
k. TOTALS (sum of 6i and 6j)	$ 223,666	$ —	$ —	$ —	$ 223,666
7. Program Income	$ —	$ —	$ —	$ —	$ —

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SECTION C - NON-FEDERAL RESOURCES

(a) Grant Program	(b) Applicant	(c) State	(d) Other Sources	(e) TOTALS
8. —	$ —	$ —	$ —	$ —
9. —	—	—	—	—
10. —	—	—	—	—
11. —	—	—	—	—
12. TOTAL (sum of lines 8 - 11)	$ —	$ —	$ —	$ —

SECTION D - FORCASTED CASH NEEDS

	Total for 1st Year	1st Quarter	2nd Quarter	3rd Quarter	4th Quarter
13. Federal	$ 146,307	$ 7,227	$ 47,423	$ 47,157	$ 44,500
14. NonFederal	—	—	—	—	—
15. TOTAL (sum of lines 13 and 14)	146,307	7,227	47,423	47,157	44,500

SECTION E - BUDGET ESTIMATES OF FEDERAL FUNDS NEEDED FOR BALANCE OF THE PROJECT

(a) Grant Program	FUTURE FUNDING PERIODS (Years) (b) First	(c) Second	(d) Third	(e) Fourth
16. —	$ —	$ —	$ —	$ —
17. —	—	—	—	—
18. —	—	—	—	—
19. —	—	—	—	—
20. TOTAL (sum of lines 16-19) —	$ —	$ —	$ —	$ —

SECTION F - OTHER BUDGET INFORMATION

21. Direct Charges: —

22. Indirect Charges: Overhead and profit are calculated as 1.78 x personnel costs

23. Remarks: —

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OMB Approval No. 0348-0040

ASSURANCES - NON-CONSTRUCTION PROGRAMS

Public reporting burden for this collection of information is estimated to average 15 minutes per response, including time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding the burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to the Office of Management and Budget, Paperwork Reduction Project (0348-0040), Washington, DC 20503.

PLEASE DO NOT RETURN YOUR COMPLETED FORM TO THE OFFICE OF MANAGEMENT AND BUDGET. SEND IT TO THE ADDRESS PROVIDED BY THE SPONSORING AGENCY.

NOTE: Certain of these assurances may not be applicable to your project or program. If you have questions, please contact the awarding agency. Further, certain Federal awarding agencies may require applicants to certify to additional assurances. If such is the case, you will be notified.

As the duly authorized representative of the applicant, I certify that the applicant:

1. Has the legal authority to apply for Federal assistance and the institutional, managerial and financial capability (including funds sufficient to pay the non-Federal share of project cost) to ensure proper planning, management and completion of the project described in this application.

2. Will give the awarding agency, the Comptroller General of the United States and, if appropriate, the State, through any authorized representative, access to and the right to examine all records, books, papers, or documents related to the award; and will establish a proper accounting system in accordance with generally accepted accounting standards or agency directives.

3. Will establish safeguards to prohibit employees from using their positions for a purpose that constitutes or presents the appearance of personal or organizational conflict of interest, or personal gain.

4. Will initiate and complete the work within the applicable time frame after receipt of approval of the awarding agency.

5. Will comply with the Intergovernmental Personnel Act of 1970 (42 U.S.C. §§4728-4763) relating to prescribed standards for merit systems for programs funded under one of the 19 statutes or regulations specified in Appendix A of OPM's Standards for a Merit System of Personnel Administration (5 C.F.R. 900, Subpart F).

6. Will comply with all Federal statutes relating to nondiscrimination. These include but are not limited to: (a) Title VI of the Civil Rights Act of 1964 (P.L. 88-352) which prohibits discrimination on the basis of race, color or national origin; (b) Title IX of the Education Amendments of 1972, as amended (20 U.S.C. §§1681-1683, and 1685-1686), which prohibits discrimination on the basis of sex; (c) Section 504 of the Rehabilitation Act of 1973, as amended (29 U.S.C. §794), which prohibits discrimination on the basis of handicaps; (d) the Age Discrimination Act of 1975, as amended (42 U.S.C. §§6101-6107), which prohibits discrimination on the basis of age; (e) the Drug Abuse Office and Treatment Act of 1972 (P.L. 92-255), as amended, relating to nondiscrimination on the basis of drug abuse; (f) the Comprehensive Alcohol Abuse and Alcoholism Prevention, Treatment and Rehabilitation Act of 1970 (P.L. 91-616), as amended, relating to nondiscrimination on the basis of alcohol abuse or alcoholism; (g) §§523 and 527 of the Public Health Service Act of 1912 (42 U.S.C. §§290 dd-3 and 290 ee 3), as amended, relating to confidentiality of alcohol and drug abuse patient records; (h) Title VIII of the Civil Rights Act of 1968 (42 U.S.C. §§3601 et seq.), as amended, relating to nondiscrimination in the sale, rental or financing of housing; (i) any other nondiscrimination provisions in the specific statute(s) under which application for Federal assistance is being made; and, (j) the requirements of any other nondiscrimination statute(s) which may apply to the application.

7. Will comply, or has already complied, with the requirements of Titles II and III of the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970 (P.L. 91-646) which provide for fair and equitable treatment of persons displaced or whose property is acquired as a result of Federal or federally-assisted programs. These requirements apply to all interests in real property acquired for project purposes regardless of Federal participation in purchases.

8. Will comply, as applicable, with provisions of the Hatch Act (5 U.S.C. §§1501-1508 and 7324-7328) which limit the political activities of employees whose principal employment activities are funded in whole or in part with Federal funds.

9. Will comply, as applicable, with the provisions of the Davis-Bacon Act (40 U.S.C. §§276a to 276a-7), the Copeland Act (40 U.S.C. §276c and 18 U.S.C. §874), and the Contract Work Hours and Safety Standards Act (40 U.S.C. §§327-333), regarding labor standards for federally-assisted construction subagreements.

10. Will comply, if applicable, with flood insurance purchase requirements of Section 102(a) of the Flood Disaster Protection Act of 1973 (P.L. 93-234) which requires recipients in a special flood hazard area to participate in the program and to purchase flood insurance if the total cost of insurable construction and acquisition is $10,000 or more.

11. Will comply with environmental standards which may be prescribed pursuant to the following: (a) institution of environmental quality control measures under the National Environmental Policy Act of 1969 (P.L. 91-190) and Executive Order (EO) 11514; (b) notification of violating facilities pursuant to EO 11738; (c) protection of wetlands pursuant to EO 11990; (d) evaluation of flood hazards in floodplains in accordance with EO 11988; (e) assurance of project consistency with the approved State management program developed under the Coastal Zone Management Act of 1972 (16 U.S.C. §§1451 et seq.); (f) conformity of Federal actions to State (Clean Air) Implementation Plans under Section 176(c) of the Clean Air Act of 1955, as amended (42 U.S.C. §§7401 et seq.); (g) protection of underground sources of drinking water under the Safe Drinking Water Act of 1974, as amended (P.L. 93-523); and, (h) protection of endangered species under the Endangered Species Act of 1973, as amended (P.L. 93-205).

12. Will comply with the Wild and Scenic Rivers Act of 1968 (16 U.S.C. §§1271 et seq.) related to protecting components or potential components of the national wild and scenic rivers system.

13. Will assist the awarding agency in assuring compliance with Section 106 of the National Historic Preservation Act of 1966, as amended (16 U.S.C. §470), EO 11593 (identification and protection of historic properties), and the Archaeological and Historic Preservation Act of 1974 (16 U.S.C. §§469a-1 et seq.).

14. Will comply with P.L. 93-348 regarding the protection of human subjects involved in research, development, and related activities supported by this award of assistance.

15. Will comply with the Laboratory Animal Welfare Act of 1966 (P.L. 89-544, as amended, 7 U.S.C. §§2131 et seq.) pertaining to the care, handling, and treatment of warm blooded animals held for research, teaching, or other activities supported by this award of assistance.

16. Will comply with the Lead-Based Paint Poisoning Prevention Act (42 U.S.C. §§4801 et seq.) which prohibits the use of lead-based paint in construction or rehabilitation of residence structures.

17. Will cause to be performed the required financial and compliance audits in accordance with the Single Audit Act Amendments of 1996 and OMB Circular No. A-133, "Audits of States, Local Governments, and Non-Profit Organizations."

18. Will comply with all applicable requirements of all other Federal laws, executive orders, regulations, and policies governing this program.

SIGNATURE OF AUTHORIZED CERTIFYING OFFICIAL	TITLE
Christine Champe	Principal and Vice President
APPLICANT ORGANIZATION	DATE SUBMITTED
Stillwater Ecosystem, Watershed, & Riverine Sciences	16 April 1999

Standard Form 424B (Rev. 7-97) Back

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