



CALFED Progress Report
California Sea Grant College Program

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Preparer Information

PrepName_1A John C. Stella
PrepEmail_1B stella@nature.berkeley.edu
PrepPhone_1C 510-643-2450

Project Information

ProjectNo_2C R/SF-2 **StartDate_3a** 4/1/03 **EndDate_3b** 11/30/05
ProjectTitle_4 A Mechanistic Model to Evaluate and Improve Riparian Restoration Success

CALFed Fellow contact information

FelTitle_5A Mr **FelLast_5B** Stella **FelFirst_5C** John **FelInit_5D** C
FelInstitution_5E University of California, Berkeley
FelDepartment_5F Department of Environmental Science, Policy, and Management
FelStreetAddr_5G 140 Mulford Hall
FelCity_5H Berkeley **FelState_5I** CA **FelZip_5J** 94720-3110
FelPhone_5K 510-643-2450 **FelFax_5L** 510-848-8398
FelEmail_5M stella@nature.berkeley.edu
FelPositionTitle_5N Predoctoral Fellow/Doctoral Candidate

Research Mentor (for additional please see #8)

RMTTitle_6A Dr **RMLastName_6B** Battles **RMFirstName_6C** John **RMInit_6D** J
RMInstitution_6E University of California, Berkeley
RMDepartment_6F Department of Environmental Science, Policy, and Management
RMStreetAddr_6G 140 Mulford Hall
RMCity_6H Berkeley **RMState_6I** CA **RMZip_6J** 94720-3110
RMPHONE_6K (510) 643-0684 **RMFax_6L** _____
RMEmail_6M jbattles@nature.berkeley.edu
RMPositionTitle_6N Associate Professor

Community Mentor (for additional please see #9)

CMTTitle_7A Dr **CMLastName_7B** Patten **CMFirstName_7C** Duncan **CMInit_7D** T
CMInstitution_7E Montana State University
CMDepartment_7F Big Sky Institute for Science and Natural History
CMStreetAddr_7G 1605 S. 5th St. (MSU Faculty Court)
CMCity_7H Bozeman **CMState_7I** MT **CMZip_7J** 59717-3490
CMPhone_7K (406) 994-2784 **CMFax_7L** (406) 582-0488
CMEmail_7M dtpatten@montana.edu
CMPositionTitle_7N Research Professor

Additional Research Mentors and Community Mentors

Additional Research Mentors_8

Dr. Joe R. McBride, Professor
 Department of ESPM, UC Berkeley
 Berkeley, CA 94720-3110
 jrm@nature.berkeley.edu
 (510) 643-8074

Additional Community Mentors_9

Project Objectives: Please type your responses, and answer the questions in a style appropriate for laymen.

ProjectObjectives_10

The goal of this research is to develop a predictive understanding of recruitment and survival of the pioneer riparian tree species cottonwoods and willows that dominate the crucial initial phase of riparian community recovery.

As part of this effort, I am drawing on existing sources of hydrologic, topographic and vegetation data, and integrating new research with those data. Anticipated products from this project include:

1. completion of field-based, regionally- and species-specific numerical model calibrating a general conceptual framework of pioneer tree recruitment to field sites on the Tuolumne River.
2. outreach to resource managers and restoration practitioners to disseminate the findings of this research for use in designing and refining flow schedules and on-the-ground restoration projects;
3. a doctoral dissertation detailing results of this research;
4. several manuscripts for submission to peer review journals.

Summary of progress in meeting each of these goals and objectives

ProgressSummary_11

Field Work Overview--Field work was conducted and continued in 2004 for the seed release phenology and reach-wide seedling demography studies (see Project Modifications section). The phenology study involved 13 field visits to each of the 3 Tuolumne River sites. The seedling study consisted of a 3-day canoe survey in August 2004 to document seedling recruitment patterns on 14 sandbars on the lower Tuolumne River, and a sandbar topography survey was a 2-day effort at two sandbars that we had previously surveyed in 2002. Specific field and laboratory efforts are described below and in the Additional Information section.

Degree-Day Modeling--Using seed release phenology data collected during 2002-04, I developed a degree-day model to assess whether climate factors such as accumulated air temperature and/or relative humidity are good predictors of seed release timing. Besides the phenology and temperature data we collected, I used historical climate data from the California Irrigation Management Information System (CIMIS) and National Climate Data Center (NCDC). The degree-day model significantly improved prediction of seed release initiation over calendar time. This model promises to be a valuable tool for water managers to use in timing restoration flows to coincide annually with seed release and maximize seedling recruitment.

Riparian Stand Structure, Tree Age and Vigor--In order to document the range of ecological conditions and tree demographics among and between phenology sites, I collected demographic data for trees used in the phenology study. For all Fremont cottonwood and Goodding's black willow trees in the study, we recorded diameter and height, cored them to estimate age and relative vigor, and quantified local stand density using the point-quarter method. We conducted dendrochronological analyses using a sliding stage micrometer and ring-reading software. We developed a master chronology of tree growth rates each for the Tuolumne River trees and San Joaquin River trees. Preliminary results indicate that tree growth rate is correlated with annual river volume.

Seedling Isotope Analysis--In 2002 I conducted a controlled experiment testing simulated river stage changes on seedling growth and survivorship. This experiment, conducted with 750 seedlings in 20 large tanks, yielded abundant data on seedling root and shoot growth and biomass allocation in response to varying levels of water stress. During Year 2, I analyzed a subset (N=350) of the seedlings for differences in species-specific ecophysiology that would explain the differences in survivorship. I quantified the leaf area ratio to assess differences in morphological plasticity between species, and $^{13}C/^{12}C$ carbon isotope ratio to assess species differences in time-integrated water use efficiency. The isotopic analysis was conducted at the Center for Stable Isotope Geochemistry at the University of California, Berkeley and supported by a grant from the National Science Foundation. I conducted preliminary analyses of differences between species and treatment levels.

All data from the 2004 field and laboratory studies were entered and thoroughly quality-checked and corrected.

PROJECT MODIFICATIONS: Please explain any substantial modifications in research plans, including new directions pursued. Describe major problems encountered, especially problems with experimental protocols and how they were resolved. Describe any ancillary research topics developed.

Modifications_12

The only major modification in Year 2 was the decision to collect phenology and end-of-summer seedling distribution data for the Tuolumne River. Several events in Spring 2004 presented a unique and unanticipated opportunity to greatly improve the project. During Spring 2004, the combination of the warm air temperatures and relatively high flows on the Tuolumne River provided a unique opportunity to expand the limited parameters of our model (which had been based on data from 2002 and 2003, when conditions were similar). In response, I conducted targeted, efficient field efforts throughout the 2004 growing season to investigate the influence of these physical factors on riparian seedling recruitment. Preliminary analyses of the data indicate that in 2004 seed release was approximately 3 weeks earlier than in the previous two years and is correlated with the interannual difference in cumulative temperature. These correlations allow me to predict seed release patterns with better accuracy using a temperature-based degree day model. This development would not have been possible using only the 2002-2003 data.

Because the new data were collected through the end of September 2004, additional time was needed in late 2004 and early 2005 to analyze and incorporate these data into the project.

We requested and received a no-cost extension to complete this work and extend the contract termination date.

BENEFITS AND APPLICATIONS: Suggest the relevance of these new findings to management. Describe any accomplishment, that is significant effects your project has had on resource management or user group behavior. CALFED is looking for "management cue" (see <http://science.calwater.ca.gov/pdf/soemgmtcues.pdf>).

BenefitsApplic_13

Many of CALFED's priority at-risk species rely on riparian ecosystems to maintain fundamental habitats and processes. Thus restoration of riparian forests is a priority objective for CALFED (CALFED 1999, AFRP 1997, SJRMP 1995, CALFED 2001). This project will directly benefit CALFED and its public constituents by the development of field-tested, regionally applicable tools for designing and evaluating restoration projects.

This research has several important applications to water and floodplain management. The component field studies are designed to provide crucial life-history data on keystone native floodplain tree species. These data and analyses will allow water managers to target flow timing, magnitude, and ramping rates that will maximize natural recruitment. Field tests of model predictions will provide key information about the effects of existing spring flow releases and help prioritize potential future releases based on water year characteristics. This research is also relevant to the potential effects of climate change on water supplies and spring restoration flows; potential impacts to floodplain tree populations can be better assessed. Restoration project managers will also benefit from the field studies in setting floodplain design elevations and physical characteristics to optimize conditions for a sustainable, native vegetation community.

PUBLICATIONS: List any publications, presentations, or posters that have resulted from this funded research. Give as many details as possible, including status of paper (e.g., in review; in press), journal name, conference location and date of presentation. Please note (as outlined in the conditions of the award) that each fellow is required to submit an abstract for an oral or poster presentation at each State of the Estuary conference and CALFED Science Conference during the duration of the fellowship.

Publications 14

During Year 2, the following article was published, based on work that I did before embarking on my doctoral studies:

Stella, J.C., J.C. Vick, B.K. Orr. 2004. Riparian vegetation dynamics on the Merced River. The Wilderness Society. Riparian Floodplains Conference Proceedings. Sacramento, CA. March 2001.

Publications in preparation

In addition to completing my dissertation, I plan to publish several components of the research in peer-reviewed journals. One manuscript on riparian tree propagule timing is nearly complete and will be submitted for publication in June 2005. Another article on seedling physiology is in preparation, with the intention of submitting for publication in early Fall. Working titles are listed below:

Stella, John C., John J. Battles, Bruce K. Orr, Joe R. McBride. (in prep). How do riparian trees time the flood? Modeling propagule availability and snowmelt timing using common climate cues.

Stella, John C., John J. Battles, Bruce K. Orr, Joe R. McBride. (in prep). Physiological thresholds and water relations of riparian tree seedlings in response to simulated river regimes.

Conference presentations

During the second program year I completed two conference oral presentations and one seminar presentation at UC Berkeley, listed below. The CALFED Science Conference presentation was part of a panel that I helped organize on restoration issues on big rivers. Other conference presentations on this research are listed in the Year 1 report.

Stella, John C., John J. Battles, Bruce K. Orr, Joe R. McBride. 2004. Riparian forest sustainability: calibrating a physical and biological recruitment model for the lower Tuolumne River, CA. Oral presentation. Ecological Society of America annual meeting, Portland, OR.

Stella, John C., John J. Battles, Bruce K. Orr, Joe R. McBride. 2004. Seed release patterns of native riparian trees and implication for flow-based restoration strategies. Oral presentation. CALFED Science Conference, Sacramento, CA.

On March 14, 2005, I gave a 50-minute oral presentation on the propagule availability study as part of the weekly iEcolunchi seminar series in the Department of Integrative Biology at the University of California, Berkeley.

Peer Review

In addition to the peer review outreach that I provide to the California Department of Water Resources in Year 1, I provided the following peer review in Year 2:

2004. Peer reviewer for a manuscript submitted to Wetlands, the journal of the Society of Wetland Scientists.

2004. Peer review to the University of California, Berkeley Center for Forestry on several quantitative monitoring methodologies developed for the California Department of Fish and Game to guide salmonid habitat protection and recovery projects.

number of the question you are adding to.

Additions_19

Two additional field tasks were conducted in 2004 and are described below. For space reasons, these were not included in the Project Progress section.

Sandbar Site Hydrology and Topography

I conducted the follow-up topographic survey on two sandbars that were surveyed in 2002. The objectives of the resurvey were to document gross changes in sandbar shape, to quantify the distribution of finescale microtopographic change (erosion and deposition) across the bars, and to survey flow lines that will be used to construct stage-discharge relationships. The data were collected using a Sokkia TotalStation instrument and changes in topography between the 2002 and 2004 surveys were plotted as a surface of differences in ArcGIS. Data from the two pressure transducer stage recorders were downloaded. Water table measurements from the eight remaining sandbar wells were collected several times during the summer 2004. Field marking gear such as wire flags, rebar, and flagging were removed from the sandbar sites following the completion of all field work. Data analysis is ongoing for this task.

Reach-wide Seedling Transects

In late summer 2004 we conducted the third annual synoptic survey of reach-wide seedling recruitment to validate field parameters on the recruitment box model. The survey was conducted on 10 sandbars distributed throughout a 12-mile reach of the lower Tuolumne River between Modesto and the confluence with the San Joaquin River. At each sandbar, 2-5 transects were established normal to the direction of flow and seedling data recorded for continuous 1 m² quadrats. Data collected include seedling composition, density, height above summer low-flow water level, and composition and height of salicaceous sprouts and saplings. Data from the canoe survey were entered into a database (MS Access) and analysis is ongoing.