Delta Science Fellows Annual Report
California Sea Grant College Program

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Project Information

ProjectNo_2C: R/SF-25 | StartDate_3a: 4/1/10 | EndDate_3b: 3/31/11
ProjectTitle_4: Modeling Physical Drivers and Age Structure of Cottonwood Forest Habitat: An Integrated Systems

Delta Science Fellow contact information

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Research Mentor (for additional please see #8)

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Additional Research Mentors and Community Mentors

Additional Research Mentors_8:

Additional Community Mentors_9:

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

ProjectObjectives_10

The ultimate goal of this project is to improve the long-term prospects for protecting and restoring floodplain forests dominated by a foundational species in the Central Valley's riparian ecosystem—Fremont cottonwood. We are using an integrated approach, combining field surveys of cottonwood forest structure with models of the physical processes driving cottonwood habitat creation and cottonwood population dynamics. The study focuses on a 100-mile stretch of the Sacramento River from Red Bluff to Colusa. The Nature Conservancy, resource agencies and other stakeholders view this area as a prime site for conservation and restoration because the river still migrates naturally and is not confined by levees. These combined approaches are being used to assess the current ecological status of the riparian forest along the Sacramento River, successional trajectories, and implications of future changes in river management and climate change. We will also integrate these findings with those from similar ecosystems in other mediterranean-climate regions with comparable climate limitations and management pressures.

Summary of progress in meeting each of these goals and objectives

ProgressSummary_11

In the third year of our project we completed development of the physical/biological model of cottonwood dynamics, conducted and published the sensitivity analysis of model parameters, reassessed project data needs, and completed the first year (of three years so far) of forest stand inventory sampling along the Sacramento River. The field work was designed to address key uncertainties identified by the sensitivity analysis, and to provide a complementary method to assess the ecological status of the riparian forest. This work led to five articles published during this grant reporting period on forest ecology along the Sacramento and other Central Valley rivers and three presentations at national and regional conferences. In addition, we conducted exchanges with scholars investigating similar questions in mediterranean-climate ecosystems in Europe, publishing one article and delivering four conference presentations on this comparative aspect of the project.

The cottonwood forest model, developed in the first two years of the study, consists of two components, a river channel meander migration model (based on historical aerial photographs, and published previously by Dr. Alex Fremier and colleagues) coupled with a mechanistic, life-history based model of cottonwood forest stand initiation and development. Several of the component pieces to the life history-based model were completed and published during this grant year (e.g., Stella et al., 2010; Stella and Battles 2010). In addition, we published an article outlining an important but little-appreciated pathway of riparian forest establishment in former river channels (Stella et al., 2011). These findings have important consequences for prioritizing floodplain areas for conservation and protection.

The key findings of the cottonwood forest model sensitivity analysis, published in Ecological Applications (Harper et al., 2011), allowed us to reassess priorities for data needs and feasible analysis approaches. This analysis improved our understanding of the complex interactions among biotic and abiotic drivers in the Bay-Delta ecosystem. However, it also pointed out the need for extensive field work to sample cottonwood ages (see Modifications) to account for the high environmental heterogeneity in floodplain environments.

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

Project delays stemming from the budget-based work stoppage in 2008-09 caused some re-evaluation of project objectives and necessitated no-cost extensions (as described in previous annual reports. In addition, the cottonwood forest patch model sensitivity analysis (Stella et al. 2011) highlighted the need for extensive empirical data to understand how heterogeneity of floodplain conditions affects forest composition, growth and age structure. Therefore, we designed a forest inventory sampling effort that was begun in summer 2010. Point bar sites were identified along the river and existing GIS coverages of floodplain age and vegetation communities used to target and stratify forest stands for sampling. Nineteen point bars were identified for sampling along a 107-year chronosequence, and the first 5 bars sampled in 2010 by a SUNY-ESF field crew with in-kind and permitting help from TNC, CDWR, USFWS, CDFG, and CDPR. This effort was continued in subsequent project years under both this project budget and outside projects by PI Stella. This represents one of the most extensive riparian forest inventory and sampling efforts ever undertaken, and promises to advance our understanding of linked physical/biotic processes and community succession occurring in riparian zones.

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. Delta Science is looking for "management cues" (see http://science.calwater.ca.gov/pdf/soemgmtcues.pdf).

BenefitsApplic_13

Fremont cottonwood is a 'keystone' species in the Bay-Delta riparian ecosystem, and cottonwood populations have declined due to floodplain conversion and widespread flow regulation, which influence the physical and biotic drivers of demography. Restoration of Fremont cottonwood populations requires an understanding of the interactions among the biotic and abiotic drivers in this complex ecosystem. We published two articles during this reporting period with important management implications. In Harper et al. (2011), we found that predicting the fate of cottonwood forests will require better understanding of how several physical factors, including sediment texture and channel morphology, vary along the reach. Therefore, flow prescriptions for restoring cottonwood seedling recruitment will likely be site-specific in their effectiveness. Secondly, we found (in Stella et al., 2011) that abandoned channels are an important and often overlooked refugium for cottonwood forest stands. On the Sacramento River, over 50% of cottonwood forest area is associated with abandoned channels, and the colonization window in these habitats is short, <10 years in most cases. Therefore, in order to maintain a multi-aged forest with actively regenerating areas, river managers must protect both the floodplain regions where abandoned channels occur, and the physical processes that allow channel cutoff, infilling

with sediment, and terrestrialization.

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 Delta Science Conference during the duration of the fellowship.

Publications_14

Sacramento River and Central Valley riparian ecosystems (5 articles; 3 presentations)

Stella, J.C., M.K. Hayden, J.J. Battles, H. Piégay, S. Dufour, and A.K. Fremier. 2011. The role of abandoned channels as refugia for sustaining pioneer riparian forest ecosystems. Ecosystems 14: 776-790. DOI: 10.1007/ s10021-011 -9446-6

Harper, E.B., J.C. Stella, A.K. Fremier. 2011. Global sensitivity analysis for complex ecological models: a case study of riparian cottonwood population dynamics. Ecological Applications 21: 1225-1240. DOI:10.1890/10-0506.1

Downs, P.W., M.S. Singer, B.K. Orr, Z.E. Diggory, T.C. Church, and J.C. Stella. 2011. Restoring ecological integrity in highly regulated rivers: The role of baseline data and analytical references. Environmental Management 48:847-864. DOI: 10.1007/s00267-011-9736-y

Stella, J.C., and J.J. Battles. 2010. How do riparian woody seedlings survive seasonal drought? Oecologia 164:579–590. DOI: 10.1007/s00442-010-1657-6

Stella, J.C., J.J. Battles, J.R. McBride, B.K. Orr. 2010. Riparian seedling mortality from simulated water table recession, and the design of sustainable flow regimes on regulated rivers. Restoration Ecology. 18(S2): 284–294. DOI: 10.1111/j.1526-100X.2010.00651.x

Harper. E.B., J.C. Stella, A.K. Fremier. Multiscale validation of a spatially explicit patch-based demographic model of Fremont cottonwood on the Sacramento River. Poster at the 6th Biennial CALFED Science Conference (Ecosystem Sustainability: Focusing Science on Managing California's Water Future), 27-29 September 2010, Sacramento, California.

Hayden, M.K., J.J. Battles, Stella, J.C. Drivers of Pioneer Riparian Forest Establishment within Abandoned Channel Refugia. Poster at the 6th Biennial CALFED Science Conference (Ecosystem Sustainability : Focusing Science on Managing California's Water Future), 27-29 September 2010, Sacramento, California.

Harper. E.B., J.C. Stella, A.K. Fremier. Multiscale validation of a spatially explicit patch-based population model: Understanding the population dynamics of Fremont cottonwood in the Sacramento River watershed. Oral presentation at the Annual Meeting of the Ecological Society of America, Pittsburgh, PA, August 2010.

Cross-biome studies in other mediterranean-climate riparian ecosystems (1 article; 4 presentations)"
Rodriguez-González, P.M., J.C. Stella, F. Campelo, T. Ferreira, A. Albuquerque. 2010. Subsidy or stress? Tree structure and growth in wetland forests along a hydrological gradient in southern Europe. Forest Ecology and Management 259: 2015–2025. DOI:10.1016/j.foreco.2010.02.012

Stella, J.C. (invited), J. Riddle, H. Piégay, M. Teece, 2011. Integrating tree-ring and stable carbon isotope analysis to

measure riparian ecosystem function, integrity, and meso-scale hydrogeomorphic impacts. Seventh Symposium for European Freshwater Sciences, Girona, Spain, 27 June – 1 July, 2011.

Stella, J.C. (Convener), J. Bendix, H. Piégay, and P. Downs. Special session on "Non-equilibrium Drivers in Mediterranean Climate River and Riparian Ecosystems" at the American Geophysical Union Fall Meeting, San Francisco, CA, December 2010.

Stella, J.C., J. Riddle; H. Piégay; M. Gagnage; M. Trémolo. Multi-Scale Drivers of Riparian Forest Decline Along a Mediterranean-Climate River. Poster at the American Geophysical Union Fall Meeting, San Francisco, CA, December 2010.

Bendix, J. and J.C. Stella. 2010. A Geographic Analysis of Riparian Biogeomorphology. Annual Meeting of the American Association of Geographers. Washington, D.C, April 2010.

COOPERATING ORGANIZATIONS: List those agencies and/or persons who provided financial, technical or other assistance to your project since inception. Describe the nature of their collaboration.

CoopOrganiz_15

1. Dr. John Battles, UC Berkeley. Technical expertise on designing forest inventory protocol.
2. Dr. Alex Fremier, University of Idaho, Moscow, Idaho. Collaborator working in the middle Sacramento River and Ain River (France), GIS and spatial-data analysis.
3. Dr. Greg Golet, TNC, Chico. Access to TNC properties, field lodging.
4. Dr. Hervé Piégay, CNRS, Lyon, France. Collaborator working in abandoned channels of the middle Sacramento River.
5. Adam Henderson, California Department of Water Resources. Side logistics and in-kind support of jetboat for vegetation surveys at remote sites.
6. Joe Silveira, USFWS; 7. Henry Lomeli, CDFG; 8. Woody Elliott (subsequently Jim Dempsey), CDPR. All permitting and field site access.

AWARDS: List any special awards or honors that you, or mentor or members of the research team, have received during the duration of this project.

Awards_16

Not applicable.

KEYWORDS: List keywords that will be useful in indexing your project.

Keywords_17

Riparian vegetation, Fremont cottonwood, population model, river floodplain, ecogeomorphology, sensitivity analysis, riparian forest succession

PATENTS: List any patents associated with your project.

Patents_18

Not applicable.

Additions: Additional information can be added here. Please begin the text with the number of the question you are adding to.

Additions_19

Not applicable.