FINAL PROJECT REPORT

PROJECT TERM: JULY 1, 2011 – JULY 1, 2014
PROJECT TITLE: Integrating Ecosystem, Flood Control, Agricultural, and Water Supply Benefits: An Application to the Yolo Bypass
AMOUNT FUNDED: $267,050

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PROJECT SUMMARY (ANY FORMAT)

Floodplains in California and elsewhere are extremely productive habitats with high levels of biodiversity, yet they are often permanently disconnected from rivers by urban or agricultural development. This poses a potential threat to the many native fish, bird and other species that evolved to take advantage of seasonal floodplain inundation. The traditional restoration approach to this problem would recreate historical floodplain in some places by restoring natural hydrologic and successional processes. However levees, dams, and development prevent this approach in much of California. Recognizing these constraints, reconciliation ecology encourages land and water managers to re-engineer human-dominated landscapes to be more inclusive of native species' preferences without eliminating human uses. California's Yolo Bypass, an engineered floodplain on the Sacramento River, is an excellent case study for this new approach to native species management. This study developed, parameterized, and utilized a multi-objective analysis of the Yolo

Bypass to suggest approaches for balancing economic and ecological goals on engineered floodplains. Results suggest that significant habitat improvement is possible for several fish and bird species with little annual economic losses for farmers, and further that agricultural land uses can be important and useful in the habitat mosaic for fish and birds on the bypass.

BUDGET SUMMARY

EXPENSE	AMOUNT INVOICED (1ST YEAR)	AMOUNT INVOICED (2ND YEAR)	AMOUNT INVOICED (3RD YEAR)	AMOUNT INVOICED TO DATE (ALL YEARS)
Salaries and Wages	46,642.71	64,777.79	48,444.41	159,864.91
Employee Benefits	17,322.92	23,335.13	20,685.55	61,343.60
Equipment & Facilities	0.00	0.00	0.00	0.00
Supplies, Materials & Services	402.65	1,126.18	327.14	1,855.97
Travel	0.00	0.00	0.00	0.00
Subcontracts	0.00	0.00	0.00	0.00
Indirect Costs	13,228.79	17,501.46	13,255.27	43,985.52
Overhead				
Totals	$77,597.07	$106,740.56	$82,712.37	$267,050.00

LIST OF TASKS AND ACTIVITIES PERFORMED

TASK 1: PROJECT MANAGEMENT

Cathryn Lawrence managed project accounts and invoice reporting. Robyn Suddeth provided text for these reports. Robyn Suddeth also set up and ran several meetings with various students and professors working on the Yolo Bypass (both internal to this project and external). These meetings served as progress and knowledge updates, a place to voice data and/or modeling needs, and a forum for collaboration and refinement of project goals. Robyn Suddeth also wrote a roughly 200 page PhD dissertation which recorded model development and parameterization, and results of the model's application to the Yolo Bypass. (Several chapters and appendices are currently being edited for publication – see list below for expected titles and journals.)

TASK 2: AGRICULTURAL MODELING

Juhwan Lee (with help from Duncan MacEwan) completed a dataset of gross revenues per acre for each crop type on the Yolo Bypass, varying with last day of over-topping at Fremont Weir. These were used, on a weekly time step, in the larger optimization model (Task 4). Additional time for field drainage and preparation were built into the model. This dataset was completed using various sources and models. Crop prices are averaged 2005-2007 year prices from the County Agricultural Commissioner Reports. The National Agricultural Statistics Service was used for Safflower and Sunflower prices. Yields were generated from the DAYCENT model, and vary depending on last day of flooding in a given field. Finally, gross revenues were calculated as price*yield. Richard Howitt also provided parameters from the Yolo Bypass GAMS model for use in the cost portion of the economic objective in the optimization model (Task 4).

TASK 3: GROUNDWATER MODELING

Carlos Arenas developed preliminary recharge rates for the Yolo Bypass given different flow scenarios. However a more detailed understanding of zone or even field-level recharge potential was not possible without a more developed high-resolution 2D surface flow model of the Bypass. This has now been developed; further research on the Yolo Bypass would benefit from using higher resolution output from a surface flow model as inputs in calibrating a more detailed model of groundwater recharge so that this data could be used in economic decision-making.

TASK 4:DEVELOPMENT OF PROMISING MANAGEMENT ALTERNATIVES

Robyn Suddeth successfully developed and parameterized an Excel-based multi-objective optimization model (YBMOM) for land and water management of the Yolo Bypass. Results are discussed in the following section of this report. This prescriptive model can now be used to iterate promising solutions with floods simulated by a HEC-RAS 2D flow model developed by Bill Fleenor and Laila Kaisuri (also as part of Task 4).

LIST THE ACHIEVED OBJECTIVES, FINDINGS, AND MAJOR CONTRIBUTIONS

Primary Objective to be Achieved: Identify tradeoffs and promising land and water management alternatives for reconciled ecosystem and economic uses of the Yolo Bypass.

Findings:

Tradeoffs:

1. We can do better for fish and birds on the bypass with little annual costs for farmers.
2. A compensation package of $100,000 - $500,000 per year to farmers or bypass landowners should be adequate for a reconciliation program

Land Use:

1. The cheapest way to improve habitat is to exchange some pasture in the southern bypass for wetlands.
2. Agricultural land uses can contribute to fish and bird habitat quality at very little cost, as long as flooding is optimized in space and time (i.e. rice and wild rice are a part of the flood mosaic in February, but are phased out in March). The agricultural land uses best suited to serve a dual purpose as habitat are rice, wild rice, pasture, and fallow fields.
3. It might be worthwhile to grow additional acres of rice and wild rice as habitat.

Flooding Management:

1. The best start date for a 6 to 8 week inundation is between late January and mid February. Later start dates in this range (towards mid-February) better balance benefits across individual fish and bird species.
2. The ability to move and control the area flooded over a 6 to 8 week inundation event can significantly increase the cost-effectiveness of flooded habitat quality improvements on the Bypass. Hydraulic management could direct most flooding to the southern bypass, where agricultural losses are not as high, and phase rice, wild rice, and sometimes safflower out of the flood footprint by mid-March, when lost yields from a delayed plant date begin to more significantly reduce crop revenues. Hydraulic control of flows also could move water that drains from these fields to wetlands and pasture for the remaining weeks of inundation, so fish and birds can still take advantage of food resources built up in the water column.
3. Tools like this one can help guide this hydraulic management and integrate new knowledge into decision-making.

DISCUSS THE MANAGEMENT IMPLICATIONS OF PROJECT FINDINGS

This work makes several recommendations for land use changes with varied implications for different stakeholders on the Yolo Bypass. Trading pasture for wetlands or adding acres of rice and wild rice will have tax implications for Yolo County and financial implications for local farmers and landowners. None of these changes can occur without first deciphering how to finance them, or more specifically, designating who pays for changes in management. The YBMOM can help provide detailed and zone-specific information about the

economic implications of management decisions, and a rough estimate of ecological and economic gains or losses resulting from any changes.

Another potentially required land use change will be the creation of new wetlands and fields devoted to habitat-friendly crops; strategically locating these land uses close together and near the water source will allow applied water to be more easily managed for depth and duration. It is more difficult to flood x acres of rice and y acres of pasture if they are several miles apart and far from the eastern channel that delivers water down the length of the Bypass. The model makes zone-specific recommendations that were not studied in detail here, but would warrant closer examination once water is actually available. This would also help in developing more location specific mitigation or incentive programs for landowners.

Regardless of these needed steps, the qualitative conclusions presented above are robust: even under a wide variety of assumptions on habitat and species preferences, there is much promise for a reconciliation approach to management of the Yolo Bypass that need not be extremely costly to landowners and farmers. This study highlights the ability for birds and fish to both benefit from management of a mixed agricultural and wetland landscape, without large tradeoffs among them. Importantly, agricultural crops are optimally a vital component of the overall habitat mosaic, a sign that even heavily modified floodplains can be improved for native species without eliminating human use. The YBMOM and similar quantitative analysis can help provide detailed suggestions for managing the system when infrastructure modifications allow for more controlled and more frequent inundation.

PROJECT DELIVERABLES

- Presentations:
    - System Optimization Modeling for Flood Extent, Depth, Land Use and Timing on the Yolo Bypass. Bay Delta Science Conference, October 17, 2012
    - Yolo Bypass Ecosystem Reconciliation – Insights from many models and lots of field work.
        - California Water and Environmental Modeling Forum, April 24, 2013
        - State of the Estuary Conference, October 28, 2013
- Attached: Project Executive Summary, PhD Dissertation by Robyn Suddeth
- Expected Publications (in progress):
    - Developing a Multi-Objective Analysis for Reconciled Ecological and Economic Purposes on an Engineered Floodplain in California's Central Valley: the Yolo Bypass.
      Target Journal: San Francisco Estuary and Watershed Science
    - Reconciling Fish, Farms and Fowl: multi-objective analysis applied to land and water management decisions on an engineered floodplain in California's Central Valley.
      Target Journal: Journal for Water Resources Planning and Management