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# Informing Rangeland Stewardship With Research: Lessons Learned From Yolo County, California<sup>1</sup>

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## Abstract

Approximately 70 percent of the contiguous United States is in private lands with half of this total in row crop or rangelands. Audubon California's Landowner Stewardship Program engages with farmers and ranchers on conservation and restoration projects in a manner compatible with existing agricultural operations. To assess the success of these efforts, Audubon, University of California, Davis, Agricultural Research Service, and Michigan State University conducted multi-disciplinary studies across a range of habitats in Yolo County, California. We present the results from this multi-disciplinary research as well as highlights of key lessons learned.

*Keywords: Oak woodland, private land conservation, restoration.*

## Introduction

The Willow Slough watershed in Yolo County, California, is an important contributor to the health of the Bay-Delta ecosystem (ERPP 2001). The watershed encompasses the steep eastern slope and low-lying foothills of the inner coast range and the relatively flat alluvial plain of the southern Sacramento Valley. In 1996, the Willow Slough Watershed Integrated Resources Management Plan identified three major categories of natural resource problems within this 131,000-acre watershed, including lack of biodiversity and quality habitat for wildlife as a result of conventional land management practices; degradation of water quality through sediment and nutrient loading; and threats to agricultural sustainability in the region (Jones & Stokes 1996).

In 1998, Audubon-California's Landowner Stewardship Program teamed with the Yolo County Resource Conservation District to implement the recommendations of the Willow Slough Plan throughout the watershed. Conservation actions in the watershed were based upon two assumptions:

1. Successful implementation of conservation and restoration practices is best achieved through a community-based watershed stewardship program with voluntary participation by landowners; and
2. Conservation and restoration practices on individual farms and ranches will increase biodiversity and quality habitat for wildlife, improve water quality, control invasive non-native plants, and sustain the economic conditions for agriculture.

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To test these assumptions, we implemented restoration projects, developed a monitoring plan and collaborated with scientists from diverse disciplines to test a series of research questions. Data collected throughout the project provided important land management and conservation information for Audubon. In addition, our findings provided innovative and effective ways for partnering with local farmers on private land conservation projects implemented in a manner compatible with existing agricultural operations.

## Research Studies

Our research projects present background descriptions from an analysis of multiple studies that provides synthesis and allows comparison of results across multiple disciplines. Summaries of questions, research objectives, and actions undertaken by collaborators include:

1. **What are the plant and soil responses to restoration of native perennial grasslands?** Researchers hypothesized that rangeland restoration using deep-rooted native perennial grasses will improve grassland ecosystem health and reduce rangeland erosion potential by improving soil water percolation and retention, reducing soil compaction, enhancing nutrient use efficiency, and ensuring vigorous regrowth compared to annual grassland systems (Griffith 2005).
2. **How do grassland and riparian avian communities respond to habitat restoration?** Research objectives were to document the effects of grassland restoration on bird abundance and species composition at upland restoration sites, and to collect baseline data on avian response to riparian restoration to compare with avian use of remnant stands of riparian vegetation (Goerrisen 2005).
3. **What are the forage preferences by livestock to native perennial bunchgrasses versus annual grasses?** Researchers evaluated livestock preferences for annual versus native perennial bunchgrasses as well as measured nutritional quality of both types of grasses (Laca 2005).
4. **What are the correlates of successful native perennial grass establishment, and how can forbs enhance biodiversity in the ecological restoration of annual rangelands?** Two studies examined the correlates of successful upland native perennial grass establishment and the feasibility of using native forbs in grassland restoration to increase biodiversity (Lulow and Young 2005).
5. **Can remotely sensed imagery be used to estimate biomass in rangelands?** Researchers monitored and analyzed biomass dynamics across the watershed; developed methods for remotely detecting different vegetation types; and created a Web-based delivery system to deliver information to stakeholders and inform their range management activities (Malmstrom and Butterfield 2005).
6. **How does vegetation respond to conservation and restoration activities?** Research and monitoring activities included collecting baseline data on plant community composition, measuring vegetation response to restoration activities, establishing monitoring protocols for future long-term data collection and assessing per unit costs of restoration activities (Audubon 2005).

## Results

We summarize the results from these six research questions into three broad themes, vegetation response to restoration, avian response to restoration and utility of remote sensing tools to rangeland management, which cut-across the individual studies.

### ***Vegetation Response to Restoration***

Monitoring undertaken to determine vegetation response to restoration showed that tree and shrub survival in upper rangeland sites averaged 30 percent with a 24 to 70 percent variation. This average survival, compared to 75 to 80 percent in Audubon valley sites, reflected difficulty of establishment in rangelands largely due to inadequate irrigation (Audubon 2005). In fact, we found that actively managed irrigation at each site led to a significantly higher percentage of survival rates (Audubon 2005). There was variation, however, in the success rate, depending on the species: Blue oak (*Quercus douglasii*), live oak (*Quercus wislizenii*), and foothill pine (*Pinus sabiniana*) had the highest survival rates across all the sites. Use of metal cages to prevent browse and damage from cattle showed a significant increase in survival numbers from 50 to 88 percent, depending on site and species (Audubon 2005).

Control of non-native invasive species was a challenge in many of the research projects undertaken. However, quantitative assessment of medusahead (*Taeniatherum caput-medusae*) relative cover showed drastic reductions from 23 to 36 percent to 0 to 5 percent following prescribed fire. However, data from sites treated in 1999 and 2000 suggested that medusahead may be on the increase three or four years post-fire, even at sites that have been seeded with native perennial grasses and managed with grazing (Audubon 2005). Other studies indicated that early spring prescribed fire may be effective at controlling barbed goat grass (*Aegilops triuncialis*) (DiTomaso and others 2001). In other sites, barbed goat grass cover varied annually, likely responding to other yet to be determined climatic or management variables.

Two studies examined the combined affect of treatments for invasive species (Audubon 2005, Malmstrom and Butterfield 2005). Sites treated with burning or rotational grazing alone showed more variable effects; short-term reductions in weed fractions were evident after prescribed burns, but the effect was not as long-lasting as revegetation (Audubon 2005, Malmstrom and Butterfield 2005). Similarly, the combination of prescribed fire and Transline™ herbicide significantly reduced relative cover of yellow star thistle (*Centaurea solstitialis*) from 6 to 9 percent to 0 to 1 percent.

Determination of biomass production was a component of two out of the six studies. Native perennial grasslands produced more above- and below-ground biomass per unit area and contained higher tissue nitrogen at the growing season's end (Griffith 2005). Similarly, sites revegetated with perennial species generally exhibited higher above-ground biomass levels in spring and fewer weeds than untreated sites, particularly if the revegetated sites were actively managed with fire or grazing (Malmstrom and Butterfield 2005).

Soil characteristics were a strong determinant of restoration success (Lulow and Young 2005, Griffith 2005). Sites with richer soils can have very high rates of early restoration success (Audubon 2005, Lulow and Young 2005). Native perennial grasslands had higher soil nitrogen fertility, allowed plant roots to absorb more soil-

bound water (particularly in drought conditions), allowed for more surface water infiltration and minimized erosion on hillsides. (Griffith 2005). One of the most interesting and striking responses that the perennial grassland had on soil properties was the change that occurred in soil water retention characteristics (Griffith 2005). This could be due to the ecological advantage to plants in perennial grasslands by allowing more water to be extracted from the soil under harsh dry soil conditions.

### ***Avian Response to Restoration***

Monitoring of avian abundance, diversity and population dynamics is an important tool to measure the performance of restoration sites (Gardali and others 2006). Avian monitoring at grassland sites demonstrated species richness and abundance to be greater in perennial grasslands than annual grasslands with the strongest patterns observed in grassland specialist birds (Goerrisen 2005). Within grasslands with constructed brush piles, nesting by several bird species occurred, as well as avian seed dispersal. Riparian monitoring results showed greater avian species' richness and abundance in mature riparian vegetation sites (Goerrisen 2005). Avian monitoring also occurred at constructed brush piles.

### ***Utility of Remote Sensing Tools to Rangeland Management***

Malmstrom and Butterfield (2005) demonstrated that a vegetation classification based on time series of remote-sensing imagery—a multi-temporal analysis—can successfully separate late-season weeds and cool-season forage grasses in project grasslands. Aerial photography proved in many ways to be superior to satellite imagery for vegetation mapping, particularly in terms of its cost, spatial resolution, and the flexibility of scheduling image acquisition. The vegetation classification revealed medusahead and barbed goat grass to be widespread throughout the project watershed. Levels of these two weeds were markedly reduced at several restoration sites, in seeded clover fields and at sites in which we conducted prescribed burns.

Interviews with landowners concluded they would use remote sensing and associated World Wide Web management systems to assist in determining forage dynamics throughout ranches (Butterfield and Malmstrom 2006). The researchers concluded that remote sensing tools would be a cost-effective means to enhance private rangeland conservation (Butterfield and Malmstrom 2006).

## **Discussion**

Research questions have resulted in important findings to further our understanding of restoration in blue oak woodlands. These insights are already being incorporated into conservation and restoration actions throughout the region. Restoration actions implemented with local ranchers with multidisciplinary research projects led to a number of important lessons for working with private landowners.

1. **Collaborate among complementary organizations**—It is well recognized that farming with the wild begins with conservation-minded communities (Imhoff 2003). The conservation partnership between Natural Resources Conservation Service (NRCS), Center for Land-Based Learning, Audubon, and Yolo County Resource Conservation District was critical to the successful implementation and to provide the broad spectrum of technical resources and funding to carry out successful projects.

2. **Develop projects from small to landscape scale**—An unexpected benefit of implementation with landowners was increased habitat connectivity between groups of landowners throughout the watershed. Several researchers have noted the importance of restoration in agricultural areas to native pollinators and other species (Jackson 2005, Maestas and Knight 2003, Kremen 2004). Results from the Audubon studies showed that multiple landowners can be engaged and cooperate in landscape-scale restoration, particularly if it helps to profitably manage forage, weeds and cattle.
3. **Create projects with multiple benefits**—Many of the Audubon-implemented projects had multiple economic and agronomic benefits outside of the intended habitat restoration project objectives. These included improved water quality, reduced soil erosion, flood control and non-native invasive plant control. In general, multiple benefits projects are more appealing to the farm and ranch community due to long-term cost reductions.
4. **Involve students in hands-on restoration projects**—Conducting ecological restoration provides a good opportunity for students to experience hands-on learning. Students participated in many of the restoration projects through planting, installing irrigation, select monitoring activities, and meeting the landowners.
5. **Utilize farmer-to-farmer extension**—Extension or learning between farmers, in addition to learning from experts, has long been recognized as important to technology transfer (Bunch 1982). Creating farmer-to-farmer learning opportunities, formally through workshops and informally through such activities as site visits or field days, engaged more farmers in the program and provided more credible learning opportunities than if Audubon worked on restoration projects individually with farmers. A “bottom up” extension approach allowed us to reach a more diversified group of growers from the large to small and different types of farm operations.
6. **Base projects on resource management plans**—The Willow Slough Watershed Management Plan provided the overall project framework and identified key project needs. Watershed plans often provide the basis for multiple-use projects across many stakeholders and help identify multiple conservation benefits, including agricultural, water, and natural resources.
7. **Provide financial, technical, and logistical assistance for landowners**—The Landowner Stewardship Program was initiated to provide technical and financial assistance to landowners for project implementation. In addition, negotiating the administrative paperwork required by private land conservation programs and regulatory permitting is essential to implement successful projects. Assistance, however, needs to be undertaken in a manner that builds participation and farmer ownership of the process. In this vein, projects must be developed with the landowner’s objectives in mind and integrate in-kind and monetary input from participating landowners.
8. **Test assumptions and measure success**—The research projects described demonstrated the efficacy of treating habitat restoration projects as experiments useful for landowners, researchers and Audubon. However, it is difficult to implement an adaptive management program on three-year funding cycles. Further research is also needed to examine the interactions between restoration projects and agricultural production. Future research for the Landowner

Stewardship Program will be coherently linked through a programmatic science agenda to guide future research and fully assess restoration assumptions. The science agenda will be shared widely with research institutions, conservation organizations, donors, and landowners.

## Conclusion

Restoration on agricultural lands is a relatively new field and much still remains to be learned. The projects described in this paper were a first attempt at beginning to understand direct effects of restoration upon biotic and abiotic systems found in Yolo County. Applying research results to management actions in an adaptive management process is not easy, particularly given uncertain funding cycles. Nevertheless, actively testing assumptions made in the field, measuring restoration success and attracting high-caliber research is essential to increasing the credibility and quality of future conservation actions and perhaps public support for the conservation value of farming with the wild.

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## References

- Audubon California. 2005. **Final monitoring report**, Willow Slough Rangeland Stewardship Program. Sacramento: CALFED.
- Bunch, R. 1982. **Two ears of corn: a guide to people centered agriculture improvement**. New York: World Neighbors.
- Butterfield, S.; Malmstrom, C. 2006. **Experimental use of remote sensing by private range managers and its influence on management decisions**. *Rangeland Ecology Management* 59: 541-548.
- CALFED Bay-Delta Program. 2001. **Ecosystem Restoration Program Plan (ERPP)**, Vols. 1 and 2.
- DiTomaso, J.M.; Heise, K.L.; Kyser, G.B.; Merenlender, A.M.; Keiffer, R.J. 2001. **Carefully timed burning can control barbed goat grass**. *California Agriculture* 55(6):47-52.
- Gardali, T.; Holmes, A.; Small, S.; Nur, N.; Geupel, G.; Golet, G. 2006. **Abundance patterns of landbirds in restored and remnant riparian forests on the Sacramento, River, California, USA**. *Restoration Ecology* 14(3): 391-403.

- Goerrisen, J. 2005. **Avian monitoring and assessment of perennial grassland and riparian restoration efforts in the Willow Slough watershed.** Unpublished final report. Winters: Audubon, California.
- Griffith, S. 2005. **Plant and soil response to restored native perennial grasslands versus non-native annual grasslands.** Unpublished final report. Winters: Audubon, California.
- Imhoff, D. 2003. **Farming with the wild: Enhancing biodiversity on farms and ranches.** Healdsburg, CA: Watershed Media.
- Jackson, D.; Jackson, L. 2002. **The farm as natural habitat: Reconnecting food systems with ecosystems.** Washington, D.C.: Island Press.
- Jackson, L. 2005. Personal communication.
- Jones & Stokes Associates, Inc. 1996. **Willow Slough watershed integrated resources management plan.** Woodland, CA: Yolo County Resource Conservation District.
- Laca, E. 2005. **Evaluation of forage quality and selectivity by livestock of native perennial and introduced grasses.** Unpublished final report. Winters: Audubon, California.
- Lulow, M.; Young, T. 2005. **Correlates of successful native perennial grass establishment and enhancing biodiversity with native forbs in ecological restoration of annual rangelands.** Unpublished final report. Winters: Audubon, California.
- Kremen, C., and others. 2004. **The area requirements of an ecosystem service: Crop pollination by native bee communities in California.** Ecology Letters 7: 1109-1119.
- Maestas, J.; Knight, R.; Gilgert, W. 2003. **Biodiversity across a rural land-use gradient.** Conservation Biology 17:1425-1434.
- Malmstrom, C.; Butterfield, S. 2005. **Use of remote sensing for the estimation of biomass and mapping of vegetation in semiarid and arid rangelands.** Unpublished final report. Winters: Audubon, California.
- Natural Resources Conservation Services (NRCS). 2002. **Natural Resource Inventory.** <http://www.nrcs.usda.gov/technical/land/nri02/nri02lu.html>. USDA, Washington, D.C.

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