

ScienceAction

BIG PICTURE

Bringing Back Native Grasses

California's hills rise in the landscape of the American imagination as gold as the ore that gave the state its nickname. But scientists think that before the Spanish claimed this new world for their cattle and missions, the hills were green, not gold, long into the summer. The grasses brought here by the Spanish, and the settlers and farmers who followed, live fast and die young. It is the shoots and shattered seeds of these exotic annuals, rather than the deeper-rooted, more drought-tolerant native perennials they displaced, that burnish the state's hills and valleys with gold come May.



California native grasses.
Photo: Peter Rubissow

No one knows exactly how much grassland once covered the Central Valley, but certainly it was only part of a mosaic of desert scrub, riparian zones, wetlands, and other habitats. A 2003 state atlas of biodiversity suggests that California once supported about 22 million acres of grasslands, about 20% of which lay in the Central Valley. Less than 10% of the Valley's grasslands remain today. Farms and homes have claimed more grasslands

than any other habitat in the state. And those plants now growing on the Golden State's rangelands and foothills are more exotic than native.

"The massive grassland ecosystem that was once the Central Valley is largely gone, and native grasslands only exist now in remnant patches," says Vance Russell, who directs Audubon California's Land Stewardship Program. Russell points out that as settlers brought in animals and hay from other parts of the world, and suppressed the fires that regularly cleared vast acreages, they opened the way for a plethora of exotic plant species. The invaders have since spread, out-competing the natives, disrupting natural plant and wildlife communities, stealing water from crops, and robbing ranges of nutritious forage for cattle. With the natural balance so out of whack, other plants are growing where they never grew before, or are not wanted.

"When we first started ranching here in the 1970s, there were no more than a few star thistle plants," says rancher Scott Stone, whose family runs Black Angus cattle on 7,400 acres in Yolo County and who is now restoring native grasses. "But over the years, some very aggressive weeds have come in like goat grass and medusahead. We're fighting weeds all the time now."

The restoration work on Stone's ranch, through Audubon California's Land Stewardship Program, is only one of the more than 50 restoration and conservation projects benefiting wildlife and fish on agricultural lands that CALFED has supported since the mid-1990s. CALFED is a state and federal program coordinated by the California Bay-Delta Authority. It was established to balance competing needs for the state's freshwater supplies while protecting its endangered fish and wildlife and restoring the creeks, rivers, and watersheds flowing into the Sacramento-San Joaquin River Delta and San Francisco Bay.

"Wildlife-friendly agriculture is one of the foundations of our ecosystem restoration efforts," says Jay Chamberlin of the California Bay-Delta Authority. CALFED's approach is to

provide voluntary incentives and other tools that assist landowners in helping wildlife and fish on their property, he says. Since 2000, such "working landscapes" projects have included protection of more than 54,000 acres of agricultural or rangeland, largely through easements, retiring only about 3,500 acres of active farmland from production. The program Chamberlin was recently hired to manage has also helped farmers flood fields full of grain and corn stubble after harvest to feed migrating birds; plant the banks of levees, ditches, and ponds to shelter wildlife and shade fish; build ponds to trap runoff; replant grasslands with native species; encourage grazing that controls exotic plants and weeds; and create wetlands and floodplains on marginal croplands that offer recreation and associated income to landowners. Despite these successes, the program is very much in its infancy, says Chamberlin. "Finding the best ways to achieve public goals on private lands is a nut society is still trying to crack," he says.

These pages focus on the particular challenges, milestones, and science of grassland restoration on private lands in Yolo County. They also examine how grassland restoration has grown on public lands along the Sacramento River corridor, and how native grasses contribute to CALFED's landscape-scale restoration goals for the entire watershed. Whether public or private land, range or riparian zone, such efforts tend to cross the ecologically artificial boundaries created by fence lines and spawn unusual partnerships among farmers, firefighters, biologists, water managers, environmentalists, and planners.

"We have a tradition in the U.S. of piecemealing the landscape and staying out of each other's business," says range biologist Carolyn Malmstrom, whose 19th-century ancestors lost their ranchlands to a reservoir and who, in recent CALFED research, employed satellites and airplanes to show those on the ground what's growing where. "But these days I see ranchers and scientists working together to not only restore water quality and the ecosystem, but also to stay profitable. We have to help them keep our watersheds open. We can restore an overgrazed ecosystem but not an asphalt one." **ARO**

Seeds of the Past & Future

John Anderson is the Johnny Appleseed of California's native grasslands. Where his predecessor passed out apple pips to Ohio farmers, Anderson grows species such as purple needlegrass, creeping wild rye, and California oniongrass for farms and wildland restoration projects across Northern California.

Hedgerow Farms is now the primary grower of native grasses from the Central Valley west to Marin County, and Anderson has become a major player in the movement to revive the nearly vanished remnants of this important ecosystem.

Anderson started his unusual business more than 16 years ago. While working as a primate veterinarian for U.C. Davis in the mid-1970s, he and his wife, Marsha, bought a 50-acre farm near the Central Valley town of Winters. The clean-farming movement was in full vogue among Anderson's agricultural neighbors. Those who had once tolerated a few weeds around their fence lines



began spraying herbicides to keep their crop rows and ditches clear of vegetation. Populations of birds and other wildlife disappeared as their last vestiges of habitat vanished.

Following the suggestion of local farm advisers, Anderson planted hedgerows of non-native plants to help attract animals. Soon thereafter, he says, "I recognized that native plants ought to be what we were using." He began collecting local native grass seeds and planting them



Harvested seed waiting for cleaning.

in his backyard as a hobby. By the mid-1990s, he was too busy to do anything but grow native grasses full time.

"Just in the last 10 years, really, have people finally been starting to adopt natives as something we should be using," Anderson says. "Now, it's trying to restore functioning ecosystems with as many of the parts as we can put together, and hoping they become viable."

Hedgerow Farms is a shining example of why native plants are the way to go. Hedgerows grow in place of fences to attract beneficial insects, such as pest-eating lacewings and native bees. Cottonwoods and willow trees flourish along Anderson's irrigation canals, and the lacy ivory blooms of elderberry bushes decorate his tailwater ponds. Today, the farm is alive with families of beavers, otters, and quail, and biologists use the spread to show skeptical landowners the benefits of going native.

To develop the array of seeds and plantings needed for restoration projects, Anderson works closely with government agencies and land managers. Several years before a restoration project is scheduled to begin, he will collect seeds from wild grasses growing near the project site.

Obtaining local genetic strains called ecotypes is critical because they are genetically adapted to local growing conditions. Hedgerow Farms now cultivates more than 20 species of native grasses representing nearly 50 ecotypes. "The general philosophy is not to

look for a superplant but to grow multiple genetic types. That way, you better your chances of having one of those types survive," Anderson says.

Because native grass stands are now rare, he often returns with just a few pounds of seeds—just enough to grow a crop for propagation. He plants the wild seeds in tomato seedling

trays, and sprouts them in greenhouses. He transplants each "plug" into the ground in winter to grow a seed production crop. By the end of the year, he often has enough seeds or plugs to satisfy a given project's planting needs.

Native grass seed is expensive—and Anderson says it always will be. Elaborate, multi-step procedures are needed to ensure the seeds are clean and free of noxious weeds. The high cost, says Anderson, means that subsidized programs will continue to be needed in order to make restoration economically feasible for private landowners.

Restoration projects funded by CALFED, including those handled by the U.S. Fish & Wildlife Service, the California Department of Fish & Game, Audubon California and other groups, are among Anderson's largest clients. Despite the fact that funding for restoration waxes and wanes, and demand for each ecotype is erratic, business has been GREAT. "We're going to have to increase in size if the industry continues to develop like it has," Anderson says. And that's good news for the grasses.

KMW



Threshing native squirreltail grass.

RESEARCH

Ripple Effects in Yolo

There's a place on the Yolo Land and Cattle Company Ranch those familiar with the lay of the land call the "Corral Pasture," where the grass is greener, the bugs busier, and the soil looser now than ever before. This small 30-acre field lies at the heart of a 7,400-acre ranch near Winters owned for two generations by the Stone family. The foothills of the inner Coast Range climb to the west, the farmlands of the Central Valley roll out to the east, and here and there stand a red barn, a herd of Black Angus, and a locked gate with a "No Hunting" sign. Two brothers work the ranch these days, often on horseback, but they've been doing something a little out of the ordinary in the Corral Pasture lately. They've not only restored an extensive area of native perennial grasses, and planted willows and shrubs along a seasonal creek, but also collaborated with scientists from as far afield as Oregon and Michigan and as close as Winters and Davis, allowing them to bring in backhoes and satellites to study soil quality, carbon cycling, and grazing management.

"We're trying to manage our ranch for both habitat values and cattle values," says Scott Stone. "There's no reason the two can't overlap. It takes longer and costs more than you'd expect. But the restoration has produced a tremendous amount of feed and brought Canada geese and pond turtles to our property."

Stone's pasture is one of 26 Yolo County sites in Audubon California's Land Stewardship Program. Since 1999, the program has worked with landowners to restore native perennial grasses on 300 acres and control weeds on an additional 1,200. Much of this work has been supported by CALFED, as well as by the many local agencies, farmers, and conservation organizations involved in developing the 1996 integrated resources plan for the 130,000-acre Willow Slough watershed. By 2001, some of the sites had attracted university research teams. Five such research projects, all of them supported by CALFED through Audubon California, have been exploring the relationship between native perennial grass restoration and rangeland quality by measuring the health of the soil, the length of the forage season, the use of water, the number of spots hosting birds and beetles, and the amount of nutritious green stuff available for the beef cattle and sheep flocks to eat.

"It's not just science," says Audubon's Chris Rose, who also works in the stewardship program. "There's a lot of art, a lot of farming, and a lot of information sharing involved in restoration."

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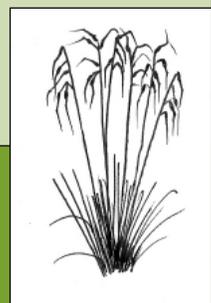
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What Audubon and its lead restoration ecologist Jeanne Wirka tried on the Stone's Corral Pasture shows one possible five-year sequence. As a first step, Wirka walked the pasture site; looked at slopes, microclimates, and existing vegetation; and worked with the Stones on a seed mix that included seven native grass species.



Medusahead (*Taeniatherum caput-medusae*). Photo: Peter Rubissow

Flames initiated the process, burning the existing vegetation to the ground in June 2000. Next came the heavy machinery—a disk to open up the soil and a seed drill to drive the new seeds half an inch into the ground. Four months later, in March 2001, the exotic annual grasses had grown waist high but the perennial natives were just emerging at the 4- to 6-inch level. So Wirka asked the Stones to call in the cows. "The great thing about native grasses and cows is that the latter eat from the top down, and get all the bad stuff first," she says. After five



Purple needlegrass

Illustration: Alex Palmerlee

GRASSES IOI

California has more than 300 species of native grasses. Many are perennial bunchgrasses—they grow in bunches, leaving space for other plants and wildlife, rather than growing in a uniform carpet. Some native perennials, like purple needlegrass, can live for up to 100 years. They sprout slowly at first, putting much of their energy into extending deep roots that ensure a supply of moisture over the hot, dry summer.

Many of the non-native grasses that dominate the California landscape, on the other hand, are annuals; they grow fast and die young. These more

shallow-rooted species sprout shoots early in the season, directing most of their energy to the parts of the plant above ground. Annuals die soon after going to seed, covering the landscape with rattling, straw-bleached husks. As in all diverse plant communities, there is great variation to the norm: Both native annual grasses and non-native perennial grasses can also be found in California's fields today.

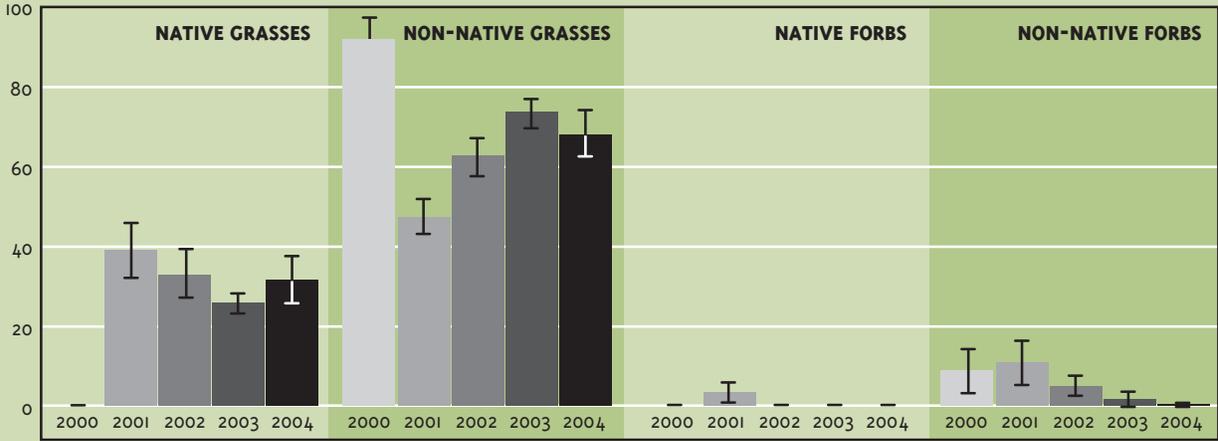
Scientists say the conversion of native perennial grasslands to non-native annual grasses has increased the potential for runoff, erosion, and weed invasion, and reduced retention of water and nutrients in the soil.

SIX PERENNIAL NATIVE GRASSES

- Elymus glaucus* Blue wildrye
- Elymus multisetus* Squirreltail
- Hordeum brachyantherum* Meadow barley
- Leymus triticoides* ... Creeping wildrye
- Nassella pulchra* .. Purple needlegrass
- Poa secunda secunda* One-sided bluegrass

Ripple Effects in Yolo

CHANGE IN RELATIVE COVER OF GRASSLAND SPECIES GUILDS BEFORE & FOUR YEARS AFTER BURNING & SEEDING



While native perennial grasses achieved over 39% cover within a few years at this Corral Pasture site (and over 50% cover at other Audubon sites), medusahead and goat grass reinvasions continue to challenge the restoration – underlining the importance of long-term
Source: Wirka, Audubon California

days, the 200 cows had eaten most of the annual grass crop, revealing once again the tidy rows of seedling perennials, unharmed by the herd. The well-timed graze just before the seeds of the annuals mature, and well before the perennials set seed, has been repeated every year since.



Seed of a purple needlegrass, *Nasella pulchra*, with its corkscrew tail designed to drill down into the soil. Purple needlegrass is preferred by grazing sheep over soft chess (an annual exotic), according to a CALFED-funded U.C. Davis study by Emilio Laca. But sheep preferred the native only when it was clipped and not flowering, suggesting that land managers may wish to consider the growth stages of grasses when using livestock grazing and native grasses in rangeland restoration.
Photo: Peter Rubissow

“There are those that think that since livestock caused the problem that all cows are bad,” says Wirka, referring to the role of cattle in the

spread of annual grasses, overgrazing, and subsequent soil erosion. “But our grasslands were always grazed. You have to use today’s livestock to mimic the natural grazing patterns of elk and antelope, which let in light and removed dead growth. The difference is that the wilder animals moved around enough not to compact the soil or clear it down to the dirt.”

Next on the Corral Pasture project came the weeds. When yellow star thistle began rearing its prickly and productive heads—one plant can generate more than 100,000 seeds—the Stones sprayed a herbicide across the entire field (sheep grazing at just the right moment in the thistle cycle can also work). By May 2002, however, another much more pernicious weed—goat grass—had gained ground. To combat it, Stone “swathed” the field—basically chopping it down in sections and laying it down as in a hayfield.

By spring 2005, however, the goat grass had spread again. This year, the Stones will fight these unpalatable weeds (goat grass is tough to eat) with fire. “The trick is to burn when the goat grass is still green, before the seeds mature, but also when there’s enough dry and crispy thatch to carry the fire. It steams the weed seeds,” says Wirka.

As the years have gone by, Wirka has been monitoring the Corral Pasture site twice a year, pitching a

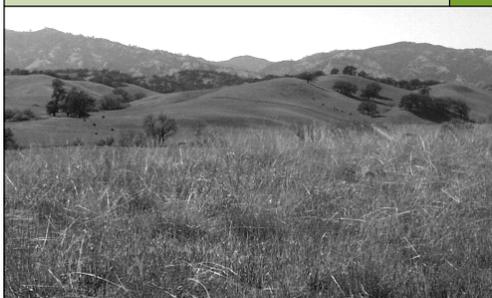
pointy stick into the ground every few steps and noting the first species speared. To do this “step-point method,” she divided the field into eight lines of 40 points each, for a total of 320 samples. Based on results from this and other Audubon restoration projects, she’s concluded that the most successful sites achieved 50% cover of native grasses about two to four years after seeding. Seeded sites that were improperly grazed or not managed at all had lower native grass cover than those subjected to post-seeding fire, herbicide, or grazing treatments. Though spring burns drastically reduced the weed medusahead, she’s still searching for effective controls for goat grass.



Steve Jaouen, NRCS range conservationist, examines native perennial bunchgrasses planted by Audubon at Yolo Land and Cattle.

In six years of work, Wirka and her colleagues at Audubon have learned to be patient in the wait for visible results, and have fine-tuned the seed mixes to better match soils and farm budgets (native grass seeds range from \$7-\$80 per pound, but mixes average around \$25 per pound). They've also started using some native annuals that grow fast but don't out-compete the perennials. Audubon would like to do more controls and more experiments, but the unexpected shifts in climate, weeds, and government budgets often seem to intervene.

"CALFED and its partners are always trying to make sure studies are strategic and relevant to the information needs of farmers and restorationists," says CALFED's Rhonda Reed.



Citrona Farms, one of Steve Griffith's research sites.

Other CALFED-funded researchers, meanwhile, have been filling in some of the data gaps on success or failure of native grassland restoration on the Yolo sites. "The problem with most restoration projects is that monitoring only goes on long enough to prove to the farmer or the funder that it was completed, but not long enough to say whether or not it was a long-term success," says U.C. Davis ecologist Truman Young.

Young's graduate students Megan Lulow and Jeffrey Clary tried to figure out what factors—soil types, topography, land preparation, weed-control timing—correlated with long-term success in establishing purple needlegrass and five other native perennials on a 180-acre site along Union School Slough. After the first three years of monitoring, they got some interesting results: most exciting, according to Young, was the profound difference in success between north- and south-facing slopes. After the third growing season, native grasses covered twice

THE WATER & SOIL ANGLE

It may be dry, steep, and harsh out there on California's rangelands but it doesn't seem to bother the natives. When it comes to getting deep water, extracting nutrients, holding the soil in place, and producing green up top and roots down deep, the natives outpace the annuals, according to a 2002-2004 Yolo County study by plant physiologist Stephen Griffith with the U.S. Department of Agriculture, Agricultural Research Service.

The study—funded by CALFED through Audubon California—focused on two pairs of sites with similar soils in close proximity to each other. One pair compared a site dominated by annual non-native grasses with a newly restored (2002) native perennial grassland. The second pair compared another annual-dominated site with a 10-year-old native perennial grass restoration area.

Researchers fenced off the sites from grazing, set out 100 meter x 400 meter survey plots, and visited them numerous times over the three-year study period—digging down and measuring rooting depth and mass, testing the soils for water and nutrients, surveying above-ground plant growth and dieback, and testing water infiltration and holding capacity of the soils back in the lab.

Among other things, Griffith found that the native grass restoration sites produced about 35% more biomass on average than the non-native annual grass sites, that the natives with their deeper roots mined more nutrients out of the soil to produce this biomass (perennials had up to four times more total soil nitrogen during the fall than the annual grass-dominated sites), that water infiltration was 11% slower on the annual sites, and that natives withdrew more water from the soil throughout the season, even in dry conditions (see chart).

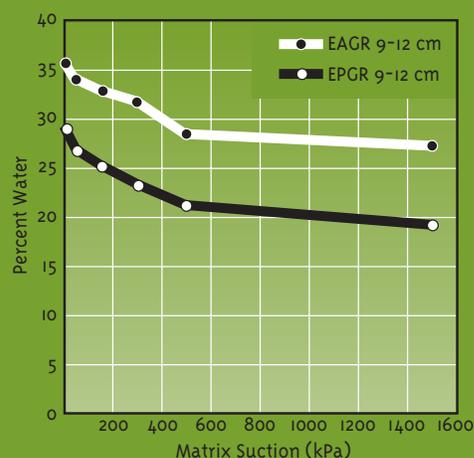
"The biggest difference we found between the annuals and the perennials, whether newly restored or older, was the ability of the soil to give the water up to the root," says Griffith. The restored sites did this much more readily, probably because of some combination of more root biomass reaching deeper and opening up channels in the soil, more surface litter from plants

reducing evaporation, or changes in the soil's physical and chemical characteristics.

In a related study, Griffith also found that as perennials take in carbon dioxide from the atmosphere and convert it to sugar, roots, and stems, they stash some of the carbon in the soil. His research suggests that perennials sequester more in the soil than annuals—reducing carbon releases back into the atmosphere, and associated greenhouse gas emissions. "When pioneer farmers first tilled the American grassland prairies, enormous amounts of carbon dioxide were released into the atmosphere. Modern-day farmers have learned from this, and many now use no-till planting methods, leaving the soil much improved and the land much more like the undisturbed grasslands of old."

So the take-home message seems to be that the perennials do indeed improve soil health, conserve water, and produce higher-quality forage grass for livestock. "In many respects, the perennial grasslands seem to have a large ecological advantage," says Griffith. ARO

ANNUAL VS. PERENNIAL GRASSES SOIL WATER RELEASE



EAGR = established annual grass site
EPGR = established perennial grass site

In the laboratory, researchers applied suction to soil blocks cut from 9-12 centimeters below the surface to see how much water could be released. Soil from the perennial grassland released more water than the annual grassland soil.

Source: Griffith, USDA-ARS

Ripple Effects in Yolo

as much of the north-facing slopes as the south-facing slopes (probably due to greater soil moisture). "Because these sites were all wiped clean and grasses started from scratch, this finding suggests there's something fundamental to success about the non-biological parts of the environment," says Young.

The only species that seemed to do just as well on north- and south-facing slopes was purple needlegrass, a big-seeded species known for being "tough as nails, and able to survive in the last places you'd expect," says Young. Perhaps for this reason, and because people think it was prevalent before humans disrupted the scene, purple needlegrass is one of the most-used species in native grassland restoration. Young isn't sure this is always a good thing. "Maybe its prevalence in harsh remnant sites, including those that have never been plowed, is more about the sites themselves than about the historic dominance of the species," he says.

Clary and Lulow also examined whether the timing of herbicide sprays affected the ability of perennial grasses to out-compete weeds, and found that giving the grasses a one-year head start always helped. The team is now experimenting with a second-year pass of chemicals designed to kill weeds before they even break the surface.

While chemicals may help give the grasses a leg up, Young is also interested in the importance of what species gets planted first. "If we establish a very aggressive plant early and first, like creeping wild rye, are we setting a trajectory for that field to be dominated by that

species?" He's started to think about introducing a greater number of minor players early, so they aren't immediately overwhelmed by more dominant species. This is somewhat of a sea change in the restoration game. For years, he says, biologists have emphasized restoration of the dominant species. "In the tall grass prairie, we planted tall grass; in mixed conifer forests, we planted conifers; in riparian zones, we planted cottonwoods and willows. Now we're moving beyond the focus on dominant species and trying to examine what went in between and underneath."

In native grasslands, what went in between may have been species called "forbs." These poppies, tidy tips, tarweeds, and clovers, among others, are defined by what they are not: not grasses, not woody. Forbs often fill in the interstices between grasses and do well in years when grasses don't, according to Lulow's research. "If we can predict year-to-year effects of conditions, we might get better success rates, seeding the right plants in the right years," says Young.

Young says restoration ecologists are in the midst of a lively debate over two hypotheses. According to the first, order of arrival (priority) drives the plant community in specific directions—whatever you plant first "grabs space, gets big, and dominates." The second hypothesis proposes that in the long term, domination by any one species will converge toward a more "original" and diverse community—in other words, "succession will sort things out." If the goal is to restore and maintain multiple species, then knowing whether or not succession trumps priority becomes critical, he says.

Which species dominates, including weeds, is something it may be easiest to see from up high rather than on ground level. Yolo landowners participating in Audubon's restoration projects gained access to remote photography of their lands as a result of CALFED-funded research. According to Michigan State University's Carolyn Malmstrom, the Yolo landscape is perfect for remote sensing because it's not too steep, trees are relatively few, and restora-



Scott and Hank Stone: Scott, on left, suited up for prescribed fire in June 2000.

tion patches are big enough to see from the imagers and cameras of space satellites and planes 18,000 feet up in the sky. Using these remote sensing tools, Malmstrom evaluated forage biomass and weed distribution over a 4,293-acre area, as part of broader monitoring of a 15,808-acre area. She also compared her current Landsat images with those of the same watershed taken over the past 20 years.

Looking at the images of Yolo's ranchlands in May, Malmstrom could clearly see the patches of late-season weeds showing up as green patches on the otherwise gold hills, she says. By catching such pictures, Malmstrom and her team could measure the amount of weeds and determine how their extent had been influenced by grazing and burning treatments. The team knew the weeds were significant players at the end of the growing season, but they were surprised to see how much the weeds were also suppressing range productivity during the peak growing time earlier in spring. A March photo showed the inverse of the May pattern: The weed patches at that earlier point—when ranchers were counting on lush, green foliage to feed their animals—were instead brownish and less active.

Malmstrom put the remote imagery into a password-protected Web site where ranchers could click on maps and see their whole property, or zoom in on specific pastures. "The satellite imagery showed us the amount of weeds and the quality of the forage, and the tremendous difference between the areas where we planted perennials and burned in the spring and the rest of our ranch," says Scott Stone.

"This tool is a good fit for ranchers," says Malmstrom. "Ranchers,



*Corral Pasture riparian zone tree plantings, protected by wire caging.
Photo: Peter Rubissow*

more than the average person, are good at interpreting spatial data. They're used to looking over their land and making decisions based on what they see. We've had neighbors starting to compare their results, then changing their minds about what to burn or graze, for example. It's really helped them see the tradeoffs of different management actions. It's putting a tool used by universities and government agencies into the hands of landowners on the ground."

As neighbors compare notes, or simply remark on the slow summer greening of the landscape touched by restoration, a larger-scale picture of change is materializing. Audubon

is now working to connect individual projects scattered throughout Yolo County into a mosaic of agricultural, rangeland, and wildlife habitats running from the ridgeline to the valley floor along streams, creeks, and waterways. They're also working to demonstrate that these multiple uses are compatible.

In a major step forward, Audubon and the California Department of Forestry and Fire Protection worked with eight ranchers to develop the state's largest vegetation management plan, which covers 45,000 acres and which will include spring grass burns and fall brush burns. Goat grass is so pervasive, for example,

creeping over fence lines without a care for restoration boundaries, that it can't be wiped out by a crew with backpack sprayers full of weedkiller. Only a landscape-scale assault such as the multi-property vegetation management plan has a chance of succeeding.

"The postage-stamp approach we started with has been totally worth it for the ripple effect," says Wirka. "Neighbors look over their fences and see good things. They see restoration can be done in a way that won't impact, and may even benefit, their agricultural operations." **ARO**

Grassland Birds Need More Than Grass

In the last 30 years, grassland birds across the country have been declining at a greater rate and more consistently than any other group of birds. Such trends are echoed in the Audubon Society's October 2004 *State of the Birds* report. As native prairies and grasslands have been mowed and transformed into housing tracts, these birds—which unlike many songbirds spend lots of time on the ground—have disappeared. California is no exception. Even common Western meadowlarks, the voice of the grasslands, have declined substantially. Yet recent studies by U.C.



Grasshopper Sparrow

Davis' Jan Goerrissen indicate that native grassland restoration—if done with the birds' needs in mind and on large enough swaths of land—could help them recover. Goerrissen focused on two secretive sparrows—one with a call like the buzz of a grasshopper (the aptly named grasshopper sparrow), and another small streaky bird that runs like a mouse on the ground (savannah sparrow). He compared how the birds used native perennial grasslands, restored grasslands, and fields of exotic (introduced) annual grasses. In the midst of

his research, Goerrissen discovered the first breeding pair of grasshopper sparrows—listed by Point Reyes Conservation Science as a species of special concern—in a restored grassland in Yolo County.

"The big news," says Goerrissen, "is that, 'wow, you can plant these native grasses—plus native wildflowers and other forbs—and the birds will come back.'"

There are a few caveats. One is that you need to leave space between the bunchgrasses. Goerrissen monitored two sites where the restoration of native bunchgrasses had achieved 90% cover—but says that from the birds' perspective, that may not be any better than a field of exotic annual grasses.

"The birds need structure and diversity," he says. "And they need to be able to move between the grasses. They really can't walk or maneuver efficiently through a grassland that looks like a wheat field." The birds, he adds, recognize the structure of a bunchgrass habitat where there is room for them to walk between the clumps, and know it as a place they can use. Unlike many songbirds, grassland birds tend to spend a lot of time foraging and nesting on the ground, which is why the open spaces between the bunchgrasses



Savannah Sparrow

are so important. Those "interstitial spaces" also allow them to avoid predators.

Another key to habitat restoration for grassland birds is that wildflowers and other plants need to be planted along with the bunchgrasses.

"Historically in California, wildflowers would start blooming early," says Goerrissen. "In January and February, they would get their first flowers, then you'd have a succession of different species of forbs that would flower through July, August, and September." The seeds of those plants, produced throughout much of the year—plus the insects that pollinate them—are critical for grassland birds, says Goerrissen.

To truly support these special birds, grasslands need to be restored in big chunks. "Lots of grassland birds have large area requirements. If the field is too small, they just fly past." Large grasslands also enable the birds to stay away from the edges—where predators can better see them. "Some birds don't want to nest in a grassland under 300 or 500 acres," he adds. "It could be that we had many more of these birds here historically, but not anymore because our grasslands are too small." Grasslands are also important to migratory birds. "After wetlands, grasslands are the most important wintering habitat on the Pacific Flyway," says Goerrissen, whose studies were funded by CALFED. **LOV**

Pools in the Grass

Amid the Central Valley's vast sea of now exotic grasses lie some of the oddest ecological islands in California. Known as vernal pools, they are home to dozens of tiny plants and animal species that live nowhere else in the world. From microscopic fairy shrimp to dainty white popcorn flowers, each has adapted to a world that floods in winter and dries to a crisp by summer.

Vernal pools owe their existence to a confluence of geology and climate. When winter and spring rains fall on hardpan and claypan soils, the resulting pools may linger for many weeks or months. The sudden arrival of moisture rouses the pools' dormant residents to life. During the heady few months while the ponds are wet, a frenzy of hatching, courting, and mating goes on. After all, there isn't much time. Clouds can disappear and pools evaporate with no whisper of warning.

So the first chance they get, spadefoot toads dig their way upward from several feet beneath the soil and set out to catch their meal of the year. After nightfall, tiger salamanders waddle out of borrowed ground squirrel burrows and look for mates beneath the stars. Just add water to the cysts of tadpole and fairy shrimp—really embryos in suspended animation—and they'll hatch into instant adults. Their wiggling legs and waving antennae offer a welcome snack for waterfowl migrating along the Pacific Flyway.

As the waters recede, the animals vanish too, hunkering down into the soil for another year. Now the wildflowers emerge, surrounding each pool in rainbow rings. Yellow tidy-tips, their toothy petals edged in white, may grow in concentric circles along with violet-bearded downingia, lilac-tinted meadowfoam, and carpets of miniature goldfields. Each week of drying brings one or two new blooms as another species sets seed and fades.

Each pool—and there may be dozens in a single field—shelters a unique community of animals and plants. Across California, naturalists have identified more than 100 species that live only in and around vernal pools.

"Their disappearance or decline would mean a significant loss of state biodiversity," says Jaymee Marty, an ecologist with The Nature Conservancy. By the early 1970s, California had already lost approximately 80% of its pools. Fast-growing Sacramento County alone has lost more than 30% of its pools over the last decade.

Biologists are studying how best to preserve the few pools that remain. Most occur in areas that have been rangeland for the past 100 years. To determine whether cattle grazing is good or bad for vernal pool health, Marty studied 72 pools on 12,362 acres of the Howard Ranch in eastern Sacramento County (a non-CALFED-funded study). She allowed cows and calves to graze on some pools, but excluded the livestock from others. She also surveyed the species diversity at each pool annually during the three-year experiment.



Botanists from the Cosumnes River Preserve sample vegetation in grazed vernal pools. Photo: TNC

"We suspected we wouldn't find a perfect fit, that for some species grazing would be positive and for others, negative," Marty says. "But in the end, we found the historic level of grazing actually had the highest diversity for both native plants and aquatic invertebrates." Without grazing, native plant cover dropped by 20% to 50% at both pool edges and upland areas, while exotic grasses increased their territory. Wildflowers and other forbs declined, while grasses began to dominate.

In addition, protected pools dried an average of two months faster than grazed pools. The extra time can spell the difference between life and death for species like the California tiger salamander. "They need 90 days for

larvae to turn into adults and walk out of the pools," says Marty. If the pools dry up too fast, salamanders "are going to be stranded and die." She suspects much of the water in the ungrazed pools was sucked out of the pool by the extra grass.

Non-native grasses pose another threat to this fragile habitat. Most invasive species can't withstand the dramatic moisture swings and alkaline soil found within the pools. Unfortunately, those defenses don't faze all non-natives. Pepperweed, for example, marches right in on spreading subterranean runners. Growing up to three feet tall, it starves petite natives of nutrients, moisture, and sunlight.

Biologist Niall McCarten of Environmental Science Associates managed a CALFED study to determine how to eliminate pepperweed from a 320-acre vernal pool site at the former McClellan Air Force Base near Davis. He faced a terrible dilemma. Pulling up the plants and their runners by hand would disturb the soil, and could upset the ecology of the pool. And while herbicide spraying would kill the weed, it might also contaminate pool water and kill native wildflowers, including endangered species. He opted for a more painstaking approach instead. After the pools dried, his scientists trimmed the tops from many pepperweed plants with hand shears. They hand-painted some with the herbicide Roundup, and left the other clipped weeds alone.

A month later, the weeds that had been clipped and painted were dead, and some species of endangered grasses in those plots increased in size and number. Meanwhile, those that had only been clipped were regenerating. Control plots, where pepperweed had been left unmolested, had done even worse, losing an average of four individual endangered grass plants per experimental plot. The group plans to return this summer to see how the plots have fared a year later.

"It is labor intensive, but the results are worth it," McCarten says. After all, the pools are also the only known habitat for Solano grass, a federally endangered species. "When you've got such rare species, we'd rather not take big risks." **KMW**

Adding Grasses to the River Restoration Mix

When ecologists first set out to restore the banks of the Sacramento River National Wildlife Refuge complex, they envisioned a happy Hollywood ending. "Plant willow and cottonwood and other native trees and shrubs," they thought, "and the native understory will follow." The cottonwoods and willows grew up tall and lush, shading many a pool and riffle for salmon and attracting special-status species such as yellow-billed cuckoo and valley elderberry longhorn beetle. But a grimmer picture prevailed ashore: Crop after crop of invasive weeds smothered the land, leaving natives no space to grow.

"After several years of letting the forest mature, and seeing mostly non-native plants coming into the understory, we realized we would have to take a much more active role in putting native grasses and forbs back," says restoration ecologist Ryan Luster of The Nature Conservancy.

In retrospect, they could see why their original plan didn't work. For one thing, the original behavior of the river has been fundamentally altered by dams and pumps and bank armoring. Floods no longer seeded virgin banks with native grass and forb seeds. And now there are precious few native grass seeds to distribute. Decades of intensive agriculture in the Central Valley had left little of the region's original grasslands in place. Finally, years of cultivation had introduced a lineup of non-native weeds with which native grasses and forbs could not compete.

Now, a consortium of government agencies and nonprofit organizations, many funded by CALFED and federal agencies such as the U.S. Fish & Wildlife Service and the Bureau of Reclamation, are applying their expertise in native grass growing to riparian corridor restoration. The new approach should help restore the complex mosaic of habitats that graced the Sacramento's banks ages ago.

That mosaic began at the waterline with water-tolerant sedges and willows intermixed with thirsty cottonwoods. Slightly farther inland, valley oaks and open bunchgrasses dominated, with forbs such as lupine and monkeyflower growing in sporadic patches.

"I would say the hurdle yet to overcome is how to make our grassland/understory restoration more diverse. We're relying on a few species that are aggressive starters and with our help can compete with the non-native weeds. But now we're trying to figure out how to get the forbs back in there," Luster says. Research conducted at restoration sites and remnant habitats has shown that both native songbirds and the valley elderberry longhorn beetle, a federally threatened species, are more successful breeding at sites that include a wide variety of understory plant species.

The first riparian restoration project to include a grassland component was 50 acres of a 110-acre project conducted on a former farm field known as the Ord Bend Unit of the Sacramento River National Wildlife Refuge. Dan Efsseff, a restoration ecologist with the nonprofit restoration group River Partners, began work on the three-year project in 1999.

His team's first task was to decide what kind of habitat once occupied this area. Existing patches of riparian trees and a good understanding of the life histories of woody plants suggested the site could support valley oaks, elderberries, coyote brush, and other plants. Developing a planting palette for a native understory, however, was a far more difficult task. All they could do was hazard a guess by factoring in soil type, flooding frequency, and nearby stands of native species.

"Only remnant patches in the foothills give us clues as to what the valley floor once looked like. Short of creating a time machine, we'll never know whether it was dominated by bunchgrasses or rhizomatous creeping rye or forbs," Efsseff says.



One-year old riparian forest planting with 6-month old native grass understory planting, Pine Creek Unit, USFWS Sacramento River National Wildlife Refuge, Butte County.



Six-month native grassland planting adjacent to the Sacramento River, Pine Creek Unit, USFWS Sacramento River National Wildlife Refuge, Butte County.

Over the long term, the biologists decided that the project area was likely to become oak savanna, populated by a handful of drought-tolerant species. "We used to plant typically cottonwoods, willows, and oaks. On Ord Bend, we shifted to a model that has a huge diversity of species—30 different plant species on 100 acres to be planted over several years. They include understory native grasses, sedges, and some wildflowers," Efsseff says. "On top of that you layer things like shrubs, vines, and then trees. You wind up with a pretty complex mosaic on the landscape."

Though understory restoration along a river was new and unfamiliar, it offered several major advan-

Adding Grasses

tages. Floodwaters tend to suppress non-native weeds, giving the natives an advantage. "A lot of sites will flood right after we've planted them, and will stay underwater for two weeks or more. It looks pretty bleak at first, but these plants are resilient to flooding and they pop back," Efseaff says. Flooding can also reduce the need to replant adjacent sites by spreading seeds from established grasses. Then again, soils along gravel and sandbars tend to be low in nutrients, making it difficult for any plants to get established.

The presence of the river also forced ecologists to design their plantings with imminent inundation in mind. "We know areas of low profile will get inundated in a flood. But next to it, we might plant a line of trees oriented toward the flood flow direction—it provides great habitat yet has a minimal footprint to obstruct the current," Efseaff says.

The first year, they planted a cover crop of beans so that the thatch would choke out any sprouting weeds. In fall, they planted the trees. The group made sure to include fast-growing cottonwoods on the planting list. Over time, Efseaff says, the cottonwoods should drop out of the mix and the oaks will come to dominate. "In the meantime, a few dozen generations of birds will use the cottonwoods until the oaks get to size."

The year's first rains triggered a flush of winter weeds, but a spraying of herbicide knocked them down again. Only then did the ecologists sow the site with native grass seed using a no-till drill. The drill slices a hole in the soil and then presses it shut with a small roller, thus keeping the soil undisturbed so weed seeds will remain dormant.

Knocking down weeds as soon as they emerge keeps the odds favoring the home team. The idea is to eliminate the tangle of non-native thatch that can shade out struggling native sprouts. "We have maps from the 1840s that include handwritten notes that say, 'antelope grazing here,'" Efseaff says. "But pronghorn and elk have been removed from the system." California grasslands also burned regularly in both natural fires and those set by Native Americans. Today, land managers use grazing, mowing, and occasional controlled burns to keep the European upstarts in check.

Another season of growing and spraying allowed the grasses to get established while further depleting

non-natives from the soil. Only then could the biologists begin planting wildflowers and other forbs. Herbicides such as glyphosphate would have killed these broad-leaved plants.

"One on one in any single year the annuals will win," Efseaff says. "But if we give enough advantage to the perennial natives, they start taking over." Five years later, "the plants are reseeding themselves in areas we didn't plant," Efseaff says, and native grass cover is well over 50%. "We're creating a self-perpetuating situation, a shift that is long-term and permanent." **KMW**

KIDS LEARN LAY OF THE LAND

Building stewardship extends to the next generation. Bringing kids from Sacramento, Oakland, and other urban zones to the farms and ranches around them, and providing opportunities for them to adopt projects and take part in hands-on restoration work, is a critical component of ecosystem restoration. In coordination with the Audubon program, and with a separate grant from CALFED, the Center for Land-Based Learning has brought more than 500 kids from eight cities to work on a total of 15 restoration projects.

These students came to Dave Batcheller's 30-acre sheep ranch near Winters five times a year for three years running. Batcheller raises lambs from a herd of 50 black-faced Suffolk ewes, and has restored ponds, wetlands, hedgerows, and native grasses with Audubon's help.

On one visit to Batcheller's ranch, he recalls, the students planted plugs of native grass; on another, willow and cottonwood trees. They also installed irrigation for the new plantings and built bird boxes. During one rest break, when the post was up but the box still lying on the ground, the young workers marveled at the bluebirds that swooped in to investigate, says Batcheller. During lunch on the banks of one of his new ponds, a river otter surfaced and snorted right in front of them.



Another day, Batcheller took the students into the barn and let them pet and hold lambs. They asked him what he did with the lambs, and were incredulous to make the connection to lamb chops. Looking back on that moment, Batcheller says: "It was like that story that kids don't know where their food comes from. Lots of people these days are generations away from the farm. So when it comes to the issues these kids have to vote on someday, maybe they'll look back on these experiences, and think about giving back to nature. Rubbing shoulders with those kids, and with the teachers and mentors and agencies that make the outreach

program possible, is like finding kindred spirits. It gives me chills." **ARO**



Dave Batcheller, sheep rancher.



MANAGEMENT

Getting & Giving Back

Planting purple needlegrass, restoring tailwater ponds, trying to recreate whole plant communities—from tall cottonwoods to tiny tidy tips—along the riverbank may seem more of a luxury than a necessity. But those taking the long view—whether from their government desk, through their birdwatching binoculars, under a microscope, or off the back of a horse or seat of a tractor—all see a vital connection between restoration and the health of not only the ecosystem, but also farming communities in the Central Valley.

"It's not that all of these ranchers have an intrinsic love for native grasses or wetlands, or that they're all progressive, organic, change-the-world types," says Audubon's Jeanne Wirka. "It's that they know that ranching is all about soil health, and they like to have wildlife on their properties."

Though government budgets for environmental initiatives are getting leaner, California's Prop. 50, passed by voters in 2002, earmarks \$20 million from CALFED's Ecosystem Restoration Program to "assist farmers in integrating agricultural activities with ecosystem restoration."

"This is a huge opportunity, a chance to design incentive programs for wildlife-friendly agriculture that work in the context of California's crushing endangered species issues, incredibly complex plumbing, and rising competition for water," says CALFED's Jay Chamberlin, adding that billions more in funding for conservation and restoration are potentially available from the fed's 2002 Farm Bill if successful approaches can be demonstrated. "The trick now will be to draw on lessons we've learned, and that our partners have learned, to design a more performance-based program." Bond funds will give CALFED a chance to underwrite farm conservation activities that address California's unique challenges in a scientifically credible and landowner-friendly way, according to Chamberlin. As in the past, CALFED will also seek to leverage its funds with those of other public and private

agencies to maximize project benefits. Every dollar spent by CALFED on Audubon programs in Yolo County was matched by another two or more from other sources.

Knowing where and how to access current farm-friendly funds is an art Audubon California has clearly mastered. Wirka says when Audubon first conceived of its Landowner Stewardship Program, it was impressed by all the different sources of money for erosion control, water conservation, endangered species mitigation, and ecosystem restoration. Small grants for private landowners are available from the National Resources Conservation Service, the State Wildlife Conservation Board, and the U.S. Fish & Wildlife Service, to name only a few. "Our observation was that the primary limiting factor for landowners interested in restoration wasn't so much funding as paperwork time," says Wirka. "So we designed our stewardship program as a service. We help them cobble together enough funding from multiple sources to do their projects, and limit their personal contribution to something they can afford—labor and equipment."

Audubon is now trying to replicate its Yolo stewardship program in the Imperial Valley. In Yolo, it had the benefit of John Anderson's years of passionate leadership as a board member of the local Resource Conservation District (RCD) and the Audubon Society (see p. 2). According to the Yolo County RCD's Paul Robins, Anderson motivated a lot of his neighbors and other locals to try native grasses at a time when the government was still promoting the giant reed (*Arundo donax*) and tamarisk for erosion control—two exotics the state is now spending big bucks to keep out of wildlife habitats. "In the mid-1990s, Yolo County was an oddball among RCDs, pushing natives, installing its own restoration projects, conducting energetic outreach to landowners. Now we're unremarkable; many of the RCDs are doing it. We don't get plaques anymore, but that's cool," says Robins.

With a critical mass of private landowner support already established in Yolo, Audubon was able to go ahead and create its model

stewardship program and coordinate restoration and science research goals enough to win the three-year CALFED grant. Even then, many local ag interests were deeply suspicious of CALFED. "No one was really sure CALFED wasn't this big bad evil trying to suck water away from Northern California and give it to the cities down south," says Robins. "Taking the money was like going to the dark side for some, but John Anderson didn't give up."

Nor did Audubon when it began helping him carry the torch. "We wanted to link the farming, environmental, and scientific communities, instead of butting heads," says Audubon's Vance Russell. "I think we've shown that restoration is intrinsically compatible with agriculture. But we've just scratched the surface of what can be done."

Now that the three-year grant is coming to an end, Audubon is worried about follow-up. So too may be other wildlife-friendly farming projects underwritten by CALFED. The crash of Delta endangered fish populations in 2004 has got budget committees and legislators calling on CALFED to refocus on the salmon and smelt, do a better job of running the pumps, and pull back from its terrestrial and watershed work. "We had a moment in the sun to incubate these great projects on private lands," says Chamberlin. The bar will be set higher for the next round of grants, applying lessons learned, and focusing on projects that can best benefit the species of



Common yarrow, a native plant preferred by Native American basket weavers. Along the Merced River, CALFED salmon habitat restoration managers have been working with local Native American tribes to identify native grasses with traditional uses, like basketweaving, and to then include them in the restoration planting palette. Similar outreach efforts are underway as part of restoration along the San Joaquin, reflecting CALFED's ongoing commitment to addressing tribal concerns.

Getting & Giving Back

greatest concern to federal and state biologists, including fish, giant garter snakes, and wildlife CALFED has a commitment to save.

Last year Scott Stone shared some of the lessons he learned when he gave a tour of his Corral Pasture to CALFED's then-director Patrick Wright. "I showed him where the rubber meets the road," says Stone. "A lot of time and money is spent on restoration and science in our watershed, and sometimes not much gets done. It's neat to show something that did get done and had great results. That's the way these programs are supposed to work."

CALFED still has the \$20 million Prop. 50 money to invest in restoration efforts on agricultural land. Chamberlin hopes the funds will be invested this year, and is relying on advice and input from a body called the "Working Landscapes Subcommittee" (part of CALFED's larger Public Advisory Committee). The subcommittee—which is made up of farm organizations, conservationists, and water purveyors—has already drafted recommendations for how to spend the \$20 million. Staff are now working to usher these recommendations through a scientific and public review process.

Kim Delfino, who works for Defenders of Wildlife and serves on the committee, sees room to maneuver on the priorities problem: "We ought to look for projects where there's synergy and opportunity to benefit both fish and terrestrial species. Any kind of vegetation of streams and channels, any kind of planting of native grasses, has not only helped fish but also birds."

Whether fish or birds, if they're endangered, lots of landowners don't want them on their farms and ranch-

es. Many fear that restoring a pond or creek or grassland may invite the appearance of a salamander or salmon or beetle that will bring regulators to their front porches. Restoration managers and environmentalists recognize these concerns, and have been promoting "safe harbor" permits that can indemnify landowners if endangered species return to their farmland habitats following restoration actions.

"We support the safe harbor approach," says Delfino. "If you have a zero baseline of endangered species on your land there's no regulation, but also no incentive to make improvements. That doesn't do the species we're trying to save any good, in terms of providing more habitat. Stewardship works, and in the last few years we decided we need to be more proactive and collaborative with landowners, instead of running around waving regulatory restrictions."

While government and environmental groups may provide advice and money, it's ultimately the landowners themselves who will make the biggest changes in the landscape of the future. Yolo County ranchers Scott Stone and Dave Batcheller both con-

sider themselves "forward thinkers" but not unusual among their peers. Stone laments that the public seems to think that the majority of farmers and ranchers "rape and pillage the ground and spray chemicals everywhere."

Both men use the same phrase when they talk about why they go to all this trouble. "You have to leave the place better than you found it."

ARO

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RESOURCES

- Audubon California Landowner Stewardship Program http://ca.audubon.org/LSP/Willow_Slough.htm
- The Nature Conservancy www.tnc.org
- Hedgerow Farms www.hedgerowfarms.com
- CALFED Bay-Delta Program <http://calwater.ca.gov>
- Farming for Wildlife, Voluntary Practices for Attracting Wildlife to Your Farm.* Clark & Rollins, California Dept. of Fish & Game.
- Know Your Natives: A Pictorial Guide to California Native Grasses.* Yolo County RCD.
- Bring Farm Edges Back to Life!* Yolo County RCD.
- A Manual of California Vegetation.* California Native Plant Society.
- Wild Harvest: Farming for Wildlife and Profitability* www.calwild.org/resources/pubs/harvest.php



Sign for a tailwater and sediment pond demonstration project at Audubon.

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