Oaks

FALL/WINTER 2021 CALIFORNIA OAKS

California's oaks in the 21st century: Oaks and groundwater recharge

by Angela Moskow, California Oaks

Oaks were once abundant along the riparian corridors of the San Joaquin River and its tributaries, with woodlands and savannas growing a considerable distance from the river. These ecosystems also ringed the valley, primarily on its eastern side and along the Kings and Kaweah Rivers.[1] The Kaweah River plain alone is estimated to have supported over 100,000 hectares of valley oaks in the early 20th century.[2,3]

The region's hydrology and vegetation were dramatically altered in intervening years. Today, many critically over-drafted groundwater basins are in the San Joaquin Valley. A report by the Public Policy Institute of California estimates that over half a million acres of land will be retired in the San Joaquin Valley as its groundwater basins come into compliance with requirements of the Sustainable Groundwater Management Act (SGMA).[4]

SGMA, enacted in 2014, requires the formation of agencies to develop and implement groundwater sustainability plans that detail the process for critically overdrafted alluvial basins, in order to achieve sustainability by 2040.[5]

Improving watershed health to recharge depleted groundwater basins

The reintroduction of oaks on agricultural lands and other large acreages in this region will enhance ecosystem function, including groundwater recharge. Oaks facilitate the replenishment of groundwater by reducing stormwater runoff and stabilizing soil. They improve water quality by reducing erosion and sedimentation. Oaks also provide food and habitat for California's native vertebrate, invertebrate, and plant species; over half of California's terrestrial vertebrates are oak dependent.[7]

The 2017 *Watershed Enhancement Strat-*

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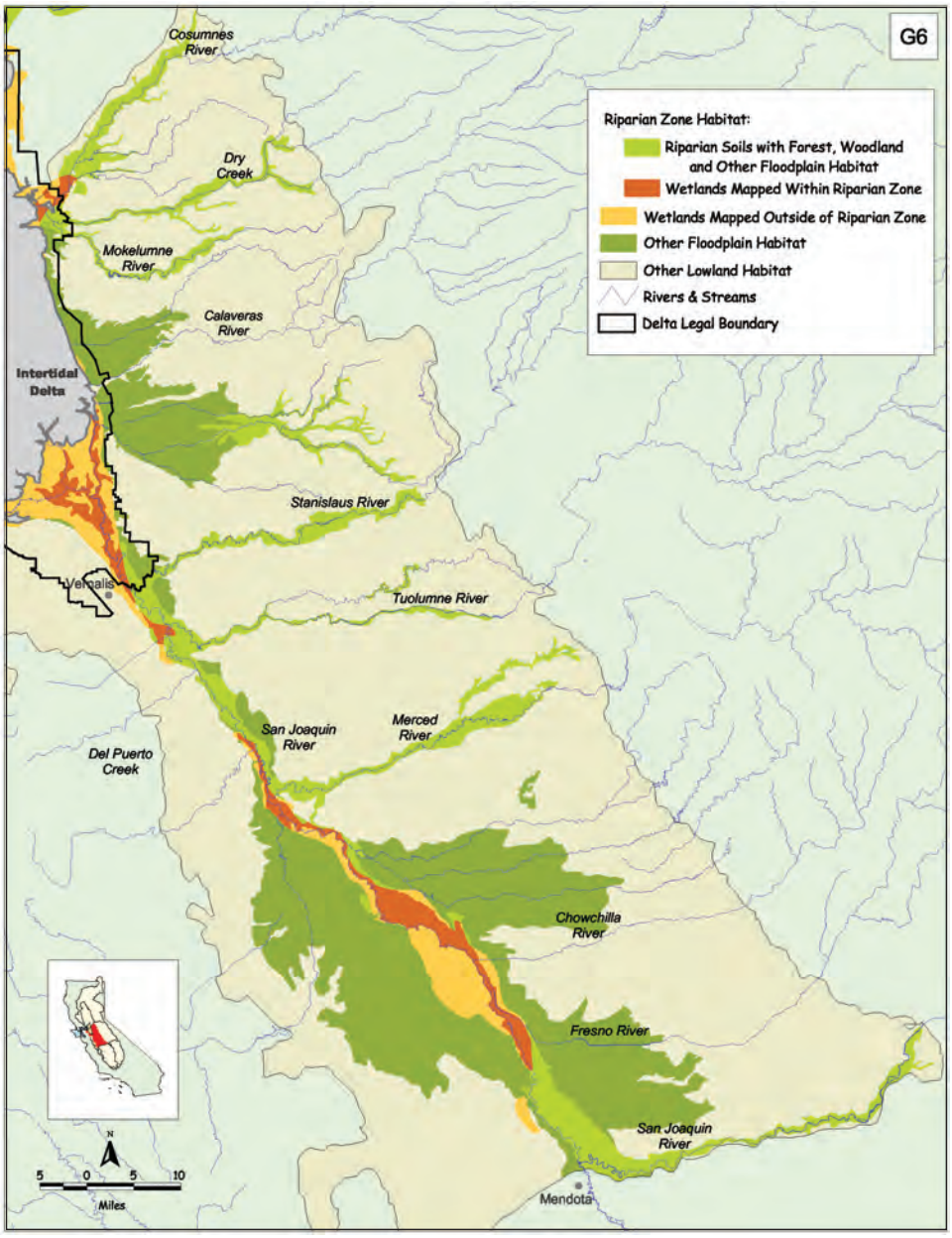

San Joaquin Valley historical river floodplain ecosystem[6]

Restoration of California's oak woodlands will help protect our water supply and wildlife, clean our air, and mitigate catastrophic wildfire and flooding. Oaks are an essential component to successfully managing groundwater in our state. —Kimery Wiltshire, President and Chief Executive Officer, Confluence West, a member of California Oaks Coalition

Inside

Watershed health is essential for replenishing groundwater

© John Shelton, San Joaquin River Conservancy

Valley oak within a riparian oak woodland on the Ball Ranch properties of the San Joaquin River Conservancy just outside of Fresno, California

Restoring oaks should be an integral part of plans to replenish San Joaquin Valley groundwater basins in compliance with the Sustainable Groundwater Management Act (SGMA). Regenerating degraded riparian oak ecosystems recharges aquifers; improves water quality; provides vital habitat for endangered, threatened, and other sensitive plant, wildlife, and insect species; and sequesters carbon. Restored floodplain habitat slows floodwaters, building resiliency for flood events, which are expected to be exacerbated by the warming climate.

Many oak species are also aquifer-dependent and need to be protected via groundwater sustainability plans. Based on the International Union for Conservation of Nature's ecosystem "Red List," California Central Valley Mixed Oak Savanna is critically endangered with losses of greater than 90%.[1] The *Conservation Gap Analysis of Native U.S. Oaks* reports a population decline of more than 80% for valley oak statewide.[2] Remaining savannas in the San Joaquin Valley often have no visible oak recruitment. They are in essence a graveyard rather than an ecosystem. San Joaquin Valley riparian oak ecosystems are also highly degraded.

The central focus of California Wildlife Foundation's California Oaks program is and will remain keeping oaks standing, but the climate and biodiversity crises necessitate nature-based solutions to regenerate ecosystems. Restoration of California's primary old growth resource is a cost-effective way to enhance San Joaquin Valley watersheds.

Oak restoration can improve the habitat values of working landscapes as well as floodplains and other lands that may be retired as groundwater basins come into compliance with SGMA. Many factors—including habitat fragmentation, groundwater depletion, changed rainfall patterns, disrupted fire regimes, nonnative grasses, and predation—contribute to diminished oak diversity and poor regeneration. Projects such as Dos Rios Ranch Preserve (see page 4) highlight the potential for reintroducing oaks into the San Joaquin Valley through a program that has a strong track record of restoration success.

Successful oak regeneration requires site assessment, careful selection of trees and plants, and maintenance until trees and plants are established, including with protective caging, fencing, and monitoring. The availability of sufficient resources is essential to allow for professional restoration design, the selection of suitable plant material, sufficient irrigation and weeding, and ongoing monitoring of site conditions.

Many oak mitigation projects throughout California have failed, in large part due to the lack of investment in needed resources over the necessary period of time to ensure success. The escalating impacts of changes to the climate mean failure is no longer an option.

Sincerely,

Janet

Janet S. Cobb, Executive Officer
California Wildlife Foundation/California Oaks

[1] Comer PJ et al., "Long-term loss in extent and current protection of terrestrial ecosystem diversity in the temperate and tropical Americas." *PLoS ONE* 2020:15(6).

[2] Beckman E et al., *Conservation Gap Analysis of Native U.S. Oaks*. Lisle, IL: The Morton Arboretum, 2020, p 147.

California Oaks Coalition

California Oaks Coalition brings together national, state, regional, and local organizations to conserve and perpetuate the state's primary old growth resource. Members of California Oaks Coalition are united by the vital role of oaks in sequestering carbon, maintaining healthy watersheds, providing habitat, and sustaining cultural values.

Amah Mutsun Land Trust; American River Conservancy; American River Watershed Institute; AquAlliance; Banning Ranch Conservancy; Butte Environmental Council; California Institute for Biodiversity (CIB); California Invasive Plant Council (Cal-IPC); California Native Plant Society (CNPS), including Dorothy King Young Chapter, San Diego Restoration Committee, and Sanhedrin Chapter; California Rangeland Trust; California State University Chico Ecological Reserves; California Water Impact Network (C-WIN); California Wilderness Coalition (CalWild); Californians for Western Wilderness (CalUWild); Canopy; Center for Biological Diversity (CBD); Chimineas Ranch Foundation; Clover Valley Foundation; Conejo Oak Tree Advocates; Confluence West; Dumbarton Oaks Park Conservancy; Elder Creek Oak Sanctuary; Endangered Habitats Conservancy; Endangered Habitats League; Environmental Defense Center; Environmental Protection Information Center (EPIC); Environmental Water Caucus; Foothill Conservancy; Forests Forever; Friends of the Richmond Hills; Friends of Spenceville; Global Conservation Consortium for Oak; Hills For Everyone; Laguna de Santa Rosa Foundation; Lomakatsi Restoration Project; Los Padres ForestWatch; Lower Kings River Association; Northern California Regional Land Trust; Planning and Conservation League; Redlands Conservancy; Resource Conservation District of Santa Monica Mountains; River Partners; River Ridge Institute; Rural Communities United; Sacramento Tree Foundation; Santa Clarita Organization for Planning and the Environment (SCOPE); Save Lafayette Trees; Save Napa Valley; Shasta Environmental Alliance; Sierra Club Placer Group; Sierra Foothill Conservancy; Tejon Ranch Conservancy; Templeton Heritage Tree Foundation; Tuleyome; Tuolumne River Trust; University of California, Los Angeles, Mildred E. Mathias Botanical Garden

California Oaks provides four areas of support for coalition members:

1) Research and advocacy updates.
2) Information to educate and engage the public.
3) Tools for participating in planning processes and educating opinion leaders.
4) Materials to inform local, regional, and state governmental agencies of the opportunities for and benefits of protecting oak woodlands.

For more information, please contact Oaks Network Manager Angela Moskow, amoskow@californiaoaks.org.

RESOURCES

GUIDES TO ANIMAL TRACKS

A Field Guide to Animal Tracks, by Olaus Murie, was first published in 1954, with the third edition in 2005. Covers the United States and Canada, from Labrador to the Aleutian Islands. Available in bookstores, libraries, and online.

Princeton University animal tracking cards: https://outdooraction.princeton.edu/sites/default/files/files/articles/trackcard_0.pdf

U.S. Fish and Wildlife Service animal snow tracks website: https://www.fws.gov/refuges/features/snow-tracks.html

RESOURCES ON OAK RESTORATION

California Riparian Habitat Restoration Handbook (2nd ed.), by F. Thomas Griggs, PhD, River Partners, July 2009: http://riverpartners.org/wp-content/uploads/2018/09/restoration-handbook.pdf

Compatible Plants Under and Around Oaks, by Hagen BW, et al., California Oak Foundation (now California Wildlife Foundation/California Oaks), 1991: https://californiaoaks.org/wpcontent/uploads/2016/04CompatiblePlantsUnderAroundOaks.pdf

How to Collect, Store, and Plant Acorns, by Douglas D. McCreary, California Oak Foundation: https://californiaoaks.org/wp-content/uploads/2016/05/HowToAcorns07.pdf

Regenerating Rangeland Oaks in California, by McCreary DD, University of California Agriculture and Natural Resources, 2009 (2nd ed.): https://anrcatalog.ucanr.edu/pdf/21601e.pdf

"Restoring native California oaks on grazed rangelands," Douglas DD et al., in Dumroese RK et al., *National Proceedings: Forest and Conservation Nursery Associations*, USDA Forest Service Proceedings Rocky Mountain Research Station, 2005, p 35: https://californiaoaks.org/wp-content/uploads/2016/04/Oaks_Grazing.pdf

Restoring Oak Woodlands in California: Theory and Practice, by Elizabeth A. Bernhardt et al., 2001: http://phytosphere.com/restoringoakwoodlands/oakrestoration.htm

Tending the Wild: Native American Knowledge and the Management of California's Natural Resources (2nd ed.) by Kat Anderson, University of California Press Books, 2013. Available in bookstores, libraries, and online.

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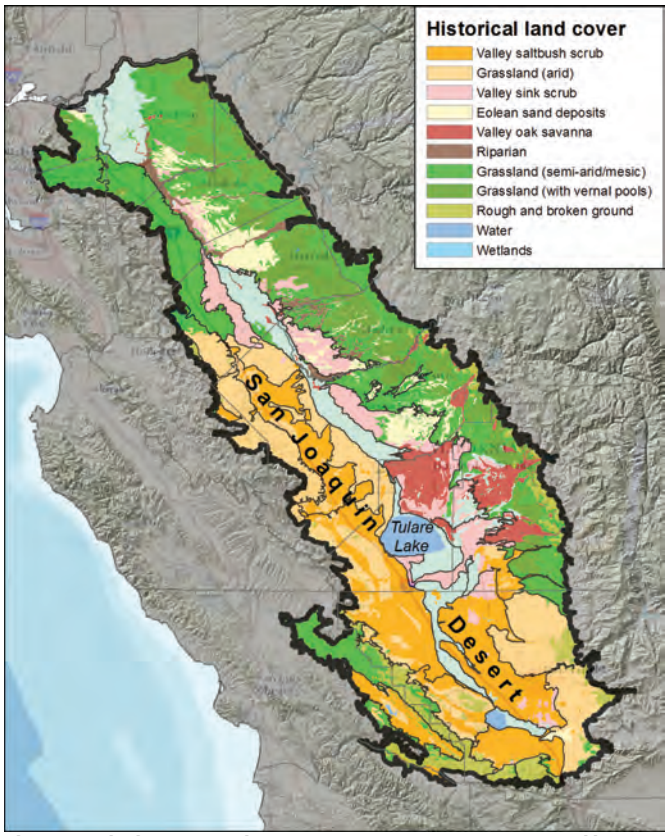
tegies for Groundwater Sustainability report, published by Sequoia Riverlands Trust, explores the potential contribution of land-based strategies to watershed function, usable water supply, and groundwater sustainability. These include land management practices that enhance soil organic matter, reducing the need for supplemental irrigation and increasing the amount of water available for recharge. Practices such as on-farm flooding and recharge help to reduce annual groundwater depletion, and projects that restore at least some natural function to modified floodplains (e.g., streamside areas of farms and ranches, or sites like Kaweah Oaks Preserve) could make a measurable contribution to groundwater recharge by slowing floodwaters and providing larger areas for infiltration. The report estimates that these approaches have the potential to offset at least 25% of the annual groundwater deficit in the Kaweah and Tule River watersheds by addressing both the supply and demand sides of the water balance equation.



The map, which estimates historic vegetation cover, was created by Scott Phillips of the Endangered Species Restoration Program. He digitized old soil survey maps of the San Joaquin Valley and assigned soil units to vegetation classes, based on their descriptions.

Conservation organizations, including Audubon California, Environmental Defense Fund (EDF), Sustainable Conservation, and The Nature Conservancy have also engaged in extensive review of groundwater sustainability plans to incorporate ecosystem considerations, such as protecting water supplies for groundwater-dependent species—including oaks—and surface waters that provide bird habitat.

Other SGMA-related efforts are focused on sharing information and other forms of engagement. For example, EDF's Central Valley Resilience Initiative seeks to establish an integrated landscape that supports wildlife habitat and high-quality agricultural land, while sustainably managing water resources. EDF is engaged in several groundwater planning and related processes, such as the Kaweah Subbasin Regional Conservation Investment Strategy, which is leveraging a conservation planning process to address SGMA. EDF is also authoring a series of publications on topics including protecting groundwater quality, addressing regional surface-water depletions, trading water, and building multi-benefit recharge basins to bring conservation and water management expertise to the SGMA process.

Conservation organizations have identified opportunities to enhance biodiversity as lands are taken out of production. The Nature Conservancy and collaborators have issued publications to inform a larger strategic land-retirement planning analysis primarily focused on the western San Joaquin Valley, because of its high concentration of threatened and endangered species and arid conditions.[8]

The Public Policy Institute of California report with the land retirement estimate also offers rough figures of how retired lands could be repurposed. These include expansion of riparian corridors and floodplains to reduce flood risk and restore fish and wildlife.[9]

Habitat for species at risk

The presence of oaks benefits the watershed and provides habitat for native species, including listed and sensitive species. The U.S. Fish and Wildlife Service's 1998

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Valley oaks in floodplain restoration contribute to climate resiliency

by Angela Moskow, California Oaks

© Photo courtesy of River Partners

While the 1,600-acre Dos Rios Ranch Preserve was used for commercial agriculture over many decades, some remnant areas of oak forests remain and serve as a marker for what the Dos Rios landscape will look like in the future.

The Dos Rios Ranch Preserve, located at the confluence of the San Joaquin and Tuolumne rivers, is the largest public-private floodplain restoration project in California history, and it is a model for how restoration can deliver multiple benefits, including drought resiliency. The restored floodplain is recharging groundwater, improving water supplies and quality, sequestering carbon in the new native vegetation and soil, and cooling river water beneath riparian forests. Endangered, threatened, and other priority species are benefitting from the restoration of 1,600 acres along eight miles of riparian corridor flanking Dos Rios and the adjacent Hidden Valley Ranch, as are nearby and downstream communities from improved flood protection, increased public access, and job creation. The area's farms reap benefits from the preserve's pollinators, as well as improvements to water supply and quality.

The Dos Rios land was purchased by River Partners (www.riverpartners.org) in collaboration with Tuolumne River Trust (www.tuolumne.org) (both members of California Oaks Coalition), while the adjacent Hidden Valley Ranch was subsequently acquired by River Partners. Restoration of its 500 acres will start in the fall of 2021. The preserve is situated between the Tuolumne River Regional Park and San Joaquin River National Wildlife Refuge, along a stretch of river proposed for the Lower Tuolumne River Parkway. River Partners planted more than 350,000 native trees and shrubs, including 30,809 valley oaks over nearly a decade, creating approximately 250 long-term jobs, channeling more than $3 million in nonpayroll monies into the local economy, and beginning work to increase public access to nature in an economically disadvantaged community. River Partners received the 2020 Integrated Flood Management Award from the Floodplain Management Association for Dos Rios.

Lessons from the last drought and the road ahead

As California and the Western United States navigate this year's severe drought, there are lessons to be learned from the 2012 to 2016 drought and the innovative work of California Oaks Coalition members. According to a recent interview with Felicia Marcus, William C. Landreth Visiting Fellow at Stanford University's Water in the West Program and Chair of the State Water Resources Control Board from July 2012 until February 2019, these lessons include the importance of resilience in water infrastructure, the need to protect vulnerable human and natural communities from the extreme impacts of drought, and the need to enhance groundwater storage to prepare for both lowered snowpack and the increased rainfall and flooding associated with climate change.[1]

It is clear from the geophysical record that the storage and conveyance infrastructure built for three to four-year drought cycles is out of step with the larger disruptions that have occurred historically, Marcus said in the Pacific Council interview, *Resilience versus Sustainability: The United States' Water Future*. Looking to the future, climate models predict greater extremes of drought and precipitation.

Building resilience by addressing multiple functions—such as flood control, water quality, and water supply—offers the greatest flexibility in managing for extreme drought or precipitation, Marcus continued. Former Governor Jerry Brown's administration started to lay the groundwork for water planning in the context of climate change. Approaches from the state's *Climate Action Plan* were utilized to navigate the prior drought. For example, the State Water Resources Control Board funded many innovative climate-smart, multi-benefit projects.[2] The collaboration between River Partners and Tuolumne River Trust to restore Dos Rios Ranch Preserve is an example of a project that builds drought-resiliency on multiple levels.

Addressing ecosystem needs during drought: Management of ecosystem needs is often lost when water supplies are low. River Partners and Tuolumne River Trust are addressing the need for water dedicated to the environment, utilizing California's Water Code section 1707 to petition for the rights to the water saved by conversion of Dos Rios's land from farming to riparian floodplain habitat. If the petition, which was filed with the State Water Resources Control Board, is successful, this water would be left instream for the beneficial use of fish and wildlife, instead of being diverted for other purposes. Section 1707 limits the amount of eligible water to the difference in consumptive water use associated with the new land use. Consumptive use refers to water associated with evapotranspiration on the parcel, which does not flow back into the system. Professor Daniel Howes of California Polytechnic State University's Irrigation Training and Research Center utilized remote-sensing technology and ground-based water data to calculate the change in consumptive water use at Dos Rios as 1,340 acre-feet per year; in turn, the 1707 petition asserts the right for these 1,340 acre-feet of water.

Conserving water: The restored vegetation at Dos Rios will not require irrigation once it is established. Approximately 7,140 acre-feet of irrigation water were applied annually when the Dos Rios and Hidden Valley lands were farmed. In addition to the change in consumptive use of 1,340 acre-feet, the balance of conserved water—5,800 acre-feet—represents the amount of water utilized by approximately

© Photo courtesy of River Partners

River Partners planted and nurtured more than 350,000 native trees, shrubs, and plants over nearly a decade at Dos Rios Ranch, often partnering with the Greater Valley Conservation Corps (pictured).

10,000 households yearly.

Recharging groundwater and enhancing water quality: Groundwater is a major source of the state's drinking water. The state water board estimates that approximately 33 million Californians, including most residents of rural areas, use groundwater from a public water supply or a private domestic well for drinking and other household uses.[3] Many communities with poor water quality ran out of water during the last drought, focusing policymakers on the importance of ensuring the availability of clean, safe, and affordable drinking water.[4] Unfortunately, contaminants and groundwater depletion continue to pose enormous challenges for domestic water supplies in many areas.

Diminished snowpack, earlier snowmelt, and expected precipitation extremes all point to the need for enhanced groundwater recharge.[5] Widened floodplains slow water flows, allowing more time for recharging groundwater basins. Vegetated floodplains also improve water quality by removing the nutrients that run off from agricultural fields into drinking water supplies.[6]

Shifting farther south, hydrogeographer Peter Vorster offers that restoring flow in the Tulare Basin's waterways will recharge depleted shallow groundwater that historically supported oaks. Oak and flow restoration could provide water quality benefits to communities dependent upon these aquifers.[7]

Building resiliency for flood protection: The Department of Water Resources 2018 update of its *Central Valley Flood Protection Plan* cautions that flood risk in the San Joaquin River basin could be exacerbated by climate trends and ameliorated by riparian and floodplain restoration, citing climate change analysis that projects increased flood volumes of 60% to 80% over 50 years:

> Most of the watersheds in this basin are at higher elevations and dominated by snow accumulation, with historically snowmelt-driven flood peaks ... Wise floodplain management is especially important along the tributaries and San Joaquin River corridor for allowing future adaptation. Floodplain transitory storage could provide wise use of the floodplain because of its ability to provide nonstructural flood-risk reduction (by keeping land out of urban development), as well as important ecosystem restoration benefits. Floodplain transitory storage could also provide potential groundwater recharge benefits, help to offset subsidence where channel capacity is threatened, and reduce operations and maintenance needs.[8]

The department's companion conservation strategy for the flood protection plan is built on the principles of achieving net system-wide improvements to riverine and floodplain ecosystems; increases in flood system flexibility and ecosystem resiliency; prioritization of investments in multi-benefit flood-risk reduction projects that incorporate ecosystem improvements; and coordination and collaboration with land management agencies and existing conservation efforts.[9]

Reconnecting habitat for sensitive species and human communities

Vital habitat for sensitive species: Dos Rios provides terrestrial and aquatic habitat for multiple species of concern, including two federally endangered mammals, the riparian brush rabbit (*Sylvilagus bachnani riparius*, also state endangered) and riparian woodrat (*Neotoma fuscipes riparia*). Six sensitive bird species utilize Dos Rios habitat: least Bell's vireo (*Vireo bellii pusillus*, federally and state endangered), yellow warbler (*Setophaga petechia*), tricolored blackbird (*Agelaius tricolor*, state threatened), Swainson's hawk (*Buteo swainsoni*, state threatened), greater sandhill crane (*Antigone canadensis tabida*, state threatened and California fully protected), and willow flycatcher (*Empidonax traillii*, state threatened); as well as three sensitive fish species: Central Valley (San Joaquin River) spring-run Chinook salmon (*Oncorhynchus tshawytscha*, extirpated, Endangered Species Act *Experimental Population* being restored), steelhead – Central Valley Distinct Population Segment (*Oncorhynchus mykiss irideus* population 11, federally threatened), and Sacramento splittail (*Pogonichthys macrolepidotus*).

Dos Rios habitat also played an important role in the recovery of the federally delisted Aleutian cackling goose (*Branta hutchinsii leucopareia*), whose population has recovered to greater than 200,000 from less than 800 in 1974. The restoration also benefits sensitive invertebrate species. River Partners planted more than 12,000 milkweed and other pollinator-friendly plants on 150 acres of the preserve to restore habitat for the western monarch butterfly, whose populations have plummeted 99% since the 1980s.

Building access to natural areas: Dos Rios is also an inviting landscape for human visitors. Tuolomne River Trust has been utilizing Dos Rios Ranch as both an outdoor classroom and community volunteer site, helping to create local connections with the preserve. The trust partners with local elementary schools, offering field days for hands-on learning where students can identify native plants and wildlife and understand the diverse roles of California's rivers. It has also hosted several outreach events for local community members to plant native trees and shrubs as part of the riparian restoration efforts.

© Photo courtesy of Victoria Martinez, Tuolumne River Trust

Tuolumne River Trust volunteers planted milkweed at Dos Rios to create habitat for the western monarch butterfly.

Ultimately, River Partners and Tuolomne River Trust envision the restored Dos Rios and Hidden Valley lands to become part of the San Joaquin River National Wildlife Refuge, located across the river. As we look to the future, the ecosystem services provided by historical landscapes offer important lessons about resilience and connectivity. Dos Rios incorporates innovative design to build resilience for climate change. Valley oak, which once graced great swaths of the San Joaquin Valley's landscape, remains a keystone species vital to reconnecting the ecosystem.

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[1] A November 2020 Pacific Council interview of Felicia Marcus by Newsha Ajami, PhD, focused on lessons from California's last drought and challenges and opportunities ahead. Dr. Ajami is Director of Urban Water Policy at Water in the West, Senior Research Associate with Stanford University's Woods Institute for the Environment. Visit https://www.pacificcouncil.org/activities/resilience-vs-sustainability-united-states-environmental-future to tune into *Resilience versus Sustainability: The United States' Water Future*.

[2] *Ibid*.

[3] https://www.waterboards.ca.gov/water_isssues/programs/groundwater/gw_basics.html

[4] See *Supra* note 1.

[5] Visser A et al., "Importance of river water recharge to the San Joaquin Valley groundwater system." *Hydrological Processes* 2018;32:1202–13.

[6] Griggs FT, *California Riparian Habitat Restoration Handbook* (2nd ed.), River Partners, July 2009, p 3.

[7] Conservation with the Peter Vorster, August 13, 2021.

[8] p 37.

[9] Department of Water Resources, *Central Valley Flood Protection Plan Conservation Strategy*, November 2017, p 3-1.

Back Bay Science Center: Delivering hands-on and virtual education

by Leslie Kretschmar, Education Specialist, California Department of Fish and Wildlife

© Leslie Kretschmar, CDFW

Local students participating in a beach seine to catch, identify, measure, and count nearshore fish in the Upper Newport Bay Ecological Reserve.

Visitors to Newport Beach's Back Bay Science Center's website (www.backbaysciencecenter.org/) can assist in tracking changes to coastal environments by identifying marine invertebrates and aquatic invasive species on "Zooniverse," one of a suite of online platforms the center assembled to deliver education during the COVID-19 pandemic. The online tools about watersheds, estuaries, and marine ecosystems were developed as teachers across the country struggled to find new ways to keep students learning in the face of seemingly endless obstacles: How do you teach students without traditional methods and tools, including those who are not present or have limited internet skills and access?

Located in the Upper Newport Bay Ecological Reserve, the Back Bay Science Center is a state research and education facility that offers hands-on and virtual educational programs for students in grades seven through college (including those from schools in Orange County that serve low-income families), as well as providing opportunities for the public to engage as citizen scientists. The center's mission is to provide a facility where students and the public can study and enjoy the estuarine ecology of Newport Bay and the marine ecology of the Pacific Ocean, while promoting natural resource conservation and stewardship throughout the watershed. Field trips introduce the center's resources and one of the largest estuaries in Southern California.

California Department of Fish and Wildlife (CDFW), landowner and manager of the reserve, has a formal operating agreement with the City of Newport Beach, Orange County Health Care Agency, and the University of California, Irvine, for the Back Bay Science Center's operations and maintenance. The department also collaborates with a wide range of program partners, including California Wildlife Foundation (CWF).

Transitioning from in-person to virtual education presented many challenges for the center's educators. Luckily, the Department of Fish and Wildlife partnership with CWF includes administrative services, which facilitated the center's ability to create web-based lessons and utilize multiple online platforms as the primary teaching tool during the pandemic. Numerous web-based activities include printable versions that teachers can distribute to students with limited internet access.

Thanks to the new online learning tools, the Back Bay Science Center has extended its reach, linking a densely populated area to educational resources and terrestrial and aquatic restoration activities, including living shoreline stabilization that utilizes natural habitat to build resilience for sea-level rise and a program for early detection and rapid response to harmful algal blooms.

Although virtual lessons can never replace holding a sea star or catching a fish, they can reinforce and enhance those hands-on encounters. As the Back Bay Science Center moves toward welcoming visitors back onsite, educators are learning how to operate new programs and technologies and students are improving their digital skills. Click on the CDFW Virtual Learning Opportunities link of www.backbaysciencecenter.org/education to view the digital tools.

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Recovery Plan for Upland Species of the San Joaquin Valley, California, reports that federally endangered San Joaquin kit foxes (*Vulpes macrotis mutica*) are associated with annual grassland and valley oak woodland in the northern portion of their range. Recovery tasks include the preservation of grassland and oak savanna in San Joaquin, Stanislaus, Merced, and Madera counties. The plan also reports that dusky-footed woodrats (*Neotoma fuscipes riparia*) inhabit evergreen oaks and other thick-leaved trees and shrubs, and calls for riparian conservation and restoration (also known as riparian woodrat, this species is now federally endangered but had not received the designation when the recovery plan was issued):

> Because much of the river bottomland in the San Joaquin Valley is in private ownership, a concerted outreach effort must be made to enlist the help of landowners in the conservation of riparian woodrats and their habitat … incentives must be provided to encourage the establishment or restoration of riparian habitat.[10]

Lastly, the plan includes protections for grassland and oak savanna on the east and southeast edges of the valley for several listed species.[11]

The San Joaquin River Restoration Program is another major development in the region. This comprehensive, long-term effort is restoring water to the main stem of the river from the Friant Dam to its confluence with the Merced River, to achieve a self-sustaining Chinook salmon fishery while reducing or avoiding adverse water supply impacts. This effort resulted from the settlement of a lawsuit focused on the river's fishery.[12]

A 2019 assessment of San Joaquin River vegetation addresses the impacts of agricultural and urban development, gravel mining, and fuel wood harvesting on the river's vegetation:

> Reduced riparian vegetation along streambanks has decreased shaded riverine cover, organic inputs, water temperature control, and habitat structure (including inputs of large woody debris to aquatic habitats in the river), thus degrading aquatic habitat and fishery health. Important functions of the floodplain have also been reduced or eliminated, including flood flow retention and the ability for the channel to meander, which in turn increases both the risk of flooding and the amount of sediment deposited by flood flows.[13]

Alignment with state and regional watershed management goals

Restoration of oaks in the San Joaquin and Tulare basins would also advance several state and regional watershed management goals associated with water supply, flood protection, and ecosystem health.

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California Governor Gavin Newsom issued an executive order in 2019, directing the California Natural Resources Agency, California Environmental Protection Agency, and California Department of Food and Agriculture to identify and assess a suite of complementary actions to ensure safe and resilient water supplies, flood protection, and healthy waterways for the state's communities, economy, and environment. The governor's order identified principles on which to base this portfolio. These include prioritizing multi-benefit approaches that meet several needs at once; utilizing natural infrastructure such as forests and floodplains; and encouraging regional approaches.

The portfolio, released in 2020, integrates and builds on programs, policies, and investments already in place. Its discussion of the protection and restoration of natural systems recognizes their importance in supporting biodiversity, recharging groundwater, improving water quality, ameliorating flood risk, and building community and economic resilience.[14] The portfolio also discusses the importance of incentives for on-farm conservation practices and innovative partnerships in enhancing natural systems on agricultural lands.[15]

As California envisions the path forward as climate extremes such as drought and atmospheric rivers intensify, oak restoration in the San Joaquin Valley will rebuild watershed health and resilience.

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[1] Vorster P et al., *From the Sierra to the Sea—The Ecological History of the Bay–Delta Watershed*, The Bay Institute, 1998, p 2-30.

[2] Mensing S, "The History of Oak Woodlands in California, Part II: The Native American and Historic Period," *The California Geographer*, Volume 46, California Geographical Society, Arcata, CA, 2006.

[3] Jepson WL, *The Silva of California*. University of California Memoirs V2, 1910.

[4] Hanak E et al., *Water and the Future of the San Joaquin Valley*, Public Policy Institute of California, 2019.

[5] SGMA does not apply to brackish groundwater, which often sits below alluvial basins and can be treated and used. It also does not govern water stored in fractured hard-rock and volcanic aquifers. See Thompson B et al., *Mind the Gaps: The Case for Truly Comprehensive Groundwater Management*, Water in the West, 2021.

[6] See *Supra* note 1. GIS maps for the publication were produced by GreenInfo Network. The wetlands were mapped by 19th-century surveyors, and the riparian zone and other floodplain habitat were determined indirectly from soil

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Connecting Wildlands and Communities project builds climate resilience and capacity

The impacts of climate change in the arid, fire-prone landscapes of the Southwest are wide-reaching. In Southern California, the proximity of large urban areas and wildlands presents the additional challenge of balancing climate resilience for both people and nature. The Climate Science Alliance (www.climatesciencealliance.org), which is fiscally sponsored by California Wildlife Foundation, develops partnerships focused on building resilience, capacity, and community to catalyze climate adaptation actions in the region.

One such partnership, Connecting Wildlands and Communities (https://www.climatesciencealliance.org/cwc), was envisioned by and created for land managers, planners, conservation practitioners, and Tribal decision-makers working on the frontlines of climate change. A collaboration of the San Diego State University Institute for Ecological Monitoring and Management (https://iemm.sdsu.edu/) and the Climate Science Alliance, the partnership brings together a team of planners, environmental engineers, ecologists, geographers, and artists to bridge geographic boundaries and disciplines and explore how connected landscapes can support adaptation and resilience to climate change for both ecosystems and human communities in Southern California.

Funded by the California State Strategic Growth Council through the California Climate Investments initiative, Connecting Wildlands and Communities was inspired by previous research focused on exploring where connected landscapes are needed to allow ecosystems to persist and adapt to climate change. Research has expanded to include wildfire risk reduction, water sustainability enhancement, and land and biodiversity conservation. Partners and stakeholders guide the research, identifying issues of concern, data gaps, and barriers to adaptation.

Also inspired by Tribal partners and the tradition of Indigenous stewardship, Connecting Wildlands and Communities is integrating research results into inclusive, translatable information and a suite of actions that can be used now and into the future for local and regional planning. Preliminary project results—shared at the digital 2021 Southwest Climate Adaptation Forum (www.swaf2021.org)—highlight how the collaboration's data are influencing practice.

For example, Kimberly Clark of Southern California Association of Governments, a panelist in the "FIRE: Research and Applications" session, spoke about how project data on the association of drought severity with increasing fire vulnerability of chaparral influenced the unanimous adoption of a climate emergency resolution by their Regional Council in January 2021. The resolution outlines actions that the association can take to bring regional leaders together to ensure that climate adaptation is at the forefront of planning.[1]

Project results are also being communicated through innovative community outreach. A team of artists has created visual interpretations of the collaboration's data to bridge the gap between research and application in the community. The Resilient Connections website (https://tinyurl.com/cwcstorym), created by Climate Science Alliance artist Audrey Carver, combines mapping data, art, and stakeholder reflections and stories about what resilience means to them. In addition, Kim Reasor, the Alliance's 2020 Climate Art Fellow, produced a series of works, including visualizations of refugia, fire facets, bio-fragmentation, and explorations of wildlands; including oak environments.[2] The artwork also provides a teaching tool in the Alliance's Climate Kids program, and it was featured at the Southwest Adaptation Forum to help inspire creative communication and outreach to advance adaptation efforts across the region.

One of a series of Connecting Wildlands and Communities graphics created by Audrey Carver

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[1] See: https://scag.ca.gov/post/regional-council-january-7-2021-resolution-no-21-628-1

[2] See: https://www.climatesciencealliance.org/post/carlsbad-exhibit-features-2020-climate-art-fellow-kim-reasor

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The San Joaquin River National Wildlife Refuge in Stanislaus County contains thousands of acres of dense riparian woodlands, including valley oak trees, along the San Joaquin, Stanislaus, and Tuolumne rivers.

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surveys and geologic maps. For additional information on creation of the map, see *From the Sierra to the Sea*, p A8–9.

[7] Giusti GA, Tinnin PJ (eds.), *A Planner's Guide for Oak Woodlands*. Pub. of the Integrated Hardwood Range Management Program, Department of Forestry and Resource Management, University of California, Berkeley, 1993, p 40.

[8] See The Nature Conservancy et al., *Roadmap for Restoration* policy brief, "Identification of potentially suitable habitat for strategic land retirement and restoration in the San Joaquin Desert." 2020. Also see Bryant BP et al., "Shaping Land Use and Ecosystem Restoration in a Water-Stressed Agricultural Landscape to Achieve Multiple Benefits," *Front Sustain Food Syst* 2020:4;138.

[9] See *Supra* note 4, p12.

[10] Williams DF et al. USFWS, Region 1, Portland, OR. p 129, 155–156, 304.

[11] *Ibid*. See task 5.3.3.

[12] The Department of the Interior entered into the 2006 San Joaquin River Settlement (Settlement) in NRDC *et al. v. Kirk Rodgers et al*. The settlement was subsequently approved by the court in October 2006, and the San Joaquin River Restoration Settlement Act, Public Law 111-11, authorized and directed the Secretary of the Interior to implement the settlement.

[13] *Monitoring of Vegetation along the San Joaquin River*, 2019 Report, U.S. Department of the Interior, Bureau of Reclamation Technical Service Center Denver, Colorado, September 2019, p 2.

[14] *2020 Water Resilience Portfolio—In Response to Executive Order N-10-19*. p 2.

[15] *Ibid*. p 23.

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How you can help:

- Donate to California Wildlife Foundation/California Oaks. A secure donation can be made from our website: californiaoaks.org.
- Spend time in an oak woodland or forest. Click on californiaoaks.org/resources for a partial listing of oak landscapes around the state that have public access.
- Please consider including oak conservation in your financial and estate planning efforts. Information can be found at: californiaoaks.org/donate.
- Be vigilant about threats to oak woodlands and oak-forested lands in your community and consult californiaoaks.org for guidance.
- Restore oaks to areas where they historically grew.
- Sign up for the *Oaks* e-newsletter at californiaoaks.org.
- Support local and statewide measures to protect natural resources.
- Hold decision-makers accountable for protecting green infrastructure.

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