Aerial view of farmland, San Joaquin Valley, CA, USA
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San Joaquin Valley Foodscape

Balance food production and biodiversity under water scarcity

UNITED STATES

LOCATION: California, United States
AREA: 13 million hectares

SUMMARY
At the beginning of the 20th century, California's San Joaquin Valley was a dry plains habitat. This seems incongruous with the current, public view of the valley: intensive agriculture and one of the world's most important breadbaskets for fruits, vegetables, and tree crops. This contrast captures the fundamental transformation of the San Joaquin Valley foodscape: a once arid landscape that now has 2 million ha of irrigated cropland and exceeds sustainable water use by more than a half-trillion gallons of water per year.

To address this imbalance, California passed the Sustainable Groundwater Management Act (SGMA) that requires the San Joaquin Valley to come into hydrological balance over the next several decades. Achieving this balance will likely require fallowing around 250,000 ha of agricultural land. At the same time, the San Joaquin Valley foodscape needs to maintain its agricultural productivity.

THE SAN JOAQUIN VALLEY

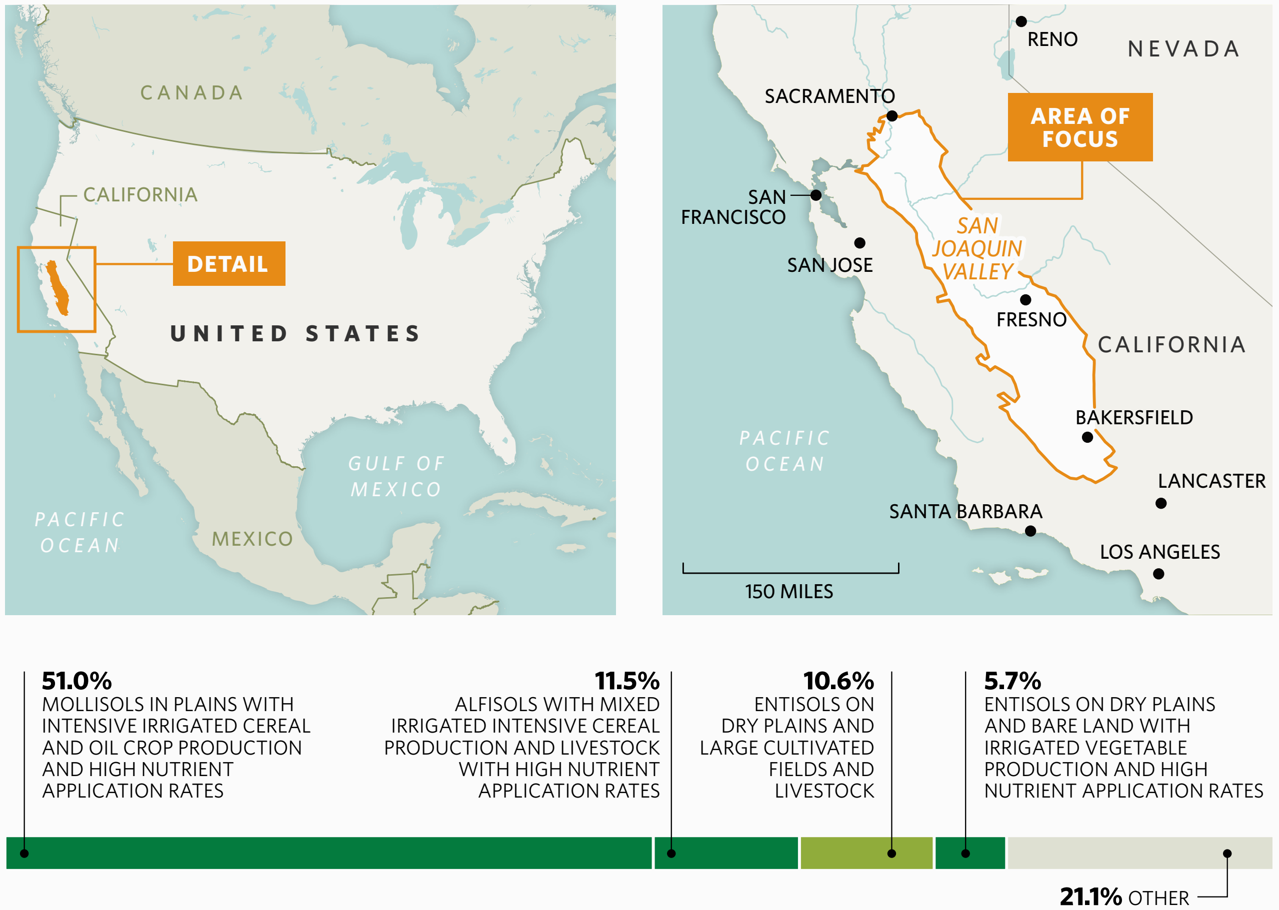

FIGURE 1. Map of San Joaquin Valley foodscape. The bars represent the most extensive foodscape classes within the foodscape. The color of bars indicates the intensity groups corresponding to those classes: intensive production dominant (dark green) and mixed mosaic food cultivation (light green). The other category includes the classes that each made up <5% of the foodscape area.

In this time of transition for the San Joaquin Valley and its communities, planning at the level of the entire foodscape could help show where nature-based solutions, such as restoration of retired agricultural lands, would be most useful in reducing the impacts of climate change and policies like SGMA on farmers and keep them farming. Transitioning to a more diversified landscape that balances biodiversity, agriculture, water stewardship, and energy production will require careful management to ensure that the most vulnerable groups (e.g., disadvantaged communities and small family farms) do not carry a disproportionate amount of the costs of transition.

Nature-based solutions here, especially strategic restoration, could help recover biodiversity and benefit local communities through sustainable agriculture, improved water supply, water quality, air quality, and access to open space.

Almond trees reflected in flooded irrigation water in the San Joaquin Valley, California, USA
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DESCRIPTION OF FOODSCAPE

The San Joaquin Valley foodscape (FIGURE 1, p.10) contains 2 million ha of irrigated agricultural land. Farms in the region range from small family farms under 5 hectares to large agricultural operations with hundreds to tens of thousands of hectares in production. This foodscape produces one-quarter of the fruits, nuts, and vegetables consumed in the United States and is home to six of the top 10 dairy-producing counties in the United States.

Seven of California's top food-producing counties are in the San Joaquin Valley foodscape and produced more than $30 billion of agricultural revenue in 2016, which has increased more than 70% since the 1980s.[10] This increase in revenue largely reflects expansion of high-revenue commodities including milk, almonds, grapes, citrus, cattle, and pistachios. From 2000–2016, the area of perennials grew by 27%.[41] Irrigated horticultural crops, though making up a smaller area, still represent a crucial element in national and global supply chains. For instance, 95% of the processing tomatoes in the United States come from California, and the San Joaquin Valley foodscape makes up 70% of the state's production.[42] The majority of California's grapes — both for wine and table grapes — are grown in this area. This level of production has been allowed by unsustainable levels of surface and groundwater use.

Some of that water comes from the surface water sources within the San Joaquin Valley — rivers fed by winter rains and snowmelt from the Sierra Nevada Mountains. The region also imports surface water from the Sacramento River Valley via the Sacramento-San Joaquin Delta and a series of large canals on the eastern and western sides of the valley. Yet many farmers rely on pumping groundwater, especially in drought years when surface water deliveries are lower. Paired with agricultural expansion, this intensive use of groundwater has led to overdraft of aquifers (see next section on Challenges), widespread subsidence, and impacts to drinking water access in some communities.

Originally inhabited by the Yokut and Miwok people, the vast, flat valley floor of the San Joaquin Valley was historically composed of hundreds of thousands of hectares of permanent and seasonal wetlands, including the great Tulare Lake. These wetlands formed the backbone of the Pacific Flyway that supported millions of migratory shorebirds and waterfowl on their journeys to and from their breeding grounds. Surrounding the wetlands was an upland desert scrub ecosystem that was home to dozens of species found nowhere else on earth. From 1850–1950, these wetlands were drained and the landscape was transformed from one that supported limited dryland cropping and rangelands to intensive, irrigated fruit and vegetable crop production.

Rebalancing land and water use in the San Joaquin Valley foodscape to achieve groundwater sustainability presents an opportunity to achieve long-term water security for the region's farms while also recovering its native species, many of which are still present in small pockets of protected areas, by restoring their native habitat on working and retired agricultural lands.

Over time, 95% of the original habitats of the San Joaquin Valley, from permanent and seasonal wetlands to upland desert scrub, were converted, primarily to agriculture. As a result, many of the unique San Joaquin desert species, including the giant kangaroo rat, blunt-nosed leopard lizard, Tipton's kangaroo rat, Bakersfield cactus, San Joaquin woolly-threads, and the San Joaquin kit fox, are now listed as threatened or endangered, and the wetlands that millions of migratory birds rely on have been largely lost.

Almond (Prunus dulcis) orchard trees reflected in flooded irrigation water used in watering the trees.Taken in the San Joaquin Valley, California, USA.

CHALLENGES

Over time, the agricultural footprint of the San Joaquin Valley has continued to grow, expanding by more than 800,000 ha from the end of World War II up to the turn of the millennium. Due to this large-scale transformation of the landscape and the high level of endemism of the species that relied on the valley's desert scrub habitat, the San Joaquin Valley has some of the highest concentrations of endangered species in the United States.

At least 30,000 ha of upland habitat would need to be restored and/or protected to support the recovery and potential delisting of the 11 most important threatened species within the San Joaquin Valley.[43]

For a dryland ecosystem to achieve the status of one of the most important food-producing regions in the world requires large-scale transformation of water resources for irrigation. For most parts of the valley, groundwater accounts for about 40% of irrigation water in wet years and up to 60% in dry years, with the remainder supplied by imports from the Sacramento River and major tributaries of the San Joaquin River and Tulare Lake watersheds that flow out of the Sierra Nevada Mountains.

However, approximately 20% (>300,000 ha) of all irrigated lands in the San Joaquin Valley are completely dependent on groundwater for irrigation. Changing water supplies due to drought, climate change, and water policy have resulted in an overdependence on groundwater. The San Joaquin Valley has an overdraft of water of approximately 0.7 trillion gallons per year.[41]

The overuse of groundwater has many consequences that go beyond availability of water for irrigation. Overdraft is leading to rural drinking water wells drying up, decreased water levels in rivers and wetlands, and land subsidence, which has exceeded 25 feet in some areas of the San Joaquin Valley and which can lead to the collapse of infrastructure such as the canals that transport water throughout the valley.

Dependence on groundwater pumping has been exacerbated by crop shifts from annual crops that can be fallowed in dry years toward perennial crops, such as almonds, that require irrigation even when water is most scarce. Because these crops represent long-term investments, and because they need to be irrigated every year to stay alive, there is little flexibility to downscale irrigation in drought years, resulting in a "hardening" of water use.

The pressures that led to groundwater overdraft in the region are likely to intensify as climate projections predict that the whole San Joaquin Valley will be in a desert climate in the next 50 years. Increasing soil salinity is also a major challenge for agricultural production in the San Joaquin Valley. Increased salinity occurs when groundwater pumping draws up soluble minerals and they accumulate in the root zone. It has been estimated that soil salinity costs farmers in the San Joaquin Valley $370 million per year.[44]

The San Joaquin Valley is a hotspot for poor water and air quality, including some counties designated by the U.S. Environmental Protection Agency as having air quality hazardous to human health.[45] More than half of the children living in the valley suffer from asthma.

Air quality problems are due to the combustion of fossil fuels associated with tractor use, shipping trucks, and nitrogenous fertilizers.

Because rural areas depend largely on groundwater sources for drinking water, they are disproportionately exposed to agricultural and naturally occurring pollutants such as nitrates and arsenic. Excess nitrates in drinking water, which leach into groundwater from overapplication of agricultural fertilizers, cause birth defects. In addition to nitrates, certain areas of the San Joaquin Valley – and in particular deeper groundwater – have naturally higher arsenic levels, which is linked to heart disease, diabetes, and cancer.

SOLUTIONS

In 2014, spurred by increasing overdraft in the midst of a historic drought, California passed its first attempt at groundwater regulation, the Sustainable Groundwater Management Act (SGMA). SGMA (pronounced Sigma) mandated the creation of new groundwater sustainability agencies that are now responsible for developing Groundwater Sustainability Plans to bring each of their jurisdictions into balance by 2040. The geographical boundaries of these agencies were defined by local stakeholders and do not necessarily map onto traditional hydrological boundaries. The agencies aim to achieve groundwater sustainability through a combination of water supply enhancement projects – new imports and groundwater recharge – and demand reduction, such as irrigation efficiency projects, crop switching, and fallowing of marginal cropland. Adoption of practices like local or regional water trading

Almond orchard with ripening fruit on trees and fame worker mowing grasses between trees.
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could aid in optimizing allocation of water supplies to where they are most needed, requiring less demand reduction to achieve sustainability.

For instance, water trading restricted to local basin transfers would lead to more than $5 billion in losses for the agriculture sector, whereas losses for valley-wide trading would be less than $2 billion.[41] Economic losses due to SGMA implementation are expected to be greatest for perennial tree crops.

Across the valley, SGMA is driving creative approaches to land and water management. Within the context of the San Joaquin Valley foodscape, such willingness to experiment and try new approaches presents two primary opportunities for nature-based regenerative agriculture solutions: (1) rebalancing water use to better provide farms with secure water supplies while creating and restoring habitat for native species on retired lands, and (2) managing productive lands in ways that provide wildlife benefits, such as on-farm recharge to replenish groundwater supplies. This can be done on seasonally fallowed fields or on active fields of compatible crops and serves the dual purpose of creating temporary wetland habitat for birds using the Pacific Flyway and recharging groundwater.

Taking agricultural land out of production presents significant opportunities for restoring habitat for important wildlife.

Restoring upland areas could meet the habitat needs of many of the most important species in the San Joaquin Valley, provided such restorations are strategically located in proximity to other important protected areas.[46] Doing this could allow for achieving target conservation goals on about half as much land as would be necessary if restoration was not strategically sited.

Nature-based solutions such as habitat restoration within the foodscape also stand to improve air and water quality by reducing dust and nitrous oxide emissions associated with agriculture and fallowed lands, as well as eliminating future fertilizer applications that could contribute to further nitrate contamination of groundwater. For some crops, such as almonds that depend on pollination, restoring upland habitat may provide critical habitat for pollinators that increase crop yields or make farmers less dependent on seasonal importing of bees.

Re-envisioning how the San Joaquin operates to support a vibrant farming community while also providing habitat for the fish and wildlife that live in the valley and its rivers will require large-scale investments and financial incentives, such as ecosystem services markets. By implementing nature-based solutions in the San Joaquin Valley Foodscape, both land and water stewardship can play a role in the region's recovery.

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This is a case study excerpted from the report *Foodscapes: Toward Food System Transition*. Please access the entire global report at nature.org/foodscapes.

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