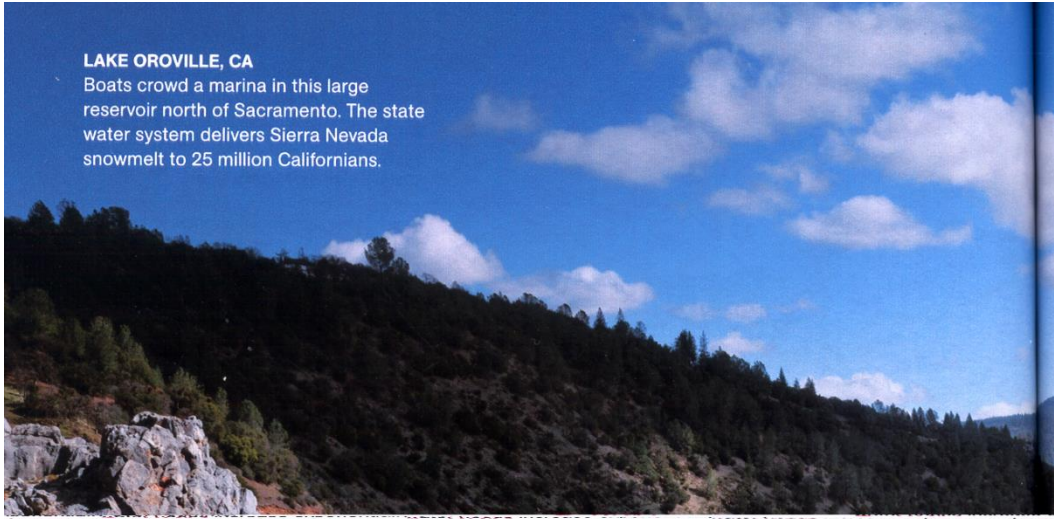


## Water Issues in the Southwest USA

National Geographic Oct. 2014 p. 58-77

### LAKE OROVILLE, CA

Boats crowd a marina in this large reservoir north of Sacramento. The state water system delivers Sierra Nevada snowmelt to 25 million Californians.





# When the Snows Fail

*The American West faces  
persistent drought, whether  
or not relief comes this winter.  
When will the hard choices be made?*



430,000 ACRES IN CALIFORNIA WILL BE LEFT FAL



**FARMLAND NEAR AVENAL, CA**

This plot is usually planted with wheat, tomatoes, or melons. Last summer water shortages kept many Central Valley fields bare and dusty, worsening the area's already substandard air quality.

PANORAMA COMPOSED OF FIVE IMAGES

**BE LEFT FALLOW THIS YEAR DUE TO DROUGHT.**

By Michelle Nijhuis  
Photographs by Peter Essick

**F**or three generations the Diener family has farmed the same ten square miles of Central Valley dirt. In the 1920s they grew barley and alfalfa to feed the mules that powered the construction of Los Angeles. In the 1930s, as internal combustion replaced animal muscle, they grew cotton to bind rubber car tires.

Today, as California limps through its third year of drought, John Diener, his sons, and their land are getting into the cactus business.

Diener grows produce on as grand a scale as any in the Central Valley, cultivating hundreds of acres of tomatoes, almonds, organic broccoli, and other crops. But he thinks differently from most farmers here. Maybe it's that he's the youngest son of a youngest son, used to making the most of bad situations. Or maybe his years living outside the valley have given him a maverick's confidence.

Whatever the reason, he doesn't put much stock in more dams, fewer environmental restrictions, or any of the other measures his neighbors say will relieve the economic pain. Short-term fixes, he shrugs. "The real problem," he says as he navigates his pickup through the valley's grid of dusty roads, "is that there's just not enough water in the system."

On the western edge of his property, below the snowless hills of California's coastal mountains, Diener stands on the dry dirt between rows of young cacti, inspecting the bright green new growth. In cooperation with researchers at the U.S. Department of Agriculture, Diener has planted about 20 acres of a patented variety of prickly pear cactus, a crop he hopes to sell

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*Science writer Michelle Nijhuis has covered the West for 15 years. Photographer Peter Essick's work captures the fragile state of our environment.*

#### **WATER DRILLING NEAR HANFORD, CA**

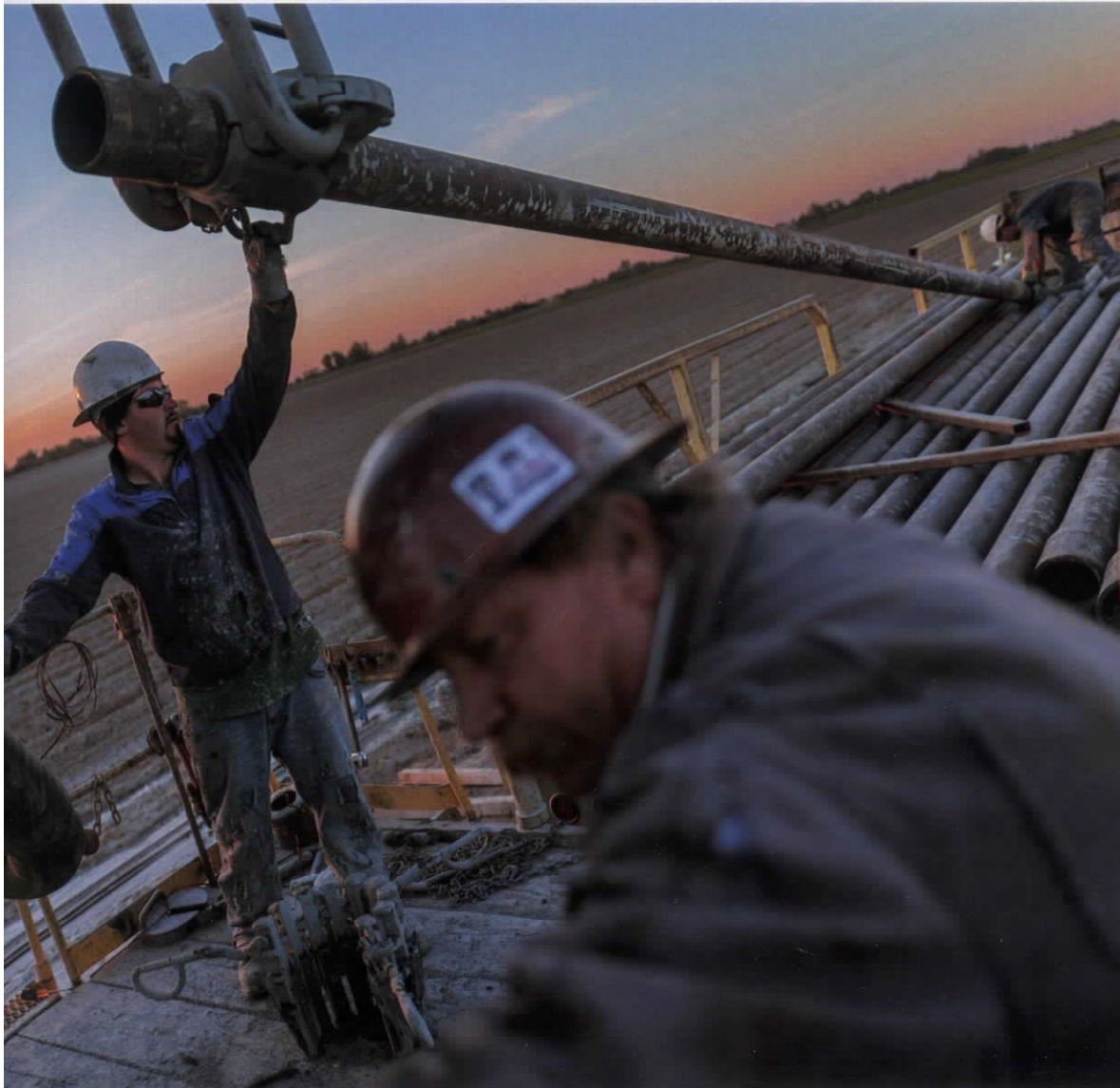
With water supplies slashed, farmers have been sinking hundreds of new wells into the region's dwindling groundwater reserves, leaving land vulnerable to subsidence.

both as food and as a mineral-rich nutritional supplement. Years of drought have concentrated naturally occurring salts in this field's soil, but the cacti appear to be doing just fine.

"If we need to, we'll plant more," he says. He laughs. "We're opportunists, after all."

THE STORY OF THE CENTRAL VALLEY of California is the story of much of the American West, and of other inhabited deserts around the world.



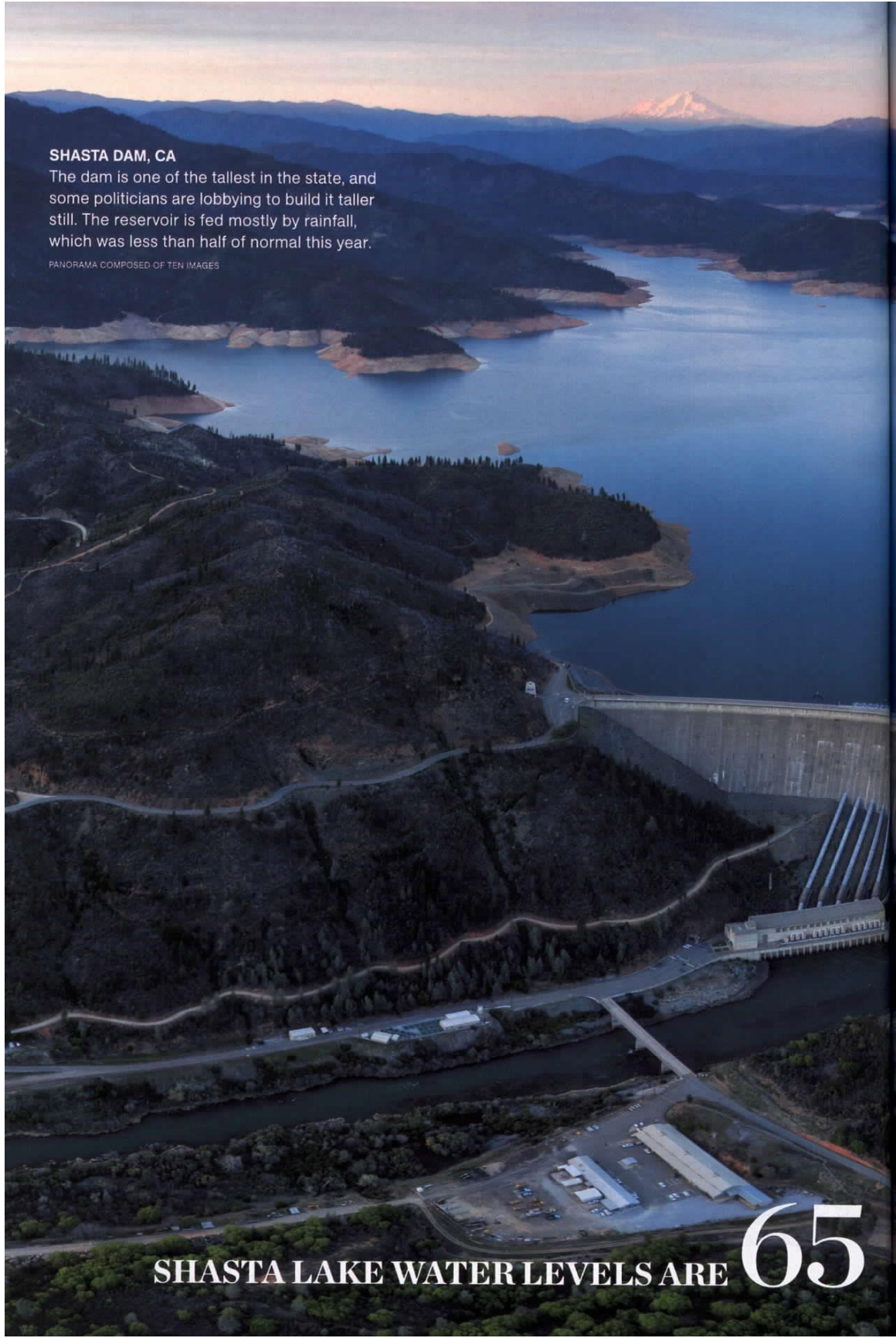


We have altered the driest parts of California, Nevada, and Arizona to fulfill our ambitions, and for years we have been able to ignore their natural limits. Now a growing population and a changing climate are exposing those limits as never before.

And yet the Central Valley is in many ways an agricultural paradise. The soil is rich—remarkably so. The weather is warm—reliably so. More than 300 different crops, from rice and

asparagus to pomegranates and oranges, thrive on the valley's wide, flat floor, and at times grow better here than anywhere else in the country. Virtually all of the almonds, olives, and walnuts grown in the United States come from the Central Valley, as does most of the nation's domestic supply of canned tomatoes.

For all its riches the valley looks nothing like paradise, and in drought years like this one, its shortcomings are excruciatingly obvious. Dust



**SHASTA DAM, CA**

The dam is one of the tallest in the state, and some politicians are lobbying to build it taller still. The reservoir is fed mostly by rainfall, which was less than half of normal this year.

PANORAMA COMPOSED OF TEN IMAGES

SHASTA LAKE WATER LEVELS ARE **65**



**PERCENT BELOW THE HISTORIC AVERAGE.**



An aerial night photograph of Phoenix, Arizona, showing a vast urban landscape illuminated by city lights. The sky is a dramatic mix of orange, red, and purple, indicating a sunset or sunrise. The city's grid pattern and various structures are visible, with some areas appearing more brightly lit than others. The overall scene conveys a sense of a large, active metropolitan area.

# THE POPULATION OF THE PHOENIX AREA GREW

## SUN CITY, AZ

The Central Arizona Project, a 336-mile-long system of canals and pipelines, carries Colorado River water through the desert to the Phoenix metro area.

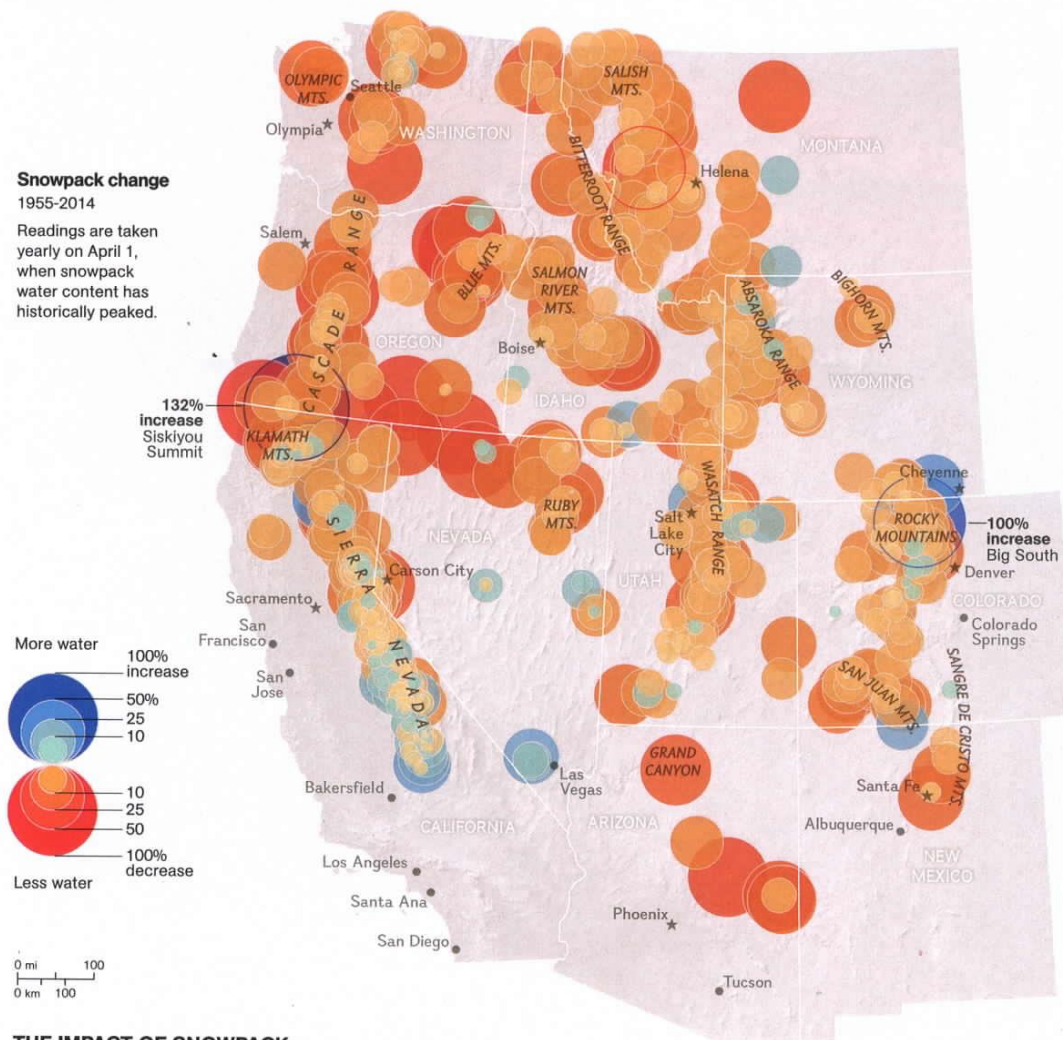
PANORAMA COMPOSED OF 12 IMAGES

**4** TIMES LARGER BETWEEN 1970 AND 2010.



**Snowpack change**  
1955-2014

Readings are taken yearly on April 1, when snowpack water content has historically peaked.



**THE IMPACT OF SNOWPACK**

Mountain snowpacks are frozen reservoirs, their spring melt supplying as much as 75 percent of the West's water. Decades of measurements, taken by hand or automatic sensors, show dramatic decline.

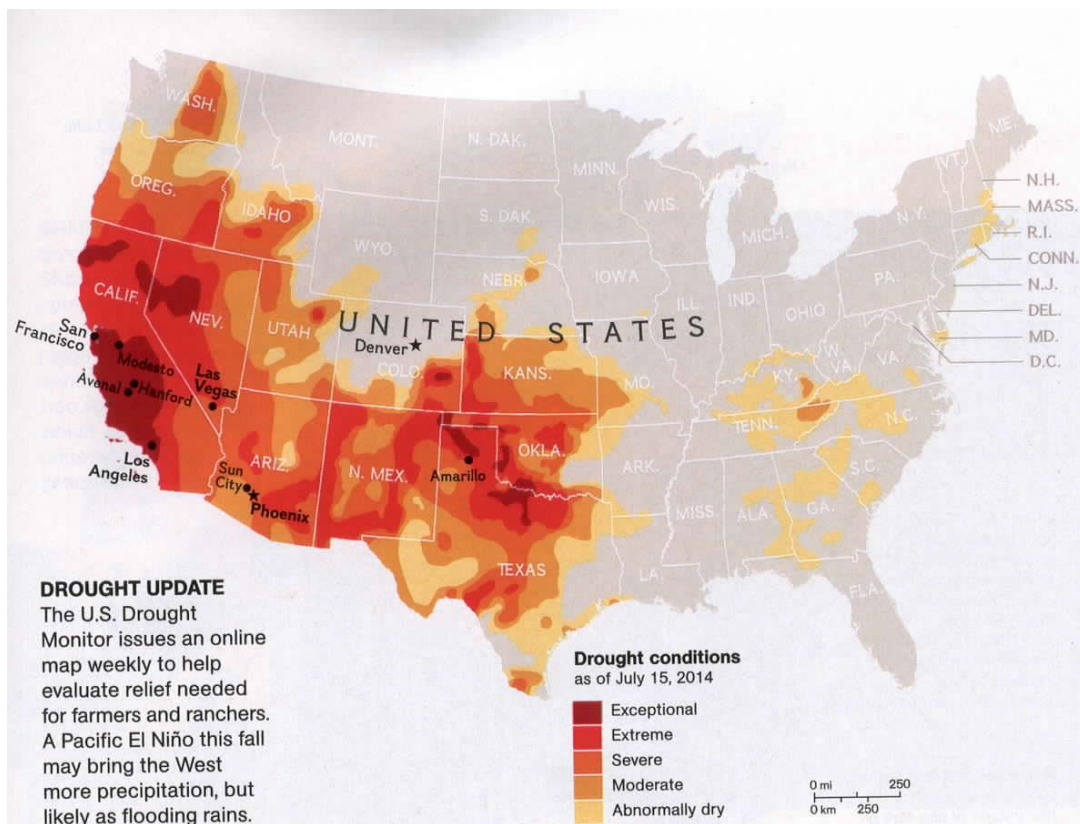
rises from fallowed fields, often thickly enough to obscure the snowcapped Sierra Nevada in the distance. The whole place seems to stagger under a heavy blanket of grit and heat.

Here, where rain is just a lucky break, farmers have long depended on two interconnected sources of water. Many use surface flows from the San Joaquin and Sacramento Rivers, divvied up according to water rights that date back to the 19th century and delivered to fields via a complex network of pipes and canals. Most supplement this plumbing with groundwater,

and in the driest corners of the valley, aquifers are so overdrawn that fields have sunk by more than 30 feet. "The pattern of groundwater use in California practically defines the term unsustainable," says Jay Famiglietti, a hydrologist from the University of California, Irvine, who uses satellite data to study water supplies.

On this land farming takes money: money for the equipment to move water to fields, money to survive the driest years, and money to fight the constant legal and political battles over water in the state. Most farmers in the Central Valley win

VIRGINIA W. MASON AND KELSEY NOWAKOWSKI, NGM STAFF  
SOURCES: NATURAL RESOURCES CONSERVATION SERVICE, CALIFORNIA DEPARTMENT OF WATER RESOURCES, DARRIN SHARP AND PHILIP MOTE, OREGON STATE UNIVERSITY



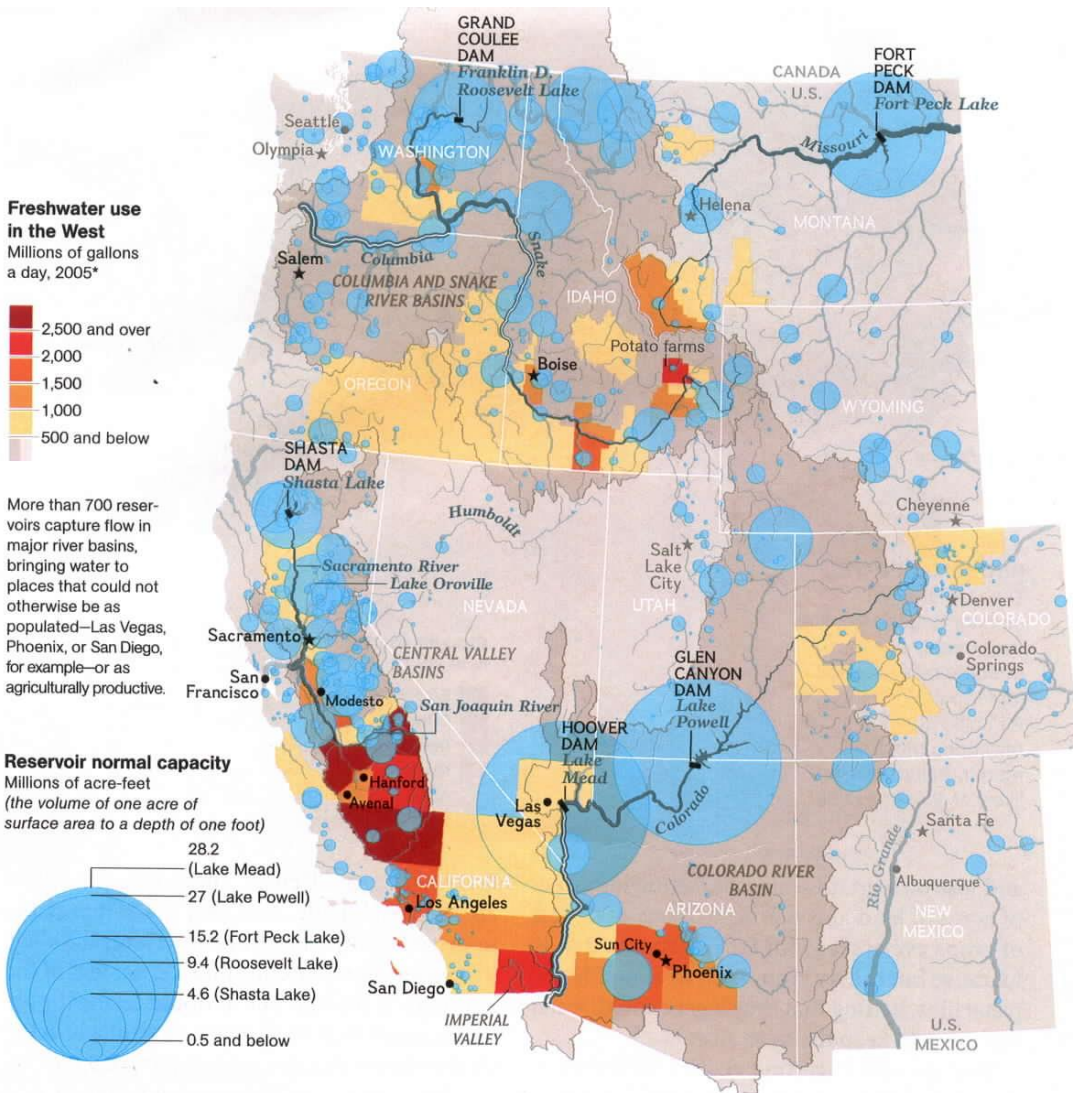
and lose on a grand scale, cultivating hundreds of acres of land and selling millions of dollars of crops every season. Many have invested in lucrative but thirsty crops such as almonds and pistachios, betting that they'll get enough water each year to keep the trees alive.

That gamble is getting riskier. In the western United States, most water arrives in winter storms, which swoop in from the Pacific and dump snow atop the region's mountain ranges. Mountain snowpack serves as the West's water tower, and over the past century Westerners have built hundreds of dams to catch and store snowmelt as it fills the region's rivers in spring. Today most major rivers in the West are saddled with a complex system of dams, canals, and aqueducts. Most years the Colorado River never reaches its mouth in the Gulf of California, and its once lush delta has become a vast mudflat. Salmon and other fish are struggling or gone altogether. Hetch Hetchy, a mountain valley said to have rivaled Yosemite in beauty, was flooded in 1923 to provide water to San Francisco.

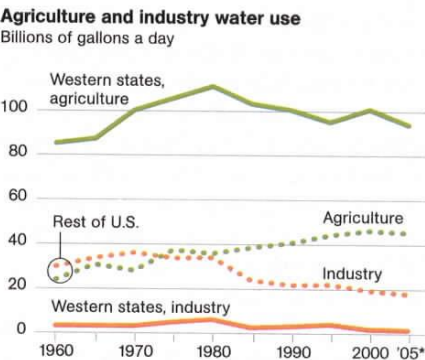
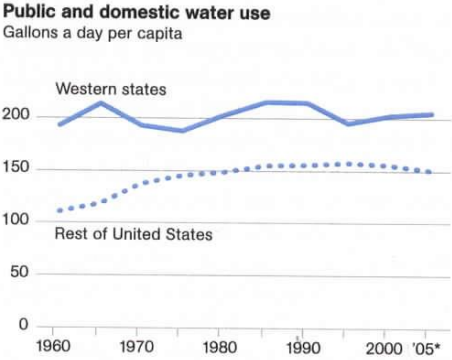
Yet in their way these systems work. They built and sustain cities like Phoenix, Las Vegas,

Los Angeles, and Denver. They make uninhabitable land habitable. And they make it possible to grow food in places like the Central Valley. The valley represents just under 2 percent of the country's cropland, but in dollar terms it produces nearly half of the nation's fruit and nuts. As the climate changes, scientists predict that the southwestern U.S. will get less precipitation, and the northwestern U.S. will get more. They're not so sure about the future of precipitation in the Central Valley, where it may decrease, increase, or simply fall at different times during the year than it used to.

As in most of the rest of the American West, fortunes depend less on how much precipitation falls from the sky than how much of it falls as snow and how long that snow stays in the mountains. Despite the occasional severe winters, western snowpacks have declined in recent decades, and key researchers expect the trend to accelerate. "Warmer winters are reducing the amount of snow stored in the mountains, and they're causing snowpacks to melt earlier in the spring," says Philip Mote, director of the Oregon Climate Change Research Institute at



**TAPPING THE WEST**  
U.S. domestic and municipal water use is highest per capita in the West. Naturally dry, the region relies on irrigation to keep landscaping green. California's agricultural dominance accounts for much of the farm-water usage.



\*Most recent data; does not include thermo- and hydroelectric power  
VIRGINIA W. MASON AND KELSEY NOWAKOWSKI, NGM STAFF  
SOURCE: NANCY BARBER, USGS

#### SHASTA LAKE, CA

Before the 602-foot-high Shasta Dam was completed in 1945, the pine and fir forests were logged. As the reservoir contracted this spring, tree stumps—some of which were preserved underwater for 60 years—were exposed.



Oregon State University. Shrinking snowpacks and earlier snowmelts mean—in practical terms—that the region faces a persistent and worsening drought.

Early this year, as the East Coast shivered, California baked. January wildfires burned suburban homes, a sinking reservoir exposed the long-drowned ruins of a gold rush town, and in the spring, Yosemite Falls shrank to a trickle. As the drought crept toward historic levels, the political conversation settled into familiar ruts.

Farmers called on Congress to lift protections for endangered fish species. Urbanites pointed out that an average of 41 percent of California's water is used for agriculture, while less than 11 percent goes to cities (nearly 49 percent stays in the rivers). Sound bites prevailed, and any sign of rain silenced the conversation entirely.

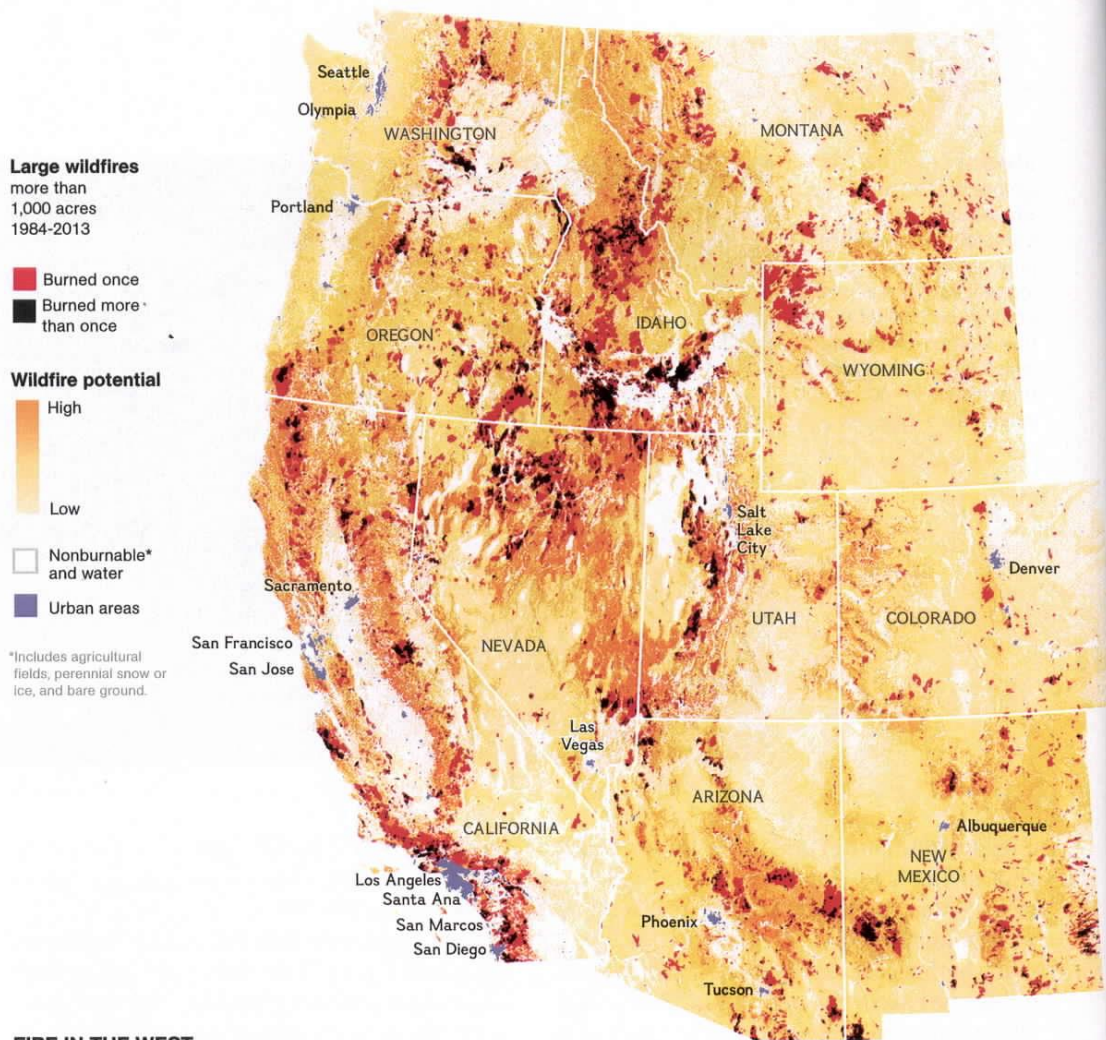
“And it never failed that during the dry years the people forgot about the rich years,” John Steinbeck wrote in his 1952 epic, *East of Eden*, a family tragedy set in the Salinas Valley of the early 20th century, “and during the wet years they lost all memory of the dry years.”

Such forgetfulness is almost a western

birthright. But it doesn't have to be. For proof, look to Australia, a place with deep parallels to California and the West.

Both California and Australia have desert cores and a temperate, urbanized edge. Both depend on complex plumbing to move their water: In fact, the pair of Canadian brothers who built some of California's first irrigation systems in the late 1800s also helped engineer the water-delivery systems of Australia's arid Murray-Darling Basin.

Australia's Big Dry, a decade-long drought that began around the start of this century, led at first to the same kind of political bickering heard recently in California. But after years of environmental destruction, urban water stress, and great suffering by many dryland farmers, Australian politicians—and farmers—took some serious risks. “At the peak of the drought, it became very apparent that the environment doesn't lie,” says Mike Young, a professor at the University of Adelaide who was active in the country's drought response. Australia reduced urban water use by investing billions in conservation, education, and efficiency improvements.



### FIRE IN THE WEST

Vegetation such as chaparral and ponderosa pine flourishes with occasional wildfires. But a drier West has seen more frequent and intense burns. Protecting a rising population has hiked firefighting costs.

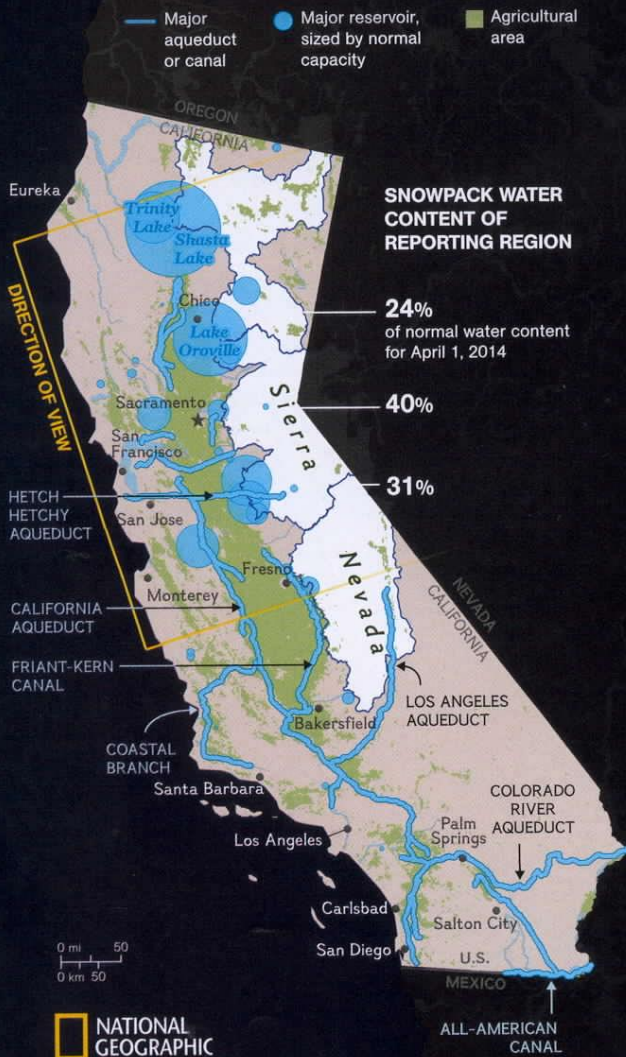
Most important, it began to reform the old water allocation system, which, like California's, had promised specific amounts of water to rights holders. The country instituted a system that guaranteed a minimum supply of water for the environment, then divided the remainder into shares that could be quickly sold and traded—or stored for the next season. Farmers fought the changes, but with a financial incentive to use less water, they soon got more creative and more efficient. Water use dropped, and though consumption has risen since the drought eased

in 2010, it remains below pre-drought levels in towns and cities.

California's water system—with annual expenditures exceeding \$30 billion—is a long way from following Australia's "shining example," says University of California, Berkeley, economist Michael Hanemann. "California and most of the West haven't done a damn thing to put ourselves in a good position to handle drought," he says. "We have been unwilling to make the sort of changes ahead of time that we absolutely need [to make] to face a drier future."

# California's Water Challenge

Stretching between the coastal ranges and the snowcapped Cascades and Sierra Nevada, the 450-mile-long Central Valley (right) is the fertile expanse that makes California the U.S. agricultural leader. Every light-blue line or icon on the map is a man-made part of a system engineered to irrigate fields and bring drinking water to much of the state. But it relies mainly on spring melt from snowpacks, now declining (below).





**WILDFIRE NEAR  
SAN MARCOS, CA**

Hills and canyons burn in the Cocos fire, which ravaged San Diego County in mid-May. Because of drought and rising temperatures, the western wildfire season now lasts at least two months longer than just a few decades ago.



Yet after decades of unregulated, unsustainable pumping of groundwater in California, some regional authorities have instituted rules to protect groundwater supplies. Los Angeles and other large cities have dramatically improved water efficiency. “There’s a lot of slack in the system that we’ve tolerated for a long time, just because we could get away with it,” says Peter Gleick, president of the Pacific Institute. “Now we have to learn to live within the limits of what nature provides.”

The story of water in the American West hasn’t changed: It’s still a tale of ambition and optimism, both in dangerous amounts. But the California drought, and the droughts to come, could force the start of a new chapter.

John Diener plans to be part of it. Unlike many Central Valley farmers, he hasn’t moved into Fresno, to farm at a distance. He still attends church in nearby Riverdale, and when pressed for time, he goes to the Spanish-language Mass at the mission church his aunt and uncle established in the 1940s. But although he’s attached to the place, and to the land his family claimed nearly a century ago, he’s a pragmatist to the core.

This year Diener didn’t receive any river water, so he fallowed half his acreage. He planted tomatoes and broccoli, watering them with the high-efficiency underground drip systems he’s purchased in recent years. He is working with a local public-private partnership to turn his sugar beets into ethanol. And of course, he’s tending his 20 acres of cactus. He’s not making money off his plants yet, but he’s optimistic that they will find a market: Prickly pear pads, or nopals, are a wildly popular vegetable in Mexico and elsewhere in Latin America, and they have value as selenium-rich supplements. It’s hardly the future his uncle and father expected. But if the elder Dieners were here today, they’d probably approve. Adaptation helped them survive too. □

**MORE ONLINE**

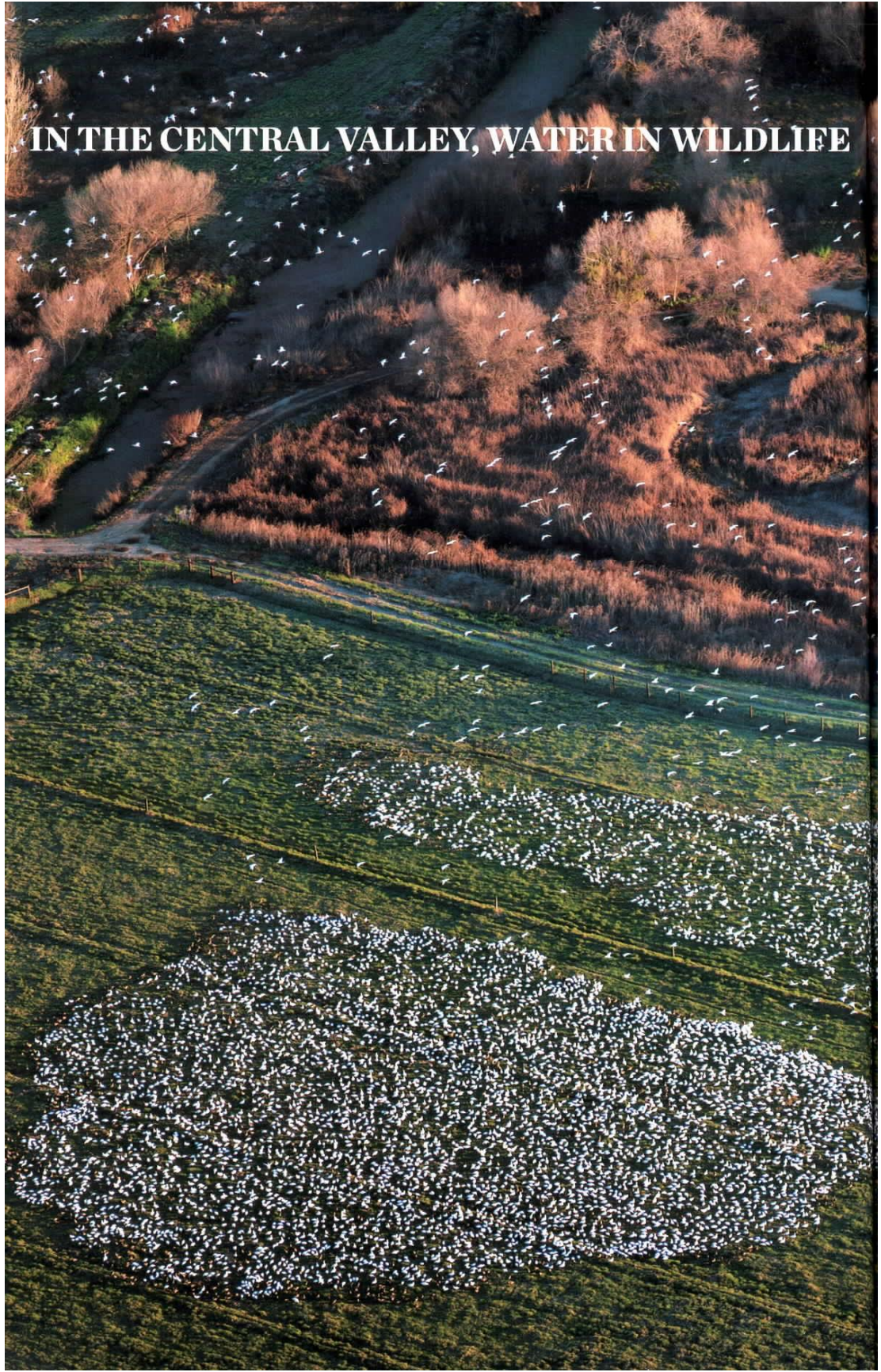
[ngm.com/more](http://ngm.com/more)



**INTERACTIVE**

*Motion graphics show the crucial role of snowmelt in irrigating California’s Central Valley.*

**IN THE CENTRAL VALLEY, WATER IN WILDLIFE**

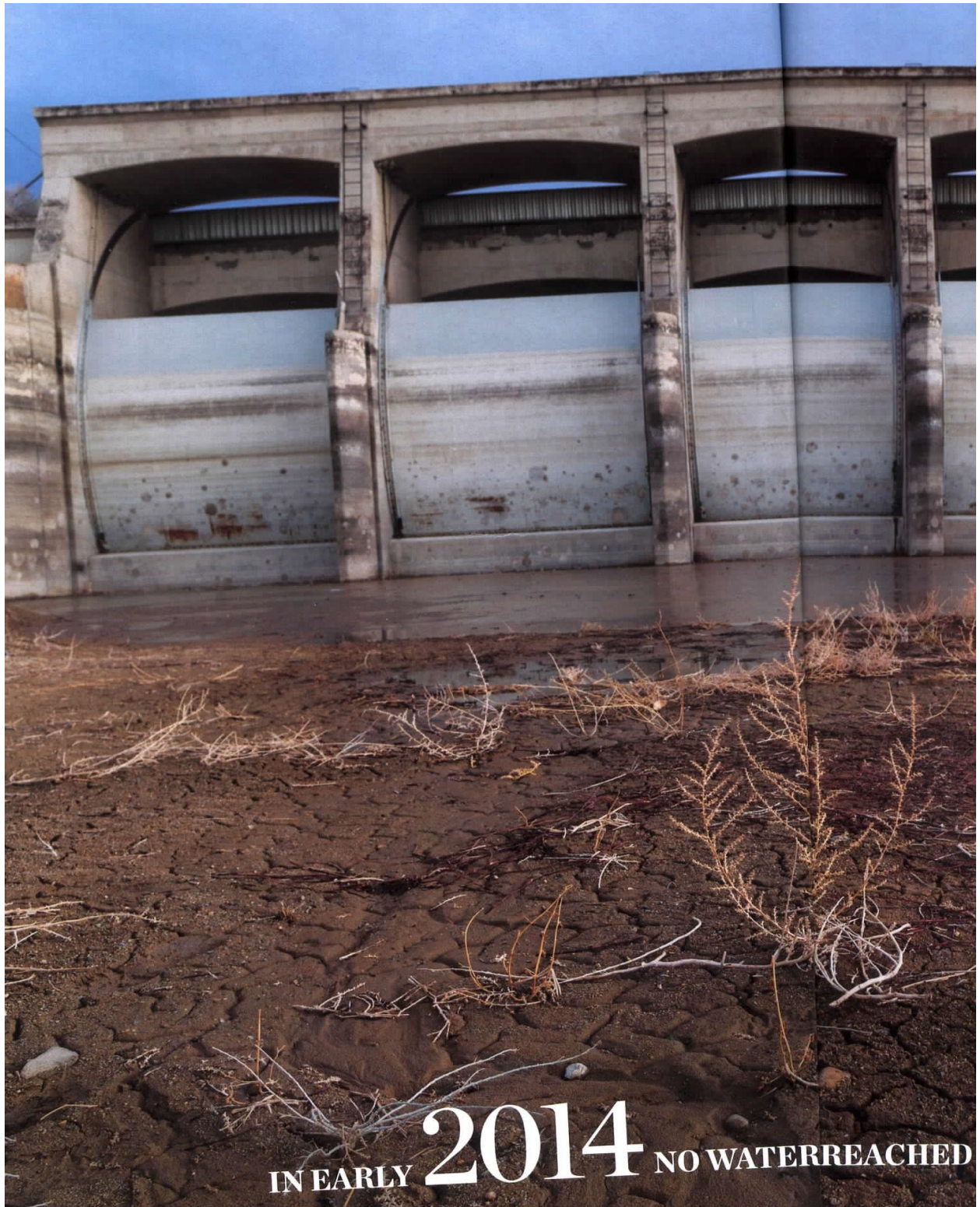


An aerial photograph of a wetland area, likely a wildlife refuge, showing a large flock of geese. The landscape is a mix of green fields, brown reeds, and blue water. The geese are scattered throughout the scene, with a particularly dense cluster in the lower-left foreground. The text "REFUGES IS DOWN BY AROUND 30 PERCENT." is overlaid in white, serif font across the upper portion of the image.

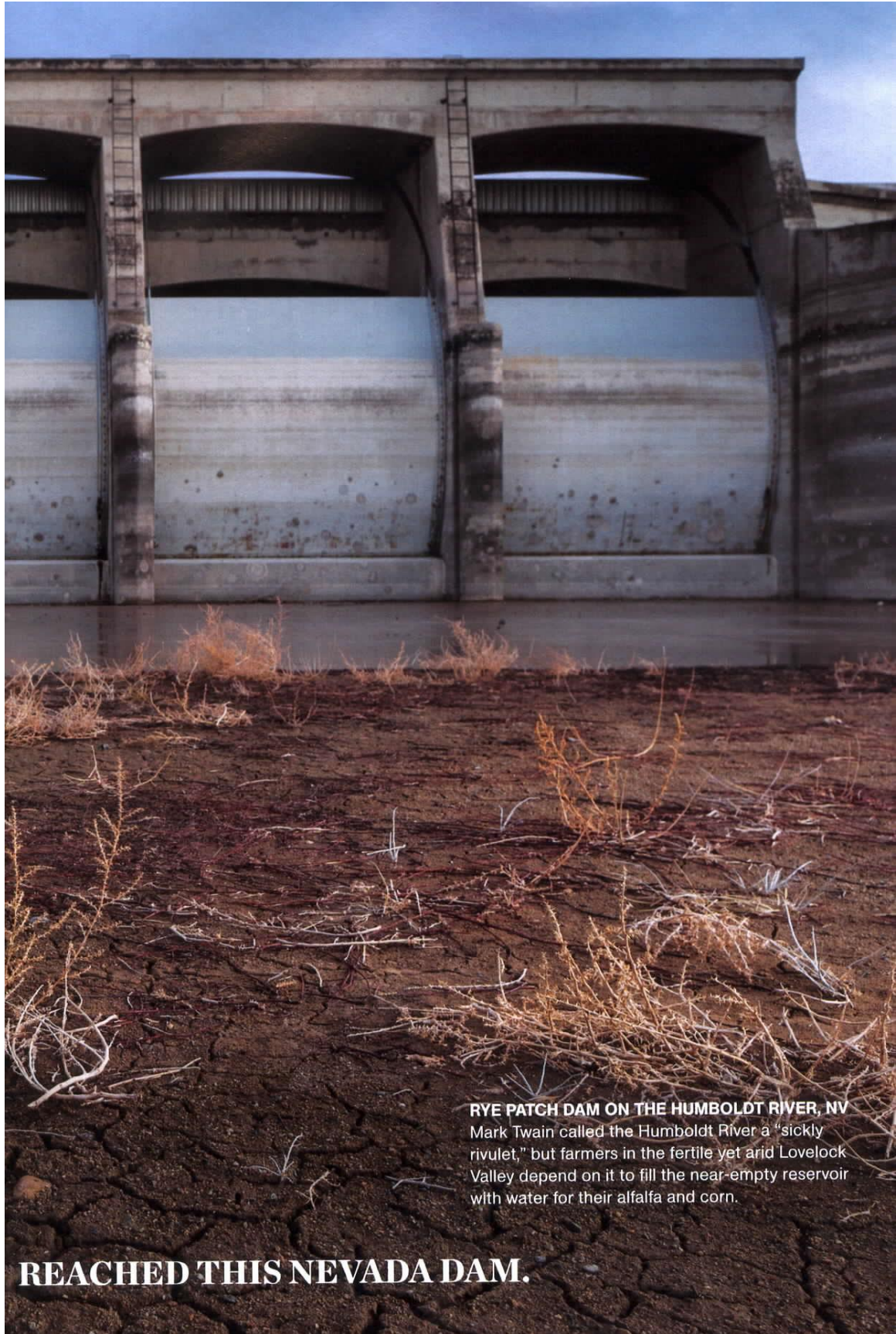
REFUGES IS DOWN BY AROUND **30** PERCENT.

**GEESE NEAR MODESTO, CA**

On their journey north, migratory geese congregate on the Faith Ranch near the San Joaquin River National Wildlife Refuge, one of the Central Valley's few scraps of native wildlife habitat.



IN EARLY **2014** NO WATER REACHED



**RYE PATCH DAM ON THE HUMBOLDT RIVER, NV**  
Mark Twain called the Humboldt River a "sickly rivulet," but farmers in the fertile yet arid Lovelock Valley depend on it to fill the near-empty reservoir with water for their alfalfa and corn.

**REACHED THIS NEVADA DAM.**