

California needs to manage its main water source more effectively

The headwaters—or upper watersheds—of California’s mountain regions supply most of the water for farms, cities, and freshwater ecosystems. These heavily forested areas are a key part of the state’s natural water infrastructure—and essential for a sustainable future. They also support habitat for much of California’s biodiversity, including threatened and endangered wildlife. They provide timber, forage, and recreation; sequester carbon; and are rich in cultural and historical value. But the health of these headwaters is at risk.

The latest drought’s hot, dry conditions led to record tree mortality and wildfires in headwaters across the state—a glimpse of what the future might hold. Conifer forests in the Sierra Nevada and southern Cascades are particularly

vulnerable. Historic forest and fire management practices have made these forests overly dense, increasing their susceptibility to drought, insect attacks, and extreme wildfires.

Despite recent progress in collaborative management, a need remains for targeted actions and long-term investments at local, state, and federal levels. Better collaboration with federal agencies is essential, as they own about two-thirds of the major headwater region. Barriers to large-scale management include the challenging task of building public acceptance for forest fuel reduction; the patchwork of federal, industrial, and family land ownership; and the lack of infrastructure and markets for forest products removed to improve forest health.

Upper watersheds are California’s natural infrastructure

Headwaters naturally collect, treat, convey, and store water. The mountainous forests of the Sierra Nevada and southern Cascade ranges are critical for the state’s water and energy supplies and for local economies.

- **Headwaters provide most of the runoff ...**

Mountainous headwaters occupy less than one-fifth of the state but provide most of its surface water. Many smaller headwaters collect and convey water and contribute to local supplies.

- **... and they store water.**

Roughly a third of California’s annual water supply is stored as snowpack that melts during the spring and early summer when

demands are high. Water is also stored in the ground and released through springs. More than 40 percent of the inflow to Shasta Reservoir—the state’s largest—comes from springs in the northern Sierra Nevada and southern Cascade ranges.

- **Headwaters also supply high-quality water ...**

Water from the mountainous headwaters is of exceptionally high quality. Much of the Bay Area, for example, can avoid the costs of filtration because of water sourced directly from the Sierra Nevada.

- **... and help reduce greenhouse gas emissions.**

On average, 15 percent of electricity comes from hydropower produced in the upper headwaters—a clean source of energy with low greenhouse gas emissions. Headwater forests also sequester carbon by storing it in plants and soil.

THE FEDERAL GOVERNMENT OWNS MOST OF THE LAND ABOVE THE STATE’S MAJOR RESERVOIRS



SOURCE: V. Butsic et al., *Improving the Health of California’s Headwater Forests* (PPIC, 2017), Figure 1.

NOTES: The figure depicts ownership of lands, including montane conifer forests, that drain into the major water supply reservoirs of the Central Valley. The US Forest Service, National Park Service, and Bureau of Land Management own about two-thirds of this major headwater area and more than half of all forestland in California.

- **Rural economies depend upon this natural infrastructure.**

Although not a large part of the state’s economy, headwater forests can generate jobs in local towns. This includes recreation and tourism, public resource management, industrial timber harvesting, and grazing.

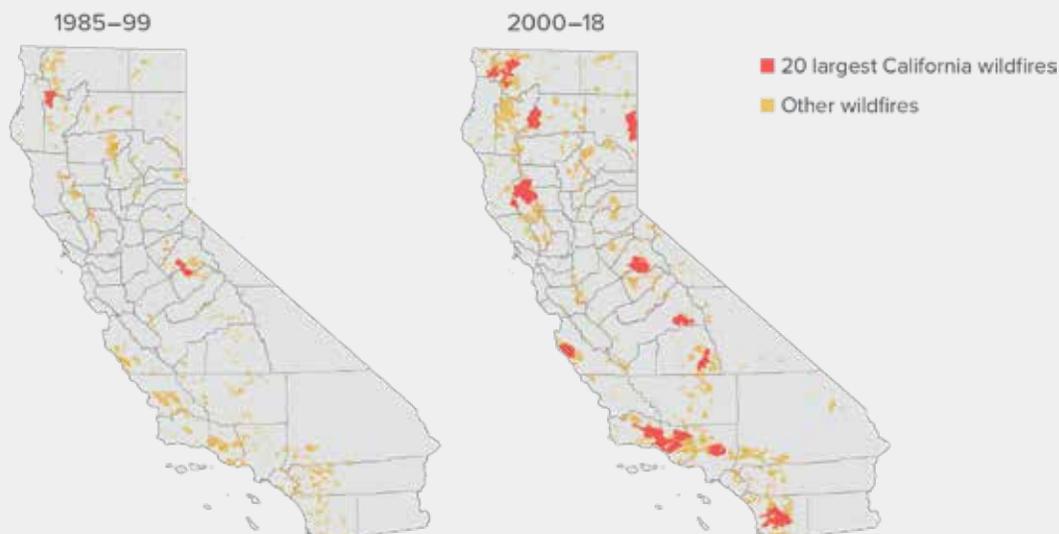
Wildfires pose a major challenge for the state, and the risk is growing

California faces a significant crisis in managing its mountainous headwater forests—fueled by drought, a warming climate, and decades of practices that resulted in overly dense growth. Recent record-setting fires mostly occurred outside this region, but the issue must be addressed to help prevent future large, high-severity fires.

- **Extreme wildfires are becoming larger and more destructive.**

The size and severity of California’s wildfires have increased since mid-century. Nearly three-quarters of the state’s largest wildfires have occurred since 2000. Fire behavior is also becoming more extreme. For example, some wild-fires now continue to grow throughout the night, which makes them harder to control.

MOST OF CALIFORNIA’S LARGEST WILDFIRES HAVE OCCURRED SINCE 2000



SOURCE: Adapted by the authors from Cal Fire, Fire and Resource and Assessment Program fire perimeter database.

NOTES: Cal Fire’s fire perimeter database is a complete record of acreage burned by wildfires from 1985 to 2017. The 20 largest wildfires are measured in terms of acres burned. The figure includes two top-20 fires from 2018 (the Carr and Mendocino Complex Fires) and excludes three top-20 fires that burned before 1985. The two top-20 fires from 1985 to 1999 burned 287,000 acres, and the 15 top-20 fires from 2000 to 2018 burned 3,326,000 acres.

- **Extreme fires have many negative impacts.**

Large wildfires can generate air pollution across a wide area, creating significant public health risks. Erosion of ash and exposed soils can reduce water quality and reservoir storage capacity. Risks of flooding and landslides also increase.

- **Communities are expanding into areas with high fire risk.**

Having more people and buildings in high-risk areas threatens public safety, raises the cost of fighting fires, increases the potential for economic losses, and heightens the potential for human-caused fires.

- **Different landscapes have different wildfire drivers.**

In the Sierra Nevada and southern Cascades, fire suppression and past timber harvesting practices have created exceptionally dense mountainous forests. Severe tree mortality and warming temperatures have primed these forests for large, extreme wildfires. So far, most of the record-breaking wildfires have occurred elsewhere, in oak woodlands and chaparral. Wildfire risk in these areas is also driven by other factors, such as wind.

Managing headwater forest health is complicated

Despite clear understanding of the approaches that can improve the health of California's mountainous headwater forests, regulatory and financial barriers persist. And other challenges increase the complexity of reducing wildfire risk.

- **Forest management rules prioritize short-term objectives over long-term resilience.**
California's forest management regulatory framework often protects forests from short-term impacts at the expense of long-term resilience. Tools like prescribed fire and mechanical thinning (selective removal of small- and medium-size trees) are essential for improving long-term resilience to drought, insects, and fire in the major headwater regions. But because they can also result in short-term negative impacts, their use is often discouraged.
- **US Forest Service and family forest owners face management barriers.**
Collectively, the US Forest Service (USFS) and private families own about three-quarters of the 15-million-acre Sierra Nevada and southern Cascade headwater forests. The decline of timber harvesting and the growing cost of fire suppression have limited USFS's capacity and funding to manage their vast holdings. Family owners are less likely to manage their lands because of high per-acre costs of forestry work.
- **California lacks the market and infrastructure to support large-scale management.**
Markets and infrastructure for forest products were once able to support large-scale management in headwater forests. But now lumber mill closures and forest access road deterioration have increased costs, making some fuel reduction projects prohibitively expensive.
- **Tools for reducing fire risks vary across landscapes.**
Strategies that work in mountainous headwater forests—notably mechanical thinning and prescribed burning—may not be effective elsewhere. In Southern California chaparral, where dense communities have expanded into fire-prone areas, it works better to suppress fires aggressively and to create firebreaks around structures. And in oak woodlands, grazing to reduce fire-prone vegetation and creating firebreaks can help make fires easier to manage.
- **In addition to declining forest health, headwaters have other issues.**
In some places, historic mining has affected water quality, particularly with acid mine drainage and mercury. Past intensive timber harvesting has impaired streams and wetlands across the state. Overgrazing has damaged many meadows and their streams. Hydropower and water supply dams block fish migration and change the timing, magnitude, and temperature of flows needed to support native fish.

Looking ahead

To sustain its major headwater areas and reduce the risk of extreme fire, California needs targeted management actions and long-term funding solutions.

Increase active management of unhealthy forests. Reducing fuel accumulation and thus the risk and severity of wildfire requires more frequent prescribed and managed wildfires in headwater forests. Some areas will also need tree removal through mechanical thinning. Implementing these strategies will require both easier federal and state permitting and community acceptance. A new law will help by streamlining permitting for forest health projects on private and federal lands and providing several years of dedicated funding to manage forests. Project-level collaborations between federal and state agencies, local governments, communities, and the forest products sector will be essential to confront the massive scale of the state's forest health crisis.

Use creative funding partnerships to expand forest management. Funding to improve forest health is needed not just for new management projects but also for long-term maintenance. Mobilizing those who benefit from healthy headwater forests may be an effective way to expand long-term stewardship. Federal forest management policies allow external partners to provide financial and technical support to work on federal land. In spring 2018, Governor Brown directed state agencies to make more effective use of these policies.

Lower the barriers to family forest management. State forest, water, and air resource agencies have been directed to lower barriers to fuel management on family forests. Agencies can accomplish this by streamlining the permitting process and providing technical and financial support.

Develop a better understanding of forest management benefits and cost savings. Some large forest management projects are motivated by an interest in reducing future wildfire impacts on water supply and hydropower infrastructure. But to expand this approach, California needs better field-level information about how fuel reduction benefits water quality and runoff timing, along with carbon sequestration and air quality. Large-scale experimental programs are needed to measure and track these benefits over time.

Consider investments in forest products infrastructure. Decline in the state's forest products industry has greatly reduced infrastructure needed for forest management. To make it more economically viable, support for lumber mills and biofuel generation plants near forests may be warranted.

Reduce urban encroachment into wildland areas. California needs to discourage development in fire-prone landscapes, which increases the risks and potential costs of wildfire. One option is to create incentives for development in areas that can be defended effectively from fire.

Build social awareness of the risks of status quo management. Despite growing public awareness of the problems afflicting headwater forests and the resulting increased wildfire risk, resistance to large-scale fuel management remains an impediment to action. USFS and Cal Fire could help build awareness of proactive management's value by ramping up public education on these issues.

CONTACT A PPIC EXPERT

Jeffrey Mount
mount@ppic.org

Ellen Hanak
hanak@ppic.org

Henry McCann
mccann@ppic.org

Brian Gray
gray@ppic.org

CONTACT THE RESEARCH NETWORK

Van Butsic, vanbutsic@berkeley.edu

Ted Grantham, tgrantham@berkeley.edu

Yufang Jin, yujin@ucdavis.edu

Scott Stephens, sstephens@berkeley.edu

Joshua Viers, jviers@ucmerced.edu

READ MORE

- CLIMATE CHANGE AND WATER
- THE COLORADO RIVER
- ENERGY AND WATER
- MANAGING DROUGHTS
- PAYING FOR WATER
- PREPARING FOR FLOODS
- PROTECTING HEADWATERS
- PROVIDING SAFE DRINKING WATER
- THE SACRAMENTO–SAN JOAQUIN DELTA
- STORING WATER
- WATER FOR CITIES
- WATER FOR THE ENVIRONMENT
- WATER FOR FARMS

This series is supported by the annual sponsors of the PPIC Water Policy Center.

The PPIC Water Policy Center spurs innovative water management solutions that support a healthy economy, environment, and society—now and for future generations.

The Public Policy Institute of California is dedicated to informing and improving public policy in California through independent, objective, nonpartisan research. We are a public charity. We do not take or support positions on any ballot measure or on any local, state, or federal legislation, nor do we endorse, support, or oppose any political parties or candidates for public office. Research publications reflect the views of the authors and do not necessarily reflect the views of our funders or of the staff, officers, advisory councils, or board of directors of the Public Policy Institute of California.

Public Policy Institute of California
500 Washington Street, Suite 600
San Francisco, CA 94111
T 415.291.4400 F 415.291.4401
PPIC.ORG/WATER

PPIC Sacramento Center
Senator Office Building
1121 L Street, Suite 801
Sacramento, CA 95814
T 916.440.1120 F 916.440.1121



PPIC

PUBLIC POLICY
INSTITUTE OF CALIFORNIA