IMPROVING THE RESILIENCY OF CALIFORNIA'S HEADWATERS

— A FRAMEWORK —

Association of California Water Agencies
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Association of California Water Agencies

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ACWA's mission is to assist its members in promoting the development, management and reasonable beneficial use of good quality water at the lowest practical cost in an environmentally balanced manner.

Front cover photo: *The Sierra Nevada is the source of about 60% of the state's developed water supply. More effective management of headwaters areas in the Sierra and other mountain ranges could provide multiple benefits to the state's water management system and the environment.*

Back cover photo: *Meadows such as Cookhouse Meadow in the Lake Tahoe basin provide essential wildlife habitat, improve downstream water quality, act as critical firebreaks and even sequester carbon.*

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Overview

Left: The 2013 Rim Fire burned more than 402 square miles and destroyed habitat and structures, including a house on Packard Canyon Road near Yosemite National Park. Photo credit: Al Golub, Golub Photography

Right: The King Fire can be seen advancing out of a canyon toward the South Fork of the American River and Pollock Pines on Sept. 14, 2014. Photo credit: Wes Schultz, CAL FIRE

Severe drought and one of the most destructive wildfire seasons on record have focused renewed attention on the health of California's headwaters. That attention is well placed because the forests, meadows and source waters that play a critical role in our water supply and water management system are threatened by factors ranging from climate change to incomplete management to a lack of planning and coordination.

The numbers from the 2014 fire season alone are sobering. More than 400,000 acres of state and federal lands burned, destroying homes, devastating watersheds, displacing residents and costing the state and federal government hundreds of millions of dollars. In 2013, the massive Rim Fire threatened San Francisco's main water supply source and shattered records for the largest wildfire ever in the Sierra Nevada. Statistics suggest that wildfires are growing in size and intensity, and are becoming harder to extinguish. As drought conditions stretch into a fourth year, there is little reason to expect this pattern to improve.

With many of the state's headwaters increasingly at risk of wildfires and other threats, action is needed to help safeguard California's future water supply reliability and water quality. For all their importance as a source of high-quality water for communities, farms, natural systems and the economy, headwaters areas are subject to management policies and practices that are cumbersome and increasingly ineffective – particularly as they relate to water quality and supply. Some policies have become disconnected from the resources they are designed to protect, jeopardizing the long-term sustainability not only of the forests, but also of the entire water management system.

In 2013, ACWA's Board of Directors adopted *Policy Principles for the Improved Management of California's Headwaters,* reflecting the pressing need for action to address this intensifying and important resource management issue. This Framework takes those principles a step further, outlining the benefits of healthy headwaters, identifying challenges to success, and offering a number of recommendations for improving the resiliency of California's headwaters, including:

- The state of California should establish improved headwaters management as a high priority within its state planning and natural resources management functions.
- Policymakers should prioritize funding for proactive headwaters improvements and substantially increase restoration efforts, as opposed to the current reactive mode that involves "chasing fires."
- The Board of Forestry within the California Department of Forestry and Fire Protection (CAL FIRE) should be realigned to better reflect this priority, including requiring two members of the board to have water resource management expertise and establishing a permanent Headwaters Advisory Committee.

- Local and regional land use planners should engage with water resource managers and incorporate headwaters management strategies into their planning activities.
- Federal and state agencies should regularly review and update forest management regulations to optimize the multiple benefits of tools such as forest thinning, vegetation management, and controlled burns that reduce fuel loading and, consequently, the damage resulting from large wildfires and secondary impacts to California's water resources.
- Stakeholders at all levels of government should invest and participate in landscape-level research that explores water and forestry relationships, including the benefits of fuels management on water supply reliability, water quality and other ecosystem benefits.
- The state should pursue actions that promote biomass management, an important component of forestry management, as a potential source of revenue for headwaters protection while ensuring other renewable energy sources remain economically viable.

Effective action in these areas and pursuit of this Framework's other recommendations will require the commitment of landowners (particularly the U.S. Forest Service and National Parks Service), state and local governments, private timber owners, local water agencies, nongovernmental organizations, and the business community. Given the severity of recent wildfires, ongoing changes in our climate, the current drought and other factors, it is imperative to focus attention upstream and make decisions that will improve conditions in California's headwaters now and into the future.

Estimates vary, but according to the California Water Plan 2013 Update, there are about 30 million acres of forestland in California. Roughly 60% of that is publicly owned and managed, primarily by federal agencies (including the Forest Service, the U.S. Department of Interior Bureau of Land Management and National Park Service) with a small percentage owned by state and local agencies (including CAL FIRE, local open space, park and water districts and land trusts). About 40% of California's forestland is privately owned by families, Native American tribes, or private companies.

The Role of Headwaters in California Water Management

California's headwaters serve a critical role in a resilient water management system. The forests, meadows and river sources are the state's natural infrastructure, working in tandem with engineered elements as an integrated system to provide reliable and high-quality water supplies for water users and the environment. The Sierra snowpack, as the state's largest "reservoir," is critical to that system. When the snowpack is low or massive wildfires rage in the forests, it can affect the quantity and quality of water resources for many areas of the state.

Though the Sierra Nevada is the source of about 60% of the state's developed water supply, there are important headwaters in all of the state's mountain ranges. These areas are diverse in geographic characteristics, socioeconomic conditions, beneficial uses of water, land use, landowner goals and objectives, and local expectations. Given these differences, there is no "one-size-fits-all" approach when it comes to developing effective management strategies. For example, a strategy that is effective for the forested headwaters on the North Coast may not work in the Sierra Nevada, while the upper watersheds of the South Coast may require a different approach altogether to serve local conditions and priorities.

What are the Benefits of Healthy Headwaters?

With more effective management, "healthy headwaters" could provide multiple benefits to the state's water management system and the environment, including:

Increased Water Supply Reliability

Research is ongoing, but some early results indicate that proactive forest management can contribute to improved water supply reliability, including potential generation of additional

WHAT'S WORKING

Santa Ana Watershed Protection Authority Forest First Program

As home to the headwaters of the Santa Ana River, the San Bernardino and Cleveland national forests encompass approximately 33% of the Santa Ana watershed's land mass. These forest areas also receive 90% of the watershed's annual precipitation. The Forest First program is envisioned as a collaborative venture between the Forest Service and downstream stakeholders focused on ensuring the national forests within the Santa Ana watershed are kept as healthy as possible and continue to provide high-quality water to the valleys below. The effort underscores the forests' vital significance to the overall health and continued sustainability of water resources within the watershed. The Santa Ana Watershed Project Authority and the Forest Service have entered into a Memorandum of Understanding that is the first step to integrating forest management practices with interests of downstream water users. (www.sawpa.org/collaboration/projects/forest-first/)

water supplies. Preliminary studies focused primarily on water supply benefits suggest that with sufficient landscape-scale efforts, Sierra forests could produce substantially more water each year (Bales, 2011). At Northern Arizona University, the Ecological Restoration Institute's work in the Beaver Creek Experimental Watershed found that a robust thinning project with regular maintenance (including restoring a natural fire regime) could offer a potentially cost-effective way to provide additional water.

These water supply benefits extend to groundwater resources as well. The Forest Service has estimated that proper meadow restoration could increase groundwater storage by 50,000 to 500,000 acre-feet per year just within national forest lands in the Sierra bioregion (DWR, 2009).[1]

Improved Water Quality

Improved headwaters management, particularly fuels management measures, also could improve water quality, reducing the potential for contamination and the level of subsequent water treatment in some downstream portions of the watershed.

Proactive efforts could reduce soil erosion, a widespread and significant issue that affects headwaters landscapes, storage capacity and water quality downstream. Projects to improve road location, construction and associated drainage facilities could reduce many of the impacts of erosion. Additionally, activities to lessen wildfire risks could help limit sediment load, since bare soil produces significantly more sediment per acre than soil with vegetative cover.

Water quality also would be improved through programs to mitigate the effects of illegal diversions and other activities in forested lands that contaminate water sources with rodenticides, fungicides, herbicides, insecticides, soil amendments, fertilizers and legacy pollutants.

Reduced Impacts from Catastrophic Wildfires

Effective fuels management measures such as mechanical forest thinning, prescribed/controlled burns, and chipping could reduce the risk and magnitude of wildfires such as the 2013 Rim Fire, which burned more than

1 California Department of Water Resources. California Water Plan Update 2009 Volume 2. Resource Management Strategies.

Left: Many public forestlands have become dangerously overgrown and are in need of thinning, though many thinning projects are blocked by delays and litigation.

Right: Managing forests can reduce the threat of high-intensity wildfire and protect biodiversity.

Photo credit: California Forestry Association, California Forests, Winter 2009, Volume 13, Number 1.

WHAT'S WORKING

San Diego IRWMP- Reservoir Source Protection and Restoration

San Vicente Dam, owned by the City of San Diego, was raised by the San Diego County Water Authority as part of its Emergency Storage Project. The dam raise doubled the capacity of San Vicente Reservoir, the keystone facility of the San Diego region's water supply infrastructure. To ensure an adequate source water protection buffer is in place to protect water quality, the city, SDCWA, California Department of Fish and Wildlife, U.S. Fish and Wildlife Service, San Diego Gas and Electric, and other partners have collaborated to advance San Vicente Reservoir source water protection through the Watershed Property Acquisition and Restoration Project, which acquires into preserve status lands surrounding the reservoir and along San Vicente Creek, the major tributary stream. These collaborative efforts prevent further water quality degradation that might come from development, agricultural uses, or other general disturbance of the watershed lands. The acquisitions also will help prevent future development of several parcels, enhancing watershed function and reducing potential sources of contamination. (www.sdirwmp.org/2013-irwm-plan-update)

257,000 acres and took two months to contain. These measures also could produce numerous ecological, economic and public health benefits.

First and foremost, activities such as forest thinning could provide water supply reliability and water quality benefits. Water quality improvements could include less ash and sediment load downstream and enhanced aquatic habitat for native fish species. Potential water supply benefits could be considerable; further studies are in progress to determine the ideal density and distribution of trees to maximize fire prevention efforts while also improving snowpack retention and runoff.

Other benefits of active fuels management include, but are not limited to, improved wildlife and aquatic habitat, increased availability of forest products, improved forest rangeland grazing conditions, expanded recreational opportunities, reduced fire risk and damage to homes and infrastructure, and job opportunities in local economies.

Increased Renewable Energy Supplies

One increasingly important benefit of headwaters management is the potential development of renewable energy through biomass activities.

Biomass materials being processed at California Redwood Company's Korbel Mill. Photo credit: California Redwood Company.

Woody biomass is a renewable, low-carbon fuel that can substitute for fossil fuels in the production of energy and other products — a potentially important tool for reducing greenhouse gas emissions and mitigating the impacts of global climate change. When developed, markets for logging residues, small diameter trees, and other secondary forest products could add economic value to working forests, create local jobs, help offset the costs of forest management, and create incentives for investing in sustainable forest management. Forest thinning and removal of small-diameter, low-market value trees are integral parts of forest management for a number of benefits — snowpack retention and runoff, biodiversity conservation, ecological restoration, wildfire prevention, and timber stand improvement.

Biomass development also could help achieve the goals in California's Renewables Portfolio Standard, which requires utilities to increase renewable electricity to 33% by 2020.

Improved Response to Climate Change

While California's headwaters are expected to be impacted significantly by climate change, improved management of these areas could help mitigate these effects, produce multiple ecological benefits, and improve local and statewide water supply reliability.

Top: Mule deer, indigenous to western North America, would benefit substantially from landscape-scale conservation efforts. Photo credit: Constantine Kulikovsky

Bottom: Fisher populations have dwindled as large blocks of forest have been destroyed by logging, development and wildfires. Photo credit: Sierra Nevada Adaptive Management Project.

Because climate scientists predict substantial increases in wildfire frequency and acreage burned, adaptation strategies such as restoration, thinning and biomass development could make forests more resilient to these climate-related disturbances. These management strategies could then increase the percolation and natural water storage capacity of these areas.

Healthy forests also improve long-term sequestration of carbon and thereby help to reduce the amount of carbon dioxide in the atmosphere, the primary contributor to climate change. United States forests currently sequester about 10% of U.S. carbon emissions[2], and one acre of trees can offset the carbon footprints of 18 average Americans, according to the California Forestry Association.

Enhanced Habitat

Maintaining and improving various types of forests could help ensure appropriate habitat for the different aquatic and terrestrial wildlife species dependent upon California's headwaters areas.

While fire-damaged forests can provide habitat for certain species, fuels management can help mitigate or prevent catastrophic wildfires such as the Rim Fire, which killed countless animals and destroyed thousands of acres of wildlife habitat. In addition, because plants and animals often are the most susceptible to subtle changes in their environment, they likely would benefit greatly from forest management measures that improve water quality or water supply reliability.

2 Woodbury, P.B.; Smith, J.E.; Heath, L.S. 2007. Carbon sequestration in the U.S. forest sector from 1990 to 2010. Forest Ecology and Management. 241: 14–27.

Evolution of Headwaters Management in California

In 1864, the California State Legislature accepted the Yosemite and Mariposa Grove land grant from the federal government with the understanding that the areas were to be managed for the benefit of present and future generations. While Yosemite began as a state park, it was the first time the federal government had set aside park land specifically for preservation. This action set a precedent for the establishment of Yellowstone in 1872 as the first official national park. Eighteen years later Yosemite would become the second national park.

It was also during this period that both state and federal oversight of California's forests truly began to take shape. The Forest Service and predecessor agencies to the CAL FIRE emerged as the primary management agencies for California's headwaters along with the Bureau of Land Management (BLM). Preservation efforts were led by the National Park Service and the California Department of Parks and Recreation.

United States Forest Service

The U.S. Forest Service, an agency within the U.S. Department of Agriculture, has existed for more than 100 years with the express purpose of managing public forests and grasslands. The national forests (first called forest reserves) began with the Forest Reserve Act of 1891, which allowed the president to establish forest reserves from timber-covered public domain land. Several early leaders and visionaries, along with willing presidents (especially President Theodore Roosevelt), scientific and conservation organizations, and newly trained forestry professionals, led the successful effort in preserving millions of acres of federal forest land for future generations.

The United States currently has a system of 155 national forests, 20 national grasslands, and 222 research and experimental forests, as well as other special areas, covering more than 192 million acres of public land. The Forest Service has evolved into a 30,000-employee agency that manages the national forests for a number of multiple uses, including recreation, timber, wilderness, minerals, water, grazing, fish, and wildlife.

The Forest Service is divided into nine regions and five research stations. California is in Region 5, or the Pacific Southwest Region.

Left: Hetch Hetchy Valley, as viewed from the southwest in the early 1900s. The Tuolumne River is seen flowing through the lower portion of the valley prior to damming.

Center: President Teddy Roosevelt and John Muir at Glacier Point, Yosemite, May 1903; Yosemite Falls and the cliffs of Yosemite Valley in the distance.

Right: Yosemite Falls and surrounding cliffs, with the Merced River and meadows in the foreground.

Photo credit: Images courtesy of Yosemite National Park Archives Museum and Library – RL015688, RL012904, RL000361.

Early Policy Direction on Forests

The **Organic Act of 1897** established the first national policy direction for national forest use and management. It gave the president of the United States the power to establish national forests on public domain lands "*to improve and protect the forest within the boundaries, or for the purpose of securing favorable conditions of waterflows, and to furnish a continuous supply of timber for the use and necessities of citizens of the United States*." This clause later became the basis of the general national forest policy for sustained-yield management of forest products and services.

The Weeks Law of 1911, the Wilderness Act of 1964, the Multiple-Use Sustained-Yield Act of 1960, the Forest and Rangeland Renewable Resources Act of 1974 and the National Forest Management Act of 1976 provided additional direction for headwaters preservation, fire control and management of multiple uses on national forests.

"In all the great arid regions of the Rockies and the eastern Pacific slopes one of the most vital reasons for making and maintaining the National Forests is to save every drop of water and to make it do the most effective work." *— Gifford Pinchot, first Chief of the U.S. Forest Service*

Pacific Southwest Region

After years of overuse and degradation of western lands, President Grover Cleveland proclaimed 13 new forest reserves in 1897, known as the "Washington's Birthday Reserves." Two of these reserves were located in California: the San Jacinto and Stanislaus. In 1907, all 13 reserves were formally designated by Congress as "National Forests." In accordance with the "Use of the National Forests" initiative championed by Gifford Pinchot, the first chief of the Forest Service, wood, water, forage and recreation were to be used, pursued, and managed for the benefit of present and future generations.

The Pacific Southwest Region of the Forest Service now manages 18 national forests and 20 million acres of land in California and assists state and private forest landowners in California, Hawaii and the U.S. Affiliated Pacific Islands. National forests are located throughout California in the North Coast, Cascade, and Sierra Nevada ranges and in the South Coast range from Big Sur to the Mexican border. These national forests are the source, or headwaters, for 50% of the total surface water runoff in California (over 35 million acre-feet) and comprise the watersheds that supply water to most major surface water projects and more than 2,400 reservoirs in the state. In addition, they are home to more than 75% of the state's fish and wildlife species and nearly 4,000 of the 6,500 native plants, making the Forest Service California's single largest habitat manager.

California Department of Forestry and Fire Protection

While the federal government established a forest management structure by creating the Forest Service and passing several pieces of landmark legislation, large areas of privately-owned timber and watershed lands beyond the National Forests and Parks areas are subject to state authority.

The California State Legislature established the Board of Forestry in 1885 to improve wildland fire protection, which was one of the first state-appointed forestry boards in the nation. After it was dissolved less than a decade later, the Legislature reestablished it in 1905 and created the new position of State Forester. The Division of Forestry was then created in 1927, which evolved into CAL FIRE, a department within California's Natural Resources Agency dedicated to the fire protection and stewardship of over 31 million acres of California's privately-owned wildlands. CAL FIRE is an emergency response and resource protection department, protecting lives, property and natural resources from fire; responding to emergencies of all types, and protecting and preserving timberlands, wildlands, and urban forests.

CAL FIRE is responsible for protecting natural resources from fire on land designated by the State Board of Forestry as State Responsibility Area (SRA), managing the state forest system (including eight demonstration state forests totaling 71,000 acres) and providing varied emergency services in 36 of the state's 58 counties via contracts with local governments.

CAL FIRE also is responsible for enforcing the Forest Practice Act, first enacted in 1945 and revised in 1973. The act created a comprehensive process in which CAL FIRE oversees enforcement of California's forest practice regulations including timber harvest plans (THP), which must be prepared by registered professional foresters for all commercial operations.

Today's Landscape: Overgrown & Underfunded

Left: The King Fire engulfs a canyon northeast of the south fork of the American River near Fresh Pond along Highway 50 on Sept. 17, 2014. Photo credit: Wes Schultz, CAL FIRE

Right: The area near Forebay Road, north of Pollock Pines, experienced high soil burn severity and a high degree of tree loss following the King Fire. Photo credit: SMUD

A number of factors have led to deteriorating conditions in many headwaters landscapes that are negatively affecting water resources. The recommended actions contained in this Framework are intended to address the factors listed below:

Catastrophic Wildfires

One of the most immediate threats to the health and sustainability of many of California's headwaters — and, subsequently, to water supply sources — is catastrophic wildfires. While fire is an inevitable and essential part of healthy forests, fire suppression practices, inadequate forest management funding and activities, climate change and increasing populations in the wildland-urban interface have led to exceptionally dense forests and a significantly higher risk of wildfires. In fact, in the Sierra Nevada, the amount of land burned between 2010 and 2014 has already surpassed the total amount of land burned in seven previous decades, according to the Sierra Nevada Conservancy. And by some estimates, the average size of fires has increased by a factor of five since the 1970s.

The effects of these fires on the state's water resources are significant. Such fires can and have significantly damaged or completely destroyed entire forest stands within headwaters areas, reducing or eliminating the forest canopy and increasing the amount of snowpack that is exposed to direct sunlight. Subsequent increases in snowmelt and evaporation adversely affect both the local ecosystem and downstream water users. There is less water overall because of the evaporation, and the accelerated snowmelt that remains moves faster through the distribution system, reducing the amount of water that can be used for groundwater recharge or captured and retained by reservoirs for future distribution. In addition, absent necessary management activities, re-growth after such wildfires can produce thick stands of bush and small trees in excessive numbers that consume large volumes of water.

Catastrophic wildfires also can damage soils to the point that they become "hydrophobic," which means water cannot permeate the topsoil. This condition affects groundwater recharge and can limit or alter the vegetative recovery because it is more difficult to establish new trees and vegetation in the burned-over area. In addition, the absence of ground cover, combined with a lack of permeability, increases runoff, which causes erosion and sediment discharge that can adversely affect water quality downstream.

These water quality effects can continue to affect a community long after the fire has been

Lasting Effects: A Tale of Two Wildfires

Crisis in the Sierra Nevada

The Rim Fire of 2013 was the largest wildfire on record in the Sierra Nevada and the third-largest in California's history. The fire, which began in a remote canyon in the Stanislaus National Forest, burned more than 257,000 acres (402 square miles) and charred more than 20% of the Tuolumne River watershed, the largest tributary to the San Joaquin River. Countless animals were killed, and habitat for numerous species was destroyed.

Gov. Jerry Brown declared a state of emergency for the City of San Francisco after the fire damaged power infrastructure serving the Bay Area, including causing the shut-down of two out of three hydroelectric power plants, and threatened Hetch Hetchy Reservoir, the main source of water for San Francisco and major portions of the Bay Area.

While the Rim Fire garnered attention due to its size and intensity, the blaze and its aftermath are providing important lessons for future management decisions. The Tuolumne watershed's history of wildfires suggests a pattern of increasingly large and intense blazes coupled with inadequate management activities and funding to support necessary fuel thinning and restoration efforts.

The Old Fire crossing Highway 18. Photo credit: Troy C. Whitman.

Firestorm in the Southland

The Old Fire of 2003, which started in the San Bernardino Mountains, was one of 15 wildfires throughout Southern California that year. This series of fires became known as the "2003 Firestorm" and the "Fire Siege of 2003" and included the Cedar Fire, the second-largest fire in California's history after the Santiago Canyon Fire of 1889.

Fanned by Santa Ana winds, the Old Fire burned 91,281 acres, destroyed 993 homes and caused six deaths. When combined with the neighboring Padua and the Grand Prix fires, a total of more than 750,000 acres was blackened across five Southern California counties. Because cleanup, watershed damages and other expenditures are not included when tallying firefighting and property damage costs, wildfire impacts and expenses are generally much higher than initially reported. A Forest Service report estimated the actual costs of these fires at nearly $1.3 billion.

WHAT'S WORKING

American River Canyon Shaded Fuelbreak

Decades of fire suppression and conflicts over forest management have resulted in dense and unhealthy forested slopes in the American River Canyon and the City of Auburn, located in the western foothills of the Sierra Nevada. This condition has led to an increased risk of large, damaging wildfires, threatening water supply reliability, water quality and reduced water storage capacity as a result of post-fire sediment that can ultimately reach Folsom reservoir.

In 2012, the Sierra Nevada Conservancy awarded a $146,690 grant to the City of Auburn Fire Department to help create part of an 11 mile-long shaded fuelbreak that will act as a buffer between the city and canyon and protect water quality. The project will complement and leverage work done by other agencies and community volunteers. (www.sierranevada.ca.gov/other-assistance/sncgrants/docs/788.pdf)

extinguished. The 2002 Hayman Fire in Colorado burned 138,000 acres, destroyed more than 600 structures, and deposited more than 1 million cubic yards of sediment into Strontia Springs Reservoir, a primary drinking water source for the City of Denver. Clean up costs continue to grow and have already exceeded $150 million.

Other water-related impacts include increased flood risk, destruction of fish and wildlife habitat, lost recreational opportunities and long-term impacts to water infrastructure, water quality and water supply reliability.

On Borrowed Time

The Forest Service allocates hundreds of millions of dollars to fire suppression and firefighting costs every year. In fact, while the Forest Service budget has remained relatively stable over the past 20 years, the amount spent on fire suppression has jumped from 12% in 1991 to 47% in 2012.

Currently, the Forest Service and the Department of the Interior pay for these costs out of their annual discretionary budgets. When there are severe or frequent fires, the initial budget often runs out and the Forest Service "borrows" from other programs such as resource protection and forest restoration. In just the last two years, more than $1 billion was "borrowed" from other Forest Service programs to cover fire suppression shortfalls.

Because the percentage spent on wildfires has increased and even more is "borrowed," the reduced spending on other areas adversely affects proactive forest management efforts, delaying or preventing the completion of key resource protection programs and activities. In 2012, critical projects in 10 California national forests were not finished or were canceled, affecting wildlife protection, fuels management and other restoration activities. Even the road maintenance budget has seen a 40% decrease in overall budget allocation, reducing erosion control activities.

This funding formula has unfortunately, but predictably, led to a destructive cycle where the Forest Service is "chasing fires" rather than performing critical restoration work that could mitigate or even prevent catastrophic wildfires in the first place. Currently the Forest Service can treat on average 150,000-200,000 acres per year, but to improve and maintain the 20 million acres in the Pacific Southwest Region, the pace of restoration needs to increase to at least 500,000 acres per year.

Climate Change Impacts

Perhaps the most daunting factor likely to affect the reliability and quality of California's water resources, including its headwaters, is climate change. In the 2009 Update to the California Water Plan, the Department of Water Resources (DWR) concluded that "[c]limate change is already having a profound effect on California's water resources as evidenced by changes in snowpack, river flows, and sea levels. Scientific studies show that these changes will increase stress on water systems in the future."

Current models suggest that in the future more winter precipitation is expected to fall as rain rather than snow and the precipitation season overall likely will become shorter. There likely also will be more intense rainfall events,

WHAT'S WORKING

Coca-Cola Stream Restoration Grant

In September 2012, Coca-Cola joined the National Fish and Wildlife Foundation in granting nearly $377,000 ($196,000 from Coca-Cola) to the Forest Service to restore water to Indian Valley, a 500-acre meadow that sits atop the Sierra Divide and is in the headwaters of the Mokelumne River watershed. The watershed is a key source of water for the East Bay Municipal Utility District and Coca-Cola's San Leandro production facility.

The project demonstrates a unique financing approach to improve water supply and water quality on federal lands and is designed to restore a stream so it can access the floodplain and spread out. This reduces the energy of the water flow and rewaters the nearby meadow. The seasonal water table is expected to stay higher for longer into the dry season, encouraging the growth of riparian vegetation and providing cooler water for fish and wildlife. (www.fs.usda.gov/detailfull/r5/workingtogether/?cid=stelprdb5390138&width=full)

WHAT'S WORKING

Ash Creek Wildlife Area Restoration Project

Ash Creek Wildlife Area is located in rural Modoc and Lassen Counties and is one of the finest examples of meadow habitat in the Sierra Nevada. Ash Creek and its wetlands and floodplain feed the Pit River, a major water contributor to Shasta Lake and an integral part of the federal Central Valley Project. Over the years, stream channels throughout the area were modified to adapt the land for agriculture, eroding into deep channels that affect water quality in the Pit River and significantly lower the natural water table and water levels in nearby waterways.

The Pit Resource Conservation District leveraged more than $3.5 million in funds from a variety of sources to restore the streams, leading to critical improvements in water quality and wildlife habitat as well as increased water quantity to the Pit River system. In total, the project restored 3.5 miles of Ash Creek and 2,400 acres of associated wetlands and floodplain while maintaining historic agricultural uses in the area. (www.dfg.ca.gov/lands/wa/region1/ashcreek.html)

creating runoff and stream flow patterns that cannot be effectively managed by current water infrastructure. Because the snowpack is California's largest "reservoir," the potential exists for significant water supply losses should snow levels and water retention continue to decline in future decades.

Climate change likely also will result in substantial increases in air temperature for most if not all of California, with some models showing end-of-century warming of approximately 2.7 to 10.8 degrees above the 1961-1990 mean for summer months statewide (Franco *et al.* 2011). Studies over the past decade consistently indicate warming in the Sierra Nevada is expected to result in the highest relative departure from California's overall baseline (Hayhoe *et al.* 2004)[3], with the average temperature predicted to increase by 2 to 4 degrees in the winter and 4 to 8 degrees in the summer.[4] According to DWR, a 5 degree temperature increase would result in 4-5 million acre-foot losses in snowpack storage.

Further effects likely will include increased downstream flooding, fewer opportunities for extended water storage and hydropower generation, increased number of wildfires, and reduced water for groundwater recharge and meadows. While the severity and specific location of many impacts remain uncertain, adaptive research and management activities will be essential to improving management of California's headwaters.

Vegetation Management

Human activities such as long-term fire suppression and early timber harvesting methods have significantly altered the vegetative structure of California's headwaters areas. This also affects the size, types and density of the trees,[5] affecting the annual snowpack and increasing susceptibility to insect and disease epidemics that contribute to tree mortality and excessive fuels buildup in the headwaters.

Similar to when fires destroy entire forest stands and expose snowpack to direct sunlight, research has shown[6] that significant *increases* in forest stand density also adversely affect snowpack and runoff because it not only restricts snowfall from reaching the ground, it causes increased evaporation and transpiration of water back into the atmosphere because the snow remains in the trees. Controlled burning to reduce this fuel buildup is not a viable option in many dense forests because there are not opportunities to sell or transport the biomass material that would first have to be mechanically removed, making fuel reduction projects cost prohibitive.

3 Joshua H. Viers, Sabra E. Purdy, Ryan A. Peek, Anna Fryjoff-Hung, Nicholas R. Santos, Jacob V.E. Katz, Jason D. Emmons, Danielle V. Dolan and Sarah M. Yarnell, January 2013. Montane Meadows in the Sierra Nevada, Changing Hydrologic Conditions, Concepts and Vulnerability Assessment. Center for Watershed Sciences, UC Davis

4 H.D. Safford, M. North, and M.D. Meyer, March 2012, USDA, Forest Service, PSW Research Station, GTR-237, Chapter 3.

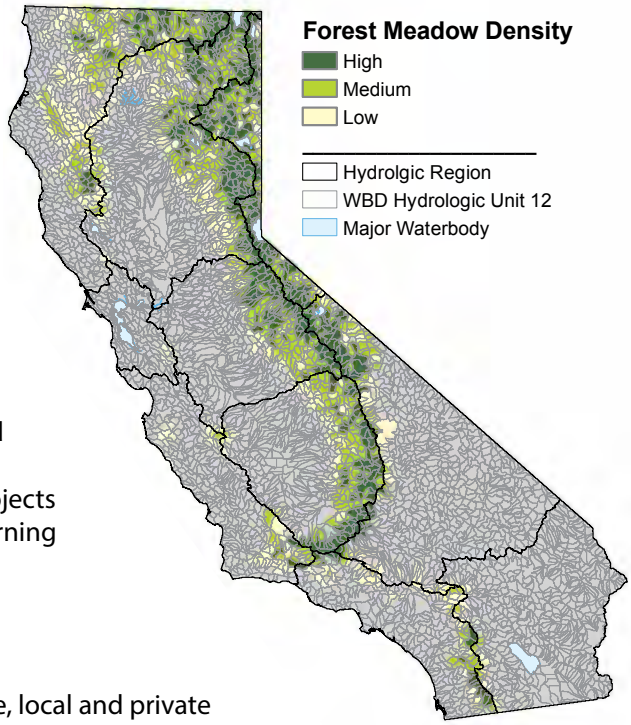
5 H.D. Safford, M. North and M.D. Meyer, March 2012, USDA, Forest Service, PSW Research Station, GTR-237, Chapter 3.

6 Roger C. Bales, John J. Battles, Yihsu Chen, Martha H. Conklin, Eric Holst, Kevin L. O'Hara, Philip Saksa and William Stewart, November 2011. Forests and Water in the Sierra Nevada: Sierra Nevada Watershed Ecosystem Enhancement Project. Sierra Nevada Research Institute, Center for Forestry UC Berkeley and Environmetal Defense Fund

Meadow Habitat

By some estimates, California has more than 10,000 meadows totaling about 300,000 acres, mostly located in the Sierra Nevada and Cascade mountains. These fragile ecosystems provide essential wildlife habitat, filter water and improve water quality, act as critical firebreaks and even sequester carbon. However, about 40% to 60% of Sierra Nevada meadows are considered degraded: damaged by early logging actions, road and railroad-logging construction, excessive grazing practices, rodent activity, excavation and intense recreational use.

The damage to the state's meadows and adjacent forests has been significant, impairing the water storage and filtration capabilities and affecting the hydrologically connected forests that depend upon the meadows' water resources. While innovative meadow restoration projects are under way, science is still emerging on the best methods for returning these areas to their natural state.



Watershed ranking of the density of forest meadows. Data Sources: Sierra Nevada Montane Meadows, USFS R5 (2000); Statewide Land Use / Land Cover Mosaic, FRAP (2006); Watershed Boundaries Database for California, NRCS (2009)

Regulatory Alignment

California's headwaters are managed by a diverse mix of federal, state, local and private entities. These land managers operate under different budgets, regulatory structures and sometimes conflicting legislative mandates, often making it difficult to align objectives. For example, the Forest Service recently proposed Directives for National Best Management Practices for Water Quality Protection on National Forest System Lands (National BMPs). These National BMPs would revise Forest Service directives and establish a new national system for meeting mandates under the Clean Water Act on Forest Service lands. While the Forest Service indicates that the program is intended to support and assist the states and tribes in their efforts to ensure compliance on national forests and grasslands, there is concern that these proposed BMPs would be duplicative of some state programs, interfere with existing state authority, and possibly lead to project or program delays. In addition, the Forest Service has released a Proposed Directive on Groundwater Resource Management that was developed to provide direction on groundwater activities, approvals, and authorizations on its lands, but there are similar concerns to those raised in response to the proposed BMPs as well as a foundational criticism that the proposal may exceed the Forest Service's authority and illegally encroach into states' groundwater management rights.

WHAT'S WORKING

Sierra Pacific Industries Conservation Easements

In April 2012, Sierra Pacific Industries (SPI), The Trust for Public Land and the Truckee Donner Land Trust entered into conservation easements that will protect private timberland from being subdivided for development of homes. SPI will continue logging the land near Jackson Meadows Reservoir north of Truckee.

Located in the headwaters of three major rivers — Middle Yuba, Little Truckee and Feather — that are a critical part of California's water supply system, nearly 1,200 acres are now protected through the first-ever conservation easement acquired from the timber company. The easements mean permanent protection for the land, which includes streams, meadows and a variety of plants and wildlife. The easements were purchased with money from the California Wildlife Conservation Board, the Sierra Nevada Conservancy, and the Northern Sierra Partnership. The California money came from bonds approved by voters in 2006 as part of Proposition 84. (www.spi-ind.com/spi_news_documents/TPLSPIPressRelease04_03_12.pdf)

WHAT'S WORKING

Upper Mokelumne River Watershed Authority

The Upper Mokelumne River Watershed Authority (UMRWA) is a joint powers authority composed of six water agencies and the counties of Amador, Calaveras and Alpine.

Since its inception in 2000, UMRWA has been engaged in a wide variety of water resource matters. Key accomplishments have included completion of the first comprehensive watershed assessment in the Mokelumne, adoption of Integrated Regional Water Management Plans in 2006 and 2013, sponsoring a watershed education program in local schools, and serving as lead agency for grant and non-grant funded water supply and water quality projects. (www.umrwa.org/index.html)

Forest pests such as bark beetles contribute to tree mortality in some headwaters areas. According to a 2013 report, beetle activity increased throughout Northern California due to drought in 2013 and resulted in large pockets of mortality among Douglas firs in Lassen, Plumas and Shasta counties.

Regulatory and other systematic hurdles also are preventing the construction of facilities that can produce energy from woody biomass, which could achieve multiple management objectives for state and federal agencies including increased snowpack retention and enhanced runoff. Further, state regulations designed to address other environmental attributes (e.g. air quality constraints on prescribed burning) can unintentionally limit the use or significantly increase the cost of fuel reduction efforts to the point of inhibiting progress on headwaters restoration projects.

The policies and practices affecting California's headwaters and related water resources can be inconsistent, duplicative or unnecessarily complicated. This lack of integration and coordination among regulatory agencies often results in conflicting regulations, significant delays, additional costs, and in some cases make an otherwise viable project economically infeasible.

Land Use/Urban Development

The costs for conserving and maintaining California's forests can be high. When those forests are privately-owned, a lack of state or federal financial support and increasing regulations prompt some owners to sell their land for development or other uses (Alig 2007). Because about 40% of California's forests are in the hands of private interests, this issue has significant implications for the water resources sourced from those headwaters landscapes.

When larger forested tracts are divided into multiple parcels owned by several owners, these smaller, more disconnected parcels can negatively affect water quality and aquatic species diversity, timber volume and management, native wildlife populations, forest structure and function, wildfire risk, and scenic quality and recreational opportunities (Sampson and Decoster 2000, Smail and Lewis 2009, Stein et al. 2005).

Road Management

Forest roads provide essential access for recreation, firefighting equipment and resource management activities including timber harvest. In California, the 18 national forests alone contain approximately 50,000 miles of forest roads and private forest lands contain many additional thousands of miles. The Forest Service estimates that 40% of the state's national forest roads under its jurisdiction are unnecessary or unstable. When these roads are improperly designed, constructed, or maintained, they can adversely affect hydrology and water quality, creating significant additional challenges for water and forest land managers.

For example, roads can convert subsurface water to surface water when a road cut dissects a spring. They also can alter the magnitude and timing of peak flows, and reduce soil infiltration. If not properly maintained, roads also increase the risk of landslides and debris flows, which can lead to increased erosion and associated sediment delivery to streams. These sediments often end up in California's drinking water supplies, negatively affecting filtration systems and the costs to operate those facilities.

Forest Pests

According to CAL FIRE, forest pests (invasive insects, plants and diseases) annually destroy 10 times the volume of timber lost due to forest fires. Fire

suppression in some of California's headwaters has led to large-scale tree mortality from bark beetles due to higher stand density and subsequent tree moisture stress (Fettig et al. 2008). Drought also can cause a condition in trees called "carbon starvation," which prevents carbon dioxide absorption needed for growth and reduces the ability of trees to ward off pest attacks.

Tree mortality and disease have many of the same effects on water resources as large-scale fires, including accelerated snowmelt and runoff, increased evaporation caused by a loss of canopy, and lack of water retention in soils as a result of erosion. Loss of water supply and reduced water quality can both result when diseased trees overcome a forest.

Forests pests move quickly, often through commercial sale of firewood that is moved across state and national borders. The goldspotted oak borer beetle, a new pest in Southern California that arrived on firewood from Arizona, has been aggressively attacking three oak species and is linked to significant oak mortality in San Diego County. While this pest currently is isolated to one county, it has the potential to kill native oak species throughout the state.

Illegal Activities

California's headwaters are adversely affected by a number of illegal activities that directly and indirectly affect water supply, water quality and the surrounding ecosystem. Marijuana grows, dumping, and illegal camping, hunting and ATV use are all examples of activities that can significantly damage resources in headwaters landscapes.

Several of California's recent major wildfires have been traced to arson and other unlawful human activity, including the Rim Fire and the King Fire.

Water supply and quality also are impacted by illegal diversions from streams or dumping large quantities of rodenticides, pesticides and insecticides into the waterways. Substances include a range of toxicants from legacy contaminants to over-the-counter products to the illegal pesticide carbofuran. Notably, National Oceanic and Atmospheric Administration (NOAA) National Marine Fisheries Service has identified increased water use and other actions by the marijuana industry as a threat to the recovery of Coho salmon in the Emerald Triangle of Northern California and Southern Oregon.

Education and Outreach

Many Californians, including policymakers, do not fully appreciate the critical role the state's headwaters play in a resilient water management system. This results in a relatively low level of attention on headwaters until a catastrophic wildlife or other large-scale emergency occurs and puts the issue on the radar.

Outreach and education must be integral components of a comprehensive headwaters management strategy. Without a more informed public and increased understanding by legislators, it will be difficult to make large-scale improvements and reverse the alarming trends outlined throughout this Framework.

Pilot Project Looks at Impacts of Active Marijuana Grows

A multi-agency partnership conducted a three-day inspection of active marijuana grow operations in the Eel River watershed in January 2015 as part of a pilot project aimed at minimizing harm to nearby waterways and wildlife.

The project, which involved staff from the State Water Resources Control Board's Division of Water Rights, the North Coast Regional Water Quality Control Board, biologists and wildlife officers from the California Department of Fish and Wildlife, and members of the Humboldt County Sheriff's Office, was intended to ensure compliance with environmental regulations and assess impacts on Sproul Creek, which is home to five endangered salmon species. The stream went dry in 2014 for the first time in many years, likely due to water diversions for marijuana cultivation combined with ongoing drought conditions. There also are concerns about potentially significant pollutants entering the watershed from sediments, pesticides, fertilizers and other contaminants that can degrade the environment and threaten plants and wildlife.

The effort is expected to include inspections in other at-risk watersheds with known growing operations in the coming months.

Investing in Landscape-Scale Research

Left: While stream buffer protection zones usually include only minimal active timber management, biomass thinning is regularly used within Collins Almanor Forest including in the surrounding areas of Butt Creek in Plumas County shown here. Photo credit: Collins Pine Company.

Right: Thinning projects such as the one shown here can help increase runoff in watershed areas. Photo credit: Pete Aleshire, Payson Round Up

While research continues to evolve regarding the effects of many of these factors and the benefits of improved headwaters management, many critical questions and hypotheses have yet to be fully assessed. This uncertainty prevents many projects from moving forward due to lack of investment or stakeholder support.

The most effective way to quantify these benefits is through landscape-scale research, a planning and coordination model that looks at headwaters across large areas, bridging land ownership and vegetation/forest types. While such research is most effective when it is collaborative, water utilities in particular should consider engaging and investing in these projects because they can contribute to improving long-term resiliency of the state's water resources both in headwaters and downstream areas.

The South Fork American River Cohesive Wildland Fire Management Strategy Project, encompassing approximately 250,000 acres in the Eldorado National Forest, is an example of this collaborative approach because it takes a holistic view of fire on the landscape and will require a joint effort by all of the partners, including community members, to be successful. The Eldorado National Forest is one of only two forests recently selected by Forest Service to serve as a demonstration area that will implement this strategy and received $625,000 for 2014 activities. This project is intended to characterize benefits from active fuels management by restoring and maintaining landscapes resilient to wildland fire, creating fire adapted communities, and improving responsiveness to wildfires.

Another landscape-level planning report providing important information is The Nature Conservancy's innovative assessment of the potential for increasing water supply availability in the Northern Sierra Nevada through mechanical thinning. Based on a hypothetical three-fold increase in the scale of thinning work on National Forests and past research on forest harvest and water yield, the report's initial analysis suggests that thinning could provide economic benefits by increasing water yield. The increased water yield from forest thinning could potentially cover from 6% to 34% of the thinning costs assuming a low response, and 18% to 101% of thinning costs assuming a high response. The majority of these benefits come from additional hydropower generation. The planning report highlights the need for research in the Sierra Nevada to clarify the relationship between forest thinning and water yield and to develop specific economic values for individual watersheds. The report also summarizes past studies showing that meadow restoration can affect the timing of water discharge, helping to offset some of the restoration costs. The Nature Conservancy's analysis suggests that

water supply and hydropower utilities may receive significant value by investing in forest and meadow restoration projects in watersheds upstream of their facilities.[7]

One additional element that should be considered in this type of research is the avoided costs due to proactive management, such as the savings to state and federal fire fighting and disaster funds that occur when fuel treatments reduce the severity or even prevent wildfires. The Mokelumne Watershed Avoided Cost Analysis conducted by the Sierra Nevada Conservancy and others provides an example of this type of research as it demonstrates that strategic fuel reduction treatments are a good investment and produce multiple benefits to landowners, residents and watershed interests and beneficiaries.

Landscape-scale projects that accurately quantify the water supply, quality or other benefits of forest vegetation changes will help facilitate financing of headwaters restoration and maintenance strategies, especially by downstream water users who can then point to a direct nexus between their investment and a water supply or water quality benefit. With quality information, policymakers and other stakeholders are more likely to support large-scale investments in the headwaters.

Below: Landscape-scale research in headwaters areas can quantify the benefits of improved management and provide critical information to policymakers and stakeholders.

7 Podolak, K., D. Edelson, B. Aylward, S. Kruse, M. Zimring, and N. Wobbrock. 2015. Water supply benefits from forest and meadow restoration in California's Sierra Nevada. The Nature Conservancy: San Francisco, CA (forthcoming February 2015).

Recommended Actions

Left: Collins Pine Company utilizes riparian management in its forests, including this section of Mud Creek in Collins Lakeview Forest, in order to protect water quality and wetlands habitat, improve flood-water retention and groundwater recharge and support greater biodiversity. Photo credit: Collins Pine Company

Right: The Sierra snowpack typically provides about 30% of the state's water supply when it melts. Photo credit: Dale Kolke, DWR

Headwaters — from the Cascades to the Sierra Nevada to the coastal ranges and mountain foothills — significantly contribute to California's water quality and water supply reliability. However, variables such as climate change, increasing wildfires, groundwater overdraft and reduced snowpack are looming, and action is needed to help adapt to these changes and create healthy, resilient forests. By rethinking traditional management concepts and implementing a more integrated systems and multi-benefit approach, California's headwaters can provide greater and longer-lasting benefits to the state's water system. To help achieve these outcomes, ACWA makes the following policy and management recommendations:

Improved Planning, Coordination and Implementation

1. The state of California should establish improved headwaters management as a high priority within its state planning and natural resources management functions.

2. The California Resources Agency, charged with the management of the state's natural resources, should partner with the Forest Service and other appropriate federal land managers to complete compatible management strategies. Protocols should be put in place by Dec. 31, 2017 to do the following:

   a) Identify mutual priorities that will guide collective and individual actions.

   b) Define responsibilities within each agency that eliminate duplication when feasible and reduce conflicts related to jurisdictional boundaries and overlap.

   c) Develop common terms and references when pursuing similar actions.

   d) Adopt a wildfire classification definition that focuses on the nexus of wildfires and the resulting adverse impacts to water quality, water supply and reliability.

3. Because locally-driven headwaters management is most effective, the state's forest land managers should develop stewardship management partnerships, both public and private, that reflect these protocols, recognize the diversity of California's headwaters and involve the local communities and other affected stakeholders.

4. The California State Legislature should amend section 730 of the Public Resources Code to include the requirement that two public members of the Board of Forestry have water resources expertise when they are appointed. The revised structure would be: five members from the general public (two of which have water resources expertise), three from the forest products industry, and one member from the range-livestock industry. These revisions would go into effect upon the departure of the first two public members of the board.

5. A permanent Headwaters Advisory Committee should also be established within the Natural Resources Agency to do the following:

   a) Determine the state of current research on headwaters and headwaters management; develop a list of research gaps and the costs/timelines to complete this research.
   b) Review agency policies and procedures for opportunities to streamline regulations or guidance affecting headwaters areas.
   c) Develop a set of clearly defined multi-benefit actions that would improve the overall health of headwaters and protect the water quality in California's headwaters.
   d) Review regulatory obstacles to carrying out activities to reduce greenhouse gas (GHG) emissions and maintain or enhance carbon storage associated with forests and headwaters lands.

   A report including the above-listed items should be presented to the Secretary of Natural Resources no later than 12 months after the Advisory Committee is established.

6. State and federal land managers should develop and implement improved post-fire monitoring programs to better assess water-related wildfire impacts:

   a) Monitoring should include but not be limited to assessment and monitoring of infiltration, runoff, erosion, and stream sedimentation; changes in the amount and quality of runoff from burned over watersheds; and vegetative type, canopy, plant regeneration and impacts of vegetative cover on water retention in the soils.
   b) Monitoring for water quality and water supply impacts must take place over a longer (multi-year) period of time to accurately determine the extent of impacts to downstream watersheds and streams as well as the relative severity of impacts.
   c) Monitoring should incorporate information from various post-fire responses including, but not limited to, the Burned Area Emergency Response and should be funded by emergency accounts.
   d) Monitoring should be accomplished as a collaborative effort of the different natural resources agencies and stakeholders (e.g. fish and wildlife agencies, suppliers of municipal and agricultural water supplies, downstream water rights holders), with information shared among all of the parties.

7. As part of its Integrated Regional Water Management (IRWM) Strategic Plan and other streamlining efforts, DWR should review opportunities to ensure headwaters management strategies are incorporated into applicable IRWM plans. Specifically each new or updated IRWM Plan should be required to include the identification of headwaters that supply or influence each respective region.

8. State and federal land managers should jointly establish headwaters monitoring programs that help quantify GHG benefits and other performance metrics of proactive headwaters management.

9. Water managers should partner with the Forest Service and other land owners to reduce the impacts of roads on streams by prioritizing and implementing timely actions such as road decommissioning or reconstruction. These treatments should be monitored to ensure effectiveness and can be enhanced through public-private partnerships.

Managing Headwaters Resources

1. In accordance with the Organic Act and subsequent laws, the Forest Service should ensure that its Land and Resource Management Plans and management practices include actions that improve water supply reliability and water quality as the water moves through the national forest.

2. The state should work with local communities and other stakeholders to develop a risk assessment process for each major watershed in the different headwaters regions. This process should include:

    a) Determining the potential impacts of fire to the natural infrastructure within the local watershed and downstream water supplies.

    b) Determining the potential long-term impacts to water supply and quality.

    c) Preparing an inventory of all watersheds that are deemed to be "at significant risk" and placing those areas on a priority list for expedited treatment to protect local and downstream water supplies.

This work should be completed by Dec. 31, 2018.

3. Local land use planners and state agency resource managers should actively engage water resource managers in their planning and management initiatives to ensure these plans actively consider the impacts of land use decisions on water supply reliability and water quality in the headwaters.

4. The state and federal governments should consider providing incentives to private landowners to expand the application of forest best management practices for the benefit of the environment and downstream water users.

5. The Forest Service, in collaboration with state resource agencies, should assist public and private landowners to improve the condition and trend of meadows and watersheds to enhance the water quality and water supply functions of those areas as well as lessen wildfire impacts on downstream water resources.

6. The state should promote the use of conservation easements and leases as one method of watershed protection to ensure a stable and high quality water supply.

7. Federal, state and local agencies should regularly review and update regulations to optimize the multiple benefits of forest management tools such as forest thinning, vegetation management, and controlled burns that reduce fuel loading, and consequently the damages resulting from large wildfires and the secondary impacts to water resources of California.

8. Federal, state and local stakeholders including law enforcement entities should commit to long-term strategies and investments that will help address the effects of illegal marijuana cultivation on California's water resources.

9. Working with local agencies, the state should assess and support solutions for legacy issues affecting water quality and supply to improve the conditions of affected watersheds.

Research

1. State and federal land and resource management agencies should actively support and engage in a rigorous and collaborative research program focused on headwaters and forestry relationships. The University of California and the California State University systems should serve as the lead research institutions and provide a report to the governor outlining investments that can be made on public lands to improve the condition and functions of California's headwaters to benefit water supply reliability for the state.

2. Water utilities, state and federal land and resources managers, tribes, private interests and interested stakeholders should promote and invest in landscape-level research to determine:

    a) The impacts of climate change on headwaters and identify potential adaptation strategies to mitigate those impacts.

b) The impacts of active fuels management and response measures.

c) The resource benefits that headwaters currently provide.

d) The impacts of forest thinning on water yield and water supply reliability.

e) The resiliency of forests and landscapes during fire recovery.

3. CAL FIRE, through its Fire and Resources Assessment Program and in coordination with the Forest Service, academic institutions, and other interested parties, should develop a long-term research program with applied research and monitoring projects that focus on efforts to improve headwaters management, particularly as it relates to water supply and quality.

Financing Headwaters Improvements

1. The federal government through the Department of Agriculture and Department of Interior should advance administrative or legislative proposals that establish exclusive accounts for fire suppression activities and proactive forest management. Establishing separate accounts would help ensure funds remain dedicated to critical projects in each area and keep fire suppression costs from limiting proactive forest management activities.

2. Congress should significantly expand funding for Forest Service restoration activities within the Pacific Southwest Region. Eligible categories should include: long-term monitoring of post-fire recovery efforts which in part assess ecosystem response as related to water supply and quality, research-based development of adaptive forestry management programs, decommissioning or the improved maintenance of roads and other sediment producing areas, wildfire prevention activities such as forest thinning and watershed restoration, overall water resources monitoring, development of a local workforce trained and dedicated to long-term forestry management, and biomass management and removal.

3. Congress should continue to provide robust funding for programs like the Forest Service Legacy Roads and Trails Remediation Program, which is helping protect and restore water quality in California by mitigating the negative impacts of roads.

4. The state and federal government should allocate additional financial and technical resources to the California Firewood Task Force as a proactive measure to help prevent the spread of forest pests.

5. The California Air Resources Board through California's carbon market should encourage and provide carbon credits for investments in lands management programs and biomass energy projects that balance or create gains in carbon sequestration benefits and air quality concerns.

6. The state should actively work with federal and local stakeholders to implement the 2012 California Bioenergy Action Plan in support of forest biomass activities. Actions should promote biomass management, an important component of forestry management, as a potential source of revenue for headwaters protection while ensuring other renewable energy sources remain economically viable.

7. The state and federal government should, in conjunction with stakeholder and private interests, facilitate innovative research that can develop new markets for forest products and create financial support for restoration activities.

8. The Forest Service should explore opportunities to maximize the benefit of public-private partnerships where possible to support improved headwaters management. There are numerous examples of innovative financial arrangements that could be pursued through partnerships between the public and private sectors to benefit headwaters areas.

For purposes of these policy principles, "headwaters" is defined as those upper portions of a watershed which contribute to or influence the surface and subsurface waters that give rise to or contribute to a river or other waters flowing to the lower reaches of the watershed.

ACWA Policy Principles on Improved Management of California's Headwaters

A reliable supply of high quality water is fundamental to securing drinking water for all Californians, maintaining agricultural productivity, and supporting a vibrant and diverse economy. Headwaters — from the Cascades, the Sierra Nevada, the coastal ranges and mountain foothills, and to the numerous ranges of the San Bernardino and Cleveland National Forests — contribute to achieving this imperative for the State. However, if better managed, they could do much more.

Ultimately, managing California's headwaters is integral to optimizing the water supplies that nature provides. Increasing water yield and quality; reducing the risk and impacts of catastrophic wildfire; and enhancing natural features and functions; are all benefits to be derived, locally and statewide, from improved headwaters stewardship. Enhancing the resiliency and adaptability of headwaters is overdue.

California can no longer afford to relegate management of its headwaters to the margin.

Local water management agencies / districts, working cooperatively with appropriate stakeholders, including state and federal resource agencies, should pursue headwaters management strategies consistent with the following principles that have been adopted by ACWA's Board of Directors.

Improved Planning, Coordination and Implementation

1. California needs to implement strategies that emphasize the resiliency and sustainability of California's headwaters.
2. Headwaters improvement and management strategies need to recognize that "one size does not fit all" and must account for variability among these areas throughout the State, and even within a particular watershed.
3. State and federal land and resource management agencies, in consultation with stakeholders, should increase coordination and integration as they plan and implement efforts to improve stewardship of California's headwaters.
4. Local communities' priorities, knowledge and expertise should be addressed and used to the greatest extent feasible when developing and implementing management strategies for headwater areas.
5. Projects and management practices designed to improve headwaters should yield benefits to local and downstream communities, and environmental resources that use water from the headwaters.
6. Planning and/or permitting processes on public and private lands should ensure that land-use proposals in the headwaters adequately assess potential significant adverse impacts on water supply and quality and minimize or mitigate those impacts.

Managing Headwaters' Resources

7. The natural infrastructure of the headwaters and the engineered water infrastructure throughout the State are too often considered unrelated and instead should be managed in an integrated manner.
8. Public and private landowners and resource managers should be encouraged and assisted in efforts to improve water quality and water supply reliability through headwaters stewardship.

9. Landowners and resource managers should be encouraged and assisted to manage and improve the resiliency of the natural features of the headwaters.

10. To maintain the integrity and improve the resiliency of the headwaters, public and private landowners and resource managers should implement actions that reduce the risk of catastrophic wildfire which also may reduce the adverse effects of such fires, including deleterious impacts on water supply and water quality.

11. Forest management tools as such forest thinning, biomass management and controlled burns that reduce fuel loading, and consequently, the risk of catastrophic wildfires should be utilized to the extent feasible, taking into account other resources objectives, including water management, and public health and safety. Federal and state regulations that limit such efforts should be reassessed to better accommodate these management tools.

12. The U.S. Forest Service must reaffirm and commit to the charge Congress gave it in the Organic Act of 1897 "to improve and protect the forest within [and for] securing favorable water flows", and revise its policies and management practices necessary to prioritize and achieve those mandated goals.

Research

13. State and federal resource and land management agencies, in cooperation with academic institutions, water agencies/districts, the private sector and non-government organizations, should develop a prioritized applied research and monitoring program to gather data and design models to improve headwaters management and enhance resource services, particularly those related to water supply and quality.

14. Research and strategies to improve headwaters should be based on the best available science that is, to the greatest degree feasible, peer reviewed.

15. Headwaters research programs should engage in the field testing of research hypotheses that may improve the resiliency and sustainability of California's headwaters and consequently, may contribute to improved water supply reliability and water quality.

16. State and federal land and resource management agencies, in collaboration with private and public stakeholders, should pursue research to assess the impacts of climate change on headwaters. They should determine the resource benefits the headwaters currently provide, create models to assess the impacts of climate change on these resources and develop strategies to adapt to those impacts.

Financing Headwaters Improvements

17. It is imperative that Congress provide direction and appropriations to the Department of the Interior and the Department of Agriculture for the development and implementation of programs to enhance the health and resiliency of federally-managed headwaters to improve the supply and quality of water originating on federal lands.

18. The state has historically underinvested in headwaters stewardship. Future general obligation bonds should contribute funding to restore, manage and protect California's headwaters to provide the statewide public benefits associated with healthy and resilient headwaters.

19. Private landowners should receive assistance in terms of education and information, technical expertise and incentives (e.g. tax credits, conservation easements, development agreements, etc.) to encourage their commitment to long-term protection and enhancement of headwaters on their property.

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Greg Zlotnick, Groundwater Cmte. Chair, 6
Thomas A. Cuquet, ACWA/JPIA Vice President, 2

East Bay MUD, Director
Cucamonga Valley WD, Director
Eastern MWD, Board Vice-President, Director, MWD First Vice Chair
Humboldt Bay MWD, Director
Hidden Valley Lake CSD, Director
Western Canal WD, Board President, Director
Browns Valley ID, General Manager
Calaveras County WD, Director
El Dorado ID, Director
Reclamation District #2068, General Manager
Sacramento Suburban WD, General Manager
Zone 7 WA, Director
Scotts Valley WD, Director
Kings River CD, General Manager
Angiola WD, General Manager
Wheeler-Ridge-Maricopa WSD, Outside Consultant
Kaweah River Power Authority, Director
Newhall County WD, General Manager
Upper San Gabriel Valley MWD, Director
Elsinore Valley MWD, Director
Desert WA, Director
Irvine Ranch WD, Director
Helix WD, Vice President, Director
Municipal WD of Orange County, MWD Representative, Director
Valley Center MWD, General Manager
City of Sacramento, City Council, Vice Mayor / Councilmember
Yuba County WA, Outside Counsel
Glenn-Colusa ID, General Manager
Zone 7 WA, General Manager
San Diego County Water Authority, General Counsel
San Juan WD, General Manager
Vista ID, Director
Placer County WA, Director of Financial Services
Dublin San Ramon SD, Community Affairs Supervisor
San Luis & Delta-Mendota WA, Delta and Special Projects Administrator
South Sutter WD, Director

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**Board roster at the time of the Headwaters Framework's approval in November 2014.*

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ACWA is a non-profit statewide association of public water agencies whose 440 members are responsible for about 90% of the water deliveries in California.