

High Country News

For people who care about the West

FIRESTORM

Inside the dangerous and
unpredictable behavior of wildfire

By Douglas Fox



A plane spraying fire retardant passes near the plume of the 2014 King Fire in California while a lidar machine on a truck scans the smoke. BRANIFF DAVIS/SJSU FIRE LAB

On the cover

A column of smoke rises from the Pioneer Fire in Idaho. Inside the opaque plume, air moves at gale forces, which can redirect wildfire into unexpected places.

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Editor's note

You can't take politics out of the West

Since last year's presidential campaign and election, I've received a number of letters from readers angered by what they call the "political" content in the magazine. Stick to the West's core issues, they say, topics like timber and grazing, and leave our nation's divisive politics out. Unfortunately, that just isn't possible. The American West has had a complicated relationship with politics and the federal government from the get-go, and under the current administration, that relationship is feeling a new strain.



President Donald Trump seems to have little regard for the kinds of federally funded programs that make life in this region better. The latest White House budget seeks significant cuts to the departments of Education and Energy, and absurdly deep cuts to the departments of Interior, Commerce and Agriculture. Taken together, the cuts represent a huge chunk of funding for federal agencies that play essential, interlocking roles in keeping the American West economically and ecologically healthy. Some agencies, such as the National Oceanic and Atmospheric Administration, do the basic research concerning our land, air and water that we need to fill in the considerable gaps in our understanding of the place we live.

This issue's cover story, by award-winning contributor Douglas Fox, provides a timely example, as early-season wildfires are already sweeping parts of the West. Fox takes us into the towering plumes of smoke to follow the work of researchers — often helped by federal funding — as they advance the science of wildfires. His story reminds us of the destructive nature of both fire and humanity: The early fire research done by the U.S. military was designed to help the Allies more efficiently firebomb German cities in World War II. New research is uncovering how intense wildfires create their own weather and move across the land — knowledge that could save lives. If Trump's budget cuts hobble that research, it will harm, not strengthen, the West's security.

National politics play out in other stories, too. Correspondent Krista Langlois describes the problem of aging dams, like California's Oroville, as researchers warn of potential super-floods. And correspondent Josh Zaffos describes the anxieties of refugees and undocumented workers in northern Colorado — people who are as much a part of our region as our loggers and ranchers. The West is as bound to national politics as anywhere else. There is no way to separate the defunding of science from the xenophobic policies of our current president, nor those policies from the ecological destruction we continue to inflict on the region. For readers who wish it were otherwise, I apologize. But if you see these issues as part of a larger story, the story of the West, and thereby of the United States, then read on.

—Brian Calvert, editor-in-chief



Interior Secretary Ryan Zinke arrived for his first day of work at the Interior Department in Washington, D.C., riding Tonto, a 17-year-old Irish sport horse, and then proceeded to sign two orders that showed his support for the sportsmen community. INTERIOR DEPARTMENT

Zinke's balancing act

The new secretary of Interior, Ryan Zinke, has his work cut out for him. So far, his priorities for Interior have been vague but unsurprising: rebuilding trust between the public and the department, increasing public-lands access for sportsmen, and improving outdated infrastructure at national parks. Zinke has been mum on how he will combat climate change as the head manager of a fifth of the nation's landmass, in contrast to his two predecessors, who created climate research centers and pushed renewable energy. The secretary has also said he will conduct a "bold" restructuring of the agency, though details on that are still slim. Perhaps the biggest questions are how he will balance a mining- and drilling-friendly agenda with habitat conservation and access to public lands, as well as how he will achieve his priorities if President Donald Trump follows through with proposals for major budget cuts.

TAY WILES

MORE: hcn.ws/zinkes-priorities

Trending

Big Rec's big move

In Utah, despite widespread use of public land for recreation, top elected officials want to whittle down federal land protections. As a result, the Outdoor Retailer trade show, which brings in \$45 million to the local economy, is leaving the state. In an opinion piece, Gretchen Bleiler agrees that Utah doesn't deserve the show. But now that Big Rec is on the move, where should it go? Colorado isn't a shoo-in, Bleiler says: The state's leaders could take a leading role to abate climate change — and if they don't, the show should go somewhere that does.

GRETCHEN BLEILER, OPINION

You say

PAT WAYNE:

"Not sure I agree with the author. She makes the same tired mistakes by making big pronouncements like 'The old extractive order is behind us.' While that may be true in places like California ... it certainly isn't true in the USA as a whole."

CHRISTIAN CUTSHAW:

"If we're going strictly off of environmental and conservation efforts, the show should go to Washington or California."

DENECE VINCENT:

"Moving the show out of Utah seemed reasonable. Trying to enact purity standards before 'awarding' the show seems a bit too ivory-tower-ish."

MORE: hcn.ws/bye-utah and [Facebook.com/highcountrynews](https://hcn.ws/facebook.com/highcountrynews)

“(Utilities) have to work with us to provide access to solar. It doesn't matter if it's a red state or a blue state, there's enormous customer demand.”

—Alex McDonough, vice president for policy at Sunrun, a solar panel leasing company, after Nevada and then Arizona backed off anti-solar policies that penalized consumers who installed solar energy. ELIZABETH SHOGREN

MORE: hcn.ws/solars-power



SUNRUN SOLAR



Darryl Thorn, Jason Patrick, Jake Ryan and Duane Ehmer, pictured from left, were found guilty of charges associated with the 2016 occupation of the Malheur National Wildlife Refuge. The four were minor players in the occupation, whose ringleaders, Ammon and Ryan Bundy, were acquitted of charges last October. MULTNOMAH COUNTY SHERIFF'S OFFICE

Malheur trials are over— but the movement rages on

In late October, Ryan and Ammon Bundy, the Malheur occupation's key players, were acquitted of all charges. The verdict surprised even the defense. But in mid-March, a new jury looked less favorably on the remaining defendants, delivering a mix of guilty and non-guilty verdicts on conspiracy and gun charges. The decision perplexed many: How

does a jury find Ammon Bundy, who was touted as the leader of the occupation, not guilty of conspiracy, but convict those who played a lesser role? The recent verdicts may have further motivated the takeover's sympathizers. To them, the guilty verdicts made martyrs of the occupiers. LEAH SOTTILE

MORE: hcn.ws/malheur-movement



JASON CONNOLLY/AFP/GETTY IMAGES

Finding sanctuary

Jeanette Vizguerra, an undocumented Mexican mother of three U.S.-born children, holds her fist up as she addresses supporters gathered outside the First Unitarian Church in Denver in February. She skipped a scheduled meeting with U.S. Immigration and Customs Enforcement officials for fear of detention and deportation, and has been staying in the church's basement since. SARAH TORY

MORE: hcn.ws/sanctuary-start

250,000

Estimated number of migrating ducks that the Great Salt Lake can no longer support due to an invasion of European phragmites. The reed, a perennial grass, has covered 25,000 acres since the early 1990s, reducing habitat for phalaropes, snowy plovers and other birds, and annually sucking up a lot of water, estimated (in acre-feet) at

71,000

EMILY BENSON

MORE: hcn.ws/phragmite-insight

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THE STORY OF HIG AND BIG GUY

Regarding Anna V. Smith's recent story about Oregon's Valley of the Giants ("Growing pains," *HCN*, 3/6/17), long, long ago my boss, Guy Higginson, supervised a group of BLM foresters. I was one of them. The Bureau of Land Management back in the 1970s was a timber-producing machine, and we O&C foresters pulled the levers. In those days, our axes could point at a patch of timber and off it went to the mill. But not the 51 acres in the Valley of the Giants. Guy (known as "Hig") was friends with a barber in Salem, Oregon, an aficionado of big trees. The barber discovered that the largest Doug fir in Oregon stood tall in this valley, and he and Hig initiated a two-man effort to keep timber beasts out. The tree, "Big Guy," was written up in the paper. It was listed in books about giant trees. It was famous. Hig, leader of the foresters, stretched out his arms and told us beasts to stay back, so we did. A few years passed and we promoted the place a bit; it's not easy to find. Then three of us hacked a trail right up to Big Guy and posted a sign by the road — "Trail to Big Guy." A few people visited. It's of minor ecological value; an island in a landscape of private second- and third-growth timber.

More years passed, and the BLM turned a little "green" — even O&C foresters did. Somewhere along the line, Valley of the Giants was designated an "outstanding natural area." It didn't need Hig to watch over it anymore. Ancient Big Guy toppled in a 1981 winter storm. My boss and friend fell, too, some 24 years later. Those of us who care know that protection of special places in the West is often initiated by one or two people who take action, be it from within the agency or without. Thanks for the memories.

*Pete Schay**Bureau of Land Management, retired
Camp Sherman, Oregon*

FALCONRY BIRDS AREN'T PETS

As a 55-year-old lifelong raptor enthusiast with 12 years of professional raptor work under my belt, I enjoyed seeing a ferruginous hawk on the cover ("Now you see her," *HCN*, 3/6/17). As a licensed falconer of over 30 years, though, I take exception to the author's statement that "ferruginous hawks, however, are not popular pets among falconers." That's because falconers don't keep raptors as "pets."



JOEL PETT EDITORIAL CARTOON USED WITH THE PERMISSION OF JOEL PETT AND THE CARTOONIST GROUP. ALL RIGHTS RESERVED.

According to the North American Falconers Association, "Falconry can be defined as the taking of wild quarry in its natural state and habitat by means of a trained raptor." I suppose one could define "pet" in such a way to include a falconry bird, but I think, on the whole, that few dog, cat, parrot or horse owners spend much time pursuing wild quarry in its natural state with said beasts. Furthermore, these animal caretakers even more rarely capture their animals from the wild, train them, hunt with them for a while, and then release them back to the wild, as falconers commonly do. Falconers really don't like their birds being called "pets."

I personally would have preferred the author to quote a U.S. falconer regarding ferruginous hawks, rather than a U.K.-based one. All U.K. non-native raptors are bred in captivity and imprinted; imprinting is a bad choice for most buteos, but especially so for something as stubborn and powerful as a ferrug, as your author found out. Here in the U.S., ferruginous hawks are usually taken as non-imprinted older chicks or captured as immature "passage" birds and have far fewer of the behavioral problems associated with imprinted birds. They're a handful more because of their flight style, in which they often refuse close-flushed quarry and prefer to pursue jackrabbits going over the horizon, and because of their stubborn attitude. Even so, there are a few outstanding ferruginous falconers here in the U.S.

*Bryan Kimsey
Clayton, New Mexico*

WHY COAL HAS DECLINED

In "Overdosed" in the Feb. 20 issue, the author writes, "Federal regulations and the low cost of natural gas have combined to create the worst economic climate for coal in decades." While this sentence is true, it is also misleading. The real economic issue for Craig is not just the decline in coal demand, but massive changes in the industry that have resulted in hardship for the miners of Craig and the rest of the community that relied on those paychecks. Far ahead of regulations are the shifts in practices that allow Wyoming miners to produce five times the coal per year of a Colorado miner.

Likewise, mountaintop removal provides a huge productivity margin over other methods. And of course, we can't overlook the shift away from union operations, which also depresses wages. Even in the narrowest interpretation of the statement, low-cost natural gas has had far more impact than any federal regulations. This will become quite apparent when the Trump administration rolls back regulations (at the expense of the environment) and coal jobs still don't come back, because natural gas will remain a preferable fuel.

It is this sort of misleading attack on regulation that allows Trump and his ilk to attract the support of the economically displaced with lies and false promises of a return to the past.

*David Strip
Llaves, New Mexico*High
Country
News

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Can aging dams withstand super-floods?

Scientists warn that enormous deluges may be more likely than we thought

BY KRISTA LANGLOIS

In the late 1980s, Japanese paleontologist Koji Minoura stumbled on a medieval poem that described a tsunami so large it swept away a castle and killed a thousand people. Intrigued, Minoura and his team began looking for evidence beneath rice paddies, and discovered that not one but three massive, earthquake-triggered waves had wracked the Sendai coast over the past 3,000 years.

In a 2001 paper, Minoura concluded that there was a significant possibility of another tsunami. But officials were slow to respond, leaving the Fukushima Dai-ichi nuclear power plant and other coastal infrastructure unprepared for the 50-foot wave that devastated the region in 2011.

For the past several decades, University of Arizona paleo-hydrologist Victor Baker has been using techniques similar to Minoura's to study the flood history of the Colorado Plateau. Like Minoura, he's found that floods much larger than any in recorded history happen fairly routinely. And like Minoura, he feels his research is largely being ignored by agencies and public utilities with infrastructure in potential flood paths.

In February, when a spillway at the nation's tallest dam in Oroville, California, buckled under massive rainfall, the consequences of underestimating flood risk became national news. When many Western dams were built in the mid-20th century, they were designed to handle the largest floods that scientists deemed probable. At the time, the best science to determine such probabilities came from historical records and stream gauges.

But that record stretches back only to the late 1800s, a timespan Baker calls "completely inadequate." Today, technology allows scientists to reconstruct thousands of years of natural history, giving us a much clearer picture of how often super-floods occur. "The probability of rare things is best evaluated if your record is very long," Baker explains.

By combing Southwestern rivers like the Colorado and the Green for sediment deposits and other evidence and carbon-dating the results, Baker has concluded the short-term record underestimates the

size and frequency of large floods. On the Upper Colorado near Moab, Utah, Baker and his team estimated the average 500-year flood at roughly 246,000 cubic feet per second, more than double the 112,000 cfs predicted from the stream gauge record. Baker's calculations put the 100-year flood at 171,000 cfs, also much greater than the previous estimate of 96,000 cfs. In comparison, the legendary flooding of 1983 and 1984 that nearly overwhelmed Arizona's Glen Canyon Dam, just downstream, peaked at just 125,000 cfs. (The Bureau of Reclamation has since bolstered the spillway to handle flows up to 220,000 cfs, and more can be stored in its reservoir.)

In California, too, super-floods may be more common than previously thought. U.S. Geological Survey hydrologist Michael Dettinger and UC Berkeley paleoclimatologist B. Lynn Ingram studied the record across a broad swath of the state and discovered that such floods happen at least every 200 years, and maybe more frequently. The last one, in 1862, killed thousands of people and crippled the state's economy — and it was only half as big as one 17th century flood.

In 2013, Dettinger and Ingram wrote

in *Scientific American* that California was due for another huge water year. Their prediction proved prescient: So much precipitation pounded California this winter that water managers were forced to spill excess water over the Oroville Dam's emergency spillway for the first time in the structure's 49-year history. The sediment-choked water eroded a hole in the spillway, putting 180,000 downstream residents at risk of inundation.

Luckily, emergency crews patched the spillway. But in many ways, Californians dodged a bullet: This winter's precipitation was nowhere near as heavy as the storms Dettinger and Ingram have studied, and yet if Oroville's reservoir hadn't been depleted by years of drought, floodwaters could have overwhelmed it.

Oroville is far from unique — across the country, some 2,000 dams whose failure could be deadly are in need of repair, according to the Association of State Dam Safety Officials. And while agencies like the Bureau of Reclamation have used paleoflood research to retrofit some dams, other agencies are more reluctant: Officials with the U.S. Army Corps of Engineers believe we've so altered rivers that ancient flood records are no longer realistic indicators of current risks.

But Baker believes it would be foolhardy to not at least plan for the possible failure of some of the West's biggest dams. That Japanese officials were warned of a tsunami and didn't act is "an embarrassment," Baker adds. "We may have some similar things occurring in the United States, if we don't seriously pay attention to this science." □

A member of Cal Fire, right, talks to workers on the Oroville Dam project in front of the main spillway in Oroville, California, on Feb. 20, as forecasters issue flash flood warnings for the San Francisco Bay Area.

HECTOR AMEZCUA/THE SACRAMENTO BEE VIA AP



Correspondent Krista Langlois lives in Durango, Colorado, and frequently covers Alaska.

Twitter: @cestmoiLanglois

Arafa Mhuammad-Yunus of Myanmar holds the hand of her daughter, Nurasmah, 7, during a march in Greeley in support of refugees and immigrants.

ALYSON MCCLARAN/GREELEY TRIBUNE



Anxious in Greeley

A conservative community that's home to refugees, undocumented workers and international students grapples with the new political reality

BY JOSHUA ZAFFOS

On a sunny morning in early March, over 400 people hit the sidewalks of Greeley, a small city on Colorado's Eastern Plains. A diverse crowd in sweat-shirts, blue jeans, robes, ankle-length skirts and headscarves, they marched to show their support for the city's sizable refugee and immigrant population. They started at the University of Northern Colorado, wound toward downtown and ended up at the Global Refugee Center, a local nonprofit.

The route was no coincidence: Greeley is an island of cultural and intellectual diversity in a conservative, rural county. Refugees and undocumented workers help keep the agricultural economy afloat, and the university's international student population has grown in recent years. By most accounts, these new residents have settled in with relative ease.

But as the targets of President Donald Trump's nationalist rhetoric and new security measures, many have spent the last few months anxious about possible

deportations, arrests and general hostility. Though Trump's latest "travel ban," which would have suspended immigration from six predominantly Muslim countries, has been blocked, U.S. Immigration and Customs Enforcement (ICE) is stepping up detentions, arresting hundreds of immigrants nationwide. In Greeley, this new political reality has presented local leaders with sometimes uncomfortable choices: What can — and should — the community do to make its new residents feel safe?

Greeley was founded in the 19th century as a utopian colony, whose white settlers emphasized communal living and egalitarian values. Today, surrounding Weld County is fiercely conservative; last November, Trump won here by 22 points. Weld County is one of the country's top agricultural producers, and Greeley's largest non-government employers are the university, a wind-turbine manufacturer, the hospital system, and JBS USA, which runs a large beef-processing plant on the city's north end. Migrant and undocumented workers, along with refugees fleeing war and environmental disasters,

fill most of the meatpacking jobs. Several hundred Somalis now live here, along with refugees from Myanmar and Ethiopia. On campus, there are 395 international students from 47 countries.

"Our economy depends on undocumented and Latino people," and the university is made stronger by its diverse student population, says Matt Birnbaum, one of several Northern Colorado professors leading efforts to protect international and immigrant students and community members. "If we're not going to protect them, that's troubling."

Three days after the election, Northern Colorado president Kay Norton sent a two-minute video to students and faculty condemning verbal attacks over "identity" and "affiliation" that, according to student reports, spiked following a Trump campaign rally on campus on Halloween. She described the school as "a family" where everyone is "welcome and necessary."

But students criticized Norton's message as tepid and insincere, with some calling her dismissive of harassment. Fifty students protested near her office,

Correspondent Joshua Zaffos writes from Fort Collins, Colorado. [@jzaffos](#)

chanting “Hey-hey, ho-ho, Kay Norton has got to go!” Then they went to the school board of trustees to demand her termination, along with increased funding for student centers that serve minorities.

Faculty members got involved, too, delivering a “sanctuary petition” in November. It urged Norton to refuse to share students’ personal information with federal authorities, to resist immigration detentions on campus, and to publicly back Deferred Action for Childhood Arrivals (DACA), an Obama administration program that enables undocumented youth who grew up in the U.S. to work or attend college without fear of deportation.

Anthropology professor Whitney Duncan, who helped organize the petition effort, says many faculty felt an “urgent need” to show support for DACA and immigrant students, considering Greeley’s history. Just over a decade ago, ICE agents stormed a local meatpacking plant and arrested 273 undocumented workers. Many locals still remember the raid and its aftershocks, as parents were detained and, in many cases, deported, leaving behind spouses and children.

In response, the university’s board of trustees passed a resolution in support of DACA, and Norton joined a group of over 600 university presidents who signed a pro-DACA statement. But Northern Colorado stopped short of declaring itself a “sanctuary” school. In a January campus-wide email, Norton argued that the term lacked a meaningful definition.

University leaders seem “generally supportive and sympathetic,” Duncan says. They’ve started offering trainings for staff on how to handle law enforcement requests for student information without a warrant. But so far, the administration hasn’t committed to take specific steps to support students, such as providing legal counsel or establishing spaces where immigrant students can take refuge during raids.

The president of Washington State University in Pullman — another diverse campus surrounded by a rural population which is 89 percent white — also signed the DACA statement following a sanctuary petition and student walkout in December. A follow-up list of grievances from an undocumented students’ alliance repeats a call for sanctuary campus status and urges Washington State to hire a full-time employee to work with undocumented students, expand diversity training for staff and faculty, increase employment and housing opportunities, and explicitly support a path to citizenship for undocumented youth.

Washington State is “doing everything it can, legally, in order to protect immigrant students,” says Mary Jo Gonzales, the school’s vice president for student affairs. That includes “know your rights” workshops for students and support for the undocumented student group. “But

the university doesn’t plan to declare itself a sanctuary campus.” Doing so, Gonzales points out, would not give the school legal cover for resisting a federal warrant to detain an undocumented student. And some administrators warn that sanctuary declarations could provoke Trump to withhold federal funding, as he has threatened to do with cities that refuse to aid federal immigration enforcement.

But the possibility of losing international students also has schools on edge. More than 1 million international students enrolled at U.S. universities in the last academic year, doubling numbers from 15 years ago. The growth reflects a concerted effort by state universities and colleges to court international students who pay higher tuition rates, usually without financial aid, which helps offset shrinking public education budgets. Yet a recent survey found that nearly 40 percent of 250 schools are reporting declines in international applications this year, which some are referring to as the “Trump Effect.”

“America is a big symbol of equality. There are moments when I have worries that is a myth.”

—“Nahid,” Iranian graduate student at the University of Northern Colorado

Nahid, an Iranian graduate student, came to Greeley with her husband and young son in late 2015 after waiting a year for a visa. (Nahid asked *HCN* to withhold her real name to avoid being targeted.) Her field of study doesn’t exist in Iran, and she wanted her son to receive a secular education. But Trump’s rise has chilled her American experience. Even though his travel ban shouldn’t directly affect her since she has a visa, she feels the order labels her and all other Iranians as “radical” Muslims.

“America is a big symbol of equality,” she says. “There are moments when I have worries that is a myth.”

Nahid, a practicing Muslim, hasn’t felt personally threatened; professors and administrators have made her feel welcome. But she confesses to crying when she thinks about never seeing her family in Iran; she worries about being denied re-entry if she leaves the U.S. She still hopes to work and raise her son in the U.S., but admits that if she were deciding on graduate school today, she would look at universities in other countries. “We feel so uncertain and fearful about our tomorrow,” she says.

Uncertainties are simmering off campus, too.

Refugees generally feel welcome in Greeley, says Entisar Tuha, who works

at the Global Refugee Center, which helps them learn English, find work and settle into their new community. “But after the election, there’s also a lot of fear that their immigration status can change or they can be deported.” Born in Ethiopia, Tuha came to Colorado in 2011 to live with her mother. She got a green card and is now attending community college. Since the election, she says, the center’s citizenship classes have been fully booked with refugees rushing to complete the process.

Immigrant-rights activists, meanwhile, are trying to calm nerves, says Sylvia Martinez, spokeswoman for Latinos Unidos, a local advocacy group. This February, false rumors of ICE highway checkpoints and raids in Greeley led some people to skip work and keep their children home from school. Martinez, the daughter of migrant farmworkers who grew up working alongside undocumented laborers, says it’s crucial to dispel inaccurate reports so immigrants don’t feel intimidated or quit working and lose their incomes. At the same time, she acknowledges cause for concern: “A raid can happen.”

Martinez is speaking with local churches about serving as safe havens for undocumented families. Since February, Jeanette Vizguerra, an undocumented Mexican with three U.S.-born children, has been living in a Denver Unitarian church after skipping a meeting with ICE. So far, federal agents have been reluctant to arrest immigrants taking shelter in churches.

Trump has said he will not revoke DACA, and claims that ICE is only targeting dangerous criminals. The latest version of the executive order suspending entry of immigrants and refugees from six countries does not affect current visa holders and, on paper, allows for travel waivers.

But the president has often changed his positions, and his aggressive moves to deport immigrants and ban Muslims have unsettled communities with changing demographics. At a Feb. 28 city council meeting, Rochelle Galindo, Greeley’s only Latina representative, proposed a resolution stating that Greeley “stands in solidarity” with its residents regardless of immigration status. Mayor Tom Norton responded belligerently, railing against sanctuary cities. Another councilman told Galindo, “You’re in the wrong community, I think.” Both men later apologized.

A few days later, Galindo shared the story with the crowd gathered on campus for the march. “If someone can say that to someone born and raised here,” she said, “imagine what they say to immigrants.” A moment later, Martinez took the mic, delivering a message she keeps repeating to local business owners, officials, professors, students, citizens and undocumented people — all of whom make the community what it is and will be: “We cannot sit on the sidelines.” □



Workers enter a project area during the Hanford cleanup.

DEPARTMENT OF ENERGY

THE LATEST

Backstory

At the Hanford Site in eastern Washington, corporations hired by the government have been working since 1989 to clean up the hazardous and complicated legacy of more than four decades of plutonium production. Over the years, the project has run into problems ranging from leaking tanks and groundwater contamination to whistleblower complaints of mismanagement and suppression of dissent (“The Hanford Whistleblowers,” *HCN*, 2/10/14).

Followup

Though work recently resumed on dismantling one of Hanford’s plutonium plants after a radiation alarm in January caused delays, the cleanup project now faces a new challenge. **Washington Sens. Patty Murray and Maria Cantwell, both Democrats, wrote to the Department of Energy’s Office of Inspector General to request an investigation of workers’ compensation at Hanford, citing worker allegations of intimidation and harassment after they filed claims.** The senators also voiced concern that the Trump administration’s recent stay of a regulation to protect whistleblowers might discourage workers from coming forward.

REBECCA WORBY

THE LATEST

Backstory

In 1995, the U.S. Fish and Wildlife Service reintroduced endangered gray wolves in Yellowstone National Park and central Idaho, and they soon spread throughout the Northern Rockies. After a series of lawsuits, in 2011 Congress delisted wolves in Montana, Idaho and parts of Washington, Oregon and Utah. ("How the gray wolf lost its endangered status — and how enviros helped," *HCN*, 6/6/11). **In Wyoming, wolves remained listed until 2012, when they came under state management. Conservation groups sued, and federal protection was restored in 2014.**

Followup

In a March 3 ruling, the D.C. Circuit Court of Appeals reversed that decision. **Wyoming's wolves will again be placed under state management,** and Wyoming will implement its 2012 plan, which allows wolves to be shot on sight across most of the state. "This decision highlights that Congress should not step in to block judicial review under the Endangered Species Act," wrote Earthjustice attorney Timothy Preso in a statement. Plaintiffs say they may ask for a rehearing.

ANNA V. SMITH



A gray wolf in Wyoming's upper Gros Ventre drainage.

MARK GOCKE/WYOMING GAME AND FISH DEPT.



Conservation groups including hunters, anglers, hikers and horsemen gather at the Montana state Capitol in Helena in January to protest the idea of the federal government transferring public lands to the states.

WILLIAM CAMPBELL/CORBIS VIA GETTY IMAGES

Sportsmen step up for public lands

A hook-and-bullet groundswell confronts legislative threats

BY REBECCA WORBY

On Feb. 2, Rep. Jason Chaffetz, R-Utah, announced his intention to withdraw a bill proposing the transfer of 3.3 million acres of federal lands to 10 Western states. "Groups I support and care about fear it sends the wrong message," he explained, alongside a photo of himself in camo, a dog in his arms. Only a week had passed since he introduced the legislation, but sportsmen's groups had taken to social media swiftly and aggressively, impelling their members to speak out publicly against it.

Chaffetz's H.R. 621 is one of several recent proposals that have struck a nerve with sportsmen. Many fear they'll lose access to the federal lands where they hunt and fish if those lands are transferred to states, which are likely to sell or develop them. The hook-and-bullet contingent has long played a significant role in conservation — especially economically, via taxes on firearms and ammunition as well as through hunting and fishing licenses. But now, more are putting their mouths where their money is: speaking out online, signing petitions, attending rallies and town halls.

Galvanized by escalating threats and the national sweep of activism since the election, sportsmen are poised to play a key role in public-lands legislation under President Donald Trump's adminis-

tration. Generally, they tend to be more conservative than other outdoor groups, supporting gun rights and small government. "We do have a little more credibility in some conservative circles," says Steve Kandell, sportsmen's conservation project director for Trout Unlimited.

The Malheur National Wildlife Refuge occupation in January 2016 "woke people up," says Land Tawney, president and CEO of Backcountry Hunters & Anglers. Although the Sagebrush Rebellion began decades ago, the "return the land" rhetoric of the Bundy family and their supporters made more sportsmen realize how deeply a small — but increasingly vocal — contingent of Westerners resents federal management of public lands. And "the drumbeat has really ramped up since the election on these issues," says Whit Fosburgh, Theodore Roosevelt Conservation Partnership president and CEO.

When Chaffetz introduced H.R. 621, sportsmen were "ready at the flick of a switch to engage," says Aaron Kindle, Western sportsmen manager for the National Wildlife Federation. His group has been preparing for public-lands battles for several years, educating and engaging members as they fought "bad bills" at the state level. It was particularly easy to mobilize people against H.R. 621 because the bill made the potential loss of public lands

tangible. "It starts to hit home," says Kindle, "when you think about those acres you won't be able to hunt in anymore."

Members of Backcountry Hunters & Anglers have organized local events across the West to get the word out, including "Public Lands Pint Nights." "They're on the ground," Tawney says. "We just amplify their voices." And the group has a lot of voices to amplify: Membership has tripled over the last year. Other groups have also seen unprecedented engagement: Kindle has been struck by the number of National Wildlife Federation members asking, "How can I write a letter? What hearing can I show up to?"

Under the Trump administration, sportsmen could wield significant influence — and not just because many of them vote Republican. It helps to have legislators and leaders who can identify with sportsmen's connection with public lands, notes Kindle: rising before dawn and hiking miles in the dark, being "purely quiet" while watching for wildlife. Trump's son Donald Jr. is a "Life Member" of Backcountry Hunters & Anglers, and Interior Secretary Ryan Zinke also hunts. And Chaffetz is among the nearly 300 members of the House and Senate who make up the long-standing bipartisan Congressional Sportsmen's Caucus.

George W. Bush's administration heeded sportsmen when they spoke out against threats to environmental protection: In 2004, hunters and anglers met with Bush and encouraged the administration to abandon Clean Water Act revisions that would have threatened wetlands and streams valuable to fish and wildlife.

Hook-and-bullet groups may also serve as a bridge between traditionally left-leaning environmental groups and the current administration when it comes to public lands. Threats to public lands are "creating one of the biggest unlikely alliances in the world," says David Allen, president and CEO of the Rocky Mountain Elk Foundation. As Tawney points out, sportsmen tend to take a middle-ground approach, while the environmental community creates a more ambitious "goal-post" to work toward. This allows groups to make more centrist deals.

Now, sportsmen's organizations intend to continue harnessing their members' energy and passion on behalf of public lands. Their message to politicians is clear: "If you think you're gonna come and tromp on the bedrock issue for all these people," says Kindle, "you're gonna have a hell of a fight on your hands." □

Rebecca Worby is an editorial intern at *High Country News*. [@beccaworby](#)

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Laura Rodriguez | Quincy, CA
Thomas Rogers & Betsy Nelson | Ocean Park, WA
Donald Ross | Dolores, CO
Stan Rovira | Hartsel, CO
Fred Royce | Helena, MT

Scott & Kathy Rudge | Boulder, CO
John Ruffner | San Luis Obispo, CA
Katrina Running | Pocatello, ID
Tom Ruppenthal & Jenna Marvin | Tucson, AZ
Terrance & Mary Lynn Ryan | Madison, SD
Joyce Ryba | Port Angeles, WA
Vanessa Saavedra | Sacramento, CA
Loren Sackett | Tampa, FL
Mary Jo Sage | Cincinnati, Ohio
Buck Sanford | Flagstaff, AZ
Mary Sari | Sterling Forest, NE
Dave Saylor | Albuquerque, NM
Stanley C. Schaefer | Denver, CO
P.B. Schechter | Denver, CO
Rodger Schmitt | Port Townsend, WA
Frances Schneider Liau | Pasadena, CA
Lucy & John Schott | McCall, ID
Carrie Scoggins | Salt Lake City, UT
Jeff Sconyers & Debra Godfrey | Seattle, WA
John Scott | Lexington, KY
Robert Sehl | Albany, NY
Richard & Judith Sellars | Santa Fe, NM
Barbara & Bud Shark | Lyons, CO
Karin P. Sheldon & James Thurber | Lafayette, CO
Jeri D. Shepherd | Greeley, CO
Leila Shepherd | Twin Falls, ID
W. Kenneth Sherck | Salt Lake City, UT
Doris & Bob Sherrick | Peculiar, MO
Christine & Mike Siddoway | Colorado Springs, CO
Valerie & Scott Simon | Twentynine Palms, CA
Jack & Joanne Sites | Orem, UT
Daniel Slater & Ann Wiemert | Grand Junction, CO
Robert L. Slatten | Sumas, WA
Doug & Joanne Smith | Steamboat Springs, CO
Erma J. Smith | Lake George, CO
Larry & Debbie Smith | Butte, MT
Larry & Margie Smith | Johnstown, CO
Robert B. Smith | Idyllwild, CA
Florian & Lou Smoczynski | Madison, WI
Mary Lou Soscia | Portland, OR
Sam H. Sperry & Joyce Beckes | Helena, MT
Alicia Springer & Christopher P. Thomas | Chico, CA
Wendy Spurr | Grand Junction, CO
Carrie Starr | Mountain Center, CA
Sherman Stephens & Martha Taylor | Flagstaff, AZ
Darlene Marie Steward | Boulder, CO
Jim & Peggy Stewart | Ferndale, WA
Lon R. Stewart | Boise, ID
James Stickman | Seattle, WA
Rick & Lynne Stinchfield | Pagosa Springs, CO
Marilyn Stone | Paonia, CO
Daniel Stonington | Seattle, WA
David & Miriam Stout | Salida, CO
Louis E. Strausbaugh | Colorado Springs, CO
Bill Strawbridge & Meg Wallhagen | Mill Valley, CA
Laura Stuntz | Fort Collins, CO
Andrea Suhaka | Centennial, CO
Donald Sullivan | Denver, CO
Steve Swanson & Val Metropoulos | Aberdeen, WA
Diane Szollosi | Lafayette, CO
Liz Taintor | Steamboat Springs, CO
Theodore Taylor & Denise Stone | La Grande, OR
Beth Thebaud | Wilson, WY
Alice Thomassen | Belfair, WA
Pierre Thompson | Aztec, NM
Russell B. Toal | Santa Fe, NM
Mike Todd | Phoenix, AZ
Larry E. Tomberlin | Mountain Home, ID

Chuck Tonn | Port Orford, OR
Janet & Greg Torline | Harrison, ID
Constance L. Trecartin | Tucson, AZ
Janna Treisman | Fall City, WA
Dale & RuthAnn Turnipseed | Twin Falls, ID
Jessica Turnley | Albuquerque, NM
William Tweed | Bend, OR
Chuck Twichell & Mary K. Stroh-Twichell | Santa Rosa, CA
R.T. Twiddy | Mesquite, NV
James Tydings | Boulder, CO
Bruce Van Haveren | Evergreen, CO
William Vancil | Eloy, AZ
MaryBeth & Mark Vellequette | Boulder, CO
Eve Vogel | Amherst, MA
Chrilo Von Gontard | Bainbridge Island, WA
Kirk & Kris Vyrberg | Sacramento, CA
Ellen R. Walker | Florissant, CO
Kody Wallace & Gary W. Donaldson | Salt Lake City, UT
Fred Walls | Lafayette, CO
Eric Waltari | Brooklyn, NY
Beth Walukas | Lummi Island, WA
Robin Waples & Paula Jenson | Seattle, WA
John Ward | Klamath Falls, OR
Vicki Warner-Huggins | Ridgway, CO
John & Paula Warren | Garden City, ID
Cathy & Norman Weeden | Bozeman, MT
Stephen C. Weeg & Nancy Greco | Pocatello, ID
John M. Weh | Seattle, WA
N.C. Weil | Denver, CO
Mary Weisberg | San Mateo, CA
Michael T. Weiss | Longmont, CO
Robert & Jill Welborn | Prineville, OR
Toby Welborn | Carson City, NV
David L. Wells | Grizzly Flats, CA
David Wells | Twin Falls, ID
Miriam Wells | Loveland, CO
Richard & Barbara Wells | Moscow, ID
Gordon West | Silver City, NM
Bruce Weydemeyer & Charlotte Kinney | Santa Fe, NM
George Whatley | Spokane, WA
Bryce A. Wheeler | Mammoth Lakes, CA
Marilyn Whittaker | Lafayette, CO
James Willett | Kalispell, MT
Byron Williams | Saguache, CO
Steve Williams | Denver, CO
Bill Wilson | Seattle, WA
Sharon L. Wilson | Aurora, CO
George Winters | Darrington, WA
Grant & Barbara Winther | Bainbridge Island, WA
Janet Wise & Paul Michalec | Lakewood, CO
John Wise | Hidden Valley Lake, CA
Liz Wise | Vernon, AZ
Lee Witter | Bellevue, WA
Barbara Wolf | Sacramento, CA
Sheldon Wood | Centerville, UT
Greg Woodall | Hurricane, UT
Steve & Susan Woods | Shoreview, MN
Jack L. Wright | Bremerton, WA
James & Brenda Werz | Fort Collins, CO
Thomas C. Wylie | Centennial, CO
Ronald Yankey | Boise, ID
Chris Yoder | Baltimore, MD
Dave Yokel & Kathy Taylor Yokel | Fairbanks, AK
Larry Young | Salt Lake City, UT
Marianna Young | Monte Vista, CO
Richard C. Young | Carlsbad, NM
Paul Zarn | Petaluma, CA
Wendy Zeigler & Jamie Longe | Holladay, UT

A dramatic photograph of a wildfire. Thick, billowing white and grey smoke rises from a dark forest, partially obscuring the sky. Bright orange and yellow flames are visible along the ridges of the forest in the lower portion of the image. The overall scene is one of intense heat and danger.

FIRESTORM

Inside the dangerous and unpredictable behavior of wildfire

FEATURE BY DOUGLAS FOX



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Smoke rises from the Pioneer Fire, burning in the Boise National Forest in Idaho in 2016. Scientists are discovering new ways to see inside the smoke to better predict fire behavior.
KARI GREER

Aircraft N2UW has flown through all kinds of weather. The twin-propeller plane is sleek, petite, and so packed with scientific gear for studying the atmosphere that there's barely room for two passengers to squeeze into its back seats. Monitors show radar reflections, gas concentrations and the sizes of cloud droplets. The plane has flown through tropical rainstorms in the Caribbean, through the gusting fronts of thunderheads over the Great Plains, and through turbulent down-slope winds that spawn dust storms in the lee of the Sierra Nevadas. But the four people on board Aug. 29, 2016, will never forget their flight over Idaho.

The plane took off from Boise at 4 p.m. that day, veering toward the Salmon River Mountains, 40 miles northeast. There, the Pioneer Fire had devoured 29,000 acres and rolled 10 miles up Clear Creek

Canyon in just a few hours. Its 100-foot flames leaned hungrily into the slope as they surged uphill in erratic bursts and ignited entire stands of trees at once.

But to David Kingsmill, in the plane's front passenger seat, the flames on the ground two miles below were almost invisible — dwarfed by the dark thing that towered above. The fire's plume of gray smoke billowed 35,000 feet into the sky, punching into the stratosphere with such force that a downy white pileus cloud coalesced on its underside like a bruise. The plume rotated slowly, seeming to pulse of its own volition, like a chthonic spirit rising over the ashes of the forest that no longer imprisoned it. "It looked," says Kingsmill, "like a nuclear bomb."

Undaunted, Kingsmill and the pilot decided to do what no research aircraft had done: Fly directly through the plume.



An N2UW research plane flies over the Pioneer Fire smoke plume. NICK GUY/UNIVERSITY OF WYOMING

**"We've never
seen this kind
of structure in
a fire plume,
ever."**

*—Fire meteorologist Craig
Clements commenting
on data collected from
the Pioneer Fire*

Orange haze closed around them, then darkened to black, blotting out the world. Kingsmill felt his seat press hard against his back as the plane lifted suddenly, like a leaf in the wind. Then the black turned back to orange. The plane jolted and fell. Pens, cameras and notebooks leaped into the air and clattered against windows. A technician slammed headlong into the ceiling. A moment later, N2UW glided back into daylight.

According to the plane's instruments, it had been seized by an 80 mph updraft of hot, buoyant air, followed by a turbulent downdraft. It was "the strongest updraft I've ever flown through," says Kingsmill, a precipitation and radar scientist at the University of Colorado in Boulder. Even stronger forces were at work several thousand feet below: The plane's radar waves, reflecting off rising smoke particles, had registered updrafts exceeding 100 mph.

Hundreds of miles away, Kingsmill's research partner, Craig Clements, a fire meteorologist at San Jose State University, watched the plane's flight path creep across a map on his laptop screen. The unfolding drama offered a tantalizingly detailed glimpse into the anatomy of an extreme wildfire. "It's amazing," says Clements. "We've never seen this kind of structure in a fire plume, ever." For decades, scientists have focused on the ways that topography and fuels, such as the trees, grass or houses consumed by flames, shape fire behavior, in part because these things can be studied even when a fire isn't burning. But this line of inquiry has offered only partial answers to why certain blazes, like the Pioneer Fire, lash out in dangerous and unexpected ways — a problem magnified by severe drought, heat and decades of fire suppression.

A mere 1 percent of wildfires account for roughly 90 percent of the land burned each year in the Western United States. Some of these fires "really are unprecedented," says Mark Finney, of the U.S. Forest Service's Missoula Fire Sciences

Laboratory. Their behavior "is particularly threatening because we don't have a good way to anticipate or predict (it)." So Finney, Clements and a handful of others are increasingly turning their gaze to fire's invisible and diaphanous incarnations: the hot, roiling gases and smoke swirling among the flames, and the rising plumes they coalesce to form.

There, they believe, lies the key to understanding the way a wildfire breathes — roaring into conflagration with bigger gulps of oxygen or sputtering along more slowly on little sips. How it moves, spawning lethal fireballs or hurling burning logs ahead of the flames. The way it grapples with the upper layers of the atmosphere, sending embers in unexpected directions to propagate itself across the land. Even, perhaps, the role its elemental opposite — water — plays in driving its explosive growth.

Nailing those connections could provide new tools for monitoring fires and predicting their behavior. This could give firefighters precious minutes of advance warning before potential catastrophes, and better inform the difficult decision to order an evacuation.

But it won't be easy. "The plume is orders of magnitude harder to study than the stuff on the ground," says Brian Potter, a meteorologist with the Pacific Wildland Fire Sciences Laboratory in Seattle who sometimes works with Clements. Indeed, it took a global conflagration much darker than any forest fire to even begin laying the foundations of this work. Kingsmill's observation about the bomb, it turns out, isn't far off.

The evening of July 27, 1943, was stiflingly hot in Hamburg, Germany. The leaves of oak and poplar trees hung still in the air as women and teenagers finished factory shifts and boarded streetcars. They returned home to six-story flats that lined the narrow streets of the city's working-class neighborhoods. They opened windows to let in cooler air, and folded

themselves into bed. It was nearly 1 a.m. when British planes arrived.

Searing yellow flares drifted down over the city, dropped to mark the city's eastern quadrant as that night's target. Bombs followed, tearing open buildings and exposing their flammable contents to a rain of incendiary canisters that hissed as they fell.

Thousands of small fires sprang up. Families retreated into basements. The buildings above them roared into flame, and these growing fires greedily sucked air from their surroundings. Their collective inhalation drew winds through the narrow urban canyons, pulling along embers that ignited yet other buildings. Within minutes, the fires were merging.

The British historian Martin Middlebrook has collected the accounts of survivors who dampened their clothing, fled their bunkers and crawled through the streets. They described the inflowing winds as "shrill," "shrieking" and "howling" — the scream of "an old organ in a church when someone is playing all the notes at once." Gales exceeding 110 mph uprooted trees, pushed struggling full-grown adults deeper into the fire zone, and sucked babies and elders into burning buildings.

The winds swirled into flaming tornadoes that swept up people and turned them into "human torches." Balls of fire shot out of buildings. Within 60 minutes, a spiraling pillar of smoke had swelled into an anvil-shaped thunderhead that towered 30,000 feet over the city.

At least 42,000 people died, and another 37,000 were injured. Sometime during the night, someone scribbled a word for the unspeakable destruction into the logbook of the Hamburg fire department: "feuersturm" — in English, "firestorm."

Such cataclysms had occurred before. Fires destroyed London in 1666, Peshtigo, Wisconsin, in 1871, and San Francisco following the 1906 earthquake. But Hamburg might have been the first time that people intentionally created a firestorm, with chilling calculation.

The British chose to bomb that section of the city, not just to demoralize the workers in Germany's critical U-boat industry, but also because of the tightly packed buildings that covered 45 percent of its ground area. And their tactics were almost certainly influenced by experiments begun four months earlier, across an ocean and half a continent, on a remote desert playa in northwest Utah.

There, the U.S. Army's Chemical Warfare Service had commissioned Standard Oil Development Company to construct a row of steep-roofed European-style apartment buildings. Erich Mendelsohn, an architect who had fled Nazi Germany, specified every detail: 1 1/4-by-2-inch wood battens, spaced 5 7/8 inches apart, to hold the roof tiles; 1-inch wood flooring underlain by 3 1/2-inch cinderblocks, and so on — all to replicate the dwellings of German industrial workers. The wood was maintained at 10 percent moisture to mimic the German climate. Rooms were outfitted with authentic German curtains, cabinets, dressers, beds and cribs — complete with bedding — laid out in traditional floor plans.

Then, military planes dropped various combinations of charges on the buildings, seeking the most efficient way to penetrate the roofs and lace the structures with flame.

Those experiments offered clues on what factors could cause firestorms. And in the years following World War II, scientists would study Hamburg and other bombing raids to derive basic numbers for predicting when a firestorm might form: the tons of munitions dropped per square mile, the number of fires ignited per square mile, and the minimum area that must burn. They concluded that Hamburg's unusually hot weather set the stage for the firestorm, by making the atmospheric layers above the city more unstable and thus easier for a smoke plume to punch through. Scientists theorized that this powerful rise had drawn in the winds that whipped the flames into even greater fury.

Later, scientists studying urban fires during the Cold War noticed something that underscored this finding: When a fire plume rotated, the rate of burning seemed to increase on the ground. It suggested that rotation lessened the drag between the plume and its surrounding air, allowing it to rise more strongly and pull in fresh oxygen more effectively on the ground.

Fire is so universally familiar that we take for granted that we



A model German apartment building goes up in flames during a test of the M-69 incendiary bomb in the 1940s at Dugway Proving Ground, in Utah.

STANDARD OIL DEVELOPMENT COMPANY



A Lancaster plane flies over Hamburg, Germany, in 1943. On the night of July 27, 1943, more than 700 planes dropped bombs that started the Hamburg firestorm.

IMPERIAL WAR MUSEUM



An aerial view shows ruined buildings in Hamburg, Germany, after the bomb-induced firestorm, in July 1943.

IMPERIAL WAR MUSEUM

understand how it works. And yet these old experiments, finished by 1970, are still a key source of knowledge about extreme fire behaviors. Until recently, technology was simply too limited to reveal much more about the specific mechanisms by which a fire plume might feed a firestorm, let alone how beasts like fire tornadoes and fireballs form. Scientists needed new ways to see within the smoke and turbulent flames — to make the invisible visible. And as it happens, they began finding them almost by accident.

One morning in February 2005, Craig Clements watched as a 6-foot wall of flame crept across a prairie a few miles outside Galveston, Texas. He was not yet a fire scientist; in fact, he was slogging through his seventh year of graduate school, studying a completely unrelated topic — mountain winds. This was just a side project, a favor he was doing for his Ph.D. advisor at the University of Houston, who had a steel weather tower in the field. A prescribed fire had been planned there to prevent fuel buildup that could cause a more serious blaze. What would happen, they wondered, if they mounted extra instruments on the tower to measure the winds, heat

The Bald and Eiler fires in Northern California were only 10 miles apart, but they traveled in opposite directions, different than what could be predicted based on just the wind.

RYAN ALBAUGH



and gases released by the fire passing directly beneath it? The results were stellar: Clements' sensors showed that the flames produced a surprisingly strong pulse of water vapor.

Scientists knew, theoretically, that the combustion of dry plant matter would release water vapor along with carbon dioxide, but it had never been measured this carefully in a real fire. And when Clements showed his work at a conference several months later, scientists there implored him to do more experiments. "It rescued my life, my academic career," Clements now says. "Totally."

Clements abandoned his previous line of study and landed a faculty job at San Jose State in 2007, where he continued his research. His instrument towers, deployed in carefully controlled fires, provided yet more unprecedented and precise measurements: how winds accelerate and draft into an advancing flame front, the heat and turbulence above the flames, and the speed of the rising hot air.

Still, dangerous behaviors like fire tornadoes, or lofting of embers, usually happen in much larger fires than experiments can replicate. And the plumes of those fires rise thousands of feet. Clements was capturing the action only within a few feet of the ground. And he was just getting point measurements — like following a single bird to understand the movement of an entire flock wheeling in the sky.

Clements wanted to capture the whole phenomenon — to look inside the opaque mass of an entire fire plume from a distance, and see all of its parts swirling at once. In 2011, he found his lens: a technology called Doppler lidar.

Unlike the Doppler radar that police use to measure the speed of passing cars, lidar is tuned to detect reflections of its low-powered laser off particles smaller than red blood cells. It actually scans the sky, collecting thousands of pinpoint measurements per second, which can be reassembled into a picture of both the plume's surface and its internal air currents. Clements and his then-Ph.D. student, Neil Lareau, mounted this television-sized gadget in the back of a pickup truck and hit the road in search of wildfires.

In June 2014, live ammunition fired during an Army training exercise afforded them the chance to watch a fire roll through 4,800 acres of grass and oak hills at the Fort Hunter Liggett training ground in California. They watched through lidar as a rotating

column of smoke stretched, narrowed, and accelerated into a fire tornado two football fields across, with winds swirling 30 mph.

These tornadoes, or "whirls," can pose sudden dangers in wildfires. During a 1989 blaze near Susanville, California, a powerful whirl raced out of a flame front, with winds estimated at 100 mph. Three fire engines retreated just in time to escape being torched, but four crewmembers were hurled into the air — all of them seriously burned.

For now, fire whirls are nearly impossible to predict. But that afternoon at Fort Hunter Liggett, Clements and Lareau began to get a sense of how they form.

It was an eerie and beautiful process, hidden deep inside the smoke column. First, an embryonic disturbance in the fabric of the plume: Hot rising gases began to rotate with the motion of an air current coming from the side. This vague motion coalesced into two small, separate whirls. They circled around one another like dancing, swaying cobras preparing to mate, then merged into a single powerful vortex.

"The laser is seeing through a lot of the smoke," says Lareau. "It's showing you something that you can't necessarily see by the naked eye about what the fire is doing." If firefighters had access to similar technology, they could potentially recognize an impending whirl in real time before it forms, and escape.

A month after Fort Hunter Liggett, Clements and Lareau stumbled onto another discovery at the 17,000-acre-and-growing Bald Fire, north of Lassen Volcanic National Park in California. On a warm, hazy morning, the pair sped in their pickup truck along Highway 44, south of the fire, looking for a good vantage point for seeing the plume. From the bed of the truck, their lidar and radar wind profiler pointed straight up at the sky, recording the smoke, winds, and clouds directly overhead. Then the highway began to gradually descend down the slope of the volcanic plateau where the fire burned, and they noticed something strange. Even as the winds thousands of feet up blew north, the smoke just below those winds was drifting steadily south.

They spent the rest of the day following the broad mass of smoke as it oozed 20 miles downhill, like a gauzy, viscous lava flow in the sky. During that drive, they downloaded weather and satellite images of the broader smoke plume from both the Bald Fire and the similar-sized Eiler Fire, 10 miles to the south-

west of it. A surprising picture emerged.

Smoke from the Bald Fire had shaded broad swaths of the landscape — cooling the ground, and several thousand feet of air above it, by a few degrees. Even as the winds blew north, this cool, dense air was rolling downhill like molasses, pushing under the winds as it followed the contours of the land — carrying a layer of smoke 6,000 feet thick along with it.

“We had no idea we were going to see things like that,” says Lareau, who now holds a faculty position at San Jose State. “It seems like every time we go, we end up with new perspectives.” The team’s insight about the Bald and Eiler fires has implications for predicting smoke and air quality — a constant concern for communities near large fires. It also impacted the fires themselves. Even though both fires existed in the same atmospheric environment of pressures and winds, and burned across similar terrain, they were spreading in opposite directions that day — Bald to the south, and Eiler to the north. This denser current of cold air and smoke was actually pulling the Bald Fire in the opposite direction of what was predicted based on wind alone.

Clements imagines a future in which lidar is not simply a tool of research, but also standard equipment mounted with automatic weather stations on fire trucks.

This device would theoretically be much smaller and cheaper than current technology. It scans the plume continuously to obtain real-time data, which “is then uploaded into a mainframe computer that’s running a fire-weather model,” says Clements, “and boom, problem solved.” The fire crew would receive a fire-behavior forecast that reflects detailed information about a plume’s evolving structure — something not currently possible. That forecast could warn about impending events, such as a strengthening updraft that might conspire with winds higher up to toss embers into unburnt areas, or an incipient plume collapse that might splash the fire and hot gases in unexpected directions.

Yet even in its ideal form, that bit of technology wouldn’t be able to forecast everything: Some extreme fire behaviors are driven by smaller-scale forces that even lidar can’t capture. Scientists suspect these might be responsible for some of the more tragic firefighter deaths in recent years.

The South Canyon Fire hardly seemed threatening at first. Lightning started it on July 2, 1994, atop a ridge overlooking Interstate 70, a few miles west of Glenwood Springs, Colorado. It crept at a civil pace down the mountain’s slopes, through dry grass and Gambel oak. Then, around 3 p.m. on July 6, a cold front swept over the area, spawning winds that pushed the lower part of the fire across the mountain’s southern face — igniting the base of an unburned drainage. The fire crew working there may not have realized their peril until too late.

Fourteen firefighters were crossing the drainage as the fire entered its lower reaches. The flames quickly gained on them as they hurried diagonally across it, toward the ridge top, following a firebreak through the dense vegetation that they had cleared the day before. Firefighter Kevin Erickson, a couple hundred feet in front of the others, glanced back to see a wall of flame advancing up the sides of the gully before he crested the ridge and scrambled down its other side. Firefighter Eric Hipke was 45 seconds behind him. His pace quickened as the heat grew unbearable. Several steps short of the ridge top, a blast of searing air struck him from behind. He slammed to the ground with a yell, then scurried to his feet, shielding his face from a maelstrom of smoke and flying embers, and sprinted over the top.

Hipke was the last person to reach the ridgeline alive. Only later did he realize that his backpack’s shoulder straps had melted through, leaving it bobbing from his waist belt. He sustained third-degree burns across the back of his arms, legs, torso and head. The bodies of the 12 remaining crewmembers were found that evening. (Two from another party, who died in a separate part of the blaze at the same time, were found July 8.) Hipke’s crew was strung out along the path they’d been following, some with their backpacks still on — as though overcome, simultaneously, by a sudden force.

Observers have speculated for years about what, exactly, killed them. The fire may have overtaken them or a gust of wind

may have pushed the hot gases of the plume down onto them. In the years since, however, scientists have uncovered another possibility — a type of blowup that may have caused multiple fatalities over the years, but left no survivors to describe what happened.

Like Clements, Janice Coen stumbled onto these questions by accident. Coen works at the National Center for Atmospheric Research in Boulder, Colorado, where she studies fire’s inner workings. In September 1998, she spent several hours aboard a Hercules C-130 aircraft as it circled over Glacier National Park. The McDonald Creek Fire was marching up a steep slope at roughly three feet per second. Its smoke obscured the advancing flames, but infrared video cameras mounted outside the plane recorded what was happening underneath. It was only later, as Coen looked through individual frames of that video, that she noticed something strange: At one point, a jet of flame seemed to shoot ahead of the fire. It lasted only a second or two, but left a trail of newly ignited vegetation in front of the fire. Not until Coen calculated the size of the pixels and the time between frames could she appreciate its true significance.

The jet had surged 100 yards ahead of the fire’s front, advancing 100 mph — “like a flamethrower,” she says. It was 10 times faster than the local wind — generated, somehow, by the fire’s own internal tumult.

Coen called it the “finger of death,” and for her it brought to mind the unconfirmed reports of fireballs that occasionally circulated among firefighters. She had never seen such a thing, but as she examined footage of other fires, she was surprised to find fire jets again and again. Her infrared videos were in some ways akin to those classic blurry clips of Sasquatch walking in a forest — a strange and fleeting embodiment of fire’s turbulence, without clear explanation for its existence.

When you think about turbulence, what comes to mind is something felt but not seen — like a bumpy airplane ride, where the air currents themselves are invisible. Only in the special case of fire is it possible to see turbulence with the naked eye — sort of. The flames are composed of hot, glowing gases; their flickers and licks are the roiling movements of those gases. That movement unfolds too quickly for the eye to comprehend. So Finney has spent years slowing down videos of fire in experiments at his Missoula laboratory, rewinding and replaying them, exposing the secret details that have long hidden in plain view. An advancing flame front seems chaotic. “But there is organization in there,” he says. There are “flame structures that (are) very repeatable.”

In his lab experiments, Finney used high-speed cameras to watch what amounted to miniature forest fires: walls of flame advancing through hundreds of cardboard “trees” the size of matchsticks.

The advancing flame front resembles a jagged-toothed saw blade at any given instant, with interspersed high and low points, flickering several times per second. But slow it down, watch a single one of these high points, and you begin to perceive something more complex. The flickering peak of flame repeatedly curls over on its side, like a surfing wave in Hawaii, viewed edge-on as it rolls into a pipe and crashes on itself.

This churning wave of flame rolls over and over, staying in roughly the same place. It is a horizontal, rolling current, driven by the constant push and pull of gases within the fire. Combustion gases heated to 1,800 degrees Fahrenheit are only one-quarter as dense as ambient air — a difference that makes them more buoyant and causes them to rise, creating the flickering peaks of flame. Cooler, denser gases rush downward to fill the void, driving the downward side of the rolling current and pressing down on the fire to create low spots in the flame front.

Finney’s slow-motion videos show that these rolling eddies exist in pairs within the fire. They roll in opposite directions, coupled like interlocking gears. Their combined motion periodically pushes down on the advancing front of the fire, causing flames to lick downward and forward, ahead of the fire.

Finney believes that these forward flame-licks are scaled-down versions of the “fingers of death” that Coen has seen in wildfires — possibly even related to the fireballs said to have shot out of buildings during the 1943 Hamburg firestorm.

Coen has actually documented similar flame-rollers in real

A rotating column of smoke stretched, narrowed, and accelerated into a fire tornado two football fields across, with winds swirling 30 mph.

Mark Finney and other scientists observe fire spreading in a wind tunnel at the U.S. Forest Service's Missoula Fire Sciences Laboratory. The experiments are filmed with high-speed cameras so that the fire's movement can be better observed once the footage is slowed down.

RICHARD BARNES/OTTO



The flickering peak of flame repeatedly curls over on its side, like a surfing wave in Hawaii, viewed edge-on as it rolls into a pipe and crashes on itself.

wildfires using infrared video. But she believes that the finger of death also requires another factor. As bushes and trees are heated by an approaching fire, their decomposing cellulose releases hydrogen, methane, carbon monoxide and other flammable gases in a process called pyrolysis.

Coen and Shankar Mahalingam, a fluid-dynamics engineer at the University of Alabama in Huntsville, believe that rolling currents can mix these flammable gases with oxygen-rich air. "The dangerous situation is when the fire is going up on a hill," says Mahalingam. "Maybe there are pyrolysis products that have accumulated" in front of the fire and mixed with fire-boosting oxygen. As the flame licks forward into this invisible tinderbox, it ignites a blowtorch.

Reflecting back on the South Canyon Fire in 1994, it is tempting to wonder whether the same blast that flattened Hipke near the ridge top also killed the 12 firefighters behind him — one of them just 40 yards back. Some have even speculated that Hipke would have died along with them — his lungs seared by hot combustion gases — had he inhaled rather than yelled as he fell to the ground. Coen sees the South Canyon tragedy as one of several likely caused by the "finger of death" — a monster created by the turbulent respiration of the fire itself and the violent rise of its hot, buoyant gases.

These same buoyant gases also supply the momentum that drives a fire whirl to spin once it is triggered. And on a much larger scale, they are what pushes a fire plume ever higher in the sky, powering the in-drafts that keep the fire burning below.

But the source of the speed and energy with which these gases rise is still the subject of intense speculation. Potter, of the Pacific Wildland Fire Sciences Laboratory, has found some surprising possible answers. They arise, in part, from some of those old military fire experiments — these particular ones conducted in the aftermath of World War II by a U.S. government that feared the devastation of Hamburg might represent the future of modern warfare.

In the wrinkled, sage-covered mountains of Nevada near the California border, 30 miles east of Mono Lake, there is a meadow that seems to lie in shadow even on sunny days. Spread across it are hundreds of dark patches, where the soil

is mixed with charcoal. These spots lay row upon row, like the ghostly foundations of a dead city. In a sense, that is exactly what they are.

In 1967, workers with the Forest Service and the Department of Defense stacked 342 piles of juniper and piñon logs in this place — 20 tons of wood per pile, spaced 25 feet apart. Then, at 8 a.m. on Sept. 29, they set fire to them.

Project Flambeau comprised some two-dozen experiments like this one, meant to simulate an American suburb under nuclear attack — specifically, the many small fires that would merge into a storm, as happened not only in Hamburg, but also Hiroshima and Nagasaki.

Lengthy reports describe how helium balloons released near the fire here rose several hundred feet, then swooped down into the flames, revealing strong downdrafts feeding the fire from its sides. But what drew Potter's interest was the water. Concentrations of water vapor rose 10 to 20 times higher than the surrounding air.

Water is a major product of combustion, second only to carbon dioxide. It forms as oxygen binds to the hydrogen atoms in wood, gasoline or just about any other fuel — creating hydrogen oxide, otherwise known as H₂O. Burning four pounds of perfectly dry wood releases a pound or two of water.

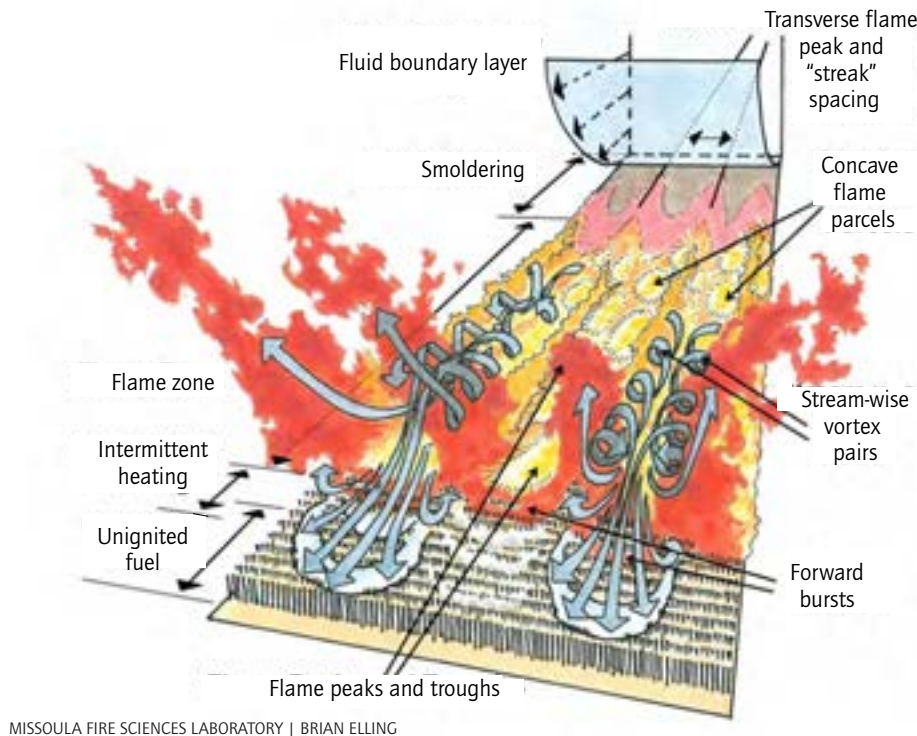
Exhale onto a car window and you will see another form of the same phenomenon, fogging the glass: water produced from the oxidation of food you have eaten. This vapor is familiar and mundane; it hardly seems like a violent force.

And yet water vapor fuels the strongest updrafts in nature, says Potter, from thunderstorms to tornadoes to hurricanes. As moist air rises during these storms, the water vapor condenses into cloud droplets, releasing a small amount of heat that keeps the air slightly warmer than its surroundings, so it continues to rise. "Water," he says, "is the difference between a weak updraft and a really powerful updraft."

Potter wondered if the water vapor released from combustion might infuse extra energy into wildfire plumes. By condensing and giving off heat, it might allow some plumes to rise higher and faster, accelerating the fire on the ground.

Through a bit of serendipity, this theory actually led to Clements's first fire experiment — the prescribed prairie burn back

HOW FIRE MOVES



MISSOULA FIRE SCIENCES LABORATORY | BRIAN ELLING

Gazing at a fire like one modeled here — hopefully from a safe distance — you'd first notice the **flame zone**. Paired spirals — or vortices — of spinning air give fire its **flame peaks and troughs**. **Vortex pairs** push the flames down into the fuel. The fire spreads through **forward bursts**. Like waves of water breaking on a beach, waves of flame splash onto **unignited fuel**, several times a second, causing **intermittent heating** and cooling. Meanwhile, **concave flame parcels** — small dishes of flames — splash throughout the flame zone. In **smoldering** combustion, the charcoal left behind by a fire burns like the charcoal in a grill. **Peak and "streak" spacing** of charcoal reveals the pattern of the fire that passed through. The charcoal under the peaks burns brighter and glows longer because it had less oxygen during the burn. Sometimes wind is induced by fire; sometimes it drives a fire. The **fluid boundary layer** indicates the air that's an important part of a fire. A fire segment like this one would be part of a very dynamic, variable conflagration expanding to the left and right for a very long way. The entire flame zone would be moving, and hopefully so would you. **MAYA L. KAPOOR**

in 2005. It was Potter, who happened to know Clements' Ph.D. advisor, who suggested it. Neither the results of Clements' experiment nor those of Flambeau were conclusive about the importance of this pulse of water vapor. Still, some people have latched onto the theory.

Michael Reeder, a meteorologist at Monash University in Australia, is one of them. He believes that water was pivotal in fueling the firestorm that swept through the suburbs of Canberra, the Australian capital, on Jan. 18, 2003.

The fire consumed 200,000 acres of drought-stricken territory that day, isolating the city under a glowing haze of Halloween orange. Remote infrared scans suggest that during a single 10-minute period, it released heat equivalent to 22,000 tons of TNT — 50 percent more than the energy unleashed by the atomic bomb dropped on Hiroshima.

A series of four pyrocumulonimbus clouds rose into the stratosphere that afternoon. These fire-fueled, anvil-shaped thunderheads lofted black, sooty hail up to six miles away. One of them spawned a tornado that snapped the tops off pine trees as it plowed a path of destruction 12 miles long and a quarter-mile wide.

The tornado and the height of the clouds "point to something extraordinary," says Reeder. "(They) require moisture — and the question is: How do you get that much moisture over eastern Australia during drought conditions?"

Combustion provides a plausible source for it. Reeder estimates that the fire incinerated over 2 million tons of wood and vegetation that day, liberating at least a million tons of water vapor into the sky.

The temperature and density differences that drive such cataclysmic power can seem deceptively minuscule. When N2UW flew through the plume of the Pioneer Fire in 2016, its instruments registered updrafts of 80 to 100 miles per hour. Yet at that elevation, 8,000 feet above the flames, the interior of the plume was only 3 to 6 degrees Fahrenheit warmer than the surrounding air, meaning that its buoyant stampede through the atmosphere was powered by a density difference of just about 1 percent.

In other words, given the right atmospheric conditions, a few degrees of warmth and extra buoyancy could spell the difference between a plume that pushes 40,000 feet up, into the

stratosphere, powering a vicious blaze on the ground — as Pioneer did — and one whose smoke never escapes the top of the boundary layer at 3,000 feet, leaving the fire stunted, like a weather-beaten dwarf tree gasping for life at timberline.

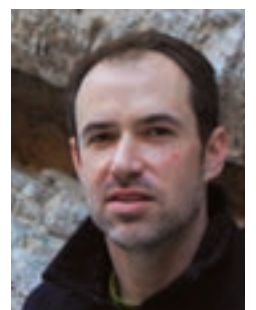
N2UW made two more passes through the plume of the Pioneer Fire on Aug. 29. During that third and final pass, static electricity roared through the cockpit radio. Concerned that lightning from the plume might strike the plane, the pilot turned off his antenna.

That flight yielded far more than the first direct measurement of a plume's updraft. Days later, Clements found himself looking at a portrait of the fire's plume unlike any that has existed before: a vertical MRI slice of sorts cut along the path of the plane—captured by its fine-tuned scientific radar, aimed straight down.

Color-coded by the velocity of its air currents, the blotchy mass resembled a hovering spirit — large-headed, legless and deformed. Clements's trained eye began to pick out some basic structures: a 40 mph downdraft next to a 60 mph updraft signified a turbulent eddy on the edge of the plume. Hot air pushing up past cooler, stationary air had set in motion a tumbling, horizontal vortex — the sort of thing that could easily have accounted for the plane's brief freefall. Those blotchy radar pictures may finally allow us to see through wildfire's impulsive, chaotic veneer — and perceive the more predictable, underlying forces that guide its behavior. "We didn't even know this would work," said Clements. "This is the most exciting thing I think I've ever seen in my career."

Simply seeing can be transformative. Not until people saw microbes could they comprehend and fight diseases like malaria — once blamed on foul spirits or miasmas. And not until Earth's colorless, odorless magnetic field became visible could people appreciate how it shaped the planet's environment.

While the smoke plume of the Pioneer Fire was apparent to the naked eye, the violent forces within it were also deceptively invisible. As the plane first approached it on Aug. 29, the pilot's standard weather console showed the plume as nothing but a swath of cool blue — a seemingly gentle updraft, with no hint of what lay in wait. □



Douglas Fox is a freelance writer based in Northern California. His stories have appeared in *Scientific American*, *Discover*, *Nature*, *Esquire*, *Virginia Quarterly Review*, *National Geographic*, and *The Best American Science and Nature Writing*.

This coverage is supported by contributors to the High Country News Enterprise Journalism Fund.

Spring break, snowpack and tricky ravens

Melissa Muñoz and Katja Nasr picked up some of the latest issues as well as information about a BLM development plan for the valley where *High Country News* is based.
BROOKE WARREN

The daffodils are bright and the apricot tree behind the *High Country News* office in Paonia has burst into bloom. Spring is here — we think — so we'll be taking one of our quarterly publishing breaks and skipping an issue. Look for another issue May 1.

As the days slowly lengthen, our visitors are returning like the robins on the back patio. In the first days of March, a group of friends who'd met on the Appalachian Trail stopped by. **Gary** and **Kiki**, who live in the North Fork Valley, and visiting friends **Awesome** and **Possum** (those are

trail names, per AT tradition) had a story to share: The day before their visit, they'd rescued a man who'd broken the top of his femur in Dominguez Canyon, west of town — carrying him more than a mile to the parking lot. His hip was replaced that evening. Our readers are real American heroes.

Melissa Muñoz and **Katja Nasr** also came by. Melissa used to volunteer with public health campaigns in Denver and now lives in Paonia, where she works on environmental issues on the Western Slope. It has been an "eye-opener," seeing how hydraulic fracturing could impact a place like the North Fork Valley, she says. Katja, who has been an environmentalist since the 1960s, protested at Rocky Flats, the infamous former nuclear weapons facility near Denver. Thanks for sharing your stories with us!

Father-son duo **Pete** and **Riley Gang** of Petaluma, California, stopped by on a sunny day in mid-March. Riley was on the road for a ski trip through the Western U.S. and Whistler and Banff in Canada, for about two months, taking advantage of this year's awesome snowpack. His dad flew out to join him for two weeks, and the pair made time to visit us in Paonia. They appreciate *HCN's* mix of environmental

news and politics, Pete says. "We enjoy the honest news of the West," Riley adds. Enjoy the sun and the snow, you two!

Some news on an old friend: Storyteller and desert-reveler **Katie Lee's** folk opera will be performed in Cottonwood, Arizona, this May. Katie originally wrote *Maude, Billy & Mr. 'D'* years ago, based on a story by author **Helen Eustis**. The story, which details a journey of love and death in the West, will be produced with fellow Arizona folksingers.

Lastly, a few corrections from the travel issue (*HCN*, 3/6/17). In her essay "An expedition through the Edgelands," Diane Sylvain wrote that certain ravens introduced themselves as "Corvus" and "Corvax." The writer is well aware that the correct word is "Corax" without the "v," but believes that the raven in question was either croaking with an accent or perhaps just having her on. In any case, she apologizes for the error, which the ravens, naturally, find hilarious. In "Cowboys with surfboards," there was an error on crop succession near Hanalei, Hawaii. The taro field did not take the place of an older sugarcane plantation; rather it was once a rice plantation, with sugarcane growing on the hill above.

—Anna V. Smith, for the staff



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PUBLICATIONS AND BOOKS

Travels on the Green Highway: An Environmentalist's Journey by Nathaniel Pryor Reed (Available on Amazon.com) Nathaniel Reed, former assistant secretary of Interior, shares memories of events that helped shape this nation's environmental laws during a period of environmental renaissance. Reed's career has been based on deeply held principles that reflect his love of nature. But his success has come from solutions that require bipartisan support. Anyone who wants to see a path forward for environmentalism should understand how the trail got cut in the first place, and Reed shares those behind-the-scenes stories. This book tells us the how and why, and it's a fun read. His inspiring life story should energize anyone who cares about the air we breathe, the water we drink and the planet we share.

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Democrat Rob Quist performs at the University Theater in Great Falls in celebration of the 50th Anniversary of the Wilderness Act. FOREST SERVICE NORTHERN REGION/FlickR



Republican Greg Gianforte, who has aligned himself with President Donald Trump. WIKICOMMONS

The battle over Montana's vacant House seat



OPINION BY
BEN LONG

Even if you don't normally consider high-stakes poker a spectator sport, you may want to turn your attention toward the Treasure State. Up here, we're watching the Republican Party double down on a candidate with a losing hand against a Democrat who wears a Stetson and plays the banjo.

Winner takes all, or in this case a vacated seat in the House of Representatives. Neither man has spent an hour in any elected office, which lately appears not only to be an asset for the job, but a prerequisite.

Here's the deal: When President Donald Trump named Montana Congressman Ryan Zinke to be Interior secretary, it triggered a special election for Montana's sole seat in the U.S. House of Representatives. State party officials picked the candidates for the May 25 vote.

Anyone who regularly bets on a Democrat in Montana is a gambler who likes long odds. Democrats who do manage to win here — Sen. Jon Tester or former Gov. Brian Schweitzer — tend to know how to drive a tractor, look good in a cowboy hat and boots, and also have outsized rural Western personalities.

This year, Democratic operatives think they have their man in Rob Quist. Quist earned his statewide name recognition not as a politician, but as a cowboy singer. Quist posters have been plastered all over county fairs and Fourth of July picnics in Montana for decades.

He was a founding member of the legendary Mission Mountain Wood Band, which was the Montana bluegrass answer to the Grateful Dead, before many of its band members were killed in a tragic plane crash in 1987. (Quist had

previously left the band for a successful solo career.) In his political campaign, Quist, who was raised on a Montana cattle ranch, has focused on the agriculture economy, quality education and access to public lands and rivers.

Republican Greg Gianforte is a highly successful businessman in the tech industry who is proud of his business acumen and his fiscal and social conservatism. His sole brush with the electorate came in 2016, when he challenged Democratic incumbent Steve Bullock for the governor's mansion.

Gianforte, who lives in Bozeman, anted up millions of his own dollars for that campaign and still lost to Bullock by 4 percentage points. One loss may not mean much; after all, Abraham Lincoln lost a lot of races before he was elected president. But Gianforte's loss occurred on an Election Day where the same voters went for Donald Trump by 21 points over Hillary Clinton.

One might think that the kind of conservative, jobs-oriented voter who liked billionaire-businessman Trump would go for billionaire-businessman Gianforte. Instead, thousands of Montana Trump supporters dumped Gianforte for a down-ballot Democrat. In 2016, Trump's coattails and Gianforte's pocketbook both fell short.

Even before Gianforte was chosen to run in the Congressional race, the nation's Republican establishment had gone on the attack. A GOP Super PAC bought six-figure ad buys against Quist, labeling him a gun-grabbing, Bernie Sanders socialist. Maybe the labels will stick, but they could also backfire. My guess is that this election will not be about jobs, health care or even a referendum on Trump. In

these turbulent times, the question in voters' minds will be: Who understands Montana, and who will have the interests of everyday Montanans in mind?

Montanans tend to remember their history, when the Copper Kings bought Senate seats with envelopes of cash. This is a problem for Gianforte, because the more money he spends, the more he inadvertently reinforces the story that he is a rich man trying to buy votes. The message and the medium don't matter as much as the means.

Gianforte already stepped in the horse pucky on this topic. In his last campaign, it came to light that he had sued the Montana Department of Fish, Wildlife and Parks over public-fishing access to the Gallatin River near his Bozeman estate. This was a political disaster for Gianforte, because it reinforced the narrative that he failed to understand how crucial access to the outdoors is to the rank-and-file Montanan.

The issue wasn't the river. The issue was freedom. That became the eight-and-a-half-hand that killed Gianforte's campaign for the governor's job. It's still two months until the election, and Gianforte may have cards he isn't showing. However, he can't undo the past. The Gallatin River narrative is still out there, fresh in the public's mind, should Quist chose to exploit it. □

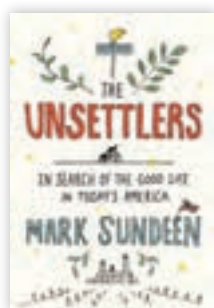
Ben Long writes about the environment and politics in Montana.

Writers on the Range is a syndicated service of High Country News, providing three opinion columns each week to more than 70 newspapers around the West. For more information, contact Betsy Marston, betsym@hcn.org, 970-527-4898.

WEB EXTRA

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Living right in an unsettled world



The Unsettlers:
In Search of the Good
Life in
Today's America
 Mark Sundeen
 324 pages, hardcover:
 \$26.
 Riverhead Books,
 2017.

For Mark Sundeen, the search began with a guilty meat snack.

After two decades of bumming around the country — first as a dirtbag outdoorsman stringing together jobs in the rural West and later as a city-bound freelancer and “money-lung ... whose sole purpose was to inhale dollars, transform them into pleasure, then exhale a stream of carbon into the air, feces into the sewer, and plastic containers into the landfill” — Sundeen settled in Missoula, Montana, seeking a simpler existence. He got engaged to a woman who valued the same, bike-commuted 14 miles daily, lived on garden feasts that took hours to concoct and left the sink cluttered with wholesome dirt clods.

In a world where human appetites obliterate entire ecosystems, Sundeen recognized that what we choose to consume has moral implications. But one night while grocery shopping, faced with the \$6.50 price tag on organic butter, he broke and headed instead for the much cheaper stuff in the conventional food aisles. There, he succumbed to a greasy breast of fried chicken, no doubt factory-raised on monoculture grain and cruelly

caged with a throng of its brethren. Then, he wiped his sins away with a moist towel and pedaled home.

It's a wry encapsulation of a conundrum that those who aspire to sustainability face: We carve out sacrifices here and there — *Drive less! Recycle! Install solar!* — until they interfere with other desires. In search of a clearer path, Sundeen, author of *The Man Who Quit Money*, sets out to find people who have gone far beyond what most of us consider “good enough.”

The result is *The Unsettlers: In Search of the Good Life in Today's America* — a gorgeous new book that provides a contemporary twist on Wendell Berry's 1977 classic, *The Unsettling of America*. Where Berry argues that industrial agribusiness and modern capitalism have distanced people from the land and each other, with catastrophic consequences for the environment and communities, Sundeen explores a movement toward radical simplicity meant to solve those ills, digging deep into peculiarly American strains of utopianism and telling the stories of three couples trying to live out their ideals in wildly different places.

Olivia Hubert, a black horticulturalist,

and Greg Willerer, a white former teacher with roots in the anarchist punk scene, create a tiny urban farm, hoping to localize and humanize Detroit's inner-city food system — part of a bigger ambition to build a more just version of a city bludgeoned by industrial collapse, racism and poverty. There is Ethan Hughes, who led a cross-country, bike-driven “superhero” expedition to do good, and his wife, Sarah Wilcox, a classically trained soprano, who created a car-free, electricity-free intentional community in Missouri that engages in nonviolent activism. Finally, we meet Luci Brieger and Steve Elliott, who founded a successful small organic farm not far from Missoula, and catalyzed a vibrant local food scene across western Montana.

The book is part memoir — chronicling Sundeen's own new marriage and quest for a better life — part interwoven biography, and part social history. But though Sundeen finds beauty in each of the couples' lives, he doesn't flatten them into human Instagrams: “the soft-focus shots of sun-dappled mason jars and fresh-picked pears” that tug at the hearts of the rest of us cubicle-bound hordes. Hubert and Willerer must run off armed intruders from the crackhouse across the street instead of merely grappling with gophers as other farmers do. Hughes and Wilcox weary of the infighting so common in intentional communities and grope to maintain momentum when few of their peers are willing to commit to the enterprise for more than a summer. And Brieger and Elliott watch their dream enter mainstream society as yet another piece of the corporate machine: Mega-organic agriculture that plants sprawling monocultures and sends plastic-sealed produce thousands of miles, driving right over the environmental and community benefits of the small, diversified farms that the couple built their own lives around.

The characters are weird, stubborn and strong, and Sundeen provides a nuanced picture of their beliefs, underpinned by both religious and social justice movements and influences ranging from Berry and Thomas Jefferson to the Quakers, Booker T. Washington, the Nation of Islam, Tolstoy and Gandhi. Importantly, Sundeen also acknowledges that the “renunciation of privilege” can become “just another means of exercising it.”

In the end, nobody finds revelatory answers, and yet all persist despite obstacles. And Sundeen himself recognizes that his own role is not to be a pioneer of simple living, but to be what he already is: A writer. In this, the book seems to suggest that the true recipe for revolution is not utopianism per se, but the emotional foundations from which its practitioners strive. In other words, to live right, one must find true purpose, work hard in its service and do the best good she can.

BY SARAH GILMAN



“Unsettler” Luci Brieger rides her bike home from the fields after a day of planting onions. She and husband Steve Elliott own Lifeline Farm Produce in Victor, Montana.
 RAB CUMMINGS

LOVE across the landscape



RYAN NELSON / ALAMY STOCK PHOTO

This is a story about love and land management.

Danielle and I are seasonal federal employees. When we first met, in the winter of 2014, Danielle was a forestry technician in the Coconino National Forest, based in the bustling tourist town of Sedona, Arizona. I worked for the Natural Resource Conservation Service, in a ghost town 200 miles away.

Danielle's job was to implement a wilderness education program for "city folk," which often involved answering questions like, "When do you turn off the waterfalls?" My job was to help restore the habitat of an unremarkable but endangered gray bird called the southwestern willow flycatcher. This included chopping down invasive tamarisk and protecting streams from cows by putting up barb-wire fence. While Danielle typically talked to 300 tourists in a day, I sometimes went a week speaking only to Ghost, a feral cat who deigned to keep me company on the front steps of my cabin.

For the first year, Danielle was happy to drive eight hours every other weekend to see her lonely cowboy on Signal Road. I signed up for cell and internet service so that we could keep in touch between visits. In the fall of 2015, Danielle moved in with me at the ranch, which is where we typically spend our winter off-seasons. Our love seemed as serene as an alpine lake.

Danielle and I are nomadic by nature. In fact, the work we do encourages it. In the spring of 2015, I was offered a position as a range technician for the Forest Service outside Taos, New Mexico, riding on the high desert plateaus and herd-

ing cattle into backcountry allotments. Danielle accepted a wilderness ranger job in the Wind River Mountains of Wyoming, leading a trail maintenance crew and riding horseback alongside a team of packhorses. Every month or two, we met up halfway someplace, seeking out cheap hotels or tent-camping during three-day weekends. But most of the time, only the Continental Divide and our letters connected us.

In July, Danielle, who is also a Type 2 wildland firefighter, was sent out on a hand crew for two weeks in Libby, Montana, and forced to cancel one of our precious meetings. Our shared disappointment erupted into a vicious argument. One night, when she called from fire camp, I told her that I felt we were running away from each other and in turn, driving ourselves mad. "Just cut me loose!" were my exact words. The distance, once romantic, had begun to feel suffocating. I suspected that Danielle loved her work more than she loved me, and she suspected the same of me. Though both of us were wrong, the distrust was painful. The day after that argument, I sent Danielle an apology in the form of a poem; such small gestures, along with the promise of the next reunion, coaxed us through the hard times.

In the winter of 2016, after being together for two years, I asked Danielle to marry me. It was a sweltering 92 degrees in mid-February. We backpacked into the Superstition Mountain Wilderness of Arizona, and I proposed at sunset on the yellowed cliff face of Battleship Mountain. We held each other and vowed that we would — somehow and soon — find work

in the same place. Even though we had spent so much time apart, we couldn't imagine our lives without each other.

But the spotty job market continued to put mountain ranges and a sea of lakes between us. In the summer of 2016, I accepted a position in Grand Teton National Park at the historic Elk Ranch. Danielle, in turn, accepted a permanent seasonal job as a lead wilderness ranger in the Boundary Waters of northern Minnesota. Her job entailed up to several miles of daily paddling and portages, while my work was that of a typical Wyoming cowboy — hazing one-ton wild bison and keeping an eye out for grizzlies and wolves. One day, while visiting me in Moose, Wyoming, Danielle sat on a piece of driftwood and gazed into a cerulean lake. "I want you to come with me to Minnesota," she said softly. She paused, waiting for a reply.

I realized that I couldn't wait for the job market to cooperate: It was time for me to make good on my vow. And so, in the spring of 2017, Danielle and I will quietly part with the mountain forests and deserts of the West we so love. I'm looking for forestry work near my fiancée in Grand Marais, Minnesota. The prospect of marrying and settling down in the humble North Woods tickles Danielle and I even more than a rafting trip through the Grand Canyon or peak-bagging Teewinot. Maybe that's just us, preparing for a new adventure. □

Rafael Reyna is a graduate student in ecological restoration at Colorado State University. He currently resides in Wikieup, Arizona, with his fiancée.

*Every month
or two, we met
up halfway
someplace,
seeking out
cheap hotels
or tent-
camping
during three-
day weekends.
But most
of the time,
only the
Continental
Divide and
our letters
connected us.*



HEARD AROUND THE WEST | BY BETSY MARSTON

MONTANA

Don't even think about asking Scott Sales, the Republican president of the Montana Senate, to join you on a friendly bike ride around Helena, the state capital. When a bill came up that would have increased road safety by establishing definite driving distances between vehicles and bicycles, Sales unloaded. Even if you honk at cyclists, he said, "They won't move over (because) they think they own the highway." Moreover, he added, bike riders are "rude," "self-centered" and "have an 'entitlement mentality,'" so "quite frankly, I don't want more of them in the state because there's already too many of them as it is." Dick Barrett, a Democratic senator from Missoula, took offense, saying he'd been a cyclist for 40 years, reported the *Missoulian*. But Sales' attack helped kill the bill, which had passed the House, 62-37.

CALIFORNIA

Snowfall was so heavy in the Sierra Nevada this winter that the grand total in parts of the Truckee-Tahoe area may surpass 58 feet, Allen Best notes in *Mountain Town News*. For the Squaw Valley resort, it was the snowiest in 45 years of record keeping. But the melting of all those big drifts, together with recent heavy rains, is causing mice, chipmunks and other critters to be flooded out of their dens and into new homes. As these new digs are often inhabited by humans, things can get crowded: "Mice can have upward of a dozen babies," reports the *Lake Tahoe News*. "Then it's pretty much an infestation."

UTAH

To hear most Utah legislators tell it, public lands and national monuments drain local economies and ought to be sold off or developed more profitably by the state. The owners of a thriving restaurant near the Grand Staircase-Escalante National Monument in Boulder, Utah, population 180, couldn't agree less. Blake Spalding and Jen Castle, who named Hell's Backbone Grill and Farm after a weird local geological feature, say business is booming. Four



COLORADO They may not share, but they do shear.
BROOKE WARREN

full-time farmers stock the kitchen with 23,000 pounds a year of local vegetables and fruits, and the annual payroll for 72 people is \$700,000. "We pour so much into the tax rolls and yet they ignore us," said Spalding at a state Capitol news conference organized by the Escalante Chamber of Commerce. "That's painful." Scott Berry, co-founder of the Boulder Mountain Lodge, told the *Salt Lake Tribune* that visitors come from all over the world to stay at his inn because they appreciate the spectacular scenery and relative solitude. "We see the (Grand Staircase-Escalante) monument as a call to start a new garden," Berry said, "and after 20 years we are seeing those shoots come up."

CALIFORNIA

A camouflaged hunter near Mono Lake, California, thought he'd lure a coyote by lying flat on the grass and blowing a call that mimicked a wounded rabbit. Well, the ruse worked, but the predator lured was a mountain lion that leaped for the hunter's head. The hunter, who was not identified, shot the big cat twice, killing it. Lions are a protected species, reports *The Tribune*, but wildlife officers decided he was justified in defending himself.

CALIFORNIA

All the Marine Corps Air Ground Center at Twentynine Palms, California, wants to do is expand its training turf by 165 square miles. And the hitch? The California desert tortoises that call the place home. Unfortunately, if the U.S. Army's previous attempt at relocating tortoises is any guide, it's a dicey solution. After the Army moved 670 tortoises from the Barstow area to the western Mojave Desert in 2008, 90 of the animals were dead in less than a year, most eaten by coyotes. And not surprisingly, the tortoises, which are protected by federal and state endangered species acts, prefer their native turf, defined by "complex social networks linked by trails, arroyos and hibernation borrows," says the *Los Angeles Times*. It is true that wherever the tortoises are these days, enemies

abound, including dogs, solar developments and ATV and other traffic. But in the new home that Marines have chosen for the tortoises, the threat comes from voracious ravens, also a protected species. Ravens just love newly hatched tortoises — one biologist calls them "walking tortellini for ravens" — because the thin-skinned babies have no defense against the birds. But you can count on the Marines to hatch an arsenal to meet the challenge: realistic-looking "techno-tortoises," which emit irritants derived from grape juice concentrate whenever a raven pecks one. If that fails to deter the birds, the Marines can also employ a "raven-repulsion green laser," a hand-held laser rifle with a mounted scope. Its intense beam of laser light sweeps a half-mile of desert floor, causing ravens "to take to the air in a chaotic chorus." Ravens, however, are anything but dumb. One of the 100 biologists hired by the Marines speculated that the birds will quickly learn that lasers come — and lasers go.

WEB EXTRA For more from Heard around the West, see hcn.org.

Tips and photos of Western oddities are appreciated and often shared in this column. Write betsym@hcn.org or tag photos [#heardaroundthewest](https://www.instagram.com/heardaroundthewest) on Instagram.



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“If they're unwilling to bend down with a baggie and bundle up a few dog turds, what hope is there that big problems will get fixed in my lifetime — or ever?”

Lucia Hadella, in her essay, "The dog turds lurking on our trails," from *Writers on the Range*, hcn.org/wotr