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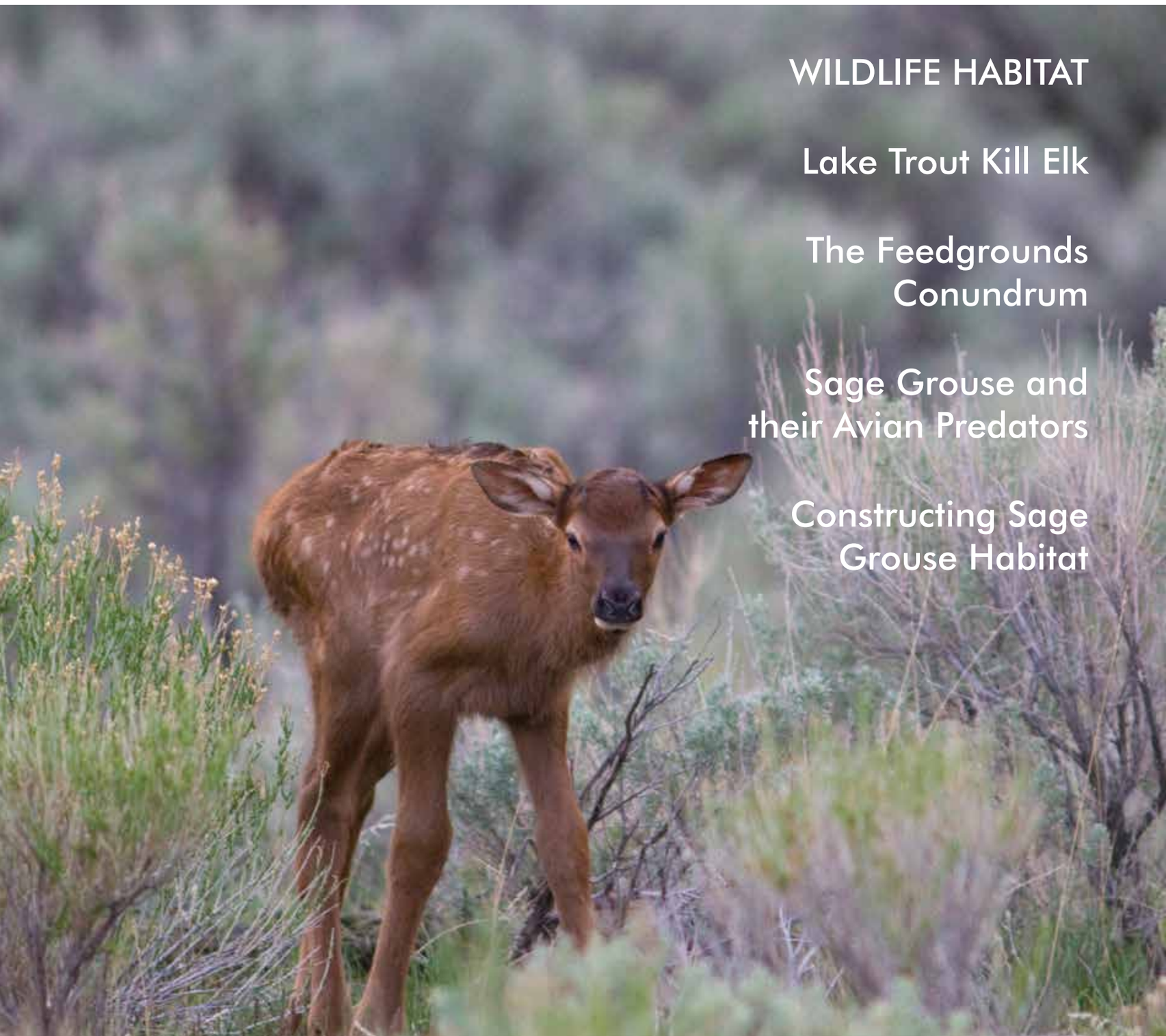
Western Confluence

NATURAL RESOURCE SCIENCE AND MANAGEMENT IN THE WEST



WILDLIFE HABITAT

Lake Trout Kill Elk

The Feedgrounds Conundrum

Sage Grouse and their Avian Predators

Constructing Sage Grouse Habitat

A publication of the William D. Ruckelshaus Institute at the University of Wyoming's Haub School of Environment and Natural Resources

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Twice a year, *Western Confluence* magazine brings you on-the-ground, science-based stories about the research and policies shaping natural resource management and decisions in the West. *Western Confluence* tells clear, relevant stories of interdisciplinary, collaborative solutions to our toughest natural resource challenges.

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ASSOCIATE EDITOR'S NOTE

In Wyoming, wildlife does more than just satisfy the fleeting affections of summertime tourists holding smartphones out car windows. For many of the state's residents, wildlife means food for the body and soul, money in the bank, a way of life. A 2014 public opinion poll conducted by the UW Ruckelshaus Institute, Wyoming Stock Growers Association, Wyoming Stock Growers Agricultural Land Trust, and The Nature Conservancy – Wyoming, found that 74% of Wyomingites surveyed considered wildlife to be an important part of their daily life. And 66% said that declines in numbers of big game animals are a serious issue, on par with concerns about jobs and quality public education.

To talk about wildlife is to talk about habitat, both of which Wyoming still has in abundance. Blur your eyes and the sagebrush steppe reduces down to blue sky and gray-green sea. The highway traveler might use words like *empty* or *wasteland*, but the researchers highlighted in this issue look closer. Hidden beneath the sagebrush, ants bring hyper-order to the ecosystem through a precise lattice of mounds, and a struggle for life and death rages as ravens attack sage grouse nests. The sagebrush steppe and its grassland cousin are rich in detail and texture, far from empty.

The threads that bind wildlife, land, and people are woven throughout this issue of *Western Confluence*, meandering and crossing in unexpected ways. Take the connection between a fisherman on Yellowstone Lake and the decline of an elk herd in Cody. Or a mule deer that disappears, only to be found 150 miles away, connecting a drill rig in the desert to a fall hunt in the mountains.

We humans are not just observers—we are stitched into the pattern. Whether it's manipulating sagebrush to improve sage grouse habitat or gillnetting lake trout to help elk, stories in this issue illustrate the mighty challenges that managers and landowners face. Sagebrush, so difficult to get rid of in the past, is awfully hard to cultivate when it's wanted. Managers feed elk to reduce conflicts with livestock and along the way, increase disease prevalence that is a danger to cattle. The pattern becomes complicated.

It is fitting that Doris Florig, the artist featured here, uses tapestry as a medium. Her work reveals the connections and the threads that make up our world. Tug on one part and it pulls on something else. But it is more than a collection of beautiful fibers. To step back from her work is to see the whole thing, much greater than its parts. In Wyoming, what first appears as a tangle of knots—fish with elk, elk with cattle, cattle with people, people with ravens—turns out to be an elaborate tapestry with each part tied to the others.

Nicole Korfanta

On the cover: Elk calf in Yellowstone National Park. Photo by Mark Gocke.

This page: Artist Doris Florig uses natural dyes and materials to create fiber arts pieces that describe the natural world. Read more about her work on page 32. Image courtesy of the artist.

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A Tale of Two Migrations

The splash of one fish ripples through an ecosystem

By Charlie Reinertsen

In 2007, biologist Arthur Middleton was studying the Clark's Fork elk herd, which migrates between Yellowstone National Park and the foothills northwest of Cody, when he made a perplexing discovery. Surveys documented about half as many calves as historically observed on the elks' winter range. At first, biologists speculated that wolves were targeting vulnerable elk calves during the winter. However, when the elk returned in the fall from Yellowstone National Park, there was a surprise—the calves were already missing. The wolves on the winter range were not the culprit. "Something was going on up in Yellowstone," Middleton described, and he set out to solve the mystery.

Middleton, who received his doctorate in 2012 from the University of Wyoming studying elk in northwestern Wyoming, had an idea of where to start. As a biologist, he knew that grizzly bears were the primary predator of newborn elk calves, and that recent research was documenting a shift in grizzly bear diet. This spurred him to dig into historic research on grizzlies to find out if this shift in diet could explain the missing elk calves. "I found myself fascinated by the interactions. I read through dozens and dozens of old papers, going back into the 70's and the 80's and the 90's, and digging through the library for the stuff that wasn't online, and really getting deep into the history of studies that compare diets. I exhaustively used everything we knew about bear diet so that I could compare historical diets to contemporary diets."

Through his investigation, Middleton started to piece together an intricate food web of interactions. Grizzly bears eat a wide variety of

foods, from moths and berries to full-grown elk and moose. Their diet is limited seasonally as different foods become available. In the spring, the bears around Yellowstone Lake focus their foraging efforts on spawning Yellowstone cutthroat trout. That is, they did until the cutthroat population plummeted in the mid-1990s.

In 1994, scientists discovered lake trout, a non-native fish species, in Yellowstone Lake. It is widely thought that rogue fishermen introduced them to the lake in the mid 1980s for sport fishing. Adult lake trout primarily eat other fish, and in Yellowstone Lake, they eat Yellowstone cutthroat trout. Since the invasion, lake trout have wreaked havoc on the native trout. As the lake trout population grew, cutthroats started to disappear. When combined with the effects of drought and whirling disease, which is caused by a parasite that has decimated trout throughout the west, the cutthroat population has reached dangerously low numbers.

Cutthroat trout are a crucial component of the surrounding ecosystem, and lake trout do not fit into the food web in the same way. In the spring, cutthroats migrate up tributaries to spawn, where they are exposed to grizzly bears, osprey, otters, and over 30 other native predators. Unlike cutthroat, lake trout do not spawn in streams. Instead, they spawn in Yellowstone Lake in the fall, out of reach of bears and other predators.

As cutthroat numbers dwindle, the many species that once relied on them have lost a major spring food source. The grizzlies have turned to newborn elk calves to supplement their diet. The most recent research Middleton uncovered, published by the Interagency Grizzly Bear Study Team, indicated that grizzly bears near Yellowstone Lake are eating more elk calves than ever, and that this shift is due to the decline of Yellowstone cutthroat trout.

Middleton had something to add to the conversation. "What the people who documented [this shift] didn't know, that I knew, is that if grizzly bears are switching from cutthroat trout to elk calves in the watershed of Yellowstone Lake, … they can only be eating the calves of migratory elk." Middleton said. "I sort of came into the picture and said, wow, you know, this effect, this change in the grizzly bear diet, is something that could be transmitting all the way out to places like Cody and Jackson and Paradise Valley, because these are migratory elk herds."

Middleton wanted to find out what the shift in grizzly bear diet would mean for the migratory elk. To do this, he used his detective work with historic research papers to estimate how many trout and elk calves the bears used to eat, and compared that number to how many trout and elk calves the bears eat today. To compare the number of elk calves from year to year, Middleton looked at what biologists call the "cow/calf ratio," that is, the number of calves per 100 cows, which indicates the reproductive success of a herd. Historically, biologists documented 30 to 35 elk calves for every 100 cows in the Clark's Fork herd.

Middleton, working with a University of Wyoming postdoctoral researcher Tom Morrison, used this information to create a computer model that could calculate whether the bears' shift in diet was enough to actually impact the elk herd. The surveys starting in 2007 had documented a drop to 10 to 15 elk calves per 100 cows. Of the 15 to 20 missing elk calves per 100 cows, Middleton's model predicted that the observed shift in bear diet accounted for 3 to 4 of them. This may sound like a small number, but to an ecologist, it matters. Middleton described the implications with excitement: "You know, wow, trout 70 miles away can affect how many elk calves there are. It is just kind of crazy."

The remaining missing elk calves may be due to drought (which reduces the available forage), increased grizzly bear populations, and wolf predation. Although a shift in grizzly bear diet does not entirely explain the observed decline in elk calves, it is playing a role.

In April of 2013, Middleton published his research, adding elk to the list of species affected by the lake trout invasion. Meanwhile, contract fishermen were gearing up for yet another season of lake trout removal on Yellowstone Lake, as they had been doing for the past four years.

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The ice on Yellowstone Lake typically goes out in late May, and contract fishing operations start as soon as the water is open. Three fishing boats with four fishermen each set out from shore at dawn. The boats are equipped with hydraulic lifts to raise miles of gillnet that have been set in the lake overnight. As the fishermen draw the nets out of the

Charlie Reinertsen

Elk and calf in Yellowstone National Park.

water, sun flashes off slabs of silver—a good haul. The fishermen grasp the frigid, slime-covered fish and remove them from the nets. This is not your typical contract fishing operation—these fishermen are in the heart of the nation's first National Park, and these fish will never see a dinner plate. Instead, their carcasses are destined for the bottom of Yellowstone Lake.

"Part of the Park Service mission is to conserve natural resources, and conserving the Yellowstone cutthroat population within Yellowstone Lake is a huge portion of our natural resources, especially in the fisheries," explains Patricia Bigelow, fisheries biologist for Yellowstone National Park who has been part of the lake trout control program on Yellowstone Lake for the past fifteen years.

"The problem is the lake trout predation, so if you want to help the cutthroat trout population, *that* is what you need to address," Bigelow continues, "The goal is to suppress the lake trout population to the point that the cutthroat population can rebound."

Yellowstone cutthroat trout, named for the red gashes of color slicing underneath their jaws, are highly valued fish. Anglers come from all over the world to fish for this black-spotted, golden-red trout that can only be found in the Greater Yellowstone Ecosystem. Hundreds of thousands of Yellowstone National Park visitors once watched from Fishing Bridge on the Yellowstone River as teams of spawning trout jockeyed for position. And as researchers have shown, cutthroat trout are a crucial component of the food web. For these reasons, the Park Service has gone to war against the lake trout invasion.

In 1995, the Park Service invited a panel of scientists to assess the severity of the situation and advise the control efforts. The panel advised the park to remove lake trout, and the park started the efforts immediately. In 2008, the science panel reconvened and advised the park that it was on the right track, and it needed to do even more to stop the lake trout population growth. In response, the park tried hiring contract fishermen to harvest lake trout, and has continued to increase the control effort every year. By 2012, the park reached control levels recommended by the science panel. Middleton published his research in 2013, providing further fuel for lake trout control efforts and inspiring bumper stickers proclaiming "Lake Trout Kill Elk."

Jay Fleming

Commercial fishermen use gillnets to pull lake trout out of Yellowstone Lake.

Today, the park contracts the Hickey Brothers from Wisconsin to net lake trout every day from ice off until early October, roughly 130 days of fishing every year. On average, the fleet of three boats catches over two thousand fish every day. The fishermen kill the lake trout (if they aren't already dead), count them to monitor the population, pop the air bladder so that the carcass will sink, and dump the fish in the deepest sections of the lake.

The park, with the help of the Hickey Brothers, has deposited metric tons of fish in Yellowstone Lake in the hopes that these carcasses will keep nutrients in the system. Bob Gresswell, a research biologist who served as chair on both science panels and has been studying Yellowstone cutthroat trout with the park and the US Geological Survey since 1974, says there is no evidence that dumping the fish into Yellowstone Lake is harmful; however, some scientists are concerned that it may be altering the ecosystem in unpredictable ways. Further research is needed to understand the impacts of this "nutrient loading."

Gillnetting removes fish efficiently, but not without consequences, including by-catch of Yellowstone cutthroat trout. The fishermen reduce the amount of by-catch by adjusting the gillnet mesh size. They also focus on areas of the lake that have high densities of lake trout and very few cutthroat trout. The science panel closely monitors by-catch to ensure that it does not exceed levels that could negatively impact the cutthroat trout population. Additionally, if a cutthroat is caught in a net, the fishermen attempt to return it safely to the lake. Even so, over half of the cutthroats caught in the nets will die.

Gillnetting is also expensive. Lake trout control costs the park (as well as other donors and organizations) over two million dollars annually, of which gillnetting claims 1.7 million. And if the park ends the program today, all of the progress will be lost. "All of our modeling shows that if you cut back at any point in time, the lake trout will begin to increase again," Gresswell explains. "The suppression of lake trout is something that will always have to occur in Yellowstone Lake. It has to become something that is just part of the working budget of Yellowstone Lake, just like plowing the roads, or cleaning the bathrooms and the campgrounds."

The park is testing cheaper and more efficient ways to control lake trout. One alternative uses large grids of electric wires to zap embryos and emerging fry in lake trout spawning areas. Another uses a mining dredge

Grizzly and cub in Yellowstone.

to suck the embryos out of spawning beds. These alternatives show promise by eliminating by-catch, but they still cannot completely remove lake trout from the system.

Future technologies may provide the solution. Gresswell suggests that "emerging genetic technologies" could help eradicate lake trout from Yellowstone Lake. One solution scientists are developing is to genetically alter male lake trout so that they can only produce male offspring. The idea is that the park would continually stock Yellowstone Lake with these genetically altered males while maintaining gillnetting efforts to control the overall population. With several decades of stocking altered males and gillnetting, the park may be able to eradicate lake trout.

Even without new technology, "There are lots of very positive signs that this suppression activity is beginning to accomplish its goal," explains Gresswell. Bigelow states that "it is really exciting that population modeling is showing a decline in the lake trout population overall," and Gresswell is hopeful that "we should see a relatively rapid, within decades, resurgence of cutthroat trout."

Mark Gocke

When irresponsible fishermen introduced lake trout in Yellowstone Lake, they could never imagine the consequences of their actions. Over thirty years later, the lake trout effect is still rippling through the ecosystem in surprising ways. "These cutthroat trout are not just important because they're native fish," Middleton said, "they are important because they are at the heart of a … web of interactions that reaches all the way to elk in the outskirts of the Greater Yellowstone Ecosystem that are economically, recreationally, and culturally immensely valuable." But even with cutthroat trout rebounding, this web of interactions may never be the same again.

Bringing cutthroats back to historic levels would be a huge accomplishment for the park. But whether or not the resurgence of cutthroats will restore the ecosystem is uncertain. "We can't go around complacently thinking that we have restored Yellowstone. We are not going back to a baseline; we are not fixing it to where it was. We are all going somewhere new," explained Middleton, "And that's as sad as it is exhilarating."

Charlie Reinertsen *is the 2014-2015* Western Confluence *editorial fellow.*

THE TROUT EFFECT

Cutthroat trout once linked aquatic and terrestrial ecosystems in Yellowstone National Park. As their numbers decline, the link is weakening.

OSPREYS
Ospreys are only one of many native predators that once relied on cutthroat trout as a major food source. As cutthroat numbers have declined, so have osprey nests on Yellowstone Lake, from several dozen down to just three or four.

YELLOWSTONE LAKE
Yellowstone Lake lies in the heart of Yellowstone National Park, a protected ecosystem. Even there, seemingly small human disturbances have far-reaching consequences for the abundant wildlife that call it home.

GRIZZLY BEARS
Grizzly bears that once relied on spawning cutthroat trout in the spring are now switching their diet to newborn elk calves.

CUTTHROAT TROUT
In the spring, native cutthroat trout migrate up tributaries surrounding Yellowstone Lake to spawn. Before their numbers started to dwindle, millions of spawning fish fed as many as 30 different predator species.

LAKE TROUT
Invasive lake trout were discovered in Yellowstone Lake in 1994. Adult lake trout eat cutthroat trout, and have decimated the native fish population.

ELK CALVES
As grizzlies turn their attention to newborn elk, fewer calves survive the first two weeks of life. Because the elk are migratory, the grizzly diet shift is impacting winter range numbers up to 70 miles away.

RESOURCES

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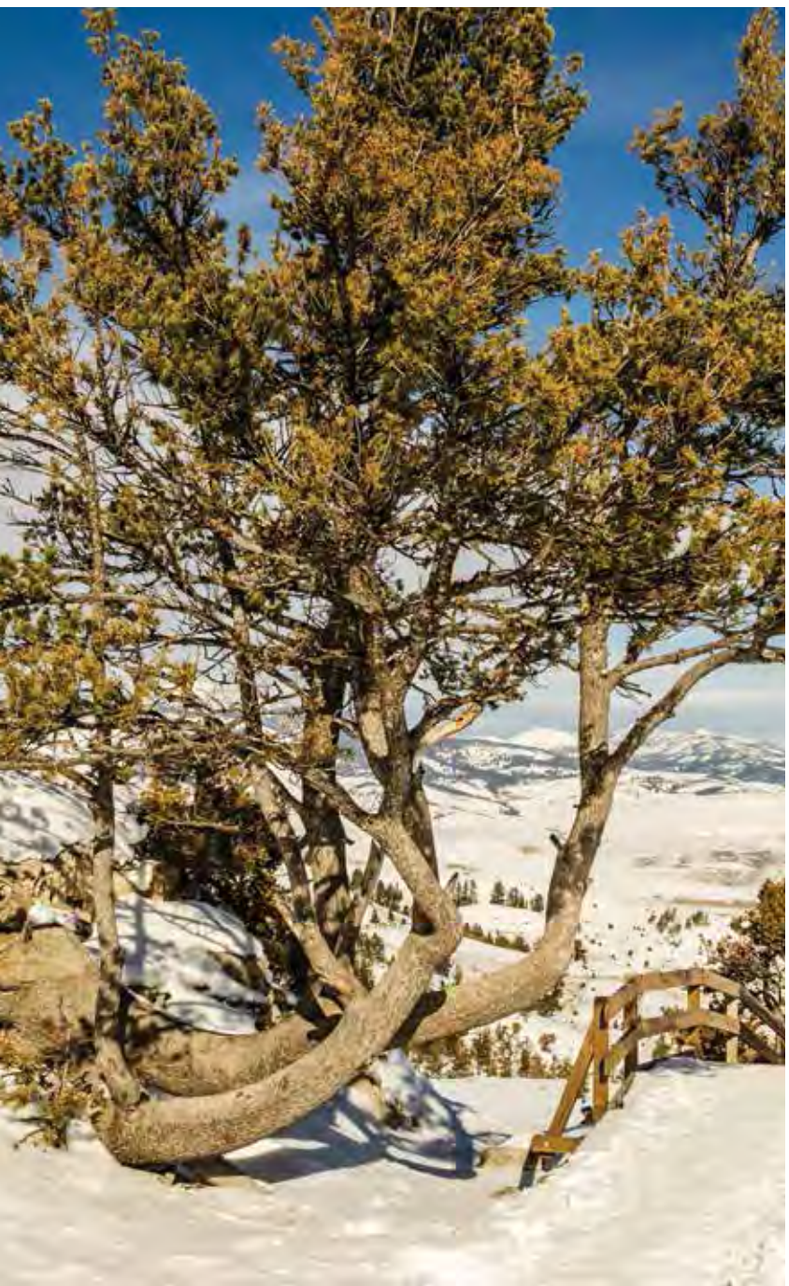


Where do bears turn when an important food source starts to vanish?

By Kristen Pope

Golden and red-hued leaves and crisp evenings mark the coming of fall in the Greater Yellowstone Ecosystem (GYE) as grizzly bears search for an important food: whitebark pine seeds. The bears don't collect these treats on their own. They rely on red squirrels to climb trees, collect the seeds, and store them in middens, or burrows. Grizzlies then sniff out the middens, excavate them using four-inch-claws (ideal for digging but not climbing trees), and devour the wealth of calorie-dense whitebark pine seeds inside.

These whitebark pine seeds, an important part of grizzly bears' fall diets in the GYE, are in decline. Scientists, such as Dr. Cecily Costello, an ecologist at the University of Montana, wonder how the decline of whitebark pine and the changing availability of seeds may impact the ways GYE grizzlies move around, with implications for managing human-bear conflicts.

The ecologists considered bear habitat at least 500 meters from roads or human developments "secure" with a lower risk of human conflicts. Whitebark pine, a high-elevation species, tends to grow in safer, more secure areas, luring bears away from potential clashes with people. When bears have to travel to find new food sources, they may enter areas with more roads and human habitation, increasing the risk for conflict.

Climate change and mountain pine beetles, which have killed millions of trees across western North America, are eating away at whitebark pine forests. Warming temperatures allow the beetles to spread to higher elevations and to whitebarks in areas that were previously too cold for beetles to thrive. Recent surveys have found that in some forests over three-quarters of whitebark pines have already died. Over the next 50 years, scientists predict whitebark pine ranges will shrink as increasing temperatures allow beetles to infest

Mark Gocke

tebarks

Over the next 50 years, scientists predict whitebark pine ranges will shrink as increasing temperatures allow beetles to infest more of these forests.

more of these forests. Furthermore, warming temperatures will likely allow less hardy tree species to successfully inhabit these higher elevation locations and compete with the whitebark pines.

Costello is lead author on a recent paper in *Ecology and Evolution* on the topic. Her study team trapped grizzly bears, affixed collars that store global positioning system (GPS) location data, and then tracked the bears' movements in late August and September when they rely on the seeds as a key food source. Whitebark pine typically has a strong production cycle every two or three years. Bears eat according to availability, with up to 50-80 percent of scat volume consisting of the seeds during the years when whitebark pines produce an especially robust crop.

"The historical relationship is that if there is a good whitebark pine crop, human conflict and mortality is lower," Costello said. "The opposite is true of a poor whitebark pine crop. Of course, with the fact that whitebark pine is threatened, especially from pine beetles, there is a concern from the standpoint that every year is a bad year then."

Since whitebark pine is such a large component of grizzlies' food during years of high seed production, Costello and her colleagues wanted to find out how the changing climate, and decline of whitebark pine, may be affecting these bears. To do this, the team examined GPS location points collected from 72 individual grizzlies from 2000 to 2011, tracking what types of habitat the bears spent their time in and when and how far they moved to other areas, to test two alternate hypotheses. The first hypothesis, the one the researchers expected to be true, was that bears would move to new areas to find more whitebark pine seeds, putting them more at risk of conflict with humans. The alternate hypothesis was that the seeds perhaps weren't that important to the bears and they would stay in the same area and find different foods instead.

By Richard Sniezko, US Forest Service Dorena Genetic Resource Center, Wikimedia Commons

Cones of the whitebark pine.

Bears eat all types of things, making them what biologists call a "generalist" species. Previous research found GYE grizzlies eat 266 different kinds of food, including 175 plants and 83 animals and suggested that in years with low whitebark pine production rates, bears might shift to eating more animals, including elk, bison, and cutthroat trout. Also, regardless of whitebark pine production, some bears go to hunting areas each fall to take advantage of gut piles, wounding loss, and other animal remains left by hunters, thus increasing the risk of human conflict.

Males, which can be twice the size of a female, are particularly prone to carnivorous tendencies. "Male bears tend to be more dominant at a carcass of any kind, and they can pretty much beat anyone out: wolves, mountain lions, other bears," Costello said. During one flight, the research team observed 13 bears within 250 meters of a single carcass. It's easy to see why this may cause conflict in areas where hunters gather.

"Meat is really valuable to bears because it represents such a calorie-dense food," Costello explained. "This is also true of whitebark pine seeds that are really high in fat and come in a perfect little package that is actually ideal for them to gain fat on."

To understand to what extent those "perfect little packages" were enticing grizzly bears in the GYE, the ecologists measured how grizzly bear foraging behavior changed as bark beetles hammered whitebark pines during the 2000s. They'd expected the bears to move around more to target remaining pockets of whitebark pine seeds, as scientists have observed in some acorn-dependent populations of black bears. In falls with poor acorn crops, these black bears will travel farther to find more acorns.

However, Costello and her colleagues were surprised to find that the opposite was true. While the grizzlies could have traveled farther to find whitebark pine stands unaffected by beetles, they chose not to. "We saw no evidence that they moved larger distances as whitebark pine abundance declined," Costello said. "I thought they would keep looking for [whitebarks] to more of a degree than they did." Rather, the bears stayed put and switched foods when whitebark pine was unavailable. That's good news, as the researchers found that even as whitebarks declined, bears stayed in secure habitats and did not come into more conflict with humans.

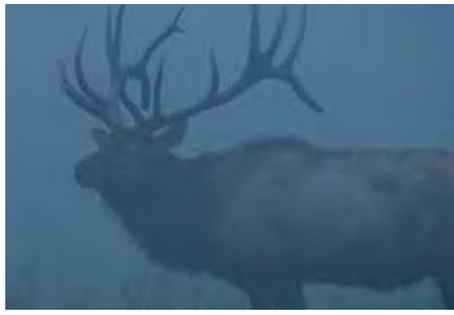
As grizzlies have a harder time finding whitebark pine seeds in the fall, it's hard to say exactly what foods will fill the gap. While climate change may cause continuing declines in whitebark pine, bears are less at risk than specialist species that rely heavily on one particular food. "Generalists tend to respond to environmental changes more favorably than species that are specialists," Costello said. "In the big picture, climate change has a high probability of having a negative effect on whitebark pine and much less so on grizzly bears."

Kristen Pope *is a freelance writer and editor who specializes in science and conservation topics and lives in Jackson, Wyoming. Find more of her work at kepope.com.*

The Feedgrounds

Brucellosis spreads as Wyoming tries to protect livestock

Conundrum



By Emilene Ostlind

As he does every single morning from November into April, Bondurant, Wyoming, rancher Kevin Campbell leads his two draft horses, Ed and Smoke, out of their pen and harnesses them to the hay wagon to feed elk. The elk are not domestic or farm-raised animals, but wild, native, and free ranging through the mountains on the south end of the Greater Yellowstone Area. Dell Creek Feedground, tucked into the Gros Ventre foothills, is one of 22 run by the state Game and Fish Department in western Wyoming. The agency pays Campbell $60 per day throughout the winter to scatter bales for elk.

Emilene Ostlind

Rancher Kevin Campbell harnesses his team of horses to deliver hay to elk at the Dell Creek Feedground.

"When there was that snow the other morning they were all acting pretty hungry because the hills were covered up," Campbell says as he stacks alfalfa hay bales onto the wagon. "So I gave them 36 [bales] that day. We'll give them 30 today I think."

By now, the last week in March, snow is pulling back from the hillsides and the elk trails are melting into wide, muddy swaths. Most of the state feedgrounds have already shut down for the spring, and this one will close soon. The elk will follow the spring green-up into the mountains where they'll stay until the fall when snow drives them back down. Then, rather than heading out into the valleys as they did historically, some elk will aim for the feedgrounds.

"We are basically short stopping these migrations," says Brandon Scurlock of the Wyoming Game and Fish Department, who's feeding with Campell today. "One of the big purposes of feedgrounds in my mind is to control elk distribution."

Why control elk distribution? Historically, it was to keep elk from marauding ranchers' haystacks in the winter. A couple hundred head of elk could destroy an entire winter hay supply in just a few days. And a state statute makes the Wyoming Game and Fish Department liable to ranchers for damages to stored crops caused by wildlife. The agency quickly learned that it was easier, cheaper, and more amicable to stop the elk at feedgrounds and serve them their own hay than it was to replace wrecked haystacks in the middle of winter. Plus some of the feedgrounds help elk survive the winter in places where populations wouldn't fare well without the assistance.

But today the feedgrounds serve an additional purpose. They keep elk from transmitting a disease called brucellosis to cattle.

Brucellosis is a bacterial infection that causes animals including elk, bison, and cattle to abort their calves, go lame, and produce less milk, all of which means lost money for producers. It also afflicts humans with a terrible fever that comes in waves over months or years accompanied by depression and night sweats that smell like wet hay. In the 1920s and 30s it ran rampant through U.S. livestock herds and sickened tens of thousands of people. In 1934, the U.S. Department of Agriculture launched the State-Federal Cooperative Brucellosis Eradication Program, and has since spent over $3.5 billion to get rid of the disease in livestock herds.

Most efforts have focused on a combination of calfhood vaccination and test-and-slaughter. Gradually, state-by-state, brucellosis has come under control. It wasn't until February 2008 that the U.S. Department of Agriculture announced livestock in all fifty states plus Puerto Rico and the Virgin Islands free of brucellosis infection. Now, wild elk and bison in the Greater Yellowstone Area harbor the last remaining reservoir of brucellosis in the U.S.

In many ways, thanks to nation-wide collaborations and aggressive action, the brucellosis eradication story in North America is one of triumph. Still, ranchers in the Greater

Courtesy Mark Gocke/Wyoming Game and Fish Department

Emilene Ostlind

Elk paths melt out of the snow in late March at the Dell Creek feedground in the foothills of the Gros Ventre Mountains.

Yellowstone Area don't see it that way. They are at the center of the last remaining battle against the disease. The federal government is pulling back from efforts to eradicate it there, leaving that challenge up to Wyoming, Idaho, and Montana. And wildlife managers, charged with protecting wild elk and bison as well as reducing disease transmission to domestic livestock, must navigate longstanding politics as they seek to improve scientific understanding of brucellosis and develop better management.

There are a few stories explaining how the disease got into wild elk and bison in Yellowstone. One claims it came from cows brought to the park to provide fresh milk for park workers. Another blames Charles Jesse "Buffalo" Jones, a Yellowstone National Park game warden who released hand-reared bison calves, likely infected via cows' milk, into the park to reestablish the depleted herd. Ongoing genetic research of the DNA from hundreds of stored brucellosis bacteria samples indicates Yellowstone wildlife infections probably came from multiple livestock spillover events. However it happened, brucellosis, introduced from livestock, persists in Yellowstone, mostly in bison who bunch up together and also in elk.

Now ranchers fear transmission from those wild animals back to livestock. During the third trimester of pregnancy, usually in March to May for elk, the *Brucella abortus* bacteria proliferates in the womb, thriving on erythritol, a sugar in fetal fluids. It overwhelms the fetus, killing it and causing the mother to expel it. The aborted fetus swarms with billions of bacteria. If another elk or a beef cow sniffs or licks it or otherwise comes into contact with those fluids, she will become infected, continuing the cycle. Spring is the most likely season for transmissions, and the most dangerous time for elk to mingle with cattle.

When brucellosis does get into a livestock herd, it brings serious economic repercussions for the rancher and impacts the livestock industry throughout the surrounding region and state.

Zac Roberts was one of the last ranchers in Wyoming to have a "hot cow." Back in the winter of 2008 two of his beef cows aborted their calves, and that spring when he sold them for slaughter, their blood tests showed up positive for brucellosis. That triggered blood testing for his whole herd, and the testing turned up more "hot," or infected, cows. It's likely the spillover came from elk on the nearby Franz Feedground, adjacent to one of Roberts' pastures.

Roberts had to quarantine all of his livestock on his private land in the Upper Green River Valley just north of Daniel, Wyoming. In the summer, ranchers in this area usually move their herds onto public national forest land grazing allotments in the surrounding mountains while they grow hay down on their private land. Cattle from different herds mix on the forest allotments. A herd in quarantine can't go to its summer allotment. That means the animals eat through the summer what is meant to be hay stored for winter.

Wildlife managers, charged with protecting wild elk and bison as well as reducing disease transmission to domestic livestock, must navigate longstanding politics as they seek to improve scientific understanding of brucellosis and develop better management.

Roberts' infected cows bumped Wyoming from "Class Free" (no brucellosis infections in livestock) to "Class A" (less than 0.25 percent of livestock herds have a brucellosis infection) status. The move to Class A status triggered additional testing for all producers. To remain competitive in the cattle market, states strive for Class Free status. Wyoming had achieved Class Free status in 1985, and maintained it for nearly two decades. Then, in 2003, brucellosis showed up in a cattle ranch near Boulder, Wyoming. The suspected source: elk packed onto the nearby Muddy Creek Feedground. Before the cattle could be destroyed, they infected another herd. Wyoming lost its Class Free brucellosis status in February 2004, and later that year, two more herds in Teton County, Wyoming, showed up positive. Ever since then a couple of cattle or domestic bison herds per year in Wyoming, Idaho, or Montana have been infected, including Roberts' herd in 2008 and herds in Park County, Wyoming, in 2010 and 2011.

In 2009 and 2010, Wyoming, Montana, and Idaho worked with the U.S. Department of Agriculture to outline "designated surveillance areas" in the Greater Yellowstone Area. Ranchers inside the DSAs, regions defined by elk and bison herd units known to have infected animals, are treated separately from ranchers across the rest of the state as far as brucellosis testing requirements. Now, even if the DSA loses Class Free status, ranchers in the rest of the state are free from sanctions.

By the end of summer 2008, Roberts' herd was still widely infected and neighboring ranchers whose cattle had mixed with his the year before were testing their herds. (It looked like one of them was infected, too, but that turned out not to be the case.)

Meanwhile, Roberts saw no end to the quarantine, and the whole state was waiting for him to clean his herd so Wyoming could regain its Class Free status. His only remaining option was a whole-herd buyout by the U.S. Department of Agriculture.

First, he phoned officials in Washington, DC, requesting that they slaughter only his cows, not his heifers—the younger animals, yet to be bred, that he'd kept separate from the older cattle—but the regulations called for all-or-nothing. The Agriculture Department sent an appraiser to his ranch to value and pay for the herd. "There were some purebred cows I felt were worth more than the appraisal," he says. In October that year, the cows were shipped away to slaughter. (Because the bacteria proliferate in reproductive fluids but not in muscle, well-cooked meat from infected animals is safe to eat and can still be sold as beef.)

Even after his whole-herd buyout, Roberts' trouble was not over. He had to pay to have the new cattle shipped to his ranch, a cost the federal government wouldn't cover. "This herd of cattle has been going since the late 1800s. I had to buy cattle that I don't know where they came from," Roberts says. "You have a herd that knows how to get around, where they need to be. Then you buy a set of cows that don't know nothing."

The new cows had what he calls "brisket disease," caused by pressure in the pulmonary artery from high elevation, something he'd bred out of his original herd. "Too much pressure causes the brisket to swell up and kills them."

Roberts is still struggling with the aftermath of his herd's infection. Meanwhile, Wyoming cattle herds are brucellosis free for now, but it's only a matter of time before the disease jumps from elk to livestock again and another herd tests positive. In the meantime, ranchers and wildlife managers in the western part of the state are searching for ways to slow or stop the disease.

In 2001 Brandon Scurlock, who'd always wanted to work in the west, moved from Kentucky, where he'd recently finished his graduate studies on ruffed grouse, to Pinedale, Wyoming, for a job in the Brucellosis Program at the Wyoming Game and Fish Department. His task was to study brucellosis in elk and use collaboration to find management solutions. In 2004 he moved up to become the Brucellosis Program Manager.

"Elk are neat critters," he says. "You have to respect them when you work with them. They can eke out a living wherever they are." His objectives as Brucellosis Program Manager include both preventing transmission of brucellosis from elk to cattle and reducing (or eliminating) the disease in elk.

"We are losing a few [elk] cows

Courtesy Mark Gocke/Wyoming Game and Fish Department

Feeders distribute hay for wild elk on a western Wyoming feedground.

Emilene Ostlind

Wyoming Game and Fish Department Brucellosis Program Manager Brandon Scurlock has been involved with several research projects to improve understanding of how elk carry and transmit brucellosis.

[to brucellosis] but we are basically offsetting that by eliminating winter mortality," Scurlock says. Brucellosis is not a terrible disease for elk. A herd can persist with low-level infection. "Populations are still growing. There are way worse diseases for wildlife. The problem with the disease is when it spills over into cattle."

That's where the feedgrounds come in. They are in place to protect livestock, but they also elevate the disease in elk. While only about 1-3 percent of elk that spread out on native winter ranges show signs of exposure to the disease, 15-60 percent of crowded-together feedground elk carry brucellosis antibodies. Scurlock's challenge is to spread elk out so they won't pass the disease around while packing them together to keep them away from cattle.

When Scurlock started, brucellosis control efforts were mostly focused on managing habitat around feedgrounds to encourage elk to disperse during calving season, and vaccinating feedground elk by shooting them with bio-bullets containing Strain 19, a brucellosis vaccine. Scurlock got to work studying how elk carry and transmit the disease in a search for better management solutions.

For starters, no one really knew how many "seropositive" elk—those whose blood showed antibodies to brucellosis—were actually contagious. Elk might be seropositive if they had recovered from the disease in the past, or if they were exposed to it and their immune system built enough antibodies to fight it off. The quickest way to test for infection in an animal is to look for antibodies in the blood, but seroprevalence doesn't necessarily mean the animal carries the bacteria or is infectious.

Scurlcok and his colleagues at the Wyoming Game and Fish Department and the University of Wyoming saw an opportunity to answer this and other questions when the state started a test-and-slaughter campaign. The state Brucellosis Coordination Team, established by Wyoming Governor Freudenthal after the brucellosis outbreak in 2003-04, recommended the Wyoming Game and Fish Department conduct a five-year test-and-slaughter program to reduce brucellosis in feedground elk. Because test-and-slaughter had worked to cull the disease in livestock, the team wanted to see if it would work in elk as well. "We built the mother of all elk traps and caught a whole bunch of elk and tested them and held them overnight and eliminated the positives," says Frank Galey, chair of Wyoming's Brucellosis Coordination Team.

From 2006 to 2010, the program destroyed over 200 elk on three feedgrounds at a cost of $1.2 million. Seroprevalence at the Muddy Creek Feedground dropped from around 37 percent down to about 5 percent during the test-and-slaughter program. "It worked pretty well for a few years and then the instances just came back up," Galey says. By 2015, brucellosis seroprevalence at Muddy Creek was back up to 21 percent.

To learn how many of the seropositive elk were contagious, graduate student researchers followed the elk as they were trailered to a slaughter facility in Idaho, collected lymph node and tissue samples, and took them back to the lab for further testing. They found only about half of the seropositive elk (those carrying antibodies to brucellosis) were actually contagious (carrying

A BRIEF HISTORY OF BRUCELLOSIS

1887 – British physician David Bruce investigated a mysterious illness that killed four soldiers on the Mediterranean island of Malta

1894 – First cases of "Malta fever" reported in the U.S., mostly in soldiers returning from overseas

1897 – Bernard Bang studied "contagious abortion," nicknamed "Bang's disease," in cattle in Denmark

1902-1905 – Game warden Charles Jesse "Buffalo" Jones released bison captured as calves and raised in captivity (and possibly infected by milk from domestic cows) into Yellowstone National Park to restore the wild herd

1905 – Greek physician Themistokles Zammit determined the Maltese goat passed Malta fever to people through unpasteurized milk

1912 – National Elk Refuge established south of Yellowstone to compensate for loss of historic winter range in Jackson Hole

1917 – Bang's disease detected in Yellowstone National Park bison

1918 – American microbiologist Alice Evans connected the organism responsible for Bang's disease to that for Malta fever, and Karl Meyer, a San Francisco veterinary scientist, proposed grouping the organisms under the genus *Brucella*, named for Dr. David Bruce

1926 – Forty-six cases of brucellosis reported in humans in the U.S.; the disease infected tens of thousands more over the following decade

1929 – Wyoming Game and Fish Department began feeding elk in western Wyoming

1934 – USDA launched the Cooperative State-Federal Brucellosis Eradication Program, which used test-and-slaughter to slowly clean the disease out of livestock herds over about 70 years; the program has cost over $3.5 billion and still continues today

1941 – Strain 19 vaccine, an accidental discovery by USDA Bureau of Animal Industry veterinarian John M. Buck, was licensed for use in cattle; vaccination became a major part of the brucellosis eradiation effort

brucellosis bacteria), fewer than expected.

In another project during the test-and-slaughter campaign, Scurlock and his colleagues investigated disease transmission on feedgrounds. The thinking at the time was that if a cow elk saw a fetus on the ground, her maternal instincts would kick in and she would go out of her way to investigate it, thus contracting the infection. To test this, the team collected fetuses from the non-infectious seropositive pregnant elk sent to slaughter. They placed those frozen fetuses on feedgrounds, and field technicians observed and video taped how cow elk interacted with them. This study showed the "maternal instincts" idea was wrong: rather than walking toward a fetus once she saw it, a cow elk would only sniff or lick a fetus if she passed directly next to it. Fetuses spread out across the feedground had many fewer contacts compared to those on hay lines, where elk feed shoulder to shoulder and all walk along the same path.

Scurlock also needed to know where and when cow elk were aborting. The only information he had came from feeders who happened to find a fetus on a feedground and report it. In this study, Game and Fish captured elk in the winter, and put vaginal implant transmitters, or VITs, into seropositive pregnant elk. The transmitters send out a signal researchers can detect with an antenna to pinpoint the location, date, and time to within a half hour of when the VIT was expelled. So far, Scurlock's team has put out nearly 600 VITs and has documented about 30 reproductive failures. They've started to narrow down the time of year that abortions occur.

Now Scurlock and his team are applying these findings to feedground management to try to reduce brucellosis prevalence among the fed elk. He's focused for now on two "simple" ideas in the Target Feedground Program. For one, he's changing how hay is distributed. Instead of placing hay in a line, Target Feedground Program feeders spread it in a checkerboard, reducing the likelihood that an elk will stumble across an aborted fetus. Second, he's ending feeding earlier in the season at some Target Feedgrounds where neighboring cattle operations are not at risk, causing the elk to disperse into the hills just when abortions might happen and greatly reducing the transmission potential. He's monitoring these two changes to determine how effective they'll be at lowering brucellosis prevalence in the feedground elk, but doesn't expect to see effects for another eight to ten years.

But reducing brucellosis prevalence within feedground elk is just one small piece of the puzzle. The goal remains to eradicate the disease throughout the region.

"Here's what it'll have to take," Brucellosis Coordination Team Chair Galey says. "Changes in management in terms of either less dense feedgrounds or less concentration of elk. In addition, development of a much more effective vaccine. I think management alone probably won't fix the problem and I don't think a vaccine alone will fix it. I think it's going to take both."

As far as creating less dense feedgrounds, back in 2004 the Brucellosis Coordination Team recommended Brucellosis Management Action Plans, or BMAPs. Created by local ranchers, sportsmen, wildlife managers, and others in each of the effected elk herd units in Wyoming, the BMAPs outline fencing projects and other strategies to reduce disease transmission. In part, the BMAPs were designed to get local constituents to discuss whether feedgrounds, which elevate the disease in elk, can be phased out, though none are on the table for a phase out yet. "They wanted more dialog between the Game and Fish and livestock producers, and it's definitely done that," Scurlock says. "If you're talking to one another you are developing trust."

On the vaccine front, Strain 19, developed by USDA researchers in 1941, was the inoculation of choice for many decades, but it had its problems. It showed false positives in vaccinated animals, leading to scares as well as time-consuming and expensive additional testing. In addition, its effectiveness faded as the animal got

1981 – U.S. Department of Agriculture defined Class Free and Class A-C statuses and declared states could be divided into two areas with separate classifications

1985 – Wyoming declared free of brucellosis in livestock herds; began vaccinating feedground elk with Strain 19

1989 – Twenty-seven states declared free of brucellosis in livestock herds

1996 – USDA Animal and Plant Health Inspection Service licensed RB51 vaccine for use in cattle to replace Strain 19, which caused false positive brucellosis test results

November 2003 – Infected cattle found in Sublette County, Wyoming

February 2004 – Wyoming lost its Class Free brucellosis status, Governor Dave Freudenthal convened a Brucellosis Coordination Team, which met monthly and produced 28 recommendations

September 2006 – Wyoming regained Class Free status

February 2008 – All fifty states, Puerto Rico, and Virgin Islands reached Class Free status for the first time since brucellosis eradication efforts began

September 2008 – Montana lost its Class Free status, and Idaho and Wyoming soon followed

2009-2011 – USDA and states defined Designated Surveillance Areas (DSA) in at-risk areas overlapping infected wildlife herd units in Wyoming, Montana, and Idaho where livestock brucellosis testing requirements are stricter than elsewhere in the states

2010 – Brucellosis detected in livestock herds in Park County, Wyoming

2012-present – Brucellosis seroprevalence detected in blood samples from hunter-killed elk in the Bighorn Mountains and areas of Montana outside the DSA

2015 – Ballistics manufacturer stopped producing the bio-bullets used for feedground elk vaccination; Wyoming Game and Fish used the last of their bio-bullets

older, but it wasn't supposed to be administered more than once. In 1996 the USDA licensed a new vaccine for cattle called RB51. This one wouldn't lead to false positives and could be administered multiple times.

"Neither vaccine is that efficacious in cattle, or elk or bison for that matter," says Galey. One study showed RB51 prevented only about 60 percent of cow infections and abortions. Strain 19, which since 1985 has been administered to feedground elk annually, leads to only a 25-30 percent difference in calving success compared to unvaccinated elk.

That may not matter any more as the bio-bullets used to administer the vaccine to elk are no longer being manufactured. "We just used the last of our bullets a couple weeks ago," Scurlock says. Without bio-bullets there's no realistic way to get the vaccine into thousands of wild elk each year.

Rather, a more effective vaccine for cattle is greatly needed, but the hope to find one is stymied by the fact that brucellosis is classified as a bioterrorism agent. Any lab research of the disease has to be conduced in a Bio Safety Level 3 laboratory. "It makes these studies hideously more expensive than they need to be," Galey says. The University of Wyoming, under Galey's leadership, has constructed a BSL3 lab, but it's had design challenges and has not yet been certified for operation. Though other such labs exist in the U.S., brucellosis vaccine research development hasn't advanced much in recent years, in part, perhaps, because of the fact that it's only really a concern for a handful of ranchers and elk hunters in a remote pocket of the country and not much on the national stage.

While the rest of the country has washed its hands of the problem, the challenges in the Greater Yellowstone Area are daunting, and the millions of dollars of support U.S. Department of Agriculture Animal and Plant Health Inspection Service has sent to the region over the past decades are drying up.

"The USDA's walked away from us," says Galey. "They really cut back on their surveillance and their support for our programs. They won't indemnify ranchers if they want to slaughter their whole herd now."

Now, it's up to the states to wipe out the remaining pool of brucellosis. Galey and the Brucellosis Coordination Team will continue to push. He's lobbied Congress to provide research funding for vaccine development, written letters to have *Brucella* removed from the bioterrorism list, and more.

"We've got to have a better vaccine," Galey says. "And we've got to have some prudent and knowledgeable management strategies."

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On the management side, some groups are calling on the state to close the feedgrounds, because they perpetuate the disease, create unsanitary conditions for the elk, disrupt migratory behavior, and otherwise convert an iconic wild species into feedlot stock. Montana has no feedgrounds, and Idaho operates only a couple. Still, other constituents support the feedgrounds either because they elevate elk numbers or stop elk from mingling with livestock.

"Sportsmen like the feedgrounds," Galey explains. "Some of the conservationists on the other hand do not. …Veterinarians are pretty uniform that if you had fewer elk and they weren't bunched up, they wouldn't get any kind of disease. … The ranchers are interesting. Ranchers outside the area want fewer elk because obviously the brucellosis risk goes down. Ranchers in the area are going, oh my gosh, if you get rid of the feedgrounds they are going to overrun us."

Game and Fish sets population objectives for each elk herd in the state. Of those herds that include feedgrounds, seven are within their population objectives and one is well above. That's the Piney Herd Unit, which encompasses five feedgrounds southwest of Pinedale. There, Game and Fish sets liberal hunting quotas in an effort to reduce the number of elk, but much of the herd unit spans private land with challenging hunting access. To date decreases have only been minimal.

Even if they do elevate elk numbers and brucellosis prevalence in elk, rancher Zac Roberts maintains the feedgrounds are, "definitely necessary. Otherwise the elk would be down here by the cattle aborting in the spring."

Proposals to get rid of feedgrounds crash before they can get off the ground. "Feedgrounds currently have a lot of support in Wyoming, so ending a feedground is politically unfavorable and unlikely," says Scurlock. Brucellosis, bad as it is, won't be enough to end feedgrounds.

"Another disease, if it gets into these populations, potentially chronic wasting disease or tuberculosis or something else, it's going to be ugly," says Scurlock. Chronic wasting disease, or CWD, already infecting deer in eastern Wyoming, is moving west across the state toward the feedgrounds. This year biologists found it just 32 miles from Yellowstone. "It's a question of *when* it's gonna get here," Scurlock adds. "It's not a question of *if* but *when.*"

An animal infected with CWD suffers and looks bad: its ribs stick out, head and ears droop, saliva strings from its mouth. If animals in such condition show up on the National Elk Refuge outside Jackson, Wyoming, where the U.S. Fish and Wildlife Service feeds about 6,000 elk each winter, for example, and photos of them make it onto social media, that could sway the feedground politics. "It will probably take something like that with a high mortality rate to say, hey, they [feedgrounds] are not serving their purpose any more by keeping elk alive," Scurlock suggests.

Even as CWD moves west, the brucellosis story has taken another turn. "Now we are seeing increased evidence that it's not just maintained in those artificial concentrations that feedgrounds create," Galey explains. "We are seeing it in native-winter-range-utilizing elk in Montana, in Idaho in some areas, and in Wyoming in the Bighorns."

To monitor brucellosis, Wyoming Game and Fish collects blood samples from elk killed by hunters across the state. In recent years a few elk in the Bighorn Mountains, 40 miles east of the Greater Yellowstone Area, have turned up with brucellosis seroprevalence. It's within reason to imagine elk might have wandered from Yellowstone down the Greybull River and across the Bighorn Basin to the Bighorns.

The BCT is closely monitoring the situation, and has asked ranchers

Courtesy Mark Gocke/Wyoming Game and Fish Department

in the area to voluntarily test their herds in order to assure trading partners the animals are not infectious. Game and Fish, the U.S. Forest Service, and others are preparing to put collars on elk to track their movements and learn how the disease reached this new area. The 80-plus-year race to stop brucellosis continues. Like with many living things, now that it's had a taste of the wild, the disease is running free.

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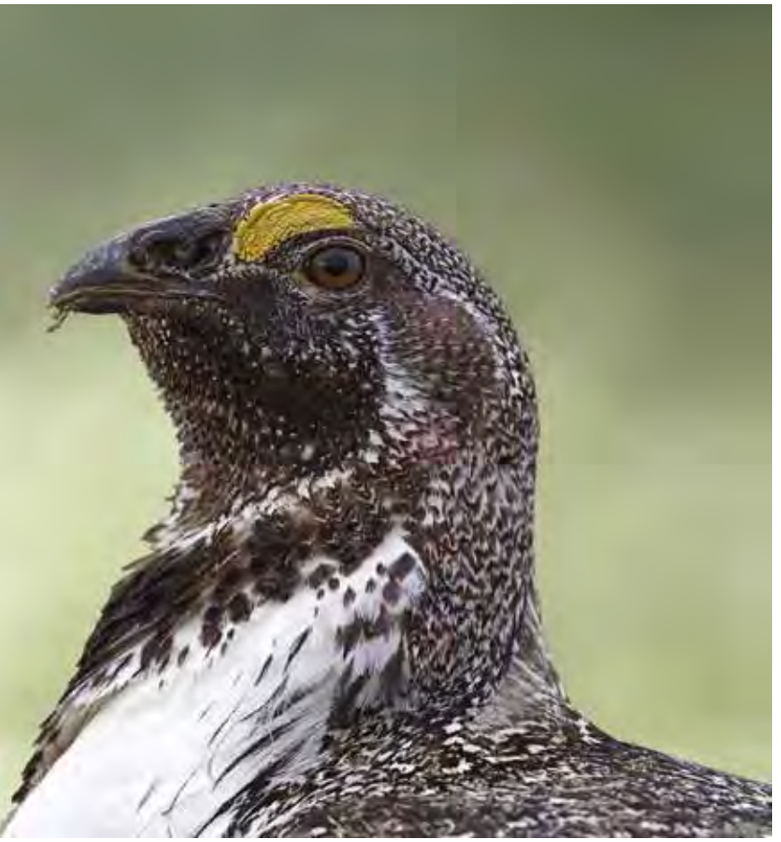
Charlie Reinertsen

BIRD v. B

The complicated relationship between sage grouse and their avian predators



IRD

By Sarah Gilman

Rancher Truman Julian says he has "a place in his heart" for greater sage grouse. A former wildlife biologist who still works land his family homesteaded near Kemmerer, Wyoming, around the turn of the 19th century, Julian has piped spring water to troughs at the dry edges of his private ground that he says benefit both sage grouse and livestock, and has installed special ramped screens the birds can climb to escape drowning should they fall in.

Sage grouse, best known for males' elaborate chest sac-puffing mating displays, need all the help they can get. Though the species persists in 11 western states and two Canadian provinces, it occupies less than half its historic range; its numbers have fallen from historic estimates in the millions to as few as 200,000 today. Environmentalists, ranchers, government officials, sportsmen, scientists, and others have been rushing to bolster sage grouse populations in advance of the U.S. Fish and Wildlife Service's decision this fall about whether the bird deserves special protections under the Endangered Species Act.

Because sage grouse declines stem from habitat fragmentation and loss, much of the recovery work has focused on protecting and restoring what's left. But Julian wondered about another variable. "Over the last 10 to 15 years, we've built up a lot of ravens," he says—whole fields black with them. "They raid everything. They kill our lambs. We had a rancher that lost five calves when ravens pecked into their hind-leg joints." Local producers were increasingly calling on Wildlife Services—a federal agency tasked with managing human-wildlife conflicts—to poison ravens at calving and lambing time. Since ravens also gobble sage grouse eggs, Julian thought, why not ask researchers to look into whether the agency's effort to protect livestock boosted local sage grouse as a side effect?

Jonathan Dinkins ended up with the project as a Utah State University PhD student in 2008. It's normal for sage grouse to get eaten, says Dinkins, now a post-doc at University of Wyoming: they're the natural prey of many different species, including ravens. But a raven boom could be contributing to a grouse bust. So in part, he would try to determine whether killing ravens actually helped more sage grouse nests succeed—that is, let more eggs hatch into chicks. It was a good opportunity, he says, "to look at management as it would occur."

He also wanted to investigate whether avian predators in general—ravens and magpies as well as raptors that kill adult grouse—had broader impacts by affecting sage grouse behavior. Could they change how the birds used the landscape? Even make otherwise choice nesting and brooding habitat unusable by *scaring* sage grouse away?

In other words, could the mere threat of predation be eating away more of the habitat the already struggling grouse so desperately needed?

The story of ravens and sage grouse is, in ways, one of diametric opposites. The raven, a remarkably adaptable and intelligent generalist scavenger and predator, flourishes in human-altered landscapes. Transmission lines, oil and gas infrastructure, and buildings provide perches and nest sites in formerly raven-scarce habitats like the sagebrush steppe and the Mojave Desert. Industrial sites, railroad bridges, overpasses, and trees provide shelter where they can ride out harsh winters that once drove them away. And livestock operations, roadkill,

and rural landfills provide windfalls of previously unavailable food. Raven populations grew 300 percent in the West between 1980 and 2007; in some areas, they increased 1,500 percent.

Sage grouse, though, are notoriously intolerant of human disturbance. They favor unbroken habitat so vast that, if you surveyed it from a hilltop, you'd see "sagebrush from horizon to horizon," says Oregon State University researcher Christian Hagen. The vastness insulates ancestral sage grouse mating grounds, called leks, and gives the bird options for finding sagebrush, among its staple foods, if, for example, a snowstorm buries its usual haunts. The bird also relies on sagebrush as camouflage. Hens' mottled plumage melts into the dappled leaf shade and litter beneath the shrub's overhanging branches, where they prefer to build nests against the trunk behind a screen of grasses. And wide swaths of unbroken land offer microhabitats that support the grouse during different life stages: hens nest in dry uplands, for example, and then take their hatchlings to wetter areas to eat insects, wildflowers, and other forbs. None of these habitat functions have been served well by spreading energy infrastructure, roads, ranchettes, wildfire, or other alterations of the sagebrush sea, and sage grouse have suffered.

As interest in the bird's predicament grew through the early 2000s, a graduate student named Peter Coates set out to document the most important nest predators of sage grouse. He and his advisor kept tabs on 87 sage grouse nests in northeastern Nevada, 55 of them with cameras. Nearly half failed due to egg snatchers. Of the depredation events caught on video, ravens were responsible for more than half. Not only that, but the more ravens were nearby, the more likely a nest was to fail. And nests under thinner shrub canopies were much more vulnerable; degraded habitat clearly gave ravens a leg up.

"It wasn't surprising that ravens were depredating sage grouse nests, because they're a well known nest predator," says Coates, now a wildlife biologist for the U.S. Geological Survey's Western Ecological Research Center. "What was surprising was just how *many* of the depredations they were responsible for, and how related that was to lack of cover. Even in areas with low raven abundance, you can end up with high predation if cover is lacking."

> "It wasn't surprising that ravens were depredating sage grouse nests, because they're a well known nest predator. What was surprising was just how many of the depredations they were responsible for, and how related that was to lack of cover."
>
> *Peter Coates, wildlife biologist U.S. Geological Survey Western Ecological Research Center*

Coates' work landed sage grouse on the long list of sensitive species harmed by ravens' human-abetted expansion, including desert tortoises and snowy plovers. As he continued research in the Great Basin, he found sites with high raven abundance where the percentage of grouse nests that succeeded averaged 22 percent or lower, significantly below the range-wide average of 40 to 50 percent. "The data suggest that some areas," he says, "are in desperate trouble."

But ravens are themselves native and protected under the Migratory Bird Treaty Act. And was killing them even a real fix? Dinkins hoped to find out.

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To assess whether killing ravens was helping sage grouse, and answer his bigger questions about how predators shape sage grouse habitat use, Dinkins would need to cover a lot of ground. Combining forces with a University of Wyoming master's student who was beginning a different research project, he set up 12 study sites that encompassed about a million acres in southern Wyoming. Seven were in areas with no raven control. Five were near lambing and calving grounds and landfills where Wildlife Services was killing the birds using dog food laced with a poison called DRC-1339 that only works on ravens and other members of the corvid family, such as crows and jays.

Each spring from 2008 through 2011, the researchers and techs boarded ATVs in the night, used spotlights to freeze female sage grouse in their tracks, then netted and fit them with little radio-transmitter necklaces. (One tech has since listed on her resume the "badass 4x4 skills" she acquired.) They checked in on the grouse weekly through the summer, locating their nests with binoculars, then using radio telemetry to track when hens were done incubating so they could confirm whether nests succeeded or failed without alerting predators to their locations. Then they kept tabs on where hens traveled with their chicks for several more weeks.

At nest and brood spots, researchers spent 10 minutes each week counting ravens, golden eagles, hawks, and other avian predators in order to calculate local densities. For comparison, they repeated this procedure at randomly selected locations. They also amassed data on vegetation and terrain, as well as the density and proximity of human structures such as power lines, oil and gas sites, and roads. There were, says Dinkins, a lot of 10-hour days.

Given Coates' and others' work, Dinkins expected predators would have some effect on where grouse chose to be. But when he and his colleagues began crunching numbers, he was surprised by just how profound that effect was. Hens nested and raised their young in spots with significantly lower densities of avian predators—including ravens—than random locations had. In fact, predators appeared to be the most significant factor influencing grouses' nesting and brood locations, above and beyond the other measures of habitat quality and human disturbances.

More fine-tuned analysis suggested grouse were taking it all into consideration, sticking close to denser sagebrush for food and cover and steering clear of predators they could see, as well as potential predator perch and nest sites like oil and gas structures or power lines. And little wonder: Dinkins found that hens in areas with denser power line development were more likely to die.

Increased predator access to the sagebrush steppe brought by human development looked like a one-two punch for the sensitive grouse. "Any feature that increases the abundance of avian predators on the landscape has the potential to reduce the amount of sage grouse there," Dinkins says—not only because more grouse get eaten, but also because they avoid predators and the structures that support them. "Those indirect effects of avoidance could have larger effects than predation itself."

"At all sage grouse life stages there is a predator that wants to eat them," adds Dinkins' advisor and co-author Jeff Beck, an associate professor at the University of Wyoming, so it makes sense that sage grouse would develop evasive maneuvers over millennia.

"Jon's work is cool because he's able to look at the interaction of that with the changing landscape."

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Ravens in particular had some alarming effects. Similar to what

Coates had found in Nevada, nests where Dinkins and his team observed a raven flying just above or nearby were vastly more likely to fail. That suggests that if ravens keep increasing in Wyoming as they are, Dinkins says, "it's like a train wreck coming."

But the jury's still out on whether killing them can soften the crash. Dinkins' preliminary analysis—which he's currently preparing for publication—does show that lowering raven density boosts grouse nest success. Yet that bump happened only after Wildlife Services significantly ramped up its efforts halfway through the study. And more favorable weather conditions also played a hefty role. Moreover, nobody has yet studied whether benefits imparted by lethal raven control persist in the long term, or whether they translate into sage grouse population gains. More chicks hatching only makes a difference for grouse numbers if they're surviving to breeding age and successfully reproducing, so if there's a bottleneck elsewhere, raven control may have no effect.

There's even anecdotal evidence from other areas that if territorial raven pairs are removed, they are replaced in much higher numbers by transients more tolerant of each other's company, suggesting that, to be successful, lethal control might require a never ending and expensive campaign. "If you want this to be your management strategy," says Dinkins, "it's going to have to be every year. And there are ethical boundaries—ravens are native and protected." For now, Dinkins says, lethal control looks at best like a short-term, emergency measure that may help buy time for pockets of grouse in especially dire straits, but is no substitute for habitat protection and restoration.

Wyoming Game and Fish in 2012 asked Wildlife Services to up raven control at some landfills for the benefit of sage grouse. Still, the state's Sage Grouse Coordinator Tom Christiansen agrees that killing ravens "is not going to solve the overall sage grouse problem" because "ravens are a symptom" of degraded habitat. He aligns with Dinkins, Coates, and others who think that getting at root causes of increasing raven predation will require limiting human development in swaths of the landscape that still support healthy populations of sage grouse, and restoring others so that they provide better protection. Strategies like Wyoming's "core areas" policy or private land conservation agreements—such as some recently enacted on hundreds of thousands of acres in Oregon—have worked toward that end, albeit imperfectly.

For inevitable development and existing development that's here to stay, managers should focus on limiting unnatural raven food sources and making perches harder to use, scientists say. That means removing roadkill from along roadways, dealing with livestock carcass dumps, and covering landfills, among other things. "Until you do those things, it's not going to do any good to control raven numbers," explains University of Washington corvid expert John Marzluff, "because they'll just increase again."

Wyoming's Upper Green River Basin Sage Grouse Working Group has mounted a successful program to replace windmills powering water pumps for livestock troughs with solar panels, which ravens can't nest on. Tubular transmission towers are less raven-friendly than latticework ones, Coates notes, and there are spiky comb-like structures that can be added to powerline cross-pieces to discourage perching. Marzluff also points to promising results from aversive conditioning experiments with corvids in the lab. Since territorial ravens live awhile and keep transient ravens out, teaching them to avoid grouse eggs by lacing similar-looking eggs with bad-tasting chemicals, or simply harassing them away from nests, he argues, may ultimately be more effective than lethal control.

But ravens' craftiness can keep them a step ahead of such efforts: They have, for example, turned some devices meant to discourage them from perching into handy anchors for their nests against the wind. And changing the way humans use a landscape in order to preserve intact habitat on broad scales is about as simple as controlling the weather. If the habitat and nonlethal fixes were easy, Dinkins points out, "this problem would have been dealt with already for shorebirds and desert tortoises."

"As we humans do, we managed to get ourselves into a corner," adds Oregon State's Hagen. "And now we have to manage our way out of a corner."

***Sarah Gilman** is an environmental journalist based in Portland, Oregon. Find more of her work at sarahmgilman.com.*

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Sage grouse shape development patterns in Wyoming

Text by Nicole Korfanta and Nicholas Graf, maps by Nicholas Graf and Coulter Sunderman

This fall, the U.S. Fish and Wildlife Service will decide whether the greater sage grouse merits endangered species protection, and Wyoming is holding its breath. Thirty-seven percent of the world's greater sage grouse call Wyoming home, and no one knows exactly what a threatened or endangered designation would mean for the agricultural and energy industries in the state. In a bid to conserve sage grouse and avert a listing, Wyoming created the Greater Sage-Grouse Core Area Protection policy meant to reduce future development in big portions of sage grouse habitat.

The policy set forth a plan to limit oil and gas, residential, and other forms of development in mapped sage grouse core habitat. To measure—and ultimately minimize—development, the state created a Density and Disturbance Calculation Tool (DDCT). Prospective developers use this geospatial program to determine whether a project will exceed the Core Area Policy "disturbance" and "disruptive activity" thresholds.

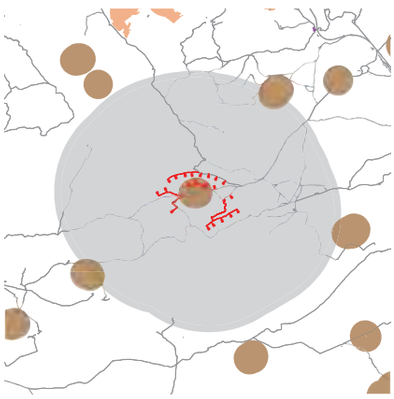
The *disturbance* calculation, which examines things like roads and wildfires, requires that no more than 5 percent of core sage grouse habitat is lost to development. *Disruptive activities*—think well pads or mining operations—are limited to an average of one per square mile. Under some conditions where valid, existing rights occur, new development may be allowed even if it exceeds the thresholds.

Two hypothetical scenarios show how the DDCT calculates disturbance and disruptions, and more importantly, leads to changes in development plans. It is up to the U.S. Fish and Wildlife Service to decide whether such changes will be enough to help slow or reverse sage grouse declines.

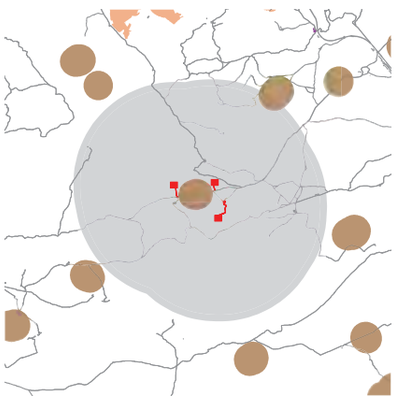
GAS WELL DISRUPTIVE ACTIVITIES

New natural gas development near a sage grouse lek comes in under the disturbance and disruption thresholds. Still, the state permitting and wildlife agencies ask the developer to keep wells at least 0.6 miles away from the lek, and to use directional drilling, drilling multiple well bores from a single well pad, to reduce surface disturbance.

PROPOSED GAS WELLS
Percent surface disturbance: 1.3
Disruptive activities per square mile: 0.23



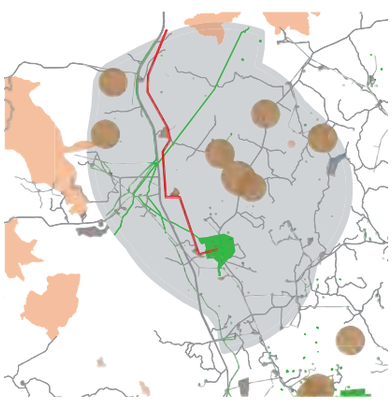
AUTHORIZED GAS WELLS
Percent surface disturbance: 1.0
Disruptive activities per square mile: 0.04



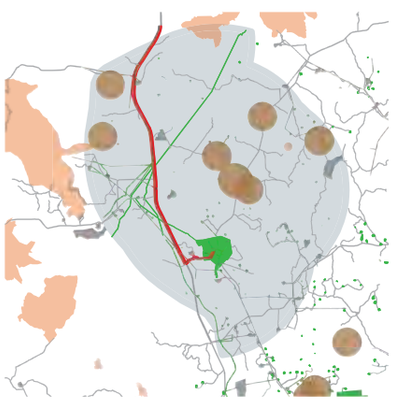
PIPELINE DISTURBANCE

Some core area habitat has quite a bit of existing development. Here, a proposed pipeline would plow under enough key sage grouse habitat to push the project area over the 5 percent disturbance threshold. Rerouting the pipeline along an existing road right-of-way reduces the new surface disturbance.

PROPOSED PIPELINE
Percent surface disturbance: 5.3
Disruptive activities per square mile: 0.34



AUTHORIZED PIPELINE
Percent surface disturbance: 4.9
Disruptive activities per square mile: 0.34



Jason Carlisle

A tractor mows sagebrush as part of a long-term habitat study near Jeffrey City, Wyoming.

Constructing Sage Grouse Habitat

Does mowing, burning, or spraying sagebrush actually help?

By Kristen Pope

Kurt Smith plucks the fifth secondary feather from the five-week-old sage grouse's wing, then loosens his gentle hold on the bird, releasing it to return to its mother and brood mates in the darkness. This bird's part in an important research project is now complete. Smith will later analyze the feather to study the chick's diet composition as part of his PhD work. Findings from this research will clarify how best to improve sage grouse habitat.

In the high sagebrush country outside central Wyoming's Jeffrey City, researchers led by Dr. Jeff Beck, an associate professor in the University of Wyoming Ecosystem Science and Management Department, are launching a multi-year study to better understand the best way to manage land to meet sage grouse habitat needs. The 736,000-acre study area is mostly federal land used for cattle grazing and big game hunting. Now it's also an important field laboratory for a cooperative study between the University of Wyoming, Wyoming Game and Fish Department, Bureau of Land Management, Wyoming Cooperative Fish and Wildlife Research Unit, Boise State University, and other partners. The research team will analyze sage grouse responses to vegetation treatments in sagebrush habitat.

Throughout their life cycle, sage grouse rely on sagebrush for food and shelter. They nest under the sagebrush canopy to hide from predators. Through the summer they eat forbs (wildflowers and other leafy plants) that grow between the sagebrush plants. The chicks rely on the ants, beetles, grasshoppers, and other insects that live in the sagebrush ecosystem. In the fall and winter, sage grouse eat sagebrush leaves.

Researchers are launching a multi-year study to better understand the best way to manage land to meet sage grouse habitat needs.

"The way sagebrush communities change is through disturbance events such as fire or drought," Beck said. "[Disturbance] reduces the overstory cover of sagebrush, effectively releasing the understory from overstory competition, thus promoting growth of forbs and grasses, then new sagebrush." Managers often burn or mow Wyoming big sagebrush or apply herbicides on it to mimic natural disturbances and jump-start new plant growth, but it's up for debate exactly how much such treatments actually help grouse. Beck hopes the new project near Jeffrey City will further our limited understanding of what these treatments mean for grouse.

Beck and his colleagues are putting the effects of the herbicide

Spike 20P—which at low application rates kills shrubs but not grass or forbs—and mowing treatments under the lens in the Jeffrey City study. They will also analyze grazing exclosures to see how vegetation responds when cattle and wild horses are kept out of an area. Though Beck has long studied how sage grouse habitat responds to treatments, this will be the first time he and his colleagues also monitor the grouse response to treatments.

The researchers conducted the pre-treatment phase of the study in 2011 through 2013. They implemented treatments in winter and spring of 2014, mowing some areas and aerially applying Spike20P on different sections of the study area. Now, post-treatment monitoring is planned to continue through 2023, with the research team monitoring treated and untreated areas over the next eight years. They will compare grass, forb, insect, and sagebrush recovery, as well as grouse populations, among mowed, herbicide-treated, and non-treated areas.

Treatment and control sites span areas where resource selection modeling suggests female sage grouse will likely rear their broods. To measure adult female sage grouse survival, nest success, and brood survival, researchers capture grouse and record their age, wing length, and weight. They collect blood and affix radio or GPS transmitters to the grouse. They also record numbers of nests that hatch, count chicks, and sample feathers from two chicks in each brood. They hope this data will help them evaluate how sage grouse fare following the habitat modifications.

Sage grouse numbers have nosedived throughout the West over the past century, and scientists are urgently looking for ways to reverse these declines. "If managers can increase nest survival, chick survival, or adult female survival, then they will have the ability to increase populations, so it does become a really important practice if the connection between treatments and population response can be made," Beck said. With nearly 40 percent of remaining sage grouse located in Wyoming, it's especially important to focus on habitat conservation efforts within the state.

Christopher Kirol

Jason LeVan

Field technician Hillary Jones and PhD candidate Kurt Smith hold sage grouse, a hen and a five-week-old chick respectively, captured at night as part of two different research projects to better understand sage grouse habitat needs.

"Loss of habitat is the primary threat to sage grouse populations in Wyoming and around the West," said Tom Christiansen, sage grouse program coordinator for the Wyoming Game and Fish Department. He noted the Jeffrey City research will be key to understanding how sage grouse respond to habitat treatments. To date, "there is little scientific data to truly demonstrate whether those benefits are real or not," Christiansen said. "Answering these questions has major implications to how we will manage sagebrush habitats."

The Jeffrey City study will build on Beck's previous studies that evaluated effects of mechanical and chemical treatments and prescribed fire on grouse habitat. Starting in the late 1980s, Beck and co-researchers evaluated sites in the Big Desert of southeastern Idaho. They gathered baseline data for one year before a prescribed burn in 1989, and then continued the study for ten out of the fourteen years from 1990 to 2003. They focused on the habitat features that sage grouse rely on for nesting, rearing their young, and wintering. While they found that grass and litter recovered fairly quickly following treatments, prescribed fire caused measurable changes in habitat features, including reduced forb cover and richness, even fourteen years later. The researchers recommended against burning Wyoming big sagebrush for sage grouse habitat enhancement.

More recently, Beck and graduate student Jennifer Hess measured vegetation structure on previously prescribed burned and mowed sites along with untreated reference sites in Wyoming's Bighorn Basin to see if burning or mowing Wyoming big sagebrush increased grass height and cover. "We wanted to compare mowing to burning in particular because mowing has been known to leave residual sagebrush on site with so many advantages for sage grouse," Beck said. There, they found that while burning did increase grass cover, in some cases treated sites did not meet the minimum sagebrush guidelines for sage grouse breeding habitat. It took mowed sites at least a decade to provide enough sagebrush cover and height to protect the birds from harsh weather and predators. Even 19 years post-treatment, burned sites still did not meet the guidelines for sagebrush in breeding habitat. Beck and Hess recommended managers not burn or mow sagebrush to improve grass production because any benefits to grouse were outweighed by the lost sagebrush structure.

Christiansen describes current sage grouse conservation efforts—habitat treatments and research projects among them—as "the largest single-species conservation effort ever undertaken on the planet." The hope is that better management practices, well informed by sound science, will prevent the need to list the sage grouse as endangered. Furthermore, Chrisitansen said, "the actions taken on behalf of sage grouse benefit the entire sagebrush ecosystem, far beyond a single species."

SAGEBRUSH TREATMENTS

Text and illustrations by Emilene Ostlind

Dr. Jeffrey Beck and his colleagues and students have quantified canopy cover, measured native and invasive plants, counted insects including ants, beetles, and grasshoppers, and more, all in an effort to understand how burning or mowing sagebrush might bolster or degrade sage grouse habitat. Now, in a new study in central Wyoming, they'll monitor not only habitat characteristics, but also sage grouse themselves, to find out whether the birds successfully rear more chicks where managers mow or chemically thin sagebrush.

Untreated Wyoming big sagebrush is characterized by tall shrubs with a thick canopy. The understory includes bare ground near the sagebrush trunks, plus some native grasses, forbs (native wildflowers and other leafy plants), and sagebrush seedlings between the shrubs. Insects, such as ants and beetles, provide choice food for newly hatched chicks. As chicks grow larger, grasshoppers become more important in their diets. An average of two chicks per hen recruited into the fall population is considered excellent reproductive success for Wyoming sage grouse populations.

Wyoming big sagebrush that has undergone prescribed burning is characterized by blackened trunks and reduced canopy cover. Establishment of new sagebrush plants is slow after burning. The understory includes similar amounts of forbs to untreated sagebrush, with increased native grasses as well as invasive grasses. Beck's earlier work found increased grasshoppers in burned patches. Research suggests burned habitat does not support as many of the birds as untreated habitat due to sagebrush loss. Prescribed burning is not part of Beck's new study.

Mowed Wyoming big sagebrush is characterized by shorter shrubs with new growth at their tops as well as more new sagebrush seedlings growing underneath. The understory includes the same amount of native grasses, forbs, and insects as untreated sagebrush, as well as some invasive grasses that thrive on disturbance. In his new study, which will continue for several years, Beck and colleagues hope to determine whether mowing sagebrush will improve or decrease sage grouse reproductive success.

Treating Wyoming big sagebrush with the herbicide Spike 20P can kill about half of the sagebrush plants, leaving standing skeletons. Beck's new multi-year study of this treatment, which will continue for several years into the future, expects to find increased sagebrush seedling growth, native grass, and native forbs compared to untreated plots. Some invasive grasses may be present as well. Beck and colleagues will try to determine whether such treatment will improve or decrease sage grouse reproductive success.

UNTREATED

BURNED

MOWED

TREATED WITH HERBICIDE

Farming Sagebrush

Can fertilizer grow more deer on public lands?

By Nicole Korfanta

Imagine the old green fertilizer spreader you haul out every spring to urge your tired lawn back to greenness, but much bigger and suspended from the bottom of a helicopter. That was the scene in 2010 and 2011, when helicopters dropped pelleted urea—a solid form of nitrogen—on 1,500 acres of the flanks of the Pinedale Anticline, a formation in western Wyoming where thousands of mule deer hunker down in the winter.

The hope is that nitrogen fertilizer will grow bigger, better sagebrush to feed wintering mule deer. That's important because the deer population on the Pinedale Anticline has declined by 44 percent, down from about 5,200, in the last decade as natural gas development stretched through the heart of the winter range. The federal authorization of that gas development stipulated that if deer numbers fell below a certain threshold, managers would be required to improve habitat near the project area before looking to off-site remedies.

Hence the helicopter, part of a pilot study to test whether fertilizing sagebrush could help the deer population. A group of UW scientists (the author included) dug into the question of whether such a plan could work. Can fertilizer grow more sagebrush? And if it does, will that grow more deer?

To answer those questions, we dusted off early range studies, scrutinized the latest science on mule deer nutrition and soil science, and built a nitrogen budget to track nitrogen movement through the sagebrush ecosystem.

The notion of fertilizing rangelands is not new. Range scientists in the 1960's and 70's first tested the idea in greenhouses with mixed results. Those early studies found that sometimes fertilizer can increase the length of leaders, the succulent new growth at the tips of Wyoming big sagebrush twigs. But only sometimes. Depending on the time of year, the amount of precipitation, and other unknown factors, fertilizer can cause anything from zero to 100 percent more annual growth compared with unfertilized plants. In dry years, when sagebrush offers the least to wintering deer, fertilization effects are the lowest. Even when fertilizer does cause more sagebrush growth, it has to be reapplied annually to maintain the effect.

Studies show less promise for improving the *quality* of sagebrush. While fertilization may cause a pulse of higher protein content in sagebrush leaves right away, that bonus is lost by fall when mule deer arrive on winter range.

The limited benefits of sagebrush fertilization are tempered by the risks. On the Pinedale Anticline, 40 pounds of urea were added per acre. That as much as quadruples the natural rate of nitrogen in the ecosystem. To understand the risks, we followed that extra nitrogen to all the places it winds up besides sagebrush.

Once it hits the ground, urea is converted into nitrate, a form that plants can take up. Along the way, secondary gases volatize off and float into the atmosphere. These include nitrogen oxide, which is both a precursor to the polluting ground-level ozone that has plagued the Pinedale area in recent years and a regulated compound in its own right. Conversion of urea also releases nitrous oxide, a potent greenhouse gas that also depletes beneficial stratospheric ozone. Another byproduct is ammonia gas, which can spread downwind toward the Wind River Range, causing nitrogen deposition in streams and lakes.

> When we fertilize our lawns, we grow dandelions as well. So too in rangelands—weeds can outcompete sagebrush for the extra nitrogen.

Urea components can make it directly into nearby water bodies as well. Excess nitrogen fertilizer in streams, lakes, and aquifers causes eutrophication—a burst of aquatic plant life whose decomposition uses up oxygen necessary for animal life. This and a host of related side effects, more typical of industrial landscapes and intensive agriculture, are well documented.

When we fertilize our lawns, we grow dandelions as well. So too in rangelands—weeds can outcompete

Courtesy Dan Stroud

Helicopters distribute pelleted urea to fertilize sagebrush on the margins of the Pinedale Anticline Project Area in western Wyoming.

sagebrush for the extra nitrogen. Cheatgrass, an uncontrollable invasive weed that increases fire frequency in ecosystems, thrives when fertilized in other ecosystems (effects of fertilization on cheatgrass are little studied in sagebrush steppe). As it spreads and flourishes, it can choke out native grasses, wildflowers, and other plants wildlife relies on. While nitrogen's beneficial effect on sagebrush leaders is temporary, it paradoxically sticks around in the soil for years, precipitating changes in the plant community long after application.

The risks associated with excess nitrogen are scalable. Fertilizing test plots for a pilot study doesn't pose much of a problem, but it might on much larger acreages. The Bureau of Land Management has authorization to fertilize more than 30,000 acres of public lands in the Upper Green River Basin, although at $55 per acre it's unlikely to fertilize all of that. Managers are considering fertilizing deer winter ranges elsewhere, including around the Continental Divide-Creston natural gas development near Rawlins, Wyoming. If large sagebrush landscapes are fertilized annually the side effects are worth considering.

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We combed through a lot of studies to arrive at the less-than-satisfying answer of "maybe" to the question of whether fertilization can help mule deer. But at what cost? In this case, the many and long-understood risks of nitrogen probably outweigh the benefits of fertilization, which are uncertain, transitory, and expensive.

For now, the BLM has tabled its plans to fertilize sagebrush in the Pinedale Anticline. Results of the pilot study didn't provide much support for fertilization either.

But the story isn't over. As the U.S. continues to develop its reserves of clean-burning natural gas, sagebrush steppe will be affected. The need for innovative methods to protect and enhance wildlife habitat will only increase. If fertilization isn't the answer, what is? It's easy to suggest that one idea won't work and much harder to come up with something better.

Ecologist ***Nicole Korfanta*** *directs the Ruckelshaus Institute and is* Western Confluence*'s Associate Editor. Study co-author* ***Indy Burke****, also an ecologist, directs the Haub School of Environment and Natural Resources.*

RESOURCES

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Life Among the Turbines

Researcher explores how grassland birds respond to wind farms

By Stephanie Paige Ogburn

Courtesy Anika Mahoney

Horned lark nestlings.

On the eastern Wyoming plains, the wind whips hard across tough little bunch grasses, clinging to the soil. Sagebrush flows along the edges of nearby gullies. These rolling plains, remnants of a great grassland sea, are home to an array of birds. More recently, they've also become home to wind farms.

Scientists have been studying the risks turbines pose to migrating bats and birds for nearly two decades. But researcher Anika Mahoney wondered what they meant for the birds that make their homes and raise their young in a landscape increasingly populated by wind turbines. How might the sudden appearance of 400-foot-tall pinwheels affect grassland birds? So far, research on this topic has been slim.

"It's just such a new and weird form of development for wildlife in those areas," said Mahoney.

She had studied birds—but not wind turbine effects—before, and was attracted to a project with a "really specific question to answer." As a biologist, she knew grassland birds weren't doing so well. Grasslands have all but disappeared in the United States, overtaken by things like agriculture, oil and gas, and sprawl. The Wyoming Game and Fish Department wanted a scientist to investigate how turbines were affecting birds living in these areas. So Mahoney took on the project.

There are a few ways wind farms might affect birds living among them. First, in a treeless landscape, giant turbines are unlike anything these birds have seen before, said Anna Chalfoun, a professor at the University of Wyoming who oversaw Mahoney's work.

"If they see a shadow that moves very quickly across the landscape, in their evolutionary history the only thing that makes a shadow like that is something flying swiftly overhead, and that would usually be a potential predator," Chalfoun said.

Also, turbines emit a kind of deep, pulsing hum. This sound might affect birds' ability to warn each other of predators, hypothesizes Chalfoun. Another change the turbines bring? Their blades kill birds and bats whose scattered carcasses may draw predators like coyotes—bad news for grassland birds and their nests.

Mahoney decided to look for wind farm effects in two main ways. She wanted to see if there were fewer birds near wind turbines compared to elsewhere. She also measured how successful the wind farm birds were at rearing young, a key factor for population survival.

She did this for the two of the more common grassland birds in this part of Wyoming. One, the horned lark, has a yellow face and a black, Batman-like mask. It's widespread now, but its numbers are declining. Mahoney, with the affection only a scientist can have for her subjects, called the larks "tough" and "underappreciated," noting many of them spend the entire winter in Wyoming's blustery, sub-zero climes.

"It's this tiny little bird surviving weeks of blowing wind."

The other was McCown's longspur, a grayish brown bird with a rust-colored swatch on breeding males. Its colors may be duller, but the male's courtship flight, a spiraling, singing spectacle, is unforgettable, said Mahoney.

On a typical field day, Mahoney and a partner, wearing hard hats, slog through an ocean of grass while the wind whips their faces. They walk away from the base of a wind turbine, a hundred-foot rope stretched between them. The rope brushes against the grass, and occasionally a scared bird takes flight.

"As soon as you see a bird fly from the rope, you drop the rope and head towards where you saw the bird fly from," said Mahoney. She hunts for the nest the bird was sitting on, marks it on the GPS, and notes what's going on—are there eggs, baby birds, birds almost ready to fledge? She'd then revisit the nest to track how well the offspring survived. Mahoney also counted birds at the different sites, to learn if there were differences in their

numbers near turbines versus sites without them.

What she found surprised her. McCown's longspur, a species of concern, is known to be picky about habitat, and Mahoney thought it might be sensitive to wind turbines. But the birds most affected by wind turbines were not McCown's longspur, but the more abundant horned lark.

"I never would have predicted [that outcome]," she said.

There were 24 percent fewer larks near wind turbines—Mahoney found around eight or nine horned larks at each study site far from turbines, and often only five or six at sites with turbines. She also looked at a factor that hasn't been studied before—turbine density. It turned out, the closer together the wind turbines were on the landscape, the less likely nearby horned lark nestlings were to survive. The horned larks in areas of higher turbine density also raised smaller young than horned larks in less disturbed areas.

McCown's longspurs, in contrast, had similar numbers and nest success in wind farms compared to undeveloped grassland. Mahoney did find an effect on the longspurs when she combined data about vegetation diversity and wind turbines. Their numbers were higher near a turbine if it also had a mixture of bare ground and plants, lower if the vegetation patterns were more homogenous.

Her results leave Mahoney with more questions: Why does density affect larks more than nearness to turbines? Why does the McCown's longspur not seem affected by either turbines or vegetation type, but those factors combined make a difference?

While scientists like Mahoney are scrambling to understand the interplay between new development and wildlife, wind farms keep springing up on grasslands in Wyoming and across the country. The Bureau of Land Management is marching south-central Wyoming's 1,000-turbine Chokecherry and Sierra Madre project through its approvals. Once built, it will be the largest in the country. Analysis of its wildlife impacts has focused mostly on the eagles it will kill and the sage grouse it may displace. Mahoney's work shows those are probably not the only birds that will be affected. Perhaps one day, her findings will help inform decisions on the siting and design of future wind projects.

Courtesy Anika Mahoney

McCrown's longspur, one of the birds Mahoney looked at in her study about the impacts of wind energy development to grassland birds.

Courtesy Anika Mahoney

Researcher Anika Mahoney studied how grassland birds fare as wind energy development appears in their nesting areas.

Stephanie Paige Ogburn *reports on science and environment in the West from Fort Collins, Colorado. Find more of her work at stephaniepaigeogburn.com.*

The Tiniest Engineer

Ants shape the sagebrush ecosystem

By Emilene Ostlind

"Can you show me some ant mounds on Google Earth?" I asked Reilly Dibner. She took my computer mouse and zoomed in on the sagebrush steppe south of Jeffrey City, Wyoming, scanned around a bit, and then magnified an area speckled with little white dots like seeds on a strawberry. It's no surprise she found the mounds so quickly. Dibner has a lot of practice searching for ants in satellite images.

Dibner, an ecologist, has a paper coming out in the journal *Ecosphere* about the landscape effects of ants. She became interested in ants because she studies lizards, and her lizards were interested in ants—that is, in *eating* ants. To better understand how the greater short-horned lizard, or horny toad, makes its way around the Wyoming sagebrush steppe, she needed to figure out what the ants were up to. Though ants are one of the smallest and most easily ignored animals in the sagebrush steppe, they are also one of the most influential.

"Many species of ants are ecosystem engineers. They can change water infiltration and the nutrient content of soil around their mounds," Dibner said. "They affect diversity of plants around their mounds. They create 'islands of fertility.'"

"Fertility" is not a term taken lightly in association with the sagebrush steppe, a wind-battered, lichen-encrusted, gravely ecosystem peppered with knee-high shrubs and thin tufts of grass. In a world like this, ants "increase plant growth around mounds and increase biodiversity in part because of their seed redistribution." Dibner pointed out dark borders around the ant mounds, visible in the aerial images, where plants flourish compared to elsewhere.

While ants' engineering characteristics are pretty well studied, Dibner had a broader question. "I was interested how the spatial arrangement of ant mounds could increase the overall reach of ants on the landscape." That matters to her for two reasons. One, because trying to understand biologically generated patterns is a cutting edge realm in ecology with implications for ecosystem health and restoration. And two, because if she could describe where ants were active in the sagebrush steppe, it might tell her something about where to find horned lizards.

To sort this out, Dibner chose a large, nearly square study area. "I limited myself to Wyoming because I had to stop somewhere," she said.

Courtesy Reilly Dibner

Ecologist Reilly Dibner is interested in ant mound patterning because she studies greater short-horned lizards, which eat ants.

Within her state-bound study area, she referenced the USGS quadrangle maps, which divide the state into an even grid. Moving from one corner of the state, she selected every fifth quadrangle offset on every third row for a total 153 rectangular plots, each covering approximately 60 square miles. Then, using Google Earth, she zoomed in to the center of each selected rectangle and spiraled outwards, scanning for ant mounds.

"If you haven't spent a lot of time looking for ant mounds, you might think prairie dog mounds are ant mounds," she said. To double check her ant mound identification skills, she visited several of the sites in person during her summer field season.

Dibner then uploaded aerial photographs of the study sites to a computer program and placed a dot on each ant mound, turning them into coordinates on a grid. This allowed her to measure the distance between mounds in multiple directions and to use statistics to put a number to the regularity of the ant mound pattern. She also compared ant mound locations and density to other landscape data such as elevation, precipitation, and vegetation cover type.

Ants from one mound won't let others establish too close to them. "Those competitive interactions can give rise to regular patterning," she explained, "as if they were placed on a checkerboard." Dibner thought the ant mound patterns would break down when the mounds were more

spread out or following some kind of environmental gradient such as rainfall. Rather, the mounds were more uniform than she'd expected over the whole study area, even where they were not as densely packed.

"Wherever I found harvester ants, they had robust spatial patterns, and those patterns can have consequences for ecosystem stability."

To better understand those ecosystem consequences, she followed up with a question about the effects of any given ant mound. "We were hoping to find in the literature enough information to tell us how ants moved from a mound," she said. "There was very little and nothing we could use."

Satellite image of ant mounds near a dirt two-track south of Jeffrey City, Wyoming.

So she designed an experiment to learn how far from their mounds ants were foraging, and how thorough they were at gathering seeds. She and her field techs chose some ant mounds about 20 meters apart. They measured even teaspoons of birdseed into salad dressing container lids and set them at regular distances from the mounds: 0 meters, 5 meters, 10 meters, etc. Then they estimated or counted each tray's seeds every half hour from 6 a.m. until sundown. (They did take a break from about 2 to 5 p.m. when ants typically siesta.) Using this data, Dibner generated a graph of ant activity to help explain the reach of ant influence in the ecosystem.

"The fact that the mounds are highly regular increases the proportion of overall landscape that is close to a mound," Dibner said. Combine that with her findings about how ants collected seeds and, "It increases the potential effect of the ants from that mound by a good bit." Ants living in regularly spaced mounds can collect up to 16 percent more seeds from their surrounding environment compared to ants in randomly scattered mounds, Dibner calculated. Seed collection, she said, represents other influential ant activities, too, such as dropping seeds that might sprout into new plants, carrying nutrients from carcasses into underground burrows, or being food for horned lizards and other sagebrush animals. When the ant mound checkerboard pattern gets disrupted, the ants that are foundational to the ecosystem miss patches of the landscape.

While she was happy to return to the horny toad aspects of her research, the ant project piqued her interest in biological patterns. "Those little ant mounds and even smaller ants can have major effects on an entire ecoregion," Dibner said. "To me that's the biggest thing."

Courtesy of Reilly Dibner

Ant mound in the sagebrush steppe at one of Dibner's study sites.

RESOURCES

Reilly R. Dibner, Daniel F. Doak, *and* Elizabeth M. Lombardi, "An ecological engineer maintains consistent spatial patterning, with implications for community-wide effects," *Ecosphere*, in press.

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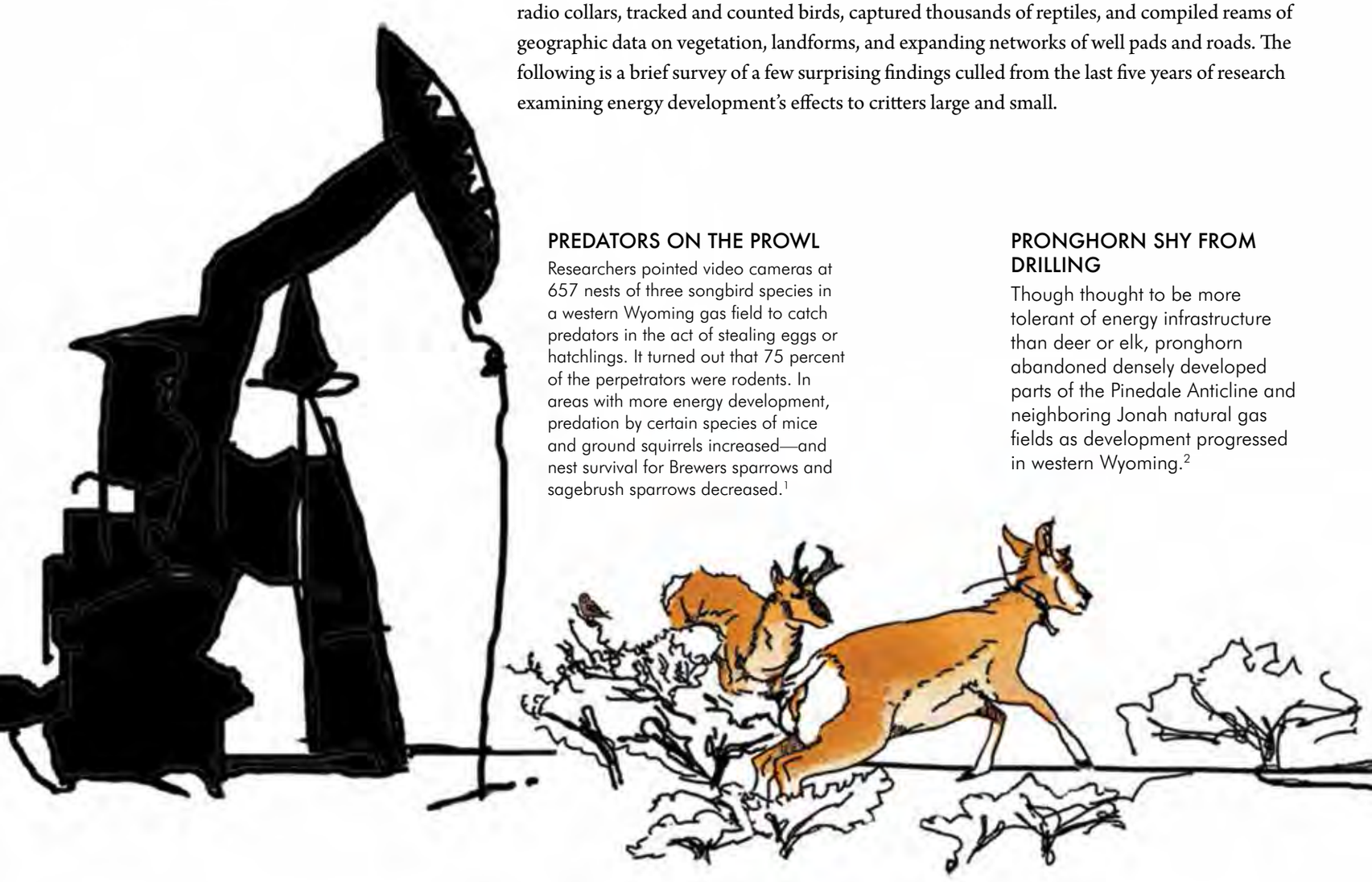
New research explores how critters

Text by Sarah Gilman and Emilene Ostlind, illustration by Bethann Merkle

Over the last 15 years, drilling has intensified in formerly remote wildlife habitats across the West. To understand its impacts, scientists have netted ungulates from helicopters to fit them with radio collars, tracked and counted birds, captured thousands of reptiles, and compiled reams of geographic data on vegetation, landforms, and expanding networks of well pads and roads. The following is a brief survey of a few surprising findings culled from the last five years of research examining energy development's effects to critters large and small.



PREDATORS ON THE PROWL

Researchers pointed video cameras at 657 nests of three songbird species in a western Wyoming gas field to catch predators in the act of stealing eggs or hatchlings. It turned out that 75 percent of the perpetrators were rodents. In areas with more energy development, predation by certain species of mice and ground squirrels increased—and nest survival for Brewers sparrows and sagebrush sparrows decreased.[1]

PRONGHORN SHY FROM DRILLING

Though thought to be more tolerant of energy infrastructure than deer or elk, pronghorn abandoned densely developed parts of the Pinedale Anticline and neighboring Jonah natural gas fields as development progressed in western Wyoming.[2]

1 Matthew Hethcoat, "Mechanistic Understanding of the Effects of Natural Gas Development on Sagebrush-Obligate Songbird Nest Predation Rates," M.S. thesis, University of Wyoming, 2014. ProQuest (UMI 1561300).

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3 Hall Sawyer, Matthew Kauffman, Arthur Middleton, Thomas Morrison, Ryan Nielson, and Teal Wyckoff, "A framework for understanding semi-permeable barrier effects on migratory ungulates," *Journal of Applied Ecology* 50 (2013): 68-78, doi:10.1111/1365-2664.12013.

4 Jessica Blickley, Diane Blackwood, and Gail Patricelli, "Experimental Evidence for the Effects of Chronic Anthropogenic Noise on Abundance of Greater Sage-Grouse at Leks," *Conservation Biology* 26, no. 3 (2012): 461–471, doi:10.1111/j.1523-1739.2012.01840.x.

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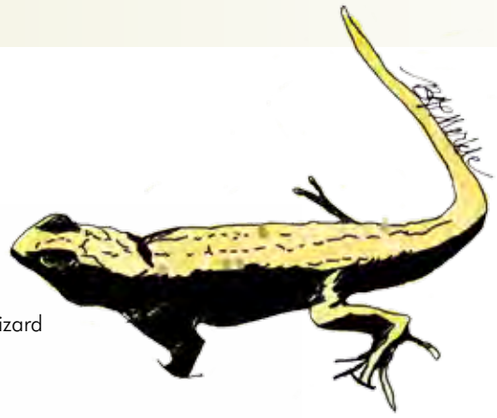
6 Sarah Ludlow, R. Mark Brigham, and Stephen Davis, "Oil and natural gas development has mixed effects of the density and reproductive success of grassland songbirds," *The Condor* 117 (2015): 64-75, doi:10.1650/CONDOR-14-79.1.

7 Clay Buchanan, Jeffrey Beck, Thomas Bills, and Scott Miller, "Seasonal Resource Selection and Distributional Response by Elk to Development of a Natural Gas Field." *Rangeland Ecology and Management* 67, no. 4 (2014): 369-379, doi:10.2111/REM-D-13-00136.1.

8 D. J. Leavitt and L. A. Fitzgerald, "Disassembly of a dune-dwelling lizard community due to landscape fragmentation," *Ecosphere* 4, no. 8 (2013): 97, doi:10.1890/ES13-00032.1.

9 Sarah Ludlow, R. Mark Brigham, and Stephen Davis, "Oil and natural gas development has mixed effects of the density and reproductive success of grassland songbirds," *The Condor* 117 (2015): 64-75, doi:10.1650/CONDOR-14-79.1.

fare in the oil and gas fields



LIZARD BLOWOUTS GET BLOWN OUT

Habitat specialists like the dunes sagebrush lizard, of the Southwest's Permian Basin, are particularly vulnerable. They rely on sandy depressions called dune blowouts, and researchers found they were much scarcer at sites where fragmentation by roads and well pads reduced this key feature. The decline of other lizard species at fragmented sites also changed overall lizard community composition.[8]

MULE DEER MIGRATE FASTER

As GPS collar tracking technology advances, biologists gather finer detail about animal movements. One study determined mule deer sped past new natural gas development in a migration corridor where they'd previously stopped to forage during spring green up.[3]

SAGE GROUSE STRESSED BY SOUND

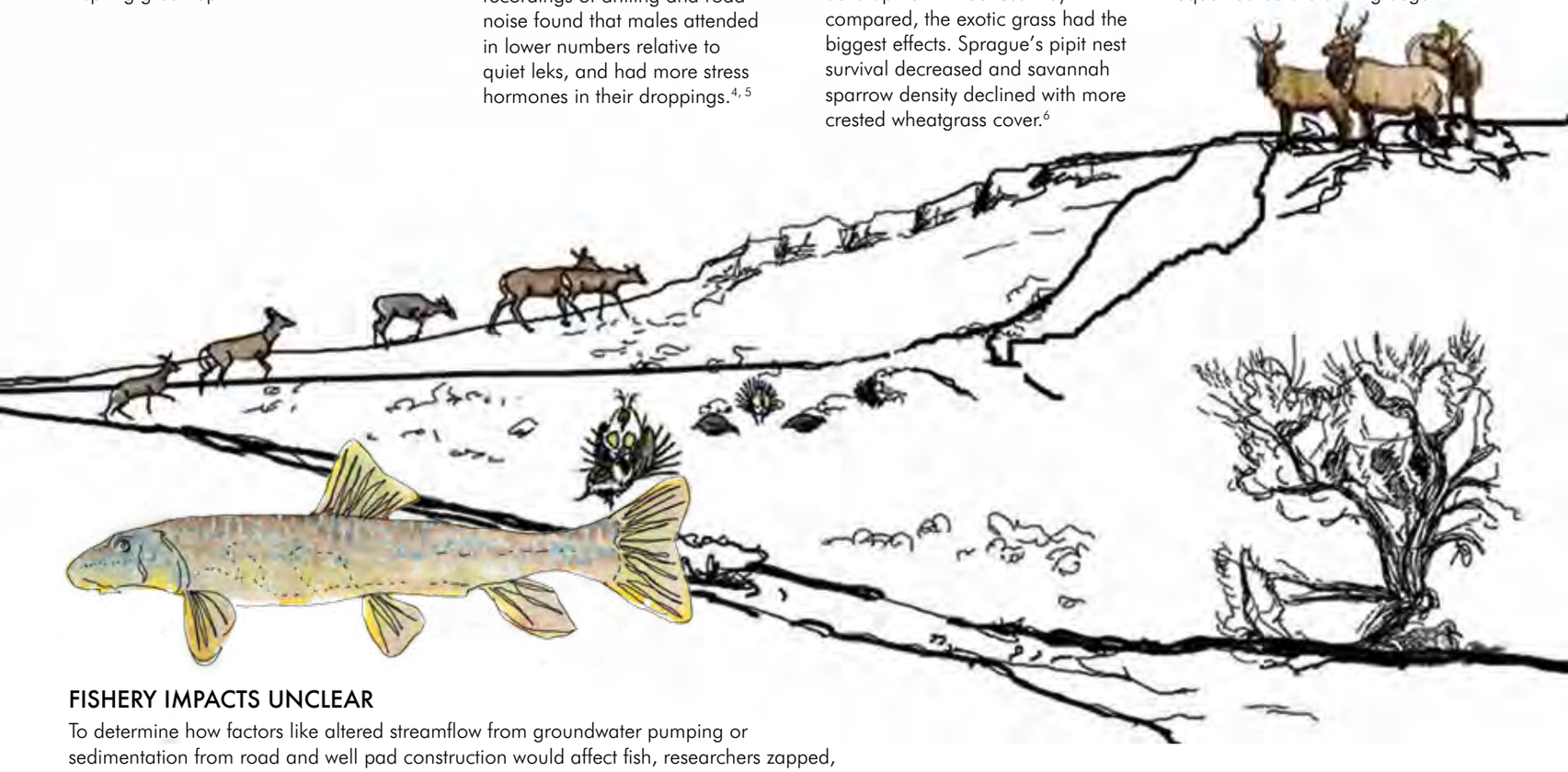
The low frequency vocalizations that sage grouse use to attract mates may be blotted out by gas-patch noise. Researchers in Wyoming who subjected sage grouse at remote leks to recordings of drilling and road noise found that males attended in lower numbers relative to quiet leks, and had more stress hormones in their droppings.[4, 5]

IT'S THE WHEATGRASS

Researchers in Alberta examined five grassland songbird species' success relative to distance to oil and gas wells and roads and cover of crested wheatgrass, an invasive plant in Canada that thrives in disturbed areas. Of the energy development influences they compared, the exotic grass had the biggest effects. Sprague's pipit nest survival decreased and savannah sparrow density declined with more crested wheatgrass cover.[6]

ELK SPURN ROADS

Elk in northeastern Wyoming's Fortification Creek Area steered clear of hundreds of miles of new coalbed methane roads. The animals moved into more rugged terrain with trees and stopped visiting big chunks of summer and winter range that they had frequented before drilling began.[7]



FISHERY IMPACTS UNCLEAR

To determine how factors like altered streamflow from groundwater pumping or sedimentation from road and well pad construction would affect fish, researchers zapped, identified, and counted them at 285 stream sites in Wyoming's Colorado River drainage. They found some species, like non-native carp, were more abundant in areas with high well densities while others, including native bluehead sucker, were more abundant at sites without wells.[9]

Nomad, Weaver, Storyteller

Fiber artist Doris Florig weaves natural history in her tapestries

By Nina McConigley

"While experimenting with natural dye materials for the pronghorn coat, I tried banana leaves and cinnamon bark," Doris Florig writes in an email from a sailboat in the Caribbean. "The result was beautiful but too green… tomorrow I will work again on the colors for the coat. This time I will try cinnamon bark and black tea."

Florig is thousands of miles from her other home in Wyoming, where she is the artist-in-residence for the Kelly campus of the Teton Science School. Her work reflects her own migrations around the world. As she travels, she weaves and creates fiber art, incorporating the natural world through her subject matter and materials.

Florig grew up outside of Philadelphia and graduated from the University of Tampa in 1971. She and her husband, Dennis Clancy, immigrated to a remote region of northern Ontario, established a family farm, and learned self-sufficiency. Far from restaurants and movies, social gatherings consisted of evenings with friends making things, especially music, art, and food. "Being surrounded by practical and creative people, inspired me to learn to spin wool and to weave on handmade portable looms," she says.

In the 80's Florig and Clancy returned to the US, and they moved West in 2005 to be near their children and grandchildren. During a natural dye demonstration at the Jackson Hole Historical Society and Museum, the associate director of the Teton Science Schools invited Florig to lead a hands-on natural dye workshop for the students. Florig soon set up a studio at the school's Kelly, Wyoming, campus, where she is the latest in a long tradition of artists in residence.

Courtesy Doris Florig

Canyon tapestry by Doris Florig, artist-in-residence at the Teton Science Schools.

Campus visitors wander through her studio, and Florig introduces them to the connection between fiber arts and the environment, showing how she gathers materials for her work from the natural world. She demonstrates how to make natural dyes as well as weaving.

This will be her third summer on the Kelly campus, a collection of rustic log cabins located inside Grand Teton National Park. The Grand Tetons and the Gros Ventre Mountains frame the school, which faces wide sage flats and the Snake River. The school's educational philosophy embraces place-based education, using the local community and surrounding environment as learning resources for the students.

For Florig, being in Kelly is a natural fit. She even takes inspiration from her daily drive to Kelly from Jackson. "It is a commute that should take about a half hour but it usually takes me about an hour and a half. The spring is especially interesting because the pronghorn are arriving and the herds of bison are appearing with their young."

Florig's work includes life-sized fiber sculptures of animals native to the wild land between Yellowstone and the Yukon. She is working on a tapestry of Yellowstone Lake inspired by the works of the nineteenth century Yellowstone landscape painter Thomas Moran. Her next project, started on her sailboat over the winter, will be *The Path of the Pronghorn*. The "tapestry will be an abstract map of their path through the mountains," she says. Pronghorn that summer and fawn near the Kelly campus in Grand Teton National Park travel almost 150 miles southwest to the Green River Valley for the winter, along the way passing housing subdivisions, gas patches, fences, and highways. Florig, inspired by their journey, has been gathering plants and minerals from the migration corridor and elsewhere to dye the yarn for the tapestry.

She'll continue the project once she returns to Kelly. First, she will finish her winter in Central America and then travel in her camper van from the East coast to Wyoming, gathering bark, tea, and leaves to add to her dye pot inventory en route.

She travels with a small nomadic style loom and weaves everywhere she goes, even in the car while her husband drives. Like the pronghorn in her tapestry, Florig migrates with the seasons, weaving across the land, finding inspiration in unexpected places.

Nina McConigley *is a writer and assistant professor in the University of Wyoming Honors Program.*

Mac Stanyk

Doris Florig weaving in her studio at the Teton Science Schools Kelly Campus.

The Forgotten Grassland Bird

Hunting for a Sprague's pipit in a changing landscape

By Robin Walter

Sagebrush scraped the doors of the beat up red truck as it bumped down the faint two-track. We were in the middle of The Nature Conservancy's Matador Ranch in northeast Montana on the hunt for the elusive Sprague's pipit. Nearly impossible to spot and increasingly rare, I had been searching for the Sprague's pipit for years. This tiny brown grassland bird, no larger than a badminton birdie, may seem ordinary, but it is worthy of attention. Sprague's pipits have the longest flight display of any other bird on the planet. Males dive in the air and sing to their mates for up to three hours without resting.

Annie McDonnell, a field technician for World Wildlife Fund, rode shotgun. She identified dozens of grassland birds erupting from the surrounding tangles of sagebrush. We'd seen vesper sparrows, meadowlarks, and curlews in the first ten minutes. Annie strained to hear the descending series of notes characteristic of pipits' flight song, which she told me sound like a laser gun: *pew pew pew pew pew pew*.

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I had stopped through the Matador Ranch as part of an expedition to document the changing prairie landscape. With four horses and a white mule named Pearl, my co-adventurer Sebastian Tsocanos and I were one week into a three-month journey to catalog North America's grasslands—and the people protecting it—through film, photography, and writing. It is easy to miss vibrant grassland life when careening past it at 80 mph. Moving at a glacial pace with horses gave us a close up look at this massively transformed landscape. We'd started our journey in Montana's Hi-Line, a thin stretch of country situated just beneath the Canadian border, and were winding our way through a maze of public and private land towards the foothills of Wyoming's Bighorn Mountains, 600 miles from where we began. The Sprague's pipit was just one of the rare grassland species we hoped to find along the way.

Sprague's pipits likely arose before the Pleistocene an estimated four million years ago from an ancestral species in South America. Much of the lightly grazed mixed grass prairie they depend on for food, nesting habitat, and cover, however, has vanished.

European settlers converted enormous tracts of grassland at the turn of the century, and fast-paced conversion continues today to meet our growing demand for food, fuel, and fiber. Over about 150 years, nearly all of our country's grasslands have been replaced by one of three crops: wheat, corn, or soy. Furthermore, insecticides and rodenticides play havoc with the prairie food chain. Disturbance from oil and natural gas development take an additional toll. Fire suppression allows aggressive invasive plants like crested wheatgrass and leafy spurge to displace the native vegetation.

As intact grasslands have decreased, so has the biodiversity they host. Today, around 80 percent of all grassland birds are in decline. According to BirdLife International, Sprague's pipits, once one of the most common birds in the prairie, have declined by 81 percent over the last 40 years.

Robin M. Walter

Sprague's pipit nestlings.

For their Rediscover the Prairie project, Robin Walter and Sebastian Tsocanos traveled 600 miles across Montana and Wyoming with four horses and a mule.

Ecologically based agricultural systems might create a fighting chance for prairie species like the pipit. One such effort, underway in Salina, Kansas at The Land Institute, is to breed perennial grain, oilseed, and legume cultivars that mimic the native prairie ecosystem. Unlike annuals such as wheat, corn, and soy, which need to be replanted each year, perennials remain year-round. Their enclosed canopy rarely exposes the soil, decreasing the need for herbicides. In addition, perennial multi-crop systems better resist insect and disease outbreaks, reducing the need for pesticides.

Another solution is to keep the land in livestock production. Much of the Great Plains biodiversity evolved with grazing species. Think enormous herds of roaming bison. In modern times, cattle perform much of the grazing. World Wildlife Fund's grassland specialist Kevin Ellison explains, "grazing animals can turn indigestible fiber into high-quality protein and leather for humans and can provide an economic livelihood for ranching families. This while maintaining a functioning and diverse ecosystem is a great win-win."

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As we bounced down a particularly bumpy stretch of two-track, sagebrush surrounding us for miles, Annie heard the laser-like song through the open window. We piled out of the truck. "The best way to spot a pipit is to lie on your back. You can take in more sky," Annie told us. We lay down, careful to watch for cactus.

Against a backdrop of blue, we saw the tiniest speck, no larger than the period at the end of this sentence, drop toward the earth from two hundred feet above. Its signature *pew pew pew pew* descended, a delicate gurgling warble that plummeted to the ground just like the diving bird. Our spines flush to the ground, we watched two male Sprague's pipits dart and surge through the morning sky. They came in and out of our vision as they belted out their crystalline, watery, and haunting flight song.

***Robin Walter** is executive director and co-founder of Rediscover the Prairie. The project has taken her across North America's grasslands to report on land issues and conservation efforts in the West. Learn more at rediscovertheprairie.org.*

News and Goings On

Happenings of potential interest to Western Confluence *readers*

EMERGING ISSUES FORUM: CONSERVING BIG GAME MIGRATIONS

The Ruckelshaus Institute will host an Emerging Issues Forum on the policy challenges and opportunities surrounding migration corridor conservation for elk, mule deer, and other ungulates. The event, to take place in Laramie, Wyoming, this fall will feature panels, speakers, and discussions to explore the science and management of the West's robust migratory big game herds. More information at uwyo.edu/haub/ruckelshaus-institute.

WYOMING LAW REVIEW: BIG HORN RIVER ADJUDICATION

After 37 years, the Wyoming courts finalized the Big Horn River Adjudication last fall. The adjudication clarified existing water rights throughout the river basin—including a very large senior right belonging to the Northern Arapaho and Eastern Shoshone tribes on the Wind River Reservation—and raised questions about exactly how the water can be used. This summer the Wyoming Law Review will publish a symposium issue with articles from a range of scholars exploring the adjudication and what it means for future water use. More information at repository.uwyo.edu/wlr.

CORNELL LAB OF ORNITHOLOGY PRODUCES "THE SAGEBRUSH SEA"

If you like what you read about the sagebrush steppe in this issue of *Western Confluence*, look for the new documentary *The Sagebrush Sea*, which premiered on PBS in May. Produced over three years by a team of biologists and filmmakers from the Cornell Lab of Ornithology, this one-hour documentary looks at the sagebrush ecosystem through the eyes of the greater sage grouse and explores our impact on the landscape. The Ruckleshaus Institute will co-host a screening in Laramie on August 12. More information at sagebrushsea.allaboutbirds.org.

UCROSS FOUNDATION RANCH DESIGNATED IMPORTANT BIRD AREA

The American Bird Conservancy and the Audubon Society now recognize the 20,000-acre Ucross Foundation Ranch in northern Wyoming as an Important Bird Area. IBAs are part of a global conservation strategy to focus attention on key habitats and species by identifying and compiling an inventory of areas that sustain healthy populations of birds. The Ucross Foundation stewards bird habitat by planting vegetation and collaborates with Yale University's School of Forestry and Environmental Studies to make acoustic recordings of Ucross birds, among other activities to support native avian species.

REMEMBERING LUKE LYNCH

As Wyoming State Director for The Conservation Fund, Luke Lynch led several projects to conserve open spaces, including critical wildlife habitat and migration corridors on large swaths of private land in western Wyoming.

He helped create the Carney Ranch conservation easement, which ensured lands would remain open through a critical bottleneck area in the famous Grand Teton National Park to Upper Green River Basin pronghorn migration corridor, and the Rolling Thunder Ranch conservation easement, which protected important elk calving areas and moose habitat from being divided and developed. This year, under his leadership, The Conservation Fund entered a contract to purchase and protect an essential 364-acre property where, each spring and fall, 5,000 mule deer swim the outlet of Fremont Lake near Pinedale, Wyoming, as part of their migration between the Hoback Basin and the Red Desert. The impact of his quiet work behind the scenes is evident across the state, where he worked for wide-open country, free-ranging wild animals, and intact working landscapes.

On May 17, 2015, Lynch died in an avalanche while skiing in Grand Teton National Park. He is survived by his parents, his wife, and their three young sons. *Western Confluence* magazine and the Ruckelshaus Institute, to which Lynch served as a senior advisor, join the conservation community in the West in mourning the loss of this spirited and dedicated open spaces advocate, and thank Luke for his legacy of protected landscapes to be enjoyed by generations to come.

The Conservation Fund continues to raise money for the $2.1 million Fremont Lake acquisition that will maintain the Red Desert to Hoback mule deer migration corridor. To contribute, contact Danielle Casavant, Senior Major Gifts Officer for the Conservation Fund, at dcasavant@conservationfund.org.

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Mule deer cross a lake outlet during their 150-mile-long fall migration from the Hoback Basin to the Red Desert.

Joe Riis

SUSTAINING MIGRATIONS

The journey from discovery to conservation in the Red Desert to Hoback mule deer corridor

By Charlie Reinertsen

It was going to be a routine mule deer study. The Bureau of Land Management contracted Hall Sawyer, a research biologist with Western Ecosystems Technology, Inc., to study mule deer movements in southwest Wyoming's Red Desert. The conventional wisdom at the time said the deer spent the entire year in the Red Desert, and Sawyer expected to document a variety of short movements in the area. In January 2011, he trapped forty mule deer and outfitted them with GPS collars and VHF radio transmitters. That spring, an airplane pilot flew over the Red Desert to check on the deer, but they were nowhere to be found.

I met Sawyer in downtown Laramie at the Front Street Bar to hear the story of the missing deer. He had spent the day near Pinedale counting mule deer from the seat of a helicopter. His face was tan from research days in the field. We ordered beers and sat down.

When he first realized the deer were missing, Sawyer said, he worried that the collars were faulty, or had been programmed incorrectly. On a hunch, he asked the pilot to keep searching for signals along the Wind River Range on the way back to Pinedale at the end of the day. Near Pinedale the VHF radio transmitter started to beep. The pilot had found one of the missing deer a staggering 100 miles from the winter range, and he soon picked up more signals.

After the initial relief of finding the deer wore off, Sawyer started scratching his head. What were these animals doing so far from home? "That was one of the toughest winters we had had in decades," Sawyer explained, "So we thought, well, maybe it was a fluke." He wondered if the collared mule deer were actually from the Pinedale area and had traveled to the Red Desert to escape the harsh winter. If so, these animals might not return to the Red Desert the following winter.

"So we waited a year, and sure enough, all of those animals came back to the desert, and that's sort of when we knew, holy cow, they really are traveling that far!" He had stumbled upon the longest documented land migration in the lower 48 states.

The results of this cutting-edge GPS technology, now used throughout the world, are often surprising. In general, animals move further and more frequently than ever imagined, and the Red Desert mule deer are no exception. As scientists reveal animal movements and migrations, conservationists and land managers are racing to respond to this new information. Sawyer's discovery, and efforts he has put into sharing that discovery with the public, is paving the way for a new era of landscape conservation.

After three years, Sawyer retrieved the collars and downloaded the data. The GPS waypoints revealed the mule deer movements, delineating a narrow corridor stretching from the Red Desert east of Rock Springs to the Hoback Basin 150 miles to the northwest. An estimated 500-1000 deer leave the desert each year and join another 4,000 deer at the base of the Wind River Range. From there, mule deer navigate highways, hundreds of fences, rural housing developments, and rivers to make this journey.

Sawyer, who has published peer-reviewed articles on ungulate research for the past fifteen years, decided to take a new approach with these findings in hopes that his discovery of this unusually long migration could help raise awareness of the challenges with conserving migratory deer in the West.

To start, he teamed with longtime friend and National Geographic photographer Joe Riis. Sawyer and Riis flew the route to scout the challenges these deer face. Then Riis set up motion-sensor cameras that captured images and videos of the deer crossing fences, rivers, and vast landscapes. He also shot aerial images and video of the migration route.

Meanwhile, Sawyer partnered with the Wyoming Migration Initiative, a University of Wyoming organization that conducts big game migration research and communicates it to a broad audience. To reveal the mule deer journey to the public, WMI created a written assessment of the migration, a short film, a traveling photo exhibit, and public talks throughout Wyoming. The assessment uses photographs, maps, and writing to describe the migration route in detail, identifies the "top 10 areas of concern" for conservation, and spells out management considerations to guide land-use planning and conservation efforts. The short film, which has reached over 3 million views online, gives close-up glimpses of the mule deer moving through the landscape, to raise awareness of the migration and its conservation concerns. Sawyer, along with Riis and Matt Kauffman, director of the Wyoming Migration Initiative, talked to the public and showed Riis's photography and short film in Laramie, Rock Springs, Lander, Jackson, Pinedale, and Cheyenne, sharing the story of the migration with hundreds of people across the state.

"My role, or what I hoped for this," Sawyer told me, "was to start a conversation about migration and just provide the science for that particular migration in a clear way that gets managers and different stakeholders thinking about it."

Why should people care about migration? Of the big game in Wyoming, over 90 percent are migratory. Migration allows animals to escape deep snow in the winter and find the most nutritious forage in the spring and summer. Without migration, Wyoming's arid landscape could not support the same numbers of big game. Research suggests that if migrations disappear, the animals that rely on them will begin to disappear as well, and scientists have shown that migrations around the world are in decline.

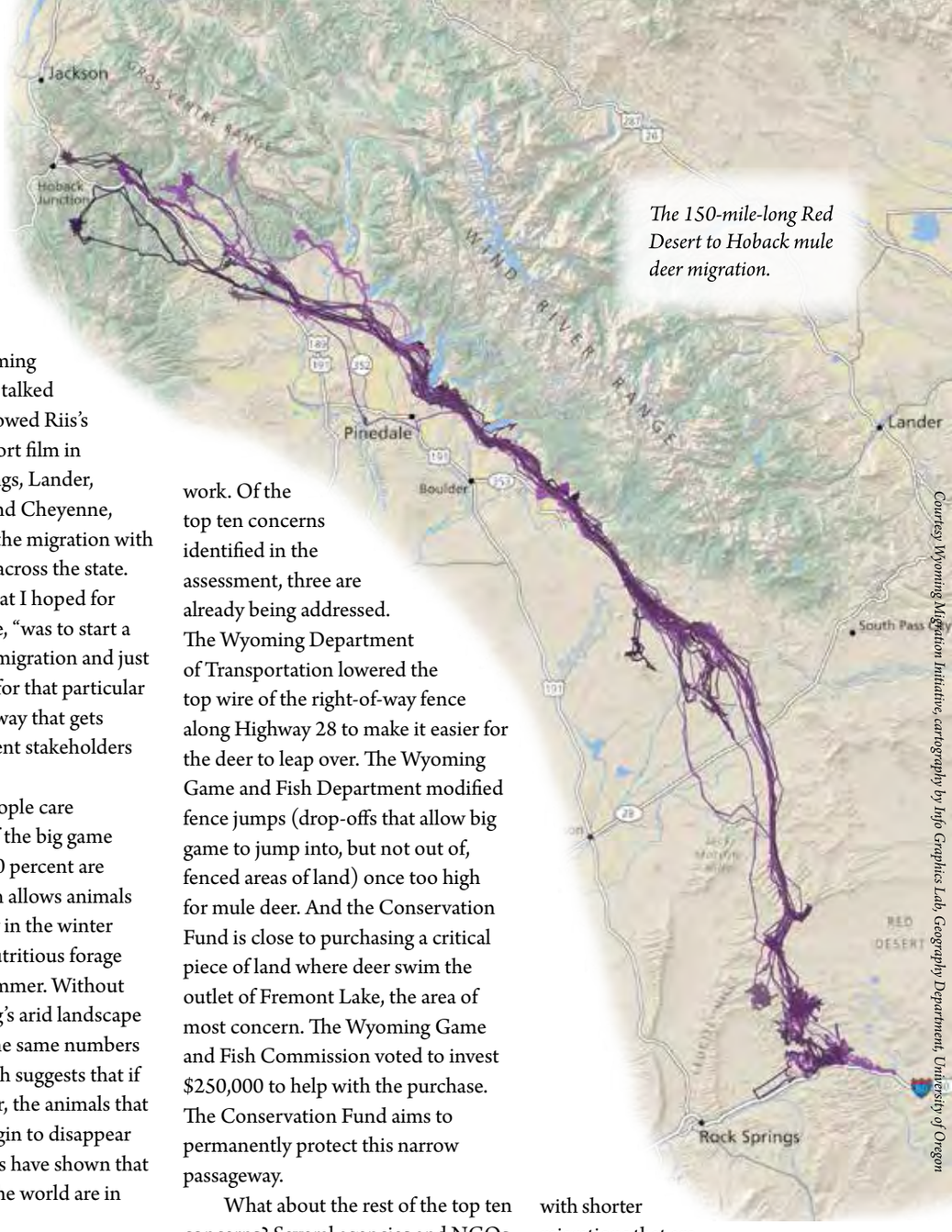
Corridors such as the Red Desert to Hoback cut across a patchwork of private, state, and federal lands, each with their own host of challenges. To succeed, any conservation strategy will have to engage a broad group of stakeholders, including landowners, sportsmen, industry, agencies, and conservationists.

"These sort of spectacles are one of the things that makes Wyoming one of the truly wild places left in the West," described Kauffman. "Our research is allowing us to look into the future," he continued, "and that work suggests that these migrations are going to get harder unless we are proactive in how we are managing them."

The Wyoming Migration Initiative's efforts are beginning to work. Of the top ten concerns identified in the assessment, three are already being addressed. The Wyoming Department of Transportation lowered the top wire of the right-of-way fence along Highway 28 to make it easier for the deer to leap over. The Wyoming Game and Fish Department modified fence jumps (drop-offs that allow big game to jump into, but not out of, fenced areas of land) once too high for mule deer. And the Conservation Fund is close to purchasing a critical piece of land where deer swim the outlet of Fremont Lake, the area of most concern. The Wyoming Game and Fish Commission voted to invest $250,000 to help with the purchase. The Conservation Fund aims to permanently protect this narrow passageway.

What about the rest of the top ten concerns? Several agencies and NGOs have partnered to tackle management options surrounding the Red Desert to Hoback migration corridor. In January, over thirty people, including many state and federal agency representatives, met for two days to walk through WMI's assessment and share information and ideas. In Sawyer's words, "that's a pretty big deal. We haven't seen anything like that before for a migration route."

Sawyer, Kauffman, and the others at the Wyoming Migration Initiative are capturing imaginations and helping people understand the science of migration. But conservation and research efforts around big game migration won't end with the Red Desert to Hoback migration. Sawyer hopes the conversation will continue with shorter migrations that are "just as important or valuable regionally as these long distance migrations. If we want to sustain our big game herds, then we'll need to pay some attention to all of them … not just the ones that migrate really far." Ultimately, the fate of this migration, and other migrations like it, is up to land managers and the public to decide. The Red Desert to Hoback migration is just the beginning.



The 150-mile-long Red Desert to Hoback mule deer migration.

Courtesy Wyoming Migration Initiative, cartography by Info Graphics Lab, Geography Department, University of Oregon

RESOURCES

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Wyoming Wins with Wildlife

By Elizabeth Storer

The cow and yearling moose that inhabited my densely populated west Jackson neighborhood all winter finally wandered off to find a quieter place to enjoy the spring thaw. A few weeks later, I spied a couple of coyotes searching for voles in a field between subdivisions as sandhill cranes made their first appearance of the season. A fox crossed the road in front of me just yesterday. Wildlife who have made this place their home for millennia continue to persist despite the challenges that human development brings. Wildlife is what defines Wyoming and makes it exceptional.

I first learned to hunt flushing sage grouse from the steppe near Saratoga. Nearly 40 percent of the world's greater sage grouse live in Wyoming—a testament to our still relatively intact large landscapes—but even here, sage grouse and many other species dependent upon sage steppe habitat are on the decline, including mule deer and pronghorn. Despite considerable efforts, including Wyoming's leadership in developing its Core Area strategy, we have yet to turn that around.

As shown by a growing body of peer-reviewed research, the cumulative impacts of sprawling housing patterns, roads, overgrazing, and energy development have limited the natural resiliency of the habitats wildlife need to survive. Add to that long-term drought and climate change and the future looks bleaker. Animals adapt—some better than others—but what is lost in the process?

Recent research indicates that at least some sage grouse are dependent on seasonal migration. At the same time, researchers are mapping routes that elk, pronghorn, and mule deer depend on to survive. And with that awareness, we can also see the challenges. Disease, human settlement, highways, fences, predation, forage competition, habitat disturbance, and fragmentation threaten migration for future generations. Are tomorrow's populations of elk and mule deer destined to be like today's big horn sheep—confined to small, geographically isolated herds, suffering from reduced genetic diversity, and struggling for survival? If elk no longer migrate up the south fork of the Shoshone into Yellowstone—preferring alfalfa fields instead—are they less wild? Are they less desirable as game? And are we humans poorer as a result?

Charlie Reinertsen

Moose in Jackson Hole.

What we think of as "wildlife management" is quite often really managing people and our impacts, or undoing the things we've done. The lake trout introduction in Yellowstone Lake reminds us that human actions—whether planned or not—often have unintended consequences. And correcting those consequences is both expensive and often ineffective. Too frequently, we fail to invest in research at a level that would better inform the decisions we make, and even when we do, we often ignore the findings.

Courtesy Elizabeth Storer

Elizabeth Storer

We mostly ask wildlife to accommodate us, rather than the other way around, but species decline is the clear result of this approach. The gap between what science tells us is necessary to protect wildlife and the policies we implement widens as the stakes grow higher. As a state, we lack the political will to actually protect the large landscapes that big game and other species depend on, and that make Wyoming truly unique.

Much of the $3 billion of Wyoming's gross state economy that comes from tourism, hunting, and fishing is fueled by wildlife, and employs tens of thousands of people. Yet the state spends less than a tenth of one percent of that figure—a trifling few million in a good year—on wildlife research. If Wyoming were more like a company (and less like a company town), it would be out of business due to its failure to invest in the research and development that keeps its products exceptional. It would have failed to compete. Here, the best wildlife researchers are left scrambling for scarce private philanthropic funds, the Wyoming Game and Fish Department's budget is woefully inadequate to fulfill its mission to conserve more than 800 species, and we have yet to have an honest discussion about what the state should be investing in this most valuable—and sustainable—resource.

If we consider our state's wildlife as its most distinctive and irreplaceable natural resource blessing—as well as a significant source of our economy and cultural pride—we will be able to work together to maintain our diverse species, our healthy ecosystems, and a healthier and more diverse economy for the future. We will recognize wildlife as a steady, long-term economic engine rather than something to sacrifice for a fast buck in a boom and bust economy. We will invest in wildlife professionals, in research and analysis, in habitat conservation and restoration—and spend as wisely as we can. For our children's children to have the opportunity to catch a cutthroat in summer, hunt a mule deer in fall, photograph a bison in winter, or see a sage grouse strut in spring, we must take the truly conservative approach and invest in the wildlife that will sustain us for generations to come.

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*A perspective from **Elizabeth Storer**, President and CEO of the George B. Storer Foundation, a Wyoming-based charitable foundation that has supported wildlife conservation, community, and education programs throughout Wyoming for more than 30 years.*

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