

NATIONAL GEOGRAPHIC



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WHAT WE CAN LEARN

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Photographs by
**RONAN DONOVAN
& KHOLOOD EID**



OF

BEAVERS



Beavers on Montana's Crazy D Ranch harvest a large cottonwood tree to construct dams and lodges.

RONAN DONOVAN



FROM THE GENIUS



FIRST, THEY
WERE PELTS,
THEN PESTS. BUT
NOW THEY ARE
EMERGING
AS SOMETHING
ELSE: **CLIMATE
HEROES.**

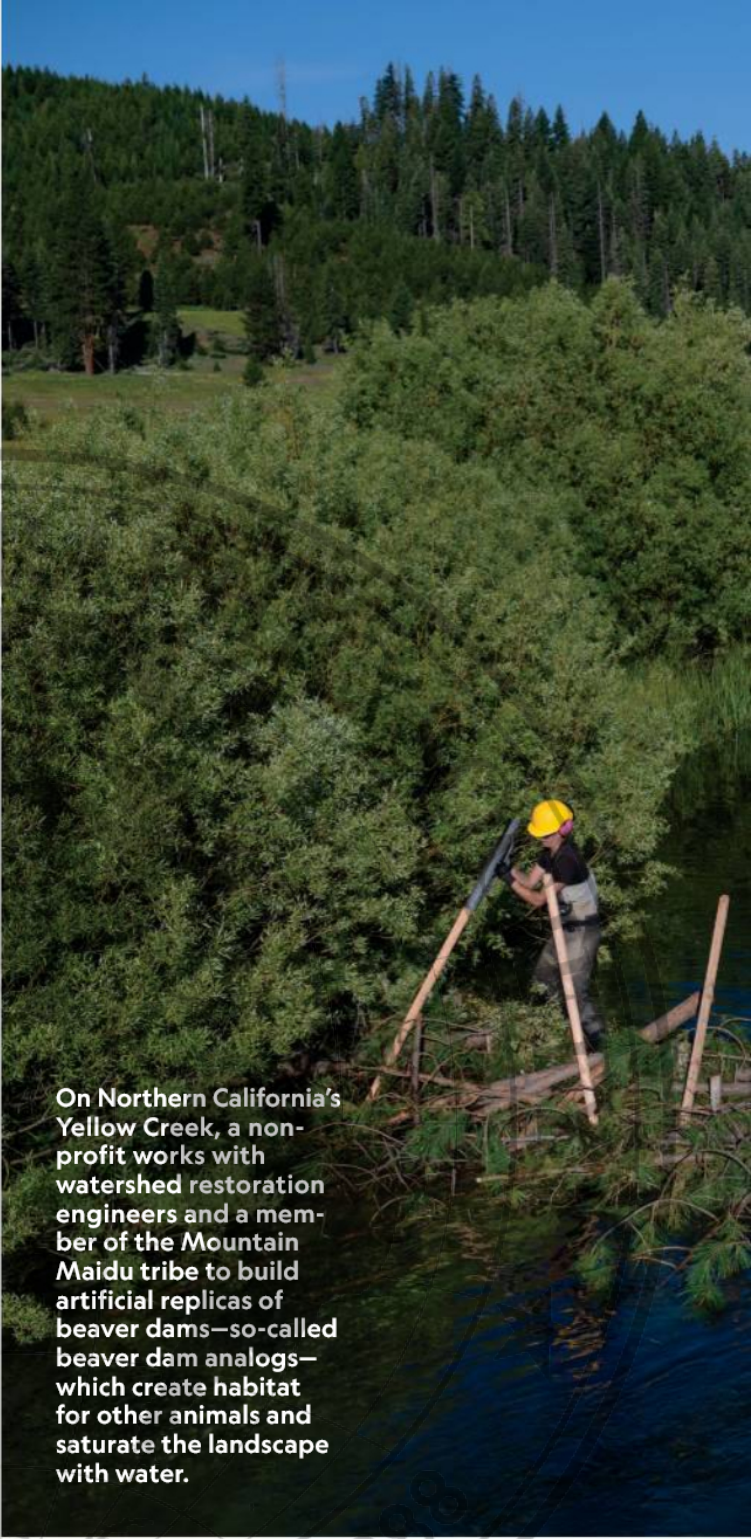
THE EAST TROUBLESOME fire erupted on October 21, 2020, whipped by strong winds and fueled by drought-parched forests. The fire roared through northern Colorado's spruce and fir woods; it leaped roads and rivers and the Continental Divide, scaling mountain passes above tree line. It incinerated historic buildings in Rocky Mountain National Park and homes in Grand County, killing two people. Ultimately, it torched nearly 200,000 acres, making it the second largest fire in Colorado's history.

In the end, just about the only thing the East Troublesome didn't consume was beaver ponds.

This was not entirely surprising. Beavers, of course, build dams that store water—and water, as you may know, doesn't burn. But the benefit the semiaquatic rodents provide goes further than that. In a study published weeks before the East Troublesome blew up, Emily Fairfax, an ecohydrologist now at the University of Minnesota, found that beaver ponds and canals irrigate the landscape so thoroughly that they turn crisp, flammable plants into lush, fireproof ones, forming green refuges in which wildlife and livestock can retreat. In a nod to another firefighting icon, Fairfax and her co-author titled their paper "Smokey the Beaver."

Fairfax studied five fires between 2000 and 2018 to reach her conclusions. But the East Troublesome was far bigger than most

of those blazes—and a harbinger of the kind of conflagration we're seeing more and more. Although fire has long been a natural force of regeneration on North American landscapes, the so-called megafires that plague the ever drier West are a different matter, stoked by climate change into explosive infernos that burn so big and hot that ecosystems don't always readily recover. Fairfax doubted



On Northern California's Yellow Creek, a non-profit works with watershed restoration engineers and a member of the Mountain Maidu tribe to build artificial replicas of beaver dams—so-called beaver dam analogs—which create habitat for other animals and saturate the landscape with water.



whether beavers could still fireproof large tracts of the landscape under those conditions. But when she visited the charred forests left behind by the East Troublesome and one other megafire, she discovered that the oases beavers created with their ponds had endured. “There are entire rivers that are basically unaffected by the fire, because it’s just beaver dams the whole way,” she said.

“Everything is full of life: The reeds are growing; the pine needles are still on the trees.” The ponds aren’t merely helpful before a fire—they can also protect ecosystems from the effects that come right after a blaze, capturing the ash and debris that run off hillslopes and shielding downstream fish and drinking water. In a 2024 paper describing their findings, Fairfax and her collaborators





A beaver swims back to its lodge underneath the frozen surface of a creek in Bozeman, Montana. Beavers don't hibernate, so they spend the entire fall stockpiling wood underwater to feed on through the winter.

RONAN DONOVAN

The lush ribbon of the Baugh Creek watershed, in central Idaho, has been restored in the aftermath of the 2018 Sharps fire, which burned 65,000 acres. Beaver dam analogs built by land managers capture the ash and debris that run off hillsides after fires.



concluded that beavers “can be part of a comprehensive fire-mitigation strategy.”

Once hunted to near extinction for their pelts and later villainized as a nuisance, beavers have rebounded. There are now 10 to 15 million swimming and waddling across most of North America, and they’re ready for their third act, cast in an improbable role: ecological saviors to a climate change-ravaged world. And fire mitigation is just the start. By building dams that slow streamflow, they create reservoirs that help combat drought; by sculpting wetlands, they furnish habitat for other animals.

Nowhere is their return more necessary than in the climate-stressed American West, where beaver restoration is unfolding, to some extent, in every state. But beavers,

tireless meddlers with a penchant for running afoul of human infrastructure, aren’t yet universally welcome.

THE SAN PEDRO RIVER snakes across Arizona’s border with Mexico through the sunblasted Sonoran Desert. Though the arid land seems better suited for rattlesnakes than for semiaquatic rodents, frontiersmen once knew the San Pedro as the Beaver River—before 19th-century trappers stripped it clean. “Anywhere there were perennial waters, there were probably beavers,” Lisa Shipek, the director of a nonprofit called the Watershed Management Group, told me one fall day along the San Pedro’s cobble-strewn banks.

RONAN DONOVAN



In 1999, in hopes of enhancing the area's wildlife habitat, the federal Bureau of Land Management restocked the San Pedro with 16 beavers, whose offspring dispersed throughout the river, including into Mexico. Since 2020, Shipek, along with Mexican biologists and legions of volunteers, has been scouring the river to estimate their population. I joined her team for a day of surveying the San Pedro's shady cottonwood galleries for beavers' chew marks, tracks, and lodges. Along the trunk of one downed cottonwood, beavers had chiseled away the bark to expose cream-colored heartwood and whittled limbs to blunt points. Pale chips littered the bank. "They were probably here within the last few weeks," Shipek half-whispered.

It's easy to empathize with beavers. Like

many of us, they live in nuclear families: A typical colony consists of a breeding pair and their offspring, which stick around until the age of two. On land, beavers are clumsy morsels for cougars, wolves, and bears, but they're balletic swimmers, endowed with transparent eyelids and webbed hind feet. Their keratin-scaled tails serve as fat-storage units and rudders; their iron-reinforced teeth scrape away the inner bark that provides the bulk of their herbivorous diet. By building dams and filling ponds around their woody lodges, beavers expand and defend their aquatic domains, like feudal lords with moats around castles.

Like humans, too, beavers are survivors. Just as *Homo sapiens* are the last in a long line of hominins, the world's two beaver species—*Castor canadensis*, the North American beaver, and *Castor fiber*, its Eurasian cousin—are vestiges of a diverse family. Their now extinct relatives include *Castoroides ohioensis*, which grew nearly as large as black bears. Although it's tempting to imagine *Castoroides* constructing Hoover Dam-size walls, the species likely didn't dam at all and died out during drier conditions. Modern beavers may have endured precisely because they could modify nature on a warming planet.

As beavers proliferated, they shaped the land. At one time, as many as 400 million of them roamed North America and constructed up to 250 million ponds. Those beaver-built bodies of water bolstered amphibian and salmon populations, supported mammals from muskrat to moose, and aided songbirds, which perch in coppiced willows and eat aquatic insects. Indigenous peoples have long understood beavers' importance: The Blackfeet environmental historian Rosalyn LaPier notes that the tribe believes beavers are divine animals that can talk with humans and venerates them for the ecological oases they create. But colonists didn't share that respect. In the 1500s, beaver pelts came into vogue in Europe. They were used for elegant hats, which milliners felted from beavers'

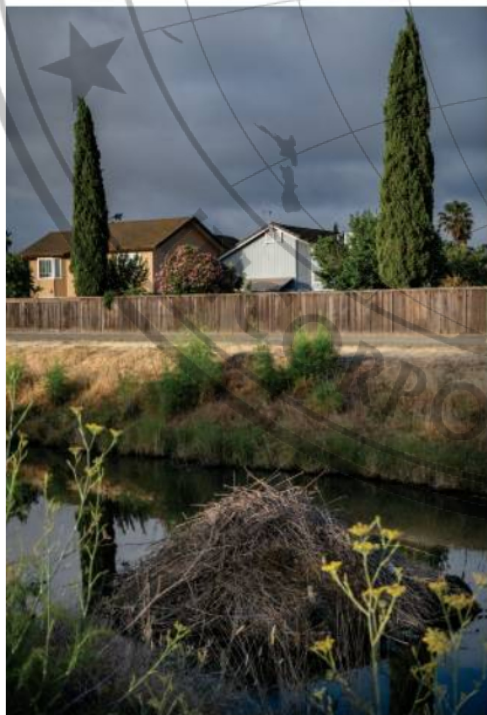


Opposite page: Heidi Perryman is president of Worth A Dam, a nonprofit in Martinez, California, that works to protect local beavers.

This page, top right: Beavers feed on the bark of small branches in the East Gallatin River in Bozeman.

Bottom right: The New Mexico Trappers Association's Tom Fisher, often called to remove problem beavers from people's land, checks beaver traps in Rio Arriba County.

Bottom left: A beaver lodge is part of a neighborhood in Fairfield, California.



BENEFITS OF BEAVERS

These engineers create their watery kingdoms to evade predators and access food. But their habitat modifications also provide surprising advantages for entire ecosystems.

Graphic and map by
FERNANDO G. BAPTISTA,
SOREN WALLJASPER,
and **AMANDA HOBBS**

ADAPTED TO DAM

Along with their stout bodies and waterproof fur, beavers have a host of adaptations that allow them to thrive.

A transparent membrane protects eyes underwater.



Chewing technique
45° angle



Beavers tilt their head and anchor one upper incisor into the tree, then gnaw the wood with a bottom incisor.

3-4 ft long
40-70 lb

Fat

Four continuously growing incisors, with enamel fortified by iron, enable a diet of woody plants.

Wide, flat, scaly tails are used for balance, fat storage, communication, and as a rudder while swimming.

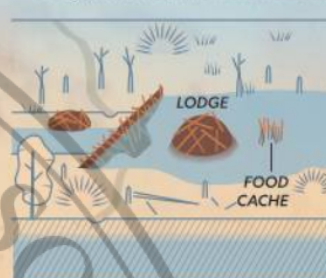
ARRIVING

Young beavers set out on their own at around two years old. When they find suitable habitat, they first build a bank den and dam.



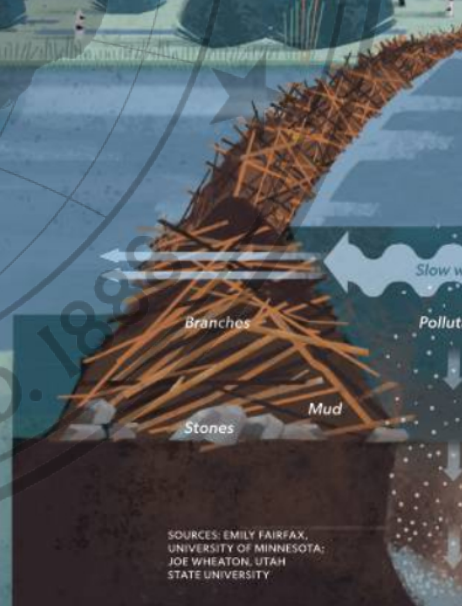
EXPANDING

As the water slows, sediments collect and the streambed widens; beavers build a lodge, store food, and make new dams.

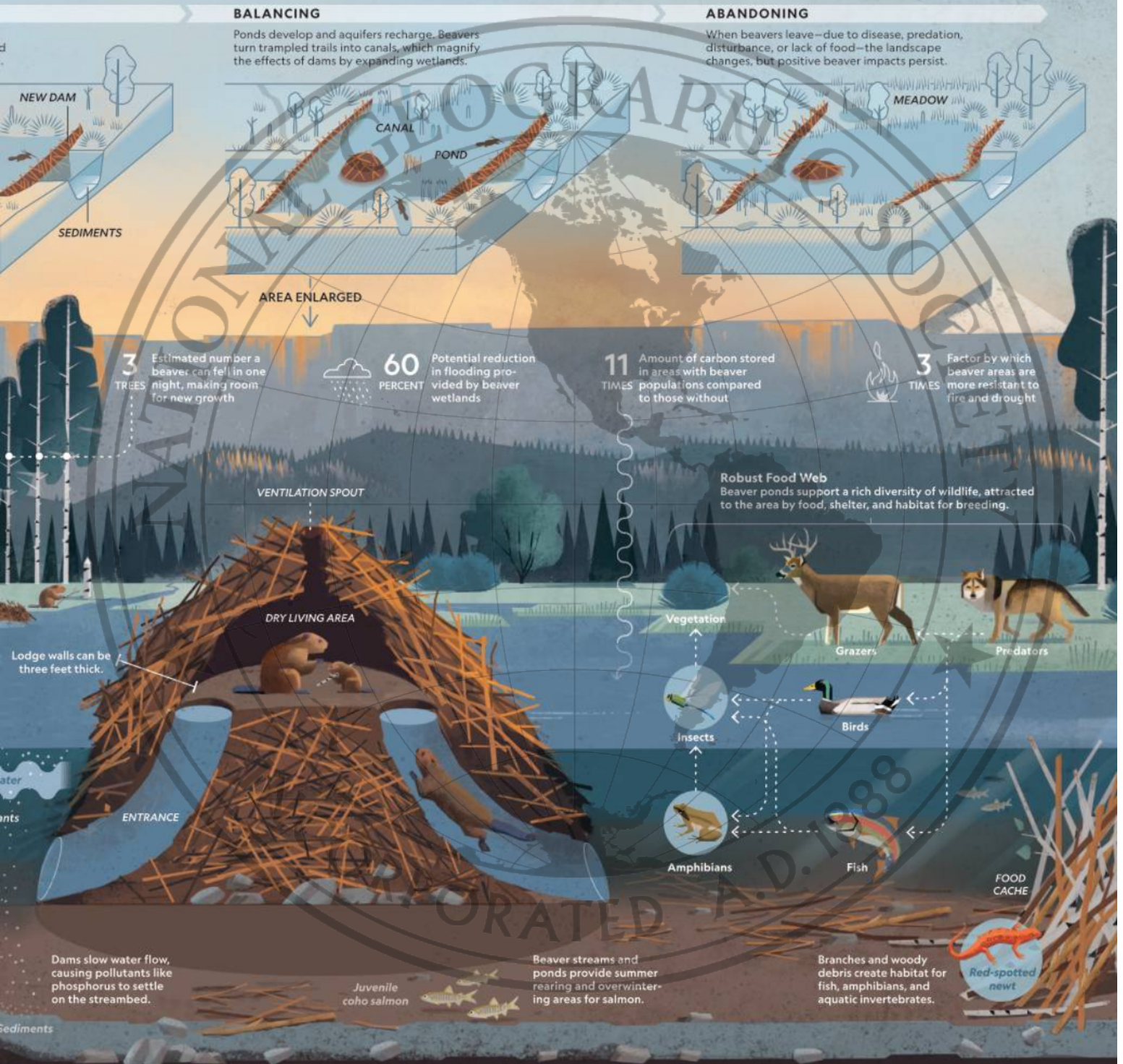


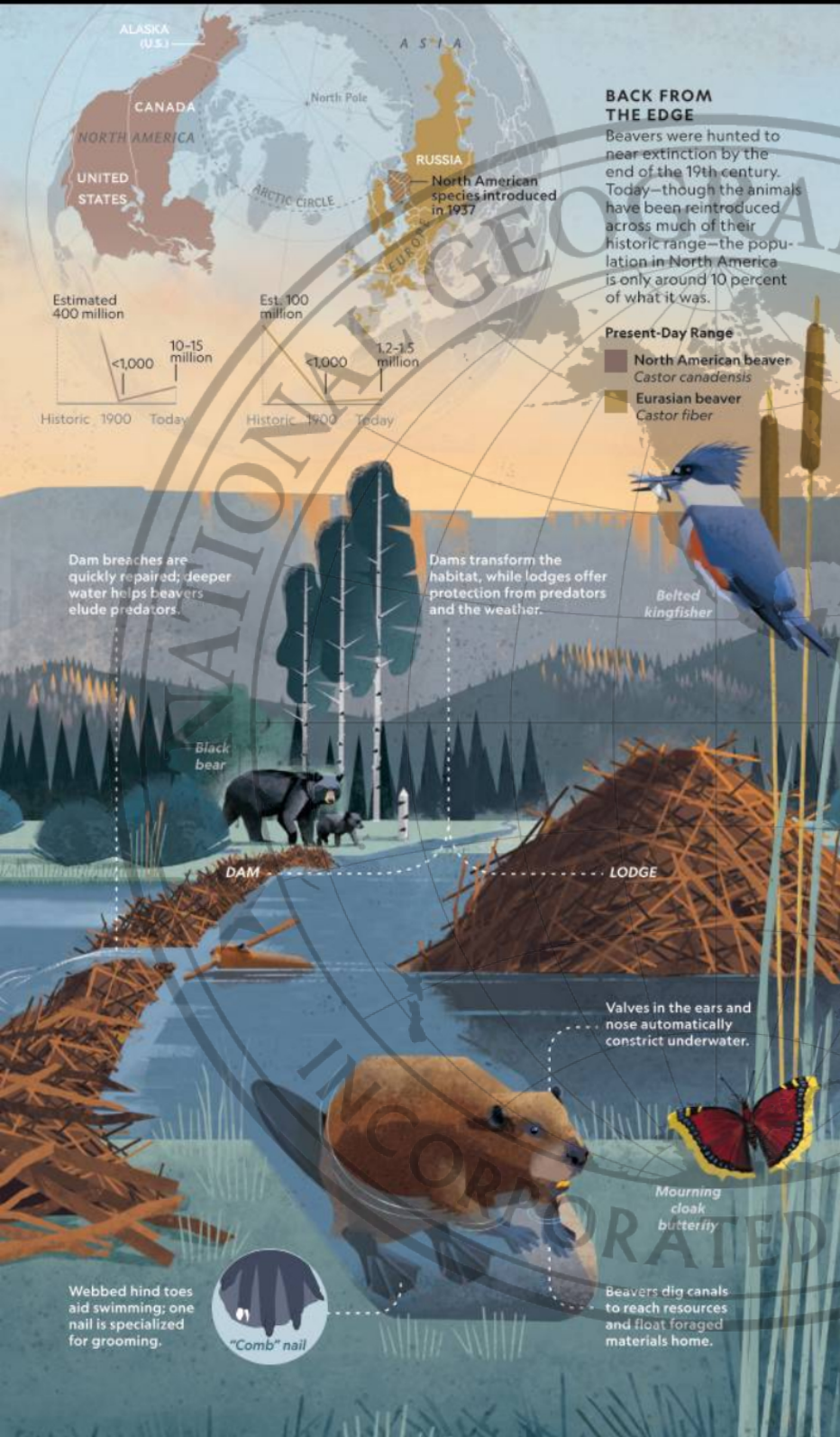
HEALTHIER LANDSCAPE

From better water quality to increased wildfire resistance, beavers improve their surroundings in a variety of ways.



SOURCES: EMILY FAIRFAX,
UNIVERSITY OF MINNESOTA;
JOE WHEATON, UTAH
STATE UNIVERSITY





Velcro-like underfur. To meet the demand, fur trappers and traders purged beavers from practically every waterway on the continent. As the animal vanished, wetlands dried up and streams eroded, a cataclysm akin to an aquatic dust bowl.

Yet beavers weren't finished. In the early 1900s, many states enacted trapping restrictions and reintroduced beavers from places like Canada and Yellowstone National Park. Some land managers got creative: In 1948 the Idaho Department of Fish & Game packed beavers into crates and dropped them by parachute into the wilderness. Two years later, the *Journal of Wildlife Management* reported that "beavers had built dams, constructed houses, stored up food, and were well on their way to producing colonies."

As beavers have slowly returned to the West over the past several decades, their helpfulness has grown more appreciated—just as our climate woes have multiplied. Their ponds store and gradually release rainfall and snowmelt, compensating for dwindling snowpack. By allowing water to seep into floodplains, they also hydrate soils and recharge aquifers. One 2022 study that tracked relocated beavers in Washington State found that the average pond stored more than a quarter million gallons of surface water and over 600,000 gallons of groundwater. "Beavers are slowing the flow, holding on to water longer, and mimicking the function of the depleted snowpack," said Joe Wheaton, a geomorphologist at Utah State University. "If that isn't serving a societal need, I don't know what is."

In the San Pedro River, Shipek estimates that up to 21 beavers now live on the Arizona side of the border and perhaps 17 more in Mexico—though the populations are divided by a metal floodgate that is part of the border wall. During our survey, we saw ample chew and a few lodges but no dams. Still, Shipek hopes that beavers could someday restore the bountiful wetlands that long ago prevailed in many desert watercourses—and help the

Southwest

"I can't have looked waded through mer Beav marshes seems so cal speci in this ar

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On a b slogging Oregon, i of Portla stems ha sucked a buzzed i across th city's wat transluce "Those l Pacific tr

This po here. In elaborate as the C Quality I als, nitra ran off st and Willa beavers humans' the dams beavers c

st address its water woes.

only imagine how different it would
ked,” Shipek said wistfully as we
rough the shin-deep flow of the for-
er River, envisioning the ponds and
that once shimmered here. “It just
important to bring back this criti-
es. It’s the evolution of restoration
ea.”

S BEAVERS REOCCUPY floodplains
and stream corridors, they risk
becoming victims of their own
success. The rodents gnaw
chards, flood roads, and block irri-
ches, mischief to which landowners
y respond by calling trappers. The
Wildlife Services program that deals
olematic animals kills an average of
er every 22 minutes. But in the places
mmunities are learning to coexist,
eaping surprising benefits.

ue May morning, I found myself
through a wetland in Gresham,
a city of 112,000 a dozen miles east
nd. A beaver-built weave of willow
d formed a pond whose mucky floor
t my boots. Red-winged blackbirds
n the bushes; wood ducks glided
e glassy surface. Katie Holzer, the
tershed scientist, scooped up some
ent jelly peppered with black specks.
ittle dots are the embryos of the
ee frog,” she said.

ocket of biodiversity wasn’t always
2008 Gresham had excavated an
e maze of berms and canals, known
olumbia Slough Regional Water
Facility, to capture the heavy met-
tes, and pesticides that habitually
reets and into the nearby Columbia
amette Rivers. To the city’s dismay,
dammed the ditches, sabotaging
best-laid plans. Workers destroyed
s and trapped the beavers, but the
ame back.

The animals, Holzer finally figured, were
there to stay—so why not study them? When
she analyzed the water trickling past their
dams, she discovered something extraordi-
nary: Beaver ponds were cleaning Gresham’s
stormwater better than the water-quality
facility had without them. Mercury, copper,
lead, and zinc settled out in ponds and were
trapped within the sediment, and woody
lattices of dams further strained out con-
taminants. Bird diversity increased, and sal-
amanders hid in the dams’
cool crevices. Beavers,
Holzer said, “are a perfect
self-maintaining system.
After every storm, they
come out and patch things
up for free.”

The city’s relationship
with beavers was still
fraught: The resourceful
animals were inundating access roads and
clogging the wastewater facility’s pipes.
Instead of killing the troublemakers, city
officials hired Jakob Shockey, a mop-topped
biologist whose truck sported B3AV3R vanity
plates, to mediate. I found Shockey waist-
deep in a pond behind a culvert packed
with sticks and mud. “Beavers are plugging
this up so often that they have to clean it out
once a week,” Shockey said, wiping his brow.
Shockey had been tasked with crafting a per-
manent solution, including fences to keep
beavers from blocking culverts and pipes to
lower road-flooding ponds. A study showed
that such nonlethal interventions work up to
96 percent of the time, and they save money
to boot.

“The best thing we can do for beavers,”
said Shockey, “is to partner with them in the
places they’ve chosen to live.”

Like Holzer and Shockey, researchers and
policymakers around the country are trying
to let the animals thrive. In Montana, a new
Beaver Conflict Resolution Program helps
landowners solve their beaver problems
without resorting to traps; in Maryland,

ecologists are counting on beaver ponds
to filter out nitrates polluting Chesapeake
Bay. Some of the swiftest progress is happen-
ing in California, which in 2023 launched a
statewide beaver program that set aside
\$1.4 million to implement beaver restoration
initiatives. That same year, California’s
Department of Fish and Wildlife released
seven beavers onto the ancestral lands of
the Mountain Maidu, the state’s first official
relocation in almost 75 years.

**‘The best thing we can do for
beavers is to partner with them in
the places they’ve chosen to live.’**

—JAKOB SHOCKEY, BIOLOGIST

Other tribes are also welcoming beavers
home. In California’s Klamath River water-
shed, the Yurok Tribe’s fisheries department
has constructed beaver dam analogs, human-
built dams designed to imitate beaver activity,
encourage the rodents to return, and create
sheltering ponds for juvenile salmon. Some
young salmon have since gone to sea and
come back to spawn, a strong suggestion that
the tribe’s beaver-based approach is working.
Higher up the Klamath, the removal of four
massive hydroelectric dams has recently
helped fish reclaim their spawning grounds.
Yet nearer the river’s mouth, the beaver-
inspired dams—small and permeable rather
than colossal and concrete—have also pro-
duced substantial gains.

“Every species teaches us lessons on how
we’re supposed to live together,” said Frankie
Myers, the Yurok’s vice chairman. Just as be-
avers design their own environment, Myers
said, Native people are charged with actively
restoring nature to ensure its flourishing. “We
do this work to restore our fisheries, restore
beaver, because this is our place, right? We
belong to this place.”

This page, top right: The incisors embedded in this beaver skull show the telltale orange tint of beaver teeth. Iron in their enamel leads to the rusty coloration.

Bottom right: The beaver's distinctive tail operates like a rudder when swimming. It also functions as a fat-storage unit, providing energy reserves during the lean winter months.

Bottom left: Wildlife biologist Molly Alves processes a beaver that had been causing problems for landowners in Washington State. After being weighed and tagged, the animal was moved to a new location where it could thrive.

Opposite page: With its chisel-like teeth, a beaver can fell a tree in a matter of hours. The animals eat the bark and use the wood to build lodges and dams.



KHOLOD EID (LEFT); RONAN DONOVAN (RIGHT)



THE FUTURE is liable to change for beavers. For one thing, they're expanding their range.

As climate change warms the Arctic, plucky beavers have followed onto willow-dotted tundra. In New York City, beavers have recolonized the Bronx River and Staten Island; in Seattle, they occupy 86 percent of suitable habitat. Considering the animals were once on extinction's doorstep, beavers have made a spectacular recovery, yet they're still at a sad fraction of their historic numbers—particularly in western states that need them most. Environmental laws like the Endangered Species Act prevent scarce animals from going extinct, but beavers pose a different challenge: How do we help an animal that's already fairly common become truly abundant?

Perhaps it starts with figuring out where they are—and aren't. The ultimate testament to beavers' influence may be that you can study their architecture from space. Engineers at Google have recently trained a machine-learning program, dubbed EEAGER, to identify the distinct appearance of ponds and dams in satellite imagery; California's wildlife department is using the algorithm to count its beavers and guide restoration. A similar effort, the Colorado Beaver Activity Mapper, has already roughly counted the Centennial State's beaver ponds (the tally: around 80,000). According to Sarah Marshall, the ecologist who led the Colorado program's development, getting a handle on beaver distributions could allow wildlife managers to preemptively address potential clashes with farmers and ranchers or pinpoint spots where beaver dam analogs and relocations will have the biggest water-storage and firefighting benefits. "Comparing where beavers used to be with where they are today is a prescription for where to do large-scale restoration in Colorado," Marshall said.

On a recent spring day, I visited Birch Creek, a stream in southern Idaho that represents a different approach to re-beaver-

Beavers can be a nuisance when they bump up against human infrastructure. This beaver was held at a salmon hatchery on the Tulalip Reservation in northwest Washington before it was released in the Skykomish watershed.

I walked upstream with Jay Wilde, a rancher who sported a battered cowboy hat and a drooping mustache. Every 60 feet or so, Birch Creek was stapled by another dam—some 80 feet long, some 10 feet high, some that formed staircases of mirrored, acre-wide lakes. Lobes of water shot onto the floodplain, single channels split into twisted strands, and beaver-dug canals spiderwebbed everywhere. A few neglected grass-covered dams melted into the landscape. It was glorious chaos, a mess of water and wood that scarcely resembled a discrete stream.

This was a recent transformation. Wilde had grown up along Birch Creek, which supported his family's homestead. By the late 1990s, though, the stream had dwindled to a pitiful trickle that would dry up



KHOLOD EID



by the Fourth of July. Birch Creek had lost its beavers, Wilde realized, and he resolved to bring them back. After two failed relocations, he contacted Utah State's Wheaton, the nearest beaver expert, whose crew built 26 beaver dam analogs in the creek between 2014 and 2017. The human-made dams created ponds in which subsequent reintroduced beavers could evade predators and focus their own damming. By the time I visited, more than 200 beaver-built dams spanned Birch Creek and its tributaries, and native cutthroat trout populations had grown more than tenfold. Better yet, the creek was again staying wet deep into summer, as water seeped from the saturated floodplain as though from a squeezed sponge. "We've gained 40 days of flow," Wilde

said, his drawl tinged with wonder.

Beavers, researchers sometimes point out, are critical infrastructure: builders of firebreaks and reservoirs and stormwater catchments. But they're also beings with their own wills, desires, and volition. Near my tour's end, a beaver popped up in one pond, head raised and ears pricked. "I had to train him all winter to do that," Wilde cracked—a joke that was funny precisely because beavers, for all their benefits to humanity, serve no master. The rodent swam to and fro, assessing us. Then, with a resounding *kerplunk*, he thwacked his tail against the surface, roiling the pond and raising a shower of droplets. By the time the tumult settled, he was gone, gliding invisibly through the watery world he had created. □





A century of smelting and logging near Anaconda, Montana, left the headwaters of the Columbia River Basin scarred and barren. Beaver dams on Mill Creek slowed the flow of water and allowed toxic pollutants to settle, improving downstream water quality.

RONAN DONOVAN