

FOREST FIGHT

Germany invented “scientific” forestry. But a huge dieback triggered by climate change has ignited a fierce debate over how the nation should manage its trees

By Gabriel Popkin, in Schwenda, Germany

Dead conifers in a forest near Königshain, Germany. Policies and tradition often discourage leaving dead trees in place.

Last summer, Friederike and Jörg von Beyme stood on a bramble-covered, Sun-blasted slope outside this small town in eastern Germany. Just 4 years ago, the hillside, part of a nearly 500-hectare forest the couple bought in 2002, was green and shady, covered in tall, neatly arranged Norway spruce trees the couple planned to cut and sell.

During January 2018, however, a powerful storm felled many of the trees. Then, over the next 3 years, a record drought hit Germany and much of Central Europe, stressing the spruces that still stood. The back-to-back disasters enabled bark-boring beetles that had been munching on dead trees to jump to drought-weakened ones. Beetle populations exploded. In just 3 weeks, towering spruces that had seemed healthy were dead.

The von Beymes salvaged what they could, rushing to log and sell the dead and diseased trees. But thousands of other forest owners did the same, causing the timber market to collapse. The couple's piles of logs were worth less than what it had cost to cut and stack them. Now, they don't expect to earn a profit from logging spruces for 20 years. "We have a big forest now with big problems," Jörg von Beyme says.

The von Beymes are far from alone. Since 2018, more than 300,000 hectares of Germany's trees—more than 2.5% of the country's total forest area—have died because of beetles and drought fueled by a warming climate. The massive dieback has shocked the public. And it has raised hard questions about how a country renowned for inventing "scientific" forestry more than 3 centuries ago should manage forests so they can continue to produce wood and protect ecosystems in the face of destabilizing climate shifts.

Everyone agrees that new approaches are needed, but no one, it seems, can agree on what those should be. Some advocates want Germany's government and forest industry to stop promoting the widespread planting of commercially valuable trees such as Norway spruces, and instead encourage landowners to allow forests to regenerate on their own. Others say that to meet economic, environmental, and climate goals, Germany must double down on tree planting—but using more resilient varieties, including some barely known in Germany today.

The stakes are high: Germany's forest products sector generates some €170 billion annually and employs more than 1.1 million people. If its wood supplies dwindle, pressure could grow to log forests elsewhere around the world. Declining forests could also imperil efforts to replace building materials that generate huge emissions of green-

PHOTO: FLORIAN GAERTNER/PHOTOTHEK VIA GETTY IMAGES

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Forest researchers Pierre Ibisch (left) and Jeanette Blumröder check a data logger in a pine forest that burned in 2018 and is now being allowed to naturally regenerate.

house gases, such as concrete and steel, with potentially climate-friendlier wood.

The disagreements are often fierce, with the opposing sides trading insults in the media and even holding competing forest summits. “The intensity of the debate,” says ecologist Christopher Reyer of the Potsdam Institute for Climate Impact Research, “is surprising for everybody.”

IT'S NO EXAGGERATION to say modern industrial forestry was invented in Germany. In the early 1700s, mining official Hans Carl von Carlowitz, who lived not far from where the von Beymes live today, became alarmed by devastating timber shortages caused by demand from mining and smelting. In response, he penned a 1713 treatise proposing that forests be managed sustainably. Wood harvests should be limited to what the land could produce, von Carlowitz wrote, and trees should be assiduously replanted to ensure a future supply. (Of course, Indigenous people around the world had been applying similar ideas for millennia.)

German forests started to recover as landowners adopted the approach. And Germany's scientific approach to forestry—planting fast-growing species in neat rows, perfectly spaced for maximum timber production—became an international model. After World War II, with Germany in ruins and Allied nations demanding shipments of timber for reparations, foresters doubled

down on von Carlowitz's vision. Areas where deciduous trees such as beech and oak would have grown naturally were planted in monocultures of fast-growing evergreen spruce and pine. The trees were so essential to Germany's economy that they became known as the *brotbaums* or “bread trees.”

For decades, the program looked like a stunning success: Even as West Germany experienced its *Wirtschaftswunder* (economic miracle) starting in the 1950s, timber stocks increased. By the early 21st century, the total amount of wood in German forests had reached a volume probably not seen since the Middle Ages. Today, nearly one-third of Germany is forested.

But many of those forests are far from natural. Norway spruce alone, for example, accounts for one-quarter of the trees—and more than half the timber harvest. The shallow-rooted species naturally grows in high latitudes or on cold mountainsides. But in Germany, as well as in the Czech Republic, Austria, and elsewhere, foresters planted it throughout low-lying and far warmer regions. The monocultures nurtured only a fraction of the biodiversity found in native deciduous forests, but as long as there was enough rain and temperatures stayed cool enough, the spruces thrived.

In recent years, however, global warming has begun to disrupt long-standing weather patterns, delivering extremes these forests hadn't experienced. The unprecedented

drought that began in 2018 was especially devastating for Germany's spruce plantations. The combination of extreme summer heat and a lack of precipitation set off a deadly chain reaction. Soils dried out to a depth of 2 meters. The water-starved spruces could no longer produce the tough goeey resin that helps protect them against insects, leaving them open to attack by bark beetles, which normally feed on dead or dying trees. Beetle populations swelled—one adult can produce hundreds of offspring in a season—and overwhelmed whole forests, turning them from green to ghostly gray.

The destruction hit hardest in Germany, the Czech Republic, and Austria. Forests in France, Poland, Switzerland, Slovakia, and Italy also took hits. Across Central Europe, some 300 million cubic meters of wood was damaged, according to forest scientist Andreas Bolte of the Thünen Institute, the German government's forest research agency.

FOR MANY forest owners, and for ordinary Germans for whom a wander in the woods is a favorite pastime and an essential part of their cultural identity, the dead trees delivered a huge shock. In a 2019 speech, former Chancellor Angela Merkel soberly recounted the “very, very large forest damage” that had affected “thousands of forest owners.” The dismay has helped fuel an intense political and scientific struggle over the future of Germany's forests.

All sides agree the recent die-off highlights the climate change threat. “It’s kind of an early warning, ... a signal of what may still come,” says forest researcher Gert-Jan Nabuurs of Wageningen University & Research. The future, he says, “is worrying.”

Most also agree that existing monocultures, so important to European forestry’s past, cannot ensure its future. “It’s a clear signal to the wood industry that you have to change the utilization from Norway spruce to other species,” Bolte says.

The consensus breaks down, however, when it comes to solutions. For some, the dieback offers a rare chance to dramatically shift forest policy toward a more hands-off approach. Allowing devastated forests to naturally regrow, the thinking goes, could revitalize ecosystems and start to reverse centuries of biodiversity decline.

One leading proponent of this view is Peter Wohlleben, a prominent author and forester. In books and media appearances, he describes natural forests as interconnected, cooperative communities. And he argues that Germany’s vaunted scientific forestry, with its single-minded focus on maximizing timber production, disrupted those communities, creating simplified forests that are highly vulnerable to climate extremes.

Wohlleben and his allies are calling for a wholesale rethinking of plantations. “It’s always better to let nature do the job,” he says. “I don’t know any place on Earth where a planted forest is better than a native forest.”

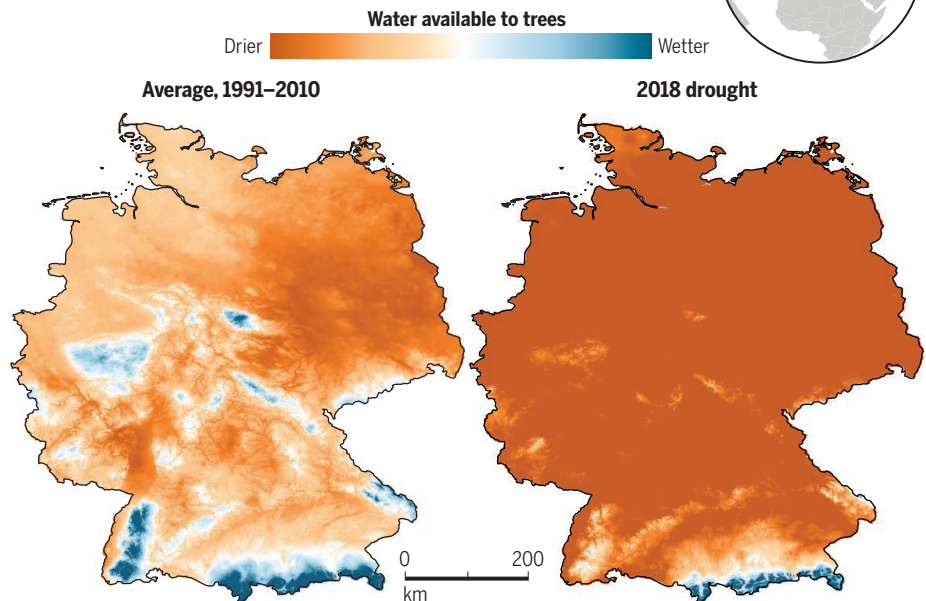
Pierre Ibisch and Jeanette Blumröder, biologists at the Eberswalde University for Sustainable Development, agree. In August, as bursts of rain and gloom alternated with intense sunshine, they visited a fire-scarred research plot 1 hour’s drive from Berlin that they believe could help prove the point.

Just a few years ago, the plot—part of a forest owned by the small town of Treuenbrietzen—was covered by Scotch pines, a common plantation species in regions with sandy soils. In the hot, dry summer of 2018, however, fires torched some 400 hectares of the pine forest, closing highways and forcing hundreds of people to flee their homes; smoke even reached Berlin. In the past, such large fires were almost unheard of in mild Central Europe.

In this plot, charred trees were removed, replaced by newly planted pines. But the drought, which continued through 2020, killed many of the puny seedlings, Blumröder pointed out as she surveyed the site. And even the survivors were struggling to keep up with fast-growing poplar saplings, some already 3 meters tall, that had sprouted on their own. The poplars’ vigor indicates that replanting is not necessary, Blumröder and Ibisch argue. “The problem

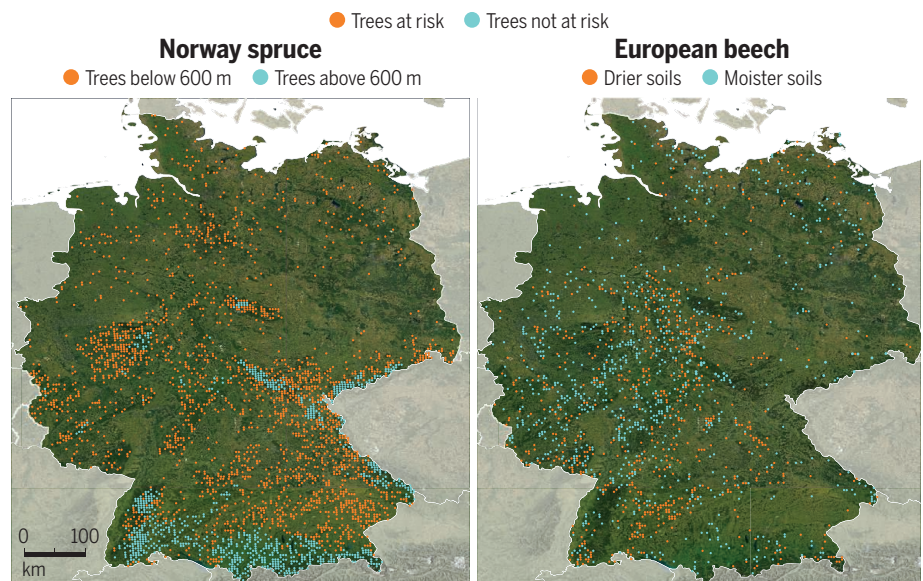
Dry spell

A record 3-year drought that began in 2018 (right) set off a cascade of tree stress, fires, and insect attacks that killed more than 2.5% of Germany’s forests. The destruction highlights the threat posed by climate change, researchers say.



Stress maps

A rapidly shifting climate has made many of Germany’s most important trees vulnerable to various threats, projections show. Droughts, which are predicted to become more severe, are expected to make Norway spruce growing in lower, warmer areas vulnerable to bark beetle attacks (left). A drier climate also threatens European beech trees growing in soils with less capacity to store water (right).



is, foresters don’t wait,” Ibisch says. “They always say they think in long-term scales. But when calamity happens ... they panic.”

In some other burned plots, Ibisch and Blumröder persuaded Treuenbrietzen’s forester to deviate from usual practices. On one tract, he left charred trunks standing and didn’t replant, allowing forest succession to proceed on its own—a rare practice.

In others, he cleared some of the snags and planted rows of oaks—which many researchers believe could be more resilient to future climate change—instead of pines.

In preliminary results, the new approaches are producing promising outcomes. In areas where some or all burned trees were left standing, for example, Ibisch and Blumröder have found more plant, fungus, and insect



Loggers remove spruce trees killed by drought and insects near Drübeck, Germany. Critics of such active management say forests should be left to rebound on their own.

species than in cleared tracts. Soil temperatures in the uncleared tracts are lower on hot days, and winds calmer, helping the soil retain moisture. Moss is beginning to cover the ground where fallen trees have started to rot, preventing erosion and stimulating the growth of underground soil fungal networks. The lesson for Germany's foresters, Blumröder believes, is that they should "step back, let the system do [its thing] first, and then learn from it."

In Harz National Park, which sits in mountains straddling the former border of East and West Germany, ecologist Gunter Karste with the Harz National Park Authority is also bucking tradition. Here, waves of bark beetles have killed more than 10,000 hectares of spruce stands. But research published by Karste and colleagues persuaded park managers to let the dead snags stand and hold off on replanting. Today, the lifeless gray, spire-like trunks are everywhere, surrounded by tangles of fallen trees, their airborne root systems still clinging futilely to soil. People now call the tracts the *Harzer Silberwald*, or Harz Silver Forest, Karste says.

Less than 3% of Germany's forests are currently managed like this, as strict nature preserves, but such practices could soon become more common. The German government has a goal to increase the figure to 5%, thanks in part to the ecological benefits Karste and others have documented. Although the dead

trees "look awful the first 5 years," Karste says, what regrows is far more diverse and resilient than a plantation. Although still largely spruce, which thrives on cold mountainsides, the trees vary far more in size and age than do those in uniform, planted stands. That creates a greater variety of niches for wildlife, Karste notes. In the understory, wildflowers bloom and bees buzz; blueberries, mountain ash, birch, and other shrubs and small trees thrive. Meanwhile, owls, bats, and other species roost in dead trunk cavities. Karste says research suggests that "when you don't leave the dead trees, you lose 40% of the biology."

The more diverse, naturally regenerating forest will also likely cope better with future drought and pests, he says, because trees of different ages respond differently to such stresses, making it more likely that some will survive. If the park had simply cleared and replanted, he says, "then in 60 years you would again have a forest that's as interesting for the bark beetle as for the spruce forester."

THE IDEA OF LEAVING forests alone alarms other researchers. They argue the climate is changing so quickly that, without human help, even many native trees won't survive in places where they've long thrived.

"We have beeches dying now, we have maples dying ... and pines that were considered pretty drought tolerant," says Henrik Hart-

mann, a plant scientist at the Max Planck Institute for Biogeochemistry. "It's not a spruce problem. It's a general forest problem." Recent modeling suggests more than half of Europe's forests are now vulnerable to insects, storms, fires, or a combination of these threats, Hartmann and colleagues reported earlier this year in *Nature Communications*.

To reduce the risks, some experts argue forest owners need to strategically plant new, more resilient tree varieties. Hints about strong candidates could come from a 250-hectare arboretum founded in the late 1800s in Wuppertal, a hilly town in western Germany. Here, collectors planted some 200 tree species from all over the world. More than 100 of those species are still growing, offering a rare opportunity to assess how the mature trees are handling climate change.

This fall, Leonore Gärtner, the state forester who now manages the area, strolled with her dog through a stand featuring some North American natives—Alaskan red cedar, incense cedar, and western hemlock—each with a number painted on the trunk. It looked more like the Olympic Peninsula of Washington state than Germany. But Gärtner was excited because the trees were thriving, even after 3 years of drought. "It's amazing," she said. "The trees are looking good, very healthy."

Gärtner believes the stand indicates foresters would do well by planting diverse mixes of commercially valuable species, increasing

the likelihood that at least some will survive to harvest age in a changing climate.

Others are exploring variations on this approach. For example, Nabuurs is co-leading a project that will plant native trees that haven't been heavily used in forestry, such as linden and sweet chestnut, at 11 sites across Europe and assess their resilience to climate shifts. Hartmann, meanwhile, urges researchers to exploit the genetic diversity hidden within European tree species. Pines, for example, grow across much of the continent, and trees from hotter, drier areas—such as southern Europe—might have already evolved resistance to conditions forecast for Germany and other more northerly nations.

Hartmann cautions against immediately replanting dead forests with trees that have grown well in the past, instead urging foresters to first consult climate models that predict which tree species might fare best in the future. “We should not just blindly start reforesting sites that have been disturbed,” he says. “We could, by doing this, create the next disaster.”

WIDELY IMPLEMENTING new forestry techniques will require changes in government policy and buy-in from foresters and landowners. Germany's agriculture ministry has already met the dieback with an unprecedented aid program, showering forest owners with €1.5 billion to help them remove dead trees and replant. Those receiving funds must plant a mix of species, the ministry has said, though owners not taking funds can still plant monocultures. And for the first time, the government has made funds available to forest owners who want to allow their woods to regenerate naturally.

Last week, Germany's newly elected government went further, saying it intends to amend federal law to increase native forests, end logging in publicly owned old-growth beech stands, and promote other policies advocated by environmentalists.

The next step is largely up to the 2 million or so private landowners—individuals, families, and firms—who own about half the country's forests, and the cities and states that own most of the rest. And whereas environmentalists want more forests managed primarily for ecological values rather than

timber, most forest owners, private or public, aim to make money from logging.

The von Beymes, for one, aren't keen on the hands-off approach. They see their denuded hillside, now thick with blackberries and grasses, not as a flourishing ecosystem, but a weedy, unprofitable mess. “That, to me, is not a forest,” Jörg von Beyme says.

Most sawmills are designed for evergreen conifers and continue to demand them, he notes. That means that for now it is nearly impossible to sell species that come in natu-

German foresters have been planting the species for nearly 2 centuries, but it is now gaining popularity because it's thought to be especially drought- and pest-resistant. Jörg von Beyme, for example, points to data from the Helmholtz Centre for Environmental Research suggesting Douglas fir can tolerate drier soils than spruce.

But some are skeptical of the tree's long-term future here. It's native to the rain-soaked Pacific Northwest, they note, a far cry from increasingly dry Central Europe. And mature Douglas firs planted decades ago at Burgholz are losing their needles, Gärtner says; some have even been attacked by bark beetles.

THE VON BEYMES won't know for decades whether the bet they've placed on their Douglas firs will pay off. In the meantime, the debate over Germany's forests continues to simmer. Earlier this year, Wohlleben organized a summit called Waldsterben 2.0 (Forest Death 2.0), at which scientists, activists, and officials from Germany's Green Party largely endorsed natural regeneration and criticized government officials for propping up the plantation system. Wohlleben says scientists from the government forest ministry declined to attend, but a ministry spokesperson says they never received invitations. The ministry held its own summit, where it announced new incentives for forest owners and a plan to compensate forest owners for using their forests to absorb and store carbon.

Some observers lament that the debate has become so polarized and are urging a middle path. “We don't have perfect solutions anymore,” Reyer says. It

is time to “stop pointing fingers at each other because it's not leading anywhere,” Hartmann adds. Trees will still need to be planted, many argue, but more forested land should be left to nature.

One thing is clear: Germans will need to adapt to forests very different from the ones they've known. “This is disturbing for people,” Hartmann says. “The forest of the future will not look like the one where I was walking with my grandpa.” ■

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Bark beetles (bottom) carve galleries in trees (top) and kill many. Infestations are spreading in Germany because of drought and warmer temperatures.

rally, such as poplars and birches, and even some new planted varieties that might do well in the future climate. The von Beymes also note that the commercially valuable deciduous trees they are growing in some forests—including oaks and beeches—can take 140 to 160 years to mature, compared with a mere 60 to 80 years for spruce. Moreover, they add, climate research indicates the cold- and moisture-loving beech “has no future” as a dominant species in their area.

That's why the von Beymes have planted some of their land with Douglas fir, a fast-growing conifer from North America.

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