



ABOVE: The present – In Virginia's Grayson Highlands.
Photo by Erik Gerhardt.
BELOW: The future? Dry savanna in California.
Photo by Scott Mansfield.

DOUBLE VISION



Climate Change Comes to the Mountains

BY STEVE NASH



LEFT. The trees in virgin forest at James Madison's Montpelier are two centuries old. BELOW. Cut-leaved toothwort, slow to migrate, is among the wildflowers that may not survive major climate changes.



Continued drought, high temperatures and an increased frequency in forest fires may leave dry savanna in place of closed forest.

We're looking at climate change in the future, perhaps occurring in a century or less, that's about equivalent, in magnitude of temperature change, to the transition from the last Ice Age to now. Which just absolutely rearranged the planet.

Hank Shugart

As the planet heats up, the fate of the Blue Ridge mountains is unclear: lost habitat or last refuge?

FINDING THE 200-ACRE virgin forest at Montpelier isn't what you'd call difficult. There's a good map for President James Madison's Virginia estate, first settled along this ridge in 1723. Staffers can give detailed directions. The trail, under a tall canopy of oak, ash, hickory and poplar, is well-worn and well marked.

It's not like that, though, when you're trying to get a look at these same venerable woods, or any of the rest of the Blue Ridge, as they will be in coming decades under the influence of global warming.

To see what's there now, and what's on the way – it's a kind of willed double vision.

Maps to those future mountains exist, but they're crude and sometimes contradictory. The trail meanders and fades into uncertainty. Even with expert guides like research ecologist Hank Shugart, there are as many contingencies as conclusions. The picture is, as it has to be, an assemblage of blurred fragments. But having them is a distinct advantage over strolling into the future sightless.

Shugart, a University of Virginia research ecologist, has been studying forest dynamics for 30 years, and he's on intimate terms with these woods. There's

evidence here, in James Madison's own meticulous climate records and in the rings of the old trees, that summer rainfall patterns have shifted. Other data confirm that spring arrives earlier now, and the growing season's longer.

Out on the trail, Shugart pauses to look around, and muses: "It's hard to say yeah, there you go, there it is – elementary, my dear Watson! – the climate's changed!" Climate scientists are all but unanimous that a shift is coming, however.

"It's kind of interesting," Shugart says. "We're looking at climate change in the future, perhaps occurring in a century or less, that's about equivalent, in magnitude of temperature change, to the transition from the last Ice Age to now. Which just absolutely rearranged the planet." That change, however, took a thousand years, not a hundred.

MOVING THE MAP

Conversations about climate usually begin with heat and rain. In the mountains, average annual temperatures have trended upward since the mid-1970s, and the broad scientific consensus is that it's going to get warmer. How much, in what seasons, and how fast is

Steve Nash teaches in the environmental studies and journalism programs at the University of Richmond, and is the author of "Millipedes and Moon Tigers" (University of Virginia Press, 2007) and "Blue Ridge 2020 – An Owner's Manual" (University of North Carolina Press, 1999).

RIGHT. Forest fires, such as the one this burnout is combating around homes in Kentucky's Daniel Boone National Forest, are an increased risk in drought conditions.

BELOW. Bears, both beloved and feared by humans in the eastern mountains, are limited in their ability to migrate to more favorable habitats if the climate shifts.



PHOTO: JEFFREY M. HARRIS

Trillium, a member of the lily family, may disappear in all its three-petaled variety.



BRIAN WATTS



ABOVE. Research ecologist Hank Shugart. RIGHT. Ecologist Steve McNulty.



more of an open question.

Climate scientists depend on a variety of computer models as they try to glimpse the future. Those models are constructed from data – mathematical descriptions of what we know about the circulation of the jet stream or the Gulf Stream, the influence of cloud cover or vegetation cover, and, most assuredly, the “greenhouse effect” of carbon dioxide and other heat-trapping, human-made gases.

Read these numbers slowly (they’re all in Fahrenheit): According to a new draft multi-agency federal report, in the 1960s and 1970s there were, on average, 15 days of temperatures above 90 degrees along the Blue Ridge region. During the two decades starting in the year 2080, there will be five times as many days above 90 degrees.

By this measure, the mountain climate in 2080 will be similar to Florida’s now.

Much depends on how humankind responds. If we’re able to rein in greenhouse gas emissions quickly, average annual temperatures in the whole Southeast are projected to rise by about 4.5 degrees by the 2080s. If we continue “business as usual,” nine degrees of average warming are projected (with about a 10.5-degree increase in summer, and a much higher heat index).

Thomas Wilbanks, a research fellow of the Oak Ridge National Laboratory in Tennessee, has worked on the two most recent United Nations Intergovernmental Panel on Climate Change (IPCC) assessments, as well as several federal reports on global warming’s implications for the U.S.

“Attention is shifting away from looking at scenarios of relatively modest climate change towards

relatively severe ones,” he says. Climate change impacts are emerging faster than was being predicted even a few years ago.

“Greenhouse gas emissions are rising faster than what has been assumed in any scenario we’ve ever taken seriously,” he adds.

FIRE AND RAIN

On future rainfall in the Blue Ridge, the jury is out – the models disagree. The most recent IPCC rainfall maps show this as a “zone of uncertainty.” Even if there’s more rain, the gathering heat will generate more evaporation, and plant transpiration – loss of water through leaves and needles – so soils may still become drier.

At least as important, however, is climate variability: how the weather arrives. “If you think of steps as leading up to a higher level, that’s climate change. Climate variability is the height of each step,” says Steve McNulty, a USDA Forest Service landscape ecologist based in Raleigh, N.C.

“The part that we know is changing is the intensity of the rain. That’s a given, a very likely scenario. With climate change, we may not see any difference at all in total precipitation. But with climate vari-

IS THIS THE REAL DEAL?

I have conversations all the time with highly intelligent people who don’t believe that global warming is real. Or if it is, humans aren’t responsible – they’re natural changes. If one recent national poll is correct, the chances are about 50/50 that you see things that way, too.

So why read an article about the mountains that takes global warming for granted, as this one does?

There are many reasons for the divide in public opinion, despite very strong agreement among climate scientists that goes back at least 20 years. But the “controversy” is political, not scientific.

A dwindling handful of climate scientists have always questioned the consensus view, but usually in statements that are not part of published, peer-reviewed research. That’s a valid contribution. It doesn’t alter the overwhelming scientific consensus, though.

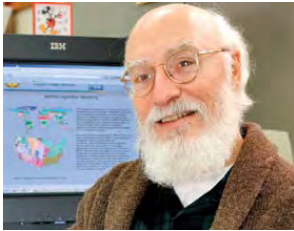
The United Nations Intergovernmental Panel on Climate Change is the premier international voice of climate science – and a very cautious group. It has long since concluded that warming is real, and human-caused.

Every major U.S. scientific group that addresses climate questions has agreed, formally, on the record: the National Academy of Sciences, the American Meteorological Society, the American Geophysical Union, and the American Association for the Advancement of Science among them.

A study of all 928 published scientific journal articles that addressed climate change between 1993 and 2003 found that none of them disagreed with the consensus position.

“Politicians, economists, journalists, and others may have the impression of confusion, disagreement, or discord among climate scientists, but that impression is incorrect,” the study concluded.

Under these circumstances, and with respect, I can only encourage you “climate skeptics” to keep reading, and keep thinking. As for the rest of us, let’s hope that the skeptics are right, but make plans on the basis that the scientists are, instead. —SN



ABOVE: Ron Neilson, a bioclimatologist with the U.S. Forest Service.

RIGHT: Salamanders, which cannot survive out of moist habitats, are part of complex and threatened stream ecosystems.

FAR RIGHT: Dominique Bachelet, a climate change scientist with The Nature Conservancy.

RIGHT, BELOW: Some of the 103 square miles of remaining spruce-fir "sky islands" in the Great Smokies, near Andrews Bald. These forests once covered 700,000 square miles.



ability, that rain may all come in a six-month period, as torrential downpours, so we're likely to have more flooding." And more drought.

Partly because of the uncertainty about rain, the crucial role of fire is still being puzzled out, too. Will we fight forest fires as much in the future? That changes projected outcomes. Will plants use water more efficiently when there's more carbon dioxide in the air? That alters the modeling, too. Researchers wind up with a couple of dozen possible scenarios rather than a few variations, or that elusive single, clear picture of the future.

Attention is shifting away from looking at scenarios of relatively modest climate change towards relatively severe ones.

Thomas Wilbanks

Dominique Bachelet, a climate change scientist with The Nature Conservancy, models the effects of global warming on broad classes of vegetation – grasses, evergreens, deciduous trees. In the Blue Ridge region, she says, "The forests we know today are adapted to a particular amount of water that may not exist in the future." If fires are more frequent and the climate is warm and dry, an open savanna with occasional trees may replace the closed forest. Turn up the heat or change precipitation still more and the rhythm of fires quickens again, transforming for-

ests into grasslands.

Bachelet's reading of her many projections is that that's quite unlikely. But her colleague and co-author, Ron Neilson, a Forest Service bioclimatologist who also does research at Oregon State University, looks at the same data and reaches a somewhat different interpretation.

Some modeling predicts large areas of forest in the Southern Appalachians that "go into drought stress and potentially burn up," he says. In the hotter scenarios, "the amount of fire that's showing up is pretty horrific," with more grass and shrubs, and fewer trees, in the last quarter of the century.

"My main mantra, frankly one of the things I'm very concerned about, is the potential for Eastern forests to turn into a conflagration, particularly in the Southeast," Neilson says. "You could see some very rapid conversions from forests to savannah."

"Pretty soon? Absolutely." Twenty or 30 years? "How about now," Neilson replies. "Consider the drought that is currently affecting the Southeast. Atlanta has seen nothing worse than this in the last one hundred years."

UP NORTH, UPSLOPE, OR GONE

At the microscopic level, some of the record of what befalls plant and tree species in the mountains when the climate changes is written in an unlikely language: fossilized pollen, deposited in the layered mud of mountain bogs. The tiny grains show that some species died off at the end of the last Ice Age, but many others spread their seeds northward as the climate warmed and the glaciers retreated.

That stability has resulted in a complex tapestry of natural Blue Ridge habitats such as shale barrens and river gravels; caves, bogs and balds; oak-hickory, beech gap and Table Mountain pine forests among them. They are home to 29 kinds of snakes, 70 or more species of mammals, a couple hundred kinds of birds, more than 1,400 flowering plants, at least 70 species of fish and more than 130 tree species.

This time around, the pace of climate change may become too rapid for some of those species to disperse or adapt. The northward path of others will be blocked by the expanse of highways, cities and farms that are now on the landscape. Still other species are too isolated at higher elevations to move anywhere but upslope to get to a cooler clime. If they're already near the top of the mountains – like brook trout or spruce-fir forest – there may be no place left to go.

The Blue Ridge region's high-elevation spruce-fir "sky islands," whose climate resembles that of south-

ern Canada, once covered 700,000 square miles, from Missouri to the Carolina Piedmont.

Already battered by logging and imported pests during the past century, only 103 square miles of this forest remains, most of it in Great Smoky Mountains National Park. Under many climate-change scenarios for the region, this unique forest ecosystem will vanish. There is no "connectivity" along a northward path for its suite of species to move along. Already, pine beetles that are usually killed off by cold winters have moved into higher elevations in North Carolina to kill healthy spruce trees.

If the climate changes quickly, the intervening period may be biologically barren, compared to the mountain landscapes we have now – an event that has been characterized as a "big die-off."

Shugart measures the problem efficiently: "Let's say the climate changed tomorrow afternoon. Your smart move would be to head off down to Georgia someplace and get a whole bunch of plants that would grow in our forest in this new climate and hire every high school kid on the planet to plant them.

"It's still going to take a couple of hundred years to develop the new forest. Even in ideal circumstances, there's a delay. You can only push the succession process so fast, which means you're going to end up for human-lifespan time periods with plants that are either going to be dying, or at least not prospering."

TROUT, AND GOOD CONNECTIONS

Forest Service aquatic ecologist Patricia Flebbe has been investigating mountain streams and modeling trout data for the last 20 years. Her recent study of the fate of wild trout bracketed the range of possible climate change by using two models, one that projects the least warming, the other projecting a lot.

The Southern Appalachians is as far south as trout can live in eastern North America. Her research arrived at a sobering conclusion. According to the model prediction, the amount of stream habitat that would remain cool enough for these fish will shrink dramatically – by 53 percent if there is a 4.5-degree rise in average temperatures, and 97 percent with a 9.9-degree increase. As fragmentation of their habitat increases, the remaining trout are predicted to be stranded in small, isolated and vulnerable high-elevation streams – as with the spruce-fir forest, there's no northward landscape "connectivity."

"Species that trout prey on will potentially become more abundant. If you take a top predator out of the system, the effects cascade through the food chain, so some things will increase and other things will decrease, depending on what's left," Flebbe says.

Unpredictable changes will follow. It's a complicated community, with other kinds of fish, salamanders, crayfish and insects – one measure of how little

we know about our natural systems, even now.

Scientists do seem confident about this general idea, however: In the Blue Ridge region, unfragmented and well-connected landscapes will function as a kind of safety zone for many species as they adapt to survive climate change.

"In mountainous, rough topography like the Southern Appalachians, you actually have an advantage, because species can shift range upslope," says Reed Noss, a conservation biologist at the University of Central Florida. They can also shift to a slightly cooler "micro-environment," such as a slope that faces away from the sun, or a place closer to a spring or seep. These small refuges preserved a variety of species in the mountains during past climate changes.

We can expect extinctions because of global warming, he adds, and populations of many species will shrink. Birds are mobile despite human-made barriers. Bears are not. Salamanders need constant moisture. Spring wildflowers like trillium or toothwort are vulnerable to change because they are slow movers – they rely on ants for pollination or to move their seeds to new locations.

Botanist Rodney Bartgis also sees these mountains as a lifeline for natural systems during the coming climate transition. A West Virginia state director for The Nature Conservancy, he works on conservation planning that takes climate change into account and tries to interest state and federal land agencies in managing land to adapt to changing conditions and in creating connectivity for wildlife movement.

"It's inspiring," Bartgis says. "The mountains have those features of resiliency and adaptation, they get me thinking. I bet we can, even in the face of climate



The southern Appalachians could lose from 53 to 97 percent of trout habitat (above: Stoney Creek, in the Shenandoah Valley) if warming trends continue.

I bet we can, even in the face of climate change, maintain 100,000 acres of spruce until the climate stabilizes again, and maintain those species that are associated with it.

Rodney Bartgis



Conservation biologist Reed Noss.

change, maintain 100,000 acres of spruce until the climate stabilizes again, and maintain those species that are associated with it. So we need a little bit of hope, and a little bit of acknowledgement that we are going to lose some things."

Noss echoes nearly all climate scientists when he says: "We've already passed one tipping point. Even if we stopped all greenhouse gas emissions now, we're still going to see major effects of global warming, at least through our grandchildren's lifetimes. But the longer we wait to act, the harder it's going to be to reverse any of this for centuries, if not longer.

"I don't think we're going to have as severe a problem as we do in the lowlands, which is encouraging in a way, but there's no room for complacency."

DOING SOMETHING

Along with reading about it, there's plenty to be done to head off the worst of global warming. If you love the mountains, you may be interested in that. There are plenty of easy ways to find out about the urgent measures needed now to throttle down on greenhouse gas emissions, and what you can do to support them.

But some immediate new policies will also help the Blue Ridge region specifically – especially those that anticipate warming's impact by assembling the largest possible core wildlands, with an ample number of connecting wild corridors for plant and animal populations to migrate along.

Reed Noss, a conservation biologist at the University of Central Florida who has a strong interest in the Southern Appalachians, proposes making protection for natural systems our priority.

Rare and endangered species – and the list is lengthening – should be perpetuated in seed banks, botanical gardens, zoos, "to try to ride this out," Noss says.

"In general I don't like to go on record as a proponent for condemnation of land as a blanket solution, but I think it has to be part of the solution. We've done it for dams and reservoirs and highways, why not for natural areas?"

"The government has done virtually nothing on land acquisition. Everything has its price, and we could just buy land." Noss has calculated that for what has already been spent on the Iraq War, a million square miles of land could be purchased and safeguarded for its environmental value to humans and to wildlife.

On our seven national forests in the Blue Ridge, Noss recommends an immediate halt to road building, and ripping up and revegetating existing roads wherever possible. "We should stop using heavy machinery that disturbs the soil, and [undertake] only very low intensity timber harvests," he adds, in order to preserve the closed forest canopy, as a buffer against the effects of warming.

Climate scientist Dominique Bachelet, of The Nature Conservancy, says that water resources will be an enormous issue in the mountains as the climate warms: "If we want our forests to be better adapted to future drought conditions," she says, "we have to reduce the number of individual trees and the number of invasive species that will also take advantage of the water resources. Limiting the density of the forests will allow them to have better access to water, and reduce fire danger.

"Leave the big trees to provide a shady canopy," Bachelet advises – don't log them anymore. "But thin out the 'bug hair' forest of skinny young over-crowded trees. They suck up too much water and then die off and become fire fuel." —SN

we're-already-in situations.

"In terms of money and finance, we're accustomed to doing policy on the fly, in a changing scene. Why can't we use those same sorts of ideas on the environmental side?"

Please write to us and let us know what you think. E-mail cmadisett@leisurepublishing.com, subject line "climate change," or write the editor at 3424 Brambleton Ave. SW, Roanoke, VA 24018.

DECISIONS, UNCERTAINTIES

Looking out at the foothills around Montpelier, Hank Shugart recalled a recent invitation. He'd been asked to brief a new Virginia state climate commission about global warming and forests. That assignment evoked a sense of dread that many scientists say they feel at times.

"One of my thoughts was to try to put a pleasant spin on anything I could," he said. "For me, giving that talk was unpleasant, because I actually had to think about that stuff in ways I normally don't. I usually detach myself from it. So it's funny – when I put this little talk together, one of the things that ran through my head was, 'God, this is kind of bad. It's really... it isn't good.'"

On the other hand, he says, "I am optimistic about what human beings can do if they ever turn their hand to it." And he counsels patience in the face of all the frustrating uncertainty.

"If you look at the stock market, my impression is that nobody knows very much, either. But that doesn't prevent us from trying to form intelligent economic policies, or of having fairly smart people work like crazy to keep us out of some worse-than-