



**Woodwell
Climate
Research
Center**



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Woodwell Climate at COP26

RECOGNIZING RISK

RAISING AMBITION

REALIZING SOLUTIONS



Woodwell Climate Research Center is uniquely dedicated to climate science pursued in partnership with stakeholders and decision-makers to produce maximum societal benefit. Our renowned researchers investigate how human activities are affecting the flow of carbon and water—key climate factors—through some of the world’s most critical ecosystems, from the Arctic to the tropics. Together with our global network of partners, we generate novel insights into the risks we face, and the just, effective solutions we can develop.

Our COP26 delegation is working to ensure that the world’s leaders recognize the full magnitude of current climate risks and respond with more ambitious, science-based targets and strategies.

RECOGNIZING RISK

The impacts of climate change are here and now; they are already material and will only continue to worsen as atmospheric carbon levels rise. Understanding the socioeconomic and geopolitical risks of climate change is critical to informing both mitigation and adaptation efforts, yet decision-makers face obstacles in accessing relevant risk assessments. We’re working with the COP26 Presidency to identify and overcome those obstacles, and enable more ambitious policies and practices.

RAISING AMBITION

Frozen Arctic ground, termed permafrost, presents the greatest under-recognized challenge to climate change mitigation. As the Arctic warms, permafrost thaws and the vast stores of carbon it contains become vulnerable to decomposition and release in the form of greenhouse gases. This process threatens the success of international efforts to limit rising atmospheric carbon levels and resulting warming. Yet, due to the challenges associated with monitoring and predicting the timing, magnitude, and form of permafrost thaw emissions, this critically important feedback has been largely left out of carbon budgets and climate policy. We’re working to ensure permafrost thaw emissions are tracked and accounted for.

REALIZING SOLUTIONS

Tropical forests act like air conditioners for the planet—producing rain, providing shade and habitat, and trapping and storing nearly a fifth of human greenhouse gas emissions. Protecting standing forests is an essential, immediately effective, but under-utilized natural climate solution. With our network of on-the-ground partners in Brazil, we’re developing and deploying evidence-based strategies to incentivize forest conservation in agricultural landscapes, while also working with partners in the financial world to improve the accountability and transparency of carbon markets and rapidly scale up finance for forest protection.

LEARN MORE

See who’s going, what events Woodwell is involved in, and follow daily updates from our delegation at: woodwellclimate.org/cop26

Giving carbon a home on the range

by Sarah Ruiz
Science Writer

Adapting ranching practices in the US could increase carbon sequestered in the American West

Rangelands occupy more than three quarters of global agricultural land. Many of the world's native grassland ecosystems have been converted to grazing land for livestock, altering their ecology and changing the flow of carbon on the landscape. However, these lands still have the potential to be a powerful carbon sink if properly managed.

On September 27 and 28, Woodwell Climate Research Center convened a workshop in collaboration with Montana State

grassland and sagebrush steppe environments, in many cases privately held," said Dr. Stephanie Ewing, an Associate Professor at MSU who co-organized the event. "And because we have a strong academic and extension community at MSU that has been engaged with rangelands and rangeland managers over time."

Day one began with a series of presentations and panels meant to facilitate discussion about rangeland management. Sessions covered rangeland ecosystem services, rangelands in

the American West, management for carbon sequestration, carbon markets, and tools for rangeland monitoring.

For Dr. Jennifer Watts, Woodwell Assistant Scientist, the discussions highlighted the vast untapped potential of rangelands to play a positive part in climate mitigation.

"There's so much rangeland in the western U.S. and so there is a huge potential for improving ecosystems and improving carbon sequestration and storage," Dr. Watts said. "But the public doesn't perceive rangelands with the same reverence that we do with forests or other ecosystems. I think if we start to value them at the national level, and realize the potential for ecosystem services and climate mitigation, that could shape how policy is going to move forward."

The following day, attendees made site visits to two ranches in the area—Red Bluff Ranch, run by MSU, and Green Ranch, owned by Turner Enterprises—for a hands-on look at the topics they had discussed the day before. They examined soil pits, dug into the grass, and talked about different land management styles. For Senior Scientist Jonathan Sanderman, the trip into the field was a catalytic moment in the workshop.

"After just a few hours on the ranches, I felt like a lot of people had lightbulbs go off about how long-term management has



University (MSU) and Turner Ranches to open discussions on rangeland management in the United States. The workshop took place in Bozeman, Montana, and brought together scientists, ranchers, and conservationists to share their perspectives on rangeland ecology, carbon sequestration, fire management, and herd health, as well as anecdotes from careers spent on the range.

"Montana offers a great location for this conversation because the majority of the state is amazing rangeland including unique

above left: The crowd waiting for entry into COP26. / photo by Glenn Bush

above right: Workshop attendees gather at MSU's Red Bluff Ranch for a hands-on discussion. / photo by Jonathan Sanderman

affected certain parts of land more than others, and how that feeds back to the soils,” Dr. Sanderman said.

One theme that emerged from the workshop was the need for more and better information on how rangelands could be included in carbon markets. While there was interest from landholders in participating, very few knew enough to get started. Drs. Watts and Sanderman hope future collaborations will allow them to dig deeper into the topic with ranchers.

“A well-functioning carbon market can provide climate benefits and an additional revenue stream, enhancing the economic resilience of ranching communities,” Dr. Sanderman said. “Quantifying and monetizing carbon sequestration from improved grazing management is still in its infancy. This means there is a lot of confusion and few agreed upon standards; but, it is also an opportunity to shape policies and design programs that benefit people and the environment.”

It also became evident that, while many ranchers were interested in carbon storage on their lands, what mattered more to them was the possibility of integrated benefits from holistic range management. Improving carbon storage in the soils can improve water management, nutrient retention, and other ecosystem services.

“Carbon is something that brings it all together,” Dr. Watts said.



Black spruce are losing their legacy to fire

by Sarah Ruiz
Science Writer

Although evolved to thrive in fire-disturbed environments, a recent study shows they are losing their resilience among more frequent wildfires

For the past five to ten thousand years, black spruce have been as constant on the boreal landscape as the mountains themselves. But that constancy is changing as the climate warms.

A recent study published in the *Proceedings of the National Academy of Sciences (PNAS)*, led by Dr. Jennifer Baltzer, Canada Research Chair in Forests and Global Change at Wilfrid Laurier University, found that shifts in wildfire regimes are pushing black spruce forests to a tipping point, beyond which the iconic species may lose its place as the dominant tree species in boreal North America.

Synthesizing data from over 1500 fire-disturbed sites, the study showed black spruce’s ability to regenerate after fire dropped at 38% of sites and failed completely 18% of the time—numbers never before seen in a species evolved to thrive after fire.

The stabilizing feedbacks of black spruce

“They almost look like a Dr. Seuss tree,” says Dr. Brendan Rogers, an Associate Scientist at Woodwell and co-author on the *PNAS* study. He’s referring to the way black spruce are shaped—short branches that droop out of spindly trunks. Clusters of small dark purple cones cling to the very tops of the trees. Black spruce forests tend to be cool and shaded by the dense branches, and the forest floor is soft and springy.

“The experience of walking through these forests is very different from what

most people are accustomed to. The forest floor is spongy, like a pillow or water bed,” Dr. Rogers says. “It’s often very damp too, because black spruce forests facilitate the growth of moss and lichen that retain moisture.”

However, these ground covers can also dry out quickly. Spruce have evolved alongside that moss and lichen to create a fire prone environment. It only takes a few days or even hours of hot and dry weather for the porous mosses to lose their moisture, and the spruce are full of flammable branches and resin that fuel flames up into the tree’s crown.

Black spruce need these fires to regenerate. Their cones open up in the heat and drop seeds onto the charred organic soil, which favors black spruce seedlings over other species. The organic soil layers built up by the moss are thick enough to present a challenge for most seedlings trying to put down roots, but black spruce seeds are uniquely designed to succeed.

Dr. Jill Johnstone, Affiliate Research Scientist at the University of Alaska Fairbanks, who also contributed to the *PNAS* study, compares it to a lottery system that black spruce have rigged for millennia.

“After fire, anything can happen,” says Johnstone. “But one way to make sure you win the lottery is to buy a lot of tickets. Black spruce has the most tickets. It has the most number of seeds that are the right size to get roots down into mineral soil, and so it tends to regenerate after fire.”



Potential competitors like white spruce, Dr. Johnstone says, don't disperse very far from standing trees so they only get a few lottery tickets. Deciduous species like aspen or birch have seeds that are too small to work through the thick organic layers—their tickets are faulty. So the fire lottery tends to perpetuate black spruce's dominance in what's known as a "stabilizing feedback loop."

Hotter, dryer conditions are inhibiting black spruce regeneration

That stable loop has begun to break down, however. Black spruce just aren't re-establishing themselves as frequently after fire. The study examined the characteristics of different sites to better understand what might be hampering regeneration success.

Sites that failed to regenerate with black spruce were typically drier than normal. They also tended to have shorter intervals between successive fires. Black spruce stands have historically experienced the kinds of intense, stand-replacing fires that burn through everything only once per century. This long interval allows the trees to build up a healthy bank of cones to release seeds the next time they burn. More frequent, returning fires short-circuit the regeneration process.

Increased burning also strips away more of that thick organic soil layer that favors black spruce, revealing mineral soils underneath that level the playing field for

other tree species. The more completely combusted those organic layers are, the more likely spruce are to have competition from jack pine, aspen, or birch. Loss of black spruce resilience was more common in Western North America, which aligns with the fact that drier sites are more likely to lose their black spruce.

"Basically, the drier the system is, the more vulnerable it is to fire," Dr. Baltzer says. "And these are the parts of the landscape that are also more likely to change in terms of forest composition, or shift to a non-forested state after fire. If climate change is pushing these systems to an ever drier state, these tipping points are more likely to be reached."

For Dr. Rogers, it also highlights the real possibility of losing black spruce across much of boreal North America as the region warms.

"This is evidence that black spruce is losing its dominant grip on boreal North America," Rogers says. "It's happening now and it's probably going to get worse."

Losing black spruce could accelerate permafrost thaw

Landscape-wide ecological shifts from black spruce to other species will have complicated, rippling impacts on the region.

Of most concern is the impact on permafrost. In many parts of the boreal, those mossy soil layers that promote black spruce also insulate permafrost, which stores large amounts of ancient

carbon. Replacing the dark, shaded understory of a black spruce forest with a more open deciduous habitat that lacks mossy insulation could accelerate thaw. Thawing permafrost and associated emissions would accelerate a warming feedback loop that could push black spruce to its tipping point.

Widespread loss of black spruce also has implications for biodiversity, particularly caribou species that overwinter in the forest and feed on lichen. Both barren-ground and boreal caribou, important cultural species for northern communities, are already in decline across the continent and would suffer more losses if the ecosystem shifts away from the black spruce-lichen forests that provide food and refuge.

Dr. Johnstone did point out some potential for black spruce to recover, even if initial regeneration post-fire is dominated by other species. Slower growing, but longer lived, conifers can often grow in the shade of pioneer deciduous species and take over when they begin to die off—but this requires longer intervals between fires for the spruce to reach maturity. There is also the possibility that more deciduous trees, which are naturally less flammable than conifers, could help plateau increasing fires on the landscape.

But both these hopes, Dr. Baltzer says, are dependent on getting warming into check, because deciduous or conifer, "if it's hot enough, and the fuel is dry enough, it will burn."

New website illustrates changing Arctic landscapes, and impact around the globe

by Sarah Ruiz
Science Writer

Woodwell Climate Research Center partners with GIS leader Esri to pioneer data visualization of climate crisis in the Arctic

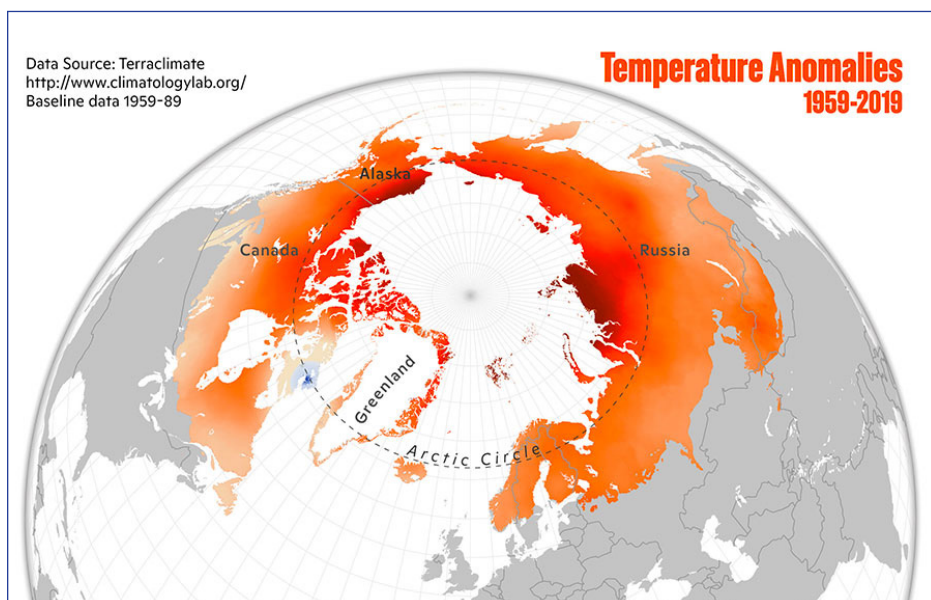
The Arctic is warming more than twice as fast as the global average, severely impacting climate systems and communities both in the Arctic and around the world. Understanding these changes and their impact on essential ecosystems will be critical to developing solutions to address the climate crisis. And so, to improve access to information about these issues and spur much needed action, Woodwell Climate Research Center, a leading source of climate science based in Massachusetts, and Esri, the world leader in location intelligence, have launched [UnstableGround.org](http://unstableground.org), an interactive data visualization hub that explores how Arctic landscapes are changing and what that means for the rest of the world.

As temperatures rise, the Arctic climate is dramatically changing, affecting plants, ecosystems, permafrost, snow and ice cover, and wildfires. And these changes have a massive impact on our global climate. The permafrost region, for example, stores approximately 1.4 trillion tonnes of soil organic carbon. As the Arctic warms, the permafrost is thawing, which can release that carbon into the atmosphere at a rapidly accelerating rate, raising the temperature of the whole planet and compounding climate risk for communities across the world.

Yet for most people, these changes remain out-of-sight, out-of-mind. [UnstableGround](http://unstableground.org) is designed to help change that, allowing users to visualize and understand the rapidly changing Arctic. [UnstableGround](http://unstableground.org) includes stories, maps, statistics, and custom applications which allow users to interact with spatial data to assess trends over time.

“What happens in the Arctic doesn’t stay in the Arctic,” said Woodwell scientist and Arctic expert, Dr. Sue Natali. “The interconnected nature of our global climate systems means that these effects extend far beyond the region, straining carbon budgets and fueling climate consequences across the planet.

Through our work with Esri on [UnstableGround](http://unstableground.org), we are able to illustrate these effects through visuals and stories, making Arctic climate science more accessible and engaging to the broader public, and bridging a key gap between science and public discourse.”



“[UnstableGround](http://unstableground.org) presents detailed information in a context that informs and inspires meaningful action. It illuminates the ways in which the fight against climate change should go hand-in-hand with the striving for social equity, and how solutions should likewise be equitable,” said Dr. Dawn Wright, chief scientist of Esri. “Understanding the complexities of these challenges visually and in a clear-headed way enables us to formulate better strategies for solving them, which is why an engagement platform like this gives me great hope.”

LEARN MORE

[UnstableGround](http://unstableground.org) explores climate change in the Arctic through key numbers and metrics, maps and graphics, and stories and case studies: unstableground.org

Above: Air temperature anomalies for 2019 are warmer (darker red) in higher latitudes when compared to the baseline of 1959-1989. / map by Greg Fiske

In the news: highlights

Dr. Jen Francis's third article for *Scientific American*, "Vapor storms are threatening people and property," is available online and will be featured on the cover of the November issue.

An *Al Jazeera* piece on abrupt Arctic change quoted Dr. Rachael Treharne and cited the Arctic team's PNAS paper from earlier this year.

Phys.org picked up our announcement about new research on the impact of increasing wildfire on boreal black spruce, published in *PNAS*. Dr. Brendan Rogers is a co-author.

The COP26 Presidency announced the Recognizing Risk--Raising Ambition workshops with G20 nations.

Dr. Jen Francis was quoted in a *Bloomberg Quint* piece on investors' concerns about winter weather.

Science Daily covered a new study co-authored by Dr. Chris Neill on the impact of residential landscaping practices on bird diversity.

The analysis of unaccounted-for emissions from EU- and UK-based burning of US-sourced wood pellets that Dr. Wayne Walker and Dr. Rich Birdsey co-authored with Chatham House received high-profile coverage by *POLITICO EU*, *Inside Climate News*, and *Mongabay* (both Dr. Birdsey and Dr. Walker are quoted).

Dr. Ludmila Rattis is quoted in a piece on deforestation in Riviera de São Lourenço in *Folha de São Paulo*.

Probable Futures was written up in *Medium's* "Data Viz Weekly."

Dr. Foster Brown was quoted in a *Mongabay Brazil* piece on the interaction between smoke and COVID-19.

Dr. Jen Francis was quoted in a *Boston Globe* article about persistent record-hot weather this year.



SPOTLIGHT

Dr. Sue Natali led a breakout session at the TED Countdown Summit in Edinburgh, Scotland earlier this month. Highlights from the conference will be live-streamed on October 30.

Beyond 1.5

A Kaneb Lecture Series

KANEB SPEAKER SERIES

Beyond 1.5

As the latest IPCC report made abundantly clear, human activities to date have kicked off unprecedented global warming and committed us to hitting or passing the 1.5° mark early next decade. We must now courageously confront what lies **Beyond 1.5°C**—the risks and choices that we face as we shape our climate future. Our fall event series wraps up with our the final webinar of the series on November 17. We hope you will join us.

NOVEMBER 17, 7PM ET

Seeing the future: What do success and failure look like?

Visualizing our future is critical to motivating wise choices today. In this endeavor, speculative fiction is a powerful complement to scientific projections. The final event in the series explores success and failure through the eyes of creatives and invites audiences to activate their own imaginations.

LEARN MORE & REGISTER AT: WOODWELLCLIMATE.ORG/BEYOND1.5

cover: Noah Davis, Red Bluff Ranch Foreman, leads a tour of MSU's research ranch during a two-day rangeland carbon workshop in Bozeman, Montana, September 2021. / photo by Jonathan Sandezman

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