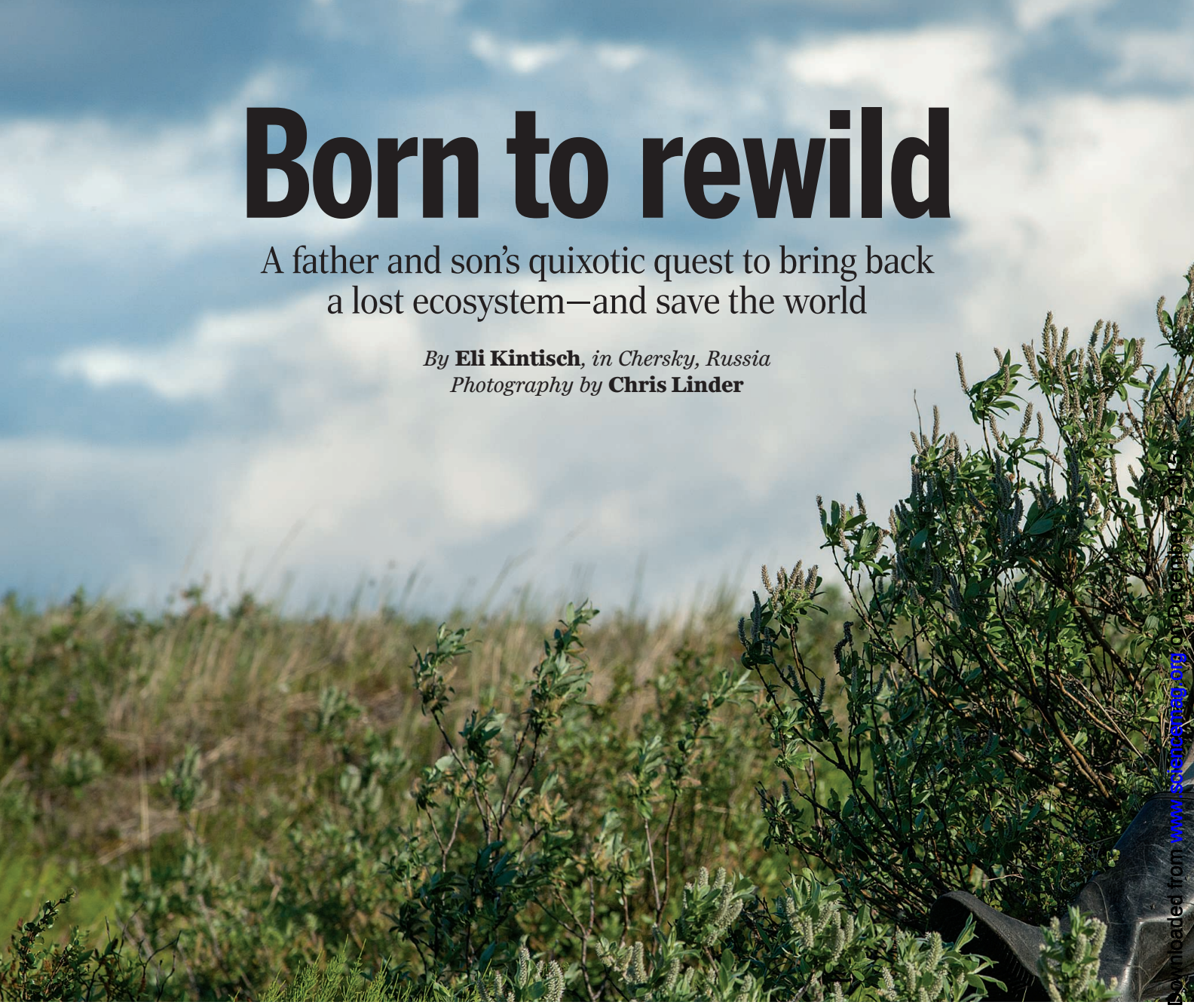
Born to rewild

A father and son's quixotic quest to bring back a lost ecosystem—and save the world

By **Eli Kintisch**, *in Chersky, Russia*
Photography by **Chris Linder**



In April 2011, Nikita Zimov climbed into a heavy duty truck with six elk in the back and set out from Novosibirsk, a major city in southern Siberia, on a 4000-kilometer trek to the edge of the world. Time was not on his side. He had to reach the Arctic town of Chersky, where he and his father, Sergey, run a hardscrabble research outpost called the Northeast Science Station (NESS), before the spring thaw melted the frozen rivers that serve as winter roads in northern Siberia. White wooden crosses marked spots along the winding road where unlucky drivers had perished. Two weeks into his journey, just 40 kilometers from home, Zimov hit a snowbank—his brakes were shot—and the truck tipped over. Unscathed, he phoned his father and spent the next 4 hours, cold and exhausted, leaning against a flimsy tarp that covered the truck's roof to keep the elk, also uninjured, from bolting. "I was miserable," he says. "Almost literally insane."

Sergey swooped in to rescue Nikita and the elk, and the animals finally reached their destination: Pleistocene Park, a 14,000-hectare reserve near Chersky founded by the elder Zimov 19 years ago. It's a grand experiment to test whether large herbivores—elk, moose, reindeer, horses, and bison—can, simply by grazing, bring back a grass-dominated ecosystem called the mammoth steppe. That biome dominated the northern reaches of Eurasia and North America for 2 million years, until the end of the last glacial period some 13,000 years ago, when the landscape turned to mossy tundra and sparsely forested taiga.

If the Zimovs are right, a brighter future for the entire globe may hinge on the experiment's success. A decade ago, Sergey and colleagues estimated that permafrost encircling the upper Northern Hemisphere contains a whopping 1 trillion tons of carbon—twice earlier estimates—and that this vast pool may be on the brink of leaking into the atmosphere. The finding was a clarion call to climate scientists to take the arctic carbon threat seriously. "This is the most dangerous territory in the world in terms of climate change," Zimov declares.

Zimov's calculations and field measurements soon persuaded his colleagues. "Sergey comes up with these wild ideas. They seem implausible, but they turn out to be right," says longtime collaborator Terry Chapin, an ecologist at the University of Alaska, Fairbanks. Now, Zimov is straining credibility again with his proposal for containing the threat. He has called for rewild-

Ecologist Sergey Zimov believes restoring the Pleistocene mammoth steppe will protect permafrost and provide habitat for millions of herbivores.

ing the Arctic: repopulating vast swaths of the permafrost zone of Eurasia and North America with large herbivores. By restoring the mammoth steppe, he says, those megafauna would help to keep the permafrost intact even as the atmosphere warms.

"Sergey is a visionary, a challenger of paradigms," says ecologist Heather Alexander of University of Texas, Brownville. But this particular vision may be a fantasy. Recreating the mammoth steppe's estimated herbivore density—20 large animals per square kilometer—would mean sustaining millions of beasts in Siberia. Yet the Zimovs have struggled to keep a handful of herbivores alive in Pleistocene Park—a speck in the vastness of Siberia. As a testament to the challenge, the elk that Nikita risked his life to bring to Chersky had all died or hopped a fence and escaped within a year of their arrival. Sergey Zimov, however, appears unfazed by the gulf between the reality so far and his monumental vision. "It's probably the biggest project ever," he says, nonchalantly.

SERGEY, with three colleagues, in 1980 established NESS in a wooden hut along a small river near Chersky as an Arctic research redoubt of the Pacific Institute of Geography in Vladivostok. Soviet-era Chersky was a bustling hub for gold miners and for scientists in transit to research bases near the North Pole. When the Soviet Union unraveled in 1991, "people were fleeing [Chersky], but Sergey said we should stay," says ornithologist Eugene Potapov, a longtime visiting scientist at NESS who works at Bryn Athyn College in Pennsylvania.

As Chersky emptied, NESS scientists ignored an official request to return to Vladivostok. Instead they capitalized on the Soviet collapse, gathering up speedboats and trucks at steep discounts and stockpiling food and fuel in shipping containers. "We were feasting off the dead carcass of the Soviet Union," says Nikita, who as a teenager spent a summer cleaning a 33-meter-long shipping barge that his dad would convert into a floating research station.

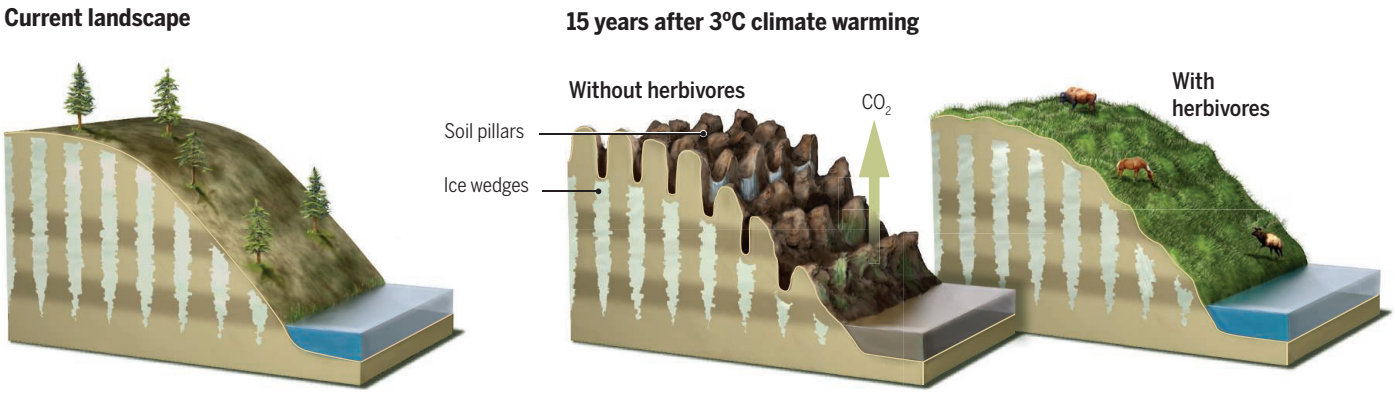
The son of a Soviet naval officer, Sergey Zimov had a maverick's temperament from the start, and it flourished in Chersky's post-Soviet isolation. He questioned the prevailing theory for why mammoths, bison, and other arctic megafauna died out at the end of the Pleistocene. Most scientists believed the warming climate disrupted northern ecosystems, changing the steppe grassland to tundra and starving the beasts. Zimov thought proponents of that idea had cause and effect reversed. He knew that in northern Siberia, taiga and tundra turned grassy wherever it was disturbed, whether by wild horses or by one of Stalin's gulags. In 1988, Zimov penned up 25 Yakutian horses, a breed adapted to the cold, and watched how they quickly transformed mossy wet tundra into grassy pasture by gnawing on shrubs and fertilizing the soil. He theorized that herbivores had maintained the expansive mammoth steppe, and the land only turned to taiga and tundra after their numbers fell for another reason—presumably human hunting.

Intrigued by Zimov's ideas, Chapin and James Reynolds, an ecologist at Duke University in Durham, North Carolina, visited NESS in the summer of 1993. "Zimov is like a spinning tornado of chaos, confusion, and creativity," Reynolds penned in his diary. They weren't immediately sold on his big idea. Zimov "takes a few data points and if his hypothesis works, he's convinced," Chapin says. But the discussions were invigorating, he says, and Reynolds came up with a model that reproduced Zimov's conclusion. In 1995, the trio and Russian colleagues published a paper in *American Naturalist* declaring that "human hunting could have played as great a role as climate" in extirpating Arctic megafauna.

Zimov saw implications for the future as well. Pleistocene grasslands in northern Russia and northwest Alaska accumulated organic material over hundreds of thousands of years. The yedoma soil distilled from all that plant material is some of the most carbon-rich on the planet, and the soil runs deep, with an average thickness of 25 meters. It is now preserved under the tundra, deep-frozen in permafrost.

Averting an Arctic apocalypse

Zimov and colleagues have warned that thawing Arctic permafrost will release prodigious quantities of greenhouse gases. Introducing horses, deer, bison, and other large herbivores, they argue, would restore arctic grasslands. By insulating the permafrost, pastures would keep the soil and ice wedges from melting into a swampy morass—and keep much of the carbon safely bottled up.



Zimov and Chapin saw yedoma as a time bomb. A decade ago in *Science*, they concluded that estimates of carbon content in Arctic soils were grossly underestimated, and that under "extreme" but plausible conditions some 500 billion tons of carbon would be liberated from yedoma within a century (16 June 2006, p. 1612). (Since then, the consensus Arctic carbon estimate has risen by another 50%; one recent study estimated that at the current atmospheric warming rate, carbon dioxide (CO_2) and methane released from permafrost would warm the planet by an additional 0.3°C by 2100.) Zimov had "basically discovered and explored a pool of vulnerable carbon approximately equal to the entire pool in plants and unfrozen soils," says ecologist Chris Field of the Carnegie Institution for Science in Palo Alto, California.

By then, Zimov was seeing, on a small scale, the devastating effects of warming temperatures in the Arctic. At a 3-hectare plot near Chersky, Zimov 11 years ago used a bulldozer to strip away the moss and soil that insulate yedoma in the summer. Ice wedges in the exposed permafrost rapidly melted, laying bare the pitted, thawing soil. Soil bacteria set to work freeing CO_2 and methane. Today, the site is pocked with 3-meter-deep melt pools and bizarre pillars of gray dirt. "This is the future we are facing if we cannot stabilize the permafrost," Zimov says.

TO AVERT THAT FATE, Zimov has proposed geoengineering permafrost on a global scale. He started small, with Pleistocene Park, a 45-kilometer boat ride up the Kolyma River from Chersky. Its modest entrance features a disgruntled cat and a metal fence in a patch of mud. Inside, 50 hectares of grasses have replaced scraggly larch and moss. Idling by a lakeshore are Yakutian horses whose grazing helped the grasses gain ground. The park, Sergey says, is "a war zone between two ecosystems."

It's also a war between Zimov's vision and some mundane challenges. Key among them, he says, is raising an army of herbivores without government support. The Zimovs have ranged hundreds of kilometers to stalk moose, driving them into rivers where they can haul the calves into boats and make off with them. In 2010, the Zimovs ventured 1000 kilometers north across the Arctic Ocean, steering clear of polar bears, to purchase six musk oxen from a wildlife reserve on Wrangel Island. Maintaining the menagerie has proven as difficult as acquiring it: Dozens of Yakutian horses have fallen prey to bears and other predators or died after eating cowbane, a poisonous member of the hemlock family. Four bison from relatively balmy Moscow died of exposure during the harsh Chersky winter. These days about 70 animals roam the park, a fraction of the 1000 Sergey hoped to have amassed by now.

Nastya Zimova cares for a moose calf purchased from a hunter for Pleistocene Park.

Even so, the browsers are helping to spare the permafrost from climate warming. Grasses are better than mosses, shrubs, and trees at reflecting sunshine, so they are more effective insulators in the summer, when for weeks the Arctic sun doesn't set. During the rest of the year, when northern Siberia is blanketed in snow, herbivores keep the permafrost frozen by ensuring it is exposed to the frigid Arctic air. By trampling down the snow, they compact it and make it a poorer insulator; in some cases they sweep away the snow altogether to graze. In Pleistocene Park, two temperature loggers in boreholes show average permafrost temperatures 2°C colder in the grazed area. That temperature difference is "enough to protect the permafrost," Nikita says.

Others aren't so sure. If winters become warm enough, says Michelle Mack, a soil ecologist at Northern Arizona University in Flagstaff, trampling or sweeping away snow could have the opposite effect, allowing warmth to penetrate the soil more quickly. "It may well be that Sergey is right," she says, but the Zimovs haven't made their case rigorously with models or data.

Chapin points out that other than cutting global greenhouse gas emissions, no solutions, apart from Zimov's, have emerged to address the "dire" prospect of permafrost carbon release. Zimov himself says it's too early to draw firm conclusions. "Pleistocene Park is an experiment that must be contin-

GRAPHIC: V. ALTOUNIAN/*SCIENCE*

In a fenced-in section of Pleistocene Park, bison and other herbivores have transformed taiga into pasture. Scaling up is a daunting challenge.

ued for tens of years," he says over moose stew one evening in NESS's dining room, a soaring round room crowned with a massive Soviet-era satellite dish.

But on his 60th birthday last summer, Sergey and a few dozen friends and colleagues celebrated his semiofficial retirement with salmon caviar and vodka toasts at NESS. Now, the fate of Sergey's living experiment rests with his son.

IN THE EARLY 2000s, Nikita attended one of Russia's top science high schools, in Novosibirsk, and then stayed there at the state university for undergraduate and master's degrees in math and computer modeling. Life in Novosibirsk offered more opportunities than moribund Chersky, where many buildings are abandoned and sinking into the thawing permafrost. "I didn't think I would want to return," he says.

"Getting Nikita to come [back] was the hardest scientific problem of my life," Sergey says. Nikita worried whether he could build on his father's legacy. "I know I can't compete with my dad as a scientist. [But] I'm interested in managing the station, growing the park."

Over the years, NESS has grown into a sprawling compound that serves dozens of visiting scientists with soil and biological labs, state-of-the-art instruments, and towers that collect atmospheric data. "There's nowhere comparable to Sergey's station in the Russian Arctic," says marine ecologist Robert Max Holmes of the Woods Hole Research Center in Falmouth, Massachusetts. Nikita wants to maintain that infrastructure in a remote hot spot for Arctic field studies. With tensions high between Russia and the West, that's a daunting challenge. Two major U.S. research grants—one supporting NESS as a teaching lab for undergraduate and graduate students and the other paying for the remote sensing—ended this year, with no promises for renewal. The Russian government, meanwhile, provides only measly salaries.

Yet fully testing Zimov's ideas will take more money, land, and animals. To lay the groundwork, Nikita plans to expand Pleistocene Park's fenced area. And to raise awareness inside Russia, the station recently created a 300-hectare preserve eight time zones to the west, near Moscow. Called Wild Field, the pasture filled with horses, sheep, deer, antelope, and cows is meant to simulate the mammoth steppe, minus mammoths and other lost megafauna.

On the prowl for major funding, Nikita showed his father's touch for schmoozing at the American Geophysical Union meeting in San Francisco, California, last December, treating colleagues to a party in his hotel room featuring Siberian vodka and beer chilling in an ice-filled bathtub. The many Arctic scientists who flock to Chersky bring dollars and euros that could help sustain the station and Pleistocene Park.

But running NESS is more rollercoaster ride than party. One day in early July, Nikita took a dozen visiting graduate students waterskiing on the Kolyma River in a dilapidated motorboat, with techno music blasting from a portable stereo. The next day came a cluster bomb of lows. The person who maintains an atmospheric sensing tower told Nikita he intended to quit; plant samples that visiting German botanists wanted to bring home were 160 kilograms too heavy, and sure to create a hassle at the airport; and a moose calf for which Nikita had paid $500 escaped after jumping a makeshift pen that Sergey had built. "I told him that he should hire a carpenter, but no, he insisted he would do it himself," Nikita says. He watches his father, wearing a mosquito head net with a hole at mouth level for an ever-present cigarette, head off on an all-terrain vehicle in search of the stray calf.

"He is stubborn," Nikita says with a shrug. "And I am stubborn." ■

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