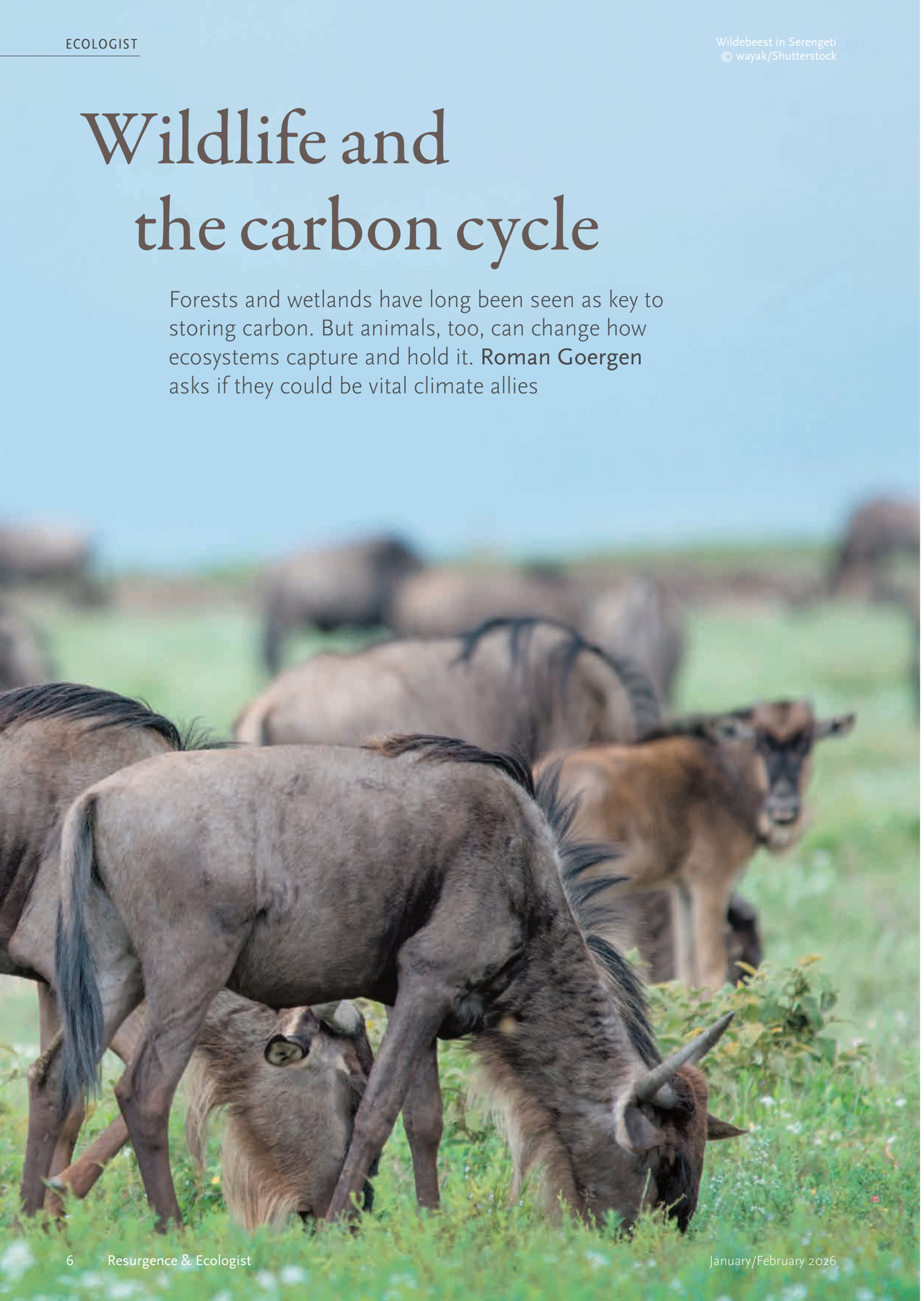

Wildebeest in Serengeti
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Wildlife and the carbon cycle

Forests and wetlands have long been seen as key to storing carbon. But animals, too, can change how ecosystems capture and hold it. **Roman Goergen** asks if they could be vital climate allies

From a wooden transport box comes the restless snorting of a wild animal. Carefully, members of Rewilding Portugal and the European Bison Conservation Center climb onto the roof of the container, set in a clearing of the Côa Valley, a tributary landscape of the Douro. With firm pulls they raise the sliding gate. The animal inside – a young bull bison – has to step backwards, hesitates for a moment, and then turns and walks slowly but firmly into the open land.

This happened in the spring of 2024. For the first time in centuries, bison once again live in Portugal. Eight of these long-endangered giants were released on the Herdade do Vale Feitoso estate in the country's north-east.

"We are viewing this translocation as a pilot," explains Rewilding Portugal team leader Pedro Prata. "The bison will be closely monitored to see how they acclimatise to the local landscape and climate," he says. "This is the first time that the Rewilding Portugal team have managed bison, so it's a learning process for us too. Members of the team will receive training in bison management." Their return is part of a broader initiative to transform the Greater Côa Valley into a 120,000-hectare wildlife corridor.

Since 2019, semi-wild Sorraia horses have grazed these hills, keeping vegetation low in a region prone to summer wildfires. More recently, hardy Tauros cattle – modern proxies for the extinct aurochs – have joined them, browsing tough shrubs and shaping a patchwork of grass and open woodland. Hooves loosen crusted soils, so rain can infiltrate; dung feeds soil life; seeds move in coats and guts. The aim is to restore ecological function and diversity; any carbon benefit is a co-product of a working landscape.

Oswald Schmitz, an ecologist at Yale School of the Environment, has long studied these links between wildlife and the carbon cycle. His core message sounds obvious: "Animals influence vegetation. And when vegetation stores carbon, then animals can also influence carbon storage." As simple as this statement may sound, it carries far-reaching consequences: it could reshape how scientists calculate and plan for climate goals. Until recently, climate strategies focused almost entirely on forests, wetlands and soils. Animals were treated as marginal. Schmitz and a growing circle of researchers now describe them instead as hidden drivers of the carbon cycle, capable of altering how much carbon ecosystems can take in and hold.

Schmitz often points to a story from East Africa for inspiration. When the rinderpest virus decimated the Serengeti's wildebeest in the early 20th century, uneaten grasses dried into tinder, fuelling huge wildfires that released carbon skyward. Once the wildebeest rebounded, the fires died down and carbon remained locked in soils. "It shows how animals and plants together create a cycle that allows ecosystems to absorb and hold carbon," says Schmitz, who drew on this story in developing his research. Similar principles underpin the work in Portugal: grazing, trampling, and seed dispersal all help ecosystems recycle nutrients and stabilise carbon.

Yellowstone National Park in the United States provides another example. Wolves were reintroduced there in 1995 after a 70-year absence. By hunting elk and altering their behaviour, wolves allowed willows (*Salix*) and cottonwoods (*Populus*) along streams to recover. This in turn created space for beavers, whose dams slowed water flow and trapped organic matter. A recent study led by Professor William Ripple of Oregon State University measured a 1,500% increase in willow canopy volume between 2001 and 2020. Researchers describe this as a classic 'trophic cascade' – an ecological domino effect triggered when a key species at the top of the food chain disappears or returns. While some scientists have debated the extent and mechanisms of these changes, the recovery of riparian vegetation following wolf reintroduction is widely documented. Ripple concludes that wolves helped reduce browsing pressure, but stresses that trophic cascades are dynamic, not linear. "Restored streamside vegetation and beaver wetlands are also storing carbon in soils," he notes, showing how predator return ripples outwards into climate benefits.

> "Animals and plants together create a cycle that allows ecosystems to absorb and hold carbon"

Yet cascades can also unravel. In False Bay on South Africa's Cape coast, white sharks – long the apex predators – have nearly vanished. Their disappearance unleashed mid-level predators such as Cape fur seals and sevengill sharks. With fewer constraints, these mesopredators expanded their range and feeding pressure, destabilising the marine food web. "Top predators like white sharks play a stabilising role in marine ecosystems," explains marine ecologist Neil Hammerschlag, lead author of a study on False Bay's food web. "The system's collapse after their decline shows that their ecological influence goes far beyond direct predation – they shape the structure, resilience, and function of the entire food web." He adds that shifts in herbivorous fish numbers can also alter kelp forests, seagrass meadows, and algal beds – important carbon sinks in the oceans.

The climate stakes are close at hand. Schmitz warns that even if humanity reached net-zero emissions tomorrow, the planet would still warm by about two degrees Celsius. That is because some 460 to 500 billion tonnes of CO_2 already linger in the atmosphere. His team calculates that at least 5.6 billion tonnes must be removed every year until 2100. "Other researchers

propose technological fixes," he says, "but we want Nature back in play." Direct air capture and enhanced weathering remain costly and unproven at scale. By contrast, ecosystems animated by animals are an overlooked natural pathway for drawing carbon back down. Yet despite this potential, animals barely appear in the major UN climate models, long dismissed as negligible because they make up only a fraction of global biomass.

This is where new models come in. Schmitz and the Global Rewilding Alliance have developed the Yale/GRA ACC model – ACC standing for Animating the Carbon Cycle. It accounts not only for vegetation growth, but also for how herbivores and predators shape nutrient flows, soil structure, and even fire regimes. One case study comes from Romania's Southern Carpathians, where a herd of bison was reintroduced to the Tarcu Mountains. By comparing areas with and without bison, researchers estimated that soils in bison range stored 1.6 to 2 times more carbon. Independent experiments in the Czech Republic found similar results with bison and Exmoor ponies, showing higher soil carbon and water retention after only six years. These findings suggest that rewilding large herbivores can quickly amplify the climate functions of ecosystems.

The Global Rewilding Alliance is now testing similar models with elephants in the Congo Basin and jaguars in Argentina, seeking proof that animals can boost carbon storage across biomes. Alliance director Magnus Sylvén stresses: "The biggest challenge is to test and validate the model predictions with real field measurements. The approach would provide reliable metrics of performance – that can be used to verify investment return – as part of a longer-term monitoring of carbon capture in the target ecosystems."

Not everyone is convinced. In the journal *Nature*, Ethan Duvall of Cornell University and Andrew Abraham of Aarhus University warn against what they call the "carbonisation" of animals. The problem, they argue, is that every step – from population counts to soil measurements – adds uncertainty. Rewilding, they note, also moves too slowly to deliver within the narrow window of climate action. And reducing animals to carbon units risks sidelining their many other ecological roles. Andrew Abraham stresses: "Our fixation on carbon is warranted due to the urgency of climate change, but it's imperative that we don't distil the value of living species only to their ability to sequester our waste carbon emissions."

Schmitz responds directly to such criticism. "We are already relying on natural solutions like forests," he says. "A forest also takes a long time to grow before it captures large amounts of carbon. The same logic applies to animals: their effects may take time, but they can be measurable even within a few years, as shown in the Czech grazing study where carbon storage rose after just six years."

Jens-Christian Svenning, director of the ECONOVO (Center for Ecological Dynamics in a Novel Biosphere) at Aarhus University in Denmark, urges a balance: "Animals should not be reduced to carbon units," he says. "Their ecological roles are diverse, and their worth cannot be measured by carbon flows alone."

But even the critical voices recognise the wider ecological value of rewilding. As Prata in Portugal puts it: "There are no silver bullets. Rewilding and reanimating the carbon cycle are part of the answer, but we must also decarbonise our cities and economies. It all has to happen in parallel." R

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Beaver ponds in Yellowstone National Park
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"Don't lose hope. If you lose hope, you become apathetic and do nothing. And if you want to save what is still beautiful in this world – if you want to save the planet for the future generations, your grandchildren, their grandchildren – then think about the actions you take each day."

Jane Goodall