UC SANTA BARBARA

THE Current

October 25, 2021
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The Circle of Life

Big animals have a big impact on the environment. Whales, elephants, bison: They're the movers and shakers of their ecosystems. But what happens when they die?

An international team of researchers, led by professors at UC Santa Barbara, will investigate how these animals' carcasses affect their ecosystems. With a three-year grant totaling more than $1.3 million, they will survey Kruger National Park in South Africa, studying the impact of elephant carcasses on the landscape.

"People focus on the role of big animals in ecosystems for obvious reasons. But almost everybody focuses on the role these animals play while they're alive; their role once they're dead is really underappreciated," said Deron Burkepile, an ecology professor at UC Santa Barbara and the project's principal investigator.

Kruger National Park is about the area of Massachusetts, and among the largest reserves in Africa. Rangers patrol sections of the park and record elephant carcasses, marking the locations with GPS coordinates. They've amassed around 30 years of data so far.

In summer 2022, the research team will survey the park by helicopter with the goal of finding 50 carcasses of varying ages in areas with different rain patterns and soil regimes. They'll begin collecting data the following year to build up their understanding of the communities and conditions around an elephant carcass.

The scientists will sample the soil for nutrients and microbial activity, the plants growing around the body, the bone from the remains themselves, and any animal scat around each site. They also plan to survey the plant and herbivore communities around the site of each carcass. The team will repeat all the surveys and sampling at a control area about 50 meters away from each carcass.

What's more, the park staff tallies a census of the number and distribution of live elephants on a yearly basis. The scientists also have a good estimate of the animals' annual mortality rate. With these data, the team can develop a simple model of how many carcasses there should be and where they may be clustered. They can then combine the insights from their fieldwork with the information from the census to create a model showing how elephant carcasses impact the Kruger ecosystem at the landscape scale.

Kruger National Park graphic

Kruger National Park encompasses the extreme Northwest of South Africa. It contains low fertility granite sand soils and higher quality basalt clay soils, with varying rainfall.

Photo Credit: NATE LEMOINE

In addition to the researchers at UCSB, the project will include scientists from Utah State University, Marquette University, South African National Parks, and the South African Environment Observation Network. "This research is really only possible because we're working with people on the ground: The scientists in South Africa in Kruger National Park that have been compiling these data on elephant carcasses," Burkepile said.

The landscape of Kruger National Park is relatively flat, and its soils are quite old. "They've been sitting there exposed — leaching nutrients, weathering and developing for millennia without having enough erosion to bring new resources to the surface," explained UC Santa Barbara soil scientist Joshua Schimel, who is a co-principal investigator on the project. As a result, the soils are quite nutrient poor.

"A dead elephant is, essentially, one heaping pile of fertilizer," he continued. In fact, it's not too different from fortifying a garden. "Bone meal is a standard substance used as an organic fertilizer in a vegetable garden. Bloodmeal for nitrogen and bone meal for phosphorous."

After an elephant dies, there’s a huge influx of organic carbon, nitrogen and phosphorous as a result of scavenger activity and the decomposition of soft tissues. Despite the flood of nutrients, the site of a fresh elephant carcass can be barren for some time. Scavengers rip up existing vegetation and high levels of nutrients prevent plants from reestablishing.

The influx of nitrogen is actually so intense that it likely makes the area uninhabitable for plants in the short term. “It’s just like when we put too much fertilizer on our tomatoes,” Burkepile said. “Those tomato plants burn. We imagine the same thing would be happening around really fresh elephant carcasses.”

In contrast, the carcass is a windfall for the soil microbiota. “Microbes get first dibs on almost everything,” Burkepile remarked. The researchers anticipate seeing a spike in microbial respiration as the soil bugs feast on the glut of organic carbon and nitrogen. Then, as some of the nitrogen is processed, they expect to see plants recolonize the area.

Nutrient cycle illustration

Nutrients cycle from the carcass, into the soil, and eventually into plants, the herbivores that eat them, and the predators that eat the herbivores.

Photo Credit: NATE LEMOINE

A carcass actually contains two pools of phosphorus, the researchers explained. Molecules like DNA and ATP in soft tissues will release a quick pulse of the element as the animal decays. Meanwhile, the phosphorous in teeth and bones takes much longer to break down, leading to a more sustained release.

Burkepile expects to see a surge in plant biomass three to four years after the animal’s death, with a peak around five years, once the nitrogen toxicity has declined and phosphorus has begun percolating into the soil. At this point, the process will likely begin affecting the local wildlife directly, especially herbivores.

The extra nutritious patch of land may well attract herbivores from all around, fostering a thriving community. As animals graze and hunt, eat and excrete, they spread seeds and aggregate nutrients from other parts of the savannah. This could then create a feedback loop where elephants frequent these spots to feed, potentially fostering these patches when they ultimately die, Schimel proposed.

As Burkepile put it: “The legacies of these animals don’t stop when they die.”

About UC Santa Barbara

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