The crucial role of scavengers in ecosystem health

openaccessgovernment.org/article/the-crucial-role-of-scavengers-in-ecosystem-health/168487

19 October 2023

Animal scavengers' role in maintaining ecosystem balance is often overlooked. Dr Laurel Lynch from the University of Idaho tells us about her important research on how scavenging by Tasmanian devils influences ecosystem processes

Scavenger declines impact ecosystem function

Declines in biodiversity threaten the function of ecosystems worldwide. Species populations have declined by ~68% globally since 1970, and humans and their livestock now account for ~97% of Earth's biomass.

Declines of top predators and scavengers are of particular concern because their loss can have devastating impacts on ecological and economic services, including secondary declines of other species, increases in disease spread, and changes in nutrient cycling that can affect food production. However, more research is needed to understand how the complex interactions among species and their environment produce the balanced, well-functioning ecosystems upon which humans depend.

Embedding scavengers in an ecosystem framework

Ecosystem ecology is uniquely suited to fill this gap because it traces how energy and nutrients flow between living and nonliving components of an ecosystem. At the most basic level, energy enters an ecosystem through photosynthesis to generate plant biomass.

When plants die, microbes break down the dead biomass, releasing carbon back into the atmosphere and converting stored nutrients into forms that can be readily used by living plants and microbes. While ecosystem models are well-calibrated for tracking the flow of energy and nutrients between plants, soils, and the atmosphere, they often miss animals, which transfer energy through herbivory, predation, and scavenging.

Animal scavengers play a critical, but often overlooked role in redistributing energy and nutrients within an ecosystem. They accelerate carrion decomposition by consuming flesh and exposing tissues to microbial and invertebrate decomposers, which in turn convert complex, animal-derived organic matter back into the simple compounds used by plants and microbes.

Carcasses can also become central arenas for interactions among scavengers that span the animal kingdom; it remains a mystery if these interactions affect ecosystem productivity.

Integrating the activity of scavenger communities in an ecosystem framework remains challenging.

This is partly due to historical siloing among biological disciplines, where community ecologists focused on scavenger abundance and behaviour, and ecosystem ecologists focused on broad-scale energy and nutrient cycling.

Pressing threats to biodiversity catalyses ambitious research that bridges these disciplines, but selecting a suitable study system remains challenging. Fortunately, the perfect set of conditions has aligned in Tasmania, Australia, surrounding the unfortunate decline of the island's top predator and scavenger.

Diseases can reorganise scavenger communities

Devil facial tumour disease (DFTD) was detected among Tasmanian devil populations in the mid-1990s. DTFD is a novel, transmissible cancer that spreads among individuals mainly through biting, and produces disfiguring tumours that almost invariably kill individuals. Seminal work by Dr. Menna Jones and others has tracked the spread of DFTD from east to west across the island. Devil populations that were infected first have declined to about 10% of their original density.

In the northwest, populations have only been recently infected, and are likely to crash within the next decade. The resulting population density gradient offers a rare, natural experiment to test how the loss of an apex scavenger influences ecosystem function.

Tasmanian devils also happen to be particularly interesting scavengers. They are only one of a few osteophages worldwide, which means they can consume and break down bone material. Bones are rich in calcium, phosphorus, and other mineral elements that are typically present at very low levels in soils but are vital for plant and microbial growth.

For instance, phosphorus is used to build DNA and proteins, providing energy for biological processes. Calcium plays several key roles in belowground carbon cycling and regulates stomatal activity, allowing plants to balance carbon fixation rates with water loss. The bone-crunching activity of devils may, therefore, sustain the health and productivity of Tasmanian forests.

Maintaining a delicate balance

To investigate how scavenging by devils influences ecosystem processes, our research team established four focal research sites spanning the devil density gradient. Using footage from remote wildlife cameras, our team of community ecologists – led by postdoctoral researcher Dr Savannah Bartel and her research mentors Drs Dave Crowder, Andrew Storfer, and

Menna Jones – showcase adult Tasmanian devils as extremely efficient scavengers. Under the right conditions, one devil can consume an entire carcass (bones and all) nearly their body weight in size, in a single sitting!

The mere presence of devils also alters the behaviour of mesoscavengers – less-dominant species that are typically outcompeted by top scavengers like the devil – by making them more vigilant. Mesoscavengers are also less efficient than devils and leave behind the hide and skeleton of carrion. Under natural weathering conditions, it could take decades for the mineral resources locked up in bone material to be made available for plant and microbial use. Removing devils from the ecosystem could thus increase resource limitation for plants, the energetic foundation of food webs.

Interestingly, the delivery of nutrients from the carcass to soil was greatest when invertebrates monopolised carcasses. Invertebrates increased soil nitrogen concentrations directly below the soil by up to 500%, drastically altering the soil microbiome. Together with Dr Michael Strickland, we found that rapidly growing bacteria capitalised on the influx of carcass- derived nutrients, outcompeting slower-growing taxa and fungi. These findings have implications for how efficiently resources are cycled belowground.

Tasmanian devil research priorities

Finally, we are working to trace the effect of Tasmanian devil declines on the productivity of Tasmania's iconic eucalyptus forests. Drs Tara Hudiburg and Justin Mathias are cross-dating over 200 wood increment cores collected across the Tasmanian devil population density gradient to reconstruct climate over the past 100 years.

We will also measure calcium and phosphorus concentrations in the tree rings to quantify scavenger impacts on tree growth. Ultimately, we will use a series of modelling experiments to forecast how future climate and scavenging scenarios may impact forest function and resilience to novel climate conditions.

Happily, new research suggests devils are no longer at dire risk of extinction from DFTD. Massive conservation efforts and successful captive breeding programs offer a hopeful pathway forward for other at-risk species. We hope shedding light on the unique role scavengers play will prioritise their protection and help maintain ecosystem resilience into the future.

Funding for this work was generously provided by the United States National Science Foundation (DEB-205471).