I BET YOU DIDN'T KNOW...

About biodiversity and trophic cascades

Paul Tyler,
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Populations of some of the world's largest carnivores are declining to such an extent that it is having a damaging effect on *biodiversity* in their *ecosystems* (Figure1).

Figure 1. Nearly all wild lions live in Africa below the Sahara Desert. Lions eat birds, hares, turtles, mice and much larger animals such as antelopes, cheetahs, baby elephants and even tall giraffes.

Large carnivores such as lions, leopards, hyenas and wild dogs are the *apex predators* in their *ecosystems*. If they were removed, then the populations of *herbivores* that they hunted would have nothing to control their numbers, they would become less fearful and start to occupy new habitats. This can lead to potentially damaging changes in *biodiversity* in ecosystems.

Research scientists were interested in studying the effects of removing the apex predators in an ecosystem on the behaviour of the herbivores that would normally have been their prey. They were also interested in the knock-on effect on plant life in the ecosystem and whether they could reverse the effect through targeted *rewilding*.

The Mozambique Case Study

Opportunities to study whole ecosystem changes do not come around very often; the researchers in a recent study focused on what happened in Mozambique's Gorongosa National Park following the Mozambican Civil War (1977–1992). During the civil war, large mammal populations declined by more than 90% with leopards, hyenas and wild dogs being wiped out and the lion population being severely reduced.

The research team took advantage of the carnivore-depleted system to study the behaviour of the bushbuck antelope (Figure 2). The bushbuck is normally a closed habitat feeder, which means it likes areas with lots of plant cover to help it hide from predators. It is not normally found in the open floodplains where there is very little plant cover to hide it. Following the removal of the apex predators, the bushbucks were observed feeding freely in open landscapes on the Urema floodplains – this behaviour had not been observed pre-war (Figure 3).

Figure 2. A bushbuck antelope.

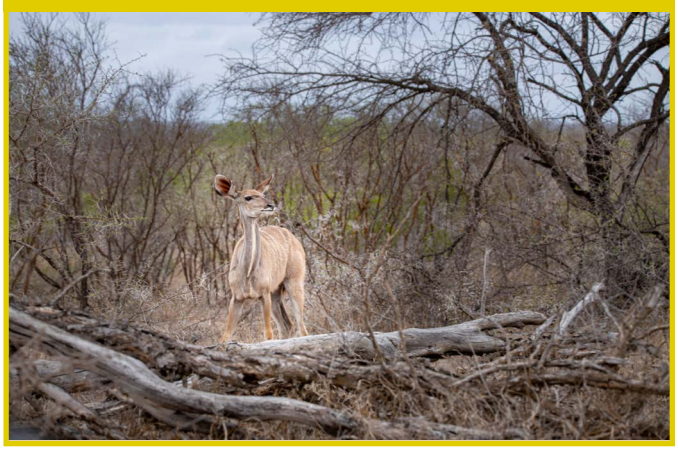


Figure 3. Aerial view of the Urema flood plain.

Map data © 2020 Google Maps.

Data was collected using the satellite-based global positioning system (GPS) to monitor the bushbucks' movements, wildlife counts in specific areas, and DNA analysis of their diets to see what they had been eating. This data allowed the researchers to build up a picture of the bushbucks' changing habits in response to the lack of predators.

Clear evidence was found showing that, once the threat of predation was removed, the bushbucks were moving into the open floodplain areas to feed on the more abundant, and nutritious, plant growth found there. One consequence of the change in diet was that the floodplain bushbucks were in better condition and consistently larger than their woodland feeding counterparts.

The researchers studied the effect on plant growth caused by the change in bushbuck behaviour. They caged off some of the plants in the floodplains so the bushbuck could not eat them and they monitored the size of various plants against the control ones. They observed an increase in 'browsed stems' (stems which have been eaten) in the uncaged plants and a decrease in the number of flowers and leaves as well as a lower average height of the plants. The study showed that even in a relatively short amount of time, the bushbucks were having a significant effect on an ecosystem that they usually did not inhabit.

The final part of the study involved observing how the bushbucks would react to the reintroduction of predators into the ecosystem. This was done by simulating predator presence and monitoring the bushbucks using GPS trackers. The research team used recordings of the predator calls, sprayed areas with their scent, put down artificial lion scat (animal droppings) and carnivore urine to mimic the presence of predators in the area. They also set up a control experiment using generic white noise and herbivore urine and dung. The results from the two different areas were able to be directly compared.

The bushbucks strongly avoided all the predator signs but ignored the herbivore signs and the white noise. Scientists also monitored the plants in both areas and found that plants in the areas the bushbucks avoided showed rapid regrowth compared to in the areas where the bushbuck continued to feed.

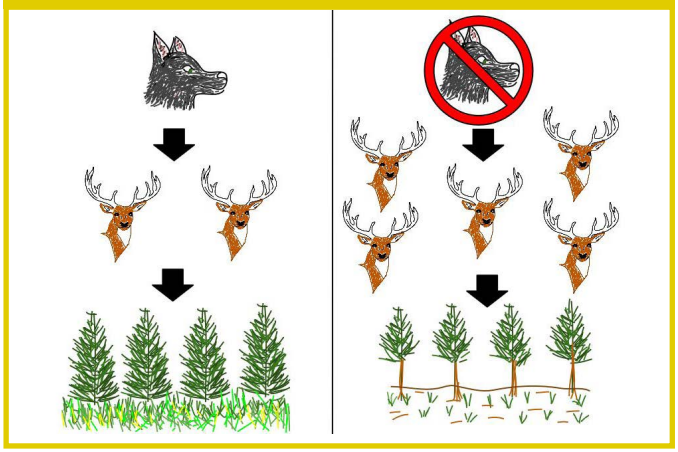
This evidence shows that the bushbucks retain their natural instincts and fear of predators. They revert to their pre-war behaviour whenever the threat of predation is present. The next phase of the research is to reintroduce wild dogs into the National Park and monitor the bushbucks' behaviour. The hypothesis is that they will vacate the floodplains and return to feeding in the more densely covered woodland areas.

Why are trophic cascades important?

It was always thought that if *apex predator* numbers in an ecosystem were reduced, then the numbers of the organisms in the *trophic levels* below would increase and there would be a net benefit to the biodiversity of the system. This was part of the reasoning behind hunting wolves to extinction in Yellowstone National Park in the USA, culling magpies in the UK, and hunting whales in the Pacific Ocean to increase fish stocks.

What American zoologist Robert Paine found in his research, culminating in the 1980s, was the opposite. Eradicating the apex predators led to a decrease in the number of species thriving in the ecosystem and in many cases caused irreparable damage. He coined the term 'trophic cascade' to describe the changes in ecosystems when populations of apex predators are changed, most often by human interference; for example, the wolves in Yellowstone National Park (Figure 4). The Teacher Guide that accompanies this article explain how the biodiversity of their ecosystems was changed.

Figure 4. Trophic cascades describe more complex relationships than a simple food chain, or web. They describe the importance of every trophic level in the ecosystem to the success of it.



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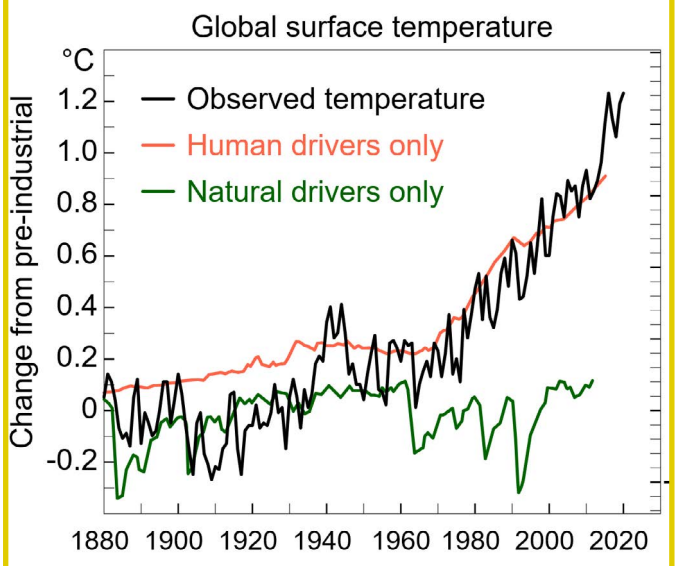
Top-down trophic cascades explain the importance of apex predators in ecosystems for ensuring that every organism, at every trophic level, thrives.

So why does rewilding matter?

In the 200,000 years since human beings have existed, they have had a greater impact on Earth's ecosystems than any other species; they are the 'ultimate ecosystem engineers'. This impact has accelerated rapidly in the last 200 years since the industrial revolution and it has mostly been negative (Figure 5).

Figure 5. The graph shows the change in global temperature (observed by NASA) against the 1850-1900 average as a pre-industrial baseline. The red line shows that the main driver for the temperature rise over the last 150 years is human activity.



Deforestation, species extinctions, natural resource exploitation and fossil fuel use have all increased almost dramatically. Unfortunately, most of this has happened without a real understanding of the impact. Ecosystems are very finely balanced, and the slightest human interaction can be the trigger for the rapid decline of biodiversity and functional species interactions.

Rewilding is simply a way of trying to return ecosystems to their pre-human interaction states by letting nature find the right balance at each trophic level. Each ecosystem is different, and cases need to be considered on their own merits but, so far, rewilding projects round the world have shown great potential in increasing biodiversity that had been adversely affected.

GLOSSARY

apex predator
top predator in an ecosystem

biodiversity
the number of different species found in an ecosystem

ecosystem
a community of living things (e.g. animals and plants) in a habitat, together with the non-living parts of the environment (e.g. air and water)

ecosystem engineer
animal that alters the ecosystem in a specific way to create habitats for other species

habitat
the place that an animal or plant lives, providing all essentials for life

rewilding
the act of introducing specific species back into an ecosystem that they once inhabited

trophic cascade
the indirect effect of changes to apex predator and herbivore populations on levels of plant life

trophic levels
the stages in a food chain

The paper that inspired this work was:

Cascading impacts of large-carnivore extirpation in an African ecosystem .

By Justine L. Atkins[1], Ryan A. Long[2], Johan Pansu[1,3,4], Joshua H. Daskin[1], Arjun B. Potter[1], Marc E. Stalmans[5], Corina E. Tarnita[1], Robert M. Pringle[1].

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