Loss of large predators tips ecosystem balance, according to study

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John DeLong, assistant professor of biological sciences

A new study has linked the size of predators atop a food chain with the ecological chain reaction triggered when they leave the head of the table.

The conclusion: The larger they are, the harder that their fall impacts an ecosystem.

Led by UNL ecologist John DeLong, the study suggests that an ecosystem's plants, algae and bacteria—its so-called primary

producers—are more strongly affected by the loss of large predators than smaller ones.

Though ecologists have studied the ripple effects of these "trophic cascades" for several decades, DeLong said, they have mostly ignored how body size might shape their dynamics.

"Previously, there was no real answer to the question of whether losing wolves and lions should really be any different than losing foxes or weasels in terms of consequences for an ecosystem," said DeLong, assistant professor of biological sciences. "Big species are already rare, but certainly we're losing a lot of the bigger carnivores globally."

A basic three-level food chain typically consists of carnivorous predators, herbivorous consumers and the primary producers, which ultimately help feed every higher-level organism in an ecosystem.

DeLong and his colleagues devised a model that explains the influence of predator size by connecting it to the size and dietary behavior of the consumers that represent their food source.

The authors proposed that the dietary needs of both predators and consumers rise in tandem with their size. Large predators consequently prey on large consumers, which in turn eat greater proportions of primary producers, according to the model.

"There are links between the sizes of (organisms) in the food chain," DeLong said. "Wolves eat moose and deer. Each individual moose is going to eat a lot more vegetation than an individual rabbit, so that link is stronger."

As a result, losing a large predator may substantially reduce the primary producers in an ecosystem by essentially giving consumers free reign to

feast on them.

Calculating the potential ecological cost of a predator's loss, DeLong said, then comes down to examining the interactions between consumers and producers. When the former consume relatively little of the latter, the absence of a large predator may not significantly influence the ecosystem.

Yet the fact that many ecosystems exhibit consistent size structure—with predator and consumer growth rates remaining in sync throughout the life cycle—means that a large carnivore often leaves behind sizable herbivores capable of depleting an ecosystem's vegetation.

This size-structure condition applied in both case studies performed by the researchers: one featuring a hypothetical food chain with prototypical parameters, the other a food chain consisting of single-cell protists and algae.

The model's ability to explore these disparate scenarios illustrates its versatility, DeLong said. By relating the body size effects of one food chain level to that of another, he said, the model can standardize outcomes and compare the dynamics of a large-scale ecosystem with a smaller-scale counterpart.

Though the results of both case studies aligned with the team's expectations, DeLong said he is interested in extending the model beyond the standard ecosystems examined therein.

"Not every system has such strong size structure," DeLong said. "We really need to ask that question: If you take the size structure away, do you take away this whole phenomenon, or does it remain? We need to challenge this model with some more data in new ways."

For now, however, DeLong said he sees the model's simplicity as a benefit to others interested in examining predator-prey dynamics.

"By taking things hierarchically and trying to put out a general model, anybody who's interested in trophic cascades may be able to use that more general observation as a useful starting point," DeLong said.

The answers to such questions are increasingly important, DeLong said, as human-driven forces accelerate and expand threats to even the largest of predators.

"People are very concerned about the consequences of losing species," DeLong said. "It's been happening for a long time, but it wasn't until modern ecology came along that we could sort of connect these dots. We're now at a place where we can understand what happens to the rest of the puzzle when we start losing its pieces."

The authors' study appeared in the March edition of the *American Naturalist*. DeLong co-authored the study with 13 researchers from the United States, Canada, England, Germany and Switzerland.

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