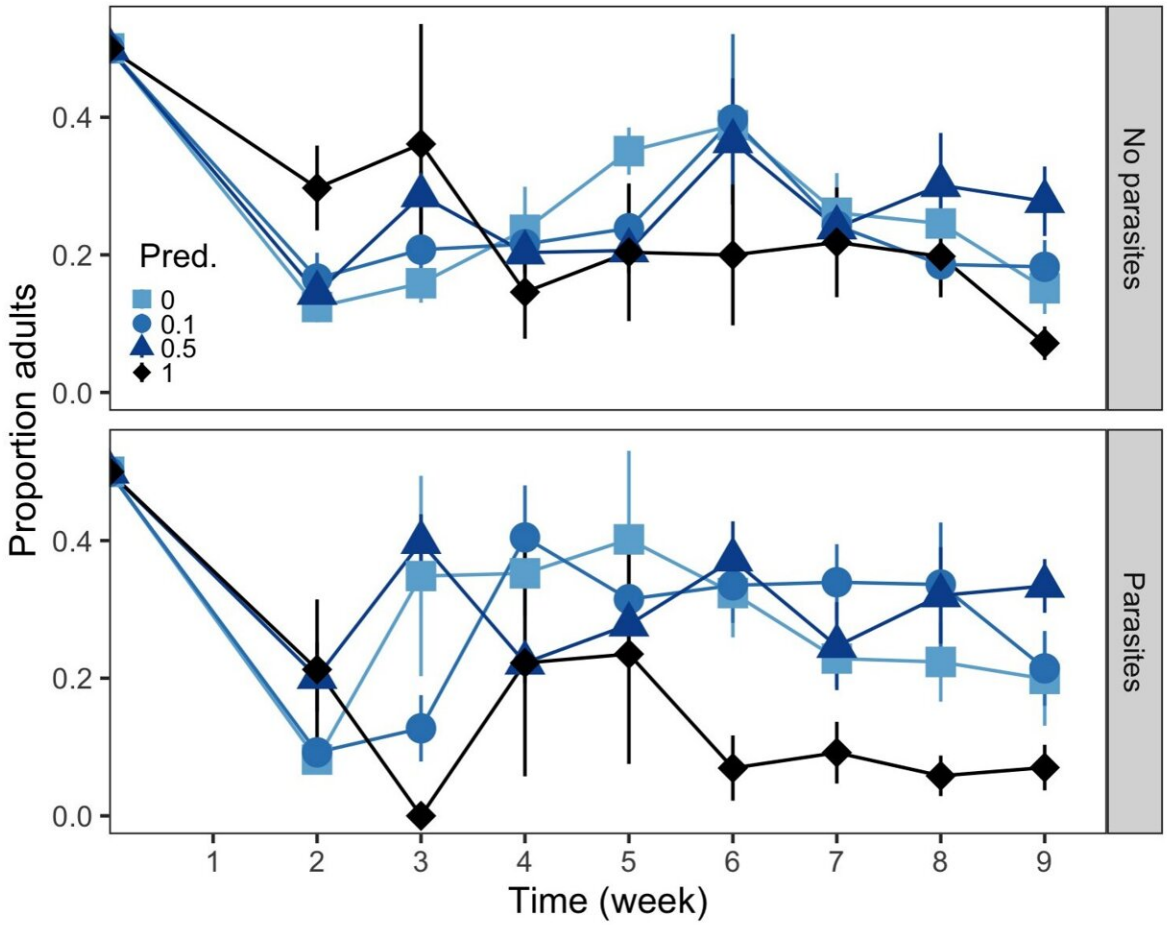
A healthy but depleted herd: Predators decrease prey disease levels but also population size, study finds

April 26 2023



Stage structure of the populations varied over time. Populations that experienced high mortality (e.g., the highest predation treatment in the + parasite treatment) were dominated by juveniles. Credit: *Ecology* (2023). DOI: 10.1002/ecy.4063

Nature documentaries will tell you that lions, cheetahs, wolves and other top predators target the weakest or slowest animals and that this culling benefits prey herds, whether it's antelope in Africa or elk in Wyoming.

This idea has been widely accepted by biologists for many years and was formalized in 2003 as the healthy herds hypothesis. It proposes that predators can help prey populations by picking off the sick and injured and leaving healthy, strong animals to reproduce.

The healthy herds hypothesis has even been used to suggest that manipulating predator numbers to protect prey might be a useful conservation strategy. Even so, hard evidence supporting the hypothesis is scarce, and in recent years many of its assumptions and predictions have been questioned.

In a study published online April 26 in the journal *Ecology*, a University of Michigan-led research team used a pint-sized predator-prey-parasite system inside 20-gallon water tanks to test the healthy herds hypothesis.

Their study system consisted of predatory fly larvae that feed on the water flea Daphnia dentifera, which hosts a virulent fungal parasite.

The researchers found that while high predation levels reduced parasitism in Daphnia—providing partial support for the healthy herds hypothesis—populations of those poppy seed-sized crustaceans were often dramatically reduced, as well. In some cases, Daphnia populations were nearly wiped out by predation.

The findings may have implications for conservation efforts involving much larger animals, according to the study authors. Specifically, the results suggest that caution is warranted when wildlife managers

manipulate predator numbers in the hopes of promoting healthy herds of prey.

"The appeal of the healthy herds hypothesis lies in the alignment of multiple conservation goals—simultaneous conservation of predators, reduction of parasitism, and protection of vulnerable populations—as well as the potential to reduce spillover risk to other populations, including humans," said U-M aquatic and disease ecologist Meghan Duffy.

"But even when predators reduce disease in their prey populations, that does not necessarily lead to increased prey population size, as our study shows," said Duffy, senior author of the new study and a professor in the U-M Department of Ecology and Evolutionary Biology.

One well-known example of "healthy herds" gone wrong involves the culling of badgers in the United Kingdom in an effort to reduce bovine tuberculosis in livestock. In that case, the culling can be viewed as a particularly efficient form of predation by humans.

The assumption behind those campaigns was that higher predation of badgers, which are a wildlife reservoir of bovine tuberculosis, would drive healthy livestock herds. Instead, the campaigns increased bovine tuberculosis in cattle. In another example, the culling of bats to reduce the spread of rabies has not been effective at reducing rabies in domestic dogs or wildlife.

Findings of the new study, and others like it, could help explain why some attempts to control disease by manipulating predators fail, according to the authors.

"Unless we develop a more comprehensive understanding of when and how predators influence disease, management strategies that propose to

reintroduce or augment predator populations could backfire," said study lead author Laura Lopez, a former postdoctoral researcher in Duffy's lab who now works for the National Centre for Immunisation Research and Surveillance in Australia.

Duffy has used Daphnia as a model organism to investigate the causes and consequences of infectious disease outbreaks for nearly 20 years—work that has included several studies of the healthy herds hypothesis.

For the latest study, the researchers experimentally manipulated the density of a predator in their three-organism study system, then monitored Daphnia population sizes and infection levels.

The predators were larvae of the phantom midge, which commonly prey on Daphnia in North American temperate lakes. The parasite was the virulent fungus Metschnikowia bicuspidata.

The predator-prey-parasite interactions occurred inside 48 experimental water tanks called mesocosms, which also contained nutrients and green algae.

At the highest levels, predation completely eliminated the fungal pathogen. However, the highest predation levels often dramatically reduced Daphnia population sizes, as well—an outcome that does not support the healthy herds hypothesis.

"If your primary concern is the overall population size of a vulnerable animal species, then adding high levels of predation that eliminate disease could be detrimental," Duffy said.

"Interestingly, intermediate predation levels reduced parasitism in our study without incurring a cost in terms of overall prey density. Any

management decisions would need to weigh the potential costs and benefits associated with increasing predation."

The authors of the *Ecology* study warned that achieving and maintaining a predation level that reduces parasitism without harming prey population size "might be equivalent to threading the proverbial needle."

More information: Laura K. Lopez et al, A healthy but depleted herd: Predators decrease prey disease and density, *Ecology* (2023). DOI: 10.1002/ecy.4063

Provided by University of Michigan