Creatures of influence: New model identifies critical species in food webs and social networks

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In the children's game "Jenga", removing the wrong block from a tower of wooden blocks can cause the entire tower to collapse. In the same way, removing certain species from an ecosystem can cause a collapse in ecological function. A common scientific question has been to identify these critical species in different ecosystems and an international research team has developed mathematical tools that can estimate which species are most influential in a food web.

The researchers from the University of Bristol, the Max Planck Institute for Physics of Complex Systems and the US Geological Survey have taken a new modeling approach to the question. The team, using the new mathematical tools, found that long-lived, generalist top predators—such as otters— play the most influential roles within a food web. The findings are published today in *Proceedings of the Royal Society B*.

Helge Aufderheide of the Max Planck Institute and University of Bristol, who led the research, said: "The interactions in an ecosystem are so complex that one can often only guess about the roles that each species plays. Therefore, knowing how to find the key players makes all the difference for understanding where to focus studies."

Long-lived, generalist top predators can highly influence ecosystems because they feed on different types of prey that occupy different parts of the food web. For example, otters feed on a wide variety of aquatic

prey and can influence multiple species throughout the course of their relatively long lifespan. Removing otters from the ecosystem would cause long-term disruptions to all those species, a theory that the new models can now confirm for other species and ecosystems.

Understanding how the gain or loss of a single species affects a complex food web has been a difficult mathematical challenge, and the new findings provide fundamental insights into complex natural systems. The new study offers a rule of thumb to help other studies focus their research and data collection on species in order of their expected importance, and increase the efficiency of their research effort.

Kevin Lafferty, an author of the paper from USGS, said: "As a biologist who studies food webs, I'm hopeful that we can use this approach to help focus our field work."

The new approach has non-ecological applications as well. Even though the research team applied the computational tools on food webs, their approach also can be applied to other types of complex systems —from electricity grids to online social networks—to identify influential components.

More information: Predicting community responses in the face of imperfect knowledge and network complexity by Helge Aufderheide, Lars Rudolf, Thilo Gross, and Kevin D. Lafferty, *Proceedings of the Royal Society B*, 6 November 2013. rspb.royalsocietypublishing.or … .1098/rspb.2013.2355

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