Loss of Top Predators Has Far-Reaching Effects

By: Jenny Marder

Photo credit: Young aspen trees in Yellowstone National Park. Photo by William Ripple, courtesy of Oregon State University.

Sea otters eat sea urchins and sea urchins eat kelp. When sea otters are present, the coastal kelp forests maintain a healthy balance. But when the fur trade wiped out the otters in the Aleutian Islands in the 1990s, sea urchins grew wildly, devouring kelp, and the kelp forest collapsed, along with everything that depended on it. Fish populations declined. Bald eagles, which feed on fish, altered their food habits. Dwindled kelp supplies sucked up less carbon dioxide, and atmospheric carbon dioxide increased.

The animal that sits at the top of the food chain matters, and its loss has large, complex effects on the structure and function of its ecosystem, according to an article published on Thursday in the online issue of the journal, Science.

That the presence or loss of an ecosystem's top predator is linked to surges and crashes in the food chain is nothing new. The term for the phenomenon is "trophic cascade," and it's been applied to coastal sea otters, as well as the gray wolves in Yellowstone and the mountain lions in Zion National Park, to name just a few.

But what is new, authors of the paper say, is that this is ubiquitous across all ecosystems. "We see it on land, we see it on water, we see it in high latitudes, we see it in low latitudes," said

James Estes, a research scientist at the Institute for Marine Sciences at the University of California, Santa Cruz and the paper's lead author. "We do not not see it anywhere."

The paper says that ecosystems are built around "interaction webs" within which every species can influence many other species. And the full impact of the loss of a top predator cannot be fully understood until the species has disappeared, but once gone, its absence can have far-reaching effects on water quality, air quality, disease patterns and fires.

Among the examples cited in the paper: A rinderpest epidemic devastated the population of wildebeest in the Serengeti, resulting in a growth of woody plants, which has led to more frequent wildfires. The decline of lions and leopards in Africa has corresponded with changes in the behaviors of olive baboons, leading them to interact more with human food and farms, and most likely causing a rise in intestinal parasites.

The article is a synthesis of the work of more than 20 scientists, and an outgrowth of a symposium held at the White Oak Plantation, near Jacksonville, Fla. in 2008 to study the impacts of large predators across global systems. "At the end of the symposium, we were all sitting around, and there was just this overwhelming sense that there really is a message here that needs to be integrated and put out there," Estes said. "There was frustration that some of our colleagues didn't realize the importance of large consumers. So we said, 'let's get a collection of credible people from around the world, mostly senior people who have worked in a diversity of global ecosystems, and see what consensus they may have.'"

The team included theoreticians and scientists who study forest, marine and freshwater ecosystem ecology in North America, South America, Africa and Europe.

"It's not reporting on any new findings, but I would say its value is that it is a synthesis," said Matthew Kauffman, a professor at the University of Wyoming, who is not part of the study. "It's showing us that there are top-down effects of large predators and large herbivores among many different ecosystems, functioning in many different ways. It allows us to see the full scope of the value of having top predators in ecosystems."

William Ripple, professor of forestry at Oregon State University, and a co-author of the study, has studied the disappearance and reintroduction of gray wolves in Yellowstone, and the influence these events have had on the surrounding animals and plants. "We cored the trees, counted the tree rings and found that the aspen trees stopped regenerating after the wolves were killed off," he said. By connecting the dots, his team developed a hypothesis: aspen tree growth and wolves are linked. Without wolves as predators, elk populations thrived, eating seedlings and wiping out many of the young aspen trees.

Since the wolves were reintroduced to Yellowstone, some aspens, cottonwoods and willows appear to be growing back. Ripple believes this is because elk, which are fewer in number and more skittish when wolves are present, are eating fewer seedlings, allowing for more tree growth.

And it doesn't stop at the plants, Ripple said. The resurgence of the plants has corresponded with more insects, birds and beavers. The beavers dam up the streams and make ponds, altering the stream ecology and fish habitat.

Scientists don't all agree on these mechanisms. Kauffman's research, for example, found that the behavior of the elk has not changed significantly since the wolves returned. More important to new tree growth, he said, is that wolves are directly reducing the elk population through predation.

But most scientists do agree that the influence of the presence or absence of top predators is far reaching. "It's intuitive, it's very obvious, yet nobody wants to talk about it," said Paul Dayton, a professor of marine ecology at the Scripps Institution of Oceanography, who was not a part of the study. "People like me will give talks about it and wave our arms around. "But I've never seen all these ecosystems and identical patterns merged into one paper."

Estes says that there needs to be a "gross rethinking" of the way management decisions are made."

Dayton's hope is that the research will prompt land managers and conservationists to focus on species interactions, rather than extinctions. "Right now, we manage through the Endangered Species Act," he said. "And it's a horrible way to manage ecosystems. We're not managing them, we're trying to save little fragments in zoos. What we need to do is manage these interactions."