Species down, disease up: Study shows biodiversity loss drives human infections

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The extinction of plant and animal species can be likened to emptying a museum of its collection, or dumping a cabinet full of potential medicines into the trash, or replacing every local cuisine with McDonald's burgers.

But the decline of species and their habitats may not just make the world boring. New research now suggests it may also put you at greater risk for catching some nasty disease.

"Habitat destruction and biodiversity loss,"—driven by the replacement of local species by exotic ones, deforestation, global transportation, encroaching cities, and other environmental changes—"can increase the incidence and distribution of infectious diseases in humans," write University of Vermont biologist Joe Roman, EPA scientist Montira Pongsiri, and seven co-authors in *BioScience*.

Their study, "Biodiversity Loss Affects Global Disease Ecology," will appear in the December issue of the journal, available on-line on December 7, 2009.

Diseases Go Global

"Lots of new diseases are emerging, and diseases that were once local are now global," says Roman, a wildlife expert and fellow at UVM's Gund Institute for Ecological Economics. "Diseases like West Nile Virus have

spread around the world very quickly."

This is not the first time humans have faced a raft of new diseases. About 10,000 years ago, humans invented farming. This move from hunting to agriculture brought permanent settlements, domestication of animals, and changes in diet. It also brought new infectious diseases, in what scientists call an "epidemiologic transition."

Another of these transitions came with the Industrial Revolution. Infectious diseases decreased in many places while cancer, allergies and birth defects shot up.

Now, it seems, another epidemiologic transition is upon us. A host of new infectious diseases—like West Nile Virus—have appeared. And infectious diseases thought to be in decline—like malaria—have reasserted themselves and spread.

"Ours is the first article to link the current epidemiological transition," says Pongsiri, an environmental health expert in EPA's Office of the Science Advisor, "with biodiversity change, decline and extinction."

"People have been working on this in individual diseases but no one has put all the studies together to compare them," says Roman. In 2006, he and Pongsiri gathered a group of scientists and policy analysts with expertise in a range of the new diseases being observed—including West Nile virus as well as malaria, the African parasitic disease schistosomiasis, hantavirus pulmonary syndrome, and several others. From that meeting, the forthcoming *BioScience* study developed.

"We've reviewed all those studies and show that emergence or reemergence of many diseases is related to loss of biodiversity," says Pongsiri.

"We've taken a broad look at this problem to say that it's not just case-study specific," she says. "Something is happening at a global scale."

Of Mosquitoes and Mice

One of the studies that Pongsiri and Roman's team examined was a 2006 investigation in Amazonian Peru. It was the first to demonstrate that malaria transmission can rise in response to deforestation. Though the mechanisms are complex and not fully worked out, it appears that loss of the structural diversity provided by trees led to higher density of Anopheles darlingi mosquitoes, a potent transmitter of malaria, as well as to higher biting rates.

"Or think about Lyme disease," says Roman, calling from Connecticut.

People get this disease from ticks infected with a bacterium, Borrelia burgdorferi. The ticks, in turn, usually get the bacterium by feeding on small mammals—particularly white-footed mice.

"Historically, Lyme disease was probably rare, because you had a large range of mammals, everything from pumas all the way down to a widespread community of rodents," says Roman. Ticks feed on different species, and, since many are poor hosts for the bacterium, only a limited number of ticks would carry the disease to people. But fragmentation and reduction of forests has led to deep declines in the number of mammals—and white-footed mice tend to thrive in species-poor places, like small patches of forest on the edge of neighborhoods.

"In fact, white-footed mice appear to be the most competent animal host reservoir of Lyme disease in the northeastern U.S.," Pongsiri notes on an EPA blog, "So, the more white-footed mice that are in the forest, the greater chance more ticks will be infected, and the greater chance you have of getting bitten by an infected tick."

In other words, if you're worried about catching Lyme disease, it's a good idea to wear long pants—but it might be a better idea to join your conservation commission or zoning board since "protecting large forested areas in the vicinity of residential areas may reduce the risk of Lyme disease," the *BioScience* paper notes.

Eco-epidemiology

It is new to think about biodiversity—and therefore, species and land conservation—as integral to public health. Until recently, almost no epidemiologists, nor medical schools, were framing questions of human infectious disease prevention in terms of, say, habitat structure, promoting genetic diversity in non-human species, or protecting animal predators as ecosystem regulators. Human diseases, goes the conventional thinking, are best understood and treated by looking at humans.

"Now there is the beginning of a movement to bring epidemiology and ecology together," says Pongsiri.

"We're not saying that biodiversity loss is the primary driver for all of these emerging diseases," says Roman, "but it appears to be playing an important role."

"We're trying to make the case that all of these environmental changes we're making, because they are anthropogenic, can be managed, can be controlled," says Pongsiri. "We may be able to actually reduce or prevent these diseases by managing for biodiversity from the genetic level to the habitat level."

A third of the bird species on the planet are at risk of extinction and a quarter of the mammals, Roman says, "and we have an incredible amount of habitat being destroyed, along with climate change. We

should expect to see the impacts of these changes occurring now, to people—and we do."

"The standard argument for protecting biodiversity is often that, well, there are medicines out there and you don't want to destroy a forest where you might have a cure for cancer," he says, " and that's true—but I don't think that's as compelling as the argument that if you cut down the forest you or your kids are more prone to infectious diseases."

Source: University of Vermont