

Invasive earthworms are remaking our forests, and climate scientists are worried

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Worms are radically changing our forests' soils and depleting terrestrial carbon stocks

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North America's forests have been largely earthworm-free since the last Ice Age. But as invaders arrive and burrow into the leaf litter, they change the soil composition — affecting native species and how the forest holds carbon. (Cristina Sevilleja Gonzalez)

For the past 300 years, a slow-motion invasion has been unfolding under our feet.

Year by year, a plethora of invasive earthworms have been quietly burrowing their way through our forests' leaf litter, grasslands and backyard gardens.

Although earthworms are beneficial for growing food, research shows they are harming our forests, and could potentially be contributing to climate change.

Earthworms are not native to most of North America. Until about 10,000 years ago, a vast ice sheet covered the northern third of the North American continent. Scientists think it killed off the earthworms that may have inhabited the area before the last glaciation.



The common earthworm, *Lumbricus terrestris*, is native to Western Europe. Known to many as the Canadian nightcrawler, it's the earthworm most commonly used for fishing bait, and likely the type of worm living in your backyard. (Cristina Sevilleja Gonzalez)

Earthworms were reintroduced to North America with the arrival of European settlers in the 18th century. There are now more than 30 species of non-native earthworms in Canada, according to Michael McTavish, a postdoctoral research fellow at the University of Toronto specializing in the ecology of non-native earthworms.

"By physically changing the soil environment, earthworms affect everything from decomposition of organic matter, to nutrient cycling, carbon storage...how water moves through [the soil]," said McTavish.

"They just kind of affect everything across the board."

Although they're usually perceived as friendly helpers in the garden, elsewhere, they can be a surprisingly destructive force.

Threatening forest diversity

Earthworms are ecosystem engineers, meaning they play a huge role in shaping their environment.

Normally, microbes and other soil-dwelling organisms such as mites, nematodes, millipedes and fungi break down organic matter in Canadian forests. They turn leaves and wood bits into soil and free up the nutrients that were once bound in organic matter. In the absence of earthworms, the litter layer, which is composed of old leaves and detritus that has built up on the soil floor, breaks down very slowly.



Earthworms such as *Lumbricus terrestris*, pictured above, quickly break down organic matter and mix different soil layers together. They significantly alter the soil's composition to the detriment of native plant and invertebrate species. (Cristina Sevilleja Gonzalez)

When earthworms move into our forests, they have the potential to rapidly change these ecosystems by devouring the leaf litter. They break down plant matter in much the same way as other invertebrates, but they do it much faster. In essence, worms speed up decomposition, which can be a bad thing for ecosystems used to taking it slow.



Small earthworm eggs are easily transported in soil or caught in tire treads, helping them invade new ecosystems. (Erin Cameron)

"When earthworms move in, you have a fundamentally different soil environment," said McTavish.

"So you can get changes in pH, in the texture and density, and nutrient enrichment. The problem is that the species that we have present in our forests are not used to those kinds of conditions."

According to McTavish, the soil environment becomes inhospitable to native plants, allowing non-native plants to thrive.

Erin Cameron, an environmental science professor at St. Mary's University in Halifax who studies invasive earthworms, found that earthworms cause a 50 per cent decrease in abundance in native soil invertebrates.

Now, to the great concern of climate scientists, invasive earthworms are expanding their range northwards, in boreal forests that have lacked native earthworms since the last ice age.

The boreal forest is losing carbon

Justine Lejoly, a soil scientist with the University of Alberta in Edmonton researching the effects of earthworms on soil carbon dynamics, says the earthworms' voracious appetite has serious implications for the boreal forest's capacity to store carbon.

The boreal is special. In warmer climates, the floor of a typical forest is a mix of mineral soil and organic soil. In a boreal forest, those components are distinct, with a thick layer of rotting leaves, mosses and fallen wood on top of the mineral soil.



Dendrobaena octaedra is the most common species of earthworm found in the boreal forest. The relatively small worm, native to Europe, feeds on the forest's litter layer, depleting its carbon stock. (Erin Cameron)

This spongy layer of leaf litter contains most of the carbon stored in the boreal soil. *Dendrobaena octaedra*, the small earthworm responsible for invading most of the North American boreal, is the type that loves to devour leaf litter and stay above ground, releasing carbon.

"Boreal forests are known to be a very important terrestrial reservoir of carbon," said Lejoly. "If we lose that organic matter, it means that there is a lot of carbon that's not going to be stored in those forests anymore."



The Canadian Boreal Forest stretches from Yukon to Newfoundland and Labrador. The world's boreal forests have been largely earthworm-free since the last ice age. But when earthworms arrive, the soil changes can release carbon and may accelerate climate change. (Natural Resources Defense Council)

Lejoly estimates that only around 10 per cent of the boreal forest currently has earthworms, but she projects that by 2050, most of the boreal forest will be invaded — which means the boreal forest soil could potentially lose most of its carbon stock.

Cameron modelled the potential effects of earthworms on carbon stored in the forest floor. Her models found that when earthworms were present, the forest floor's carbon stock was reduced by around 50 to 94 per cent after 125 years, but most of that reduction occurred in the first 35 to 40 years.

This means that boreal forests may potentially be emitting a lot more carbon, in the form of carbon dioxide, into the Earth's atmosphere, than they are absorbing. Already, rising temperatures are releasing carbon from forests, by thawing permafrost and increasing the number of forest fires.

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Second wave of invasion

More recently, several species of Asian earthworms have made their way to the continent, and they have soil scientists particularly concerned. Originally from Korea and Japan, they are known as "jumping worms," "snake worms," or "crazy worms" — named for their distinctive thrashing when disturbed. They are ravaging soils throughout the U.S., and have crossed the border into Canada.

McTavish fears that jumping worms pose an even greater threat than their European predecessors. Jumping worms have many of the same effects, except that they grow larger, recycle nutrients even faster and exist in dense colonies, sometimes numbering more than 100 individuals per square metre of ground.

Jumping worms are known to quickly churn the top layer of soil, turning it into something that resembles coffee grounds from all the worm droppings.

Managing the invasion

Invasive earthworms have been found everywhere from Ontario to Alaska. Their rapid spread across the continent is largely due to human activity. Earthworms, left to their own devices, can only spread around 10 metres per year. But invasive earthworms can easily travel a couple hundred kilometres in one day by roads, anglers, tire treads, boats and even gardeners.

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McTavish says this means it's key to educate the public about invasive earthworms, and limit the transfer of soil and earthworms between different areas.

For example, David Legros, the chief naturalist at Ontario's Algonquin Provincial Park, says the park has begun asking visitors going fishing to stop dumping their leftover bait.

"The problem is there's no way of removing them from an area once they invade," said Cameron. "So, any action or management really has to be done in terms of restricting introduction."

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