

Research shows that soil calcium limits forest songbirds

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An ovenbird feeds her young.

Acid rain and subsequent calcium depletion of forest soils in eastern North America may be limiting forest songbird populations, according to a researcher in Penn State's College of Agricultural Sciences.

In a six-year study, Sarah Pabian, who recently received her doctoral degree in Wildlife and [Fisheries Science](#), monitored populations of ovenbirds (*Seiurus aurocapilla*) in four forested, 100-hectare sites in central Pennsylvania. To determine how forest songbird habitat quality is related to soil calcium availability, researchers experimentally elevated soil calcium by applying dolomitic limestone sand to two of the test sites.

Lime was applied using a modified log skidder at the rate of 4,500

kilograms per hectare. "We measured ovenbird territory size and quantified breeding performance in 2008 and compared the data to our observations made before 2003 and for three years after -- from 2004 to 2006," Pabian said.

"Replenishing calcium to the extremely [acidic soils](#) in Pennsylvania forests made a significant difference -- we observed a 1.8-fold increase in ovenbird territory density, larger clutch sizes and more nests where soil calcium was enriched," she reported. "However, surprisingly, we did not see effects on egg characteristics, such as shell thickness."

Pabian -- who was advised by Margaret Brittingham, Penn State professor of wildlife resources who has done important research relating to the Pennsylvania habitat of neotropical migrant songbirds -- concluded that acidic forest soils restrict the availability of calcium-rich food items, such as snails, critical for the birds' reproduction.

"Forest soils in many areas of the world are becoming increasingly acidified, in part because of atmospheric deposition of strong acids produced by the burning of fossil fuels," she said.

Pabian's research, which recently was published in *The AUK*, an international journal of ornithology, is notable because little previous experimental evidence exists for the purported relationship between soil calcium and avian reproduction.

Snails are a critical calcium source for many breeding birds, Pabian explained, and she suspects that snails are the link between soils and birds, because snail abundance increased with liming and was positively correlated with soil calcium.

"We concluded that ovenbird habitat quality is related to soil calcium, that birds on our sites were calcium-limited, and that reduced soil calcium could play an important role in bird declines in acidified

forests," she said.

"Birds may be particularly sensitive to soil calcium depletion because they require large amounts of calcium to produce eggshells successfully and raise young," Pabian added. "For example, to produce a single clutch of eggs, some small bird species require more calcium than is in their entire skeleton."

Small songbirds, which do not store much calcium for reproduction and do not have enough calcium in their normal diets to produce eggs, must rely on calcium-rich food supplements (particularly snails) at the time of reproduction, Pabian said. The availability of snails is typically related to the availability of calcium in the soil, because snails require high levels of calcium to produce highly calcified exoskeletons and to reproduce.

"In areas of Europe where acidic deposition has driven down snail abundance, songbirds have laid eggs with thin or even no shells," she said. "Calcium deficiency also has been observed to limit clutch size, reproductive success and skeletal development of chicks."

Understanding the relationships between forest songbirds and soil calcium availability is of great importance in the northeastern United States, where decades of acidic deposition and forest harvesting and aging have resulted in chronically acidified forest soils with depleted calcium availability.

The majority of forested lands in the northeastern United States have naturally acidic soils that are sensitive to acid inputs and receive high levels of acidic atmospheric deposition. Approximately 17 percent of [forest soils](#) in the United States exceed critical acidic deposition loads, with the greatest concentration of acidified forests in the Northeast.

Pabian's research documented a close connection between soil

parameters, including soil pH and [calcium](#) levels and habitat quality for songbirds. "Farmers long have known that soil quality has a direct influence on crop production," she said. "Current research shows that forest ecologists and wildlife biologists also should be concerned with soil fertility and anthropogenic effects that may negatively influence it.

"Soil quality has an influence that reverberates all the way through the forest ecosystem, and fertile soils are not only important for plants but also for the multitude of other organisms and animals found within the [forest](#)."

Provided by Pennsylvania State University

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