

Northern Research Station

Rooted in Research

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Tracking Emerging Infectious Diseases That Threaten Forests

Around the world, emerging infectious diseases (EIDs) are affecting tree populations and changing forest communities. More widespread and severe in recent decades, these diseases harm native plant populations and the health of commercially available plants used in landscaping, agriculture, and forestry. One of the more extreme examples is chestnut blight, which killed most of the American chestnut trees in North America between 1900 and 1950.

Global trade and climate change are considered the largest factors contributing to the rise of EIDs. Non-native plants can transport diseases into the ranges of native plants, while warmer winters, shifting precipitation and humidity patterns, extended drought, and strong storms can create favorable conditions for pathogens and make native plants more vulnerable to disease.

Understanding the patterns and impacts of diseases on forests is crucial for effective management, according to Andrew Gougherty, research landscape ecologist with the U.S. Department of Agriculture, Forest Service Northern Research Station, who recently published a [paper](#) on EIDs. “Recent work has shown that non-native species are increasing globally,” he explains, “but less work has been done on how that increase drives infectious diseases.”

KEY MANAGEMENT CONSIDERATIONS

- Reports of emerging infectious diseases (EIDs) in trees are growing rapidly worldwide. Reports in recent years are nearly double the previous 20-year average.
- The number of EIDs is growing both geographically and in certain trees.
- Europe and North America have accumulated the highest number of EIDs over the past two decades. East Asia has experienced a rapid increase in the number of reported emerging diseases.
- Trees tend to accumulate more diseases in their native range than in places where they have been introduced.
- Pine tree species have the largest number of new diseases reported in recent decades, likely because they have a large native range in the Northern Hemisphere and are widely used in forestry around the world.

Tracking First Reports and Severity of Emerging Infectious Diseases

Gougherty tracked “first reports” of EIDs in scientific publications between 2000 and 2022. These first reports describe a disease’s location, symptoms, and how the pathogen was verified. The search uncovered 962 new EID reports from 88 countries in 284 tree species.

Gougherty concentrated on global and regional trends in EIDs affecting tree genera that are mostly native to the Northern Hemisphere, have large geographic ranges, and can be native or



A pine tree with pine needle cast disease. USDA Forest Service photo/Bugwood.org.

non-native in many regions. Among the trees included in the study are *Abies* (fir), *Acer* (maple), and *Betula* (birch) as well as *Eucalyptus* (eucalyptus), *Pinus* (pine), and *Acacia* (acacia), which are widely planted for forestry today. He found that EID first reports increased rapidly worldwide over the 22-year period in the analysis, doubling approximately every 11 years. The analysis confirmed that EIDs are likely to continue to harm native plant populations by leading to growth reduction, population decline, and even species extinction.

Regional Differences

First reports of EIDs are increasing unevenly across the world. Reports are highest in Europe for both native and imported trees, likely due to well-developed international reporting systems and relatively small country size, where a pathogen may be considered new even if it has been reported in an adjacent country. North America has also seen increases in first reports of EIDs, but the growth is considerably slower among both native and non-native trees.

The total number of EIDs in East Asia are increasing more rapidly than in Europe and North America, perhaps due to improved reporting. In Latin America and the Caribbean, diseases affecting native trees are not increasing as quickly, but those affecting non-native trees are on the rise.

Species Differences

The analysis shows that different types of trees are affected in different ways. In general, native species are accumulating more pathogens in their countries of origin than outside of their usual ranges, most likely because new pathogens are being continually introduced from abroad. For example, white pine blister rust likely came to North America through infected white pines grown in Europe, where they are not native.

A potential new threat to ash (*Fraxinus*) in North America is ash dieback, a disease that was first detected in Poland and has spread to at least 30 countries since 1992. The disease spreads through the air and by moving infected wood, and it is hard to stop once it starts. Although some European ash trees resist the disease, it remains a major concern.

Of all the genera in the study, pine trees, which have a large native range and are used widely in forestry around the world, have the most disease reports. Oak (*Quercus*) also have many EID reports, likely because there are many oak species and diseases spread easily among them. Reports of EIDs in eucalyptus trees are higher in locations outside their native range.

Looking Ahead and Testing Large Language Models (LLMs)

Gougherty cautions that the study likely undercounts the number of EIDs because tracking relies on efficient systems in every country for scientific reporting, and diseases that do not cause obvious damage or that appear in remote areas might not be reported at all. Still, he hopes that this research can lead to a better understanding of where EIDs are likely to appear.

As a next step, he and colleagues are expanding the study to more host species and longer time periods. Recently the researchers tested using large language models (LLMs) to extract EID data from the scientific literature. They sent the text of 100 EID first reports to an LLM, had it extract several pieces of relevant information and then conducted the same analysis by hand to compare the results. For simple data like country name, host name, and pathogen name, the model was able to extract the information, with high accuracy. The model was less reliable at finding data that required interpretation or was inconsistently reported, such as the percentage of the trees in an area affected by a pathogen.

Gougherty hopes that LLMs can be used to build a database of EID reports from around the world, a method that may offer the possibility of assembling data at unprecedented speeds and scales and could ultimately offer further insights into the causes and impacts of emerging infectious diseases on trees.

PROJECT LEADS

[Andrew Gougherty](#) is a research landscape ecologist with the Northern Research Station.

FURTHER READING

Gougherty, Andrew V. 2023. [Emerging tree diseases are accumulating rapidly in the native and non-native ranges of Holarctic trees](#). *NeoBiota*. 87: 143–160. <https://doi.org/10.3897/neobiota.87.103525>.

Gougherty, Andrew V.; Clipp, Hannah L. 2024. [Testing the reliability of an AI-based large language model to extract ecological information from the scientific literature](#). *npj Biodiversity*. 3: 13. <https://doi.org/10.1038/s44185-024-00043-9>.

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