eDNA vs. oak wilt: A race to protect Canadian forests

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Environmental DNA — or eDNA, for short — refers to genetic material that has been shed into the environment by living or dead organisms. As technology advances, researchers are testing for eDNA to determine if a species could be present. When it comes to invasive species like oak wilt, a disease that infects oak trees, eDNA testing could be a valuable tool for early detection. An advantage of these tests is their ability to detect organisms that are rare, hidden, or secretive — for example, an insect or pathogen that is new to an area and lives under the bark of a tree where it can't be seen. Because DNA can linger in the environment for weeks (sometimes longer), eDNA testing can also determine whether shipped material (such as wood products or firewood) came into contact with an invasive species before shipment. A positive test is a clue that live individuals could be present on future shipments.

Monitoring for oak wilt with eDNA

A single eDNA test uses less than a gram of material, so testing is most effective when large amounts of eDNA are gathered onto a surface — for example, large amounts of stream water passing through a filter. On land, accumulating eDNA is more difficult.

In the 2010s, researchers developed a test that can detect very small amounts of DNA from the invasive fungus that causes oak wilt (Figure 1). Researchers later found that sap beetles, insects known to transmit the fungus among trees, can be collected in large numbers in baited traps and successfully tested for oak wilt DNA. This was good news in the fight to keep oak wilt out of Canada.

Figure 1. From left to right: Red oaks with oak wilt drop leaves early, often starting in July, resulting in a thin crown in comparison to neighboring trees. Dieback on leaves starts at the tip and upper edges and moves down towards the base of the leaf. After the aboveground parts of the tree dies, the fungus produces spore mats. The bark of the tree cracks when the spore mat develops, allowing sap beetles to feed on the fungus and lay eggs. Photo credit to Ontario Ministry of Natural Resources staff and Nicole Mielewczyk, Canadian Food Inspection Agency.

Despite the promise of eDNA monitoring, it isn't used regularly for invasive species. One problem with the test for oak wilt is it's unclear what a positive result means. Does it mean the fungus is abundant at that location or a beetle carrying oak wilt DNA was just passing through? Another problem is that we don't yet have standardized protocols for collecting samples, which means we can't compare results from different sites and studies.

In 2025, the Ontario Ministry of Natural Resources worked with the University of Toronto and Canadian Food Inspection Agency to determine what time of year we can detect oak wilt DNA and better understand how test results differ when oak wilt is present or thought to be absent.

In May, we installed flight traps for six weeks at seven locations with oak wilt in Michigan and 18 locations without oak wilt in Ontario. To determine the best time of year to collect eDNA, we continued collecting samples at three sites in Ontario and three sites in Michigan until late September.

In the lab, we sorted, freeze-dried, and ground insect samples before extracting and testing the DNA for the oak wilt pathogen (Figure 2). We found a big difference in detection rates when infected trees weren't nearby. In Ontario, only two samples were positive, despite several collection sites bordering New York and Michigan where oak wilt is common (Figure 3). These samples were reported to the Canadian Food Inspection Agency. The samples from infected forest stands in Michigan had a positive rate of 77%.

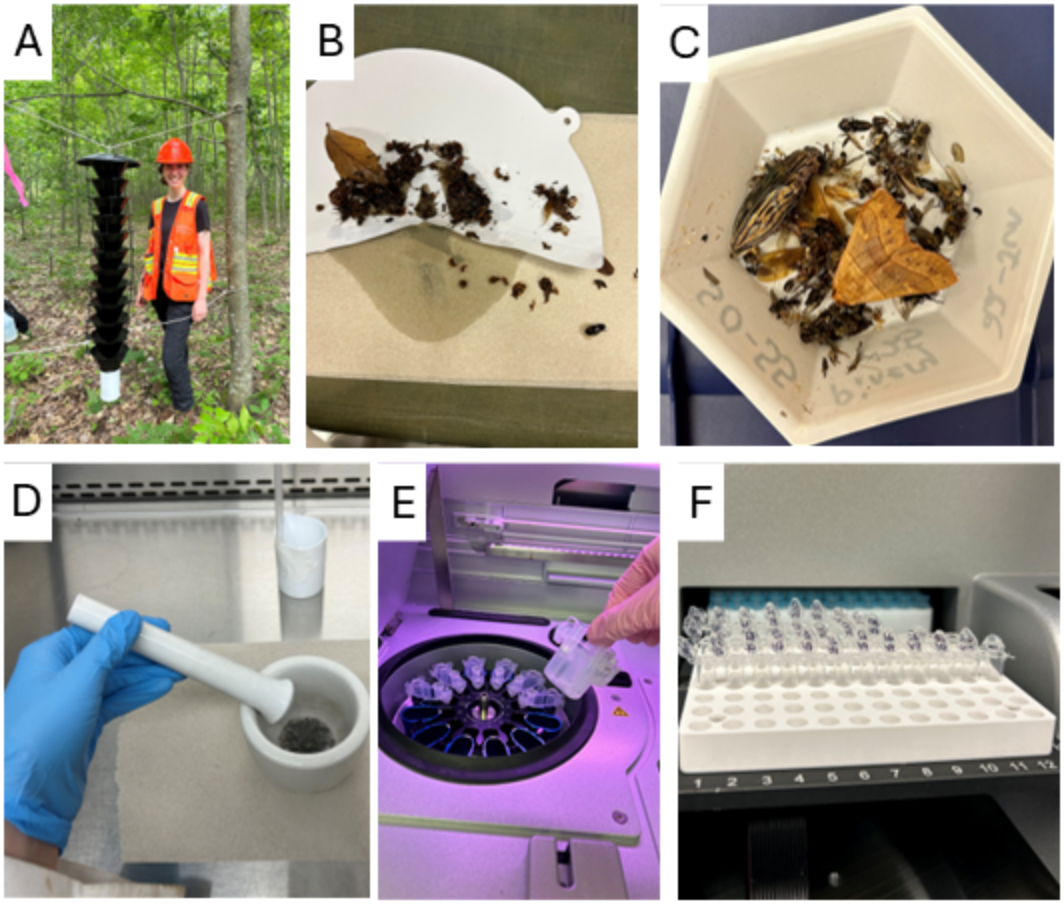

Figure 2. (A) Insect flight traps were set-up by University of Toronto master's student, Cailyn Carscadden and partners in Ontario and Michigan. (B) Leaves and other plant debris were removed (C) so that only insects remained in the sample. (D) Insects were freeze dried and ground into a powder using a mortar and pestle. The final steps were (E) DNA extraction and testing for (F) DNA of the oak wilt pathogen.

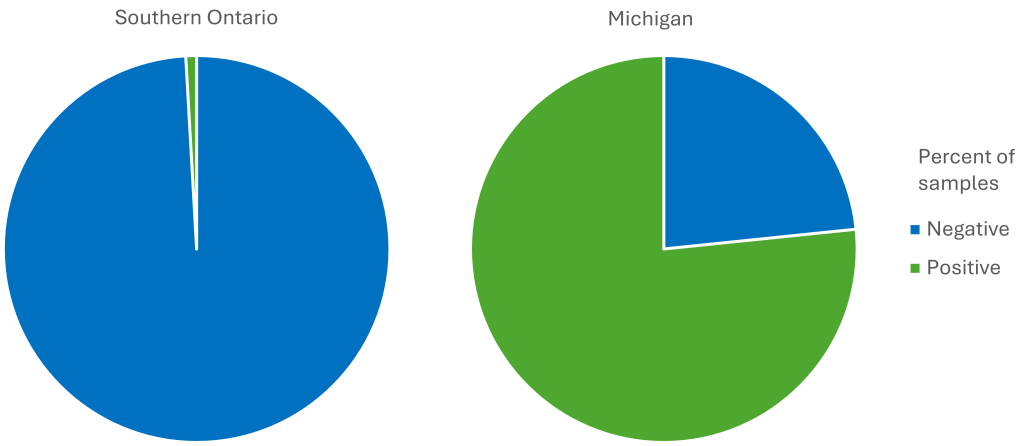

Figure 3: Percent of insect samples collected in Ontario and Michigan that were positive for eDNA of the pathogen that causes oak wilt. There were 222 samples collected in Ontario and 185 collected in Michigan.

We found that May to July was the best time of year to detect DNA of the pathogen, though some detections were still made in August and September (Figure 4). Future eDNA monitoring should occur in late spring and early summer for best results. This period is also when the risk of infection is considered greatest. Our data also supports the idea that the risk of oak wilt infection decreases after mid summer. We can't say exactly how much the risk drops since some of the DNA in our samples could have come from fungal material that can't cause infections. In addition, oak trees are less susceptible to infection late in the growing season.

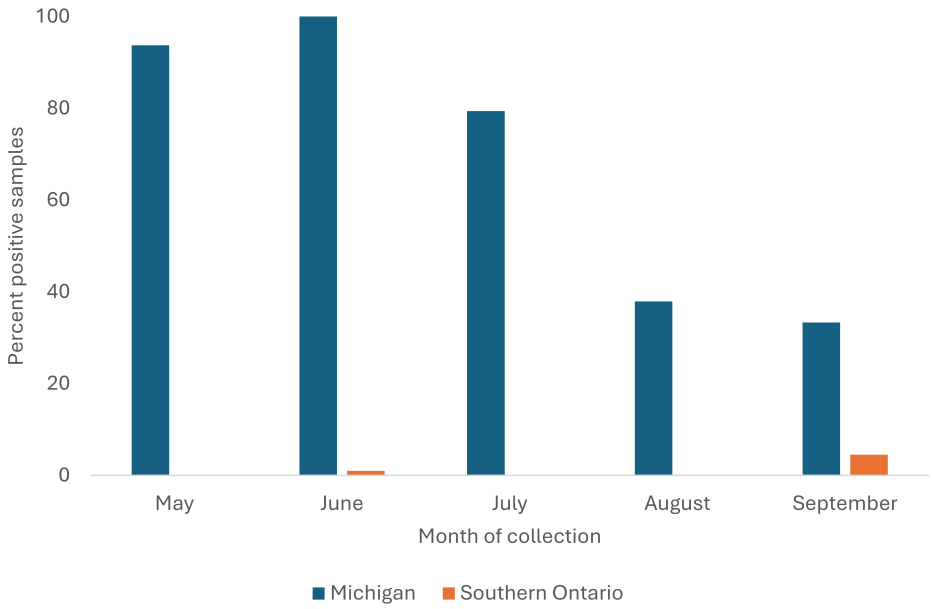

Figure 4: The percent of insect samples with pathogen DNA collected May to September at locations in Michigan with oak wilt and locations in Ontario where oak wilt is not known to occur.

You can avoid the risk of oak wilt by not wounding oaks from April to October. If you suspect a tree has oak wilt, notify the Canadian Food Inspection Agency (**OakWiltReportingOntario-Fletrissementduchene@inspection.gc.ca**).

This information will improve eDNA monitoring for oak wilt, interpretation of results, and prevention guidelines for oak wilt. We thank the Canadian TREE Fund for awarding us the Jack Kimmel Grant so that samples could be collected from July to September. We also thank our many partners and their staff that collected samples: Niagara Parks, Simcoe County Conservation Authority, the City of Hamilton, St. Clair Region Conservation Authority, the City of Windsor, Middlesex County Conservation Authority, the City of London, Toronto Region Conservation Authority, the City of Burlington, the City of Richmond Hill, Central Lake Ontario Conservation Authority, the City of Niagara Falls, Pinery Provincial Park, Rondeau Provincial Park, and the Canadian Food Inspection Agency.