OAK WILT

Survey Protocol

AT A GLANCE

- Survey forested areas containing oak around high-risk sites between early July and mid-August, assessing 50 oak trees per site.
- Look for red oak trees with dull green, bronze, yellow or brown leaves.
- Branch samples greater than 3 cm in diameter with longitudinal staining are the diagnostic focus for this survey. Samples collected from suspect trees are submitted to the CFIA Pathology lab for analysis. Each sample **should be doubled** to support a research project.
- Sampling should be completed as late in the season as possible**,** ideally in mid-August.
- Treat pruning wounds with latex spray paint if sampling occurs during the high-risk period.
- Delimitation surveys to be completed during the optimal survey window of July and August, where possible.
- All survey data will be captured in the Oak Wilt Survey Form in Survey 123.

WHAT'S NEW

- Guidelines for data submission and reporting using Survey 123 has been added to Section 8 and Appendix 1.

Canada

1. Background and Objectives

Oak wilt is a vascular wilt disease caused by the fungus *Bretziella fagacearum* (previously known as *Ceratocystis fagacearum*). The fungus develops on the outer sapwood of the tree, causing its host to develop tyloses and gums which block the movement of water and nutrients within the xylem, resulting in branch wilting and tree death. Oak wilt is primarily spread from diseased to healthy trees through root grafting. This disease can also be spread by oak bark beetles, which transmit spores while creating galleries within infected tissue, and by sap beetles, which pick up spores on their bodies while feeding on fungal mats that can then be transported to wounds on healthy trees. Species of red oak are infected more frequently and die more quickly than white oaks, often killing trees in a single season.

Oak wilt was first recognized as an important forest pest in 1944 in Wisconsin and is now known to occur in 24 states within the U.S. (South Dakota to New York, southward to South Carolina, westward to Texas and northward through Oklahoma to Nebraska). This disease was detected in Ontario, Canada for the first time in 2023 in the municipalities of Niagara Falls, Springwater, and Niagara-on-the-Lake. Based on a thorough analysis of these incursions, the Canadian Food Inspection Agency is taking an active management approach with eradication as the goal. The spread of oak wilt upon establishment in Canada would have significant impact on cities and landowners, the forestry sector and ecosystem services.

This survey is being conducted in support of plant health policy directive D-99-03, *Phytosanitary Import Requirements to Prevent the Entry of Oak Wilt Disease (Bretziella* fagacearum *(Bretz) Hunt) from the Continental United States*. The primary goal of this visual survey is early detection of the pest in areas where it is not known to occur.

2. Target Life Stages

This survey targets fungal compression mats, vertical bark cracking caused by the outward pressure exerted by the compression mats, and foliar symptoms caused by the fungus, which include discoloration or bronzing of the leaves, flagging, premature leaf drop and thinning crowns. Figure 1 outlines the disease cycle of oak wilt.

Note that the symptoms of oak wilt differ between red oaks and white oaks due to differences in their vascular systems and susceptibility to the fungus. Please refer to **section 6.3**, which outlines the signs and symptoms of attack.

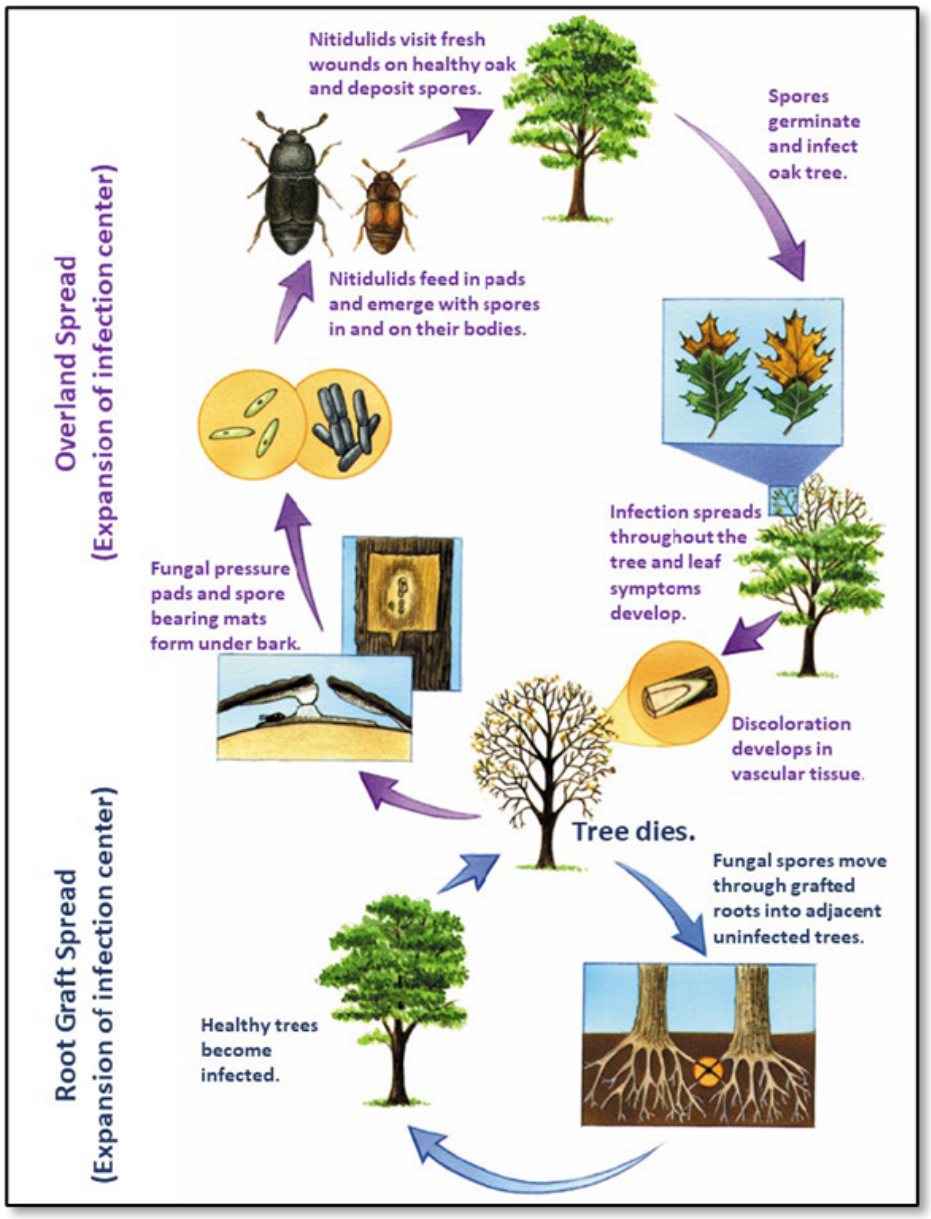


Figure 1. Disease cycle of oak wilt (USDA Forest Service Eastern Region Oak Wilt Suppression Program Participation Guidelines, 2020).

3. Target Hosts

All oak species are susceptible to oak wilt, but red oaks are more frequently infected and can die quite quickly and should therefore be prioritized for this survey. However, if there is noticeable crown decline and leaf symptoms on white oaks, these trees must be examined.

4. Timing and Duration

Oak wilt symptoms, including wilting and bronzing of foliage, are most apparent during the growing season from June through September, and peak in July and August. The optimal survey window is from July to August, within an overall survey window of June to September.

Visual **detection** surveys will occur between the beginning of July and the 2nd week of August. Where possible, **delimitation** surveys should be conducted during the optimal survey window in July and August but may be completed as early as June and into September to alleviate operational constraints.

Note: Sampling of any symptomatic material should be completed as late in the season as possible, ideally around mid-August.

5. Target Areas and Site Selection

The primary means for disease transmission is through root grafting from infected to healthy oaks. Currently, oak wilt infected counties in the US are separated from Canada by the Great Lakes or rivers. The infested areas in Canada are on residential and academic properties; the known infected trees have been removed. As the only way that oak wilt can naturally cross roads, rivers and open fields is through transmission by an insect vector, the spread of oak wilt through Canada will likely occur through the movement of infected commodities such as logs or firewood. Detection surveys will therefore focus on areas where oak wilt could have been introduced through human-assisted movement of infected commodities, focusing on the following target sites in proximity to known infested areas of Canada and the United States that are unmanaged:

- Areas in Ontario adjacent to regions where infections are known to occur (see Figure 2).
- Campgrounds (provincial and national parks, private campgrounds) where oak firewood may be transported from infected areas. Prioritize campgrounds hosting visitors from infected US states.
- Mills or other facilities importing oak logs from infected US states.
- Border crossings where firewood may be placed in amnesty bins.
- Disposal sites and areas where recent weather events may have damaged limbs/trees.

Surveys should be evenly distributed among each of the site types listed above. Sites where declining or stressed oak trees were observed in previous years, but oak wilt was not highly suspect, should also be revisited. Surveys are to occur in forested areas surrounding the target sites, but if oak is absent from the forest, that particular site should not be selected for this survey.

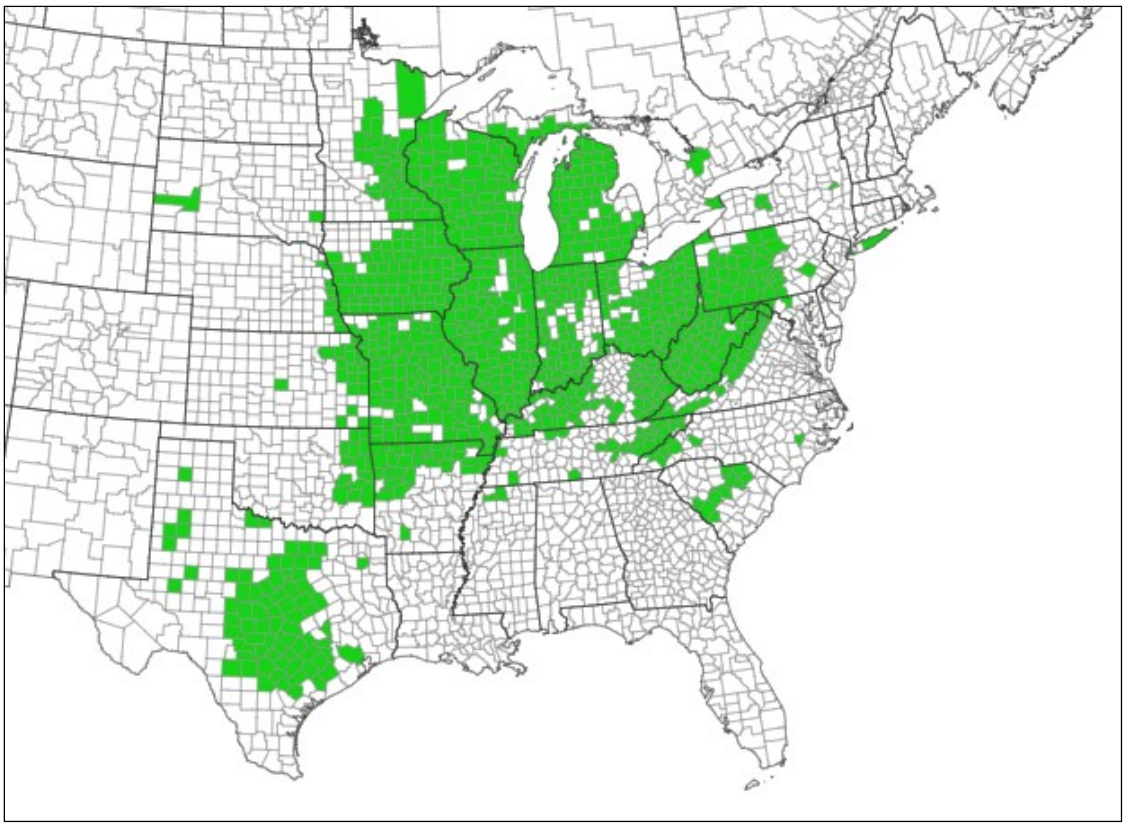


Figure 2. Map of counties where oak wilt has been detected within Canada and the US (www.eddmaps.org). This map provides an overview of the areas where oak wilt has been detected to illustrate the areas that are at risk of oak wilt introduction. For real-time updates, please consult resources provided by federal and/or state-level authorities.

6. Survey Methodology

The following survey techniques include excerpts and adaptations from the USDA Forest Service publication *How to Collect Field Samples and Identify the Oak Wilt Fungus in the Laboratory* (Jill Pokorny, 1999).

6.1 Detection Survey

This survey consists of a visual inspection of host trees for signs and symptoms of oak wilt as outlined in Section 6.3. At each target site, inspection staff will visually examine up to 50 oak trees within the forested areas surrounding the site. If the target site is very large, select 50 oak for inspection over a 500 m distance; this will ensure that a greater proportion of a site will be inspected. If there are no oak within or adjacent to a site, examine the closest forest containing oak within 3 to 5 km of the site.

Binoculars should be used to assist in surveying mature trees which cannot be effectively inspected from the ground. If symptomatic branches occur higher in the canopy, use pole pruners to remove samples. Once oak wilt has become established, it can create an expanding

pocket of dead and infested trees. If dead oaks are observed, inspect the tree and ground for signs and symptoms described in section 6.2.

Complete the Survey123 Community Science – Oak Wilt Survey Form (Appendix 1), recording all site observations.

6.2 Signs and Symptoms of Attack

Prior to beginning the survey, it is important to develop the proper search image for signs and symptoms typically associated with oak wilt. This is particularly important when conducting detection surveys for new infections or assessing lightly infected stands. Signs and symptoms of oak wilt include:

- **Leaf discolouration**: Leaves on infected trees will be dull green, bronze, yellow or brown. Colour change will move inward from the leaf margins, starting at the tip of the leaf and progressing towards the midrib and petiole. The border between healthy green tissue and discolouration will be distinct and sharp (Figure 4).
- **Flagging:** Lightly infected trees may have small clusters of discoloured drooping leaves, which give the appearance of a “flag”.
- **Thinning crowns:** Trees may have a thinning crown due to loss of leaves (Figure 5).
- **Premature leaf drop:** Infected trees may prematurely lose their leaves throughout the summer (June to August), when leaves will fall in various states of discolouration.
- **Compression mats:** Fungus or “compression mats” are composed of dark mycelia and may form under the bark of infected trees that have recently been killed by oak wilt (Figure 6). Compression mats and give off an odour similar to “Juicy Fruit” gum.
- **Vertical bark cracking:** Occasionally, compression mats may rise and cause the bark to split vertically, and mycelia may protrude from these cracks (Figures 7 and 8). Using the back of an axe head, tap along suspect areas. If there is a hollow sound, use the axe to cut a "window" around the hollow area and peel back the bark.
- **Vascular staining:** Discolouration/staining may be observed in the outer sapwood, where the fungus has induced the tree to produce gums and tyloses which discolour the wood (Figures 9 and 10).

Figure 4. Distinct border on infested leaves (Iowa State University Plant Disease Clinic).

Figure 5. Thinning crown and leaf discolouration on an oak wilt infested tree (Steven Katovich, Bugwood.org).

Figure 6. Oak wilt compression mat beneath the bark (Julie Holmes, CFIA).

Figure 7. Vertical bark crack which has formed over an oak wilt compression mat (Julie Holmes, CFIA).

Figure 8. Bark window showing an oak wilt compression mat under a vertical bark crack (Jamie Maloney, CFIA).

Figure 9. Black longitudinal staining in cross section (Julie Holmes, CFIA).

Figure 10. Black longitudinal staining in longitudinal section (Joseph O'Brien, USDA Forest Service, Bugwood.org).

Note that the symptoms of oak wilt differ between red oaks and white oaks due to differences in their vascular systems and susceptibility to the fungus. Members of the white oak group are more resistant to oak wilt and may live several years before they die, while some may even recover from infection. Some white oaks may carry the fungus with no foliar symptoms of disease. Generally, bronzing is less pronounced, and defoliation is reduced in the white oaks, frequently occurring only on a few branches of affected trees. Leaves turn brown from the leaf tip toward the leaf base and discolouration patterns resemble those due to normal fall colour changes (Figure 11).

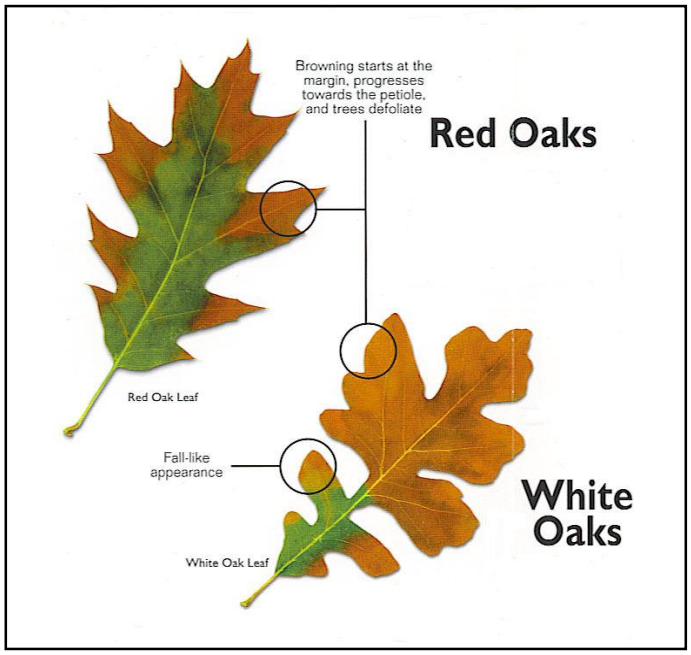


Figure 11. Leaf colour change pattern.

7. Biosecurity Precautions

Where sites have biosecurity procedures in place, inspectors should become aware of and follow them.

All equipment (e.g. knives, axes, etc.) used to cut and remove wood samples should be cleaned between samples with an alcohol-based sanitizer to prevent inadvertent spread of disease.

Sampling of any symptomatic material should be completed as late in the season as possible to avoid sampling during the high-risk period when sap beetles are active (April to July). In the event that samples are collected during the high-risk period, a thin coat of latex spray paint should be applied to limit potential attraction of sap beetles.

8. Reporting and Data Collection

8.1 Data Collection

In the event that suspect tree(s) are encountered during a survey or as a result of other field work, please take photos of the signs and symptoms noted and record the GPS coordinates in Latitude and Longitude in decimal degrees (NAD 83 datum). A piece of flagging tape should be placed on the suspect tree to assist with follow-up.

Please complete the Survey123 form as outlined in Appendix 1 to forward your observation to the CFIA. If you are unable to complete the form, please forward your report directly to your local CFIA office http://www.inspection.gc.ca/about-the-cfia/offices/eng/1313255382836/1313256130232 or Area Survey Biologist cfia.surveillance-surveillance.acia@inspection.gc.ca.

Please do not attempt to collect a sample, as we ask that the tree remain intact so that CFIA can complete their follow-up and collect a controlled sample, in accordance with the submission procedures outlined by the CFIA Pathology lab**.**

8.2 Data Collection

Both suspect and negative observations are highly valuable in tracking the spread of oak wilt. After completing a survey, please record your observations in the Survey123 Form as outlined in Appendix 1. Alternatively, an Excel spreadsheet containing latitude and longitude coordinates, address for the site surveyed, percent oak, date surveyed, results and organization details can be submitted to the CFIA cfia.surveillance-surveillance.acia@inspection.gc.ca.

Should any suspect trees be identified, these should be reported to CFIA as soon as they are identified, as outlined in section 8.1.

9. Supplies

- Mobile device with Survey123 ESRI applications installed
- Knife, axe
- Small hand saw (e.g. 8-10 inch blade)
- Hand sanitizer, ethanol or rubbing alcohol for sterilizing sampling equipment
- Binoculars
- Paper towels
- HB pencils
- Cooler
- Re-useable ice packs
- Field notebook (with waterproof paper)
- Insect repellent
- First aid kit
- Permanent markers
- Flagging tape
- Forceps
- Disposable latex gloves
- Road map
- Re-sealable plastic bags
- Pole Pruners
- Oak Wilt Pest Cards and fact sheets
- Tick Removal Kit (e.g., https://canlyme.com/product/tick-removal-kit/)
- Black or dark coloured latex spray paint

10. Supporting Documents and Additional Information

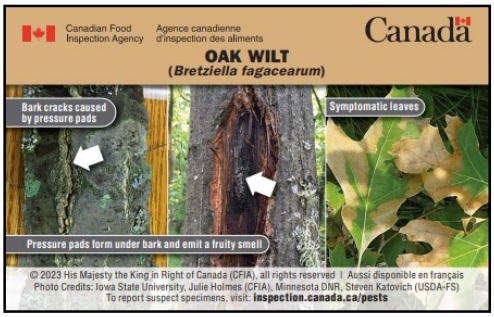
How to Identify, Prevent and Control Oak Wilt (Joseph O'Brien et al. 2017).

Oak Wilt Fact Sheet

Oak Wilt Response Framework for Canada

Invasive Species Centre Oak Wilt Information Page

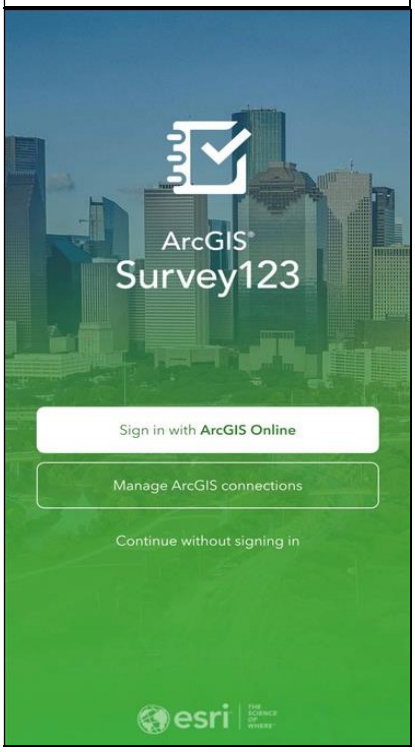
Oak Wilt Pest Card



Appendix 1: Survey123 Guidelines for Oak Wilt

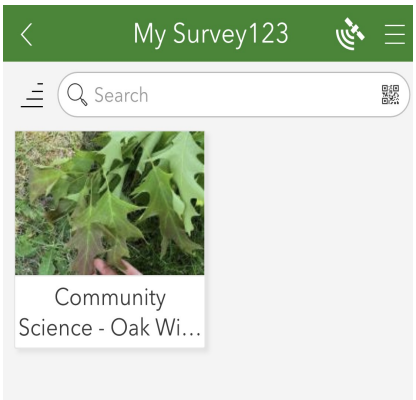
Download the free **ArcGIS Survey123** app to your smartphone. Once downloaded, scan the QR Code to the left using your camera on your phone. Alternatively, you can click on the following link:

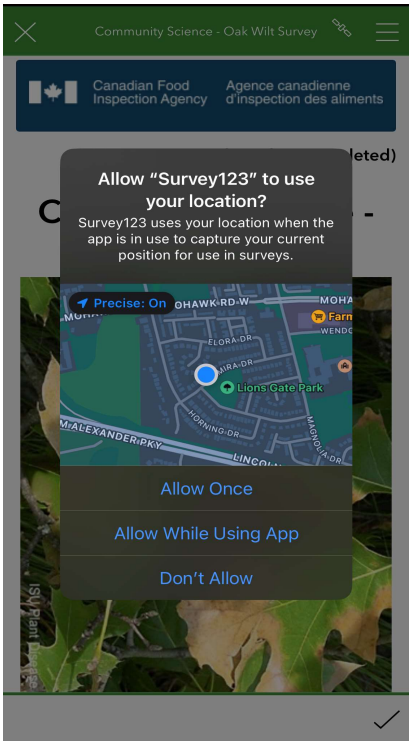
https://survey123.arcgis.app/?itemID=5608f7bd9c664e0cb121542cd6a45d8b



You will not need an account to be able to access this form.

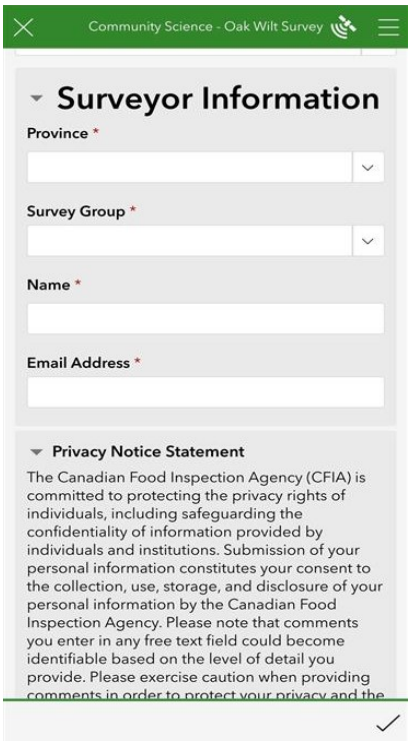
Select **Continue without signing in**. The survey form will immediately open for you and the form will be accessible on the app home screen after first use.





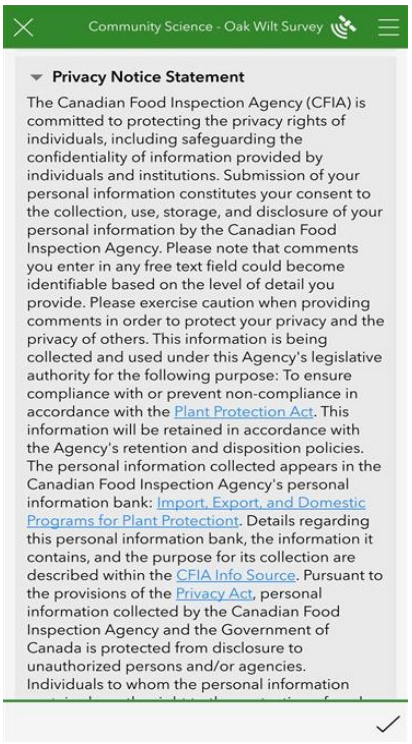
You will be prompted to **Allow "Survey123: to use your location**; please select **Allow While Using the App.**

The **Survey Date** will auto populate with the current date. This can be modified and backdated if required.

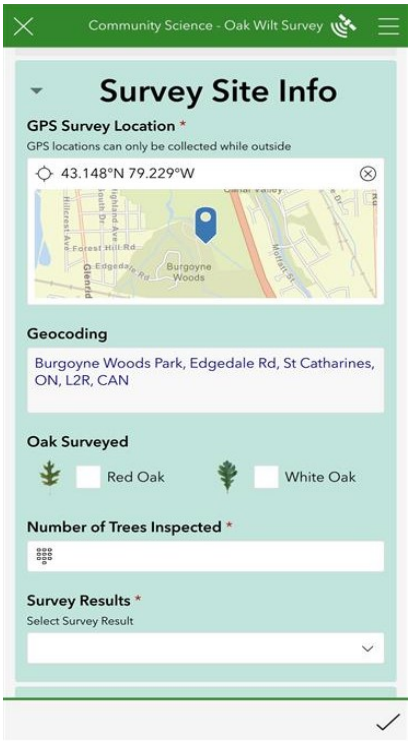


In the **Surveyor Information** section you will capture your information by first selecting the province and group you are part of from the pick list (Citizen Scientist, Conservation, Municipal, Provincial, Federal).

Then type in your name and email address. These fields are required so that CFIA can contact you to follow up on signs/symptoms of Oak Wilt.



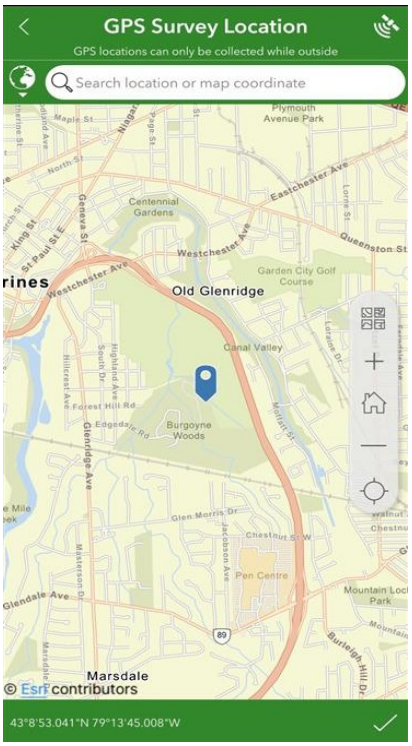
Select the **Privacy Notice Statement** tab to review details here.



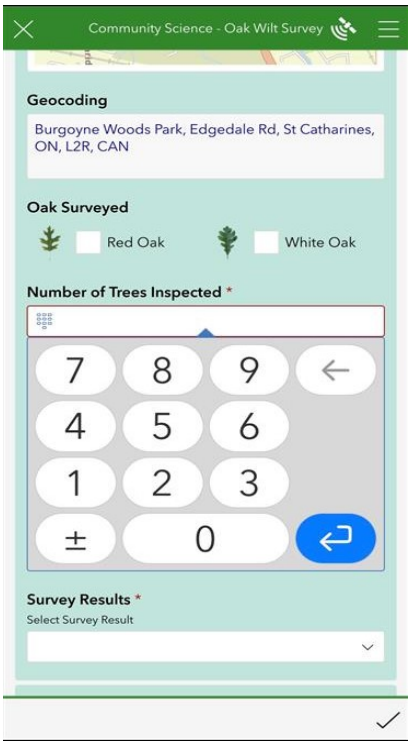
Then proceed to the **Survey Site Info** section.

In GPS Survey Location select the crosshairs icon or the map to capture the GPS. This will populate the Geocoding field with an address nearby.

Note: When the GPS reading is plus or minus more than 10 m a more accurate reading should be taken. Press on the map display and a new screen will open allowing a more precise site location to be specified.

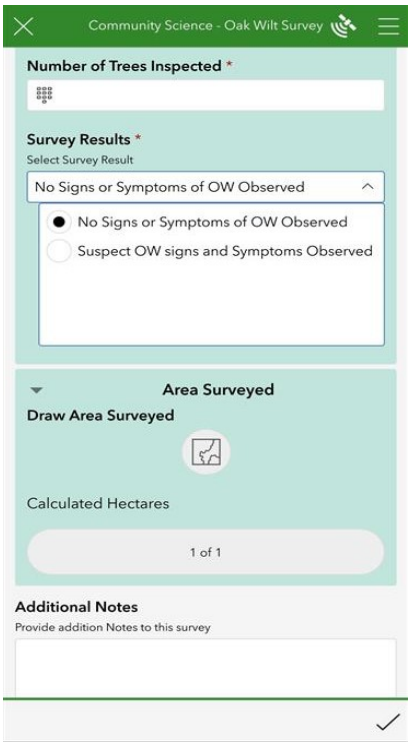


Position your location under the crosshairs zooming in as required. Press the check mark in the bottom right when satisfied.



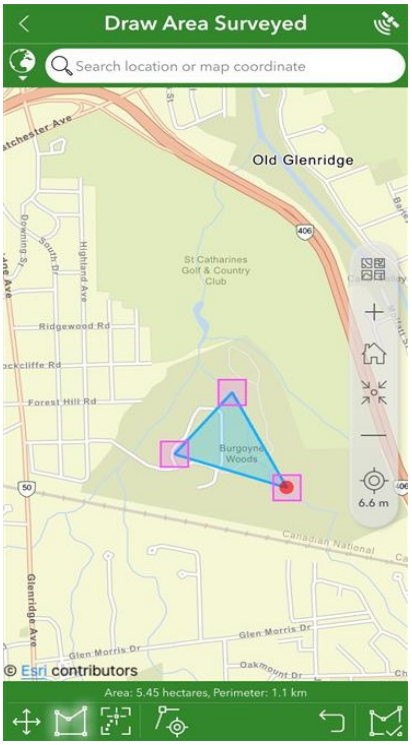
In Oak Surveyed enter the species of oak that was surveyed. Please note that you can select both boxes if surveyed both red and white oak.

Enter the Number of Trees Inspected. It is recommended that 50 oaks trees are assessed per site. If unable to complete a full formal survey, even a small amount of trees inspected is helpful to support the early detection of Oak Wilt.



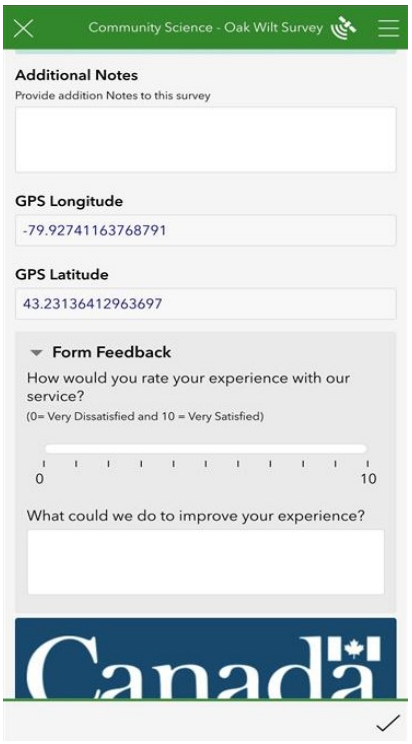
In **Survey Results** if nothing is observed select No Signs or Symptoms of OW Observed.

Press on the map icon below in **Area Surveyed** and a new screen will open.



In the bottom left hand corner click on the polygon icon. Using this tool you can outline the area that you surveyed by clicking on the map to create a polygon, this also allows us to calculate the area surveyed.

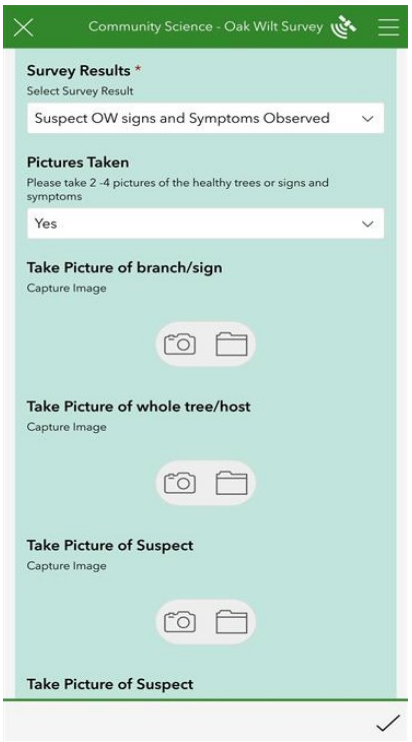
If you make a mistake you can click the back arrow in the bottom right hand corner. Once complete click on polygon with the check mark in the bottom right hand corner.



Type in any **Additional Notes** you may have about the site (number of red vs white oak in forest, general stand health, any hazards, etc.).

Complete the **Form Feedback** section if have any ideas for CFIA to improve the form.

Once you're satisfied with the data that's been entered, click the check mark in the bottom right to complete the Visual survey form.

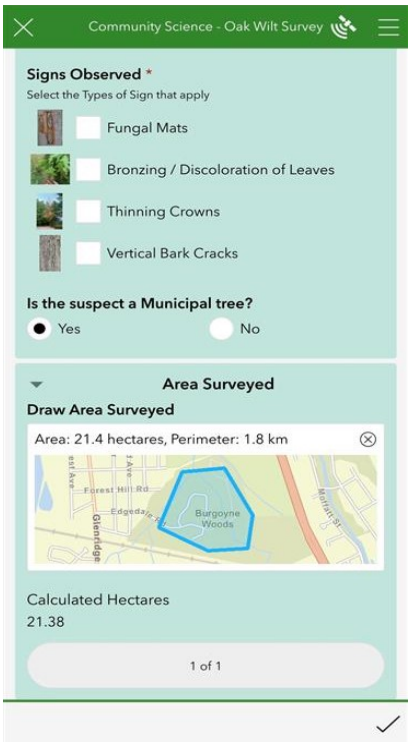


In **Survey Results** if you are suspect of Oak Wilt please select Suspect OW Signs or Symptoms Observed. Please collect pictures showing the branch, overall tree and then close up shots showing the areas affected.

Note: Contact the Canadian Food Inspection Agency when Signs or Symptoms of Oak Wilt are observed.

OakWiltReportingOntario-Fletrissementduchene@inspection.gc.ca

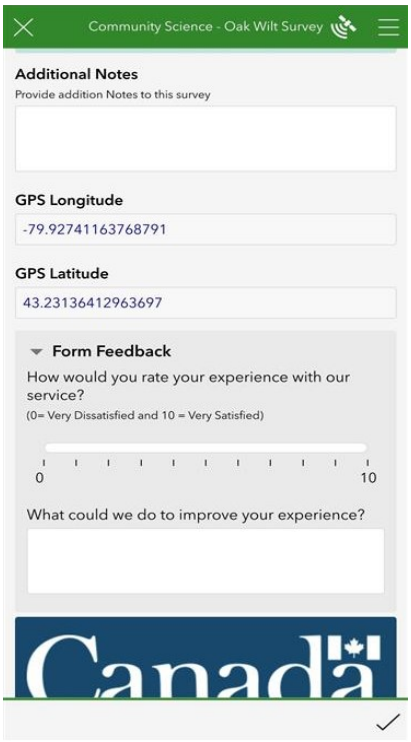
If more than one suspect specimen is identified in distinctly separate areas, submit an additional visual survey form for each specimen collected.



Record the **Signs Observed** and if the **suspect if a Municipal tree.**

Important detail to remember: browning/discoloration of leaves will start in the crown of the tree, fungal mats will only be present when the tree is dead, oak trees have furrowed bark this is different than a bark crack.).

Press on the map below in **Area Surveyed** and a new screen will open allowing a polygon to be created to calculate the area surveyed. See instructions above.



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