

Standard Operating Procedure #8:

Pests and Pathogens

Version 2.1 (1/26/2024)

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Revision History Log

Date	Previous version	New version	Authors
2014	1.0	2.0	Suzanne Sanders and Jessica Grochowski
Documentation was changed from visual confirmation of the problem to a symptom-based approach.			
2024	2.0	2.1	Suzanne Sanders and Jessica Kirschbaum
Revised to: • reword the monitoring question that this SOP addresses; we no longer try to identify the exact pest and/or pathogens; • note that we do not plan to use pest and pathogen damage as a covariate in analyses; • improve wording and flow of text.			

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8.0 Introduction

Pests and pathogens can have tremendous impacts on trees, shrubs, and herbaceous plants (Johnson and Lyon 1991, Sinclair and Lyon 2005). It is important to document and quantify outbreaks and invasions of key taxa of insects, fungi, nematodes, and other pests so that associations may be drawn between pest presence and/or abundance and long-term vegetation dynamics. This standard operating procedure (SOP) outlines the process for doing this.

This Terrestrial Pest and Pathogen indicator of forest health will be monitored within the context of the Forest Vegetation Monitoring Protocol, Version 2.1 (Sanders and Kirschbaum 2024). Instructions for both field methods and analysis techniques are contained or referenced within this SOP.

Because the network will be monitoring terrestrial vegetation at each park only once per rotation, pests and pathogens will also only be documented at this interval. We concede that it is ideal to monitor annually, however time demands and personnel costs are prohibitive, so we will only monitor for pests and pathogens while at terrestrial vegetation plots. Further, we will qualify and quantify pest and pathogen activity by the signs and symptoms evident on the vegetation, and the degree of damage to vegetation, rather than by assessing abundance of the disease agents directly (USDA Forest Service–Northeastern Area 2010). This is detailed below.

The NPS-GLKN pest and pathogen sampling and analyses are designed to answer the specific question, which pests and pathogens are present on trees and to what extent are they damaging them?

The answer to this question provides direct information about the health of forests in Great Lakes Network parks. Further, this information can be combined with information on community structure, succession, and other indices of forest growth and will allow us to draw inferences on overall forest health.

8.1 Field Methods

As part of the Forest Vegetation Monitoring Protocol, all trees tallied are assessed for damage. This is accomplished by examining the bark and any branches, leaves/needles, and buds that are accessible and/or observable from the ground. The key used for identifying signs and symptoms of pests and pathogens, as well as their severity, is shown in Box 1. The red text represents the three broad categories for identifying pests or pathogens, tree stress, signs and symptoms for foliage and twigs, and signs and symptoms for branches and bole. The text in blue are the primary pest/pathogens that may be affecting the tree, and the text in green represents the secondary pest/pathogen, which can either be a severity indicator of the primary pest/pathogen identified, or detail on the primary pest/pathogen identified.

8.1.1 A Simple Diagnostic Protocol for Tree Pest Detection

All text in **blue** is listed as the primary pest/pathogen on your datasheet. The most relevant choice from the list of options in **green** below the blue text is listed as the secondary pest/pathogen on your

datasheet. If none of these conditions are observed, then this item should not be included in your data.

1. Describe symptoms of tree stress (Look in field guide under: **Tree Stress)
(Dieback, Epicormic branches, Wilt, Abiotic factors)**

Dieback of twigs or whole branches is often a symptom of either biotic or abiotic stress, including drought, chemical injury, root injury or disease.

- Is Dieback present? (Display as: **Dieback**)
 - None noted
 - **Twig dieback in upper/outer crown (>10%), but not pervasive**
 - **Pervasive twig dieback throughout the crown**

Epicormic sprouts at the base of the tree or along the bole are often a symptom of either biotic or abiotic stress. (Display as: **Epicormic Sprouts**)

- Are epicormic sprouts present on the bole? Do not include sprouting at the root collar.
 - **Yes**
 - No
- Wilt caused by biotic or abiotic factors. (Display as: **Wilted Foliage**)
If you know that drought or other stress factors are responsible for the wilt observed, record it here. Otherwise record it under foliage symptoms.
 - No wilt
 - **Wilt, partial crown**
 - **Wilt, whole crown**
- Environmental stress or injury (Display as: **Environmental**)
 - None noted
 - **Frost cracks**
 - **Lightning strike**
 - **Hail injury**
 - **Sunscald**
 - **Broken branches**
 - **Flooding**
 - **Drought/poor soil**
 - **Cedar bark splitting**
 - **Other**
- Human-caused stress or injury (Display as: **Human-caused Stress**)
 - None noted
 - **Topping/Poor pruning**
 - **Poor or restricted planting/mulching**

- **Wounding of woody tissues**
- **Salt/Chemicals**
- **Other**

**2. Inspect the foliage and twigs for signs & symptoms of insects or disease.
(Defoliation, Discolored, Abnormalities)**

(Look in field guide under: **Signs and Symptoms of Foliage & Twigs**)

- Is defoliation present? (**Display as: Defoliation**)
Subject to a 10% threshold
 - None noted
 - **Defoliation, >10% of foliage, but not pervasive**
 - **Defoliation, pervasive throughout the crown**
 - **Leaf mining, >10% of foliage, but not pervasive**
 - **Leaf mining, pervasive throughout the crown**
 - **Chewing of the mid-rib only (any level)**
- Is the foliage discolored but not defoliated? (**Display as: Discolored Foliage**)
Subject to a 10% threshold
 - None noted
 - **Mottling, spots, or blotches (any color)**
 - **Marginal scorching (browning) of leaves**
 - **Interveinal scorching (browning) of leaves**
 - **White coating**
 - **Black coating (often sticky)**
 - **Complete browning/bronzing of leaves or needles**
 - **Complete yellowing of leaves or needles**
 - **Stippling**
 - **Yellow/orange/white pustules**
- Do the foliage or twigs appear abnormal? (**Display as: Abnormal Foliage**)
 - None noted
 - **Foliage/twigs distorted (including galls on foliage)**
 - **Witches' brooms present**
- Are any insects or signs of insects present on the twigs or foliage? (**Display as: Insect Signs Foliage/Twigs**)
 - None noted
 - **Caterpillars/sawflies feeding throughout the crown**
 - **Beetles feeding throughout the crown**
 - **Aphids/white cotton pervasive throughout the crown**
 - **Bags pervasive throughout the crown**
 - **Scales pervasive throughout the crown**
 - **Tents/webbing on more than one branch**

- How much of the foliage/twigs is affected? (**Display as: % Foliage Affected**)
 - None
 - >10%; <30%
 - >30% but not the whole crown
 - Whole crown affected
 - *Name of the causal agent, if known (enter as notes).*
3. Inspect the branches and bole for signs & symptoms of insect and disease.
 (Insect activity, Disease presence, Abnormalities)
 (Look in field guide under: **Signs and Symptoms of Branches & Bole**)
- Are there signs or symptoms of insect activity on the woody branches, on the bole, or at the base of the tree? (**Display as: Insect Signs Branches & Bole**)
 - None noted
 - Frass only
 - Sawdust
 - Pitch/resin exudation
 - D-shaped exit holes
 - Pencil round or oval exit holes ($\geq 2\text{mm}$)
 - Shot holes ($< 2\text{mm}$)
 - Other holes
 - Are insects present on the woody branches, on the bole, or at the base? (**Display as: Insect Presence**)
 - None noted
 - Caterpillars
 - Beetles
 - Aphids
 - Scale
 - Carpenter Ants
 - Are there signs or symptoms of disease on the woody branches, bole, or at the base of the tree? (**Display as: Disease Signs**)
 - None noted
 - Decay
 - Conks
 - Fleshy mushrooms
 - Cankers
 - Bleeding/slime flux
 - Resinosis/gummosis
 - Woody galls or burls

(Rhizomorphs or mycelial fans, if present, are recorded under Loose Bark)

- The signs of insect or disease activity are located on: (**Display as: Problem Location**)
 - **Branches**
 - **Bole and/or root collar**
 - **Both branches and bole**
- Are there signs of loose bark on the bole or branches? (**Display as: Loose Bark**)
 - None noted
 - **Loose bark only**
 - **Rhizomorphs present**
 - **Mycelial fans or pads present**
 - **Insect boring or galleries causing loose bark**
- *Name of the causal agent, if known (enter as notes)*

A reasonable threshold level should be exceeded for all signs and symptoms noted. For example, the presence of a single caterpillar should not be reported if there is no evidence of defoliation or other injury to the tree. Symptoms on leaves, twigs, or branches not affecting >10% of the crown should not be reported. Minor mechanical injury on the stem and branches should not be reported.

8.2 Analyses

Pest and pathogen data will be summarized and presented in tables and figures to show the current status after each year that a park is sampled. Analyses testing for either a change or trend may be performed after two or three visits to a park, respectively. These analyses, if performed, must be done so and interpreted with caution. Insect and disease outbreaks are frequently cyclic, often occurring in <5-year intervals. Results indicating differences after five or 10 years will not necessarily be a consequence of linear change during that period.

8.3 Acknowledgements

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8.4 Literature Cited

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