

SCBI Tree Disease Guide

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Introduction

The aim of this guide is to identify tree species of concern within the SCBI ForestGEO plot, and the diseases that are most likely to affect them, so that we can properly identify the causes of decline.

This is designed as a field resource for our **Annual Tree Health & Mortality Census**, with the material likely to be most heavily referenced up front. Methods are explained at the end.

Using this guide

1. Prior to beginning the census, technicians should familiarize themselves with the overall concern levels of the tree species in the plot (Table 1) and, ideally, familiarize themselves with the most common forest insects and diseases affecting species of moderate or high concern. We hope to add images to this guide, but in the meantime, please refer to the *Tree and Forest Health Guide* of the Virginia Department of Forestry. Memorizing the concern level of for common species will make the census process faster, as will knowing common signs of insects/ disease on high or moderate concern level species.
2. In the field, check the concern level of each species you census (Table 1). If the species is of high or moderate concern and is AU or dead, refer to Table 2 to identify insects and diseases affecting the species. Then refer to the *Tree and Forest Health Guide* of the Virginia Department of Forestry for symptoms of these causes.

Tree Species of Concern

Table 1. Summary of the health/ mortality status of all tree species in the SCBI ForestGEO plot. Included is IUCN status, n of living individuals ≥ 10 cm DBH in the SCBI ForestGEO plot, numbers of known species of forest insects or pathogens (FIP) and exotic FIP (EFIP) affecting the species, levels of concern based on mortality rates and “alive-unhealthy” (AU) status, and overall level of concern based on these metrics. Codes: H = high, M = moderate; L = low. Tree species codes are defined in the document SCBI_ForestGEO_sp_ecology.csv.

Tree species code	IUCN status	n living	n FIP	n EFIP	current concern level		
					mortality status	AU status	overall
acne	Least concern	11	10	1	L	M	L
acpl	Least concern	7	9	1	L	L	L
acru	Least concern	170	11	1	L	M	M
aial		3	1	1	M	H	M
caco	Least concern	213	5	0	M	L	L
cagl	Least concern	710	4	0	L	L	L
caovl		292	4	0	L	L	L
cato	Least concern	604	4	0	L	L	L
cade	Critically Endangered	1	1	1	L	L	H
ceoc	Least concern	35	0	0	H	M	M
divi	Least concern	1	0	0	L	L	L
fagr	Least concern	343	7	2	L	L	L
fram	Critically Endangered	125	10	1	H	H	H
frni	Critically Endangered	2	10	1	H	H	H
frpe	Critically Endangered	10	9	1	H	H	H
juci	Endangered	1	4	1	M	H	H
juni	Least concern	107	4	0	L	M	M
litu	Least concern	2097	4	0	L	L	L
nysy	Least concern	484	0	0	L	L	L
pato		2	0	0	M	L	L
pipu	Least concern	1	12	0	L	L	L
pist	Least concern	76	14	0	L	M	M
pivi	Least concern	2	12	0	M	L	L
ploc	Least concern	27	1	0	L	M	L
prav	Least concern	39	2	0	H	M	M
prse	Least concern	10	2	0	M	L	L
qual	Least concern	353	13	2	L	H	H
quco	Least concern	1	13	2	L	H	M
qufa	Least concern	1	13	2	L	H	M
qumi	Least concern	2	13	2	H	H	M

(continued)

Tree species code	IUCN status	n living	n FIP	n EFIP	mortality status	AU status	overall
qupr	Least concern	177	13	2	H	M	H
quru	Least concern	311	14	2	L	M	M
quve	Least concern	222	13	2	H	H	H
rops	Least concern	2	3	0	H	H	M
saal	Least concern	41	3	0	H	H	M
tiam	Least concern	120	4	2	L	L	L
ulam	Endangered	7	12	4	H	L	H
ulru	Least concern	72	12	4	H	H	H

Tree- Disease Matrix

Table 2. Matrix of forest insects and pathogens likely to occur at the SCBI Forest-GEO plot, and the tree taxa they affect. Tree species codes are defined in the document SCBI_ForestGEO_sp_ecology.csv.

Part 1/2: Tree species codes ACNE-NYSY

disease	acne	acpl	acru	aial	caco	cagl	caovl	cato	cade	ceoc	divi	fagr	fram	fmi	frpe	juci	juni	litu	nysy
Xylella fastidiosa (Bacterial Leach Scorch)	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Anoplophora glabripennis (Asian Longhorn Beetle)	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Nakacisina disstria (Forest Tent Caterpillar)	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Glycobius speciosus (Maple Borer)	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Heterocampa guttivitta (Saddled Prominent)	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ennomos subsignaria (Elm Spanworm)	1	1	1	0	0	0	0	0	0	0	0	1	1	1	1	0	0	0	0
Phellinus igniarius / Phellinus laevigatus / Phellinus tremulae (White Trunk Rot)	1	1	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
Climacodon septentrionale (Northern Tooth Bracket Fungus)	1	1	1	0	0	0	0	0	0	0	0	1	1	1	1	0	0	0	0
Cicadellidae (leafhoppers)	1	1	1	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0
Boisea trivittata (Boxelder Bug)	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Paracelemensia acerofoliella (Maple Leafcutter)	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Aphis gossypii (Aphid)	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
Lycorma delicatula (Spotted Lanternfly)	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Scolytus quadrispinosus (Hickory Bark Beetle)	0	0	0	0	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0
Hyphantria cunea (Fall Webworm)	0	0	0	0	1	1	1	1	0	0	0	0	1	1	1	0	0	1	0
Heterocampa manteo (Variable Oakleaf Caterpillar)	0	0	0	0	1	1	1	1	0	0	0	0	1	1	1	0	0	0	0
Nectria cinnabarina (Coral Spot Canker)	0	0	0	0	1	1	1	1	0	0	0	0	1	1	1	0	0	0	0
Ophignomonina leptostyla (Walnut Anthracnose)	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	1	0	0
Cryphonectria parasitica (Chesnut Blight)	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
Neofusicoccum spp. (Stem Canker)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0
Agrilus planipennis (Emerald Ash Borer)	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	0	0	0	0

Part 1/2: Tree species codes ACNE-NYSY (*continued*)

disease	acne	acpl	acru	aial	caco	cagl	caovl	cato	cade	ceoc	divi	fagr	fram	frni	frpe	juci	juni	litu	nysy
Cryptococcus fagisuga Lindinger (Woolly Beech Scale)	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
Neonectria spp. , Nectria coccinea (Beech Bark Disease)	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
Litylenchus crenatae n. sp (Beech Leaf Disease)	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
Alsophila pometaria (Fall Cankerworm)	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	0	0	0	0
Candidatus Phytoplasma (Ash Yellows)	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	0	0	0	0
Podosesia syringae (Lilac Ash Borer)	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	0	0	0	0
Ophiognomonia clavigignenti-juglandacearum (Butternut Canker)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
Geosmithia morbida (Thousands Cankers Disease)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0
Neonectria galligena (Nectrua Canker)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Euzophera ostricorella (Root Collar Borer)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
Odontopus calcaetus (Yellow Poplar Weevil)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0

Part 2/2: Tree species codes PATO-ULRU

disease	pato	pipu	pist	pivi	ploc	prav	prse	qual	quco	qufa	qumi	qupr	quru	quve	rops	saal	tiam	ulam	ulru
Xylella fastidiosa (Bacterial Leach Scorch)	0	0	0	0	1	0	0	1	1	1	1	1	1	1	0	0	0	1	1
Anoplophora glabripennis (Asian Longhorn Beetle)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
Nakacisina disstria (Forest Tent Caterpillar)	0	0	0	0	0	0	0	1	1	1	1	1	1	1	0	0	0	0	0
Ennomos subsignaria (Elm Spanworm)	0	0	0	0	0	0	0	1	1	1	1	1	1	1	0	0	0	1	1
Cicadellidae (leafhoppers)	0	0	0	0	0	0	0	1	1	1	1	1	1	1	0	0	1	1	1
Hyphantria cunea (Fall Webworm)	0	0	0	0	0	0	0	1	1	1	1	1	1	1	0	0	0	1	1
Heterocampa manteo (Variable Oakleaf Caterpillar)	0	0	0	0	0	0	0	1	1	1	1	1	1	1	0	0	0	1	1
Nectria cinnabarina (Coral Spot Canker)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
Alsophila pomataria (Fall Cankerworm)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Odontopus calcaetus (Yellow Poplar Weevil)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
Ceratocystis spp. (Bluestain Fungus)	0	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ophiostoma spp. (Bluestain Fungus)	0	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sirex noctilio (Sirex Woodwasp)	0	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Scleroderris lagerbergii (Scleroderis Canker)	0	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ips pini (Pine Engraver Beetle)	0	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ips grandicollis (Southern Pine Engraver)	0	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ips calligraphus (Six-spined Ips)	0	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ips avulsus (Small Southern Pine Engraver)	0	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Choristoneura pinus (Jack Pine Budworm)	0	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cronartium quercuum (Fusiform Rust)	0	1	1	1	0	0	0	1	1	1	1	1	1	1	0	0	0	0	0
Phellinus pini (Red trunk Rot)	0	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Dendroctonus frontalis Zimmermann (Southern Pine Beetle)	0	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cronartium ribicola (White Pine Blister Rust)	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
pineus strobi (Pine Bark Adelgid)	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Euzophera semifuneralis (American Plum Borer)	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0

Part 2/2: Tree species codes PATO-ULRU (*continued*)

disease	pato	pipu	pist	pivi	ploc	prav	prse	qual	quco	qufa	qumi	qupr	quru	quve	rops	saal	tiam	ulam	ulru
Apiosporina morbosus (Black Knot Disease)	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0
Lymantria dispar (Gypsy Moth)	0	0	0	0	0	0	0	1	1	1	1	1	1	1	0	0	0	0	0
Phytophthora ramorum (Sudden Oak death)	0	0	0	0	0	0	0	1	1	1	1	1	1	1	0	0	0	0	0
Agrilus bilineatus (Two Lined Chestnut Borer)	0	0	0	0	0	0	0	1	1	1	1	1	1	1	0	0	0	0	0
Armillaria spp. (Honey Fungus)	0	0	0	0	0	0	0	1	1	1	1	1	1	1	0	0	0	0	0
Ceratocystis fagacearum (Oak Wilt)	0	0	0	0	0	0	0	1	1	1	1	1	1	1	0	0	0	0	0
Anisota senatoria (Orangestriped Oakworm)	0	0	0	0	0	0	0	1	1	1	1	1	1	1	0	0	0	0	0
Enaphalodes rufulus (Red Oak Borer)	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
Phellinus robiniae / Phellinus rimosus / Polyporus (Heart Rot Fungus)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
Odontota dorsalis (Black Locust Leaf Miner)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
Megacyllene robiniae (Locust Borer)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
Raffaelea lauricola (Laurel Wilt)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
Xyleborus glabratus (Redbay Ambrosia Beetle)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
Popillia japonica (Japanese Beetle)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Thrips calcaratus (Basswood Thrips)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Scolytus multistriatus (Smaller European Elm Bark Beetle)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
Scolytus schevyrewi (Banded Elm Bark Beetle)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
Ophiostoma ulmi/Ophiostoma nova-ulmi/Ophiostoma himal-ulmi (Dutch Elm Disease)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
Scaphoideus luteolus Van Duzee (Whitebanded Leafhopper)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
Hylurgopinus rufipes (Native Elm Bark Beetle)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1

Pictorial guide to most important pests & diseases

This is in progress. A complete guide is the *Tree and Forest Health Guide* of the Virginia Department of Forestry.

Insect pests

Phloem feeders (Sapsuckers)

Phloem feeders pierce plant tissues to access nutrient-rich phloem sap. They are often quite small (e.g., adelgids, aphids, scale insects) but can be larger (e.g., cicadas, spotted lanternfly, brown marmorated stink bug). They are mostly in the insect order Hemiptera, including aphids, planthoppers, leafhoppers, treehoppers, whiteflies, cicadas, spittlebugs, scale insects, and shield bugs [Jiang_2019]. Damage can range from negligible to mortality. They can transmit / enable bacterial or fungal infections.

Spotted Lanternfly

Defoliators

Root/Shoot/Twig Insects

Bark Beetles/ Wood Borers

Diseases

Rusts

Root

Cankers

Foliage

Vascular

Methods & Definitions

Tree species concern levels

We assigned concern levels – high (H), moderate (M), or low (L) – to each tree species based on results of the SCBI ForestGEO mortality census, IUCN status, and the presence and lethality of pest and pathogen species.

Concern level based on observed tree mortality rates

High concern:

- mortality rate $\geq 5\% \text{ yr}^{-1}$ in more than one year, OR...
- dominant species (≥ 100 individuals of $\text{DBH} \geq 10 \text{ cm}$) with an overall increasing trend and $\geq 5\% \text{ yr}^{-1}$ in the most recent year (2021)

Moderate concern:

- mortality rate $\geq 5\% \text{ yr}^{-1}$ in only one year (but does not meet high concern criteria of dominant species with increasing trend)

Low concern:

- mortality rate $< 5\% \text{ yr}^{-1}$ in all census years

Concern level based on the fraction of alive but unhealthy (“AU” status) trees observed in the latest census

High concern:

- $\geq 20\%$ of living trees were unhealthy in the latest census.

Moderate concern:

- $\geq 10\%$ (but $< 20\%$) of living trees were unhealthy in the latest census.

Low concern:

- $< 10\%$ of living trees were unhealthy in the latest census.

Overall concern level

- If IUCN Red List status was anything other than “Least Concern”, the species was flagged as high concern
- If an exotic pest or disease with high / moderate lethality was known to be present in region, any species affected by that pest/ disease was flagged as H/M concern. (*Note: we have not yet set up the data/ code infrastructure for this, but rather adjusted individual species as appropriate.*)
- If either mortality rate or AU concern level was M or H, overall concern was assigned to match the highest concern level, but lowered one level in the case of species with < 50 individuals in the plot and only one M or H ranking.
- If IUCN Red List status was anything other than “Least Concern”, there were no known highly lethal exotic pests or diseases present, and both mortality and AU concern levels were low, the species was flagged as low concern.

Identifying tree species - disease pairs