National Park Service
U.S. Department of the Interior

Northeast Region / Midwest Region / National Capital Region / Southeast Region

Rapid Response
To Insect, Disease & Abiotic Impacts

Procedures to Protect Forest Integrity in Units of the National Park System within Eastern Forests

2010

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Cover photos – upper-left: Emerald ash borer on American ash, Steven Katovich, USDA Forest Service, Bugwood.org; upper-right: hemlock woolly adelgids on eastern hemlock, James Åkerson, NPS staff; lower-left: beech bark disease fruiting bodies, Dale Meyerhoeffer, NPS staff; and lower-right: sudden oak death symptom, Steve Tjosvold, UCCE, Santa Cruz, CA, Suddenoakdeath.org.

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Plan Approval

In accordance with the authorities and references cited, the following plan has been reviewed and approved for implementation necessary to prevent or protect the forest resources of the eastern National Park Service units from significant invasive forest pests.

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Dichotomous Key

Decision Key for Determining Causal Agents of Tree Mortality

A keying device such as this may be redundant if the trees in question are suffering from an obvious widespread malady that has already been diagnosed on neighboring lands or if there is ready access to forest health expertise. This key is useful where a methodical decision tree is desired to sort the possibilities. It is the first of three ways to determine likely tree maladies. The second is to scan the Appendix C index (first pages) that categorizes potential pests and diseases. Lastly, a person may merely scan the individual advisories found in Appendix C.

I. Species-specific Shortcuts

This section considers maladies restricted to one species or genera.

1.a. Are the forest or tree impacts restricted to only one genera or species?	Yes – Go to 2.a.
1.b.	No – Go to Section II

2.a. Are the forest or tree impacts in one of the following genera or species?

Apple (disease)	Yes – Go to **Cedar Apple Rust**
Ash tree genera (insect)	Yes – Go to **Emerald Ash Borer**
Beech (disease)	Yes – Go to **Beechbark Disease**
Black locust (insects)	Yes – Go to **Locust Borer** or **Locust Leafminer**
Butternut (disease)	Yes – Go to **Butternut Canker**
Cherry/plum genera (caterpillar feeding on leaves in early spring)	Yes – Go to **Eastern Tent Caterpillar**
(black disease growth on branches)	Yes – Go to **Black knot**
Dogwood genera (disease)	Yes – Go to **Dogwood Anthracnose**
Elm genera (insect or disease)	Yes – Go to **Elm Leaf Beetle** or **Dutch Elm Disease** or **Elm Yellows**
Hemlock, Eastern or Carolina (insect)	Yes – Go to **Hemlock Woolly Adelgid**
Juniper, redcedar / Virginia cedar (disease)	Yes – Go to **Cedar Apple Rust**
Oaks (disease)	Yes – Go to **Oak Decline** or **Oak Wilt** or **Sudden Oak Death**
Pine, white pine group (disease)	Yes – Go to **White Pine Blister Rust**
Sycamore (disease)	Yes – Go to **Sycamore Anthracnose**
Viburnum (insect)	Yes – Go to **Viburnum Leaf Beetle**
Walnut (insect or disease)	Yes – Go to **Thousand Cankers Disease** or **Walnut Twig Beetle**
2.b.	No – Go to Section II

II. Triage for the Types of Damage

This section considers both hardwoods and conifers.

II-1.a. Trees show signs of leaf/needle defoliation (evidence of actual chewed leaves)	Yes – Go to Section III
II-1.b.	No – Go to 2.a.
II-2.a. Tree leaves or needles show signs of fading, discoloration, splotches, scorching, or shriveling	Yes – Go to Section IV
II-2.b.	No – Go to 3.a.
II-3.a. Trees show signs of boreholes in the trunk/stems/branches	Yes – Go to Section V
II-3.b.	No – Go to 4.a.
II-4.a. Trees show signs of disease on trunk or branches	Yes – Go to Section VI
II-4.b. All others: sucking insects and unknowns	– Go to Section VII

III. Focus: Leaf/Needle Defoliation by Insects

This section considers leaf-eating insects.

Chewed leaves may take the appearance of having tiny holes (sometimes called shotgun feeding), jagged leaf margins that show obvious damage from chewing, or the appearance as if torn.

III-A

III-A-1.a. Hardwood?	Yes – Go to III-B
III-A-1.b. Conifer?	Yes – Go to III-C

III-B Hardwood Defoliators

(Be careful not to touch tussock (hairy) moths with sensitive parts of your skin.)

III-B-1.a. Single tree species or genera involved?	Yes – Go to 2.a.
III-B-1.b. No. Several tree species and genera are involved	– Go to 4.a.

Species-specific Defoliators

III-B-2.a. Elm species leaves exhibit holes or/and chewing on underside of leaf surface; adult beetle is 1/4" long, yellowish to green with black stripe on each wing margin; larva is 1/4" long and bright orange-yellow	Yes – **ELM LEAF BEETLE** Appendix-C-13
III-B-2.b.	No – Go to 3.a.
III-B-3.a. Viburnum species exhibit severe defoliation, leaf veins are left intact; branchlets exhibit pitting (from egg laying); larvae are distinctive greenish-yellow with dark dots, 1/4”-3/8” long; adult beetle is 1/4" long and light yellow-to-tannish brown	Yes – **VIBURNUM LEAF BEETLE** Appendix-C-41
III-B-3.b.	No – Go to 4.a.

Non-selective Defoliators

III-B-4.a. Larvae appear to live or hide gregariously inside a silk web-bag	Yes – Go to 5.a.
III-B-4.b.	No – Go to 13.a.

Larvae Using a Silken Web-bag for Gathering/Protection

III-B-5.a. Site is along the New England coast	Yes – Go to 6.a.
III-B-5.b.	No – Go to 8.a.

III-B-6.a. Adult moths are snowy white with brown hairy bodies (Highly likely to cause severe skin rash.)	Yes – **BROWNTAIL MOTH** Appendix-C-7
III-B-6.b. Either "No" or cannot find adult moths	No – Go to 7.a.
III-B-7.a. Larvae are hairy, reddish-brown with distinctive orange dots; and gregarious (Highly likely to cause severe skin rash.)	Yes – **BROWNTAIL MOTH** Appendix-C-7
III-B-7.b.	No – Go to 8.a.
III-B-8.a. Springtime to early summer appearance; feeding on cherry/plum	Yes – Go to 9.a.
III-B-8.b.	No – Go to 10.a.
III-B-9.a. Silk web at branch crotches only, not enclosing leaves; larvae are 2+" with light stripe on back, one wavy yellow line on either side, and blue-black spots on side	Yes – **EASTERN TENT CATERPILLAR** Appendix-C-11
III-B-9.b.	No – Go to 10.a.
III-B-10.a. Late summer to fall appearance; silken webs are heavy and pendulous	Yes – Go to 11.a.
III-B-10.b.	No – Go to 12.a.
III-B-11.a. 1-inch larvae have long whitish hairs; webs encase leaves and branches, not just branch crotches	Yes – **FALL WEBWORM** Appendix-C-21
III-B-11.b.	No – Go to 12.a.
III-B-12.a. Reconsider III-1; are you sure of the gregarious nature with silken web-bag?	Yes – Go to III-E-1.a.
III-B-12.b.	No – Go to 13.a.
Larvae Not Using a Silken Web-bag	
III-B-13.a. Larvae are not hairy (not tussocks)	Yes – Go to 14.a.
III-B-13.b.	No – Go to 20.a.
III-B-14.a. Infestation is along the northern tier of U.S., from Maine to Minnesota	Yes – Go to 15.a.
III-B-14.b.	No – Go to 16.a.
III-B-15.a. Larvae are 2mm-2.5cm, not hairy, dark brown with light colored spots along back; adults are 2cm across, gray to brown with brown markings	Yes – **EASTERN SPRUCE BUDWORM** Appendix C-9
III-B-15.b.	No – Go to 16.a.
III-B-16.a. Larvae are distinctive inchworms with three legs in front and behind	Yes – Go to 17.a.
III-B-16.b.	No – Go to 19.a.
III-B-17.a. Leaves are eaten except midribs and veins; fall larvae are 1" long while spring larvae are 0.8-to-1.5" long, green to black, with dark dorsal stripe and light yellow lines on sides, not hairy	Yes – **FALL CANKERWORM** Appendix C-19
III-B-17.b.	No – Go to 18.a.
III-B-18.a. Larvae are pale light green, not hairy; male moths have light grey wings, while female moths without developed wings; feeding on buds and whole leaves	Yes – **WINTER MOTH** Appendix C-47
III-B-18.b.	No – Go to 19.a.
III-B-19.a. Black and honey locust (and others) leaves exhibit brown-tan spotting and lines indicating insect mining activity; adult beetle is 1/4" long, orange and black; 1/3" flattish larva not hairy, white with black head, turning yellow with age	Yes – **LOCUST LEAFMINER** Appendix-C-35
III-B-19.b.	No – Go to III-D-1.a

III-B-20.a. Hairy larvae grow from 0.1”-to-2.5”, with five pair of blue dots followed by six pair of red dots on top	Yes – **GYPSY MOTH** Appendix C-25
III-B-20.b.	No – Go to 21.a.
III-B-21.a. Hairy larvae are 0.15”-to-2”, with keyhole-shaped white patches on top	Yes – **FOREST TENT CATERPILLAR** Appendix C-23
III-B-21.b.	No – Go to III-D-1.a.

III-C Conifer Defoliators

III-C-1.a. Is there sign of caterpillars or moths causing the needle/scale defoliation?	Yes – Go to 2.a.
III-C-1.b.	No – Go to 3.a.
III-C-2.a. Gregarious feeding; caterpillar not hairy, with shiny black head and predominately brown-to-black body with many yellow dots	Yes – **INTRODUCED PINE SAWFLY** Appendix-C-31
III-C-2.b.	No – Go to III-D-1.b.
III-C-3.a. Is there sign of strange 1.5”-2.5” brown bundles of needles/scales in ever-greens, junipers or arborvitae?	Yes – **BAGWORM** Appendix-C-5
III-C-3.b.	No – Go to III-D-1.b.

III-D No Matches

III-D-1.a. **Hardwood** defoliators – consider using a broader key source for hardwood defoliators such as cottonwood leaf beetle, Linden looper, Eastern oak looper, Elm spanworm, Orangestriped oakworm, pinkstriped oakworm, spiny oakworm, poplar tentmaker, slug oak sawfly, walkingstick, walnut caterpillar, and whitemarked tussock moth, among others.

III-D-1.b. **Conifer** defoliators – consider using another key source for conifer defoliators such as blackheaded pine sawfly, loblolly pine sawfly, pine colaspis, pine webworm, redheaded pine sawfly, and Virginia pine sawfly, among others.

IV. Focus: Leaf/Needle Diseases and Other Maladies

This section considers problems with disease and atmospheric or chemical deposition.

IV-A

IV-A-1.a. Does the leaf/needle malady involve both hardwoods and conifers?	Yes – Go to IV-D-1.a.
IV-A-1.b.	No – Go to 2.a
IV-A-2.a. Hardwood only?	Yes – Go to IV-B-1.a.
IV-A-2.b. Conifer only?	Yes – Go to IV-C-1.a.

IV-B Hardwoods

IV-B-1.a. Single hardwood tree species or genera involved?	Yes – Go to 2.a.
IV-B-1.b. Several hardwood tree species and genera are involved?	Yes – Go to 11.a.

Species-specific Diseases

IV-B-2.a. Apple leaves have yellow-orange spots on upper leaf surface that can misshape them	Yes – **CEDAR APPLE RUST** Appendix C-59
IV-B-2.b.	No – Go to 3.a.
IV-B-3.a. Dogwood leaves appear to have burned margins or spots and splotches	Yes – **DOGWOOD ANTHRACNOSE**[1] Appendix C-61
IV-B-3.b.	No – Go to 4.a.

[1] Consider also diseases such as powdery mildew (not included) and hardwood anthracnose (Appendix C-69).

IV-B-4.a. Elm species leaves are yellow and wilted; tree crown is impacted all at once; inner bark has characteristic odor of wintergreen — Yes – **ELM YELLOWS** Appendix C-67

IV-B-4.b. — No – Go to 5.a.

IV-B-5.a. Elm species leaves are brown and wilted; process of wilting-to-death may take only 6-10 weeks; inner bark has characteristic brown streaking — Yes – **DUTCH ELM DISEASE** Appendix C-63

IV-B-5.b. — No – Go to 6.a.

IV-B-6.a. Oak tree crowns become thin over a period of years (other species not involved); sudden leaf browning and shriveling but retained; terminal leaves die first; branch and bole sprouting occurs — Yes – **OAK DECLINE** Appendix C-73

IV-B-6.b. — No – Go to 7.a.

IV-B-7.a. Oak tree crowns rapidly decline (one year or less); red oak group leaves have characteristic bronze splotches growing from tips and margins down to the stem; white oak group leaves have similar progress in yellow-browns — Yes – **OAK WILT** Appendix C-75

IV-B-7.b. — No – Go to 8.a.

IV-B-8.a. Redbay foliage have reddish or purplish discoloration. Symptoms limited to part of the crown, or entire crown wilts and turns brown. Sapwood exhibits blue-to-black staining — Yes – **LAUREL WILT** Appendix C-71

IV-B-8.b. — No – Go to 9.a.

IV-B-9.a. Sycamore leaves have appearance of frost damage, or are spotted, splotched, or misshapened — Yes – **SYCAMORE ANTHRACNOSE**[2] Appendix C-79

IV-B-9.b. — No – Go to 10.a.

IV-B-10.a. Consider atmospheric and chemical problems — Yes – Go to IV-D-1.a.

IV-B-10.b. Consider non-selective diseases — Yes – Go to 11.a.

Non-selective Diseases

IV-B-11.a. Several tree species involved; no apparent bark disease; brown to black leaf spots and blotches on leaves; appearance of frost damage or blackening, shriveling; pink spores may ooze out from lower leaf surfaces — Yes – **HARDWOOD ANTHRACNOSE** Appendix C-69

IV-B-11.b. — No – Go to 12.a.

IV-B-12.a. Brown to black leaf spots/blotches on rhododendron and laurel leaf tips & margins; accompanied by twig dieback — Yes – **SUDDEN OAK DEATH** Appendix C-77

IV-B-12.b. — No – Go to 13.a.

IV-B-13.a. Consider atmospheric and chemical problems — Yes – Go to IV-D-1.a.

IV-B-13.b. — No – Go to IV-E-1.a.

IV-C Conifers

IV-C-1.a. Junipers (including VA cedar) have either bright orange gelatinous growths or brown round or kidney-shaped galls with dots — Yes – **CEDAR APPLE RUST** Appendix C-59

IV-C-1.b. — No – Go to 2.a.

[2] Consider also diseases such as powdery mildew (not included) and hardwood anthracnose (Appendix C-69).

IV-C-2.a. Consider atmospheric and chemical problems	Yes – Go to IV-D-1.a.
IV-C-2.b.	No – Go to IV-E-1.b.

IV-D Maladies Associated with Atmospheric or Chemical Deposition

IV-D-1.a. Is the malady limited to within 20' of a roadside?	Yes – Go to 2.a.
IV-D-1.b.	No – Go to 3.a.
IV-D-2.a. Might affected trees/shrubs have received deicing salts directly or indirectly?	Yes – **ROADSIDE DEICING SALTS** Appendix C-85
IV-D-2.b.	No – Go to 3.a.
IV-D-3.a. Is the forest location along the ocean coast or within 2 miles of it?	Yes – Go to 4.a.
IV-D-3.b.	No – Go to 5.a.
IV-D-4.a. Is it possible the affected trees received airborne salts or tidal storm surge from a recent storm event?	Yes – **SALT FROM STORM EVENTS** Appendix C-87
IV-D-4.b.	No – Go to 5.a.
IV-D-5.a. Is the forest location within 10 miles (and typically downwind) of an active smelter, steel mill, chemical plant, or coal burning power plant?	Yes – Go to 6.a.
IV-D-5.b.	No – Go to 7.a.
IV-D-6.a. Do conifer needles show sign of scorch or yellowing, or do hardwood leaves show signs of stippling (fine dark dots) or pigment darkening?	Yes – **SULFUR DIOXIDE** or **FLUORIDES** Appendix C-91/93
IV-D-6.b.	No – Go to 7.a.
IV-D-7.a. Is the forest location within 70 miles (and typically downwind) of an active power plant or heavy factory that burns coal?	Yes – Go to 8.a.
IV-D-7.b.	No – Go to 9.a.
IV-D-8.a. Do conifer needles show sign of scorch or yellowing, or do hardwood leaves show signs of stippling (fine dark dots) or pigment darkening?	Yes – **OZONE** Appendix C-89
IV-D-8.b.	No – Go to 9.a.
IV-D-9.a. Consider non-selective diseases	– Go to IV-B-10.a.
IV-D-9.b. Consider other maladies not in this manual	– Go to IV-E-1.a/b.

IV-E No Matches

IV-E-1.a. **Hardwood** leaf symptoms: consider using another key source for hardwood diseases such as powdery mildew, among others, and abiotic factors.

IV-E-1.b. **Conifer** leaf symptoms: consider using another key source for conifer diseases such as needle cast and brown spot needle blight, among others, and abiotic factors.

V. Focus: Bark & Wood Boring Insects

This section considers bark beetles and woodborers.

V-A

V-A-1.a. Hardwood?	Yes – Go to V-B
V-A-1.b. Conifer?	Yes – Go to V-C

V-B Hardwood Beetles, Borers

V-B-1.a. Single tree species or genera involved?	Yes	– Go to 2.a.
V-B-1.b. No. Several tree species and genera are involved		– Go to 5.a.

Hardwood Species-specific Insect Pests

V-B-2.a. Ash tree crowns fading from top downward; D-shaped exit holes in bark (1/8"); vertical fissures (splits) in bark; increased woodpecker activity in area	Yes	– **EMERALD ASH BORER** Appendix C-17
V-B-2.b.	No	– Go to 3.a.
V-B-3.a. Black locust stands have many dead with broken tops and branches and swollen knots; in springtime, wet spots appear in bark; in summer, white sawdust on bark and base of tree; adult is distinctive yellow-black striped longhorn beetle	Yes	– **LOCUST BORER** Appendix C-3
V-B-3.b.	No	– Go to 4.a.
V-B-4.a. Black and English walnuts exhibit dark stains on outer bark; beetle exit holes (size of pin pricks); inner bark shows many canker sites; yellowing and thinning in crown with wilting of leaves, branch dieback	Yes	– **WALNUT TWIG BEETLE**[3] Appendix C-81 (Thousand cankers)
V-B-4.b.	No	– Go to 5.a.
V-B-5.a. "Toothpick" frass coming from trunk and stems. Redbay sapwood exhibits blue-to-black staining. Redbay foliage have reddish or purplish discoloration	Yes	– **REDBAY AMBROSIA BEETLE** Appendix C-71
V-B-5.b.	No	– Reconsider Section I or Go to 6.a.

Non-specific Insect Pests

V-B-6.a. Large (1/4") circular holes in tree trunk and branches; chewed dimples in bark from past/current egg laying	Yes	– Go to 7.a.
V-B-6.b.	No	– Go to V-D-1.a.
V-B-7.a. Adult beetle is 1"-to-1.5" long, jet black back with white spots; black and white antennae which are 1.5-to-2.5 times body length	Yes	–**ASIAN LONGHORN BEETLE** Appendix C-3
V-B-7.b.	No	– Go to 8.a.
V-B-8.a. Adult beetle has more white than black on back	Yes	– See Cottonwood borer separate guide
V-B-8.b.	No	– Go to 9.a.
V-B-9.a. Adult beetle antennae are all black or faintly gray banded	Yes	– Go to V-C-2.a.
V-B-9.b.	No	– Go to V-D-1.a.

V-C Conifer Beetles, Borers

V-C-1.a. Is it possible the host tree was dead or recently cut/killed when insect entered?	Yes	– Go to 2.a.
V-C-1.b.	No	– Go to 3.a.
V-C-2.a. Adult beetle is 0.8"-to-1" long; black body with white spots (females); and long entirely black antennae (2 x body length for male) or gray-and-black banded (1 x body length for female) antennae	Yes	– **WHITESPOTTED SAWYER** Appendix C-45
V-C-2.b.	No	– Go to 3.a.

[3] The outer signs could indicate hardwood anthracnose without beetle exit holes and inner bark staining.

V-C-3.a. Dying tree has oozing sap on trunk; dying needles point straight down	Yes – **SIREX WOODWASP** Appendix C-37
V-C-3.b.	No – Go to 4.a.
V-C-4.a. There are dozens of trees nearby in varying stages of dying (needles fading yellow on some, bright red on others, and brown-to-straw color further away)	Yes – Go to 5.a.
V-C-4.b.	No – Consider Ips beetle in separate guide
V-C-5.a. Dying trees have 1/4”-to/1/2” yellow-white pitch tubes	Yes – **SOUTHERN PINE BEETLE** Appendix C-39
V-C-5.b.	No – Go to V-D-1.b.

V-D No Matches

V-D-1.a. **Hardwood** beetles and borers – consider using another key source for hardwood insects such as carpenter worm, cottonwood borer, cottonwood twig borer, hickory bark beetle, and red oak borer, among others.

V-D-1.b. **Conifer** beetles and borers – consider using another key source for conifer insects such as ambrosia beetle, black turpentine beetle, and Ips engraver, among others.

VI. Focus: Stem, Bark & Wood Diseases

This section considers fungi of the cambium, wood, and roots.

VI-A

VI-A-1.a. Hardwood?	Yes – Go to VI-B
VI-A-1.b. Conifer?	Yes – Go to VI-C

VI-B Hardwood Wood Diseases

VI-B-1.a. Are the disease symptoms mostly on leaves?	Yes – Go to Section IV-B
VI-B-1.b. No. The disease symptoms are mostly on branches, stem, trunk, or roots	– Go to 2.a.
VI-B-2.a. Beech trees exhibit fading crowns; white scale attached to outer bark; seasonal reddish nectria fungus on bark; bark appears pitted with many cankers	Yes – **BEECHBARK DISEASE** Appendix C-51
VI-B-2.b.	No – Go to 3.a.
VI-B-3.a. Butternut trees exhibit dieback of branches; stem cankers have black centers with white margins; branches have swelling near buds/leaf scars	Yes – **BUTTERNUT CANKER** Appendix C-57
VI-B-3.b.	No – Go to 4.a.
VI-B-4.a. Black and English walnuts exhibit dark stains on outer bark; beetle exit holes (size of pin pricks); inner bark shows many canker sites; yellowing and thinning of crown, with wilting leaves, branch dieback	Yes – **THOUSAND CANKERS DISEASE** Appendix C-81
VI-B-4.b.	No – Go to 5.a.
VI-B-5.a. Cherries exhibit black cankerous growths along branchlets and branches; typically no dead cherry trees are found in area	Yes – **BLACK KNOT** Appendix C-55
VI-B-5.b.	No – Go to 6.a.
VI-B-6.a. Red oaks exhibit black to red sap seeping from intact bark; the bark develops red-brown discoloration; cankers at the sites, typically 3’+ above ground	Yes – **SUDDEN OAK DEATH** Appendix C-77
VI-B-6.b.	No – Go to VI-D-1.a.

VI-C Conifer Diseases

VI-C-1.a. Are the disease symptoms mostly on needles?	Yes – Go to Section IV-C
VI-C-1.b. No. The disease symptoms are mostly on stems, trunk, or roots	– Go to 2.a.
VI-C-2.a. White pines exhibit swollen branches and developing cankers on branches and main stem; cankers cause pitch that flows down trunk	Yes – **WHITE PINE BLISTER RUST** Appendix C-83
VI-C-2.b.	No – Go to 3.a
VI-C-3.a. Is there a widening circle of dead conifers present in forest; yellowing needles, thinning crowns; and windthrown trees present?	Yes – Go to 4.a.
VI-C-3.b.	No – Go to VI-D-1.b
VI-C-4.a. Fungal conks are present on a few/several trees (often under leaf litter at base of trees; stumps have characteristic separation of annual rings by fungal growth	Yes – **ANNOSUS ROOT DISEASE** Appendix C-49
VI-C-4.b.	No – Go to VI-D-1.b

VI-D No Matches

VI-D-1.a. **Hardwood** pathogens – consider using another key source for hardwood pathogens such as cottonwood rust, nectria canker, hypoxylon danker, strumella canker, chestnut blight, and shoestring rot, among others.

VI-D-1.b. **Conifer** pathogens – consider using another key source for conifer pathogens such as Phomopsis blight, Fusiform rust, commandra blister rust, eastern gall rust, Annosus rot, and brown cubical rot, among others.

VII. Miscellaneous Problems Discussion

This section considers piercing and sucking insects, dwarf mistletoes, and reconsiders root rots.

VII-A

VII-A-1.a. No sign of defoliation but there are "insects" present	Yes – Go to VII-B-1.a.
VII-A-1.b.	No – Go to 2.a.
VII-A-2.a. Odd plant growth on branches; no sign of defoliation, no "insects"	Yes – Go to VII-C-1.a.
VII-A-2.b.	No – Go to 3.a.
VII-A-3.a. No sign of defoliation, no "insects," but leaves are fading	Yes – Go back to Section IV
VII-A-3.b.	No – Go to 4.a.
VII-A-4.a. Defoliation is present	Yes – Go back to Section III
VII-A-4.b.	No – Go to VII-D-1.a.

VII-B Piercing and Sucking Insects

VII-B-1.a. Hardwood?	Yes – Go to VII-D-1.a.
VII-B-1.b. Conifer?	Yes – Go to 2.a.
VII-B-2.a. Wilting and dying terminal shoots are present	Yes – Go to 3.a.
VII-B-2.b.	No – Go to 4.a.
VII-B-3.a. Oozing pitch along affected shoots is present; inside the ooze point, a white larva with brown head is present	Yes – **WHITE PINE WEEVIL** Appendix C-43
VII-B-3.b.	No – Go to VII-D-1.b
VII-B-4.a. Fuzzy white dots on hemlock only at branchlets, not needles	Yes – **HEMLOCK WOOLLY ADELGID**
VII-B-4.b.	No – Go to 4.a.

VII-B-5.a. White and brown dots on underside of needles (hemlock and other conifers)	Yes – **ELONGATE HEMLOCK SCALE** Appendix C-15
VII-B-5.b.	No – Go to VII-D-1.b.

VII-C Mistletoes and Dwarf Mistletoes

VII-C-1.a. Is the affected tree a conifer?	Yes – Go to 2.a.
VII-C-1.b.	No – Go to VII-D-1.a.
VII-C-2.a. Is the odd plant growth (mentioned in VII-A-2.a. above) scale-like?	Yes – **DWARF MISTLETOES** Appendix-65
VII-C-2.b.	No – Go to VII-D-1.b.

VII-D No Matches

VII-D-1.a. Have you considered atmospheric and chemical problems?	Yes – Go to 2.a.
VII-D-1.b.	No – Go to IV-D-1.a.
VII-D-2.b. Have you considered non-selective diseases of leaves/needles?	Yes – Go to 3.a.
VII-D-2.b.	No – Go to IV-B-10.a.

VII-D-3.a. **Hardwood** maladies – consider using another key source for sucking insects (aphids, lace bugs, other scales), hardwood mistletoes, generalized anthracnose, and environmental influences, among others, and abiotic factors.

VII-D-3.b. **Conifer** maladies – consider using another key source for conifer insects, pathogens, and abiotic factors.

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1.0 Introduction & Purpose Statement

1.1 Introduction

This document provides guidance to managers of national park system units in the eastern United States on how to respond to exotic forest insect pests and pathogens invasions. The Integrated Pest Management and rapid response information provided in this document addresses forest resource threats, whether they are found in natural settings or involve character-defining features within a cultural landscape.

Many new or exotic insects, pathogens, and plants are finding their way into the forests of Eastern North America causing dramatic changes to native plant and animal communities. The physical movements of exotic pests are facilitated through international trade and interstate travel. Invasive species appear to thrive during times of climate change. Many invasive exotics are proving to be adapted to take advantage of earlier seasonal warming for growth, flowering and fruiting than native plants (Willis, et al. 2010; and Logan, et al. 2003). As a result, invasive exotic insects and pathogens are causing significant damage to native forests at an increasing rate. Native species are being out-competed for critical habitat at the same time that the habitat itself is being altered and whole forest systems are being challenged.

Information is included in the appendix about the biology of pests. Such information could be utilized for setting monitoring and management priorities in particular park locations. This document also provides quick information about where to go for expert advice and support if a forest pest management issue cannot be managed at the park level. Perhaps more importantly, it discusses the importance of cooperative efforts and the value of leveraging resources with all concerned parties. As with most pest issues, management of forest pests is much easier when the problem is detected and dealt with early in the invasion process. A goal of the document is to provide this information in a format that will be easily referenced and rapidly utilized so time is not lost wondering how to begin. This document is a living paper that should be updated as the resources change and the pest priorities change.

1.1.1 Early Detection & Rapid Response.

Program elements for optimal forest insect and disease management include planning, prevention, early detection and rapid response, control and cooperative management, monitoring, communication and education, research, and restoration. This document focuses on early detection & rapid response with essential planning tools for control. (Note Figure-1.1.) Early detection & rapid response is employed when new or otherwise endemic species problems quickly arise. Control management comes into play as one form of rapid response as well as responding to resource damage of a more long-term nature.

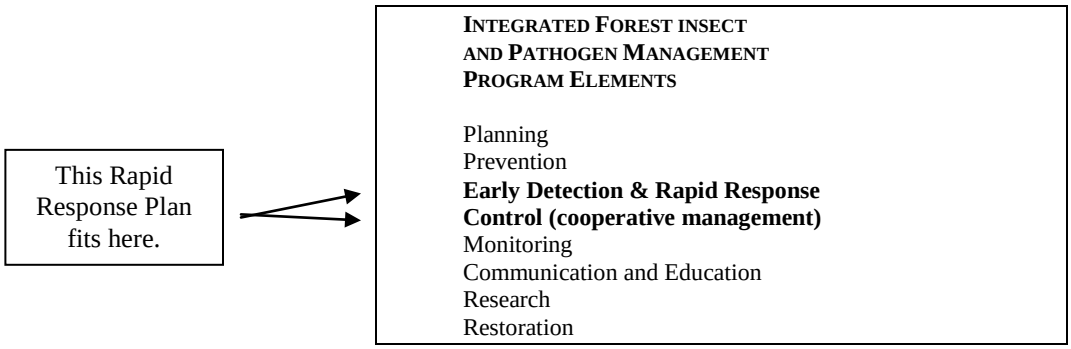

Figure-1.1.1. Program Elements of Integrated Forest Insect and Pathogen Management.

1.1.2 Invasive Exotic v. Native Pest Species.

The mere presence of insects and diseases in the forest environment is not necessarily a problem. Native insects and diseases, like all native organisms, are a natural part of the environment and are protected under NPS Management Policies. Unlike exotic invasive pest species, "emergency" management of a problematic native species would be extremely rare. (The Management Policies do permit management of a native species when it interferes with the site management objectives or presents a threat to human health (NPS Management Policies 2006 Section 4.4.5.1).) On the other hand, most invasive exotic species are a human-caused problem which puts them outside of the protected natural environment.

1.1.3 Action Thresholds.

To become targeted for control actions, species must exceed a threshold that triggers management activity. Action thresholds are determined by park management tolerance for specific resource injury levels. The injury level is the level of pest damage the resource can sustain before losing integrity or the ability to recover. The action threshold is the point when management actions must be taken to prevent injury to the resource. As a starting point, the US Forest Service has established thresholds for many existing pest species of concern in Eastern forests. Local park management objectives are determined by federal laws, agency policies, park enabling legislation, and local management issues. Therefore, park managers should adapt other agency pest management thresholds or develop their own thresholds to reflect park objectives. Park staff may seek the assistance of regional resource management staff to establish appropriate thresholds.

The integrated pest management process uses threshold analysis to focus management energies on the priority species and, when used with the latest scientific information on the biology of the pest and management options, minimize environmental impacts caused by the pest and the management action.

1.2 Authorities and References

1.2.1 NPS Organic Act.

The NPS Organic Act of 1916 establishing the NPS gives broad guidance for land management [NPS Organic Act]. A portion of the Act reads as follows:

The service thus established … purpose is to conserve the scenery and the natural and historic objects and the wild life therein and to provide for the enjoyment of the same in such manner and by such means as will leave them unimpaired for the enjoyment of future generations.

The National Park Service is directed by Congress to leave natural and historic resources *unimpaired* for future generations (see also NPS Policies section 1.4.2-5). That direction is reinforced through a series of federal court decisions and subsequent congressional acts that interpret the word *conserve* to mean, "preserve and protect." The directive provides the necessary framework to justify the need for informed management of insects and diseases where they threaten natural resources and healthy functioning ecosystems. Special effort is made to protect native species in the park units of the National Park Service, but under specific conditions, even native species can be targeted pests in need of management. Invasive exotic species, however, have not been part of the local natural sphere and are evaluated for management using different parameters. Both exotic and native insects/diseases potentially cause negative impacts to wildlands, managed landscapes, and (physical degradation to) historic structures – measures of impairment. As per section 4 in Management Policies (NPS 2006), native and exotic species can be managed under stated guidelines.

1.2.2 Integrated Pest Management.

All pest issues in the National Park Service are to be addressed utilizing the overarching integrated pest management (IPM) process. IPM is a “decision-making process that coordinates knowledge of pest biology, the environment, and available technology to prevent unacceptable levels of pest damage by cost-effective means while posing the least possible risk to people, resources, and the environment” (NPS 2006). The Draft Director’s Order #77-7 and the NPS Policies (NPS 2006) 4.4.5.2 describe the process of IPM. The IPM Program is supported with personnel at the WASO, regional, and park levels. The IPM Program Service-wide and Regional Coordinators are responsible for reviewing pest management strategies. Proposals for the use of pesticides, biocontrol agents, and genetically modified organisms must be submitted for review the Pesticide Use Proposal System (PUPS) found on the intranet. All such products must be approved before use.

Table-1.2.2. The 11 Step Process for Implementing an IPM Strategy.

The 11 Step Process to Develop and Implement an Integrated Pest Management Strategy
1. Describe the site management objectives and establish short and long term priorities.
2. Build consensus with stakeholders-occupants, decision makers and technical experts (on-going).
3. Document decisions and maintain records.
4. Know the resource (site description and ecology).
5. Know the pests. Identify potential pest species, understand their biology and conditions conducive to support pest(s) (i.e., air, water, food, shelter, temperature, and light).
6. Monitor pests, pathways, and human and environmental factors, including population levels and phonological data.

7.	Establish "action thresholds" the point at which no additional damage or pest presence can be tolerated.
8.	Review available tools and best management practices. Develop a management strategy specific to the site and the identified pest(s). Tools can include: (1) No action,(2) physical, (3) mechanical, (4) cultural, (5) biological, and (6) chemical management strategies.
9.	Define responsibilities and implement the lowest risk, most effective pest management strategy, in accordance with applicable laws, regulations, and policies.
10.	Evaluate results; determine if objectives have been achieved; modify strategy if necessary (adaptive management)
11.	Education and outreach. Continue the learning cycle; return to Step 1.

1.2.3 Cooperative Forestry Assistance Act / Cooperative Agreement.

Section 5 of the Cooperative Forestry Assistance Act of 1978, Public Law 95-313, as amended, authorizes the Secretary of Agriculture to protect trees and forests, wood products, stored wood, and wood in use from insects and diseases (U.S. Congress 1978). As a result, USDA takes lead responsibility for providing technical and funding assistance to other federal agencies and private landowners. Specific to Interior bureaus, the departments of Agriculture and the Interior created an agreement that allows transfer of funding and facilitates interagency cooperation to conduct Forest Health Protection projects (USDA and USDI, 1983). Along with other bureaus, the agreement justifies Forest Service staff activity on NPS lands and allows NPS staff to work in a broader sphere of influence to accomplish insect and disease control. Through it, the USDA passes along annual project funding for pest and disease control. Funding is project based. As a result, there is no support for ongoing programmatic needs. Technical on-site and remote technical assistance is available by contacting proper USDA-Forest Service personnel. Staff visits and telephone consultations are available to NPS units by appointment. In addition, statewide remote sensing takes place through state agencies, funded through the Agreement.

1.2.4 Federal Insecticide, Fungicide, and Rodenticide Act, as amended.

This act governs all labeling, use, transport, and storage of pesticides. Appurtenant regulations are included in Environmental Protection Agency policies, pesticide labeling, NPS Policies (NPS 2006), and NPS DO-77-7. The *Act* (sometimes referred to as FIFRA) delegates oversight of pesticides to governing states. For this reason, in the arena of pesticide management the NPS abides by governing state bodies. Storage and application of pesticides are therefore subject to state inspections and fines.

1.2.5 NPS Management Policies.

The National Park Service Management Policies (NPS 2006) [National Park Service Policies (excerpted)] provide guidance on the general principles of natural management and within that framework more specific guidance for the management of animal, plant, and disease species adversely affecting forest resources and other critical NPS resources, including invasive exotic and problematic native species. The following excerpts are germane to insect and disease management.

Outline of NPS Management Policies Regarding Insect & Disease Management

- Defining Resource Impairment/Derogation..... Section 1.4.2 - 5
- Prohibition on Impairment of Resources and Values ..... Section 1.4.4
- Partnerships..... Section 1.10
- Restoration of Natural Systems ..... Section 4.1.5

- General Principles for Managing Biological Resources…Section 4.4.1
- Defining Native and Exotic species.....Section 4.4.1.3
- Management of Native Plants and Animals…….Section 4.4.2
- Management of Invasives .....Section 4.4.4 (all)
- Pest Management .....Sections 4.4.5 and 5.3.1.5
- Integrated Pest Management Program.....Sections 4.4.5.2 and 5.3.1.5
- Pesticide Use.....Sections 4.4.5.3 and 5.3.1.5
- Pesticide Purchase and Storage.....Section 4.4.5.5
- Treatment of Cultural Landscapes.....Section 5.3.5.2

Refer to Appendix-D for excerpted portions of applicable laws, agreements, and policies governing insect and disease management within NPS units.

1.3 Cooperation Across Borders

Invasive exotic species (insects, diseases, plants) are not constrained by political or property boundaries. In the Eastern United States, the National Park Service does not manage a single "whole" forest. The National Park Service and other land managers (i.e., FWS, BIA, USFS, military bases, state lands, private, land trusts, etc.) must work together in a cooperative manner to assure that whole populations of pest species are managed to reduce pests so that remnant populations do not remain to provide reservoirs for future invasions. The benefits of this type of cooperation include increasing the managed area, extending the buffered area surrounding valued resources, elimination of remnant pest populations, increasing public awareness and early detection potential, and more effective use/leverage of limited management resources.

1.3.1 USDA-Forest Service.

The US Forest Service (USFS) was designated by Congress as the lead agency for the management of forest pests. Because the USFS works with other Federal agencies, state forestry agencies, and the public, they are positioned perfectly to coordinate cooperative forest pest management efforts. The effective arm of USFS providing such service is the Forest Health Protection Program that operates within the State & Private Forestry division. Large and small parks are encouraged to utilize USFS expertise and funding opportunities. Because of the Department of Agriculture mandate for service and funding, there are typically no NPS emergency funds available to deal with insect and disease problems. See Appendix-D [Cooperative Forestry Assistance Act of 1978 (Section 5), as amended] for law and policy statements. See Appendix-B [Contacts for Technical & Funding Assistance] for staffing contacts.

1.3.2 USDA-Animal Health and Plant Inspection Services.

A small but growing subset of pest and disease problems is new to America in the form of introduced species. The USDA-Animal Health and Plant Inspection Services (APHIS) Plant Protection and Quarantine (PPQ) and New Pest Advisory Group (NPAG) play key roles in the detection, regulation and quarantine, and management of new invasive exotic pests. In the late 2000s, APHIS-PPQ worked to eradicate three major pests in the forests of the Eastern U.S., including Asian longhorn beetle, emerald ash borer, and Sirex woodwasp. Though not a source of direct project funding, parks can benefit from APHIS-PPQ's oversight of reconnaissance and eradication contracts. See Appendix-B [Contacts for Technical & Funding Assistance] for staffing contacts.

1.3.3 State Natural Resources and Forestry Agencies.

The USDA-Forest Service works through State Forestry Agencies and organizations to accomplish statewide aerial reconnaissance and broad area control projects. Park managers should contact appropriate state agencies and organizations to obtain annual reconnaissance mapping products and learn about planned control activities. See Appendix-B [Contacts for Technical & Funding Assistance] for staffing contacts.

1.3.4 NPS Biological Resource Management Division.

The Washington level Biological Resource Management Division (BRMD) is a source for aerial mapping assistance and vegetation map information.

1.4 Authorities References

To keep this section as brief as possible, references and whole copies of authorities have been placed in Appendix D – Law and Policy Statements for further reference. Refer to that appendix for the following items.

- NPS Organic Act
- Federal Insecticide, Fungicide, and Rodenticide Act
- Cooperative Forestry Assistance Act of 1978 (Section 5), as amended
- Inter-agency Agreement
- Memorandum of Understanding between the Department of Interior and U.S. Forest Service
- Department of Interior Manual Sec 517 Integrated Pest Management Policy: Including the Use of Pesticides and Biological Control Agents
- Director's Order #77-7: Integrated Pest Management
- Director's Order #12: Environmental Impact Analysis
- Director's Order #28: Cultural Resources Management

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2.0 Effective Rapid Response

2.1 Plan Ahead to Prevent a Future Emergency

Many people respond to problems as need arises. Waiting for an infestation or outbreak to occur, however, makes prevention of resource degradation more difficult. Devoting time to preparation is therefore time well spent. As stated in Management Policies (NPS 2006) and NPS 77, following an IPM approach will ensure that monitoring of forest resources occurs and significant pests are detected early in their infestation cycle, thus minimizing needed management actions. If the park unit is part of an Inventory and Monitoring network, some of the data collected from their long-term monitoring program can be useful to refine the early detection efforts. Although new forest pests can on occasion show up without warning, information on the location of significant pests is likely available from the USFS, APHIS-PPQ, and state forestry offices. This information is critical for planning out future management needs.

Preparation Tasks – Prior to an Insect or Pathogen Emergency

1. Develop a monitoring plan for the park (early detection is key for rapid response). It can be as simple as observations at key points in the park.
2. Monitor sites at least annually. More frequent monitoring may be needed for some species.
3. Designate a park contact and backup who are responsible for these activities.
4. Develop and meet with key contacts and cooperators from local, state, and federal agencies in the area. If possible agree on key coordination elements.
5. Meet annually with key contacts to discuss trends, results and findings of the year's activities and upcoming threats.
6. Use the information to build an annual work plan for the following year.
7. Examine existing monitoring plan (if available) and adapt it, as needed, using current trends and findings.

The following subsections cover a minimum of preparative activity.

2.1.1 Develop Partnerships before an infestation outbreak occurs. Utilize the 11-step IPM process. Reflect on the management objectives, know the resources, and become familiar with potential pests.

Maintain an active dialog with the Regional IPM Coordinator. She/he is responsible to assist with pest management needs and is familiar with the most significant forest pests in the Region. Skim through Appendix-B: "Technical Assistance and Training" to determine the best persons to provide assistance in case of specific forest insect and disease problems. Highlight them or make a separate listing in the address book. Make a special effort to keep this list of technical expert contacts up-to-date. Make introductory phone calls to the appropriate pest management experts to make sure the contact list is up-to-date and has the best people identified for particular needs. When it comes to subsequent day-to-day contacts, this will save time by focusing on people at appropriate field levels.

Purposes for Making Initial and Subsequent Contacts:

- **NPS Regions** – Making contacts keeps NPS staff informed about pending and potential forest health issues; reduces administrative missteps; helps to quickly form an interdisciplinary team to gain accurate NEPA compliance advice; and helps determine best low-risk management options for pending pest issues to assure approval is possible for IPM/chemical/biological treatments via PUPS.

- **USDA-Forest Service** – Making contacts helps obtain on-the-ground technical assistance for identifying forest pest problems and treatment alternatives. The USFS is a source for obtaining a biological evaluation of landowner pest problems. Their expertise can be used to formulate effective low-risk management strategy for specific pest issues. They are the agency to submit funding assistance requests by September. They can provide field assistance for post-treatment monitoring.

- **USDA-Animal Plant and Health Inspection Service-Plant Pest Quarantine** – Making this contact helps gain technical assistance and on-the-ground treatments for newly introduced exotic invasive pests. This helps leverage resources to address critical exotic invasive species. (The agency does not provide funding directly to other Federal agencies.)

- **State Agencies (Forestry or Agriculture)** – Making contacts helps gain on-the-ground technical assistance and support, leverage resources to gain existing aerial reconnaissance mapping data (and surrounding areas for planning purposes) of forest canopy impacts and infestation size. One can also gain forest insect and disease trends information for the park and region and benefit from collaborative ventures.

- **State Cooperative Extension Service** – Making contacts helps gain quick information about forest insect and disease trends and current research activities from available website material and in-person discussions and learn what control methods are being used in the state and elsewhere.

- **Research Universities** – Making contacts helps expand knowledge base by working with the Cooperative Ecosystem Studies Unit (CESU) http://www.cesu.psu.edu to initiate park-specific forest insect and disease research (typically at park expense). One can obtain specific and broad-based advice and information from university faculty, staff, and students.

- **Canadian and Mexican University and Governmental Experts** – Making contacts helps gain full cooperation and utilization of each other's resources for issues that occur along U.S. borders, and assure better results and broader management coverage.

2.1.2 Learn the Ropes for Obtaining Funding and Assistance.

Funding Sources. Since the USDA-Forest Service is designated as the lead Federal agency for addressing forest pest management issues, the National Park Service has generally not allocated substantial base or project funds for addressing forest pest management problems on its lands. Funding is available annually from the USFS for projects they consider important and of high risk to the forests of an area. As described in Section 1.2 and 1.3, the USFS has a national mandate by Congress to provide on-going funding and technical assistance to all public and

private ownerships, to the extent possible. Though the USFS Forest Health Protection budget has line-item variations year to year, it is largely program based with sufficient reserves to respond to suppression needs in a typical year. The recent increase in the number of invasive forest species, however, has begun to limit the support dollars to a few key problematic species.

To obtain funds from the USFS, parks are asked to submit project proposals (pre-approved by the USFS) via the Service-wide Combined Call's Forest Health Program. Projects are reviewed and prioritized within the NPS and then sent to the USFS for final review and possible funding. Funding is typically released in the spring for the current year's funded projects. Detailed guidance concerning this process can be found in Appendix-A.

NPS Field Administration. There are two approaches national park superintendents have made to allow treatment expenditures prior to receipt of interagency funding. Some, with assurance from USFS officials, are willing to allow spending of park-based funds until the USDA-originated project funds arrive. Other superintendents want to be assured that the USDA or other funding will actually arrive and will not commit park funding. This funding often does not arrive until June. Thus, parks can lose the fall, winter, and early spring seasons, leaving little time for implementation. Parks should take this under consideration in the planning process.

2.1.3 Conduct Park-based Planning.

The National Park Service does not require advance programmatic planning for forest pest issues. However, environmental protection planning and clearance, satisfying NEPA, must be completed before carrying out resource management actions. The formal NEPA process should bring together a team of NPS employees, experts in their particular resource responsibilities, to generate a view of what might happen under certain conditions, and what management actions might be appropriate. An essential piece in the planning and compliance process is determining the baseline of resource condition, apparent damages, and organizational management tolerances. Such fact-finding should include the following:

(1) Ecological integrity and condition of the park's natural and cultural resources, not only for current forest insect and disease issues, but also examining other stressors that might contribute to the health of the resource. Park natural resource condition assessment reports and other assessment documents are valuable here.
(2) Potential resource damages that the park is not willing to sustain. That is the beginning of a damage threshold assessment.
(3) Suppression activities that will not cause secondary damage to resources.

As good park planning rarely takes place in a vacuum, it is important to run these ideas and management recommendations through an interdisciplinary process as well as receive review and advice from appropriate personnel in the Regional Office.

Planning Questions for Managing Exotic Invasive Forest Insects and Pathogens.

- Are there legal authorities that come to bear beyond those cited in Section 1.2?
    - What are their implications?
- Re: forest resources and insect/disease issues:
    - What are the current conditions of natural and cultural resources?
    - What metrics should be used to describe them?

- Re: damage thresholds:
  - What damage levels are unacceptable? (Available in Park Planning and Compliance Documents)
  - What metrics can be used to describe those thresholds? A zero damage threshold may be appropriate in many cases. (Generic thresholds for pests that already exist in the U.S. may be obtained from the USFS and APHIS-PPQ. Be sure to determine whether underlying objectives are appropriate.)
- Are there funding and staffing resources to keep above the damage thresholds?
  - What normal programmatic funding and staffing are needed to protect and maintain the resources?
- Professional contacts:
  - Who are the appropriate technical contacts with the USFS for likely forest insect and disease threats?
  - Who are the appropriate people to call when an imminent threat occurs?
  - Is help needed to assess the forest resource? Consider:
    - USFS
    - Universities
    - NPS specialists within the System
- Re: likely forest insect and disease threats:
  - What are the monitoring protocols and best management practices (treatments) for each pest?
  - Are the current emergency best management practices for likely forest insect and disease threats in the area acceptable? Who should be involved in discussions to clarify these issues?

2.1.4 Create a Checklist of Actions for responding rapidly to Exotic Forest Insect and Disease Infestations.

As part of the pre-planning process, parks should create their own checklist of things to do in case an unexpected forest insect and disease infestation is detected. This checklist will act as an outline for the development of a future rapid response plan. Part of the list should include a section that clearly defines the responsibilities of each park employee/discipline. Refer to Table 2.3.5 “Project Checklist for Forest Insect and Disease Rapid Response” as a starting point. At the very least, the table should be amended to fit local conditions and threats, filling in appropriate contact information of technical and administrative expertise.

2.1.5 Become Familiar with Management Tools, Methods, and their Risks. Obtain labels and MSDS (Material Safety Data sheet) for each of the chemical or biological control products that might be used.

If chemical or biological pesticides are selected as the best option for the management of a specific problematic insect and/or disease, take great care to follow the use requirements as defined on the product label. Those requirements are found on written product labeling. Two pieces of required reading are the product label and the product MSDS.

Product Labels. “The label is the law” is an accurate saying regarding product use requirements. FIFRA, cited earlier in Section 1.2, was written to give, among other things, product labels legal authority. That is important to remember when planning pesticide purchase, transport, use, and storage. If the label specifically addresses certain issues, that information carries the weight of law. Take time to read the label on several occasions such as when choosing

a product, before mixing and applying, before storing, before disposing of containers, and in emergencies. Refer to Appendix-A for an explanation of subjects covered in a typical product label.

Informative website information on product labels:
http://www.epa.gov/pesticides/label/
http://www.cdms.net/LabelsMsds/LMDefault.aspx?t=

Product MSDS. Refer to Appendix-A for an explanation on how to read and understand these documents. The information is arcane and seems most applicable to firefighters and commercial storage facilities. However, there is important information for anyone concerned with personal health dangers, fire flashpoints, reactivity, storage requirements, what to do in case of a product spill, and first-aid measures.

Informative website information on MSDS information:
http://extension.missouri.edu/publications/DisplayPub.aspx?P=G1913
http://www.cdms.net/LabelsMsds/LMDefault.aspx?t=

Pesticide Applicators. The NPS follows state regulations regarding the purchase, use, storage and disposal of pesticides. By NPS (2006) policy 4.4.5.3, applicators must be licensed within the state the park is situated. Applying pesticides inappropriately is to break the law. The certified applicator may be from another park, agency, or private contractor. In addition to satisfying FIFRA and state certification standards, the treatment application methods must abide by NPS policy and standards.

As part of the pre-planning process, make sure that the individual/s has obtained the correct license to apply the intended pesticide product(s) in a forested setting. Each state has designated "application categories" to define spraying conditions (agricultural, structural, aquatic, aerial, right-of-way, forests, public health, etc.).

2.1.6 Attend Training.

If *knowledge is power*, then training is an essential part of preparing for the effective management of exotic invasive forest insect and disease problems. As a foundation for any pest management activity in a National Park Service unit, the NPS offers an "Introduction to Integrated Pest Management" training course. Also, information specific to forest pest management can be obtained from an on-line training course created by forestry experts at the USFS, APHIS-PPQ, and land grant universities around the country.

On-line offerings are becoming increasingly popular as a way to reduce the cost to both students and teachers. Additional information on species specific management options can be obtained from park and Regional IPM Coordinators. The USFS and the Eastern and Western Forest Insect Workers each hold annual conferences to discuss recent research findings and management options for the most important forest pests. These meetings provide an excellent learning opportunity for interested NPS employees. Refer to Appendix-B for a listing of typical offerings made available within NPS and other agencies.

2.2 Prevention Tasks

Pre-planning and prevention are the most effective options for dealing with all invasive forest pests. "An ounce of prevention is worth a pound of cure" is certainly true in this arena. For managers new to the idea of insect and disease management, this seems wrong because they have to think about and do things they never did before. What they do not know is that stopping or controlling a new invasive species becomes all-consuming, leaving little time for normal programming. The following sections outline activities that can be fruitful in avoiding, warding off, or detecting infestations.

2.2.1 Avoid Allowing New Species Introductions.

Be Aware. Simply being aware of what forest insect and disease issues are going on around the region can go a long way toward preparedness. Possible sources of information are the news media, pointed conversations with resource managers at other parks, making an annual phone call to a USFS Forest Health Program specialist, and skimming insect and disease "listservs."

Many new pests "piggyback" into parks on plant materials bought for park re-vegetation projects. Always purchase plant materials that have been inspected for unwanted insects and diseases. Always buy plants that are appropriate to the region and are native to the park unit. Accidental introduction can be prevented by planning ahead and careful purchase of materials.

Another major source of accidental introduction of forest pests is the movement of firewood from one area of the country to another. Refer to http://dontmovefirewood.org. Although difficult to control, every effort should be made to prevent these types of pest "pathways" into the park. The NPS Inventory & Monitoring Program has an excellent website at http://science.nature.nps.gov/im/units/cupn/monitor/forestpest/forest_pests.cfm, with additional links, for information on native and exotic forest insects and pathogens.

Inspections. On the national level, APHIS conducts inspections of trade goods at ports of entry. Few states conduct inspections, outside of California. Inspections provide an excellent platform for monitoring and subsequent preventive actions. The NPS conducted inspections in the 1980-90s during the Mid-Atlantic's gypsy moth epidemic. Gypsy moths lay egg masses on any surface during high population levels, including cars, trailers, camping equipment, and other outdoor material. The purpose of those inspections was to detect and destroy "stow-aways" among the belongings of the visiting public and truck traffic. The goal was to avoid new epicenter establishment.

Embargoes. In the extreme, embargoing the movement of goods into an area attempts to avoid new epicenter establishment. States practice prevention when they prohibit movement of known infected materials into their jurisdictions. An example took place when several states prohibited shipments of rhododendron nursery stock from California during the expanding sudden oak death epidemic, 2000-01. Localities and parks conduct embargoes when they prohibit movement of firewood into their areas – avoiding new infestations of emerald ash borer and Asian longhorn beetle, both serious threats. Note the NPS "Interim and Immediate Recommendations for Preventing the Spread of Invasive Forest Pests" of October 29, 2009, in Appendix-D. At some point, when an insect or disease becomes ubiquitous to an area, embargoes cease to have utility.

Educate the Public. Managers should be sensitive to the reaction of the public to embargoes and other regulatory measures. Public education therefore is essential to improve the effectiveness of whatever measures are employed. (See sections 2.2.2 and 2.2.6.) Also, when it is determined that exotics are benefiting from climate change factors, managers should incorporate appropriate messaging for public education.

If NPS outreach materials are not available, the USFS and APHIS have information that can be obtained and distributed to visitors and park employees. Such brochures, fliers, and posters can provide critical information on the biology of the pests and the effects they have on the forest. Educational electronic media on key pests can be obtained from the USFS, APHIS-PPQ, and the NPS IPM programs.

2.2.2 Conduct Detection Monitoring in Likely & General Areas.

Seasonal monitoring for the signs of forest insect and disease activity is an important tool for quickly identifying problems before they become epidemic. Monitoring traps are available from the USFS, APHIS, and state agencies for detection of gypsy moth, emerald ash borer, and other forest pests. It is best to coordinate efforts with monitoring experts from the USFS and APHIS-PPQ field offices, and with other NPS cooperators. Integration of the monitoring activities required for the park forest pest management and hazard tree management programs saves time and assures that field data required by each program is collected in a similar manner. In addition, joint training classes for crews responsible for monitoring forest health and hazard trees can assure that everyone is aware of the type of data needed for each program.

Tailored Monitoring. Monitoring is a valuable tool for land managers to detect invasive forest pest populations early in their infestation cycles. It is also used as a long-term tool for determining the life stage of pests and information needed for the timely application of management efforts. The object is to detect pest and disease problems as early in their cycle of infestation as possible. A simple system must be devised to examine susceptible areas more than other areas. Tailoring the monitoring scheme based on known preferred habitats is essential and sustainable. Pay special attention to susceptible tree species, forest types, and high-risk areas such as human transportation corridors, natural wind corridors, and disturbed forest stands.

Monitoring for invasive forest insects may include the use of species-specific pheromone scented sticky traps. Placed out in the forest in a predesignated grid, they provide valuable information about presence, location, and density of infestation. More typically, ocular examination of leaves, bark, and root areas, depending on the pest/disease type, provides valuable information. Root diseases are admittedly difficult to diagnose and require the assistance of technical advisors from USFS for confirmation. Contact the appropriate Regional IPM Coordinator and the technical experts from the USFS or state forestry service for specifications on monitoring pests.

Citizen Scientists. Consider involving the public in monitoring plans. It may be the only way that financially strapped parks can commit to and conduct forest insect and disease monitoring. The recent Asian long-horned beetle infestation in Massachusetts was first detected and reported to APHIS-PPQ by a private citizen. The value of having additional eyes in the field watching over the park's resources is significant. See Section 2.2.6 and Appendix-A for additional information involving the public in park activities.

2.2.3 Pay Attention to Forest Disturbance.

Many native and exotic forest insects and diseases respond to forest disturbance by expanding out from their current locations into the disturbed areas. In situations where tree health declines due to the site disturbance, the expanding insect and disease populations often build their population levels rapidly to take advantage of the new habitat. They are the pioneer species among insects and diseases and act as initial carbon recyclers. They begin the process of rendering damaged forests into elemental forms for future forest rejuvenation. The problem for land managers is that exotic colonizers have no naturally occurring regulators to keep their populations from expanding to epidemic pest levels beyond the disturbed area. Exotic pests such as gypsy moth, Asian long-horned beetle, emerald ash borer, and beech bark disease, among many others, can cause a rapid decline in tree health over a large area, and if not managed, cause increased mortality. In comparison, native insect and diseases often jump from damaged trees to otherwise healthy ones until their heightened population levels are checked by natural control mechanisms, returning them to non-damaging, endemic levels. Among natives, many bark beetles, stem borers, and root rots act in this way. During endemic periods, they attack weakened trees, something that healthy individuals can normally fight off.

Natural Disturbance. Natural disturbance is a normal part of the forest ecosystem. It is an important part of forest succession and forest renewal, and is critical in maintaining “integrity” in the forest. The introduction and rapid dispersal of new exotic pests greatly complicates the otherwise positive role of natural disturbance in the Eastern forests. Natural disturbances include wind damage, hail/snow/ice damage, wildfire scorching of crown and bark, salt damage near coastal areas from hurricanes, flood and drought, and native insect and disease damage that leave forest stands subject to subsequent infestations. These natural disturbances vary greatly from year to year. They need to be watched to make sure that exotic invasive species do not take advantage of the naturally occurring tree damage. If monitoring observations show that exotic forest pests are building up in a particular area, site-specific management actions can help to slow population buildups and avoid having those insects and diseases spreading to otherwise healthy trees.

Human-Caused Disturbance. Human-caused problems include, among other things, air pollution, human-caused wildfire, forest fragmentation due to development that lays a forest susceptible to wind damage, and soil compaction due to construction and utilities work that inhibits free root uptake of moisture and nutrients. Construction damage is very hard on the trees and should be avoided for several reasons. The funding and programmatic cost of fighting subsequent forest insect and disease epidemics is huge. The outcome of losing a portion of the forest resource due to a management action is to have caused resource impairment to the cultural and natural setting. Subsequent action to remove damaged trees or supplement tree nutrition may be needed. Care to avoid damage reduces these problems and costs.

2.2.4 Maintain Good Forest Health.

There are many ways to maintain the health and recovery integrity of forest resources. As above, minimizing human disturbance is essential. Natural disturbances are much more difficult to manage, but monitoring those sites can often prevent epidemic pest outbreaks before they start. Good monitoring is an effective management option for minimizing potential problems.

The National Park Service does not generally utilize complex silvicultural practices for the management of its forests, but the selective use of tree care and integrated pest management (biological, physical, and chemical) management options can preserve many threatened trees. Management options will differ from park to park depending on a host of factors. The

applicability of management options will depend on the legislation that established each park, local policy, public sensitivity, available funding, scale of a given problem, and perhaps whether the management area is located in the front or backcountry. With such provisos, two silvicultural methods are included below.

Tree and Stand Fertilization. Maintaining healthy forests is easier where soil conditions are properly balanced to the needs of the resident species. In a natural area, changes to soil conditions occur on a regular basis and soil nutrients tend to be limited in only the most eroded sites. Extra fertilization in a natural area usually leads to more problems than it resolves. A baseline of soil nutrient data can be useful to a land manager when monitoring locations are being determined.

In designed or cultivated landscapes, soil protection and amelioration may be more important due to inherent human-caused compaction and erosion. Maintaining proper soil conditions is an important defense against many tree maladies. Nutrient imbalances can be temporarily resolved. For natural areas where individual specimen trees can be identified for preservation and special care, soil amendments may improve tree vigor. Typically, a soil analysis is needed to identify necessary ameliorations. Hemlock woolly adelgids pose an exception to the general rule of using soil amendments to improve plant vigor. There is good documentation (McClure, 1995) to show that nitrogen fertilization is counterproductive since it seems to result in even higher adelgid population levels.

Forest Stand Thinning. For designed landscapes and cultivated landscapes, the use of tree thinning techniques to increase plant vigor and stand conditions may be important. Thinning can prevent or reduce tree stand overcrowding and shading. Refer to Appendix-E for information about tree characteristics [Appendix E – Native Tree Species Characteristics]. Specific hardwood and conifer species are shade intolerant; many species can suffer from competition for nutrients and moisture. In a natural setting, overcrowding usually results in natural thinning from below, where smaller tree individuals die out. Overcrowded stands attract “recycler” insects and diseases. These act as positive agents for thinning. Unfortunately, otherwise endemic insects and diseases occasionally “blow-up” into epidemic events. It is extremely important to monitor forest resources to see if insect or pathogen damage is exceeding management thresholds.

2.2.5 Advanced Treatments.

Systemic applications of plant amendments (pesticides, minerals) aimed at prevention and/or management of existing forest pests can be applied either through trunk injections or as a root drench. These types of applications can assist in maintaining plant vigor which is often all the plant needs to resist initial pest invasive attempts.

Pesticide Applications. Systemic applications are particularly helpful against boring and sap feeding insects that are hard to control with traditional external pesticide treatments. Systemic applications of pesticides have proven to be one of the most effective ways for managing hemlock woolly adelgid infestations in NPS units. There is also early research indicating systemic applications are helpful to preserve ash trees from emerald ash borers.

Still in the realm of prevention, foliar pesticide applications can aid tree health by helping them avoid infestation. Used in combination with other integrated management options, foliar pesticides can work nicely against leaf and bark-feeding insects. Pesticide application to large blocks of trees is not always the most effective method for controlling pests. Generally these

methods show best results when treating small-scale areas where tree value is high, as with special landscape individuals. In situations as with emerald ash borer, where the extirpation of all ash species is at stake, integrated management actions, including systemic and foliar pesticides must be attempted to protect as many trees as possible.

Contact pesticides can also be a valuable management option to ward off an initial attack. An appropriate pesticide when applied to tree bark can prevent damage from bark beetles and wood boring adults and larvae, killing them upon their ingestion of bark material.

2.2.6 Involve the Public in Detection and Prevention.

As mentioned earlier in section 2.2.2, involving the public is a way for a park, strapped for funding, to conduct forest insect and disease monitoring. Refer to Appendix-A for sources of information on "citizen scientists." If park staffs are not able to train citizen scientists, lacking time or expertise, getting the help of NPS Regional or USFS professionals is appropriate.

Involving the public has the side-benefit of generating public understanding of the problem and a willingness to support subsequent actions. That may be very important when considering otherwise unpopular methods such as inspections, embargoes, and pesticide treatments.

2.2.7 Utilize Native Species when Replacing Plant Material.

It is well documented that the use of exotic plant material in designed landscapes can require greater watering, fertilization, and pest suppression than native materials in similar settings (Minnesota, 2009, and US Department of Transportation, 2007). Native plantings produce generally healthier landscapes and assist in the protection of the site natural biodiversity. Incorporating wholly native species into park landscape plantings is therefore an excellent means of improving the survival rates of new plantings and avoiding future insect and disease problems.

2.3 Response Tasks

Be prepared for specific forest pests that threaten park resources. Although new pest issues arise annually, most of the serious organisms in an area are already known. Talk with USFS Pest Management specialists about current threats to forest resources in the area.

It is essential to take time to reflect upon the nature of park resources at risk. In general, is the resource a forest setting or designed landscape? Is the resource at risk currently healthy or does it suffer from other maladies? What are those factors? Is the potential or current pest threat a native or exotic species? These and other issues are critical for planning and implementation of a reasonable and prudent emergency response plan. (Table 2.3.5 summarizes the following narrative.)

2.3.1 Utilize the NPS 11-Step Integrated Pest Management Process as a Planning Tool.

Utilize the IPM steps to formulate the pest planning, prevention, detection, and management strategies. Review the Director's Order #77-7. Prepare a plan that incorporates best management practices, critical pathways being used by known pests, and strategies for addressing current and long-term forest pest management. This information is available from NPS IPM technical experts, the USFS, state forestry offices, and forest resource experts within the NPS.

Make sure that all management strategies are prepared in accordance with NPS Policy. The use of a pesticide may be the best tool to manage a given pest but it is seldom the long-term answer. Strive for treatment alternatives that not only address the current problem but also work toward a long-term solution.

2.3.2 Understand the different functions of the Interdisciplinary (ID) Planning Team and the Incident Command (IC) Team.

The ID Team formulates a strategic treatment plan and satisfies National Environmental Policy Act (NEPA) requirements by considering reasonable alternatives. Initially, theirs is a technical task of assessment, diagnosis, and prescription making to address an identified forest insect and disease problem. At some point, their task switches to the administrative and public relations duties required to complete the NEPA process. The team needs technical and administrative staffing with resource management, NEPA, and public relations expertise. The initial work can readily use outside expertise, while the latter tasks require NPS background.

The IC Team has the mission of tactical planning and executing the steps needed to accomplish the preferred alternative. Theirs is a job bent on marshalling the people and materiel to effectively, efficiently, and safely treat the problem and document their actions. An important aspect of their work also requires managing the public during operations. Team members need not be from the local park location, but they should be thoroughly familiar with NPS policies and culture. The team may need to retain an outside advisor for technical aspects of the treatment application, but the main drivers of the IC Team are NPS staff.

2.3.3 Treatment Planning: Assess, Diagnose and Prescribe.

In the management of forest resources, if pest prevention has failed and damage or decline is detectable in the trees, then a rapid assessment to identify the pest and the scope of the infestation is critical. Experts from the USFS can greatly assist park units as they begin to collect this important information. Utilizing the IPM Process and the information collected in the site assessment, a list of effective low-risk management options can be developed. Because several different pest problems may have similar symptoms, it is important to work with technical experts to define the exact problem. In making any assessment, it is important to keep an open mind for the full extent of factors causing the problem and what alternative management solutions are available for implementation.

Assessment and Diagnosis. Seldom is there one problem in forest insect and disease. As an example, consider a situation where a bark beetle epidemic is devastating neighboring forest stands and it seems the beetles are coming toward the park. It may be tempting to focus on the beetles and forget to investigate the underlying problems. A few questions are important to support or negate that response. Which beetles are doing the tree killing? If they are Ips beetles, are there similar pine stands at the park? Are the park pine stands overly dense or are they well spaced? What are the treatment alternatives? Will park management be willing to execute one of the treatment alternatives?

Questions for Assessing and Diagnosing Forest Insect and Disease Problems.

- Which pest and disease species are involved?
  - Are they the source of the initial mortality or subsequent invaders?
  - For each, what are their infestation density, intensity, and magnitude?
  - Is the infestation growing in intensity?
    - What are the signs?
  - What is the pest/disease biology of reproduction?
    - Will there be more than one generation per year?
    - Is there a way to disrupt the reproduction cycle?
  - If more than one pest is present, is one more serious or easy to control?
- Which host species are being harmed? Consider:
  - Average tree ages of hosts
  - Are host species generally healthy?
    - If not, why not?
  - Are there any methods that might quickly improve overall individual tree health?
  - Is it reasonable to expect to save these stands?
    - Are there age, current health, and stand characteristics compromising factors?
- What surrounding environmental issues may be coming into play? / Are there cumulative stressors? Consider:
  - Inter-tree densities
  - Air quality
  - Soils and nutrition
  - Drought
  - Invasive species invasions
- Is the threatened area accessible?
  - What are the access types, routes, and needs?
  - Where is the nearest public airstrip?
    - Can it be used to launch observation flights and treatment applications, and store bulk pesticides?
  - Are any of these access points potential pathways for future pest re-introduction?

Prescription Making. When creating a prescription to improve forest insect and disease maladies, include measures that address both immediate and long-term health diagnoses. There is little value in suppressing a bark beetle infestation, as above, if the overarching problem of pine stand overcrowding is not improved or drought conditions cannot be altered. Therefore, address both the emergent and underlying problems. Include ways and means in the prescription. Consider and sketch out more than one treatment alternative for further decision-making consideration. That is especially important for environmental clearance considerations.

2.3.4 Plan for Emergencies: Complete NEPA/NHPA Compliance.

The Integrated Pest Management and rapid response information provided in this document was assembled to assist park and resource managers as they address forest resource threats, whether they are found in natural settings or involve character-defining features within a cultural landscape. NPS *Management Policies 2006* directs staff to consider all pest issues in a consistent, integrated fashion. It is extremely important that each park management team discusses in advance how they will address the mitigation of uncontrollable resource damage to

either natural or cultural resources within their park that may accompany infestations of these pests. Prior to conducting any pest and disease control action proposed within this document, all necessary site compliance must be completed, including environmental compliance, under the National Environmental Protection Act (NEPA) and National Historic Preservation Act (NHPA). Park coordinators for NEPA, Section 106 and cultural resources management must be consulted. Some invasive forest pest species are threats to whole regions. As a result, National Park Service's goals and needs may not be the highest priorities as decisions on pest control strategies and efforts are made to achieve the greatest good for the affected region. Given these regional-scale pest damage implications, it is advised that park's become proactive and look beyond their boundaries when they plan for possible pest threats to their parks. This also presents an opportunity for parks to help raise regional awareness to such threats and their possible resource implications as park staff engage on a professional basis with their surrounding community. Ultimately, completion of appropriate park-wide compliance and planning efforts ahead of such situations will make the rapid response and mitigation process more effective.

Director's Order #12, section 2.14, states "Emergencies requiring immediate action are exempt from CEQ's regulatory provisions for implementing the NEPA (1506.11; 516 DM, 5.8), regardless of whether the actions have the potential for significant impact." Though this approach may seem attractive and may be needed under very rare circumstances, it may also indicate that the park has not been active in prevention activities to preserve critical park resources, a form of management dereliction. Further, "immediate" means just that. If the intended action cannot take place for several weeks due to funding, staffing, technical or administrative causes, the rationale for immediate action is greatly weakened. Waiting to invoke the emergency clause in NEPA guarantees that no time will be available to complete NEPA compliance and protect the public and public resources. This is a method that should not be pursued by parks in the Eastern U.S.

Forest insects and pathogens periodically attack trees and cause damage. No action may be needed for natural areas and other backcountry sites. Further, it may not be possible to completely protect cultural sites and other managed landscapes from large scale epidemics. Determining which pest invasions and which land areas hold very high value is best discussed as part of the pre-invasion planning process, long before being forced to react. If left to the time of emergency, several treatment scenarios should be discussed as part of the NEPA and 106 clearance processes.

For parks without the in-house expertise needed to address the ecology of what makes a healthy forest, these early pre-planning meetings are opportunities to invite experts from other parks or agencies to come and participate in the process. Sometimes the best reaction to an invasive in the forest is no reaction, and knowing that beforehand saves time and energy! Early determination of a park's strategic plan for addressing selected forest pests is also important because it allows the luxury of informing the public of intended management options well in advance of an actual action.

2.3.5 Rapid Response Tasks Checklist.

Review the tasks outlined in the table that follows. Amend and expand each item to fit the local park situation. The right two columns are provided for staff assignments. Begin executing each in turn, starting from the beginning. There may be need to work on several checklist items at the same time but make sure to cover each one thoroughly before proceeding.

Table-2.3.5 – Project Checklist for Forest Insect and Pathogen Rapid Response.

FOREST INSECT AND PATHOGEN RESPONSE CHECKLIST				
Step	**Major Task**	**Sub-task**	**Who Does This?**[4]	**Time Frame?**[3]
1	An outbreak is detected			
2	Coordinate with local, state, and USFS staffs to determine if the outbreak is occurring in a broader landscape.	Call appropriate contacts	–	–
3	If broad landscape response is required, determine the lead agency for response or coordinate the park response with other agencies.		–	–
4	Initiate the NEPA process and manage public relations.	Develop a NEPA/NHPA checklist and execute the tasks – Create public relations plan and execute – Issue press release –	– – –	– – –
5	Determine actions needed by NPS in light of outbreak.		–	–
6	If infestation is confined to only NPS or if NPS is the only agency in the area that will respond (eg. protecting culturally significant, front country trees) then proceed with check list.		–	–
7	Inform people on contact list of developing problem.	NPS Park – NPS Region – Special Use Permittees - Others –	– – – –	– – – –

[4] Make staff assignments and set deadlines.

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Step	Major Task	Sub-task	Who Does This?	Time Frame?
8	Conduct field meeting with park staff and USFS technical experts to assess and prescribe.	Create an ID Team for developing a plan and NEPA/NHPA process Invite outside specialists: USDA-FS – Others – Identify gaps of knowledge and make plans fill them – Identify adjacent ownerships for collaboration –	– – – – –	– – – – –
9	Stay in contact with USDA-FS experts.	Determine progress of biological eval. – Confirm that biological eval. agrees with the developing ID Team re: NEPA/NHPA plan Get copy of biological eval. – Determine FS support of the project –	– – – –	– – – –
10	Prepare project proposal package.	FS-3400-2 form (Appendix A – 3) – Include ID Team Plan – Include copy of the biological eval. – Include a statement on NEPA/NHPA clearance process –	– – – –	– – – –
11	Submit project proposal.	Submit through NPS Region to WASO-BRMD – Assure that USDA-FS received copy of FS-3400-2 form – Consider second press release –	– – –	– – –
12	Contact NPS Region.	Determine NPS project support –	–	–

--- (continued) ---

Step	Major Task	Sub-task	Who Does This?	Time Frame?
13	Prepare for site-specific implementation of low risk management options.	Enter pesticide request info into PUPS – Contracting (?): begin contract process (develop separate checklist) – In-house work (?): (1) purchase supplies- (2) begin staff hiring process with MABO – Form an Incident Command Team (refer to I-100 booklet) –	– – – – –	– – – – –
14	Contact NPS Regional IPM Coordinator.	Confer with PUPS: is pesticide use approved? Determine ETA for transfer of funds?	– –	– –
15	Enact field treatments.	(1) Confirm receipt of project funds – (2) Confirm NEPA/NHPA compliance completion – (3) Receive go-ahead by Superintendent to proceed – (4) Mobilize IC Team – (5) Enact public relations plan (through IC Team and as outlined in step #3) – (6) Begin field treatments – (7) Conduct periodic treatment monitoring–	– – – – – – –	– – – – – – –
16	Keep project notes.	Gather notes and photographs on all project aspects – Provide a legal record for the park files –	– –	– –

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Appendices

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Appendix 2

Appendix A – Forms and Documents

INDEX OF LISTINGS

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United States Department of Agriculture
Forest Service

FOREST HEALTH PROTECTION
FEDERAL LANDS PROJECT PROPOSAL

Reference FSM 3450

1. Forest Service Region/Area	2. Agency	3. Administrative Unit (Name of National Forest, Park, Refuge, Installation, Indian Nation, etc.)	4. State	5. Fiscal Year	6. Region/Area/ Agency Priority
	NPS			20	

7. Project Name:

8. Project Number:

9. Primary Project Objective: (check only one)
- Protect Threatened/Endangered Species Habitat
- Eradicate New Exotic Insect/Disease Infestation
- Protect Developed Sites/High Value Trees
- Protect Adjacent Private Land
- Protect Native Vegetation (forests and trees)
- Other (specify).

10. Proposed Project Is In: (check only one)
- Critical Wildlife Habitat
- Urban/Wildland Interface
- General Forest Area
- Other (specify).

11. Project Is: (check only one)
- Urgent (treatment must be done this year to be effective)
- Not Urgent

12. Causal Agent(s):

13. Host(s) Protected:

14. No. Acres Protected:

15. Treatment Method(s):

16. Treatment Material(s) (if applicable):

17. Treatment Rate(s) (if applicable):

18. Project Activities

	Fiscal Year Targets and Costs		
	a. Units of Work (No. acres to be protected)	b. Unit Cost ($ in thousands)	c. Total Cost ($ in thousands)
(1). Pre-Treatment Surveys			
(2). Treatment			
(3). Post-Treatment Evaluation/Monitoring			
(4). Other (specify below in Remarks)			
(5). Direct Project Administrative Support			
(6). Carryover to be Applied			
(7). Total Funding Requested			

19. Proposed By | Title:

Signature:

Name: | Date:

20. Recommended By | Title:

Name:

Signature: | Date:

21. Brief Description of Project & Remarks:

Form FS-3400-2

Defining a Complete Project Proposal Package.

A complete project proposal package includes the following elements.

(1) **Biological Evaluation** – (Completed by USDA-FS) This document includes a robust narrative of the proposal, with alternatives described and rationale for choosing the preferred alternative treatment method. It also includes an economic evaluation that must result in a positive benefit/cost analysis.

(2) **FS 3400-2 form, Forest Health Protection Project Proposal** – (Completed by NPS park unit) This may be filled out hardcopy or online. The required information is pithy and administrative in nature. Among other things, the form asks for a project title, objectives, targeted pest, host trees being protected, treatment methods, acreage to be treated, total costs for various categories, a brief project description, and bureau signatures. (See Appendix-A for this one-page form.)

(3) **NEPA and NHPA Clearance** – (Completed by NPS park unit) NEPA clearance must be finalized before ground action takes place. The USDA-FS assumes that NEPA is satisfied and does not demand documentation. Depending on complexity, scope, and methods, this process is finalized with a CE, FONSI, or ROD.

Funding Process. Obtaining field funding is a tortured pathway fraught with predictable but unmanageable pitfalls due to the nature of interagency communications and dependence on Congressional action for budget allocations. The USDA-FS is not typically hamstrung by specific line-item budgets[5]. However, first year pest and disease projects fall into the category of new initiatives. Like other bureaus, the USDA and USDA-FS cannot authorize project funding on new initiatives until Congress passes the Interior Agencies budget. The following table illustrates the tortured pathway for obtaining USDA Forest Health Protection funding.

Table Appendix-A-1 – Describing the Steps in Obtaining USDA Forest Health Project Funding.

Pathway and Timing of Project Funding			
	Agency	Time	Task Items
1A	USDA-FS (Field Office)	August completion	(1) FS staff meets with park staff in field to assess apparent problems and form a sketch for a mutually agreeable treatment plan (this takes place at any time of the year). (2) FS staff formalizes the plan into a biological evaluation and (3) provides it to the NPS park unit while also sending it up to their FS region. There are internal FS conversations in which they convey their opinions about project viability and funding level recommendation.
1B	NPS (Park Office)	Early September completion	Parallel to the above, (1) the NPS park unit should notify its regional IPM staff of events and seek initial counsel. (2) Park staff completes its own NEPA review and clearance. (The park should use the USDA-FS biological evaluation as the basis for its NEPA process. The BE may not be available in a timely fashion. The park therefore needs to keep its own notes from the field meeting to proceed with describing proposed actions and environmental impacts.) (3) For the Northeast Region, the park may submit their project proposal package directly to WASO-BRMD-FHP/IPM staff, with copies to the regional office. (The package must include a completed FS-3400-2 form and a copy of the biological evaluation. The park should also let the region know when they anticipate NEPA clearance completion.)

[5] Indeed, line-item budgeting comes into play where Congress responds to constituent demands for specific pest and disease treatments. Line-item funding can be a tremendous boon to localities in those cases. Line-item budgeting becomes a problem for USDA-APHIS because most of its budget comes that way, causing booms and busts in its operations.

--- continued ---

2A	USDA-FS (Regional Office)	Mid-September completion	(1) FS regional staff assembles project proposals; (2) forwards to FS WASO a list of project titles, recommended funding amounts, and regional prioritized ranking. (This is done independent of NPS.)
2B	NPS (WASO)	Mid-September	NPS WASO forwards all NPS proposals as a prioritized package to USDA-FS-WASO.
3	USDA-FS (WASO)	October completion	FS WASO staff assembles all Interior proposals into a package for internal consideration and prioritizes them within pest/disease categories and their national composite.
4	NPS (WASO)	October	NPS staff meets with FS and other Interior bureaus to conduct cooperative project priority setting. Typically, there is not enough funding for all projects, so the ranking is important.
5	U.S. Congress	October 1 (rarely)	USDA and USDI wait for annual Interior Agencies budget authorization. Rarely does this take place before October 1; typically, it is November 15 – March 15.
6	USDA-FS (WASO)	(1-to-2 weeks)	FS staff requests that USDA make funding transfers to Interior as agreed to in interagency meeting and later FS influences.
7	USDA	(1-to-2 weeks)	Department budget staff makes a funding transfer to Interior with bureau allotment notations.
8	USDI	(1-to-2 weeks)	(1) Interior acknowledges receipt of funding transfer; and (2) initiates bureau transfers with park allocation notations.
9	NPS (WASO)	(1-to-2 weeks)	(1) NPS budget staff acknowledges receipt of funding transfer; and (2) initiates regional transfers with park notations.
10	NPS (Regional Office)	(1-to-2 weeks)	(1) NPS regional budget staff acknowledges receipt of funding transfer; and (2) initiates park funding transfers (in the case of NE Region, sets up regional accounts for park spending).
11	NPS (Park Unit)	(1 week)	NPS park budget staff acknowledges receipt of funding transfer or spending account information, and notifies field staff to proceed.
12	NPS (Park Unit)	(5-to-8 weeks)	If field treatments will be contracted, that process begins.

FOREST HEALTH PROTECTION

Form: Accomplishment & Expenditures Report

USDI Agency: **National Park Service** Park:

Fiscal Year: Insect/Disease Controlled:

Treatment Method:

State(s) and County(ies) and Acres Protected by County:

<u>Calculation of Expenditures and Carryover</u> COMMENTS:

(a) Total authorization
for Park for year = $

(b) Dollars expended = $

(c) Available for reauthorization
next year (a-b) = $

Product Label Information

The following sections are within a typical product label.

- Commercial brand name
- Ingredients statement
  - Active ingredients
    - Common chemical name
    - Full organic chemical name
  - Inert ingredients
  - Percentages of the above
- EPA Registration number
- Manufacturer
- Net contents
- Type of pesticide
  - If pesticide is restricted, it will say: Restricted Use Pesticide
    - In this case, the applicator and purchaser must be state certified applicators (full commercial applicator or equivalent)
  - Signal words (referring to human impacts in the first 24 hours)
    - CAUTION (least danger)
    - WARNING (moderate danger)
    - DANGER/POISON (either have extreme danger)
- Hazard statement:
  - Acute effects
  - Delayed effects
  - Allergic effects
- PPE requirements (personal protective equipment) – these are minimum requirements and must be followed. Additional protective equipment is allowed as personal preference.
- Environmental hazards
- Physical/chemical hazards
- Use directions
  - Target species
  - Mix ratios
  - Allowed tank mixes
- Storage & disposal of pesticide
- Emergency contact information of the product manufacturer.

MSDS Information

The Material Safety Data Sheet (MSDS) is the primary document in hazard communication. OSHA standards require manufacturers and importers to provide an MSDS with each of the chemicals they ship. OSHA standards also require employers to have an MSDS for each hazardous chemical they use.

The importance of the MSDS cannot be overstated. This form contains all known hazard and protection information on a hazardous chemical. The MSDS is a guide to safety.

OSHA developed a sample MSDS form that many companies are using. Although the agency does not insist that everyone use OSHA's form, OSHA expects all MSDSs to include the same basic information.

An MSDS should include information on the topics outlined below. The topics correspond with the blank OSHA MSDS form in the previous section. The completed sample is an example of how the form can vary as long as it contains the necessary information.

Section 1: Product Information

Product Identifier:
This section tells the name of the chemical as it appears on the container label. This is often the chemical name of a product but can also be the trade name, common name, code name or code number.

The only time identity information is not provided is when the chemical name is a trade secret. Even in that situation, the MSDS must provide full hazard protection data.

Product Use:
The product use(s) intended by the manufacture or supplier.

Manufactures, name, address and Emergency phone number:
The Manufacture of the product emergency phone number must be listed if one is available.

Suppliers Name Address and Emergency Phone Number:
The seller or distributor (which may be the same as the Manufacturer)

Section 2: Hazardous Ingredients

Hazardous Ingredients:
Each Hazardous Ingredient must be listed by its specific chemical name (not by its generic name)

This section also lists the exposure limits set by OSHA and other organizations. Both OSHA's Permissible Exposure Limit (PEL) and the Threshold Limit Value (TLV) set by the American Conference of Governmental Industrial Hygienists (ACGIH) are listed. These limits specify the maximum amount of exposure to the substance a worker can have based on an eight-hour workday. The OSHA limit is a legal one; ACGIH's limit is the stricter one and is only a

recommendation. Both limits are usually given in parts per million (ppm) or milligrams per cubic meter (mg/m3).

Section II may also give a ceiling, or top exposure limit, which is the maximum allowable exposure at one time. Short-Term (15-minute) Exposure Limits (STEL) may be provided. There may also be information on whether the substance is "Immediately Dangerous to Life and Health" (IDLH). If the chemical is IDLH, the respiratory protection supplied by the employer must take this rate into consideration.

Percentages:
The percentage or range of percentages for each hazardous ingredient

CAS Registry Number:
The unique number assigned to hazardous ingredient by the Chemical Abstract Service Registry.

Current LD (lethal dose) for each hazardous ingredient:
This is a measure of the short-term poisoning potential of a hazardous ingredient. LD is the lethal single dose at which 50% of a specified test population dies. Note: LD can be determined for many routes of entry, but oral (given by mouth) and dermal (applied to skin) LDs are used for classifications.

Current LC (lethal concentration) for each hazardous ingredient
This is a measure of the short-term poisoning potential of a hazardous ingredient. LC is the lethal concentration (by inhalation) at which 50% of a specified test population dies. Note: 4-hour exposures are normally used.

Section 3: Physical Data

Physical state
This section lists the chemical's normal physical state (gas, liquid, solid, paste, powder, or gel) at room temperature and helps define how the chemical will behave when released. For example, a chemical that is normally a liquid may evaporate quickly in a hot environment, thus increasing its risk as a fire hazard.

A chemical's physical characteristics could also affect its health hazards and the protection that an employee needs. A liquid may be dangerous if it splashes on skin, thus requiring that the employee wear protective clothing. But if the same chemical changes to a vapor, the chief risk may result from inhalation, requiring respiratory protection.

Appearance:
What the chemical looks like. Appearance describes color and texture for most products and includes particle size for solids.

Odor:
What the chemical smells like. Odor describes the quality of the odor of the product (for example, fruity, sharp, almond like).

Odor threshold:
The lowest airborne concentration that can be detected by the human sense of smell.

Specific Gravity
The ratio of the weight of a substance compared to water. Less than 1 the product floats and more than 1 the product sinks in water.

Vapor density:
The vapor density is the density of the chemical's vapor compared to air, which has the density of 1. If a chemical's vapor density is higher than 1, the vapor is heavier than air and will go to the floor. If the chemical's vapor density is lower than 1, the vapor will rise in the air.

Vapor Pressure:
Vapor pressure measures how volatile a liquid is. Vapor pressure also measures how easily a liquid evaporates. The higher the number, the faster the liquid evaporates.

This section of the MSDS also has a space that explains how much of the chemical will dissolve in water. The ability to dissolve is usually stated as a percentage or in parts per million (ppm).

Evaporation rate
The ratio of how fast a substance evaporates relative to a known reference standard (usually n-butyl acetate=1)

Boiling point
This is the temperature at which a liquid changes to a gas (at normal room pressure)

Freezing point (melting point)
The temperature at which a liquid becomes a solid or a solid to a liquid (at room temperature).

pH.
A value indicating the acidity or alkalinity of a product (usually liquid) pH values between 0 and 7 are considered acidic and pH values between 7 and 14 are considered alkaline (7 is neutral).

Coefficient of water/oil distribution:
This is a number that indicates how easily a product may be absorbed into the body. A value greater than 1 means a substance may enter the body through the mucous membranes of the eyes, nose, and lungs. A value less than 1 means the fatty tissue below the skin may absorb the substance.

Section 4: Fire and Explosion Hazard

Flammability:
This section states if the chemical has a potential to catch fire or explode and is classified as flammable or combustible.

Flash point:
Flash point is the lowest temperature at which a chemical's vapors are concentrated enough to ignite or explode. The lower the flash point, the more dangerous the material.

The flash point is determined either by using a "cc" (closed cup) or "oc" (open cup) testing method.

Example: Gasoline's flash point is -45°F. Diesel fuel #2 has a flash point of +125°F.

Means of extinction (fire-fighting procedures)
Type fire extinguishers or extinguishing material is suitable for use on the burning product or fire.

Upper flammable limit:
The highest concentration of a gas or vapor in air (expressed as a percentage) at which the product will catch fire or explode if near an ignition source such as a spark or open flame.

Lower flammable limit:
The lowest concentration of a gas or vapor in air (expressed as a percentage) at which the product will catch fire or explode if near an ignition source such as a spark or open flame. These are also referred to as explosive limits. These concentrations, and all concentrations in between, form the flammable range.

Note: These are also referred to as explosive limits. These concentrations, and all concentrations in between, form the flammable range.

Auto ignition temperature:
Auto ignition is the temperature above which the substance (usually the vapor) may self-ignite without an external flame or spark. Auto ignition temperatures are available only for flammable liquids and gases.

Hazardous combustion products:
The hazardous products produced when the substance burns or is exposed to extreme heat.

Sensitivity to mechanical impact:

Whether the product may explode due to physical impact (for example, being dropped, bumped, or knocked over).

Sensitivity to static discharge:
Whether the product may explode or catch fire if there is a nearby spark from static electricity.

Section 5: Reactivity Data

Some substances are unstable. They can react with other substances or in specific kinds of conditions. This section lists the chemicals or conditions to avoid. Any hazardous by-products the chemical could generate are listed, along with hazards (such as toxic gases) that could be created if the chemical decomposes.

Chemical stability:
Whether the product is chemically stable when exposed to normal intended use or when placed in extended storage.

Incompatible substances:
What chemicals or chemical groups (for example, acids and caustics –Bleach and Ammonia) that will cause violent reactions when the two products contact each other.

Conditions of reactivity:
When hazardous reactions (for example, vigorous polymerization) may occur.

Hazardous decomposition products:

Hazardous substances produced or released due to aging or reaction with air or moisture. These do not include thermal decomposition products from burning or excess heating.

Section 6: Health Hazard Data

This section describes how the chemical gets into the human body and what affects it has on the body. The following are the usual methods of exposure:

Routes of entry:
How the product enters the body during normal use:

- inhalation or breathing
- ingestion or swallowing
- direct skin contact
- eye contact

This section also lists the health hazards the chemical poses. This section of the MSDS also lists the symptoms of exposure.

Acute exposure:
Acute effects show up immediately after exposure. This is from short-term exposure to the substance, either as a single exposure or as multiple exposures occurring within a short time, 24 hours or less.

Chronic exposure
Chronic effects that develop over time (usually serious) resulting from repeated exposure over a relatively long period, anywhere from several days to years.

Exposure limits:
Exposure limits for the product, usually the 8-hour time- weighted-average, and the name of the regulatory agency. The legal exposure limits (for example, in B/C the exposure limits listed in the Occupational Health and Safety Regulation) may be different from the ones listed on the MSDS.

Irritancy of product:

Whether the product may irritate the skin, eyes, nose, throat, or any other part of the body that it contacts to produce tearing, reddening, swelling, itching, and/or pain. Irritancy is often described as mild, moderate, or severe.

Sensitization:
Whether the product may cause sensitization. A sensitizer may cause severe allergic reactions with repeated exposure.

Carcinogenic:
This section notes whether the American Conference of Governmental Industrial Hygienists (ACGIH) bases the conclusion that the chemical causes cancer on findings of the International

Agency for Research on Cancer (IARC), National Toxicology Program (NTP). The section also states whether OSHA regulates the chemical for its cancer hazard.

Reproductive toxicity:
Whether the product may cause reproductive problems.

Teratogenicity:
Whether the product may cause birth defects in the fetus at exposures that do not cause damage or injury to the mother.

Mutagenicity:
Whether the product may cause changes to the genetic material (DNA) of living cells.

Synergistic products
Other products that, when combined with exposure to the controlled product, may cause a toxic effect greater than the sum of the effects of the individual materials.

For example, product A increases the chance for getting cancer by 2 times and product B increases the chance for cancer by 2 times, but when product A and B are used together, the chance for cancer is increased by 50 times.

Section 7: Preventive Measures

This section provides the following types of information:
How to handle the chemical under normal conditions; equipment required to handle the product safely.
Safe procedures to clean up spills, leaks, and other accidental releases of the product
• what to use to clean up a spill
• whether to evacuate immediately if there is a spill
• Waste disposal Information such as proper waste container design, safe procedures for handling waste, and agencies to contact regarding disposal requirements.

Personal protective equipment:
Specific personal protective equipment, and specific type of equipment, required preventing exposure to the product.

This section describes the type of ventilation needed, such as:
- local exhaust
- mechanical exhaust
- other

It also describes respiratory protection needed (if any). This section contains OSHA's recommended protective devices and clothing. SPECIAL PRECAUTIONS are also listed in this section.

Specific engineering controls:
Recommended engineering controls, such as ventilation and process equipment design, to be used with the product.

Storage requirements:
Specific safe storage information such as:

- Separation from other incompatibles,
- Shelf life,
- Testing for peroxide formation,
- Sensitivity to light, temperature, or moisture.

Special shipping information
Safe shipping information such as:

- Product identification number (PIN) or United Nations number (UN number)
- Classification, as determined by the Transportation of Dangerous Goods (TDG) legislation
- Proper shipping name
- Packing group, as determined by TDG legislation

Section 8: First Aid Measures

Specific first aid measures:
Specific first aid measures in the event of:

- Inhalation
- Ingestion
- Skin contact
- Eye contact

Examples:

- Ingestion, DO NOT INDUCE VOMITING.
- Inhalation, remove to fresh air and start CPR if breathing has stopped.
- Skin contact, flush with water for 15 minutes.
- Eye Contact, Flush with water for at least 15 minutes.

Section 9: Preparation Information

Date of original preparation and date of last review:
Gives the date that the MSDS was first prepared and when it was last reviewed (which should be within 3 years of the current date). Manufactures or importers providing only the date that the MSDS was printed are not acceptable.

Name and phone number of preparer

Gives the name and phone number of the person or group who prepared the MSDS.

Citizen Scientist Website Information

What is citizen science? –
http://science.nature.nps.gov/im/units/NETN/Education/NETN_ProgramBrief_CitizenScience_2009.pdf

Citizen science tool kit (example from bird surveys) –
http://www.birds.cornell.edu/citscitoolkit/projects/usnps/netn/

Value of citizen science – http://www.publicsphereproject.org/patterns/pattern.pl/public?pattern_id=857

Citizen science for Appalachian forest insect and disease –
http://www.appalachianforest.org/cem_agenda.html

Appalachian National Scenic Trail Mega-Trend (monitoring with citizen scientists) –
http://nationaltrailspartnership.org/PDF/08_NST_workshop/AT_MEGA-Transect_Moore.pdf
http://science.nature.nps.gov/im/units/appa/downloads/Presentations/ATTrailFestival_MT_2009.ppt

Asian longhorn beetle monitoring –
http://www.extension.org/pages/Asian_Long_Horned_Beetle_Threatens_New_Hampshire_Forests

Emerald ash borer monitoring –
http://www.nps.gov/mabi/upload/Emerald%20Ash%20Borer%202009.doc

Example of early detection database reporting via citizen scientists for invasive plants –
http://www.eddmaps.org/southeast/

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Appendix B – Technical Assistance and Training

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FOREST INSECT AND DISEASE PROTECTION
Contacts for Technical & Funding Assistance

Including:
USDI – National Park Service
USDA – Forest Service Forest Health Protection
USDA – Animal and Plant Health Inspection Service
Various State Agencies & Universities

The authors recognize that the contact information listed below will quickly go out of date. We recommend that the reader access the following links to obtain more current information, maintained by respective NPS Regional Offices.

Midwest Region:
http://nrpcsharepoint/brmd/Invasive_Plant_Mgt/MAEPMT/Shared%20Documents/(Insect%20and%20Pathogen%20Rapid%20Response%20Plan)/MWRO_Contact-List-4-Forest-Insect-and-Disease-Protection.pdf

National Capital Region:
http://nrpcsharepoint/brmd/Invasive_Plant_Mgt/MAEPMT/Shared%20Documents/(Insect%20and%20Pathogen%20Rapid%20Response%20Plan)/NCRO_Contact-List-4-Forest-Insect-and-Disease-Protection.pdf

Northeast Region:
http://nrpcsharepoint/brmd/Invasive_Plant_Mgt/MAEPMT/Shared%20Documents/(Insect%20and%20Pathogen%20Rapid%20Response%20Plan)/NERO_Contact-List-4-Forest-Insect-and-Disease-Protection.pdf

Southeast Region:
http://nrpcsharepoint/brmd/Invasive_Plant_Mgt/MAEPMT/Shared%20Documents/(Insect%20and%20Pathogen%20Rapid%20Response%20Plan)/SERO_Contact-List-4-Forest-Insect-and-Disease-Protection.pdf

Several organizations can prove beneficial in obtaining technical expertise and funding assistance when challenged with insect and disease problems in the forested or urban landscape. The following sections describe the first best and subsequent contacts to help implement forest protection activities.

– USDI-NATIONAL PARK SERVICE –

It is essential to keep the NPS regional organization apprised of the park's emergency forest insect and disease protection needs. The combined expertise of integrated pest management and forest insect and disease protection at regional offices is an excellent aid in approaching insect and disease issues. The regional and WASO staffs also have experience in pulling together collaborative teams to address new alien invasive problems.

NPS – Biological Resources Management Division (WASO)
National IPM Coordinator (Carol DiSalvo) 202-513-7183 (o); 703-527-4730 (c)

NPS – Midwest Region
Regional IPM Coordinator (John Sowl) – 402-661-1872 (o)

NPS – Northeast Region
Regional IPM Coordinator (Wayne Millington) 814-863-8352 (o); 267-767-3253 (c)

ERMN and MIDN (I&M networks partner)
Jennifer Stingelin Keefer, M.S. 814-865-8497
(Botanist/Research Associate: invasive species, botany, dendrology)
Jennifer_Stingelin_Keefer@partner.nps.gov
The Pennsylvania State University, Chester, PA 19013

MA-EPMT
James Åkerson 540-999-3500 ext. 3496
(Forest Ecologist, Forester, IPM, exotic plant management)
james_akerson@nps.gov

OLCE (landscape management)
Charlie Pepper 617-241-6954 ext. 260
Deputy Director, NPS-Olmsted Center for Landscape Preservation
charlie_pepper@nps.gov
Charlestown Navy Yard, Quarters C, Boston, MA 02129

NPS – National Capital Region
Regional IPM Coordinator (Jil Swearingen) 202-342-1443 ext. 218 (o)

NPS – Southeast Region
Regional IPM Coordinator (Chris Furqueron) 404-507-5812 (o); 404-569-6687 (c)

– USDA-FOREST SERVICE –

The USDA–Forest Service is authorized by Congress to provide technical and funding assistance in Forest Health Protection to federal, state, and private land owners/managers. When considering general forest insect and disease issues (and after contacting NPS regional contacts), the USDA-FS Forest Health Protection program is the first best contact. This is true for technical assistance and essential for funding assistance.

The USDA-FS *Forest Health Protection National Staff Directory* (included as a web citation below) is replete with the contact information of their entire staff and expertise. Unfortunately, it is outdated. For most managers at various locations, the information is more than needed. The list that follows is a way to get started.

USDA-FS Forest Health Protection website
http://www.fs.fed.us/foresthealth/

USDA-FS *Forest Health Protection National Staff Directory* (entire 50^{+} pages)
http://www.fs.fed.us/foresthealth/fhp_personnel.shtml

USDA-FS Regional & Local Contacts

Northeastern Area (PA, WV, MD, DE, NJ, NY, CT, RI, MA, NH, VT, ME, MN, WI, IA, MO, IL, MI, IN, OH)

Newtown Square	610-557-4139
• Forest Health Program Leader (Noel Schneeberger), Newtown Square, PA	610-557-4121
• Forest Health Monitoring Coord. (James R. Steinman), Newtown Square, PA	610-557-4158
• Forest Inven. & Analysis (William H. McWilliams) , Newtown Square, PA	610-557-4050
• Invasive Pest Specialist (Don Dagnan), Newtown Square, PA	610-557-4213
Durham Field Office	603-868-7709 ext 0
• Group Leader: Forest Health Protection (Ann Archie, acting), Durham, NH	603-868-7694
• Entomologist (Mike Bonna), Durham, NH	603-868-7708
• Entomologist (Kevin Dodds), Durham, NH	603-868-7743
Morgantown Field Office	304-285-1541
• Entomologist (Bill Oldland), Morgantown, WV	304-285-1585
• Entomologist (Brad Onken), Morgantown, WV	304-285-1546
• Plant Pathologist (Alan Iskra), Morgantown, WV	304-285-1553
• Invasive Plant Control/Fire Effects (Rod Whiteman), Morgantown, WV	304-285-1555
• Forest Health Protection Group Leader (Dan Twardus), Morgantown, WV	304-285-1545
St. Paul Field Office	651-649-5276
• Forest Health Program Leader (Barbara Tormoehlen), St. Paul, MN	651-649-5276
• Forest Pathology Lead (Manfred Mielke), St. Paul, MN	651-649-5267
• Forest Entomology Lead (Michael Connor), St. Paul, MN	651-649-5180

Region 8 (**VA, GA, KY, NC, SC, TN, FL, AL, MS, LA**, AR, OK, TX)

Atlanta Office	
• Director (Wesley Nettleton), Atlanta, GA	404-347-2719
• Regional Pathologist (Paul Mistretta)	404-347-2229
• Regional Entomologist (Donald Duerr)	404-347-3541
Alexandria/Pineville Field Office	
• Entomologist (Forrest Oliveria), Alexandria, LA	318-473-7294
Asheville Field Office	828-257-4319
• Entomologist - HWA (Rusty Rhea), Asheville, NC	828-273-4322
• Entomologist - GM (John Ganum), Asheville, NC	828-273-4328

– USDA-APHIS –

The USDA–Animal and Plant Health Inspection Service (APHIS) is directed by Congress to eradicate new exotic intruders. Typically, their work focuses at ports of entry but if funded by Congress they also operate in the heartland when new invasions get past those areas. When considering a newly introduced species, APHIS will be an important contact. APHIS can help with species identifications, reconnaissance, and eradication strategies.

USDA-APHIS website
http://www.aphis.usda.gov/

General Plant Protection and Quarantine Contacts
http://www.aphis.usda.gov/contact_us/ppq.shtml

Emergency and Domestic Programs

Emergencies	(301) 734-8247
Pest Detection	(301) 734-8717

National Identification Services (301) 734-5312

APHIS State Contacts

• **CT/RI**	State Plant Health Director, Wallingford, CT	(203) 269-4277
• **MA**	State Plant Health Director, Boston, MA	(617) 565-7030
• **MD**	State Plant Health Director, Annapolis, MD	(410) 349-8055
• **ME**	State Plant Health Director, Hermon, ME	(207) 848-5199
• **NH/VT**	State Plant Health Director, Berlin, VT	(802) 828-4490
• **NJ**	State Plant Health Director, Robbinsville, NJ	(609) 259-8387
• **NY**	State Plant Health Director, Albany, NY	(518) 218-7510
• **PA**	State Plant Health Director (Coanne O'Hern), Carlisle, PA	(717) 241-2465
	State Wildlife Services Director (Harris Glass), Harrisburg, PA	(717) 236-9451
• **VA**	State Plant Health Director, Richmond, VA	(804) 771-2042
• **WV**	State Plant Health Director, Ripley, WV	(304) 372-8590

– STATE GOVERNMENT CONTACTS –

The following are forest insect and disease specialist contacts provided by NPS staff members or gathered from the internet.

CT	Bureau of Natural Resources, State Forester (Christopher Martin)	860-424-3630
	County Cooperative Extension - http://www.extension.uconn.edu/pages/department/index.html	
MA	Dept of Cons. & Recr., Bureau of Forestry, Forest Health (Charlie Burnham)	413-256-1601
	County Cooperative Extension - http://www.umassextension.org/	
MD	Dept of Natural Resources, State Forester (Steven Koehn)	410-260-8501
	County Cooperative Extension - http://extension.umd.edu/local/	
	Coop Extn: Princess Ann County Forest Service, MD DNR	443-235-1636
ME	Forestry Service, State Entomologist (David Struble)	207-287-4981
	MFS Insect & Disease Lab	207-287-2431
	Forest Entomologist (Charlene Donahue), MFS Insect & Disease Lab	207-287-3244
	Forest Pathologist (Bill Ostrofsky), MFS Insect & Disease Lab	207-287-3008
	County Cooperative Extension - http://extension.umaine.edu/county-offices/	
NH	Dept of Res. & Econ. Development, State Forester (Brad Simpkins)	603-271-2214
	County Cooperative Extension – http://extension.unh.edu/staffbios/index.cfm?fuseaction=display.list&programarea_id=5	
NJ	State Forestry Service, State Forester (James Barresi)	609-292-2520
	Dept of Agriculture, Division of Plant Industry	609-292-5440
	County Cooperative Extension - http://njaes.rutgers.edu/county/	

NY	Dept of Environmental Cons., State Forester (Robert Davies)	518-402-9405
	County Cooperative Extension (IPM) - http://www.nysipm.cornell.edu/	
PA	DCNR, Dept of Forestry, State Forester (Dan Devlin)	717-787-2703
	DCNR, Dept of Forestry, Division of Forest Pest Mgt. (Donald Eggen)	717-948-3941
	DCNR, Dept of Forestry, Forbes State Forest (Cory Wentzel)	724-238-1200
	DCNR, Dept of Forestry, Fayette County (Bob McBride)	724-437-7983
	County Cooperative Extension - www.extension.psu.edu/extmap.html	
RI	Dept of Environmental. Mgt., State Forester (Cathy Sparks)	401-647-3367
	Insect & Disease Lab - http://www.uri.edu/ce/ceec/plantclinic.html	
	RI Agricultural Experiment Station	401-874-5493
VA	Department of Forestry, Entomologist (Chris Asaro), Charlottesville, VA	434-977-6555 ext. 3
	Virginia Tech, Insect species ID (Eric Day), Blacksburg, VA	540-231-4899
	Virginia Tech, Pathology ID (Mary Ann Hansen), Blacksburg, VA	540-231-6758
	County Cooperative Extension – http://www.ext.vt.edu/offices/	
VT	Dept of Forests, Parks & Recreation, State Forester (Steven Sinclair)	802-241-3678
	DFPR, Forest Health (Barbara Burn)	802-885-8821
	DFPR, Entomologist (Trish Hansen)	802-241-3606
	U. Vermont Prof. Emeritus: Forest Pathology (Dale Bergdahl)	802-425-2177
	ForAgProtect Red Start Collaborative (Ben Machin)	802-439-5252
	County Cooperative Extension – http://www.uvm.edu/extension/?Page=offices.html	
WV	Division of Forestry, State Forester (Randall Dye)	304-558-3446
	Dept of Agriculture, Entomologist (Barry Crutchfield)	304-558-2212
	County Cooperative Extension – http://ext.wvu.edu/county_offices	

– UNIVERSITY SOURCES AND OTHERS –

NPS staffs contributed the following contact information for consideration. Subject matter expertise is listed which may be beyond insect and disease management.

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(forest ecology) Researcher, Aiken Center, Room 207, University of Vermont
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John.Shane@uvm.edu

Other Sources

Aquatic Nuisance Taskforce
Invasive Species Experts Database (searchable by state)
http://www.anstaskforce.gov/experts/search.php

– OTHER CONTACTS –

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Training Opportunities

RELATED TO IPM AND FOREST INSECT AND PATHOGEN ISSUES

Integrated pest management (IPM) is the accepted and demanded management tool, set by NPS policy and Executive Order. It is the framework to diagnose and prescribe treatments for dealing with pest problems. Even the declaration of a species as a "pest" problem must be derived through IPM, whether set in our offices, front country landscapes, or the natural environment. Initial training and refresher courses on IPM are essential to understand the overarching framework and gather helpful tips on dealing with specific pest problems. The following sources can act as a starting point for obtaining training and information on IPM.

NPS TRAINING

Contact any of the following NPS staff people for IPM training opportunities:

Carol DiSalvo, National IPM Coordinator, 202-513-7183; carol_disalvo@nps.gov

Jil Swearingen, NC Region IPM Coordinator, 202-342-1443 ext. 218; jil_swearingen@nps.gov

John Sowl, MW Region IPM Coordinator, 402-661-1872; john_sowl@nps.gov

Wayne Millington, NE Region IPM Coordinator, 814-863-8352; wayne_millington@nps.gov

Chris Furqueron, SE Region IPM Coordinator, 404-507-5812; chris_furqueron@nps.gov

SOURCES OF ON-LINE TRAINING AND INFORMATION

NPS IPM Manual – http://www.nature.nps.gov/biology/ipm/manual/ipmmanual.cfm

New York IPM Information – http://www.nysipm.cornell.edu/

Insect identification – http://www.idlab.ento.vt.edu/

Pesticide label information – http://www.cdms.net/LabelsMsds/LMDefault.aspx?t=

USDA-Forest Service pest publications – http://na.fs.fed.us/pubs/

Minnesota Cooperative Extension – http://www.extension.umn.edu/pesticides/2009/eab/

OTHER FEDERAL TRAINING

USDA – http://www.csrees.usda.gov/nea/pest/in_focus/invasive_if_ipm.html

USDA-Natural Resource Conservation Service – http://northeastipm.org/nrcs.cfm

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Glossary of Biological Terms

The following list can act as a rudimentary primer of biological terms. Any insect and disease identification manual will have a more robust glossary for quick reference.

Abdomen	– referring to the third section of an insect.
Adventitious branching	– branching and leaf sprouting from the main stem of a tree occurs when trees are damaged or in stress.
Cambium	– the outer-most layer of tree (and shrub) growth under the bark of its branches and stem. It is the area of growth.
Canker	– a disease lesion on the bark/cambium of a tree or shrub.
Dorsal	– referring to the back of the body (typically the visible part of an insect).
Elongate	– not round or stout but longer than wide.
Epicormic	– leaves and branching from along the stem; coming from dormant buds; typically sparked by sun exposure to a heretofore-shaded stem.
Frass	– insect waste and sawdust.
Head	– the first section of insect body.
Instar	– stages of growth of a larvae between molts.
Larva	– caterpillar (pl. larvae).
Oviposition sites	– the place that an insect lays its eggs.
Necrotic	– dead.
Prothorax	– segment behind the head to which the first pair of legs is attached.
Pupa	– the intermediate life stage between larva and adult (pl. pupae).
Thorax	– referring to the middle section of an insect.
Ventral	– refers to the front or under side of body, as apposed to dorsal.

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Appendix C– Insect, Pathogen & Abiotic Advisories

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Insect Pests

ASIAN LONGHORN BEETLE (ALB) – Invasive Return to Key-[V]

Asian long-horned beetle (*Anoplophora glabripennis*) was first detected at New York City harbor in 1996. By 1998, it was in Chicago and warehouses around the country. Worcester, Massachusetts was the latest detection site of August 2008. ALB originally entered port areas inside wooden crates and wood packing materials. It is transported around the country in the same way. It is particularly worrisome as a pest because it attacks at least 18 species of hardwood trees including maple, birch, horse chestnut, poplar, willow, elm, ash, and black locust. It potentially threatens the maple industry of New England and Canada; and may cause serious injury to most Eastern forests due to its wide-ranging feeding.

Identification/Biology. ALB is about 1 to 1-1/2 inches long, black and shiny with white spots. Its very long antennae are banded with black and white. The female chews oviposition sites into bark of trees to lay eggs. Egg deposit sites are dime-sized, dimpled impressions in tree bark. A single female beetle lays from 35 to 90 eggs. Hatching within 10 to 15 days, the worm-like immature beetles tunnel under tree bark and bore into the stem of healthy hardwood trees. After maturing, ALB leave behind deep, perfectly round exit holes somewhat larger than the diameter of a pencil. Tree exit holes may ooze sap; deposits of frass may collect at tree trunk and tree limb bases. After emerging, adult beetles feed on tree exteriors for 2 to 3 days, then mate. Adult beetles remain active only during summer and early fall months before perishing, completing a 1-year life cycle.

ALB can look very much like the native whitespotted sawyer and cottonwood borer beetles. Refer to the following for comparative photos and text.
http://www.na.fs.fed.us/fhp/alb/pubs/alb_wss/alb_wss.htm
http://www.na.fs.fed.us/fhp/alb/pubs/alb_cb/alb_cb.htm


Asian longhorn beetle: (A) various life phases; and (B) adult.


(C) Adults chew depressions in the bark for egg laying; and (D) perfectly round exit holes.

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Controls. At time of writing, there are no recommended forest-wide control methods against ALB. Use of a systemic pesticide such as imidacloprid has proven successful in reducing beetle populations and slowing the spread of the insect for localized areas (USDA-APHIS, 2005). Cutting and chipping of infested trees has been practiced in an effort to destroy ALB larvae under the bark and thus slow the spread to other trees.

Monitoring and quarantining of firewood movement is essential at this time to reduce the chances of spreading ALB into uninfested areas. Cooperating with USDA-APHIS and state agencies is important to press for a quarantine of firewood from infested areas.

More Information. For more information and references, refer to the following publications. This advisory used photos and information found in them.

Invasive.org - http://www.invasive.org/species/subject.cfm?sub=2178
Rutgers - http://njaes.rutgers.edu/alb/identify.asp
USDA-Ag Library - http://www.invasivespeciesinfo.gov/animals/asianbeetle.shtml
USDA-ARS (Bibliog.) - http://www.ars.usda.gov/pandp/people/people.htm?personid=5254
USDA-APHIS. 2005. *Asian longhorned beetle (Anoplophora glabripennis)* APHIS Plant Protection and Quarantine Factsheet, January 2005. Washington, DC. 3 pp. (Available on-line at - http://www.aphis.usda.gov/publications/plant_health/content/printable_version/fs_phalb.pdf)
USDA-Forest Service - http://www.na.fs.fed.us/fhp/alb/

Photo Credits (by order of appearance): (A) Kenneth R. Law, USDA-APHIS PPQ, Bugwood.org; (B) Donald Duerr, USDA-Forest Service, Invasive.org; (C) & (D) BeetleBusters.info.

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BAGWORM (NATIVE) Return to Key-[**III**]

The common bagworm (*Thyridopteryx ephemeraeformis*) forms unsightly brown bags on arborvitae, red cedar, and junipers plus many other conifers and deciduous trees. Local populations can build rapidly when established on preferred hosts. Crowded larvae may eat the buds on these conifers causing branch dieback and open, dead areas. Excessive defoliation may cause entire plant death during the following season. Moderate defoliation is unsightly. This pest rarely builds up forest-wide populations.

Bagworms have a single generation per year and overwinter as eggs inside the female bag. There may be 300-1000 eggs in a bag. The eggs hatch in late-May or early-June. The small blackish larvae crawl out the bottom of the bag and spin down on a strand of silk. These larvae are often carried by wind and ballooned to nearby plants. When a suitable host plant is found the young larva immediately begins to form a new bag over its body. This bag is only 1/8 inch long and is soon covered with sawdust-like fecal pellets. As the larva feeds and grows it enlarges the bag and begins to incorporate bits and pieces of plant material. By mid-August, the larvae are mature and they often move with the bag to a sturdy branch or other structure where they attach the bag firmly with a strong band of silk. The larvae orient themselves with their heads down and pupate.

Identification/Biology. Bagworms form 1-1/2 to 2-1/2" spindle-shaped silk bags camouflaged with bits of foliage, bark and other debris. This is the best identification piece since they are seldom outside their bags.

Bagworm: (A) drawing of adult and bag; and (B) photo of larval bags.

Controls. If bagworms are few in number and easily reached, they may be picked off the plant and squashed in late fall when deciduous foliage has been dropped or the bits of plant material on the bags turn brown and can be easily located on evergreens.

Bacillus thuringiensis (Bt), is effective against bagworms if it is used against young larvae at the end of June after all the eggs have hatched.

If chemicals are used, plant foliage must be thoroughly covered because the larvae are protected from contact in the silk bag. Products registered for bagworm control include acephate (Orthene^R), carbaryl (Sevin^R), cyfluthrin (Tempo^R), pyrethrum, permethrin (Pounce^R), and rotenone. Refer to your NPS Regional IPM specialist. Apply pesticides in spring at early larval development. Larger larva and pupae are not easily killed.

More Information. For more information and references, refer to the following publications. This advisory used photos and information found in them.

Ohio State University Extension - http://ohioline.osu.edu/hyg-fact/2000/2149.html
Penn State - http://woodypests.cas.psu.edu/factsheets/insectfactsheets/html/bagworm.html

Photo Credits (by order of appearance): (A) Ohio State University; and (B) Michael Masiuk.

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BROWNTAIL MOTH – Invasive Return to Key-[III]

The browntail moth (*Euproctis chrysorrhoea*) was accidentally introduced from Europe to Massachusetts in 1987 and quickly became a region-wide problem of New England. As natural controls began to exert themselves upon the species, by the 1970s it subsided to an occasional problem of Cape Cod, MA, and Casco Bay, ME. The larval stage feeds on the foliage of hardwood trees and shrubs including oak, shadbush, apple, cherry, beach plum, and exotic rugosa rose. Larval feeding causes growth reduction and occasional mortality of valued trees and shrubs.

A 2009 online news article from Britain indicates the insect (native to that island nation and Europe) is moving northward to hitherto uninfested areas due to global warming. It is possible that the U.S. and Canada could see similar movement of the species.

(A) Browntail moth caterpillar hairs can cause severe and persistent skin rash similar to poison ivy.

Identification/Biology. Male and female moths have white wings and a tuft of dark brown hair on the tip of the abdomen. Moths lay clusters of eggs on the underside of leaves in late July and August. Larvae emerge in August and form webs that they will stay in over the winter. Limited feeding occurs on upper leaf surfaces in fall. In early spring when plant buds expand, larvae begin to feed, often returning to the protection of the webs as temperatures cool each day. Caterpillars reach 1.5 inches, are hairy, brown with a broken white stripe on each side, and conspicuous red spots on the back. The larvae mature in late June to early July and pupate singly or in clusters on leaves, trunks, and undersides of branches. Moths emerge approximately two weeks later.

Browntail moth: (B) adults; (C) single larva.

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Browntail moths: (D) Overwintering web containing dozens of browntail larvae; and (E) emerged larvae.

Controls. Controlling browntail moths can be done by clipping the winter webs and soaking them in water and detergent anytime during September - March. The larvae inside are destroyed. Pesticides should be applied when larvae are present and feeding, from early May through the end of June. Chemicals such as pyrethrins (Pyrenone[R]) or carbaryl (Sevin[R]) provide acceptable control results. Refer to your NPS Regional IPM specialist. Note that these chemicals are not allowed within 250 feet of marine waters. Only registered fruit tree formulations should be used on apple and other fruit trees.

More Information. For more information and references, refer to the following publications. This advisory used photos and information found in them.

Britain – http://www.dailymail.co.uk/sciencetech/article-1189685/Plague-hairy-caterpillars-cause-rashes-headaches-breathing-problems-invades-Britain.html
Maine Forest Service – http://www.state.me.us/doc/mfs/btm08.htm and http://www.state.me.us/doc/mfs/btmId.htm
USDA-Forest Service – http://www.fs.fed.us/na/durham/foresthealth/pdf/browntail_moth2.pdf

Photo Credits: (A) (B) & (E) Jan Samanek, State Phytosanitary Administration, Czechia, Bugwood.org; (C) Milan Zubrik, Forest Research Institute - Slovakia, Bugwood.org; and (D) Ferenc Lakatos, University of West-Hungary, Bugwood.org.

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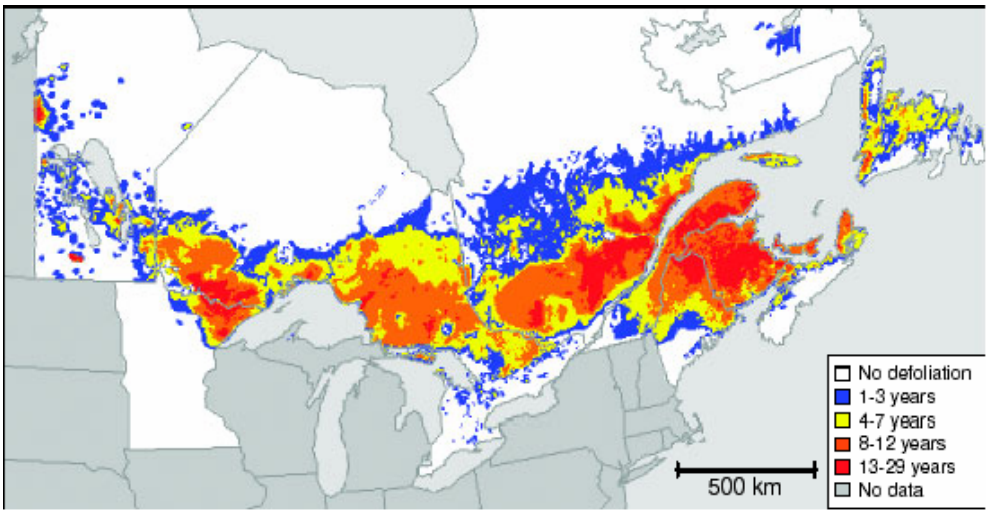
EASTERN SPRUCE BUDWORM (NATIVE) Return to Key-[**III**]

The eastern spruce budworm (*Choristoneura fumiferana*) has an extensive range in Southern Canada, with localized infestations in Maine and Minnesota. Growth loss and tree mortality are common after successive defoliations by the larvae. Host trees include balsam fir (most severe), white, red, and black spruce, and some feeding may occur on tamarack, pine, and hemlock. Spruce mixed with balsam fir is more likely to suffer budworm damage than spruce in pure stands.



(A) Eastern spruce budworm range (Williams & Birdsey, 2003).

(B) Eastern spruce budworm impact to leaves, shoots, and buds.

Identification/Biology. Adult moths have a wingspan of 2 centimeters, usually grayish with dark brown markings. Some moths are brown or reddish with gray markings. The light green eggs are about 1 millimeter long by 0.2 millimeter wide. The eggs, laid in elongate masses of 2 to 60 - averaging about 20, overlap one another.

Overwintering larvae emerge in spring and go through six instars. The first larval instar is 2-mm long, yellowish green with a light- to medium-brown head. The second instar is yellow with a dark brown or black head. As larvae mature, they go from a pale yellow to a dark brown with light-colored spots along the back. The final larva is about 2.5-cm long. Pupae are pale green to reddish brown. Adults (moths) lay eggs on underside of needles in egg masses.

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Eastern spruce budworm: (C) larva; (D) adults.

Controls. Adverse weather, diseases, predators, and parasites play an important part in naturally holding budworm populations in check. Direct controls include aerial spraying of *Bacillus thuringiensis* (biological), carbaryl and acephate (chemical), and diflubenzuron (growth regulator). Insecticidal soap can be applied with limited success.

More Information. For more information and references, refer to the following publications. This advisory used photos and information found in them.

USDA Forest Service. 1979. *A guide to common insects and diseases of forest trees in the northeastern United States*. Northeast. Area State Priv. For., For. Insect and Disease Management., Broomall, PA. p. 123, illus.
(Available on line: http://www.forestpests.org/northeast/sprucebudworm.html)

USDA-Forest Service. 19??. *Spruce budworm in the Eastern United States*. Field Insect and Disease Leaflet #160. Editors: Daniel R. Kucera1 and Peter W. Orr. U.S. Department of Agriculture Forest Service, Washington, DC.
(Available on line: http://www.na.fs.fed.us/spfo/pubs/fidls/sbw/budworm.htm)

Williams, D.W. and R.A. Birdsey. 2003. *Historical patterns of spruce budworm defoliation and bark beetle outbreaks in North American conifer forests: An atlas and description of digital maps*. USDA Forest Service Northeastern Research Station. GTR NE-308: 37 pp.

Photo Credits (by order of appearance): (A) Map by Williams & Birdsey, as above; (B) Jana Albers, Minnesota Department of Natural Resources; (C) Jerald E. Dewey, USDA-Forest Service; and (D) K.B. Jamieson, Canadian Forest Service.

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EASTERN TENT CATERPILLAR (ETC) (NATIVE) Return to Key-[I][III]

Eastern tent caterpillar (*Malacosoma americanum*) is primarily an aesthetic problem, seldom causing tree mortality. In early spring, it is most often found in wild and ornamental cherries and plums. By late spring, it moves to other trees in search of foliage to consume. When abundant, caterpillars will eat all the leaves, weakening, though seldom killing trees. Parks with historic orchards may find that the ETC destroys fruit production during years of its outbreak.

Identification/Biology. The easiest identifier of ETC is the white silken web found at branch crotches in early spring. The web location is distinct from fall/spring webworms that make their webs at branch ends. In addition, ETC webs do not encase leaves. The larvae are 2 to 2-1/2" long with black heads, and long, light brown body hairs. The back has a light stripe, bordered on each side with yellowish-brown and black wavy lines. The sides are marked with blue and black spots. Moths have a wingspread of about 2 to 2-1/2" and are yellowish-brown, with two narrow, light lines across the front wings.

Eastern tent caterpillar: (A) egg masses from summer through early spring; (B) silken tents in early spring with emerging larvae; (C) mid-developed larva; and (D) adult moth.

Controls. Control is not normally needed since tree mortality rarely occurs.
Leaf feeding can be prevented on small ornamental trees by destroying tents with a stick or pole, thus exposing the larvae to birds. Another preventive method is to prune the egg masses from twigs before the early spring hatch.

Young caterpillars can be killed by applying *Bacillus thuringiensis* var *kurstaki*. Typical chemical insecticides include carbaryl, methoxychlor, and malathion. Refer to your NPS Regional IPM specialist. Larvae within the tents are protected beneath the webbing and are more difficult to kill with an insecticide.

More Information. For more information and references, refer to the following publications. This advisory used photos and information found in them.

University of Kentucky, Agriculture - http://www.ca.uky.edu/ENTOMOLOGY/entfacts/ef423.asp
USDA-Forest Service, NA - http://www.na.fs.fed.us/spfo/pubs/pest_al/etc/etc.htm

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USDA-Forest Service, SE - http://www.fs.fed.us/r8/foresthealth/idotis/insects/easttnt.html

Photo Credits (by order of appearance): (A) & (B) USDA-Forest Service staff; and (C) & (D) Ric Bessin, University of Kentucky – Entomology.

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ELM LEAF BEETLE – Invasive

Return to Key-[I][III]

Elm leaf beetle (*Xanthogaleruca luteola*) was introduced from Europe and has become a pest throughout the North American range of elms. It feeds on all elm species but especially likes Siberian elm (*Ulmus pumila*) and Chinese elm (*parvifolia*). When defoliation is severe for several consecutive years, limbs and sometimes the tree may be killed. Most notably for the public, the beetles become a nuisance in the fall when they move into homes searching for overwintering sites. The adults may be a problem in the spring when they congregate in windows as temperatures increase.

This species does **not** transmit Dutch elm disease.

Identification/Biology. The adults are approximately 0.25 inch long and yellowish to green with a black stripe on each wing margin. Pupae are about 0.25 inch long and bright orange-yellow. The larvae are green to yellow, with a black head and two black stripes on the back.

Elm leaf beetle: (A) including adults, larvae and eggs.

Adults chew holes in the leaves, particularly on new growth. The larvae feed on the under surfaces of leaves, leaving upper surfaces and the veins intact. Leaves shrivel and turn brown when damage is severe. In the spring, the adults fly to elms and eat small holes in the newly developing leaves. Eggs are laid in a cluster on the undersides of leaves. The eggs hatch and the larvae feed for 2 to 4 weeks. The larvae crawl to sheltered places on the tree or ground to pupate. In one to two weeks, new adults emerge, again feed, and lay eggs. There are two-to-four generations per year.

Controls. Forest-wide protection and treatment is not typically advised. Landscape ornamentals can be sprayed with a variety of chemical sprays, directed at the undersides of the elm leaves, beginning in the early spring.

Elm leaf beetle feeding can be controlled with systemic insecticides, including abamectin (Avid, Vivid II), acephate (Orthene), and imidacloprid (Bayer Advanced Tree & Shrub Insect Control, Imicide, Merit). Some formulations of these materials can be sprayed onto the tree foliage, but soil applications and tree injections (if labeled for this method of application) minimize environmental contamination and may be more effective than foliar sprays. Refer to your NPS Regional IPM specialist.

More Information. For more information and references, refer to the following publications. This advisory used photos and information found in them.

Eastern Forest Environmental Threat Assessment Center -
http://threatsummary.forestthreats.org/threats/threatSummaryViewer.cfm?threatID=199

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Forestpests.org - http://www.forestpests.org/southern/elmleafbeetle.html
University of California – Davis - http://www.ipm.ucdavis.edu/PMG/PESTNOTES/pn7403.html
USDA-Forest Service - http://www.fs.fed.us/r8/foresthealth/idotis/insects/elmleaf.pdf

Photo Credits: (A) USDA-Forest Service.

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ELONGATE HEMLOCK SCALE – Invasive

Return to Key-[VII]

The elongate hemlock scale (*Fiorinia externa*) is an introduced pest from Japan. It is known to develop and reproduce on 43 species, representing seven genera of native and exotic conifers, including 14 species that are native to the United States. Spruce and fir tend to be even more susceptible than hemlock. Scale populations build slowly on healthy trees and faster on stressed ones. Stress factors include drought and other insect attacks. Feeding by elongate hemlock scale causes foliage to turn yellow and drop prematurely. An important ocular key is that needle and branch dieback progresses from the bottom of the tree upwards. Hemlock woolly adelgids, on the other hand, cause foliage to fade uniformly. Weakened trees have little chance for recovery. They fall victim to secondary pests such as hemlock borer and Armillaria root rot.

Identification/Biology. The elongate hemlock scale completes one generation per year in the Northeast, but two or more in the Mid-Atlantic and Southern regions. McClure (2001) indicates, "adult females are soft-bodied, legless, wingless, and are enclosed in an elongate, parallel-sided cover that is light yellow to brown, translucent, and about 2mm long. The male cover is elongate, white, and about 1.5mm long. Adult males are light brown, about 1.5mm long, have legs and wings, but are feeble-flying insects. Crawlers are legged first-stage nymphs that hatch from translucent eggs within the female cover. Crawlers are soft bodied, lemon-colored, and about 0.1mm long. Second-stage nymphs are enclosed in an oval, amber-colored cover, and are soft bodied, sedentary, and vary in size from 0.1mm to 1.0mm."

Each female adult lays about 20 eggs. Elongate hemlock scale overwinters as an egg or an inseminated adult female.

Elongate hemlock scale: (A) nymphs and adults on the lower side of hemlock needles, enlarged; (B) appearance of infestation at normal ocular view.

Controls. Control of elongate hemlock scale is not possible on a forest-wide basis. Ornamental plantings can be aided by thoroughly drenching trees with horticultural oil, or another registered insecticide formulation applied according to label, during early spring, when trees are dormant, and again in summer after new needles are hardened, if needed. Declining hemlocks should be removed to prevent scale population buildup and spread. Watering can help keep ornamentals healthy. Fertilization should not be done. It is counterproductive, as it seems to nourish the scale.

More Information. For more information and references, refer to the following publications. This advisory used photos and information found in them.

McClure, Mark S. 2001. *Elongate hemlock scale*. Pest Alert, NA-PR-01-02. USDA-Forest Service, Northeastern Area. 2 pp.
(Available on-line: http://na.fs.fed.us/spfo/pubs/pest_al/ehscale/ehscale.htm)

Penn State College of Agricultural Sciences - http://ento.psu.edu/extension/factsheets/elongate-hemlock-scale

USDA-Forest Service – http://www.fs.fed.us/r8/foresthealth/idotis/insects/sopnsawy.pdf

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USDA-Forest Service news release -
http://www.na.fs.fed.us/nanews/nastories/051908/News%20release%20EHS%20FINAL%20051608.pdf

Photo Credits: (A) Mark S. McClure, The Connecticut Agricultural Experiment Station; (B) Eric R. Day, Virginia Polytechnic Institute and State University, Bugwood.org.

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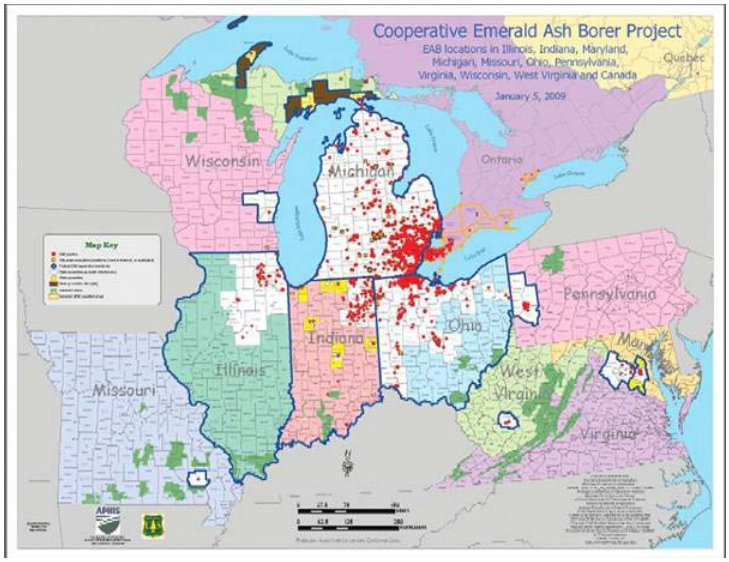
EMERALD ASH BORER (EAB) – Invasive Return to Key-[I][V]

Emerald ash borer (*Agrilus planipennis*) is native to Asia. Scientists believe EAB entered the U.S. and Canada inside infested wooden crates and pallets sometime in the 1980s. It was first detected in 2002 in southeastern Michigan and Windsor, Ontario. At time of writing, EAB has spread in a widening arc from the Detroit area. The Maryland site probably has a separate genesis but has a similar entry vector.



(A) The emerald ash borer infested area, January 5, 2009.

Identification/Biology. EAB adults are slender, elongate, and 7.5 to 13.5 mm long. Males are smaller than females and have fine hairs, which the females lack, on the ventral (under) side of the thorax. Adults are usually bronze, golden, or reddish green overall, with darker, metallic emerald green wing covers. The dorsal side of the abdomen is metallic purplish red and can be seen when the wings are spread. The prothorax, the segment behind the head and to which the first pair of legs is attached, is slightly wider than the head and the same width as the base of the wing covers. Larvae reach a length of 26 to 32 mm, are white to cream-colored, and dorso-ventrally flattened. The brown head is mostly retracted into the prothorax; only the mouthparts are visible. The abdomen has 10 segments, and the last segment has a pair of brown, pincer-like appendages.

EAB initially attacks a tree in the upper crown. Over time, the insect works its way downward in branches and main stem, eventually girdling and killing the tree. The cycle appears to take 3-to-5 years from initial infestation to tree mortality.

Emerald ash borer: (B) adult on penny; and (C) showing the D-shaped adult exit hole in bark.

Controls. Though clearcutting of infested trees including a buffer area of uninfested trees was attempted in the early years of experimentation, that control method was abandoned in 2008 due to

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the prevailing belief that where EAB is found, it is widely present and not neatly contained within advancing fronts.

A recent bulletin (Herms, et. al, 2009) recommends pesticide application to preserve ash. Most promising are soil or tree injection methods using systemic pesticides such as emamectin benzoate, imidacloprid, or dinotefuran. The approach is suitable for protecting individuals and groups. Systemic insecticides, whether applied to the soil or tree, are translocated throughout the tree and kill insects that feed upon sapwood and foliage. The authors caution against applying pesticides unless EAB has been detected within 10-15 miles. In addition, "Research and experience suggest that effectiveness of insecticides has been less consistent on larger trees. When treating very large trees under high pest pressure, it may be necessary to consider combining two treatment strategies."

At this time, there are no park-wide or forest-wide approaches available. Prevention is the essential management tool. (1) Stop all importing of off-site firewood into your park. Cooperate with USDA-APHIS and state agencies to quarantine movement of firewood. (2) If your park has natural ash stands or heavily ash-dominant landscaping, begin phasing in other species as soon as possible to avoid catastrophic loss due to EAB. Diversify landscape plantings using native tree species. Refer to Appendix-E for a listing of native tree species and their associated risk factors.

Emerald ash borer: (D) American ash killed by EAB in an urban park setting.

More Information. For more information and references, refer to the following publications. This advisory used photos and information found in them.

Emerald ash borer - http://www.emeraldashborer.info/

Herms, Daniel A., and D. McCullough, D. Smitley, C. Sadof, R. Williamson, and P. Nixon. 2009. *Insecticide options for protecting ash trees from emerald ash borer*. North Central IPM Center Bulletin; June 2009. 12 pp.
Available on-line http://www.emeraldashborer.info/files/Multistate_EAB_Insecticide_Fact_Sheet.pdf

Maryland Coop Extension - http://pestthreats.umd.edu/content/documents/FS836-Aseriousthreattoyourashtrees.pdf

USDA-Forest Service. 2004. *Emerald ash borer*. Pest Alert NA-PR-02-04. January 2004. USDA-FS Northeastern Area, State & Private Forestry. 2 pp.
Available on-line at http://www.emeraldashborer.info/files/eab.pdf

USDA - http://www.invasivespeciesinfo.gov/animals/eab.shtml

USDA-Forest Service - http://www.na.fs.fed.us/fhp/eab/

Photo Credits (by order of appearance): (A) Map from Emeraldashborer.info; Photo (B) Howard Russell, Michigan SU; (C) Deborah McCullough, Michigan SU; and (D) North Central IPM Center.

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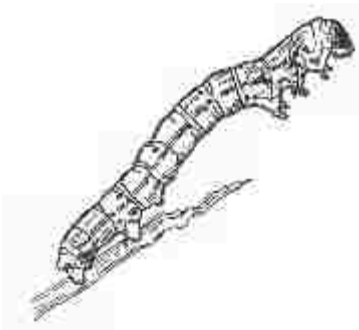
FALL CANKERWORM (NATIVE) Return to Key-[III]

Fall cankerworm (*Alsophila pometaria*) and spring cankerworm (*Paleacrita vernata*) which is less common get their names from the period that the adult is active. Both insects have their larval outbreaks in the spring. Tree hosts include the red and white oak groups, maples, elms, hickories, ash, and cherry. Heavy defoliation usually occurs in May and June, causing growth loss, mast reduction, and, if coupled with other stresses, may result in mortality. It is not generally considered a forest-wide killer. Its greatest impact is felt in high public use areas where defoliation is unsightly, and where larvae and their droppings create a nuisance.

Identification/Biology. Wings of male moths are light gray to tan, with wavy lines, and span about 1 to 1-1/2". Females are wingless. Mature larvae of the fall cankerworm are about 1" long and vary from light green to black, with light yellow lines on the sides and a dark dorsal stripe. Mature spring cankerworm larvae are 4/5 to 1-1/2" long and range in color from reddish to yellowish brown, yellowish green, or black. Larvae are of the general "inch-worm" type with the distinctive looping walk.

Small holes in the leaves are early evidence of young larvae feeding on expanding foliage. Older larvae consume the entire leaf, except the midribs and major veins.

Fall cankerworm (A) adult laying eggs.



Fall cankerworm: (B) drawing noting the looper/inchworm formation; (C) photo of larvae on leaf.

Controls. Outbreaks are usually brought under control by wasp parasitizing. Controls are not normally recommended for park-wide settings. Ornamental individuals and landscape settings may be protected in several ways. Sticky bands placed around the trunks of high value trees can trap the females as they climb the tree to lay their eggs. A horticultural oil spray of 2-3% with water is quite effective against the eggs. You must thoroughly wet the trunk bark if spring cankerworms are present. Reduce the oil rate, especially on maples, if the trees seem to be active in the spring. Spray with *Bacillus thuringiensis* (Bt) against young cankerworm larvae. Wait until all the eggs have hatched but spray before the larvae get to be over inch long. Insecticide sprays

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are effective for control of larvae if applied after all the eggs have hatched and the larvae are still small.

More Information. For more information and references, refer to the following publications. This advisory used photos and information found in them.

Forestpests.org - http://www.forestpests.org/southern/fallspringcankerworm.html
Ohio State University - http://ohioline.osu.edu/hyg-fact/2000/2558.html
Pennsylvania DCNR - http://www.dcnr.state.pa.us/Forestry/pests/fall.htm

Photo Credits (by order of appearance): (A) John H. Ghent, USDA-Forest Service; (B) Pennsylvania Dept of Cons & Nat Resources; and (C) E. Bradford Walker, Vermont Department of Forests, Parks and Recreation, Bugwood.org

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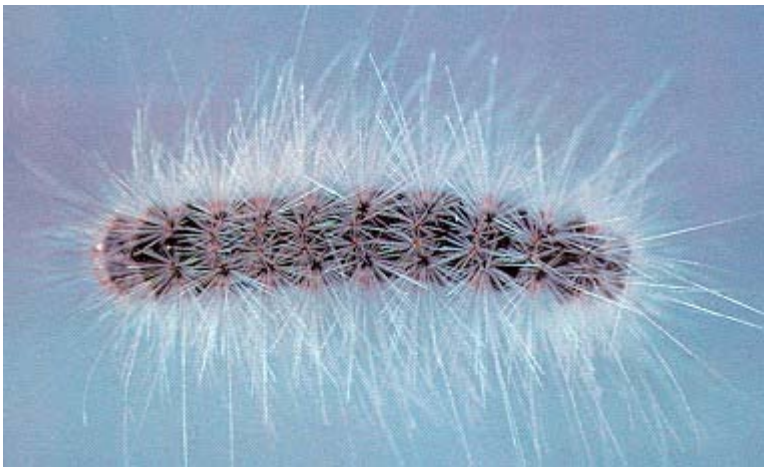
FALL WEBWORM (NATIVE) Return to Key-[**III**]

Fall webworm is not considered an important forest pest. The unsightly webs can, however, draw the negative attention of park visitors and detract from aesthetics.

Identification/Biology. Webworms enclose leaves and small branches in their light gray, silken webs, differing from eastern tent caterpillar that does not encase leaves. Occasionally, small trees may be completely encased in webbing. Larvae are gregarious until the last instar when they leave the web and feed individually. Pupation occurs in thin cocoons usually spun in the forest floor duff or just beneath the soil. The adult moth wingspan is 1 to 1-1/4"; it is snowy white, usually with dark spots on the wings. The larvae are 1 to 1-1/4" long and covered with silky white hairs. The larvae color varies from pale yellow to green, with a black stripe on the back and a yellow stripe on each side. Pupae are found inside a gray cocoon constructed of silk, frass, and debris. The eggs are small, yellow, or light green, and turn gray before hatching. Depending upon location, there can be from one to four generations per year.


Fall webworm: (A) showing heavy, messy webs; (B) webs located on branch ends, not near crotches as ETC.



(C) Fall webworm larva.

Controls. Control treatments are seldom needed. Natural biotic agents and unfavorable weather effectively control the insect. To protect ornamentals, insecticidal soap, biological agents, or chemical insecticides may be sprayed on larvae from mid- to late-summer. Refer to your NPS Regional IPM specialist.

More Information. For more information and references, refer to the following publications. This advisory used photos and information found in them.

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Bugwood.org - http://www.bugwood.org/factsheets/webworm.html
Forestpest.org - http://www.forestpests.org/southern/fallwebworm.html
USDA-Forest Service. 1989. *Insects and diseases of trees in the South.* USDA-FS, Forest Health Protection; R8-PR16. 98 pp.
Available on web: *http://fhpr8.srs.fs.fed.us/forstpst.html*

Photo Credits: (A) & (C) USDA-Forest Service, Southern Region staff; and (B) G. Keith Douce, Bugwood.org.

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FOREST TENT CATERPILLAR (FTC) (NATIVE) Return to Key-[III]

Forest tent caterpillar (*Malacosoma disstria*) is a native species found throughout hardwood forests of North America. It is a highly destructive pest in epidemic cycles. Regional outbreaks occur at 5-to-15-year intervals, where outbreaks last 2-to-5 years. At the peak of an outbreak, millions of acres of trees are stripped of their leaves by mid-summer.

Identification/Biology. FTC does not create gregarious web-tents as ETC, but does create individual silken pupa tents. Its name comes from the appearance of adults that, when resting on a branch or building, look like miniature tents. Shiny brown egg masses are present from mid-summer through next early spring. Masses differ from those of eastern tent caterpillar in having square edges, and completely encircling host twigs. Early spring larvae have distinctive keyhole-shaped white spots on the middle of the back of each segment. In May and June, larvae eat all except larger veins and petioles of leaves. The chunky buff-brown moths appear in July.

Forest tent caterpillar: (A) egg mass noting squarish ends; (B) noting white keyhole patches on larva.

Forest tent caterpillar: (C) noting hairy cocoon; (D) adult moth.

Controls. Natural control is exerted by several species of flies and wasps that parasitize the eggs, larvae, and pupae. Most important are large gray flies, *Sarcophaga aldrichi*, in the North; and *S. houghi* in the South. Female flies deposit maggots on cocoons that penetrate the silk and kill the pupae.

Small landscape trees and shrubs can be protected by hand removal of egg masses and caterpillars. During large outbreaks many thousands of caterpillars crawl long distances to find food. This makes hand control difficult. In addition, egg masses are often laid in the upper tree crowns, making them hard to reach.

Several insecticides work to control FTC. *Bacillus thuringiensis* var. *kurstaki* (Btk) is effective against young larvae and causes the least nontarget species impacts. “It is difficult to achieve satisfactory control with insecticides on areas smaller than 10 acres where less than 80% of the forested area will be treated. Several [chemical] insecticides are registered for controlling

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the forest tent caterpillar. This includes … malathion, carbaryl and acephate" (Minnesota DNR 2009). Refer to your NPS Regional IPM specialist.

More Information. For more information and references, refer to the following publications. This advisory used photos and information found in them.

Hanson, T., and E. B. Walker. [n.d.] Field guide to common insect pests of urban trees in the Northeast. Waterbury, VT: Department of Forests, Parks and Recreation. http://www.forestpests.org/vermont/introduction.html

Minnesota DNR - http://www.dnr.state.mn.us/treecare/forest_health/ftc/index.html

Pennsylvania DCNR - http://www.dcnr.state.pa.us/Forestry/foresttentcaterpillar/index.aspx

USDA-Forest Service. 1978. *Forest tent caterpillar*. Field Insect and Disease Leaflet #9. Editors: Batzer, Harold O., and Robert C. Morris. U.S. Department of Agriculture Forest Service, Northern Area State & Private Forestry. November 1978. 8 pp. (Available on line: http://na.fs.fed.us/spfo/pubs/fidls/ftc/tentcat.htm)

USDA-Forest Service, Northern Area - http://na.fs.fed.us/spfo/pubs/infosheets/tentcat/index.htm

Photo Credits (by order of appearance): (A) James Solomon, USDA-Forest Service, Bugwood.org; (B) Pennsylvania Department of Conservation and Natural Resources; (C) Herbert A. Pase III, Texas Forest Service, Bugwood.org; and (D) Whitney Cranshaw, Colorado State University, Bugwood.org.

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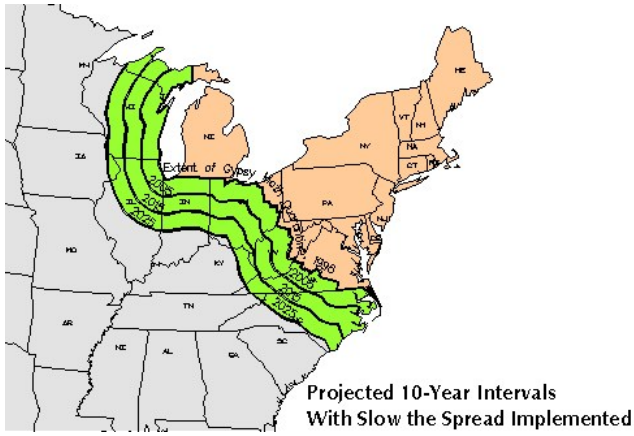
GYPSY MOTH (GM) – Invasive

Return to Key-[III]

A scientist in Medford, Massachusetts, attempting to cross European gypsy moths (*Lymantria dispar*) with silk worms to enhance silk production, accidentally allowed its escape in 1869. It quickly became a devastating defoliator of a wide variety of deciduous trees. GM larvae prefer feeding on the white oak group, but during high epidemic periods, GM may feed on several hundred different species of hardwood and conifer trees and shrubs.

Hajek (1986) and Soper (1986), of the USDA-Agriculture Research Service, initiated a study of *Entomophaga aulicae* fungus complex (containing *E. maimaiga*) for the control of gypsy moths. By the 1990s, *E. maimaiga* had become an effective biological control in the historically infested areas of the East. The current expanse of GM infestation includes most of the Northeast, Mid-Atlantic, and parts of the Lake States.



(A) Gypsy moth current (1996) and projected (through 2025) range of infestation.

Identification/Biology. GM goes through four stages of development: egg, larva, pupa (cocoon), and adult (moth). Male moths have tan-to-brown wings marked with dark, wavy bands and a wingspan of about 1.5 inches (38 mm). Females are larger than males with a wingspan of 2 to 2.5 inches (50-63 mm) and have a white to cream-colored body and wings with distinctive black wing markings. The abdomen of the female is clothed in yellowish hairs. Its body is so large and heavy that she is **unable to fly**. Only males can fly.

Adult females lay eggs in masses in mid-to-late summer. GM overwinters in the egg form. Egg masses are 1.5 inch (4 cm), tan or buff-colored, and placed on tree trunks and other vertical surfaces. Emerging larvae grow through five instars. Tiny first and second instar larvae are transported great distances by gliding or "ballooning" on breezes using silken threads (like spider webs), up to a mile or more. Movement also takes place when egg masses are laid on cars, firewood, and other items that might be carried long distances.

During the first three instars, larvae remain in the top branches or crowns of host trees. The first instar larvae chew small holes in the leaves. The second and third instars feed from the outer edge of the leaf toward the center. Mature caterpillars are from 1.5 to 2.5 inches (38-63 mm) long. When population numbers are sparse, the movement of the larvae up and down the tree coincides with light intensity. Larvae in the fourth instar feed in the top branches or crown at night. When the sun comes up, larvae crawl down the trunk of the tree to rest during daylight hours. Larvae hide under flaps of bark, in crevices, or under branches for protection. When larvae hide underneath leaf litter, mice, shrews, and Calosoma beetles can prey on them. At dusk, when the sun sets, larvae climb back up to the top branches of the host tree to feed. When population numbers are dense, on the other hand, larvae feed continuously both day and night until the foliage of the host tree is stripped. Then they crawl in search of new sources of food. Larvae reach maturity between mid-June and early July. They enter the pupal stage, lasting from 7-to-14 days, at which time they become adult moths.

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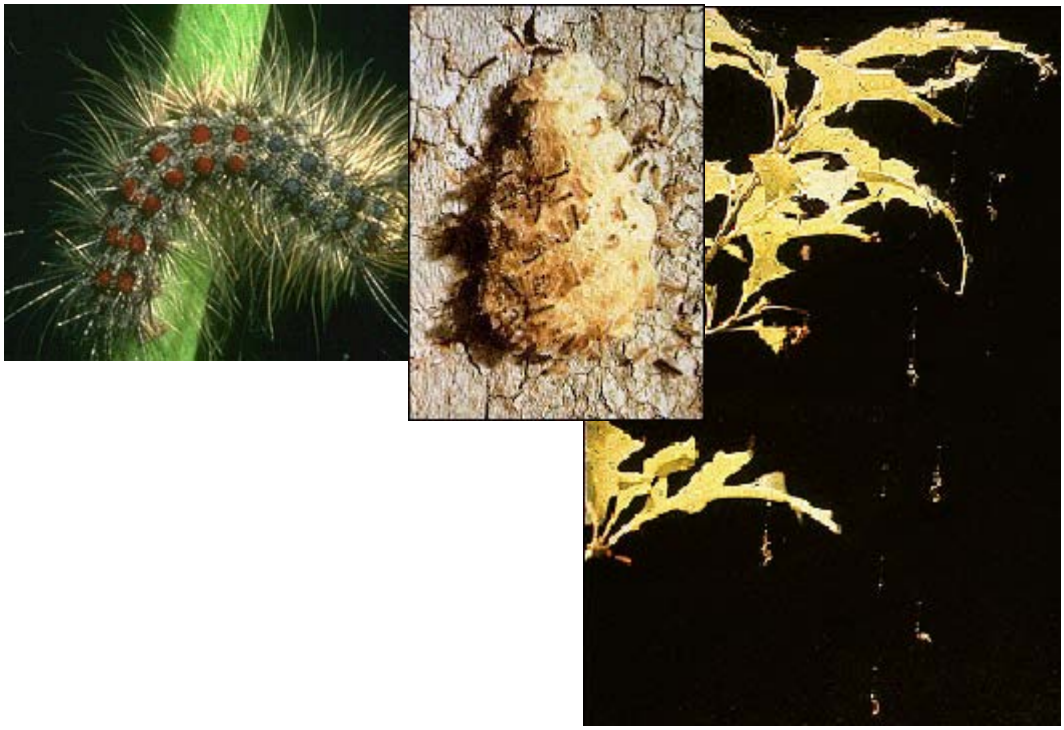

Gypsy moths (B) larva; (C) egg mass with emerging larvae; and (D) 1st and 2nd instar larvae suspended by silken threads to "balloon" on the breezes to remote locations.

Gypsy moth adults: (E) female laying an egg mass; and (F) male (l) and female (r).

Controls. If the park unit is on the leading edge of new infestation, cooperate with USDA-Forest Service efforts to "Slow the Spread" by applying mating disruption pheromones.

Destroy egg masses found on trees, outbuildings, fencing, and woodpiles. Burn or soak them in kerosene or soapy water. Caution: the hairs that coat the egg masses can cause allergic skin reactions.

Place burlap on trees, especially oaks, to provide shade and shelter for older larvae when they seek out protected resting places during the day. The number of larvae and pupae that rest under the burlap provides valuable information about the severity of infestation on your property. When populations are sparse, larvae and pupae beneath burlap can be manually destroyed.

Use barrier bands, consisting of commercially available double-sided sticky tapes, or sticky material such as TanglefootR, petroleum jelly, or grease, to prevent larvae from crawling up the trunks of susceptible trees. Caution: petroleum-based products can cause injury (swelling and cankering) on thin-barked trees.

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If the spring is droughty, apply water to the soil at the base of several trees in a stand to enhance development of the controlling Entomophaga maimaiga fungus.

Apply herbicides with due caution. Control agents used in past outbreaks have included Bt (Bacillus thuringiensis, a bio-agent such as ForayR), NPV (Nucleopolyhedrosis virus in commercial form such as GypchekR), and diflubenzuron (growth regulators such as DimilinR). Refer to your NPS Regional IPM specialist.

Gypsy moth (G) larvae hiding beneath burlap banding.

Problem avoidance options include the following:

» Enhance growth conditions for individual trees by reducing ground competition (encircling them with mulch).

» Water valued shade and ornamental trees in periods of drought to maximize recovery during refoliation.

» Fertilize shade trees.

» Avoid stressing trees (construction projects tend to compact soil and prevent moisture from penetrating to small feeder roots).

» Avoid applying lime or weed killers around trees. These chemicals can seriously damage shallow tree roots.

» Thin woodlot trees and groups of shade trees to reduce tree competition.

» Diversify the tree composition of the area to include species less preferred by the gypsy moth such as yellow poplar, honeylocust, ash, hickory, dogwood, mountain ash, and (many) conifers.

More Information. For more information and references, refer to the following publications. This advisory used photos and information found in them.

Campbell, R.W., and R.J. Sloan. 1977. *Forest stand responses to defoliation by the gypsy moth.* Forest Sci. Monograph. 19:1-34.

Hajek, Ann E. 1986. Correspondence to David Haskell, Resource Manager, Shenandoah National Park regarding *Entomophaga maimaiga* research at SNP. USDA Agricultural Research Service, North Atlantic Area Plant Protection Research Unit, Ithaca, NY. 3 p.

Soper, R.S. 1986. Epizootiology of *Entomophaga* sp. nr. *aulicae*, a fungal pathogen of the gypsy moth. Natural Resource Study Proposal SHEN-N-15. USDI National Park Service, Shenandoah National Park, Luray, VA. 3 p.

USDA-Forest Service. 1989. *Gypsy moth*. Field Insect and Disease Leaflet #162. Editors: M. McManus, N. Schneeberger, R. Reardon, and G. Mason. U.S. Department of Agriculture Forest Service. October 1989. 11 pp.
(Available on line: http://www.na.fs.fed.us/SPFO/pubs/fidls/gypsymoth/gypsy.htm)

USDA-Forest Service - http://www.fs.fed.us/ne/morgantown/4557/gmoth/

USDA-Forest Service (control data) - http://na.fs.fed.us/fhp/gm/

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Photo Credits: (A) Map from USDA-Forest Service. Photos (B) (C) (E) & (G) USDA-Forest Service staff; (D) & (F) USDA-APHIS PPQ Archive, Bugwood.org.

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HEMLOCK WOOLLY ADELGID (HWA) – Invasive

Return to Key-[I][VII]

The hemlock woolly adelgid (*Adelges tsugae*) was first described in western North America in 1924 and first reported in the eastern United States in 1951 near Richmond, VA. Though the species is found throughout Asia, molecular genetic research indicates the population found in the East derived from southern Japan. Western hemlocks (*Tsugae heterophylla* and *T. mertensiana*) are resistant to HWA mortality while eastern hemlocks (*T. canadensis and T. caroliniana*) are likely to succumb to mortality. Infestation combined with drought and other stresses hastens mortality. Impact has been most severe in Virginia, New Jersey, Pennsylvania, and Connecticut.

Eastern hemlock stands at Shenandoah NP impacted by HWA: (A) Rapidan River; and (B) Hemlock Springs Overlook.

Identification/Biology. HWA is tiny, aphid-like insect less than 1/16-inch (1.5-mm) long, and varies from dark reddish-brown to purplish-black in color. As it matures, it produces a covering of wool-like wax filaments to protect itself and its eggs from natural enemies and prevent them from drying out. This “wool” (ovisac) is visible when the adelgid is mature and laying eggs. The ovisacs of the winter generation contain up to 300 eggs, while the spring generation ovisacs contain between 20 and 75 eggs. When hatched, the first instar nymphs, called crawlers, search for suitable feeding sites on the twigs at the base of hemlock needles. Once settled, the nymphs begin feeding on the young twig tissue and remain at that location throughout the remainder of their development.

HWA is parthenogenetic (all individuals reproduce asexually) and has six stages of development: the egg, four nymphal instars, and the adult. The adelgid completes two generations a year on hemlock. The winter generation develops from early summer to mid-spring of the following year (June–March). The spring generation develops from spring to early summer (March–June). The generations overlap in mid to late spring.

Dispersal and movement of HWA occur primarily during the first instar larval stage via wind and by birds, deer, and other forest-dwelling mammals that come in contact with the sticky ovisacs and crawlers. Isolated infestations and long-distance movement most often occur as the result of people transporting infested nursery stock.

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HWA feeding upon hemlock stem: (C) summer generation without ovisacs; and (D) older brood with ovisacs.

Controls. Consider the following prevention options. Support interagency efforts to quarantine the movement of infested nursery materials into noninfested areas. DO NOT apply nitrogen fertilizers in an attempt to improve hemlock tree health. HWA appears to grow even more abundant and aggressive in such cases.

Consider the following control options and refer to your NPS Regional IPM specialist.

» Apply systemic insecticides such as imidacloprid (such as Merit[R] and Pointer[R]). These are injected directly into the tree or soil. This method kills all sap-sucking or leaf-eating insects on treated trees. These chemicals are not taken up well into the tree during droughty periods.

» Apply surface sprays directly to hemlock foliage using dormant oil (such as Ultra Fine Spray Oil[R]) or insecticidal soap (such as M-Pede[R]). The entire tree must be thoroughly covered in a drench fashion. This method suffocates all soft-bodied insects on the tree. Chemical control must be limited to individual tree treatments in readily accessible, non-environmentally sensitive areas. To date; there are no feasible forest-wide applications.

» Apply registered and approved biological control. These currently include Sasajiscymnus lady beetles (*Sasajiscymnus tsugae*), Scymnus lady beetles (*Scymnus camptodromus*, *S. sinuanodulus*, and *S. ningshanensis*), and Laricobius derodontid beetle (*Laricobius nigrinus*).

More Information. For more information and references, refer to the following publications. This advisory used photos and information found in them.

Cheah, C., M. E. Montgomery, S. Salom, B. L. Parker, S. Costa, and M. Skinner, 2004. *Biological control of hemlock woolly adelgid.* USDA For. Serv. FHTET-2004-04, Reardon, R. and B. Onken (Tech. Coordinators), 22 pp.

Invasive.org - http://www.invasive.org/species/subject.cfm?sub=289

Orwig, D. A., D. R. Foster, and D. L. Mausel. 2002. *Landscape patterns of hemlock decline in New England due to the introduced hemlock woolly adelgid*. Journal of Biogeography 29: 1475-1487.

Rutgers - http://njaes.rutgers.edu/pubs/download-free.asp?strPubID=FS751

SAMAB (interagency cooperative) - http://www.saveourhemlocks.org/

USDI-NPS-GRSM - http://www.nps.gov/grsm/naturescience/hemlock-woolly-adelgid.htm

USDA-Forest Service. 2005. *Hemlock woolly adelgid*. Northeastern Area State and Private Forestry Pest Alert, NA-PR-09-05. August 2005. (Available on line: http://na.fs.fed.us/spfo/pubs/pest_al/hemlock/hwa05.htm)

USDA-Forest Service - http://www.na.fs.fed.us/fhp/hwa/

Photo Credits: (A) (B) & (D) James Åkerson, NPS staff; and (C) USDA-Forest Service Pest Alert NA-PR-09-05.

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INTRODUCED PINE SAWFLY – Invasive Return to Key-[III]

Introduced Pine Sawfly (*Diprion similis*) was first discovered in nursery stock received at Connecticut from Holland in 1914. Its current range extends from southern Canada to Virginia and west to the Lake States and Mid-west. Preferred hosts are five-needle pines but some two-needle pines are also attacked. Hosts include white pine (*Pinus strobus*), Scotch pine (*P. sylvestris*), jack pine (*P. banksiana*), and red pine (*P. resinosa*). All size-classes of pines are susceptible. Wilson (1966) reports, "Injury to trees is caused by the loss of needles. Young larvae consume only the outer, tender parts of the needles, so that the first evidence of damage is the straw like remains of these needles. Older larvae consume the entire needle and nibble the bark. First-generation larvae feed exclusively on the old foliage because they emerge and feed in the spring before the new needles are fully developed. Later generations feed indiscriminately on old or new needles. …Late season defoliation, when buds are already formed, is sufficient to kill most conifers."

Identification/Biology. The egg is distinctive, beginning as "pale whitish blue, translucent, and shiny. Just prior to hatching, it becomes bluish green to dark green. It is nearly oval with blunt rounded ends (Wilson, 1966). It becomes about 1.5-mm long by 0.5-mm wide. Young larvae have dull gray bodies with black legs. They grow to about 25-mm long with shiny black heads. The body is marked on top along the entire length by a dark brown or black double stripe.

Introduced pine sawfly: (A) larva; and (B) larva.

The adult is fly-like but has four shiny transparent wings. The average length of the female is 8-mm, with males only slightly shorter. Adults have black heads and thoraxes; the abdomen of the female is yellow and black, that of the male black to brown. The male can be easily distinguished from the female by his broad feathery antennae.

Introduced pine sawfly: (C) adult male.

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Controls. Cold winter temperatures kill up to 50 percent of larvae and 100 percent of pupae if not protected by snow. Overwintering rodents feed heavily upon larvae in the duff layer. Birds appear to feed upon all life stages. Rarely is forest-wide control applied. Much more often, small area applications of pesticide are done from the ground.

Introduced pine sawfly: (D) larva.

More Information. For more information and references, refer to the following publications. This advisory used photos and information found in them.

Forestpests.org – http://www.forestpests.org/vermont/introducedsawfly.html
Pennsylvania DCNR – http://www.dcnr.state.pa.us/FORESTRY/leaflets/intosawfly.htm
Wilson, Louis F. 1966. *Introduced pine sawfly*. Forest Insect & Disease Leaflet #99, USDA-Forest Service, Washington, DC. 3 pp.
(Available on-line at – http://www.na.fs.fed.us/spfo/pubs/fidls/intro_sawfly/intro_sawfly.htm)

Photo Credits (by order of appearance): (A) E. Bradford Walker, Vermont Department of Forests, Parks and Recreation; (B) Dandsirish, Urbana, Frederick County, Maryland; (C) Tom Murray; and (D) S. Katovich, USDA-FS, bugwood.org.

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LOCUST BORER (NATIVE) Return to Key-[I][V]

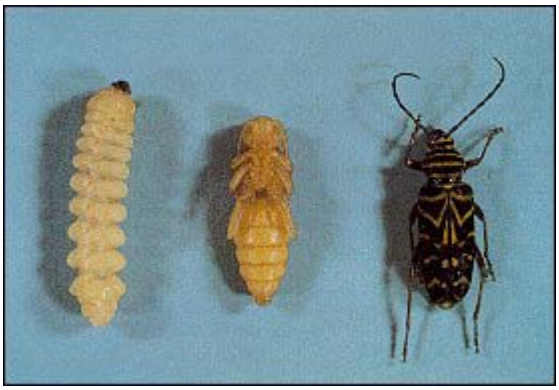
Locust borer (*Megacyllene robiniae*) is a native insect with a range coincided with that of its host tree, the black locust (*Robinia pseudoacacia*), originally along the Allegheny Mountains from Pennsylvania to Georgia and in the Ozark Mountain region, but now virtually everywhere in the country. The borer is now found from eastern Canada south to the Gulf States and west to Washington, Colorado, and Arizona.

Because black locust is not considered a long-lived tree, the borer does not usually receive serious attention.

Identification/Biology. The adult locust borer is a slender, "long-horned" beetle, about 0.75-inch long, with reddish legs and black antennae. Bright yellow bands encircle its jet-black body. A W-shaped band extends across the wing covers. Males and females are similar in appearance.

Locust borer: (A) adult.

Mature larvae are white, about 1 inch (2.5 cm) long and one-quarter of an inch (0.6 cm) in diameter (fig. 4). Newly formed pupae are creamy white and about three-quarters of an inch (1.9 cm) long. Both the larval and pupal stages are spent within the tree and are not readily seen.



Locust borer: (B) larva, pupa, and adult.

Controls. Black locust landscape ornamentals can be protected from borers by spraying a registered pesticide on the trunks and larger limbs in the spring when the buds are opening. The application may need to be repeated. Refer to your NPS Regional IPM specialist.

Old black locust trees with dying tops serve as brood trees for the borer. Remove those trees from the vicinity to reduce potential damage to younger black locust trees. The large brood trees should be cut during the dormant period and either peeled or burned to destroy the borer larvae.

Black locust is highly susceptible to light competition from other trees. Locust borer prevention can be practiced by thinning dense tree stands. In addition, borer impacts are less if the black locusts are grown among other trees rather than in monoculture. In such stands, it is wise to begin thinning the locust and planting other species below them. In the end, black locust stands

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will die out to other species, so it is not wise to plan to perpetuate black locust without employing stand replacement logging or fires.

More Information. For more information and references, refer to the following publications. This advisory used photos and information found in them.

Forestryimages.org - http://www.forestryimages.org/browse/subimages.cfm?SUB=387
USDA-Forest Service, Southern Region - http://www.fs.fed.us/r8/foresthealth/idotis/insects/locustbr.pdf
USDA-Forest Service. 1984. *The locust borer*. Forest Insect & Disease Leaflet 71, April 1984. U.S. Department of Agriculture - Forest Service. 6 pp. (Available on-line: http://www.na.fs.fed.us/spfo/pubs/fidls/locust/locust.htm)

Photo Credits: (A) (B) USDA-Forest Service.

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LOCUST LEAFMINER (NATIVE) Return to Key-[I][III]

Locust Leafminer (*Odontata dorsalis*) feeds on black locust and honeylocust leaves. Other tree species may be attacked, including apple, beech, birch, cherry, elm, oak, and hawthorn. It is not typically a mortality producer but certainly catches the public eye during outbreaks. Adults skeletonize and eat holes in the leaves, whereas larvae mine the leaves. The latter damage is more destructive. Under outbreak conditions, whole hillsides turn gray or brown.

(A) Forest stand impacts from locust leafminer.

Identification/Biology. The leafminer adult is a small, elongated, flattish beetle, about 1/4" long. The head is black, and the thorax and most of the wing covers are orange. Adults overwinter in bark crevices or in leaf litter and emerge about the time leaves begin to unfold in the spring. Eggs are deposited on the undersides of locust leaflets. They overlap like shingles in groups of three to five and are cemented together by excrement. Upon hatching, the larvae first feed collectively in a common, blister-like mine. Then, the larvae disperse, excavating their own individual mines. The fully-grown larvae are yellowish, flat, and slightly larger than adults. Pupation occurs within the translucent blisters in July. There are two generations annually.

Locust leafminer: (B) life stages, from egg, larva, pupa, to adult; (C) leaf impacts.

Controls. Control of the locust leafminer is not recommended since it rarely causes tree mortality.

More Information. For more information and references, refer to the following publications. This advisory used photos and information found in them.

Forestpest.org - http://www.forestpests.org/southern/locustleafminer.html

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South Carolina Forestry Commission - http://www.state.sc.us/forest/idleafminer.htm
USDA-Forest Service, Northern Area - http://na.fs.fed.us/spfo/pubs/pest_al/llminer/llminer.htm

Photo Credits (by order of appearance): (A) WV Department of Agriculture and USDA Forest Service, Forest Health Protection, Pest Alert NA-PR-01-01; (B) Bruce W. Kauffman, Tennessee Department of Agriculture, Forestpests.org; and (C) Laurie Reid, SC Department of Forestry.

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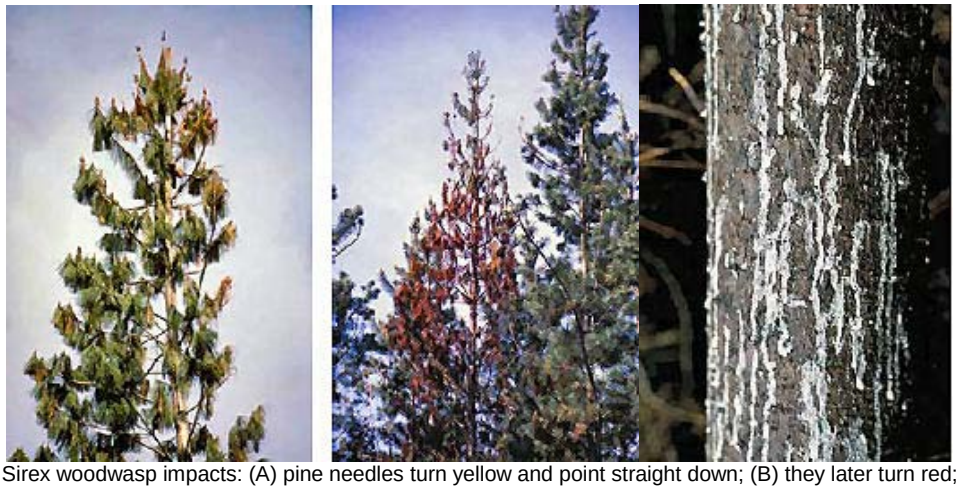
SIREX WOODWASP – Invasive

Return to Key-[V]

Sirex woodwasp (*Sirex noctilio*) is from Europe, Asia, and northern Africa, where it is generally considered a secondary pest. Introduced here via wooden shipping materials, it escaped port areas into forest areas. In its native range, it attacks pines almost exclusively. It is known to attack Monterey pine (*Pinus radiata*) and loblolly pine (*P. taeda*). Other known susceptible pines include slash (*P. elliottii*), shortleaf (*P. echinata*), ponderosa (*P. ponderosa*), lodgepole (*P. contorta*), and jack pine (*P. banksiana*).



Sirex woodwasp impacts: (A) pine needles turn yellow and point straight down; (B) they later turn red; and (C) pitch oozes from egg laying sites on the tree stem.

Identification/Biology. Woodwasps (or horntails) are large, robust insects, 1.0-to-1.5" long. Adults have a spear-shaped plate at the tail end. Females also have a long ovipositor under this plate. Larvae are creamy white, legless, and have a distinctive dark spine at the rear of the abdomen. More than a dozen species of native horntails occur in North America. No keys to identify woodwasp larvae to the species level have been developed. However, adult specimens have features to distinguish Sirex from native horntails. Key characteristics of Sirex woodwasp adults include: (1) body is dark metallic blue or black; abdomen of males black at base and tail end, with middle segments orange; (2) legs are reddish-yellow; feet (tarsi) black; males with black hind legs; and (3) antennae are entirely black. Positive identification of *S. noctilio* needs to be confirmed by an insect taxonomist. Therefore, collect and submit any suspect woodwasps to your county extension or state Department of Agriculture or Forestry office.

Adults emerge from July through September, with peak emergence during August. Females are attracted to stressed trees after an initial flight. They drill their ovipositors into the outer sapwood to inject a symbiotic fungus (*Amylostereum areolatum*), toxic mucus, and eggs. The fungus and mucus act together to kill the tree and create a suitable environment for larval development. Females lay from 25 to 450 eggs, depending upon size of the female. Unfertilized eggs develop into males, while fertilized eggs produce females. All larval instars feed on the fungus as they tunnel through the wood. The number of instars varies from 6-to-12, and the larval stage generally takes 10-to-11 months. Mature larvae pupate close to the bark surface. Adults emerge about 3 weeks later.

Sirex woodwasp: (D) larva noting developing ovipositor.

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Sirex woodwasp: (E) adult female; and (F) adult male.

Sirex woodwasp: (G) adult male.

Controls. Sirex woodwasp has been successfully managed using biological control agents. The key agent is a parasitic nematode, *Deladenus siricidicola*, attacking the larvae, and ultimately sterilizes the adult females. Infected females emerge and lay infertile eggs that are filled with nematodes, which sustain and spread the nematode population. The nematodes effectively regulate the woodwasp population below damaging levels. Nematodes can be easily mass-reared in the laboratory and introduced by inoculating it into infested trees.

Hymenopteran parasitoids have been introduced into Sirex woodwasp populations in the Southern Hemisphere, and most of them are native to North America (e.g., *Megarhyssa nortoni*, *Rhyssa persuasoria*, *Rhyssa hoferi*, *Schlettererius cinctipes*, and *Ibalia leucospoides*).

More Information. For more information and references, refer to the following publications. This advisory used photos and information found in them.

Invasive.org - http://www.invasive.org/species/subject.cfm?sub=4093
USDA-APHIS - http://www.aphis.usda.gov/plant_health/plant_pest_info/sirex/index.shtml
USDA-Forest Service. 2005. *Sirex woodwasp—Sirex noctilio F. (Hymenoptera: Siricidae)*. Northeastern Area State and Private Forestry Pest Alert, NA-PR-07-05. June 2005. (Available on line: http://www.na.fs.fed.us/spfo/pubs/pest_al/sirex_woodwasp/sirex_woodwasp.htm)
USDA-Forest Service - http://www.na.fs.fed.us/fhp/sww/

Photo Credits: (A) (D) (E) & (F) Dennis A. Haugen and Kent Loeffler, Dept. of Plant Pathology, Cornell University; (C) Dennis Haugen, Bugwood.org; and (G) USDA-Forest Service staff photo.

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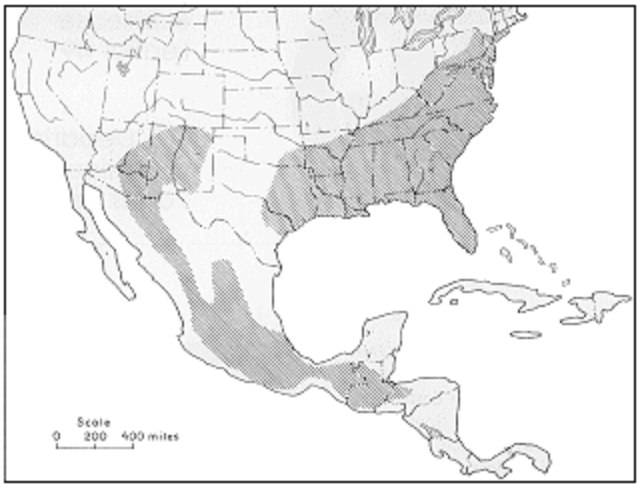
SOUTHERN PINE BEETLE (SPB) (NATIVE) Return to Key-[V]

Southern pine beetle (*Dendroctonus frontalis*) is one of the most destructive native southern beetles. Its populations build rapidly from endemic to outbreak proportions and large numbers of trees are killed. It is known to attack all pines but prefers loblolly, shortleaf, Virginia, pond, and pitch pines.



(A) Southern pine beetle range.

Identification/Biology. The first indication of beetle-caused mortality is discolored tree foliage. Needles become yellowish, then reddish, and within 1 to 2 months become brown. Typically, pines are killed in groups ranging from a few trees to several hundred acres. Pitch tubes of small yellowish-white masses of resin, 1/4 to 1/2" in diameter-mark the points of beetle attack. Removal of bark from an infested pine reveals *S*-shaped egg galleries (a distinguished characteristic) that criss-cross one another in the inner bark and on the wood surface.

Southern pine beetle: (B) trees in various stages of infestation from newly infested (yellow) through reddish to brown.

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Southern pine beetle: (C) S-shaped egg galleries under bark; (D) adult.

Controls. The primary objective of suppression is to reduce beetle population to a low level as rapidly as possible to prevent tree mortality from spreading. Trees should be cut and removed as quickly as possible. Cut a 40- to 70-foot-wide buffer strip of green trees in front of the most recently attacked trees. Newly attacked trees and trees containing larvae and pupae should be removed next. This approach ensures that further growth of the infestation is stopped and that all infested trees are removed.

If trees cannot be hauled away, the infestation spread may be controlled by felling and treating infested trees with lindane or chlorpyrifos. The entire bark surface should be soaked to the point of runoff with a coarse spray from a low-pressure sprayer. Logs must be turned so that the entire bark surface is treated. Refer to your NPS Regional IPM specialist.

More Information. For more information and references, refer to the following publications. This advisory used photos and information found in them.

Clemson Extension - http://www.clemson.edu/extfor/pest_management/forlf5.htm
SAMAB - http://www.samab.org/Focus/Ecosystem/SPB.html
USDA-Forest Service. 1982. *Southern pine beetle*. Field Insect and Disease Leaflet #49. Editors: Thatcher Robert C., and Patrick J. Barry. U.S. Department of Agriculture Forest Service, Northern Area State & Private Forestry. October 1982. 11 pp.
(Available on line: http://www.na.fs.fed.us/spfo/pubs/fidls/so_pine_beetle/so_pine.htm)
USDA-Forest Service, Daniel Boone NF - http://www.fs.fed.us/r8/boone/resources/forest_health/s_pine_beetle.shtml

Photo Credits: all illustrations from USDA-Forest Service, Forest Insect & Disease Leaflet 49.

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VIBURNUM LEAF BEETLE – Invasive Return to Key-[I][III]

The viburnum leaf beetle (*Pyrrhalta viburni*), is an invasive, exotic beetle that first appeared in New York along Lake Ontario in 1996. Native to Europe, it is now found in Canada, the Northeast and Mid-Atlantic. It has potential for being a serious pest of landscapes with native and introduced viburnums. It can defoliate viburnum shrubs entirely. Plants may die after two or three years of heavy infestation.

Identification/Biology. Adults are 4.5 - 6.5 mm long, yellowish brown to light brown. Eggs are 0.4 mm wide, rounded, and dark yellow to brown. Mature larvae are larger than adults (about 6 - 9 mm long), shiny, greenish-yellow to white, and covered with dark dots.

Viburnum leaf beetle: (A) egg pits and damage due to adult; (B) larva at 2nd instar.

There is one generation per year. The beetle overwinters as eggs on host twigs where they remain until hatching in May. By early to mid-June, larvae drop to the ground, pupate, and remain in the soil for about ten days. Adults emerge mid- to late July, and may be seen until the first frost. It takes eight to ten weeks for this species to complete development from egg to adult. Females deposit several eggs on the tips of the branches from late summer to fall. They chew holes in the bark to deposit eggs and then cover them with excrement and fragments of chewed bark and wood. Initially, there is a sharp contrast between the excrement and the pieces of wood. Females may lay up to 500 eggs.

Viburnum leaf beetle: (C) adults; and (D) skeletonized viburnum leaves.

Controls. Carefully examine young twigs in early spring for egg sites that seem to swell and lose their covers as the air temperature increases. Prune away infested twigs before egg hatch and destroy them. Monitor the lower leaf surface for the presence of larvae in late spring.

Apply registered insecticides according to label directions in the spring to manage larvae while they feed. It is best to apply these materials when larvae are small before adults can fly away or drop to the ground when disturbed. Refer to your NPS Regional IPM specialist.

Planting less susceptible viburnums would be one effective plant health care strategy against this pest. Less susceptible plants include *V. carlesii*, Koreanspice viburnum, *V. x burkwoodii*, Burkwood viburnum, *V . x juddii*, Judd viburnum, *V . x carlcephalum*, carlcephalum viburnum, *V.*

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rhytidophyllum, leatherleaf viburnum, *V . x rhytidophylloides*, lantanaphyllum viburnum, *V. plicatum*, Japanese snowball, *V. setigerum*, tea viburnum, and *V. sieboldii*, Siebold viburnum,

More Information. For more information and references, refer to the following publications. This advisory used photos and information found in them.

Cornell University Citizen Science Project - http://www.hort.cornell.edu/vlb/suscept.html
Invasive.org - http://www.invasive.org/species/subject.cfm?sub=9404
Invasive.org images - http://www.invasive.org/browse/subimages.cfm?sub=9404
Penn State College of Agriculture - http://ento.psu.edu/extension/factsheets/viburnum-leaf-beetle
University of Massachusetts - http://www.umassgreeninfo.org/fact_sheets/defoliators/viburnum_leaf_beetle.html

Photo Credits: (A) (D) E. Richard Hoebeke, Cornell University, Bugwood.org; (B) (C) Paul Weston, Cornell University, Bugwood.org.

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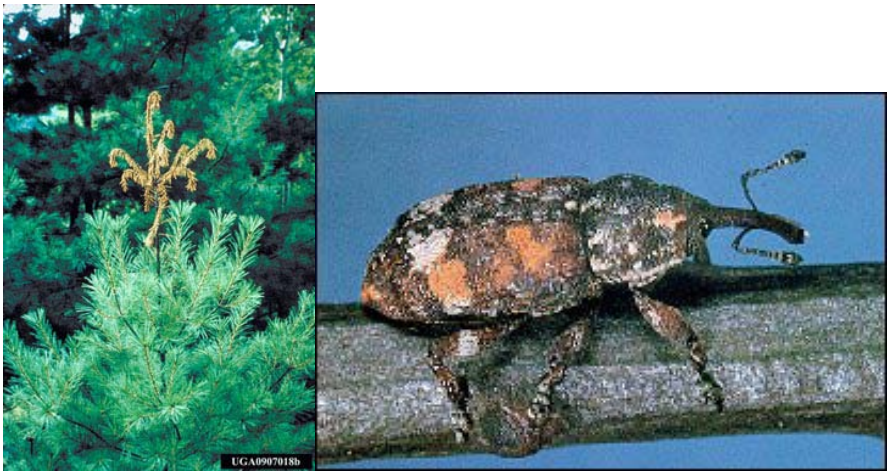
WHITE PINE WEEVIL (NATIVE) Return to Key-[I][VII]

White pine weevil (*Pissodes strobi*) is a native insect that attacks and broods on eastern white pine (*Pinus strobus*), Sitka spruce (*Picea sitchensis*), and Engelmann spruce (*P. engelmannii*). It does not kill its hosts but stunts the most current year's top growth. In the East, the insect will attack over 20 pine and spruce species of trees and ornamentals. The present distribution of *P. strobi* is continent-wide.

Identification/Biology. Presence of the weevil is evidenced by wilting terminal-top shoots of pine and spruce trees, with accompanying flowing pitch from egg laying and larval feeding in the shoot bark. The white pine weevil prefers to attack trees exposed to direct sunlight.

The adult is a small rust-colored weevil that is about 4-6 mm long. It has irregularly shaped patches of brown and white scales on the front wings. Near the apex of the front wings is a large white patch. Like most weevils, the adult has a long snout-like beak from which small antennae arise.



White pine weevil: (A) typical top kill damage; (B) adult on twig;

The larval stage, which lives beneath the bark, is white with a distinct brown head. When mature, the larva is approximately 7 mm long, legless, and slightly C-shaped.

Adults overwinter in the duff under infested trees. They emerge in early spring to feed and lay eggs in last year's terminal shoot. Upon hatching, larvae tunnel beneath the bark, girdling the leader. Pupation takes place in the oval frass-lined cells beneath the bark in the feeding channel. Adults emerge in July and August and drop to the ground. New weevil attacks become visible in early July when the terminal shoot suddenly wilts. The wilted terminal forms a very characteristic shepherds crook. Within two weeks the needles of the current emerging terminal, its laterals and the previous year terminal turn brown-red in color.

White pine weevil: (C) exposed larva within a pine terminal shoot.

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Controls. Evidence of resin droplets on the top leader in early spring may indicate adult white pine weevil feeding. Application of a registered formulation of an insecticide on the top leader should be made from late March through April when droplets of resin are first detected. There is no need to apply pesticide to the remainder of the tree. Insect parasitoids and predators as well as birds feed on the weevil though not significant enough to prevent damage.

Treatment for valued ornamentals includes pruning off affected top shoots and burning them with the burrowed larvae before mid-July. To enhance the tree appearance and growth opportunity, prune off all competing lateral branches at the top except one. This encourages a single tree leader at the top.

More Information. For more information and references, refer to the following publications. This advisory used photos and information found in them.

Penn State College of Agriculture - http://ento.psu.edu/extension/factsheets/white-pine-weevil

USDA-Forest Service. 2001. *How to manage Eastern white pine to minimize damage from blister rust and white pine weevil*. NA-FR-01-93. USDA-Forest Service, Northeastern Area. 8 pp. (Available on-line: http://www.na.fs.fed.us/Spfo/pubs/howtos/ht_white/white.htm)

USDA-Forest Service. 19xx. *White pine weevil*. Forest Insect & Disease Leaflet 21, March 1995. USDA-Forest Service, Northeastern Area. 6 pp. (Also on-line: http://www.na.fs.fed.us/spfo/pubs/fidls/wp_weevil/weevil.htm)

Photo Credits: (A) E. Bradford Walker, Vermont Department of Forests, Parks and Recreation, Waterbury, VT; (B) (C) USDA-Forest Service.

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WHITESPOTTED SAWYER (NATIVE) Return to Key-[V]

Whitespotted sawyer (*Monochamus scutellatus*) is usually considered a secondary pest, attacking the trunks of weakened, dying or dead **conifers**. Eastern white pine (*Pinus strobus*) is a preferred host, but it also attacks others including jack pine (*P. banksiana*), red pine (*P. resinosa*), balsam fir (*Abies balsamea*), white spruce, (*Picea glauca*), black spruce (*P. mariana*), and red spruce (*P. rubens*). Of concern for landscape management, adult beetles also feed on bark on the underside of twigs, causing the tips to die and turn red.

Identification/Biology. Whitespotted sawyer (native) is often confused for the highly invasive Asian longhorn beetle. The female sawyer can look a bit like the ALB due to it having slightly gray and white segmented antennae. The ALB, however, has quite distinctive white and black antennae with both male and female. Note the USDA-Forest Service physical comparison website provided below.

If ornamentals have dead/dying lateral shoots, look for wounds at the base of the dead shoots. Small piles of sawdust may be present near the base of trees where larvae have been tunneling.

Whitespotted sawyer: (A) look for evidence of the insect from flagging lateral shoots; (B) an adult male.

Larvae enter bark through oval holes. Adult beetles emerge through circular exit holes in the wood and are present during the summer. They feed on tender bark of twigs, causing tips to flag. Eggs are laid in the bark crevices of weak, recently killed or newly cut trees. When eggs hatch, young larvae bore a tunnel through the phloem into the cambium. Young larvae mine beneath the bark. Later instars tunnel toward the heartwood. Prior to pupation, the larva turns its tunnel toward the surface, where it pupates behind a chip plug.

Whitespotted sawyer: (C) male and female mating. Note the female has the white and black segmented antennae sometimes confused with Asian longhorn beetle.

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Controls. Reduce the presence of dead and dying trees near ornamental conifers to reduce the number of sawyer beetle adults in an area. Debark any dead and dying tree logs. Exposing them in direct sunlight will also decrease sawyer larval habitat.

More Information. For more information and references, refer to the following publications. This advisory used photos and information found in them.

Forestpests.org - http://www.forestpests.org/vermont/whitespottedsawyer.html
USDA-FS comparison of WSS with ALB - http://www.na.fs.fed.us/fhp/alb/pubs/alb_wss/alb_wss.htm
USDA-Forest Service. 1962. *White-spotted sawyer*. Forest Insect & Disease Leaflet 74. U.S. Department of Agriculture - Forest Service.
(Available on-line: http://www.na.fs.fed.us/spfo/pubs/fidls/ws_sawyer/ws_sawyer.htm)

Photo Credits: (A) Ronald S. Kelley, Vermont Department of Forests, Parks and Recreation; (B) William M. Ciesla, Forest Health Management International; (C) Kenneth R. Law, USDA APHIS PPQ, Bugwood.org.

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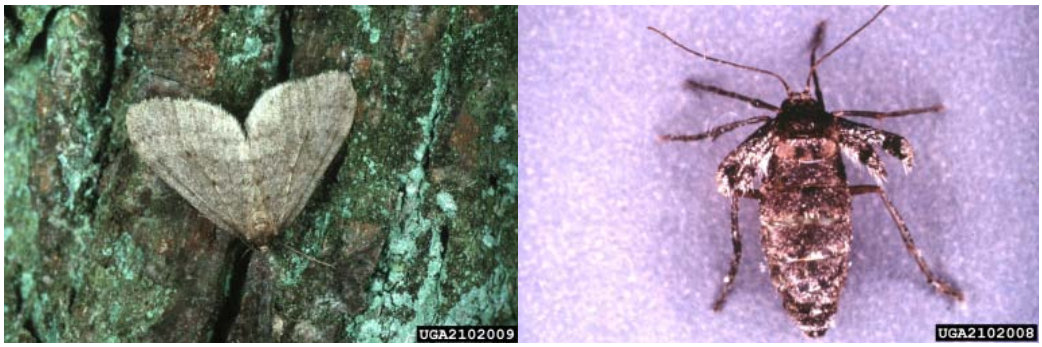
WINTER MOTH – Invasive Return to Key-[III]

Winter moth (*Operophtera brumata*) was introduced into the country from Europe in the 1930s. Winter moth attack trees, including apple, ash, basswood, blueberry, crabapple, maple, oak and some species of spruce. They cause injury in the spring by burrowing into buds and later by feeding on tiny young leaves.

Identification/Biology. Adults emerge in late November and December. Adult females are gray and wingless. They crawl on tree trunks and other objects. Adult males are light brown, small in size, and are attracted to females and light. After mating, females lay their eggs in host tree bark crevices or in other sheltered locations. The eggs hatch in the spring when temperatures rise to an average of 55 degrees F. After hatching, the young larvae crawl up tree trunks and produce silken threads that can carry them in the wind. Larvae are light green loopers (inchworms) that measure about one inch in length when fully grown. Young larvae feed within buds and on expanding foliage, while older larvae can consume entire leaves. Larvae pupate in the soil by mid-June.



Winter moth: (A) adult male with developed wings; (B) adult female with poorly developed wings.

Winter moth: (C) larva. It is of the looper or inchworm variety.

Controls. Bacillus thuringiensis (*B.t.* (kurstaki), a bacterium and specific to caterpillars of butterflies and moths, works very well on the younger larvae of both winter moth and cankerworms while they are free feeders. Insecticidal soap may be effective against younger

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caterpillars when they are exposed on the host plant. There is no residual benefit. Many chemical pesticides, such as Sevin, are labeled for winter moth. Consult your NPS Regional IPM specialist.

More Information. For more information and references, refer to the following publications. This advisory used photos and information found in them.

Forestryimages.org - http://www.forestryimages.org/browse/subimages.cfm?SUB=8671
Massachusetts Dept of Conservation & Recreation - http://www.mass.gov/dcr/news/winter_moth.pdf
New Hampshire advisory - http://www.nh.gov/agric/news/documents/WinterMothJan2006.pdf

Photo Credits: (A) Louis-Michel Nageleisen, Département de la Santé des Forêts, Bugwood.org; (B) Daniel Adam, Office National des Forêts, Bugwood.org; (C) Milan Zubrik, Forest Research Institute - Slovakia, Bugwood.org.

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ANNOSUS ROOT DISEASE (NATIVE) Return to Key-[VI]

Annosus root rot (*Heterobasidion annosum*) is a serious disease that affects conifer trees throughout the United States, but is most serious among pines in the South and pines and true firs in the West. Annosus root rot enters a stand when fungal spores land on fresh cut stump surfaces or naturally skinned bark and broken limbs. The fungus grows down into the root system and then into nearby live trees via root grafts or contacts.

Identification/Biology. The fungus produces shelf-like mushrooms, called conks that are tan to reddish brown on top and white or yellow underneath. The lower surface is covered with minute pores. Conks typically are produced at the base of the tree, often hidden from view by leaf litter. These conks produce spores that are released and carried by wind. Those that light on newly cut stumps or wounds on trees begin their life cycle.

Annosus root disease conk mushrooms uncovered in (A) Florida; and (B) Minnesota.

Infected trees tend to occur in groups called infection centers. The trees in the center die first. As the pathogen moves through the root systems, the spot enlarges and creates a gap in the forest. Infected trees may lose many of their needles, which turn light green to yellow. As the disease progresses, roots turn into a stringy, white mass of decayed tissue. Currently infected trees are often surrounded by windthrown trees that have already died from the disease.

Look for the following signs in the forest: Crown yellowing and thinning; distress crops of conifer cones; trees killed in disease centers; windthrown trees; conks on declining live trees, dead trees, and stumps; and annual rings of the wood separated by fungal growth.

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Controls. Avoid wounding tree roots and trunks.

Cut out infected groups plus a buffer. A buffer strip 50 feet wide beyond the border of the disease center should be established. Within the disease center and the buffer strip, every tree should be cut and stumps treated with borax. After infected tree removal, plant hardwood trees or resistant conifer species in the created forest opening.

Thinning to increase stand vigor is recommended early in the stand life before the potential for wounding becomes significant. Small stumps from thinning do not need to be treated with borax.

Annosus root disease: (C) applying borax to a cut stump to avoid creating a new infection center in the forest.

More Information. For more information and references, refer to the following publications. This advisory used photos and information found in them.

Alabama Forest Commission - http://www.forestry.state.al.us/annosus_root_rot.aspx?bv=3
Forestpests.org - http://www.forestpests.org/southern/annosusbuttrot.html
Forestryimages.org - http://www.forestryimages.org/browse/subthumb.cfm?sub=519
Georgia Forestry Commission -
http://www.gfc.state.ga.us/ForestManagement/documents/AnnosumRootDisease072908.pdf

Photo Credits: (A) G. Blakeslee - SFRC, University of Florida; (B) Minnesota Department of Natural Resources Archive, Minnesota Department of Natural Resources, Bugwood.org; (C) Robert L. Anderson, USDA Forest Service, Bugwood.org.

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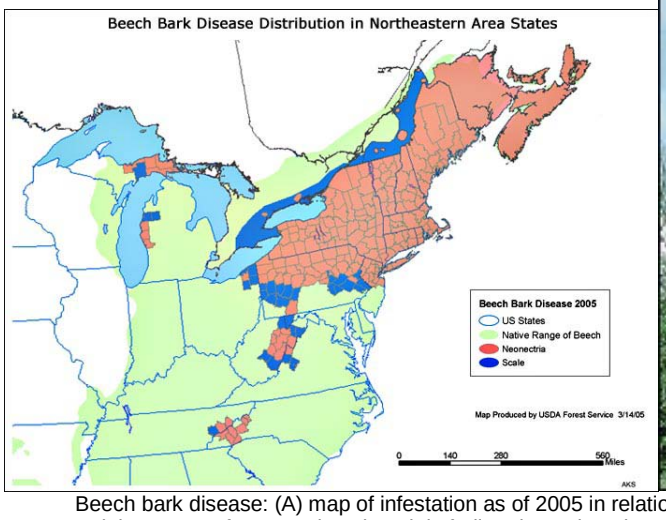
BEECHBARK DISEASE – Invasive Return to Key-[I][VI]

Beechbark disease, primarily *Nectria coccinea* var. *faginata*, a native of Europe, results when the bark of American beech (*Fagus grandifolia*) is attacked and altered by the beech scale (*Cryptococcus fagisuga*), and subsequently invaded and killed by the fungi. Around 1890, the scale was accidentally brought to Nova Scotia. By 1932, the scale and an associated nectria fungus were killing trees throughout the mature beech areas of the Maritime Provinces and in localized areas of eastern and southcentral Maine. The scale insect has continued to spread to the north into Quebec and to the west and south throughout New England and the Mid-Atlantic.



Beech bark disease: (A) map of infestation as of 2005 in relation to entire beech area; and (B) a crown of an American beech is fading due to beech scale and fungi attack.

Identification/Biology. *C. fagisuga* is a soft-bodied scale insect. At maturity, it is yellow, elliptical, and 0.5-to-1.0 mm long. It has reddish-brown eyes, a 2-mm stylet, rudimentary antennae and legs, and numerous minute glands that secrete a white "wool-like" wax. Reproduction is parthenogenetic (all individuals). Beginning in midsummer, the insect deposits pale yellow eggs on tree bark in strings of four-to-eight, attached end to end. The eggs usually begin to hatch in late summer and continue hatching until early winter. Wingless larvae (also called nymphs) emerge from the eggs with well-developed legs and antennae. Some larvae remain under the females, which die after the eggs are deposited. Some migrate to cracks and other protected areas; others are washed down or fall to the ground where most of them die; and still others are carried, usually by wind, to other beech trees. If a suitable location is found, the insect forces its tubular stylet into the bark and begins to feed. It then transforms into a second-stage nymph, without legs and covered with wool-like wax. The insect overwinters in this stage and, in the spring, molts to become an adult female.

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Beech scale: (C) as seen by the eye; and (D) a blow-up of nymph; the actual size is 0.3-mm.

The white wax secreted by the beech scale is the first sign of the disease. Isolated dots of white "wool" appear on the bole of the tree on roughened areas of bark, beneath mosses and lichens, and below large branches. It is probable that great numbers of scales feeding on the liquids of bark cells can materially weaken a tree, but serious damage results only after the later invasion of the bark by *Nectria* disease.

Beech bark disease: (E) reddish nectria fungus fruiting bodies; and (F) craterlike scars indicate that small, isolated nectria cankers were walled off by tree callus tissue. The tree successfully protected itself.

Controls. Marked decline in beech scale populations occasionally occur over large areas suggesting general environmental factors may affect the insect. Air temperatures of -37° C (-35° F) are lethal to those insects not protected by snow.

Scales on high-value ornamental trees can be controlled with insecticides. Surface spray of insecticidal soap is effective if the tree stem is entirely covered. Systemic applications of imidacloprid and others directly into the tree or surrounding soil are highly effective, but expensive. The disease in whole forest stands cannot be controlled at a reasonable cost. A program of timely salvage cuttings is the only way presently known to reduce disease losses.

Vigorous trees free of the disease are often found in heavily affected areas. Trials with these trees have shown them to be resistant to the scale. This offers hope that methods can be developed to increase the levels of resistance in affected forests.

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More Information. For more information, refer to the following websites. This advisory used photos and information found in them.

Burns, B.S.; Houston, D.R. 1987. Managing beech bark disease. Nor. J. Appl. For. 4:28-33. Canadian Journal of Forest Research.
Available on-line: http://www.ecostudies.org/reprints/Griffin_et_al_CJFR_2003.pdf

Houston, D.R. 1983a. American beech resistance to *Cryptococcus fagisuga*. In: *Proceedings, IUFRO beech bark disease working party conference*; 1982 Sep 26-Oct. 8; Hamden, CT. Gen. Tech. Rep. WO-37:38-42.

Invasive.org - http://www.invasive.org/symposium/houston.html

Mielke, M.E.; Houston, D.R.; Bullard, A.T. 1986. Beech bark disease management alternatives. In: *Proceedings, Integrated pest management symposium for northern forests*; 1986 March 24- 27; Madison, WI: University of Wisconsin, Cooperative Extension Service: 272-280.

USDA-Forest Service. 1983. *Beech bark disease*. Field Insect and Disease Leaflet #75. Editors: David R. Houston and James T. O'Brien. U.S. Department of Agriculture Forest Service. February 1983. 7 pp.
(Available on line: http://www.na.fs.fed.us/spfo/pubs/fidls/beechbark/fidl-beech.htm)

USDA-Forest Service - http://www.na.fs.fed.us/fhp/bbd/

Photo Credits: (A) USDA-Forest Service Forest Health Protection Program; (B) (D) & (F) USDA-Forest Service staff, Forest Insect & Disease Leaflet 75; and (C) & (E) Dale Meyerhoeffer, NPS staff.

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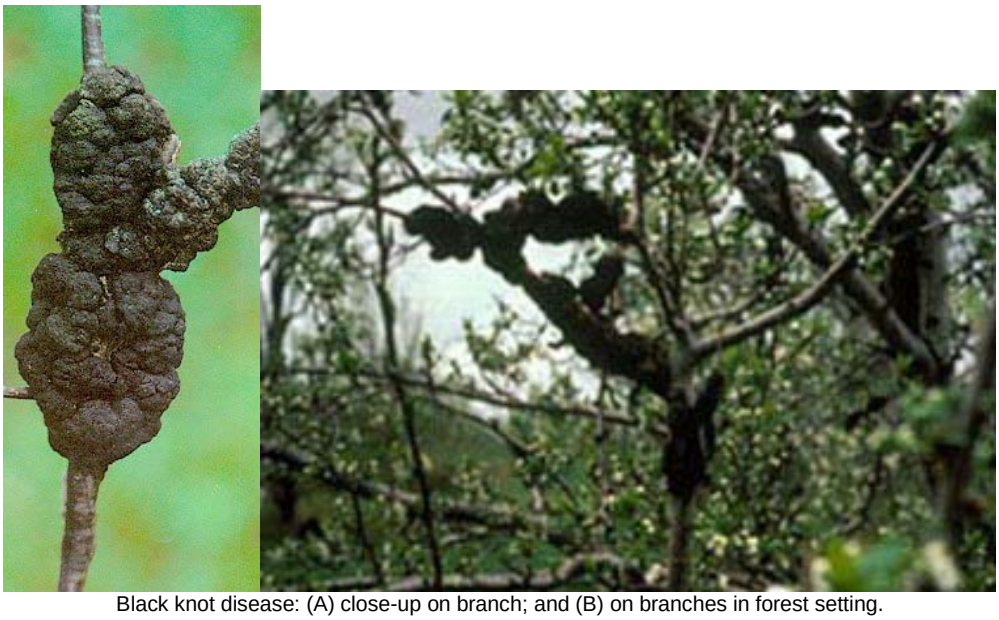
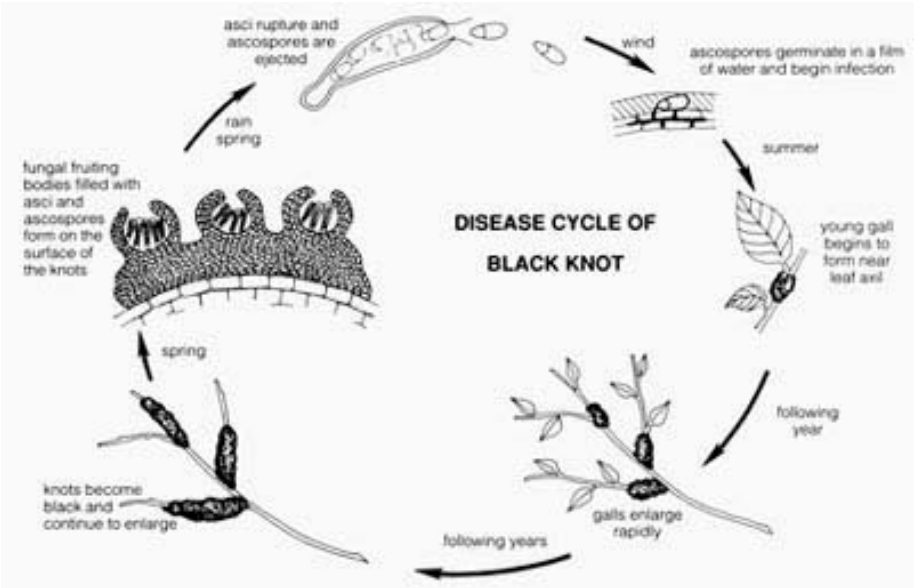
BLACK KNOT (NATIVE) Return to Key-[I][VI]

Black knot (*Dibotryon morbosum*) is a common disease of native cherries, plumbs, apricots, and other *Prunus* species. It does not typically cause tree mortality. Neighboring owners may be very concerned about the disease for its impact to fruit production or black cherry wood quality.

Identification/Biology. Black knot is a disease that causes irregular black swellings on cherry stems, branches, and twigs. Often a white fungus is found growing over the swellings. Later, the swellings blacken and appear rough. Infection occurs during the spring; swellings develop the following spring. Spore-bearing fruiting bodies form within this fruiting layer. Knots vary in size from approximately 0.5-to-12" in length and from minute measurements to 2" in circumference. Infected twigs often appear bent at the tips because of extra cellular growth on one side.



Black knot disease: (A) close-up on branch; and (B) on branches in forest setting.



Black knot disease: (C) the disease life cycle.

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Controls. Control on landscape ornamentals can be achieved by pruning off diseased tissue along with at least 12 inches of uninfected wood. If control in forest stands is desired, trees with infections on their boles should be removed during improvement thinnings.

More Information. For more information, refer to the following websites. This advisory used photos and information found in them.

Cornell University – http://plantclinic.cornell.edu/FactSheets/black_knot/blacknot.htm and http://www.nysipm.cornell.edu/factsheets/treefruit/diseases/bk/bk.asp
University of Illinois – http://web.aces.uiuc.edu/vista/pdf_pubs/809.pdf
USDA-Forest Service – http://www.fs.fed.us/r8/foresthealth/idotis/diseases/blknot.html

Photo Credits: (A) USDA-Forest Service staff; (B) Dr. Phil A. Arneson, Cornell University; and (C) Dr. Wayne Wilcox, Cornell University, NYSAES, Geneva, NY.

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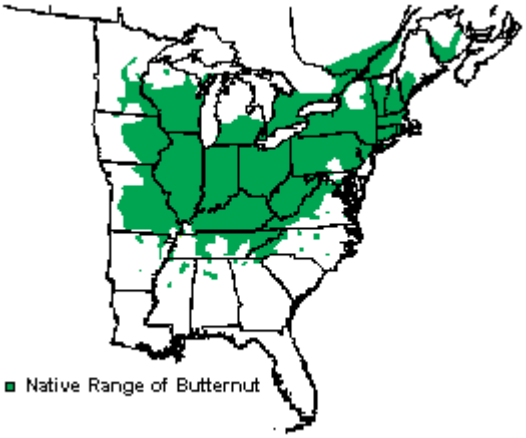
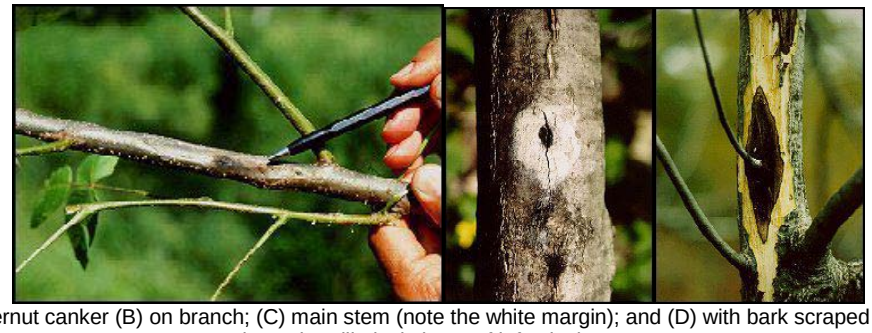
BUTTERNUT CANKER – Invasive Return to Key-[I][VI]

Butternut (*Juglans cinerea*), also known as white walnut, commonly grows on rich loamy soils in mixed hardwood forests. Butternut is being killed throughout its range by *Sirococcus clavigignenti-juglandacearum*, a fungus most likely introduced from outside of North America. Butternut is the only natural host known to be killed by the fungus.



Butternut canker: (A) map indicating the native range of butternut trees.

Identification/Biology. The fungus initially infects trees through buds, leaf scars, and possibly insect wounds and other openings in the bark, rapidly killing small branches. Spores produced on branches are carried down the stem by rain, resulting in multiple, and perennial stem cankers that eventually girdle and kill infected trees. Young, annual cankers are elongated, sunken areas commonly originating at leaf scars and buds, often with an inky black center and whitish margin. Under the bark, the fungus forms pegs that break through the outer bark surface, exposing the spores. Peeling the bark away reveals the brown to black elliptical areas of killed cambium. Older, perennial branch and stem cankers are often found in bark fissures, or covered by bark and bordered by successive callus layers. Cankers develop throughout a tree, but commonly occur on the main stem, at the base of trees and on exposed roots. The fungus can survive on dead trees for at least two years. It is spread by rain-splashed spores, and possibly by insects and birds.



Butternut canker (B) on branch; (C) main stem (note the white margin); and (D) with bark scraped away (note the elliptical shape of infection).

Controls. At time of writing, there are no known controls. Scientists now believe there is no utility in felling and destroying infected trees since the disease is present throughout the natural butternut range. The potential for breeding canker resistance is good and underway.

More Information. For more information, refer to the following websites. This advisory used photos and information found in them.

Invasive.org - http://www.invasive.org/species/subject.cfm?sub=578

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M.E. Ostry and K. Woeste. 2004. "Spread of butternut canker in North America, host range, evidence of resistance within butternut populations and conservation genetics" IN *Proceedings of the 6th Walnut Council Research Symposium*, July 25-28, 2004; Lafayette, IN: 114-120.
(Available on line: http://www.ncrs.fs.fed.us/pubs/gtr/gtr_nc243/gtr_nc243_114.pdf)

Ostry, M.E., M.E. Mielke, and R.L. Anderson. 1996. *How to identify butternut canker and manage butternut trees*. HY-70. USDA-Forest Service, North Central Forest Experiment Station, Northeastern Area and Region 8 S&PF. 4 pp.
(Available on-line: http://www.na.fs.fed.us/Spfo/pubs/howtos/ht_but/ht_but.htm)

Ostry, M.E.; Mielke, M.E.; Skilling, D.D. 1994. *Butternut-strategies for managing a threatened tree*. Gen. Tech. Rep. NC-165. St. Paul, MN: U.S. Department of Agriculture, Forest Service, North Central Forest Experiment Station. 7 p.

Schlarbaum, Scott E.; Hebard, Frederick; Spaine, Pauline C.; Kamalay, Joseph C. 1997. "Three American tragedies: chestnut blight, butternut canker, and Dutch elm disease" In: Britton, Kerry O., ed. *Proceedings, exotic pests of Eastern forests*; 1997 April 8-10; Nashville, TN. [Place of publication unknown]: Tennessee Exotic Pest Plant Council: 45-54.
(Available on line: http://www.srs.fs.usda.gov/pubs/745)

USDA-Forest Service - http://www.na.fs.fed.us/Spfo/pubs/howtos/ht_but/ht_but.htm

USDA-Forest Service - http://www.na.fs.fed.us/spfo/pubs/pest_al/butternut/butternut.htm

Photo Credits: map and photos from the USDA-Forest Service, "How To" advisory, HT-70 (Ostry, et. al, 2004).

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CEDAR APPLE RUST (NATIVE) Return to Key-[I][IV]

Cedar-apple rust (*Gymnosporangium juniperi-virginianae*) is a common disease of apple and crabapple. The fungus is unusual because it must spend a phase of its life cycle as a parasite on Juniperus species, such as red cedar or ornamental junipers. Cedar-apple rust can be severe on apple. Infections of apple fruit cause poor fruit quality and early fruit drop. Leaf spots may cause early defoliation, especially during dry summers. If trees are defoliated several years in a row, they become weakened and unthrifty. Fruit bud formation may be reduced after one year. The disease is not as harmful to juniper, causing galls but not severely affecting plant vigor.

Identification/Biology. The fungus lives nearly two years on juniper, the primary host. From July to September, spores from apples fall on junipers. During warm, moist weather, the spores germinate and infect twigs. Small galls become apparent on juniper the next spring and grow during the summer. These galls are light brown, reddish or chocolate brown, round or kidney-shaped, and up to 2 inches in diameter. The galls develop round pits with small pimple-like spots in the center. The following year, after a few warm spring rains, the galls (sometimes called cedar-apples) swell and produce bright orange, jelly-like tendrils from the circular pits. These tendrils, called spore horns, may be up to 2 inches long. They are highly visible on junipers. One large gall produces billions of spores. These “basidiospores” are carried several miles on the air.

Cedar-apple rust on Juniperus: (A) gelatinous teliospores of summer; and (B) resulting winter gall.

Apple leaves four to eight days old are the most susceptible to infection. Fruit lesions result from infections that took place before and during the blossom stage, from tight-cluster until just after petal fall. Most infections occur between early April and early May. One to two weeks after infection, small yellow to orange spots appear on the upper leaf surface. These spots increase in size up to 1/4 inch. They become bright yellow or orange, and often have a dark border. Small black dots (pycnia) develop in the spots. Similar spots develop on the fruit.

Cedar-apple rust: (C) on apple leaves.

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A few weeks after these pycnia develop, yellow spots begin to form on the lower apple leaf surface (July-August). The leaf thickens and small tubular projections (aecia) develop. These split open and curl backward forming tiny, cup-like structures sometimes called "cluster cups." The aeciospores released from these cluster cups are wind blown to junipers, where infection occurs.

Controls. Junipers – pick and dispose of the galls to improve the appearance of red cedar. Apples – control by following a recommended fungicide spray schedule beginning at the pink-bud stage and continuing through the second cover spray. Reducing the number of nearby eastern red cedars may reduce the occurrence of the disease on apple.

Tennessee Cooperative Extension recommends growing apple varieties resistant to the rust. (The University of Tennessee website lists disease resistant varieties.) When attempting to protect relic species, destroy nearby wild, abandoned or worthless apples, crabapples, cedars or junipers. Although apples may occasionally become infected by spores produced several miles away, most infections result from spores produced on Juniperus within a few hundred feet.

More Information. For more information, refer to the following websites. This advisory used photos and information found in them.

Connecticut Agriculture Experiment Station -
http://www.ct.gov/caes/lib/caes/documents/publications/fact_sheets/plant_pathology_and_ecology/cedar-apple_rust_05-01-08r.pdf
Forestpests.org - http://www.forestpests.org/southern/cedarapplerust.html
Purdue University - http://www.ces.purdue.edu/extmedia/BP/BP-138-W.pdf
University of Tennessee - http://www.utextension.utk.edu/publications/spfiles/SP277-A.pdf
West Virginia University-KTFREC -
http://www.caf.wvu.edu/kearneysville/disease_descriptions/omcar.html

Photo Credits: (A) (B) Dr. George Hudler, Cornell University; and (C) Dawn Dailey O'Brien, Cornell University.

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DOGWOOD ANTHRACNOSE / *Discula destructiva* – Invasive Return to Key-[I][IV]

Widespread dieback and decline of flowering dogwood (*Cornus florida*) was reported in 1978. Dogwood anthracnose (*Discula destructiva*, described by Redlin (1991)) has now been reported throughout most of the natural dogwood range. Millions of flowering dogwoods have been killed and disfigured by the disease.

Identification/Biology. Most common symptoms are large, brown, irregularly shaped blotches on leaves. Often, the diseased area is at or near the leaf tip, centered approximately on the midvein. The blotch often spreads down the midvein, giving a wedge-shaped look to the diseased area. Instead of blotches, leaves occasionally have brown spots with dark brown to purple margins. Infected leaves commonly drop before autumn, leaving the tree partially-to-totally leafless.

Dogwood anthracnose: (A) infected leaf.

Affected twigs have sunken tan-to-brown spots with purple borders that eventually enlarge and girdle the twig, resulting in twig dieback.

Dogwood anthracnose: (B-above) infected stem; and (C-below) exposed infection beneath stem bark.

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Dogwood anthracnose: (D) note the thinning crown and adventitious branching.

Controls. Prune out and destroy infected twigs when possible; rake and destroy fallen leaves from spring through fall; do not let irrigation wet the tree canopy.

Chemical control is possible for valued ornamentals. Begin fungicidal sprays at budbreak and continue at 10-to-14-day intervals until dry weather. Applications during the rest of the growing season may be needed if periods of wet weather occur and there are infected leaves or twigs on the tree.

More Information. For more information, refer to the following websites. This advisory used photos and information found in them.

Carr, David E. and Lauren E. Banas. 2000. "Dogwood anthracnose (Discula destructiva): Effects of and consequences for host (Cornus florida) demography." *American Midland Naturalist*, Vol. 143, No. 1 (Jan., 2000), pp. 169-177.
(Available on line: http://www.jstor.org/stable/info/3082992?seq=1)

Conn Ag Exp Sta - http://www.ct.gov/caes/cwp/view.asp?a=2815&q=376910

Forestencyclopedia.net - http://www.forestencyclopedia.net/p/p2920

Invasive.org - http://www.invasive.org/symposium/anderson.html

Mielke, Manfred E., and Margery L. Daughtrey. *How to identify and control dogwood anthracnose*. USDA-Forest Service, Northeastern Area; NA-GR-18. 2 pp.
(Available on-line: http://www.na.fs.fed.us/spfo/pubs/howtos/ht_dogwd/ht_dog.htm)

Oregon State University - http://plant-disease.ippc.orst.edu/disease.cfm?RecordID=421

Redlin, S.C. 1991. *Discula destructiva sp. nov., cause of dogwood anthracnose*. *Mycologia*. 83:633-642.

Photo Credits: all photos are from USDA-Forest Service staff, "How To" GR-18.

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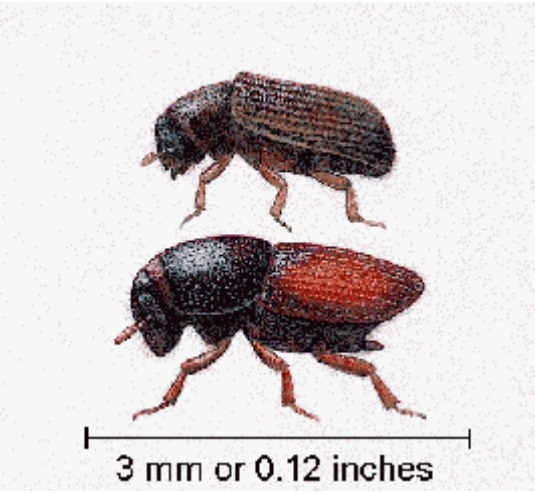
DUTCH ELM DISEASE – Invasive Return to Key-[I][IV]

Dutch elm disease (*Ceratocystis ulmi*) affects American and European species of elm, and is a major disease problem throughout most of the range of elm in the United States. The fungus is transmitted to healthy trees in two ways. Bark beetles transmit spores from diseased to healthy trees or the fungus grows through root grafts between diseased and healthy trees. Several bark beetles transmit the disease, including smaller European elm bark beetle (*Scolytus multistriatus*), the large elm bark beetle (*S. scolytus*), and the American elm bark beetle (*Hylurgopinus rufipes*).

Identification/Biology. Symptoms of the disease include wilting, yellowing, and browning of the leaves, brown or purplish brown streaking of the wood under the bark, and crown dieback. Symptoms become visible in portions of the crown but normally progress rapidly throughout. Complete wilting often occurs within six weeks of infection.

Dutch elm disease: (A) Note the fading tree crown as American elm succumbs to Dutch elm disease; and (B) many trees in a row die due to root grafting.



Dutch elm disease: (C) insect vectors; native elm bark beetle (top) and smaller European elm bark beetle (below). The European is actually larger than the native.

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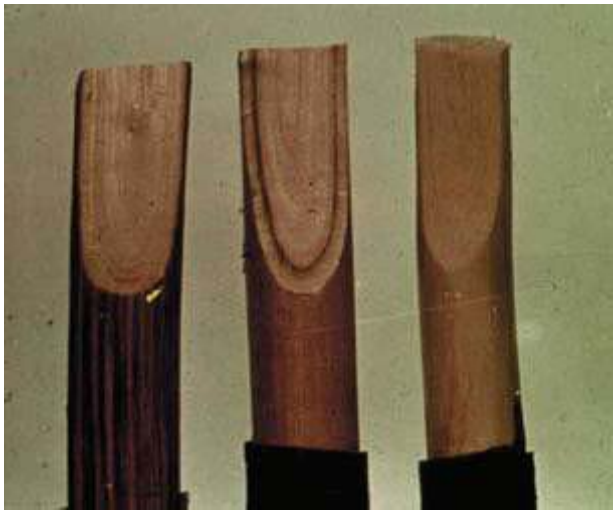

Dutch elm disease: (D) infected branches indicate staining and streaking.

Controls. The most common control is removing infected trees and promptly destroying the wood. If infected wood is to be used as firewood, it should first be debarked. Trenching to disrupt root grafts is recommended to protect highly valued healthy elm trees near diseased ones.

In urban situations, insecticide spraying of high value trees has been effective in keeping bark beetles from attacking susceptible trees.

Prevention measures are essential. Space trees further apart to prevent root grafts or use mixed tree species in ornamental plantings. Sterilize pruning equipment before use from one elm to the next to prevent spreading the fungus.

More Information. For more information, refer to the following websites. This advisory used photos and information found in them.

Forestpests.org – http://www.forestpests.org/southern/dutchelmdisease.html
Invasive.org - http://www.invasive.org/species/subject.cfm?sub=643
USDA-Forest Service - http://www.na.fs.fed.us/spfo/pubs/howtos/ht_ded/ht_ded.htm
USDA-Forest Service - http://www.na.fs.fed.us/fhp/ded/

Photo Credits: (A) Robert L. Anderson, USDA Forest Service; (B) Dr. R. Jay Stipes, Virginia Polytechnic Institute and State University; (C) Julie Martinez, Scientific Illustrator, St. Paul, MN; and (D) America Phytopathological Society.

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DWARF MISTLETOES OF CONIFER SPECIES (NATIVE) Return to Key-[**VII**]

Eastern dwarf mistletoe (DM) (*Arceuthobium pusillum*) is a plant parasite with no photosynthetic production of its own. It is considered a serious plant threat. Host trees include black spruce (*Picea mariana*), red spruce (*P. rubens*), white spruce (*P. glauca*), and tamarack (*Larix laricina*). Throughout its range, it favors wetland communities dominated by coniferous trees and influenced by acidic water. Rarer hosts include jack pine (*Pinus banksiana*), red pine (*P. resinosa*), and eastern white pine (*P. strobus*).

The eastern dwarf mistletoe southern range is New England, Pennsylvania, New York, and west to the Lake States. Its northern range seems to follow its host species to the Boreal forests of Canada, from the Maritime Provinces to eastern Saskatchewan.

Eastern dwarf mistletoe (*Arceuthobium pusillum*): (A) Map of native range.

Identification/Biology. DM is sparingly branched with greenish to chestnut or purplish stems that are circular when fresh and four-angled when dry. As Massachusetts (1994) reports, "The opposite leaves are reduced to thin, connate, obtuse (blunt-tipped) scales with a width of only 0.04". Dwarf mistletoe is dioecious (male and female flowers are on separate plants). Mistletoes reproduce by means of seeds expelled [up to 30'] from explosive fruits. The sticky seeds cling to needles, eventually sliding down the needles to germinate on twigs. During the first year, the parasite penetrates the wood with a root-like structure and develops food and water transport systems. An aerial fruiting structure arises in the early spring of the second year. The structure is green and about as long as the spruce needles….During the third year, flowers are produced. Pollen-producing structures, which survive only a short time, are large and orange-yellow.

Eastern dwarf mistletoe: (B) fruiting body on spruce foliage.

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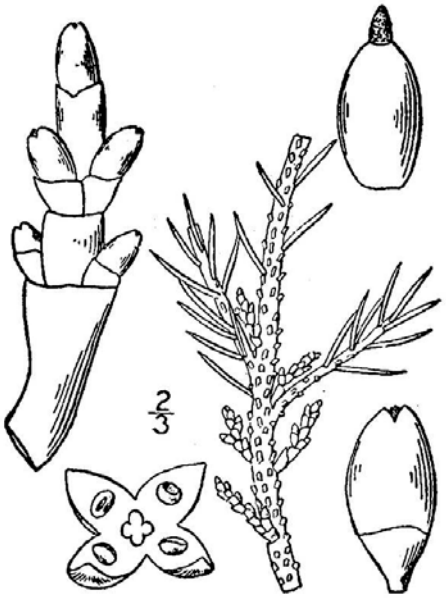

Eastern dwarf mistletoe: (C) line drawing of life stages.

Controls. Depending on infected tree height, DM spores may reach susceptible hosts 30-45' away. Pruning away the parasitic growth does not destroy the localized plant, but can help reduce the spread within the tree and from tree to tree for a three-year period. In the context of a forest stand, tree thinning to disfavor infected trees is an accepted forestry practice.

More Information. For more information, refer to the following websites. This advisory used photos and information found in them.

Britton, N.L., and A. Brown. 1913. *An illustrated flora of the northern United States, Canada and the British Possessions*. Vol. 1: 638. Courtesy of Kentucky Native Plant Society.

Hawksworth, Frank G., and Delbert Wiens. 1972. *Biology and classification of dwarf mistletoes* (*Arceuthobium*). Agriculture Handbook No. 401. February 1972. USDA-Forest Service, Washington, DC. 234 pp.

Massachusetts. 1994. *Massachusetts species of special concern:* Dwarf mistletoe (*Arceuthobium pusillum* Peck). Commonwealth of Massachusetts, Division of Fisheries &.Wildlife, Natural Heritage and Endangered Species Program, Westborough, MA. 2 pp. (Available on line: http://www.mass.gov/dfwele/dfw/nhesp/species_info/nhfacts/arcpus.pdf)

USDA, NRCS. 2009. *The PLANTS database*. National Plant Data Center, Baton Rouge, LA 70874-4490 USA. (Available on-line: http://plants.usda.gov/java/profile?symbol=ARPU3)

Photo Credits: (A) USDA-NRCS; (B) Richard A. Howard, Smithsonian Institute; (3) Britton, N.L., and A. Brown, as above.

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ELM YELLOWS – Invasive (assumed)

Return to Key-[I][IV]

Elm yellows disease, which is also called elm phloem necrosis (*Phytoplasma ulmi*), is caused by a phytoplasma (microscopic bacteria-like organism) which systemically infects the phloem tissue (inner bark) of the elm (*Ulmus*) tree. It is a serious disease that causes tree death. Its range is mostly east of the Mississippi River.

Identification/Biology. Leaves commonly droop, curl upward at the margins, turn yellowish green, then a bright yellow, and finally brown, dropping off within a few weeks. Generally, the entire crown is affected at once. Symptoms of elm yellows differ from Dutch elm disease (DED) in that the leaves turn yellow (not brown and wilted) and drop prematurely, and the symptoms appear in the entire crown at the same time rather than crown portions or the lower crown first. The brown streaking which DED causes in the sapwood is absent, but the inner bark develops a tan discoloration and a characteristic wintergreen odor.

It is spread from tree to tree by a tiny insect, the whitebanded elm leafhopper (*Scaphoideus luteolus*), whose only reported hosts are elm trees. There is some indication that once a tree becomes infected, the disease may spread to others via root contact.

Elm yellows or elm phloem necrosis: (A) yellowed and wilted leaves.

Controls. Time is of the essence if an elm shows signs of elm yellows since nearby trees may already be infected. Remove and destroy the infected tree. For street trees in a row, trench around the next two rows of trees near the infected one. Trenching severs root grafts and stops the transmission of the disease to the next tree. Spraying trees with insecticide also helps reduce the elm leafhopper that transmits the disease.

To avoid losing whole ornamental stands of elm, begin planting other tree types, and do not make landscape plans with one predominate species of any kind.

More Information. For more information and references, refer to the following publications. This advisory used photos and information found in them.

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British Society for Plant Pathology - http://www.bspp.org.uk/publications/new-disease-reports/ndr.php?id=017024
Penn State Live - http://live.psu.edu/story/35741
USDA-Forest Service comparison to Dutch elm disease - http://www.na.fs.fed.us/spfo/pubs/howtos/ht_ded/ht_ded.htm
Wikipedia - http://en.wikipedia.org/wiki/Elm_Yellows

Photo Credits: (A) Pennsylvania Department of Conservation and Natural Resources - Forestry Archive, Bugwood.org.

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HARDWOOD ANTHRACNOSE – Invasive

Return to Key-[IV]

Anthracnose, caused by fungi in the genera Gleosporium, Gnomonia, and Glomerella, and others, commonly affects many species of hardwoods, including ash, basswood, birch, catalpa, elm, hickory, horsechestnut maple, oak, sycamore, walnut, and yellow-poplar. The disease is particularly severe on American sycamore, black walnut, and oaks in the white oak group. (See separate description for Sycamore Anthracnose.)

Identification/Biology. Anthracnose diseases are caused by several species of closely related fungi. These fungi overwinter in infected leaf-and-twig debris or in cankered twigs on trees. During rainy periods in the spring, large numbers of microscopic spores of the sexual state, called ascospores, are discharged from these leaves and twigs and spread by wind or splashing rain onto young, developing leaves of host seedlings. The spores germinate under moist conditions, and the fungus penetrates the leaves.

On most species, secondary spores, called conidia, are produced in fruiting bodies on infected parts of the new leaves. Produced in large numbers, the conidia are also spread from leaf to leaf by wind and splashing rain. The rapid increase and spread of anthracnose in the summer and fall occur by means of these spores.

Symptoms of anthracnose include brown to black leaf spots, brown to black blotches, and sometimes death of entire, young leaves. Young leaves take on the appearance of frost injury, becoming entirely black and shriveled. Pinkish spores may ooze out from the (older) lower leaf surfaces.

Hardwood anthracnose: (A) leaf blotch on horsechestnut; and (B) leaf spot on hickory.

Controls. Eliminate the overwintering fungus in plant materials around valued ornamentals by raking leaves and pruning out infected twigs and branches to reduce the amount of inoculum that causes infection in the spring. The infected material should be destroyed by burning or other appropriate means.

Anthracnose can be controlled with properly timed applications of a suitable fungicide. Contact your NPS Regional IPM specialist.

More Information. For more information and references, refer to the following publications. This advisory used photos and information found in them.

Bugwood.org - http://www.bugwood.org/pestcontrol/diseases.html

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Forestpests.org - http://www.forestpests.org/nursery/anthracnose.html
USDA-Forest Service. 1985. *Anthracnose diseases of Eastern hardwoods*. Forest Insect & Disease Leaflet 133, December 1985. U.S. Department of Agriculture Forest Service. 6 pp. (Available on-line: http://www.na.fs.fed.us/spfo/pubs/fidls/anthracnose_east/fidl-ae.htm)

Photo Credits: (A) (B) USDA-Forest Service.

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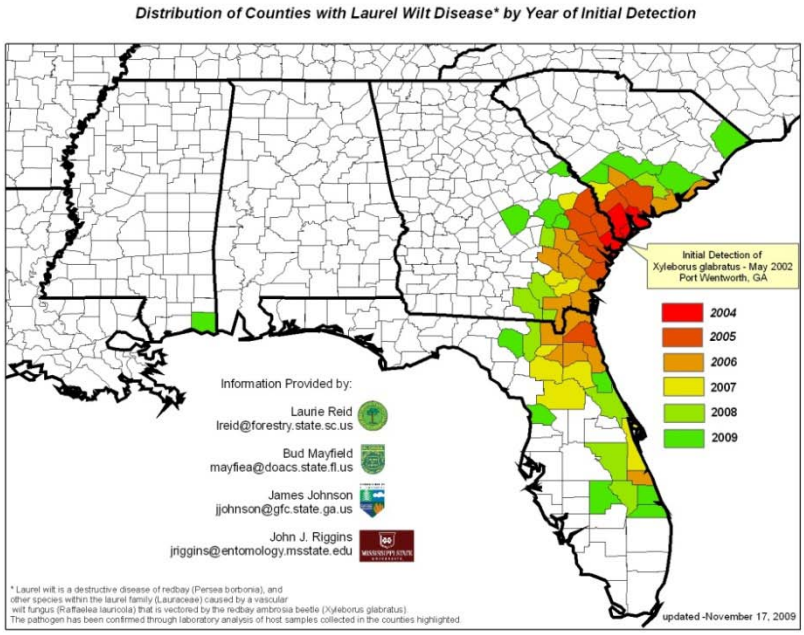
LAUREL WILT / REDBAY AMBROSIA BEETLE – Invasive Return to Key-[IV][V]

Laurel wilt is a lethal vascular disease of redbay (*Persea borbonia*) and other trees in the laurel family (Lauraceae). The disease is caused by the fungus (*Raffaelea lauricola*) that infects the sapwood of host trees, restricting the flow of water and causing the leaves to wilt. The disease was first detected near Savannah, GA, in 2002 and is spreading in the Coastal Plain. The redbay ambrosia beetle (*Xyleborus glabratus*), native to SE Asia, probably was introduced in untreated wooden packing material (e.g., pallets, crates, and boxes for shipping). The beetles (~2mm long) introduce fungal spores into its tunnels as it feeds. Laurel wilt can kill mature redbays within 3-5 years of infestation and has caused high levels of mortality in SC, GA, and FL. Other affected hosts include sassafras (*Sassafras albidum*), avocado (*Persea americana*), swamp bay (*Persea palustris*), camphor tree (*Cinnamomum camphora*), the threatened pondspice (*Litsea aestivalis*) and federal endangered pondberry (*Lindera melissifolia*).



Laurel wilt disease: (A) distribution map of counties by year of initial detection.

Identification/Biology. Redbay trees with laurel wilt initially exhibit drooping foliage with a reddish or purplish discoloration. These symptoms may be limited to part of the crown at first, but eventually the entire crown wilts and turns brown. Wilted leaves may remain on redbay trees for up to a year or more.

Leaf & plant appearance: (B) drooping and dying redbay leaves; and (C) redbay trees killed by laurel wilt.

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The fungus also causes a blue-to-black staining in the outer sapwood. As the ambrosia beetles bore and feed, they extrude frass that form characteristic and unique toothpicks of sawdust that protrude from the trunk and stems.

Wood & bark appearance: (D) blue staining caused by laurel wilt disease; and (E) redbay ambrosia beetle frass tubes.

Controls. Laurel wilt can spread to new areas through the movement of host materials infested with the redbay ambrosia beetle. Wood materials (logs, tree trimmings, chips, and mulch) from dead infested redbays and other host species should be left in place and not moved to a landfill or used for firewood or other purposes. Burning or burying the chips on site may help reduce the spread of the beetle and fungus. As a general rule, always avoid the long distance transport of any firewood. Chipping wood from an infested tree might not destroy all of the ambrosia beetles due to their extremely small size, but should reduce the suitability of the wood as breeding material. Nursery stock in the laurel family showing signs of wilt, sapwood discoloration or ambrosia beetle attack should not be sold or transported, and should be reported to State authorities responsible for tracking the introduction and spread on invasive species. Chemical control methods are under development. Preliminary research suggests that root-flare injections with the systemic fungicide propiconazole may help prevent development of laurel wilt in redbay trees. However, any treatments will probably be expensive and practical only for specimen or high-value trees.

More Information. For more information, refer to the following websites. This advisory used photos and information found in them.

Bugwood website: http://www.bugwood.org

Laurel Wilt Website Hosted by the USDA Forest Service, Forest Health Protection: http://www.fs.fed.us/r8/foresthealth/laurelwilt/

Mayfield, A.E. III. 2008. Laurel wilt. Florida Department of Agriculture and Consumer Services, Division of Forestry, Forest and Shade Tree Pests Leaflet No. 13. 2 p. [PDF 2.2 MB]

Hanula, J.L, Mayfield, A.E. III, Fraedrich, S.W., and Rabaglia, R.J. "Biology and Host Associations of the Redbay Ambrosia Beetle, (Coleoptera: Curculionidae: Scolytinae), Exotic Vector of Laurel Wilt Killing Redbay Trees in the Southeastern United States." Journal of Economic Entomology 101.4 (2008): 1276-1286. [PDF, 160 KB]

Harrington, T.C., Fraedrich, S.W., and Aghayeva, D.N. 2008. "*Raffaelea lauricola* , a new ambrosia beetle symbiont and pathogen on the Lauraceae." Mycotaxon 104 (2008): 399-404. [PDF 419 KB]

University of California, Riverside, Center for Invasive Species Research: http://cisr.ucr.edu/redbay_ambrosia_beetle_laurel_wilt.html

E.L., Smith, J.A., Bernick , S.C. , Eickwort, J.M., and Dreaden, T.J. "Effect of propiconazole on laurel wilt disease development in redbay trees and on the pathogen *in vitro*." Arboriculture & Urban Forestry 35.5 (2008): 317-324.

Photo Credits: map and photos are by Albert E. Mayfield III and James Johnson.

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OAK DECLINE – Invasive

Return to Key-[I][IV]

Periodic decline and death of oaks over widespread areas have been recorded since 1900. The problem seems to be a complex interaction of environmental stresses and pests. Though not limited to any one species or species group, outbreaks are most frequent and severe among red (*Quercus rubra*), scarlet (*Q. coccinea*), pin (*Q. palustris*), and black oak (*Q. velutina*) in the red oak group and white (*Q. alba*) and chestnut oak (*Q. prinus*) in the white oak group.

Oak decline: general appearance of tree crown in decline in (A) forest setting; and (B) city.

Identification/Biology. Oak decline is thought to be brought about by a complex of factors including tree age, site, location, weather, soil problems, fungi and insect attacks. Weakened trees are then invaded and killed by secondary insects and diseases that do not successfully attack healthy trees. The decline progression occurs over several years. The process can be considered a natural part of the native environment.

Wargo, et.al (1983) characterized oak decline as follows: *(1) progressive terminal branch dieback; (2) branch and bole sprout and staghead development; (3) sudden foliage wilt and browning, but no leaf drop; (4) fans and rhizomorphs of A. mellea often present beneath bark of roots and root collars on dying trees; (5) galleries and exit holes of A. bilineatus often present in stems of dying or dead trees (6) decline found throughout the range of oak; (7) mortality related to site features, tree stress, and affects of insets and diseases; and (8) tree mortality peaking 2 to 5 years following stress.*

Oak wilt [on the other hand] *in the red oak group… is characterized by (1) leaf wilt and drop over entire crown, (2) leaf portions bronzing or browning, (3) rapid tree mortality, (4) no progressive branch dieback, (5) formation and then death of short-lived sprouts in the season after infection, and (6) vascular streaking (dark longitudinal streaks) found occasionally in outer growth ring. Oak wilt in the white oak group… is characterized by (1) leaf wilt on scattered branches that die back and form sprouts and (2) vascular streaking common in outer growth ring. Some trees may continue to wilt and die back until all branches and sprouts are dead, yet other trees may survive.*

Controls. Landscape tree health can be improved by avoiding soil compaction near them, avoiding construction and logging damage to the tree bole, watering if it has been droughty, and fertilization. Forest stand preventative treatments include tree thinning to reduce competition and fertilization.

After the onset of the disease, cut a series of 0.5-acre patches to give oaks a better opportunity to re-grow from stump sprouts and to give oak saplings the sunlight they need to thrive. In mature stands, use prescribed fire to encourage growth of oak seedlings and reduce the number of less fire-tolerant competitors.

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More Information. For more information, refer to the following websites. This advisory used photos and information found in them.

Tennessee Dept of Agriculture – http://www.tennessee.gov/agriculture/forestry/oakdecline.html

USDA-Forest Service. 1983. *Oak decline*. Wargo, Philip M., David R. Houston, and Leon A. LaMadeleine, eds. Forest Insect & Disease Leaflet 165. August 1983. USDA-Forest Service (Available on-line: http://na.fs.fed.us/spfo/pubs/fidls/oakdecline/oakdecline.htm)

Photo Credits: (A) USDA-Forest Service; and (B) Robert L. Anderson, USDA Forest Service, Bugwood.org.

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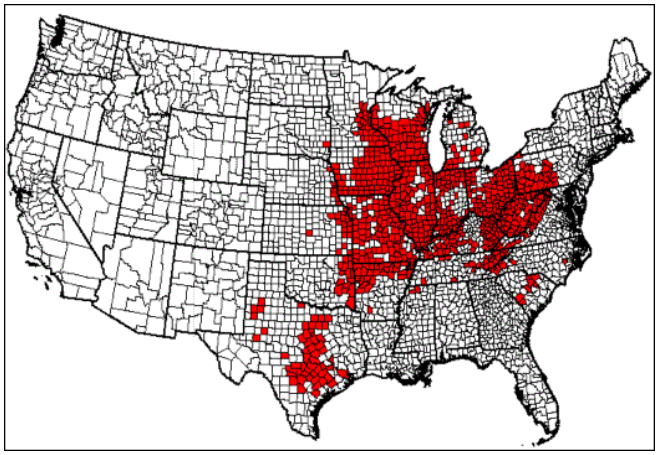
OAK WILT – Invasive

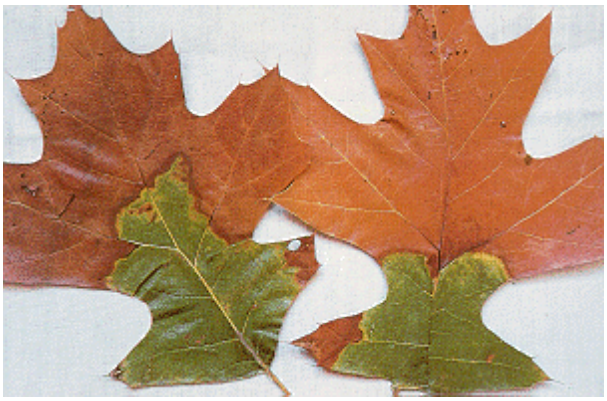
Return to Key-[I][IV]

Oak wilt fungus (*Ceratocystis fagacearum*) is most likely a native disease since no other country has isolated and described it. The wide spread nature of the disease was not recognized until the 1980s. It seems to have become an increasingly serious problem across the country as cities and suburbs expand and oaks are damaged in the process of construction. White, red and live oaks are all impacted. Of them, the white oaks are least and red oaks most vulnerable.



(A) Oak wilt distribution as of 1998.

Identification/Biology. Infection occurs in the spring. Symptoms in red oak occur as early as May. The leaves turn dull green or bronze, appear water-soaked, wilt, and then turn yellow or brown. Damage occurs from the tip and outer edges toward the midrib and base. These symptoms can quickly appear throughout the crown. Leaves at the ends of branches are shed.



(B) Oak wilt symptoms on red oak leaves.

Local spread of oak wilt usually occurs via root grafts from one oak tree to another. Under certain moisture and temperature conditions, compact masses of spore-producing fungal material called spore mats are formed on oak trees about a year after being killed by oak wilt. These mats form just under the bark, in contact with both the bark and the infected sapwood of the tree. As the mats mature, they exert outward pressure on the bark and cause it to split. Spore mats emit a strong fruity or wine-like odor that attracts many different species of nitidulid beetles. Fresh oak tree wounds also attract nitidulid beetles. If they have visited oak wilt spore mats prior, the combination becomes a long-range movement vector of the oak wilt disease. In the North, nitidulids in the genera Carpophilus, Colopterus and Epurea are most often associated with both oak wilt spore mats and fresh wounds on healthy oaks.

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(C-left) Broken bark fissure due to oak wilt spore mat beneath bark;
(D-right) Nitidulid beetles primarily responsible for overland spread of oak wilt

Controls. There are no established controls once a tree is infected. Efforts must focus on prevention and sanitation. Because fresh pruning wounds may attract beetles contaminated with oak wilt fungus, avoid unnecessary pruning and prune in winter whenever possible. Trees should not be pruned during April, May, or June when the beetles are active.

Trees killed by oak wilt should be removed and treated to prevent development of spore mats. Treatments include debarking, chipping, and drying the wood. Covering dead wood with plastic, burying the edges for 6 months, and then air-drying for a similar time will kill the fungus and any associated insects.

To avoid long-range vectoring, all oaks that die in a given year should be checked carefully for fungus mats and oak bark beetle colonization by April 1 of the following year. If the mats or beetles are present, the entire tree should be burned, chipped, or covered with plastic for 60 days.

To avoid tree-to-tree colonization, root grafts between infected and healthy trees should be severed. A trencher or vibrating plow can be used to cut or break the tree roots down to a depth of 2-to-4 feet. Soil fumigants can also be used to kill the connecting roots between trees.

More Information. For more information, refer to the following websites. This advisory used photos and information found in them.

ForestPathology.org – http://www.forestpathology.org/dis_oakwilt.html
Texas Oak Wilt Partnership – http://www.texasoakwilt.org/
USDA-Forest Service. C. 2003. *How to identify, prevent, and control oak wilt*. NA-PR-03-00. USDA-Forest Service, Northeastern Area, State & Private Forestry. (Available on-line: http://na.fs.fed.us/spfo/pubs/howtos/ht_oakwilt/toc.htm)
USDA-Forest Service. 1983. *Oak wilt*. Forest Insect & Disease Leaflet 29. October 1983. USDA-Forest Service. 4 pp.
(Available on-line: http://www.na.fs.fed.us/SPFO/pubs/fidls/oakwilt/oakwilt.htm)
Wisconsin Dept of Natural Resources – http://www.dnr.state.wi.us/forestry/Fh/oakWilt/

Photo Credits: (A) & (D) Julie Martinez, Scientific Illustrator, Minneapolis, MN; (B) & (C) USDA-Forest Service.

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SUDDEN OAK DEATH (SOD) – Invasive Return to Key-[I][IV][VI]

Sudden oak death (now identified as *Phytophthora ramorum*) is the name given to an epidemic first detected in 1995 on the California coast. Susceptible species groups include oaks, tanoak, bay, and rhododendron. The most heavily impacted areas remain on the Pacific coast and interior.

Sudden oak death: (A) Flagging foliage of tanoak.

Identification/Biology. There are two categories of hosts including foliar hosts and bark canker hosts. Foliar host symptoms range from leaf spots to twig dieback. These hosts rarely die from the infection. Bark canker hosts are tanoaks and oaks that become infected on the woody portions of a tree. Cankers on the trunk of these trees are the most damaging, often leading to mortality. Diseased oak and tanoak are often attacked by other mortality producing organisms as well such as *Hypoxylon thourasianum* (a sapwood fungus) and several bark beetles once weakened by *P. ramorum*.

Unfortunately, detecting the presence of *Phytophthora* species requires laboratory confirmation, but visual identification of sypmtoms can help begin diagnostics. Only oaks (*Quercus* spp.) in the red oak group have been found infected. Oaks from the white group do not appear susceptible. Only larger (> 4 inches dbh) adult plants show symptoms and infections of smaller saplings have never been seen in nature. The most obvious and useful symptom to look for on oaks is trunk canker. Cankers have red-brown to black discoloration and seep dark black to red or amber sap. They usually develop 1-to-2 m off the ground, although they can be at soil level, or as high as 4 m or greater; they are not thought to extend below the soil line. Bleeding sap initially appears on intact bark, absent any obvious holes or wounds, though, in later stages of the disease, the bark may split.

Sudden oak death: (B) *Phytophthora ramorum* canker on oak shows typical bleeding appearance.

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Leaf spots are the main symptom on bay and rhododendron. Lesions penetrate through the plant tissue so that spots are identical on both the top and bottom of the leaf. They can be triangular and extend along the leaf mid-vein, or can be found where water collects on the leaf surface (along edges, near the petiole, and at the leaf tip). Leaf spots have diffuse margins and the appearance of water soaking.

Sudden oak death: (C) *Phytophthora ramorum* leaf spot on California bay/Oregon myrtle; and (D) *P. ramorum* on rhododendron.

Controls. Control methods are not well established. Most effort in California and Oregon has been put toward early detection and elimination of alternate hosts such as laurel/bay and rhododendron. A promising treatment for preventing infection of individual oak and tanoak trees, but not for curing an already established infection, is a phosphonate fungicide marketed under the trade name Agri-fos^{R}. Phosphonate is a neutralized form of phosphorous acid that works not by direct antagonism of Phytophthora, but by stimulating various kinds of immune responses on the part of the tree treated. Phosphonate can be applied either as an injection into the tree stem or as a spray to the bole.

More Information. For more information, refer to the following websites. This advisory used photos and information found in them.

California Oak Mortality Task Force - http://www.suddenoakdeath.org/html/plant_symptoms.html
Invasive.org (infection images) - http://www.invasive.org/browse/subimages.cfm?sub=4603
Suddenoakdeath.org (pesticide evaluations) - http://www.suddenoakdeath.org/sodsymposium/PDF/Posters/Symposium%20Posters/09-Wagner_Fungizide.pdf
University of California - http://www.ipm.ucdavis.edu/PMG/PESTNOTES/pn7498.html
USDA-Forest Service. 2002. *Sudden oak death*. Pest Alert; NA-PR-02-02, January 2002. United States Department of Agriculture - Forest Service, State and Private Forestry, Northeastern Area. 2 pp.
(Available on line: http://www.na.fs.fed.us/spfo/pubs/pest_al/sodeast/sodeast.htm)

Photo Credits: (A) Karl Buermeyer, UCCE, Santa Cruz, CA; (B) Steve Tjosvold, UCCE, Santa Cruz, CA; (C) & (D) uncredited at http://www.suddenoakdeath.org/html/plant_symptoms.html

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SYCAMORE ANTHRACNOSE – Invasive Return to Key-[I][IV]

Sycamore anthracnose (*Apiognomonia veneta*) affects American sycamore (*Platanus occidentalis*) throughout its range. It occasionally causes mortality but most often results in unsightly leaf dieback in spring that causes growth lose. The disease requires cool, wet conditions for infection. It is most pronounced when there is free moisture (rain) and an average temperature lower than 55-degrees F for the two weeks following bud break. If it is either droughty or the temperatures are > 55-degrees F, the infection will be less serious to nonexistent.

Sycamore anthracnose: (A) severe spring leaf dieback; and (B) refoliation with evident branch dieback.

Identification/Biology. Symptoms of anthracnose include brown to black leaf spots, brown to black blotches, and sometimes death of entire, young leaves. Young leaves take on the appearance of frost injury, becoming entirely black and shriveled. Pinkish spores may ooze out from the (older) lower leaf surfaces. Rarely does anthracnose cause all of the foliage to die. Sycamore anthracnose also causes small stem cankers. Anthracnose of shade trees is usually worse in the lower or inner canopy of the tree where leaves stay moist longer.

Sycamore anthracnose: (C) leaf blotch; and (D) leaf wilt.

Controls. No forest-wide control is practical due to high cost. Rather, work to help trees produce a new flush of foliage by providing water in periods of drought. For high value landscape individuals, pruning, raking, and burning infected material, coupled with tree fertilization, improves appearance and may reduce subsequent infection. Fungicides are not recommended for early season anthracnose diseases of shade trees.

More Information. For more information, refer to the following websites. This advisory used photos and information found in them.

Colorado State University Extension - http://www.ext.colostate.edu/pubs/garden/02930.html
Forestpests.org (images) - http://www.forestpests.org/subject.html?SUB=661
University of Maryland - httpet.umd.edu/4-4art1.ht://ipmnm

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USDA-Forest Service. 1985. *Anthracnose diseases of Eastern hardwoods*. Editor: Frederick H. Berry. Forest Insect & Disease Leaflet 133; U.S. Department of Agriculture Forest Service. December 1985. 7 pp.
(Available on line: http://www.na.fs.fed.us/Spfo/pubs/fidls/anthracnose_east/fidl-ae.htm)

Photo Credits: (A) (B) Figures #181 and #182 from http://www.fs.fed.us/r3/resources/health/field-guide/fd/sycamore.shtml; (C) Frederick Berry, USDA-Forest Service; (D) Robert L. Anderson, USDA Forest Service, Bugwood.org.

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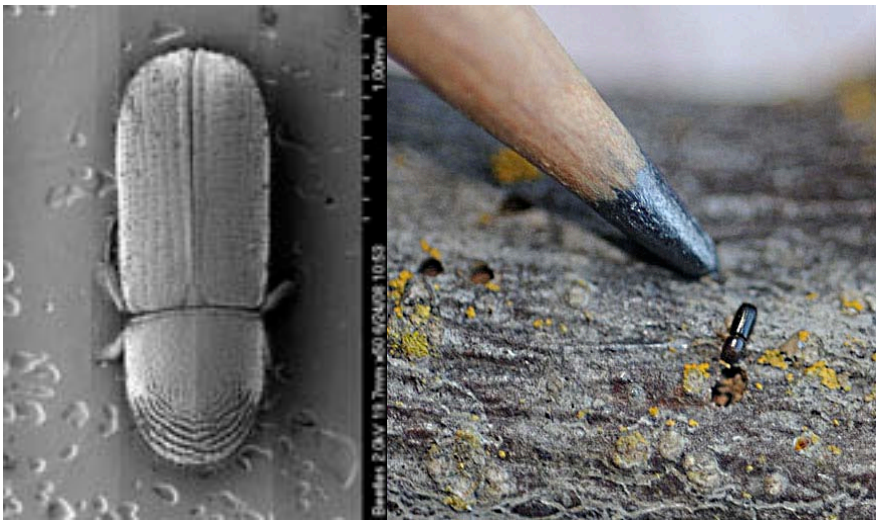
THOUSAND CANKERS DISEASE – Invasive (assumed) Return to Key-[I][VI]

and associated **WALNUT TWIG BEETLE** Return to Key-[I][V]

A newly discovered disease (*Geosmithia morbida*), a previously undescribed fungus, hitchhikes on a tiny native bark beetle (*Pityophthorus juglandis*), is infecting and killing hundreds of black walnut trees in eight Western states. More troubling, in 2010, it was also identified in Tennessee amid the native range of black walnut (*Juglans nigra*). The disease first gained notice in the Española Valley of New Mexico in 2001 when walnut trees declined and died. "The black walnut trees could go the way of the American chestnut or American elm," warns entomologist Lynn Kimsey, chair of the UC Davis Department of Entomology (UC-Davis, 2009). The tiny walnut twig beetle does relatively little damage of its own because it feeds on the bark and phloem, not the cambium and wood. The killing impact comes from the aggressive fungus.

Walnut twig beetle is native to Arizona, California, New Mexico, and Mexico. Associated with it now, the disease has been found in Arizona, California, New Mexico, Colorado, Idaho, Utah, Washington, Oregon, and most recently, Tennessee.

Identification/Biology. The walnut twig beetle adult is reddish-brown and about 1.5 to 1.9 mm long. Bark entrance holes look like pin pricks. "[Under the bark,] well-developed beetle galleries and blotches of fungal-stained wood and bark look like a thousand cankers," said Graves. The cankers, still hidden from outside the bark, widen and girdle twigs and branches, resulting in die back of the tree crown. Death comes in 10-to20 years from initial beetle invasion.



Walnut twig beetle: (A) adult beetle magnified; (B) adult in relief with a pencil.

Initial tree symptoms: look for discoloration of leaves (turning yellowish) and flagging of branchlets in mid-August; thinning and dieback begins at the top; affected trees have thinning crowns that begin to show through to the sky; external bark cankers are NOT visible, they are internal (Forestry Webinar, 2010). One must shave off bark to find beetle galleries and cankers (dark staining). Because the beetles are in the bark, not the cambium and wood, one should not shave the bark too deeply. Also, beetles tend to be on the underside of branches; tend not to be in twigs.

Disease symptoms include dark stains on the corky inner bark tissue that extends into the cambium. There is yellowing and thinning of the upper crown, wilting of leaves, flagging branches, die back and eventual death. Though beetles may be in tree up to 20 years, tree mortality occurs within three years of first visible symptoms.

Controls. No controls are confirmed at this phase of research. Due to mammal consumption of the nut crop, potential insecticides must be carefully evaluated. The natural system of beetle

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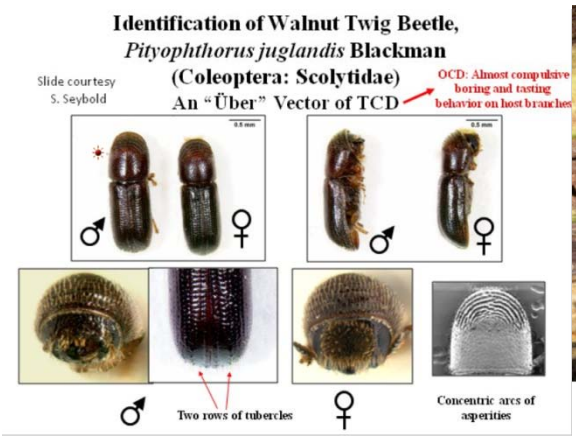
attraction to the trees and to each other might form the basis of a future monitoring and tree protection methods.

Thousand cankers disease: (C) walnut tree branch dieback.



Walnut twig beetle: (D) identification key by Steve Seybold. Thousand cankers disease: (E) disease progression photo composite by Ned Tisserat (counter-clockwise from upper-right).

More Information. For more information and references, refer to the following publications. This advisory used photos and information found in them.

Forestry and Natural Resource Webinar Series featuring Professor Ned Tisserat, CSU - http://www.forestrywebinars.net/webinars/thousand-cankers-disease-of-black-walnut-what-resource-professionals-need-to-know

Kansas Dept of Agriculture - http://www.ksda.gov/includes/document_center/plant_protection/Plant%20Disease%20Reports/PlantDiseaseN1V35.pdf

UC - Davis. 2009. "Beetle and Fungus One-Two Punch Threatens Black Walnut Trees, Scientists Warn" IN University of California – Davis, Department of Entomology website: http://entomology.ucdavis.edu/news/walnuttwigbeetle.html , July 2009.

Utah State University slideshow - http://utahpests.usu.edu/ipm/files/uploads/PPTDocs/09sh-UPIS-diseases-1000cankers-cranshaw.pdf

Photo Credits: (A) Andrew Graves, UC Davis Department of Plant Pathology; (B) Kathy Keatley Garvey, UC-Davis, Department of Entomology; (C & D) Steve Seybold, USDA-Forest Service, Pacific Southwest Research Station; (E) Ned Tisserat, Professor & Cooperative Extension, Colorado State University.

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WHITE PINE BLISTER RUST – Invasive Return to Key-[I][VI]

White pine blister rust (*Cronartium ribicola*) is the most serious disease of white pines. It was introduced into the U.S. in the early 1900s. It has since spread throughout the range of white pines (including eastern white pine, western white pine, mountain pine, and others). The disease is worst and most severe where late summers are cool (below 67º F) and damp. Generally, therefore there is more blister rust farther north.

The rust disease alternates between white pine and *Ribes* species such as currents and gooseberries. The disease cannot spread from pine to pine. Aecia are white blisters that rupture from pine cankers to release orange-yellow aeciospores, which can infect Ribes leaves as far as 200 miles away. Fungus spores (basidiospores) produced on the Ribes host during cool, wet weather in late summer and fall infect the white pine through stomata on needles or young stems. During the 1930s-1960s, and before the range of spore travel was understood, there were projects across the country to eradicate the alternate hosts in an effort to save white pines.

Identification/Biology. On young branchlets, look for patches of browning bark bordered by a yellowish discoloration of the bark or a typical spindle-shaped swelling by the second year after infection. In late spring and early summer, look for Pycnia that appear as yellow-brown blisters on the canker face and produce a sticky yellow-orange fluid containing pycniospores. Any time of year, look for mature cankers bordered by a yellowish discoloration of bark at the canker margin and rodent-feeding on cankers. On main stems, look for oozing pitch flow. Do not confuse that with damage done by the pine bark aphid that appear as scattered patches of white flecks on the bark of the tree.

White pine blister rust: (A) swelling on branch; (B) swelling on main stem and fruiting bodies.

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White pine blister rust: (C) cankers cause pitch flow; (D) a Ribes leaf with late summer rust telia forming.

Controls. Cankers on the main stem will eventually kill the tree above the canker. No control is possible in that case. Cankers on branches at least 4" from the main stem should be removed to protect the tree, thus preventing the canker from reaching the main stem to kill the tree. For best blister rust control, begin pruning when trees are about 4 years old and 2 feet in height. Stands should be pruned every 10 years until the lower 9 feet of the bole are free of living limbs.

The best approach when considering reforestation is to consider planting blister rust resistant tree stock. Also, seedlings must be planted where late summer moister is not high. Places to avoid are stream bottoms and other moist areas.

More Information. For more information and references, refer to the following publications. This advisory used photos and information found in them.

USDA Forest Service. 1979. "White Pine Blister Rust" IN *A guide to common insects and diseases of forest trees in the northeastern United States*. Northeast. Area State Priv. For., For. Insect and Disease Management., Broomall, PA. p. 123.

USDA-Forest Service. 1977. *How to identify white pine blister rust and remove cankers*. USDA-Forest Service, North Central Research Station; U.S. GPO 1989-656810. 8 pp. (Available on-line: http://na.fs.fed.us/spfo/pubs/howtos/ht_wpblister/toc.htm)

Photo Credits: (A) USDA-FS staff; (B) Steven Katovich, Forestryimages.org; (C) & (D) USDA-FS staff.

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Abiotic Problems

ROADSIDE DEICING SALTS Return to Key-[**IV**]

Hardwoods and conifers can be damaged by salts that wash into forest soils from adjacent roadways due to wintertime deicing operations. Both sodium chloride and magnesium chloride-based solutions or crystals cause tree problems. Decreased photosynthesis rates occur in roadside trees during the spring compared to trees more distant from the roadside in the same location (Ceksterea 2008, Trahan 2008). Maples seem the most susceptible to salt damage.

Identification/Biology. Salt damage can appear as a zonal issue where a plant may have impacted and unimpacted portions. That occurs in two ways. It happens when salt solution is accidentally applied directly upon evergreen leaves or needles. Photo-A below clearly shows that kind of damage. Distinct damage also takes place when applied crystals or solutions subsequently splash on vegetation by vehicular traffic.

Another form of damage is less distinct, mimicking a disease or decline. That occurs when salty effluent from road treatments seeps into the root zone of hardwoods or conifers. Photo-B represents that form of impact.

Salt damage: (A) yew bushes along sidewalk; and (B) eastern white pine along roadside, VA.

Controls. Potential ameliorations include: (1) reducing future salt inputs by working with road departments and grounds keepers to apply less salts; (2) attempting to leech out salts with copious amounts of water during the non-growing season; (3) application of soil additives such as gypsum ($CaSO_4$) to tie up salts; (4) preventing salty road runoff from reaching trees by engineered drainage or mulching around prized plantings; and (5) planting less susceptible species (Roberts, et. al, 2006).

More Information. For more information and references, refer to the following publications. This advisory used photos and information found in them.

Ceksterea, Gunta, Olgerts Nikodemusb, and Anita Osvalde. 2008. "Toxic impact of the de-icing material to street greenery in Riga, Latvia" IN *Urban Forestry & Urban Greening;* Volume 7, Issue 3, 1 August 2008, P. 207-217. Available on-line: http://www.sciencedirect.com/science?_ob=ArticleURL&_udi=B7GJD-4S7B2M8-1&_user=10&_rdoc=1&_fmt=&_orig=search&_sort=d&_docanchor=&view=c&_searchStrId=1074531736&_rerunOrigin=google&_acct=C000050221&_version=1&_urlVersion=0&_userid=10&md5=35d2fb2f6121dae6889a651b00af9fc4

Pennsylvania State University. 1987. *Diagnosing injury to eastern forest trees: A manual for identifying damage caused by air pollution, pathogens, insects, and abiotic stresses.* Skelly, J.M., and D.D. Davis, W. Merrill, E.A. Cameron, H.D. Brown, D.B. Drummond, and L.S. Dochinger, eds. PSU, College of Agricultural Sciences, Department of Plant Pathology, University Park, PA. P. 24-25.

Roberts, John, Nick Jackson, and Mark Smith. 2006. *Tree roots in the built environment*. Series: Research for Amenity Trees, No. 8. Department for Communities and Local Government. Queen's Printer and Controller of her Majesty's Stationary Office, Norwich, England. 486 pp. Available on-line:

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http://books.google.com/books?id=afiZn2h8QjEC&pg=PA215&lpg=PA215&dq=reducing+deicing+impacts+to+trees&source=bl&ots=bn6KxDKDQ6&sig=YKrnS-qP_wDiZSYYNbbX7n_ua1g&hl=en&ei=iC3vSvqbDNHolAfaiqCABQ&sa=X&oi=book_result&ct=result&resnum=1&ved=0CA0Q6AEwAA#v=onepage&q=&f=false

Trahan, Nicole A. 2008. "Impacts of Magnesium Chloride-Based Deicers on Roadside Vegetation" IN *Surface transportation weather and snow removal and ice control technology: Fourth national conference on surface transportation weather and seventh international symposium on snow removal and ice control technology, June 16-19, 2008, Indianapolis, Indiana*. P. 171-186. Available on-line: http://pubsindex.trb.org/view.aspx?id=863370

Photo Credits: (A) Joseph LaForest, University of Georgia, Bugwood.org; and (B) Timothy Tigner, VA DOF, Bugwood.org.

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SALT FROM STORM EVENTS Return to Key-[**IV**]

Airborne and waterborne salt impacts become visible in the months following severe storm events. Most recently, Hurricanes Katrina and Rita affected thousands of acres of pine and baldcypress along the Gulf Coast. In past decades, the New England coast also experienced airborne salt damage when salty air coated pine needles.

Identification/Biology. Salt spray or deluge impacts are typically easy to identify because of knowledge of storm events in the immediate past. Salt deluge impacts come from tidal storm surge during storm events. Results of storm surge is noted in Photo-A.

It is not always easy to identify airborne salt impacts along coastal areas. Year after year coastal areas are subject to storm events, yet they seldom exhibit subsequent impacts. Whether a storm was worse than local residents recognize, or winds were more highly directed than usual, trees may show surprising impacts in localized areas. Though both photos A&B are from Hurricane Katrina, photo-B could depict damage due to airborne salts from a smaller storm event as well.

Salt damage from storm events: (A) baldcypress mortality, LA; and (B) pine near Gulf Coast AL.

(C) Salt damaged maple, CT.

Controls. There are no direct amelioration treatments for these catastrophic weather events. It is prudent, however, to examine damaged individuals for secondary insect invasions, and specifically treat for those problems.

More Information. For more information and references on this and related abiotic maladies, refer to the following publication. This advisory used photos and information found in them.

Forestry Images – http://www.forestryimages.org/browse/detail.cfm?imgnum=0014001 and http://www.forestryimages.org/browse/detail.cfm?imgnum=1505042

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Pennsylvania State University. 1987. *Diagnosing injury to eastern forest trees: A manual for identifying damage caused by air pollution, pathogens, insects, and abiotic stresses.* Skelly, J.M., and D.D. Davis, W. Merrill, E.A. Cameron, H.D. Brown, D.B. Drummond, and L.S. Dochinger, eds. PSU, College of Agricultural Sciences, Department of Plant Pathology, University Park, PA. P. 1-22, 24-25.

Photo Credits: (A) Gerald J. Lenhard, Louiana State Univ, Bugwood.org; (B) Paul A. Mistretta, USDA Forest Service, Bugwood.org; and (C) University of Connecticut.

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ATMOSPHERIC DEPOSITIONS – OZONE Return to Key-[**IV**]

Ground level ozone (O_3) is typically created when coal-burning power plants and motor vehicles throw hydrocarbons into the air which are subsequently converted by the sun into ozone. (It can also be naturally created by lightning during electrical storms.) Ozone can be carried upon the wind for many hundreds of miles.

Identification/Biology. Photos A-D illustrate ozone impacts to white pine, ash, yellow poplar, and maple. Conifer scorch is not easily distinguished from salt impacts or soil mineral deficiencies. It becomes a process of elimination with questions such as, "Are the impacts widespread or localized to roadsides or coastal areas?" If the affected conifers are not in such areas, meaning they are not subject to salt inputs, then one begins to narrow down the possibilities by looking for disease fruiting bodies or insect penetration of bark or leaves/needles. Determining there are no insect and disease possibilities brings one to consider airborne chemical impacts.

Ozone damage: (A) white pine tip scorch; and (B) ash fleck.

Ozone damage: (C) stippling on yellow poplar leaves; and (D) dark pigmented stippling on maple.

Controls. There are no direct amelioration treatments for atmospheric deposition impacts. One should cooperate in regional air quality improvement efforts to reduce future impacts. Also, consider alternative plantings that are more tolerant of air deposition inputs (note the VT website below).

More Information. For more information and references, refer to the following publications. This advisory used photos and information found in some of them.

Eastern Forest Environmental Threat Center – http://www.forestthreats.org/publications/su-srs-018/ozone-bioindicator-plants

Pennsylvania State University. 1987. *Diagnosing injury to eastern forest trees: A manual for identifying damage caused by air pollution, pathogens, insects, and abiotic stresses.* Skelly, J.M., and D.D. Davis, W. Merrill, E.A. Cameron, H.D. Brown, D.B. Drummond, and L.S. Dochinger, eds. PSU, College of Agricultural Sciences, Department of Plant Pathology, University Park, PA. P. 1-22.

Virginia Tech (diagnoses and plant alternatives) – http://pubs.ext.vt.edu/430/430-022/430-022.html

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Photo Credits: (A) Andrew J. Boone, South Carolina Forestry Commission, Bugwood.org; (B)&(C) USDA Forest Service - Region 8 Archive, USDA Forest Service, Bugwood.org; (D) Robert L. Anderson, USDA Forest Service, Bugwood.org.

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ATMOSPHERIC DEPOSITIONS – SULFUR DIOXIDE Return to Key-[**IV**]

Airborne sulfur dioxide (SO_2) is produced by coal-burning power plants, steel manufacturing, and ore smelting processes when they throw effluents into the air as smoke. Those products are washed out of the air by rain and deposited onto plants and soils. (Sulfur dioxide is also naturally produced by volcanoes.)

Identification/Biology. Photos A-D illustrate sulfur dioxide impacts to pecan, oak, and blackberry. Leaf necroses could be the result of nutrient deficiencies, salt inputs, and air deposition. Sulfur dioxide deposition impacts are typically restricted to localized areas immediately downwind from a point source (PSU 1987). The forest malady is therefore made easier to diagnose if the park is located near a manufacturing plant. Refer to other guides such as the Penn State manual cited below.

Sulfur dioxide damage: (A) pecan interveinal necrosis; and (B) pecan comparison – impacted and not.

Sulfur dioxide damage: (C) oak leaf necrosis; and (D) blackberry interveinal bifacial necrosis.

Controls. There are no control or amelioration treatments for atmospheric deposition impacts. One should cooperate in regional air quality improvement efforts to reduce future impacts. Consider alternative plantings that are more tolerant of air deposition inputs (note the VT website below).

More Information. For more information and references, refer to the following publications. This advisory used photos and information found in some of them.

Eastern Forest Environmental Threat Center: http://www.forestthreats.org/publications/su-srs-018/ozone-bioindicator-plants

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IPM Images – http://www.ipmimages.org/browse/subimages.cfm?SUB=759

Pennsylvania State University. 1987. *Diagnosing injury to eastern forest trees: A manual for identifying damage caused by air pollution, pathogens, insects, and abiotic stresses.* Skelly, J.M., and D.D. Davis, W. Merrill, E.A. Cameron, H.D. Brown, D.B. Drummond, and L.S. Dochinger, eds. PSU, College of Agricultural Sciences, Department of Plant Pathology, University Park, PA. P. 1-22.

Virginia Tech (diagnoses and plant alternatives) – http://pubs.ext.vt.edu/430/430-022/430-022.html

Photo Credits: (A)&(B) University of Georgia Plant Pathology Archive, University of Georgia, Bugwood.org; (C) USDA Forest Service - Region 8 Archive, USDA Forest Service, Bugwood.org; and ; (D) Robert L. Anderson, USDA Forest Service, Bugwood.org.

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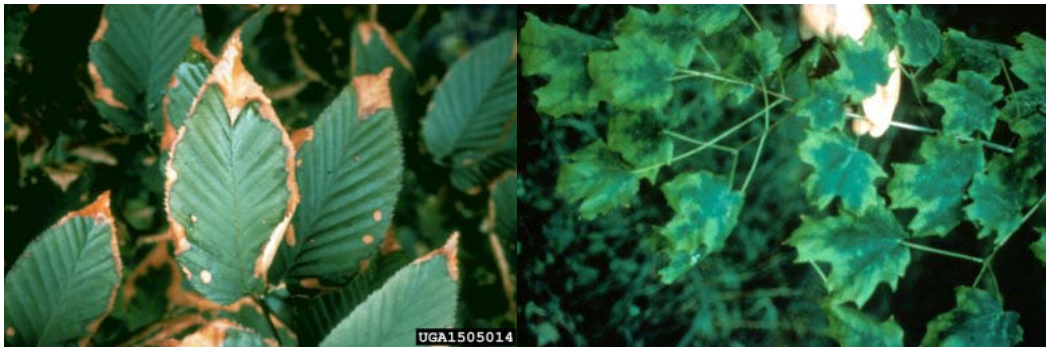
ATMOSPHERIC DEPOSITIONS – FLUORIDES Return to Key-[**IV**]

Airborne fluoride occurs as hydrogen fluoride (HF) and silicon tetrafluoride (SiF_4), commonly produced in manufacture of aluminum, phosphate fertilizer, glass, bricks, steel, and the combustion of coal. The byproducts cause very localized problems due to being released close to the ground and being highly reactive (quickly absorbed/adsorbed into vegetation, soil, and buildings).

Identification/Biology. Photos A-D represent fluoride impacts to white pine, birch, and maple. Because fluoride impacts are restricted immediately downwind of point sources, diagnosis is directly tied to the park proximity to manufacturing. Refer to other guides such as the Penn State manual (PSU 1987).

Hydrogen fluoride damage: (A) & (B) white pine tip necrosis.



Fluoride damage: (C) birch marginal leaf necrosis; and (D) maple marginal chlorosis of leaves.

Controls. There are no direct control or amelioration treatments for atmospheric deposition impacts. One should cooperate in regional air quality improvement efforts to reduce future impacts. Consider alternative plantings that are more tolerant of air deposition inputs (note the VT website below).

More Information. For more information and references, refer to the following publications. This advisory used photos and information found in some of them.

Eastern Forest Environmental Threat Center: http://www.forestthreats.org/publications/su-srs-018/ozone-bioindicator-plants

IPM Images – http://www.ipmimages.org/browse/detail.cfm?imgnum=0364092 and http://www.ipmimages.org/browse/subimages.cfm?SUB=759

Pennsylvania State University. 1987. *Diagnosing injury to eastern forest trees: A manual for identifying damage caused by air pollution, pathogens, insects, and abiotic stresses.* Skelly, J.M., and D.D. Davis, W. Merrill, E.A. Cameron, H.D. Brown, D.B. Drummond, and L.S. Dochinger, eds. PSU, College of Agricultural Sciences, Department of Plant Pathology, University Park, PA. P. 1-22.

Virginia Tech (diagnoses and plant alternatives) – http://pubs.ext.vt.edu/430/430-022/430-022.html

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Photo Credits: (A)&(B) Robert L. Anderson, USDA Forest Service, Bugwood.org; (C) USDA Forest Service - Region 8 Archive, USDA Forest Service, Bugwood.org; and (D) Natural Resources Canada, Canadian Forest Service.

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Appendix D – Law and Policy Statements

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Law & Policy

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NPS Organic Act

The National Park Service Organic Act (16 U.S.C. l 2 3, and 4), as set forth herein, consists of the Act of Aug. 25 1916 (39 Stat. 535) and amendments thereto.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That there is hereby created in the Department of the Interior a service to be called the National Park Service, which shall be under the charge of a director, who shall be appointed by the Secretary and who shall receive a salary of $4,500 per annum. There shall also be appointed by the Secretary the following assistants and other employees at the salaries designated: One assistant director, at $2,500 per annum, one chief clerk, at $2,000 per annum; one draftsman, at $1,800 per annum; one messenger, at $600 per annum; and, in addition thereto, such other employees as the Secretary of the Interior shall deem necessary: Provided, That not more than $8,100 annually shall be expended for salaries of experts, assistants, and employees within the District of Columbia not herein specifically enumerated unless previously authorized by law.

The service thus established shall promote and regulate the use of the Federal areas known as national parks, monuments, and reservations hereinafter specified by such means and measures as conform to the fundamental purposes of the said parks, monuments, and reservations, which purpose is to conserve the scenery and the natural and historic objects and the wild life therein and to provide for the enjoyment of the same in such manner and by such means as will leave them unimpaired for the enjoyment of future generations.

SEC. 2. That the director shall, under the direction of the Secretary of the Interior, have the supervision, management, and control of the several national parks and national monuments which are now under the jurisdiction of the Department of the Interior, and of the Hot Springs Reservation in the State of Arkansas, and of such other national parks and reservations of like character as may be hereafter created by Congress: Provided, That in the supervision, management, and control of national monuments contiguous to national forests the Secretary of Agriculture may cooperate with said National Park Service to such extent as may be requested by the Secretary of the Interior.

SEC. 3. That the Secretary of the Interior shall make and publish such rules and regulations as he may deem necessary or proper for the use and management of the parks, monuments, and reservations under the jurisdiction of the National Park Service, and any violations of any of the rules and regulations authorized by this Act shall be punished as provided for in section fifty of the Act entitled "An Act to codify and amend the penal laws of the United States," approved March fourth, nineteen hundred and nine, as amended by section six of the Act of June twenty-fifth, nineteen hundred and ten (Thirty-sixth United States Statutes at Large, page eight hundred and fifty-seven). He may also, upon terms and conditions to be fixed by him, sell or dispose of timber in those cases where in his judgment the cutting of such timber is required in order to control the attacks of insects or diseases or otherwise conserve the scenery or the natural or historic objects in any such park, monument, or reservation. He may also provide in his discretion for the destruction of such animals and of such plant life as may be detrimental to the use of any of said parks, monuments, or reservations. He may also grant privileges, leases, and permits for the use of land for the accommodation of visitors in the various parks, monuments, or other reservations herein provided for, but for periods not exceeding thirty years; and no natural curiosities, wonders, or objects of interest shall be leased, rented, or granted to anyone on such terms as to interfere with free access to them by the public: Provided, however, That the Secretary of the Interior may, under such rules and regulations and on such terms as he may prescribe, grant the privilege to graze live stock within any national park, monument, or reservation herein referred to when in his judgment such use is not detrimental to the primary purpose for which such park, monument, or reservation was created, except that this provision shall not apply to the Yellowstone National Park: And provided further, That the Secretary of the Interior may grant said privileges, leases, and permits

and enter into contracts relating to the same with responsible persons, firms, or corporations without advertising and without securing competitive bids: And provided further, That no contract, lease, permit, or privilege granted shall be assigned or transferred by such grantees, permittees, or licensees, without the approval of the Secretary of the Interior first obtained in writing: And provided further, That the Secretary may, in his discretion, authorize such grantees, permittees, or licensees to execute mortgages and issue bonds, shares of stock, and other evidences of interest in or indebtedness upon their rights, properties, and franchises, for the purposes of installing, enlarging or improving plant and equipment and extending facilities for the accommodation of the public within such national parks and monuments.

SEC. 4. That nothing in this Act contained shall affect or modify the provisions of the Act approved February fifteenth, nineteen hundred and one, entitled "An Act relating to rights of way through certain parks, reservations, and other public lands."

National Park Service Policies (excerpted)[6]

Prohibition on resource impairment/derogation ..... Section 1.4.2 – 5

"So, although the Organic Act and the General Authorities Act, as amended by the Redwood amendment, use different wording ("unimpaired" and "derogation") to describe what the National Park Service must avoid, they define a single standard for the management of the national park system…

"Impairment that is prohibited … is an impact that, in the professional judgment of the responsible NPS manager, would harm the integrity of park resources or values, including the opportunities that otherwise would be present for the enjoyment of those resources or values…

"An impact would be more likely to constitute impairment to the extent that it affects a resource or value whose conservation is necessary to fulfill specific purposes identified in the establishing legislation…, or key to the natural or cultural integrity of the park…, or identified in the park's general management plan…. An impact would be less likely to constitute an impairment if it is an unavoidable result of an action necessary to preserve or restore the integrity of park resources or values…"

Volunteers in parks ..... Section 1.9.1.6

"American citizens who are not employed by the Service make important contributions by supplementing the efforts of the NPS workforce. The Service welcomes their efforts and will continue to use its authority under the Volunteers in the Parks Act of 1969 to protect park resources and values; improve its service to the public; foster stronger ties with the public; and provide opportunities for the public to learn about and experience the parks."

Partnerships..... Section 1.10 and 4.1.4

"The Service recognizes the benefits of cooperative conservation (in accordance with Executive Order 13352, Facilitation of Cooperative Conservation)…with individuals; organizations; tribal, state, and local governments; and other federal agencies…

"In the spirit of partnership, the Service will also seek opportunities for cooperative management agreements with state or local agencies that will allow for more effective and efficient management of the parks, as authorized by section 802(a) of the National Parks Omnibus Management Act of 1998 (16 USC 1a-2(1))."

Restoration of natural systems ..... Section 4.1.5

[6] NPS Management Policies, 2006; see references.

"Landscapes disturbed by natural phenomena, such as landslides, earthquakes, floods, hurricanes, tornadoes, and fires, will be allowed to recover naturally unless manipulation is necessary to prtect other park resources…

"[The Service will seek to return areas to natural conditions that are impacted by human disturbances, such as] the introduction of exotic species; the contamination of air, water, and soil; …"

Defining native and exotic species ..... Section 4.4.1.3

"Native species are defined as all species that have occurred, now occur, or may occur as a result of natural processes…. Exotic species are those species that occupy or could occupy park lands directly or indirectly as the result of deliberate or accidental human activities. They are also commonly referred to as nonnative, alien, or invasive species.

"Genetically modified organisms exist solely due to human activities and therefore are managed as exotic species in parks."

Management of invasives ..... Section 4.4.4 (all)

"Exotic species will not be allowed to displace native species if displacement can be prevented.

"In general, new exotic species will not be introduced into parks.

"All exotic plant and animal species that are not maintained to meet an identified purpose will be managed—up to and including eradication—if (1) control is prudent and feasible, and (2) the exotic species interferes with natural processes…, or disrupts the genetic integrity of native species, or disrupts the accurate presentation of a cultural landscape, or damages cultural resources, or significantly hampers the management of park or adjacent lands, or poses a public health hazard…, or creates a hazard to public safety."

Treatment of cultural landscapes ..... Section 5.3.5.2

"The treatment of a cultural landscape will preserve significant physical attributes, biotic systems, and uses when those uses contribute to historical significance… Treatment decisions will consider both the natural and built characteristics and features of a landscape, the dynamics inherent in natural processes and continued use, and the concerns of traditionally associated peoples."

Pest management ..... Sections 4.4.5 and 5.3.1.5

"Pests are living organisms that interfere with the purposes or management objectives of a specific site within a park or jeopardize human health or safety."

Integrated pest management ..... Section 4.4.5.2 and 5.3.1.5

"The Service and each park unit will use an IPM approach to address pest issues. Proposed pest management activities ;must be conducted according to the IPM process prescribed in Director's Order #77-7: Integrated Pest Management."

Use of pesticides ..... Section 4.4.5.3 and 5.3.1.5

"The decision to incorporate a chemical, biological, or bioengineered pesticide into a management strategy will be based on determination by a designated IPM specialist…. Pesticide applications will only be performed by or under the supervision of certified or registered applicators licensed under the procedures of a federal or state certification system."

Pesticide purchase and storage..... Section 4.4.5.5

"Pesticides must not be stockpiled. No pesticides may be purchased unless they are authorized and expected to be used within one year from the date of purchase. Pesticide storage, transport, and disposal will comply with procedures established by (1) the Environmental Protection Agency; (2) the individual states in which parks are located; and (3) Director's Order #30AP Hazardous and

Solid Waste Management, Director's Order #77-1: Wetland Protection, and Director's Order 77-7: Integrated Pest Management."

Wilderness minimal impact imperative ..... Section 6.3.5

"All management decisions affecting wilderness must be consistent with the minimum requirement concept…applied as a two-step process that determines whether the proposed management action is appropriate or necessary for administration of the area as wilderness and does not cause a significant impact to wilderness resources and character…; and the techniques and types of equipment needed to ensure that impacts on wilderness resources and character are minimized."

Interpretive and educational programs..... Section 7.1

"Interpretation will [reach out to visitors and] park neighbors, segments of the population that do not visit national parks, and community decision-makers to stimulated discussions about the park…. In addition, interpretive services will help employees better understand the park's history, resources, processes, and visitors."

Director's Order #77-7: Integrated Pest Management

[Upon release of the insect and disease emergency response plan, DO-77-7 is not yet finalized. It is provided here for advance information and planning.]

DIRECTOR'S ORDER 77-7: INTEGRATED PEST MANAGEMENT (IPM)

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DIRECTOR'S ORDER 77-7: INTEGRATED PEST MANAGEMENT (IPM)

This Director's Order 77-7, in conjunction with reference manual (RM) *RM 77-7, Integrated Pest Management*, expands and clarifies the National Park Service's Management Policies, and supersedes and replaces previously issued guidance on Integrated Pest Management.

For technical information on integrated pest management, see the IPM Program website (accessible from National Park Service computers only): http://www1.nrintra.nps.gov/BRMD/ipm/, or the public web access: http://www.nature.nps.gov/biology/ipm.

1.0 INTRODUCTION

The mandate of the National Park Service is to preserve and protect human health and the natural and cultural resources in park units in an effective and ecologically sound manner. Integrated Pest Management (IPM) is fundamental to the achievement of this mandate. Pest issues affect every park. Whether animals are interfering with the preservation of historic structures or exotic vegetation threatens a healthy forest, *the IPM Process enables the development of an effective management strategy in order to detect and identify pests, determine if a problem exists, and develop an effective and efficient process for preventing and rectifying the underlying problems that foster pest occurrence.*

The implementation of the IPM Program is the responsibility of each park's superintendent, as well as the designated park IPM coordinator. It is also the responsibility of all persons involved in the planning, management, purchasing, and implementation of pest management strategies.

All government agencies are required by law to implement IPM strategies. Title 7 U.S.C. 136 (the Federal Insecticide, Fungicide, and Rodenticide Act [FIFRA]) states that "Federal agencies shall use integrated pest management techniques in carrying out pest management activities and shall promote Integrated Pest Management through procurement and regulatory policies, and other activities." The Department of the Interior strengthens the federal law by issuing policy in the Department of the Interior Manual, Section 517 Integrated Pest Management, which requires the Department of the Interior (DOI) bureaus and offices to incorporate Integrated Pest Management into their pest management activities. National Park Service policy goes one step further by directing each park unit to use an IPM approach to address pest issues.

These authorities agree with and support the NPS Organic Act (16 U.S.C. 1 et. seq.) and commit the Service to making informed decisions that perpetuate the conservation and protection of park resources unimpaired for the benefit and enjoyment of future generations.

What is IPM? IPM, or integrated pest management, is a science-based decision-making process that coordinates knowledge of pest biology, ecology, the environment, and available technology to prevent unacceptable levels of pest damage by cost-effective means, while posing the least possible risk to people, resources, and the environment. The IPM process is used to determine:

- if pest management is needed;
- if needed, when management should be initiated (i.e., at what population level or at what set of circumstances the pest becomes intolerable and when management action should be taken);
- where and at what frequency management treatments should be applied;
- what physical, cultural, biological, or chemical strategies should be employed for greatest efficiency and effectiveness;
- through monitoring, how effective these treatments are in achieving management objectives.

The Service will use an IPM approach to address pest issues in accordance with applicable laws, regulations, and National Park Service policies, and provide the most effective, lowest risk strategy for preventing, detecting, and managing pests in all areas. (See *RM 77-7, Integrated Pest Management*, "IPM Process for Designing and Implementing an IPM Strategy.")

The IPM process integrates compatible techniques to maintain pest damage below an unacceptable injury level while providing protection from threats to public health and safety, historic resources, and to the developed and the natural environment. IPM maximizes the use of naturally occurring factors that regulate pest populations, such as weather, predators, parasites, phenology, and pathogens. IPM also utilizes various physical, cultural, biological, and chemical pest management techniques, as well as genetically resistant hosts, genetically modified organisms, human behavior modification, and environmental modification.

2.0 SCOPE

This Director's Order applies to all lands and properties administered by the Service, including wild lands, developed areas, agricultural lands, residential areas, cultural and ornamental landscapes, museum property, artifacts, structures, concessions and maintenance facilities, and situations involving public and employee health. This Director' Order applies to all divisions, employees, researchers, volunteers, residents, concessioners, trusts, contractors, permittees, licensees, and visitors in all national park units. The use of IPM principles and techniques will be applied to all pest management actions proposed and conducted within park boundaries or on National Park System properties, whether they are managed by the Service or other Federal personnel, commercial contractors, or others. IPM will be incorporated into Servicewide, regional, and park planning efforts, procurement, park operations, restoration projects, management of natural and cultural resources, museum property management, concessions, public health protection, design, construction and maintenance of park structures and facilities, housing, landscape, and all other park management and planning activities.

Proposals to use a pesticide, biological control agent, or a genetically modified organism (when, in the context of this Director's Order, the genetically modified organism is proposed for use as a pesticide), must be forwarded to the regional and/or Servicewide IPM Coordinator for review where the request will be approved or denied for use through the pesticide use proposal system (PUPS).

3.0 DEFINITIONS

Alien species, as defined by the Executive Order on Invasive Species 13112, "means, with respect to a particular ecosystem, any species, including its seeds, eggs, spores, or other biological material capable of propagating that species, that is not native to that ecosystem."

Biological control agents are defined as any living organism applied to or introduced into the environment that is intended to function as a pesticide against another organism declared to be a pest (FIFRA, 7 U.S.C.136-136y, as amended).

Biological Use Proposal (BUP) is a request to use a biological control agent on lands or property managed by the Service. Requests must be submitted through the Pesticide Use Proposal System as described in this document. See *RM 77-7, Integrated Pest Management,* for further BUP procedures.

Exotic species (see definition for **Nonnative organisms**, below).

Genetically modified organisms (GMOs) are organisms that contain gene combinations or gene sequences that do not occur naturally and have not been created through traditional breeding practices such as artificial selection for specific traits or hybridization. Certain GMOs have been developed as tools for pest management. The technologies for creating GMOs are developing rapidly, but the current method of GMO creation often involves removing a small number of desired genes (typically one or two) from a donor organism and inserting them into a recipient organism, often resulting in the transfer of genes across taxonomic groups. The terms "bioengineered organism" and "genetically-engineered organism" are often used as synonyms for GMO. (See DO 77-5, Genetically Modified Organisms, for further information and guidance on use of genetically modified organisms, and see *RM 77-7, Integrated Pest Management.)*

Integrated Pest Management (IPM) is a science-based decision-making process that coordinates knowledge of pest biology, the environment, and available technology to prevent unacceptable levels of pest damage by cost-effective means, while posing the least possible risk to people, resources, and the environment. (See *RM 77-7, IPM Integrated Pest Management*, "IPM Process for Designing and Implementing an IPM Strategy.")

Invasive species, as defined by the Executive Order on Invasive Species 13112, means "an alien species whose introduction does or is likely to cause economic or environmental harm or harm to human health.**"**

IPM methods include education, consensus building, regulation, planning, and the appropriate incorporation of appropriate use and sequencing of tools.

IPM tools include mechanical and physical tools, cultural practices, biological control agents, genetically modified organisms, chemical pesticides and other strategies used to manage pests. After the available tools and methods are reviewed the most suitable strategy (using specific and most appropriate methods and tools) is developed to address the individual pest situation. *RM* 77-7, *Integrated Pest Management*, "IPM Tools and Methods," further explains these tools, procedures, and management strategies.

IPM Process involves a sequence of steps and actions taken to prevent, detect, manage and document pest management activities. Refer to "11 Step Process to Developing and Implementing an Integrated Pest Management Strategy", discussed in *RM* 77-7, *Integrated Pest Management*.

Native species as defined by the Executive Order on Invasive Species 13112, means "with respect to a particular ecosystem, a species that other than as a result of an introduction historically occurs or currently occurs in that ecosystem." NPS Management Policies further defines native organisms or indigenous species as "all species that have occurred or now occur as a result of natural processes on lands designated as units of the National Park System**."**

Nonnative or non-indigenous organisms or exotic species are those species that occupy or could occupy park lands directly or indirectly as the result of deliberate or accidental human activities. Nonnative species also are commonly referred to as alien or invasive species.

Pests are living organisms that interfere with the purposes or management objectives of a specific site within a park or jeopardize human health or safety, as stated in NPS Management Policies. Depending on the situation, any living organism (native or nonnative) can be a pest.

Pesticides, as defined by the two main laws which regulate pesticides, the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) and the Federal Food Drug and Cosmetic Act (FFDCA) are: (1) any substance or mixture of substances intended for preventing, destroying, repelling, or mitigating any pest, (2) any substance or mixture of substances intended for use as a plant regulator, defoliant, or desiccant, and (3) any nitrogen stabilizer. Tools that fall within this definition include insecticides, fungicides, herbicides, rodenticides, avicides, molluscicides, repellents, etc.

The term "pesticide" shall not include any article that is a "new animal drug" within the meaning of section 321 (w) [1] of Title 21, that has been determined by the Secretary of Health and Human Services not to be a new animal drug by a regulation establishing conditions of use for the article, or that is an animal feed within the meaning of section 321 (x) [1] of Title 21 bearing or containing a new animal drug. The term "pesticide" does not include liquid chemical sterilant products (including any sterilant or subordinate disinfectant claims on such products) for use on a critical or semi-critical device, as defined in section 321 of Title 21. For purposes of the preceding sentence, the term "critical device" includes any device that is introduced directly into the human body, either into or in contact with the bloodstream or normally sterile areas of the body and the term "semi-critical device" includes any device that contacts intact mucous membranes but that does not ordinarily penetrate the blood barrier or otherwise enter normally sterile areas of the body.

Note: FIFRA is also an "intent" law, which means that if someone is intending to use a substance to control a pest, the substance is a pesticide whether it is a substance produced through a chemical manufacturing process, a fermentor, or a living plant. See Reference *RM 77-7, Integrated Pest Management*, for additional information on types of pesticides and review and approval requirements.

A **Pesticide Use Proposal (PUP)** is a request to use a pesticide, biological control agent, or a genetically modified organism on lands or property managed by the Service. Requests must be submitted through the park IPM coordinator, who reviews the situation through the Pesticide Use Proposal System (PUPS) or, in an emergency, via phone or email. The pesticide request is then examined by the regional or Servicewide IPM Coordinator to evaluate potential risks. This review process includes consultation with the park and with subject matter experts, and a determination that compliance has been met. Each proposal is evaluated on a case-by-case basis to determine if the proposed application is appropriate. This evaluation is carried out using the best available information from past successes, academia, industry, and other subject matter experts. The decision to allow the proposed use, deny it, or allow it under specifically stated conditions is determined, recorded, and entered into the Pesticide Use Proposal System. Each PUP must be submitted annually and reviewed through the intranet-based Pesticide Use Proposal System or through a telephone discussion with the regional or Servicewide IPM Coordinator, and be approved prior to use. See *RM 77-7, Integrated Pest Management* , for further PUP procedures.

The **Pesticide Use Proposal System (PUPS)** is an NPS intranet-based system that is used by park units to request the use of a pesticide, biological control agent, or genetically modified organism at their site. These requests are then approved or denied by the regional or NPS Servicewide IPM coordinator(s). PUPS is also used to track the amount of pesticides, biological control agents, and genetically modified organisms used on a project-by-project basis. Each proposed pesticide use is considered a separate project and is assigned its own project number. Each PUP will be reviewed on a case-by-case basis, taking into account associated risks, environmental effects, cost, and other relevant considerations. The decision to incorporate a chemical pesticide, biological agent, or genetically modified organism into a management strategy will be based on the determination by a designated regional or NPS Servicewide IPM coordinator that it is a necessary component of the

management strategy. See *RM* 77-7, *Integrated Pest Management*, for pesticide proposal procedures.

The IPM Process is a sequential planning process used to implement the IPM approach. It involves:

- setting objectives,
- identifying pest(s),
- building consensus,
- determining action thresholds,
- monitoring (the pest population and behavior, environmental conditions, human behavior, environmental conditions, phenology, etc),
- using IPM management tools,
- assessing risk,
- science-based decision making,
- evaluation (of the management strategy,
- adapting and improving the management strategy if necessary to accomplish goals.

(See *RM 77-7, Integrated Pest Management*, "IPM Process for Designing and Implementing an IPM Strategy.")

4.0 PURPOSE AND PROGRAM OBJECTIVES

4.1 Purpose of DO 77-7, Integrated Pest Management

The purpose of this Director's Order is to:

- Provide IPM policy and guidance for the management of pests on all lands and properties administered by the Service;
- Incorporate the consistent use of the IPM process in all aspects of resource management, planning, procurement, and park operations;
- Develop Servicewide policy and guidance regarding pest management.

A compilation of IPM procedures and requirements can be found in the *NPS 77, Natural Resources Management Reference Manual.*

4.2 Purpose of the Service's IPM Program

The National Park Service implements an IPM program to:

- Reduce risks to people, resources, and the environment from pests and pest-related management strategies;
- Incorporate science-based decision-making when addressing pest issues;
- Enhance the Service's ability to detect and identify pests and prevent or rectify underlying problems that can foster pest occurrences;
- Provide IPM training and technical assistance to field staff.

4.3 Program Objectives

The objective of this Director's Order is to provide policy and procedures in accordance with applicable laws, regulations, and National Park Service policies to determine, on a case-by-case basis, the lowest risk and most effective strategy for preventing, detecting, and managing pests on lands and properties administered by the National Park Service.

This Director's Order documents the Services' commitment to:

o **Building consensus** between employees responsible for pest management and those responsible for resource and visitor protection in other Service disciplines and with partners, through communication, cooperation, and coordination;

o **Preventing pests** by conducting appropriate and applicable pest detection, environmental surveillance, and monitoring before, during, and after any management activity to determine whether pest management goals are achieved and whether the activity caused any significant, unanticipated effects;

o **Identifying conditions** that are or may be conducive to pests, and identifying, developing, and implementing a course of action to manage and correct those conditions;

o **Solving underlying problems** using sustainable methods to address pest issues on a long-term basis by understanding pest biology, changing the site conditions, and modifying human behavior through education;

o **Reducing risks** to people, park resources, and the environment from pests and pest related management strategies, and by preventing unacceptable levels of pest damage by cost-effective means;

o **Documenting and evaluating** IPM Program efforts and results that support park management goals; and

o **Incorporating the IPM process** into the standard operating procedures of other Service programs, and institutionalizing the IPM process by ensuring the uniform application of policy throughout the Service by providing training and technical expertise to Service divisions, developing and implementing monitoring procedures, and tailoring IPM practices to address specific park needs.

5.0 AUTHORITIES

Additional authorities, regulations, and/or memoranda that regulate, affect, or restrict pest management procedures are listed in *RM* 77-7, *Integrated Pest Management*, "IPM Authorities." The authority to issue this Director's Order is contained in and consistent with the following:

5.1 Laws

Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) (7 U.S.C. 136 et seq. (1988): Section 136r-1, Integrated Pest Management, (7 U.S.C.136r-1) (IPM Directive for Federal Agencies).

Reference pages for laws:
http://www4.law.cornell.edu/uscode/http://uscode.house.gov/search/criteria.shtml

5.2 Regulations, Executive Orders, Memoranda, Departmental Policy, National Park Service Policy

1. Department of the Interior Manual Section (517 DM1), Integrated Pest Management Policy
2. National Park Service Management Policies, 2006, Chapter 4, Section 4.4.5 (also see other sections referring to IPM as listed in Reference Manual)
3. Title 41 CFR 102-74.35, Facility Management: Occupancy Services: What Building Services Must Federal Agencies Provide?
4. *Meeting the Invasive Species Challenge, National Invasive Species Management Plan 2001*, 80 pp, National Invasive Species Council.
5. Executive Order 13148 Section 601(a), April 2000, Greening the Government Through Leadership in Environmental Management (http://www.archives.gov/federal.register).

6. Federal Register, July 19, 2000, Department of the Interior, National Park Service, Part III: Simplified Concession Contract: Revision. Department of the Interior, National Park Service, Section 6, Environmental and Cultural Protection, (g) Weed and Pest Management.
7. Executive Order 13112 of February 3, 1999, Invasive Species Management
8. Presidential Memorandum of August 2, 1979, directing Federal agencies to implement Integrated Pest Management.

5.3. Other NPS Guidance Pertaining to IPM

IPM is an integral part of the following National Park Service director's orders and guidance documents. See *RM* 77-7, *Integrated Pest Management*, for specific citations.

1. Director's Order (DO) 12 Conservation Planning, Environmental Impact Analysis, and Decision-Making
2. DO 13B, Environmental Leadership
3. DO 14, and Reference Manual 14, Natural Resource Damage Assessment
4. DO 24, Museum Collections Management
5. DO 25, Land Protection
6. DO 28, Cultural Resources Management
7. DO 30A, Damage Assessments
8. DO 30B, Solid and Hazardous Waste Management (under development)
9. DO 36, Housing Management
10. DO 48A, Concession Management
11. DO 77-1 Wetland Protection
12. DO77- 3 Domestic and Feral Livestock Management
13. DO 77-4 Use of Pharmaceuticals for Wildlife
14. DO 77- 5, Genetically Modified Organisms (draft 6/05)
15. DO 77-8, Threatened and Endangered Species
16. DO 83, Public Health
17. Reference Manual 83G, Zoonotic and Vector Borne Diseases
18. NPS Invasive Species Action Plan
19. Understanding the NPS IPM Program (NPS Concession guidance document)
20. Concession Environmental Management Program
21. NPS IPM Information Manual 1984
22. Interim Technical Guidance in Assessing Impacts and Impairment to Natural Resources
23. Sustainable Pest Management Procedures for The Vanishing Treasures Program

6. Policy

6.1. Organizational Structure

The Associate Director, Natural Resource Stewardship and Science, will appoint a Servicewide IPM Coordinator; each regional director will appoint a regional IPM coordinator; each park superintendent will appoint a park IPM coordinator. These coordinators will work together to implement the objectives of the Service's IPM Program systemwide.

6.2 Integrated Pest Management

The IPM process will be used to effectively manage all types of pest situations in all environments. Decisions concerning whether or not to manage a pest or pest population will be influenced by whether the pest is a native or nonnative species. The presence of an organism does not necessarily constitute a pest management problem; however, any organism may become a pest under certain specific circumstances. See "Pest" in the Definitions section of this Director's Order.

6.3 Integrated Pest Management Plans

The Department of the Interior (DOI) Departmental Manual (DM 517 Integrated Pest Management) directs bureaus to incorporate IPM into all DOI pest management activities including long and short term planning documents such as IPM plans, contracts, leases, and agreements. The DM 517 directs the Service to establish methods for implementing low-risk, effective pest management practices with the goal of protecting visitor and employee health, and park resources. Furthermore, this Director's Order strongly supports the development and maintenance of IPM plans to address priority pests on park lands and property.

Parks shall work with regional and Washington Office IPM Program staff and technical subject experts to incorporate IPM methods into resource management plans, and park operations (such as site, structural, landscape, fire, or other management plans and documents).

When appropriate, specific IPM plans (for a pest, a pest complex, or for a site) will be developed to provide a holistic and effective strategy for pest prevention, detection, and management. IPM plans incorporate key components required by other program areas in order to provide direction and guidance for associated programs, such as the environmental audits program. IPM Plans shall include defined monitoring procedures and responsibilities, seasonal activities for preventing pests, specific IPM methods tailored to the site, and requirements for pesticide applicators regarding use and storage in accordance with National Park Service and State regulations. Because IPM plans are dynamic documents, updates are necessary as new technology becomes available to ensure that plans contain the most current and correct information. (See *RM 77-7*, IPM Plan Development).

NPS contractors and contract specifications must also follow IPM procedures. (See *RM 77-7* for examples of contract specifications).

6.4 Native Pest Management

All native plants, animals, and associated ecological processes are generally protected on Service lands. Native organisms will be allowed to function unimpeded, except as noted below.

The Service may manage native pests in order to:

- Conserve endangered, threatened, or rare species, or unique specimens or communities;
- Preserve, maintain, or restore the historical integrity of cultural resources;
- Preserve, maintain, or restore the integrity and functions of native species and natural processes;
- Conserve and protect plants, animals, and facilities in developed areas;
- Prevent outbreaks of a pest from invading non-infested areas outside the park;
- Manage a significant hazard or threat to human health when advised to do so by the U.S. Public Health Service (which includes the Centers for Disease Control and Prevention and the NPS Public Health Program);
- Reduce or prevent a hazard to public safety.

6.5 Nonnative Pest Management

In accordance with *NPS Management Policies* and other laws and regulations, all nonnative plant and animal species may be managed to prevent loss and avoid displacement of native species. Nonnative species that are not maintained to meet an identified park purpose will be managed, up to and including eradication, if (1) control is prudent and feasible and if (2) the nonnative species:

- interferes with natural processes or the perpetuation of natural features and habitats; or
- displaces or competes with native species; or
- disrupts, impairs, or threatens the genetic integrity of native species; or
- disrupts or threatens the accurate presentation of a cultural landscape; or
- damages or threatens to damage or destroy cultural resources; or

- significantly hampers the management of a park or adjacent lands; or
- presents a significant hazard or threat to human health (as identified by the U.S. Public Health Service, which includes the Centers for Disease Control and Prevention and the NPS Public Health Program);
- presents a hazard to public safety.

7.0 Operational Procedures and Procurement

7.1 The IPM Process

The IPM process is based on communication, consensus building, understanding site objectives, science, and planning. The IPM process includes education, pest identification, record-keeping, monitoring, determination of action thresholds, assessment of available pest management tools, selection and implementation of the best management strategies in accordance with Federal, Departmental, and agency policies, post treatment evaluation of the pest situation, efficacy of chosen management strategies, and adaptive management. The IPM process is further discussed in *RM 77-7, Integrated Pest Management,* "The IPM Process for Designing and Implementing an IPM Strategy."

Pests are often symptoms of an underlying problem rather than the problem itself. It is the policy of the Service to rectify the underlying problem on order to prevent the pest from reoccurring.

IPM Tools
All IPM tools and methods have risks associated with them. The selection of the most effective, lowest-risk strategy and combination of tools is determined on a case-by-case basis, using the IPM process to best address the park's specific site objectives.

IPM tools include the following:

- Education
- Regulation
- Planning
- Cultural methods (i.e.: use of disease resistant plant cultivar)
- Mechanical methods (i.e.: installation of snap trap for indoor rodent management)
- Physical methods (i.e.: installation of hardware cloth to exclude raccoons from structures)
- Manual methods (i.e.: hand removal of annual weed prior to seed set)
- Pesticides (i.e.: chemical pesticides, also includes pheromones)
- Biological control agents
- Genetically modified organisms

See *RM 77-7, Integrated Pest Management* for discussion on different types of pest management tools and methods available for managing pests.

7.2 Proposal, Review, and Reporting Procedures

This Director's Order requires that the use of the following tools or methods on lands and properties administered by the Service be reviewed (approved / denied, and tracked) prior to use through the Pesticide Use Proposal System (PUPS):

- Pesticides with Environmental Protection Agency (EPA) registration numbers (including EPA Minimum Risk Pesticides)
- Biological control agents
- Genetically modified organisms
- Other products or substances used for their pesticidal (kill or repel) action

For further clarification see Pesticide Categories described in RM 77-7, Integrated Pest Management.

The use of EPA-reviewed products is preferred over non-EPA reviewed products when pesticide use is proposed. As reference, see the definition of pesticide under Section 3.0 Definitions above.

Pesticide Use Proposal System (PUPS)

The proposed use of pesticides, biological control agents, and genetically modified organisms can present higher risks to people, resources, and the environment than most other pest management tools. The proposed use of these tools shall be reviewed annually, prior to use and purchase, on a case-by-case basis, by the park and regional and/or Servicewide IPM Coordinator.

The review process is accomplished using PUPS where the proposal is reviewed and either approved or denied by the regional or Servicewide IPM Coordinator with discussion regarding alternative solutions. Urgent requests can be submitted by telephone or email for review to regional or Servicewide IPM coordinators. The IPM Program staff, often in conjunction with other subject matter experts, shall evaluate risks, environmental effects, cost and staffing, and other considerations relevant to the specific situation, and then make an informed decision to approve or deny the proposed action or recommend an alternative approach.

The decision to incorporate a certain pesticide, biological control agent, or genetically modified organism into a pest management strategy will be based on a determination by the designated Regional or Servicewide IPM coordinator, that it is a necessary and justifiable component of the management strategy.

A second level of review (approval or denial of the proposed use) is required by the Servicewide IPM Coordinator if the proposal involves any of the following:

- Restricted-use pesticides,
- Aquatic applications or situations in which the applied pesticide could reasonably be expected to get into aquatic areas,
- Pesticide use that might affect threatened or endangered species and/or their habitat,
- Applications to more than 400 or more contiguous acres,
- Aerial application, and/or
- New active ingredients not previously reviewed by the Servicewide IPM Coordinator.

Compliance

All proposed pest management actions must comply with pertinent laws, policies, and regulations, including those required by the National Environmental Policy Act, National Historic Preservation Act, Endangered Species Act, Migratory Bird Treaty Act, and other applicable authorities and policies. In cases where proposed management actions may affect threatened or endangered species and/or their habitat, or migratory birds, the U.S. Fish and Wildlife Service must be contacted for written consultation regarding proposed management actions. It is the responsibility of the park submitting the proposed action to complete any necessary compliance documents, such as categorical exclusions, environmental assessments, or environmental impact statements

The Service and all pesticide applicators working on lands and properties administered by the Service will abide by Federal and State laws relating to the application and reporting of pesticides. The pesticide label is the law**.** Pesticides used on Service lands and properties must be handled, used, and reported according to the pesticide label and State regulations, and in accordance with conditions provided in the approved PUP memo field. Pesticides may not be used on park lands or properties unless they have been approved through PUPS or via phone on a case-by-case basis. See *RM 77-7, Integrated Pest Management* for specific procedures on submitting pesticide use

proposals and documenting the use of pesticides, biological control agents, genetically modified organisms, and other methods used in a pesticidal fashion.

7.3 Purchase and Application of Personal-use Pesticides, Disinfectants, and Cleansers

The following materials and conditions require PUPS review and approval prior to use.

- Insect and tick repellents, bear-deterrent sprays, pesticides, and/or animal repellents purchased with government funds and applied to park residences, persons, pets, and/or livestock by park staff or contracted labor.
- All pesticides used in Service residences.

Individuals living in Service residences must contact their park IPM coordinator when pest issues arise to determine appropriate effective, low-risk pest management options. This requirement prevents potential long-term contamination, improper use, or other safety hazards on Service properties.

The following conditions are exempt and do not require PUPS review and approval:

- Use of cleansers and disinfectants.
- Use of insect repellents purchased by park employees or visitors with their own funds when applied directly to their own person, clothing, pets, and/or privately-owned livestock.
- Bear-deterrent sprays purchased by park employees or visitors with their own funds that are to be used only for personal protection.

The following conditions are prohibited.

- The application of pesticides, repellents, and disinfectants by visitors is prohibited on or around tent sites, recreational vehicles, and other areas administered by the Service.

7.4 Pharmaceuticals and Pharmaceuticals Used as Pesticides

- Pharmaceuticals proposed for pest management purposes will follow procedures in *Directors Order 77-4, Use of Pharmaceuticals for Wildlife.*
- Pesticidal use of pharmaceuticals may include use by veterinarians as defined by Federal Register Notice Volume 44, No. 213, Thursday, November 1, 1979, Pesticide Use and Production by Veterinarians, Statement of Policy on Applicability of FIFRA to Veterinarians. (See *RM 77-7, Integrated Pest Management for further discussion.*)
- Proposed use of pharmaceuticals as a pesticide shall be reviewed (approved or denied) by the Assigned Regional IPM Coordinator and the NPS Veterinarian.
- Wildlife contraceptives are exempt from PUP review.

7.5 Procurement of Pesticides, Biological Control Agents, or Genetically Modified Organisms

The directives presented in this section apply to all individuals in the Service with purchasing authority. Pesticides, biological control agents, or genetically modified organisms shall not be purchased unless they have been reviewed and approved through PUPS for use in the current year. NPS personnel are permitted to purchase only the amount of pesticide authorized for use for specific projects during the year of approval. The regional or park IPM coordinator is responsible for communicating with the appropriate purchasing or procurement officer regarding the status of the PUP request. Additional discussion is included in *RM 77-7, Integrated Pest Management.*

7.6 Pesticide Retail Sales

The sale of pesticides on National Park System lands is generally discouraged. Concessions, trusts, cooperating associations, visitor centers, bookstores, contractors, and other retail operations are discouraged from selling items that may present a risk to people or the park resources, promote pest problems, or provide pathways for pests into parks. Bird seed, animal feed, wildflower seeds, and other products that may increase pest incidence and adversely affect park resources are strongly discouraged from being sold in parks.

However, in some situations, such as in remote settings, the availability and sale of certain items such as personal-sized insect repellents would be beneficial to staff and visitors. The

superintendent may, after consultation with the retailer, concessions specialist, and the park IPM coordinator, determine whether or not it is appropriate to permit the sale of certain products that are in concert with the mission of the park and the Service.

Appropriate examples include mosquito repellents with a concentration of 35% DEET or less, or tick repellents with permethrin designed to be applied to clothing. Products such as rodenticides, "bug bombs," space sprays, herbicides, aerosolized pesticides, glue traps, and similar items are generally considered inappropriate sale items in parks. Pesticides offered for sale on park lands must adhere to the standards of the Service's IPM program.

Parks are strongly encouraged to create a review group consisting of the following individuals to review proposed pesticides for sale on park lands: the park superintendent, the park IPM coordinator, the park safety officer, a business office representative, and a representative of the U.S. Public Health Service.

7.7 Pesticide Transport, Storage, and Disposal

Pesticide storage, transport, and disposal will comply with the pesticide label, applicable laws, EPA and state regulations, and other Service policies and regulations. Pesticides will not be purchased unless they are authorized and expected to be used within one year from the date of purchase. Specific directions regarding storage and transport are provided on the individual pesticide label and must be followed. The label is the law.

Proper signage and storage requirements will be incorporated into the Park Operations Evaluations and Environmental Audit Program's inspection process to assess compliance with standards and to ensure that environmental and human health and safety issues are being addressed.

See *RM 77-7, Integrated Pest Management* for further information on the storage and disposal of pesticides. EPA governs the registration, storage, and use of pesticides. However, the Resource Conservation and Recovery Act governs the management of pesticide waste, which is addressed in the Hazardous and Solid Waste Amendments of 1984. Additional guidance is provided by the Service's Facility Management Division's Environmental Management Program's *EnviroFactSheets* that discuss pesticide storage and disposal and managing pesticides and other hazardous materials. The Service's Risk Management Program provides specifications on personal protection equipment and on the Hazardous Job Analysis Program.

8.0 Accountability: Reporting Use of Pesticides, Biological Control Agents, and Genetically Modified Organisms

The IPM Program and PUPS provide accountability and documentation regarding pest management decisions. Use of pesticides, biological control agents, and genetically modified organisms will be tracked in the PUPS database on a yearly basis. As per statute (44 U.S.C. 2107), these IPM data are submitted annually by the Servicewide IPM Program to the National Archives Records Administration. In addition, parks are required to abide by individual state reporting requirements and should maintain complete application records and use logs that can be shown to regulatory agencies in the event of a site visit. See *RM 77-7, Integrated Pest Management* for more direction on reporting.

8.1 Reporting Procedures

Except as noted above, in section 7.3 all use of pesticides, must be reported annually using PUPS. At the end of each calendar year, the Servicewide IPM Program Coordinator will issue an annual program call through the regional directors, directing parks to report the quantity of pesticides, biological control agents, and genetically modified organisms via PUPS. At that time, each park IPM coordinator will enter the amount used in the respective PUP by the appropriate project number. See *RM 77-7, Integrated Pest Management* for more direction on reporting.

All uses of biological control agents, and genetically modified organisms shall be reported to and maintained by the Regional IPM Coordinator annually until such time as the reporting forms for these uses are incorporated into the PUPS intranet system.

Unauthorized use of pesticides**,** biological control agents, and genetically modified organisms shall be entered into PUPS for documentation purposes. An explanation will be added to the pesticide use proposal memo field to explain circumstances related to the unauthorized use.

9.0 Roles and Responsibilities

9.1. Natural Resource Stewardship and Science Directorate

9.1.1. The ***Associate Director, Natural Resource Stewardship and Science*** (NRSS), is responsible for developing and issuing *RM 77-7, Integrated Pest Management*. RM 77-7 provides specific procedures and additional information by which the Service will carry out responsibilities under this Director's Order in accordance with *NPS Management Policies*. The Associate Director, NRSS, will work cooperatively with other associate directors, regional directors, offices, superintendents, and field personnel to ensure that IPM is incorporated into appropriate standard operating procedures and activities Servicewide.

9.1.2 The ***Servicewide IPM Coordinator (IPM Program Manager),*** located in the Biological Resource Management Division, is the principle leader of the Service's IPM Program and is responsible for recommending policy, providing oversight and uniformity to the IPM Program and database, managing and implementing the Servicewide IPM Program, developing and implementing IPM training, serving as Service's liaison with other Service divisions and other organizations, and reviewing second level PUPs.

Qualifications and standards for the Servicewide IPM Coordinator, Technical Assistant, and PUPS Database Manager are included in *RM 77-7, Integrated Pest Management.*

9.2 Regional Directorate

Regional directors will appoint a qualified regional IPM coordinator to ensure that the IPM program meets policy and regulatory requirements of this Director's Order. Each regional director will provide adequate support to ensure that the regional IPM coordinator attends appropriate Service policy and/or regulatory updates and technical IPM training, and maintains a state pesticide applicator certification.

9.2.1 ***Regional IPM Coordinators*** are the focal points for all pest management issues in the region. They implement the Service's IPM program on behalf of the regional director and represent the region on pest management issues. Regional coordinators serve as liaisons for other division leads at the regional level. The regional coordinator or alternate will review all pesticide use proposals and submit those requiring second-level review to the Servicewide IPM Coordinator. The regional coordinator or alternate provides consultation and makes recommendations regarding IPM procedures to field staff as needed. Qualification standards for the regional coordinator are included *RM* 77-7, *Integrated Pest Management*.

9.2.2 Park Superintendents have ultimate responsibility for the implementation of IPM in parks and will ensure adequate staffing and funding to effectively implement IPM in all divisions. Each superintendent will appoint a park IPM coordinator to investigate pest issues and serve as IPM liaison between the park staff and regional IPM coordinator. The superintendent will ensure the park IPM coordinator meets qualifications as set forth in *RM 77-7, Integrated Pest Management*.

9.2.3 Park IPM Coordinator is the key contact for pest management issues in the park. The park IPM coordinator must have a firm understanding of the principles and practices of IPM and must

be fully aware of the breadth of their responsibility within the park. The multifaceted nature of many pest management issues necessitates that the coordinator's purview not be restricted by organizational structure. As park coordinator, the individual is the focal point of all activities directly or indirectly related to pest management. Qualification standards for the park coordinator are included *RM* 77-7, *Integrated Pest Management*.

10.0 IPM and other National Park Service Program Areas

The IPM approach has been effectively used by NPS pest managers in a wide variety of disciplines since the 1970s. It has proven to be the most economical and effective way to manage pests while preserving resources and reducing risks to public health and safety. The IPM approach focuses on addressing the cause of the pest problem rather than the symptoms, resulting in an effective, long-term, low-risk solution to the pest problem. The discussions below point out how IPM can most effectively reduce risks to resources and people in each division's or office's management practices.

10.1 IPM and Environmental Compliance

IPM procedures and decisions regarding pest management at the park, region, and Servicewide levels will comply with the appropriate level of environmental review and impact analyses in accordance with the National Environmental Policy Act.

10.2 IPM and Natural Resources

IPM is an integral component of and supports natural resource management goals of preserving fundamental physical and biological processes. IPM principles will be used to protect natural resources and associated biological processes, including the management of native and nonnative animals and plants.

10.3 IPM and Cultural Resources

IPM is an integral component of and supports cultural resource management goals of preserving and protecting the integrity of cultural resources. IPM methods will be used to protect historic structures, museum collections, cultural landscapes, and museum objects from biological infestations and human or environmental conditions that foster pests. IPM procedures will be implemented in accordance with the National Historic Preservation Act.

10.4 IPM and Public Health Protection Program

IPM staff work closely with and provide support for the Service's Public Health Program when pests may serve as vectors of human disease or when associated pest management strategies present risks to the public. Public health personnel and park, regional, and Servicewide IPM coordinators will work cooperatively to detect and manage risks of public health pests, disease vectors, and associated pest management strategies in accordance with Service policy. (See *RM* 77-7, *Integrated Pest Management* for items and publications regarding IPM and public health in the National Park Service)

10.5 IPM and the Risk Management Program

The Risk Management Program recognizes health and safety hazards to pest managers, employees and the public, evaluates risks of chemical, physical, and biological agents associated with their processes, and assists in developing and implementing appropriate health risk reduction measures. IPM staff work closely with and provide support for the Service's Risk Management Program. (See *RM* 77-7, *Integrated Pest Management* for information regarding IPM and risk management.)

10.6 IPM and Concessions Management

The IPM Program works with and supports the Service's Concession Program. IPM strategies shall be incorporated into applicable concession contracts (see "Authorities" in this document) to reduce risks from pests on land and real property assigned to the concessioner that may affect the provision of quality visitor services and/or the protection of park resources. Concession staff and concessioners shall work cooperatively with IPM Program coordinators to identify and implement procedures and strategies to prevent pest occurrences and to implement effective, low-risk pest management strategies. Concession staff and concessioners shall follow the most current guidance found in "Understanding the National Park Service's Integrated Pest Management Program," which includes but is not limited to procedures that must be implemented when working with pest management contractors, requesting permission to use pesticides, and reporting on actual pesticide use. (See *RM* 77-7, *Integrated Pest Management*, "IPM for Concession Management.")

10.7 IPM and Facilities Management Division

IPM is an integral part of and supports the many different facets of facility management. The IPM process will prevent, detect, and manage risks from pests and associated management strategies. In order to protect resources and reduce risks and maintenance costs, the IPM process shall be incorporated into planning, design, and cyclic maintenance schedules of structures and landscapes, *EnviroCheckSheets*, housing operating procedures, facility and landscape maintenance procedures, and rights-of-way and transportation corridor management procedures. (See *RM* 77-7, *Integrated Pest Management* for references to *EnviroCheckSheets* and other items regarding IPM and the Facilities Management Program.)

10.8 IPM and Park Housing

IPM is an integral part of and supports the Service's Housing Program. IPM concepts shall be incorporated into Service housing agreements and rental contracts in order to educate occupants, prevent conditions conducive to pests, and ensure that pests are managed using the Service's IPM approach. (See *RM* 77-7, *Integrated Pest Management*, regarding IPM protocols in Service housing.) Housing specialists and IPM Program coordinators will work cooperatively to identify and implement procedures and strategies that prevent pest occurrences and conditions conducive to pests, reduce risks from pests and related pest management strategies, and implement effective, low-risk pest management strategies.

10.9 IPM and Design and Construction

IPM concepts shall be incorporated into the planning, design, and construction projects, for new, recreated, and restoration projects, in order to prevent conditions conducive to pests and to detect and manage risks from pests and pest-related management strategies. (See *RM* 77-7, *Integrated Pest Management* regarding contract specifications, etc.)

End of Director's Order

Federal Insecticide, Fungicide, and Rodenticide Act

The current version of FIFRA is found in the Act of 2008. Its current verbatim length of 109 pages is made available at the website:
http://agriculture.senate.gov/Legislation/Compilations/Fifra/FIFRA.pdf

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Cooperative Forestry Assistance Act of 1978 (Section 5), as amended

TITLE V--HEALTHY FORESTS RESERVE PROGRAM
SEC. 501. ESTABLISHMENT OF HEALTHY FORESTS RESERVE PROGRAM.

(a) ESTABLISHMENT- The Secretary of Agriculture shall establish the healthy forests reserve program for the purpose of restoring and enhancing forest ecosystems--
(1) to promote the recovery of threatened and endangered species;
(2) to improve biodiversity; and
(3) to enhance carbon sequestration.

(b) COORDINATION- The Secretary of Agriculture shall carry out the healthy forests reserve program in coordination with the Secretary of the Interior and the Secretary of Commerce.

SEC. 502. ELIGIBILITY AND ENROLLMENT OF LANDS IN PROGRAM.

(a) IN GENERAL- The Secretary of Agriculture, in coordination with the Secretary of the Interior and the Secretary of Commerce, shall describe and define forest ecosystems that are eligible for enrollment in the healthy forests reserve program.

(b) ELIGIBILITY- To be eligible for enrollment in the healthy forests reserve program, land shall be--
(1) private land the enrollment of which will restore, enhance, or otherwise measurably increase the likelihood of recovery of a species listed as endangered or threatened under section 4 of the Endangered Species Act of 1973 (16 U.S.C. 1533); and
(2) private land the enrollment of which will restore, enhance, or otherwise measurably improve the well-being of species that--
(A) are not listed as endangered or threatened under section 4 of the Endangered Species Act of 1973 (16 U.S.C. 1533); but
(B) are candidates for such listing, State-listed species, or special concern species.

(c) OTHER CONSIDERATIONS- In enrolling land that satisfies the criteria under subsection (b), the Secretary of Agriculture shall give additional consideration to land the enrollment of which will--
(1) improve biological diversity; and
(2) increase carbon sequestration.

(d) ENROLLMENT BY WILLING OWNERS- The Secretary of Agriculture shall enroll land in the healthy forests reserve program only with the consent of the owner of the land.

(e) MAXIMUM ENROLLMENT- The total number of acres enrolled in the healthy forests reserve program shall not exceed 2,000,000 acres.

(f) METHODS OF ENROLLMENT-
(1) IN GENERAL- Land may be enrolled in the healthy forests reserve program in accordance with--
(A) a 10-year cost-share agreement;
(B) a 30-year easement; or
(C) an easement of not more than 99 years.
(2) PROPORTION- The extent to which each enrollment method is used shall be based on the approximate proportion of owner interest expressed in that method in comparison to the other methods.

(g) ENROLLMENT PRIORITY-

(1) SPECIES- The Secretary of Agriculture shall give priority to the enrollment of land that provides the greatest conservation benefit to--
(A) primarily, species listed as endangered or threatened under section 4 of the Endangered Species Act of 1973 (16 U.S.C. 1533); and
(B) secondarily, species that--
(i) are not listed as endangered or threatened under section 4 of the Endangered Species Act of 1973 (16 U.S.C. 1533); but
(ii) are candidates for such listing, State-listed species, or special concern species.
(2) COST-EFFECTIVENESS- The Secretary of Agriculture shall also consider the cost-effectiveness of each agreement or easement, and associated restoration plans, so as to maximize the environmental benefits per dollar expended.

SEC. 503. RESTORATION PLANS.

(a) IN GENERAL- Land enrolled in the healthy forests reserve program shall be subject to a restoration plan, to be developed jointly by the landowner and the Secretary of Agriculture, in coordination with the Secretary of Interior.

(b) PRACTICES- The restoration plan shall require such restoration practices as are necessary to restore and enhance habitat for--
(1) species listed as endangered or threatened under section 4 of the Endangered Species Act of 1973 (16 U.S.C. 1533); and
(2) animal or plant species before the species reach threatened or endangered status, such as candidate, State-listed species, and special concern species.

SEC. 504. FINANCIAL ASSISTANCE.

(a) EASEMENTS OF NOT MORE THAN 99 YEARS- In the case of land enrolled in the healthy forests reserve program using an easement of not more than 99 years described in section 502(f)(1)(C), the Secretary of Agriculture shall pay the owner of the land an amount equal to not less than 75 percent, nor more than 100 percent, of (as determined by the Secretary)--
(1) the fair market value of the enrolled land during the period the land is subject to the easement, less the fair market value of the land encumbered by the easement; and
(2) the actual costs of the approved conservation practices or the average cost of approved practices carried out on the land during the period in which the land is subject to the easement.

(b) 30-YEAR EASEMENT- In the case of land enrolled in the healthy forests reserve program using a 30-year easement, the Secretary of Agriculture shall pay the owner of the land an amount equal to not more than (as determined by the Secretary)--
(1) 75 percent of the fair market value of the land, less the fair market value of the land encumbered by the easement; and
(2) 75 percent of the actual costs of the approved conservation practices or 75 percent of the average cost of approved practices.

(c) 10-YEAR AGREEMENT- In the case of land enrolled in the healthy forests reserve program using a 10-year cost-share agreement, the Secretary of Agriculture shall pay the owner of the land an amount equal to not more than (as determined by the Secretary)--
(1) 50 percent of the actual costs of the approved conservation practices; or
(2) 50 percent of the average cost of approved practices.

(d) ACCEPTANCE OF CONTRIBUTIONS- The Secretary of Agriculture may accept and use contributions of non-Federal funds to make payments under this section.

SEC. 505. TECHNICAL ASSISTANCE.

(a) IN GENERAL- The Secretary of Agriculture shall provide landowners with technical assistance to assist the owners in complying with the terms of plans (as included in agreements or easements) under the healthy forests reserve program.

(b) TECHNICAL SERVICE PROVIDERS- The Secretary of Agriculture may request the services of, and enter into cooperative agreements with, individuals or entities certified as technical service providers under section 1242 of the Food Security Act of 1985 (16 U.S.C. 3842), to assist the Secretary in providing technical assistance necessary to develop and implement the healthy forests reserve program.

SEC. 506. PROTECTIONS AND MEASURES

(a) PROTECTIONS- In the case of a landowner that enrolls land in the program and whose conservation activities result in a net conservation benefit for listed, candidate, or other species, the Secretary of Agriculture shall make available to the landowner safe harbor or similar assurances and protection under--
(1) section 7(b)(4) of the Endangered Species Act of 1973 (16 U.S.C. 1536(b)(4)); or
(2) section 10(a)(1) of that Act (16 U.S.C. 1539(a)(1)).

(b) MEASURES- If protection under subsection (a) requires the taking of measures that are in addition to the measures covered by the applicable restoration plan agreed to under section 503, the cost of the additional measures, as well as the cost of any permit, shall be considered part of the restoration plan for purposes of financial assistance under section 504.

SEC. 507. INVOLVEMENT BY OTHER AGENCIES AND ORGANIZATIONS.

In carrying out this title, the Secretary of Agriculture may consult with--
(1) nonindustrial private forest landowners;
(2) other Federal agencies;
(3) State fish and wildlife agencies;
(4) State forestry agencies;
(5) State environmental quality agencies;
(6) other State conservation agencies; and
(7) nonprofit conservation organizations.

SEC. 508. AUTHORIZATION OF APPROPRIATIONS.

There are authorized to be appropriated to carry out this title--
(1) $25,000,000 for fiscal year 2004; and
(2) such sums as are necessary for each of fiscal years 2005 through 2008.

Inter-agency Agreement

Title: Agreement Between The United States Department of Agriculture and The United States Department Of The Interior for the Conduct of Forest Insect and Disease Management On Lands Administered By The U.S. Department Of The Interior

[The Agreement became effective in 1983 and has not been superseded.]

AGREEMENT
between the
UNITED STATES DEPARTMENT OF AGRICULTURE

and the
UNITED STATES DEPARTMENT OF THE INTERIOR
for the
CONDUCT OF FOREST INSECT AND DISEASE MANAGEMENT
ON LANDS ADMINISTERED BY
THE U.S. DEPARTMENT OF THE INTERIOR

Prevention and suppression of damaging forest insect and disease outbreaks are essential for maintaining the health and productivity of the Nation's forests. Annually, insects and diseases kill more trees and reduce forest growth more than all other destructive agents combined. This is a matter o f great concern to the administrators responsible for managing and protecting forests on public and private lands.

Section 5 of the Cooperative Forestry Assistance Act o f 1978 (Public Law 95-313) authorizes the Secretary of Agriculture to protect trees and forests, wood products, stored wood, and wood in use from insects and diseases. This is done directly on National Forest System lands, and in cooperation with other Federal land managing agencies, the States, and private owners on other forest lands. The Secretary of Agriculture has delegated the responsibility for carrying out the provisions of the Act to the Forest Service. To do this, annual appropriations are made based on estimated control costs developed by the Forest Service, the Department of the Interior States, and other cooperating agencies.

Insect and disease outbreaks often encompass Federal, State, and private ownerships. For this reason, well coordinated prevention and suppression programs are necessary to achieve a variety of land management objectives. It is essential that the Departments of the Interior and Agriculture agree to cooperate fully t o prevent and suppress damaging forest insect and disease outbreaks in order to meet resource management objectives and the intent of Public Law 95-313. Therefore, it is mutually agreed:

1. That the two Departments will, under the legal, fiscal , and other limitations governing each, cooperate fully in the planning, coordination, and execution of field operations to prevent and suppress damaging forest insect and disease outbreaks wherever it is determined to be necessary.

2. That the guiding principles of this cooperation shall be those established by authorizing legislation, agency policy, and other direction specified in the Cooperative Forestry Assistance Act, the National Environmental Policy Act, and the Federal Insecticide, Fungicide, and Rodenticide Act, as amended.

3. That the Secretaries of the Department o f the Interior and the Department of Agriculture shall authorize their respective agencies concerned with the prevention and suppression of forest insects and diseases to develop and execute coordinated work programs and projects.

4. That, for carrying out forest insect and disease prevention and suppression programs and projects, responsible field officers of both Departments may enter into agreements with one another within the following framework:

a. Responsibilities o f the Department of Agriculture (to be carried out by the Forest service):

(1) Provide overall leadership and coordination for insect and disease prevention and suppression activities on all forest lands when the activities are financed wholly or in part with Federal funds.

(2) To the extent possible, provide technical and financial assistance to agencies of the Department of the Interior for prevention and suppression projects and programs on forest lands administered by the Department o f the Interior.

(3) Conduct detection surveys and biological evaluations of insect and disease outbreaks on forest lands administered by the Department of the Interior.

(4) Within budgetary limitations, annually transfer to the Department of the Interior such amounts of the USDA Forest Service, Forest Pest Management budget that are mutually determined to be necessary for insect and disease prevention and suppression work on forest lands administered by the Department of the Interior. To the extent possible, determine annual prevention and suppression needs by October 15.

(5) Assist agencies of the Department of the Interior in organizing and performing general insect and disease field surveillance on forest lands administered by the Department of the Interior.

(6) Inform local and national Department of the Interior personnel of forest Insect and disease conditions on other ownerships that may affect lands administered by the Department of the Interior.

(7) Prevent and suppress insect and disease outbreaks on the National Forests and cooperate with other agencies t o prevent and suppress Insect and disease outbreaks which threaten forests lands administered by the Department of the Interior.

(8) Train key Department of the Interior employees in techniques for the prevention, detection, and suppression of destructive forest insects and diseases.

(9) Assist Department of the Interior personnel in identifying new opportunities for incorporating the principles of integrated pest management in resource management decisions and programs.

b. Responsibilities of agencies of the Department of the Interior (to be coordinated by the Bureau of Land Management):

(1) Notify field units that technical assistance is available from the Forest Service and that biological evaluations are required before forest insect and disease prevention or suppression projects can be funded by the Forest Service.

(2) Facilitate detection surveys and forest insect and disease evaluations made by the Forest Service on lands administered by the Department of the Interior .

(3) Decide for or against control action on the basis o f resource management objectives, biological effectiveness, environmental acceptability , and an analysis of economic efficiency . Control decisions will be based on:

(a) An appraisal of both current pest infestation significance and projected significance with and without prevention or suppression activities. This information, as well as a discussion of alternative pest management tactics, is provided by FS pest management specialists in the biological evaluation.

(b) An evaluation o f the resources threatened within the context of management objectives.

(c) An analysis of possible adverse environmental effects of control tactic alternatives.

(d) An economic analysis of the proposed action.

(e) A forest stand pest risk evaluation (pertains only to prevention projects).

(4) Perform field surveillance and specialized detection surveys as necessary to supplement Forest Service efforts .

(5) Conduct prevention and suppression activities on lands administered by the Department of the Interior.

(6) Report prevention and suppression project accomplishments to the Forest Service by November 15 each year covering all forest pest management expenditures for the previous fiscal year.

(7) Cooperate with other agencies on adjacent or intermingled lands on Insect and disease surveillance, prevention, and suppression activities.

(8) Submit formal request for proposed needs to USDA Forest Service by October 1 of each year. The Bureau o f Land Management, acting as coordinator for the U.S. Department of the Interior, will collect and analyze the proposed needs for the Department to assure that the proposals are biologically sound, environmentally acceptable, and cost-effective .
This Agreement supersedes the Agreement for the Conduct of Forest Insect and Disease Surveys and Control which was approved by the Acting Assistant - Secretary for Land and Water Resources f o r the U.S. Department of the Interior on August 18, 1978, and the Assistant Secretary for the U.S. Department of Agriculture on August 31, 1978.

This Agreement is effective upon the date of approval and shall continue in effect until 30 days after written notice of a desire to terminate by either of the signatories.

Interim & Immediate Recommendations for Preventing Spread of Invasive Forest Pests

United States Department of the Interior
NATIONAL PARK SERVICE
Biological Resource Management Division
1201 Oakridge Drive, Suite 200
Fort Collins, CO 80525

IN REPLY REFER TO:
N1617 (BRMD)

October 29, 2009

Memorandum

To: Associate Regional Directors, Natural Resource Stewardship and Science
Regional Chiefs of Natural Resource Management

From: Acting Chief, Biological Resources Management Division, NRPC, NRSS
10/30/09

Subject: Healthy NPS Forests: Interim and Immediate Recommendations for Preventing the Spread of Invasive Forest Pests

Many parks are facing a serious and worsening threat to forested lands from invasive nonnative pests. According to research conducted by the US Department of Agriculture (USDA) Animal and Plant Health Inspection Service (APHIS) and the US Geological Survey (USGS), the movement of firewood from infested areas to non-infested areas is a significant mechanism for the spread of disease pathogens and invasive forest insects.

Invasive forest pests adversely affect natural ecosystems, cultural landscapes, local economies, and visitors' recreational experiences. Some non-native forest pests that can be spread via firewood include the emerald ash borer, Asian longhorned beetle, beech bark disease, Dutch elm disease, gypsy moth, hemlock wooly adelgid, oak wilt, and sudden oak death. Effective pest management treatments are limited therefore, education, early detection, and prevention are critical as are pest-specific monitoring protocols and rapid response strategies.

The National Park Service (NPS) is focusing interim recommendations on firewood as it is the primary means by which these pests are moved. Specific management strategies for invasive forest pests are noted in Attachment A. There is no nationwide NPS policy on the management of firewood in parks; however, the WASO Integrated Pest Management Coordinator (IPM) is preparing guidance documents that will summarize current regulations and recommendations for park managers to address risks from firewood pests. The document will include references to park specific efforts and regulations and will be posted on the IPM website http://www1.nrintra.nps.gov/BRMD/ipm/. This memo provides interim recommendations to assist parks until the guidance document is completed early in the new calendar year (2010). Please share this with your Park Facilities and Concession Management staff. We hope this information is helpful until such time as we have completed additional

guidance. If you would like additional assistance, please contact Carol DiSalvo, Servicewide IPM Coordinator, at (202) 513-7183.

Interim Recommendations for Preventing the Spread of Invasive Forest Pests:

- **Monitor forest health conditions.** Early detection of new invasive forest pests within a park is critical to the success of control efforts. Regional IPM Coordinators can provide technical assistance with monitoring techniques and protocols.
- **Consult state quarantine maps and regulations regularly**. Park and Regional IPM Coordinators should contact local U.S. Forest Service Offices and State Forest Health Program Offices to find out what firewood quarantines are in effect both locally and in neighboring states.
- **Educate park concessioners, employees and visitors.** The NPS protects over 22 million acres of forest lands, many with campgrounds. Outreach and informational materials should be used to make the public aware of the importance of inspecting vehicles and camping equipment before leaving home and of using firewood only from sources known to be "pest free" as per state regulations.
- **Assess the risk of introducing invasive insects and diseases via firewood.** Analyze the origin of park visitors, locations that sell firewood and their sources of origination, consider reviewing uses of firewood in the park. Information and data from the APHIS Campground Reservation Risk Analysis Files is provided in Attachment C. This data derived from the National Recreation Reservation System (NRRS) database provides risk analysis reports for participating campgrounds.
- **If the park is in a quarantined area, review the quarantine requirements, and re-evaluate current use of firewood.** If aquarantine is in effect, parks must abide by the quarantine and control firewood use pursuant to the superintendent's authority. This control could include: continued employee and visitor education; allowing only concession-sold firewood certified as pest free, or allowing only firewood that has been certified as originating from a non-quarantined area; providing campers and/or concessioners with firewood from hazardous trees removed from within the park; and inspection of vehicles at entrance gates and confiscation and destruction of firewood brought in by visitors.
- **Submit a proposal to obtain assistance in managing forest pests.** The USFS Forest Health Program provides parks with an annual funding opportunity through the Forest Health Program, Insect and Disease Suppression funds. The call for NPS forest health protection proposals is announced each year in August.

Attachments:
A) Links to Technical Information
B). Information on the Zip Code Project

Attachment A: Links to Technical Information

USDA APHIS
APHIS provides research, detection, and containment of forest insects and other invasive pests. APHIS Plant Protection and Quarantine Officers use interstate quarantines to educate the public and regulate pests that can be transported in on firewood.

APHIS publications: http://www.aphis.usda.gov/publications/plant_health/
APHIS Invasive Species Fact Sheet:
http://www.aphis.usda.gov/publications/plant_health/content/printable_version/fs_invspec_forest_health.pdf
The Northeast Forest Pest Outreach and Survey Project:
http://www.aphis.usda.gov/APHIS_News_4States/2009/September/index.html

US Forest Service (USFS)
The U.S. Forest Service (USFS) provides assistance and insect and disease suppression funds to parks through the Forest Health Protection Program. Regional USFS field offices provide technical assistance and funding for parks in preventing, detecting and managing forest pests. The NPS regional IPM Coordinators serve as liaisons between parks and local U.S. Forest Service field offices by coordinating regional efforts, technical assistance, and policy interpretation on forest pest issues.

FS Forest Health Protection Program publications:
http://www.fs.fed.us/foresthealth/publications.shtml

Species Specific Links:
Gypsy moth: http://na.fs.fed.us/fhp/gm/index.shtm
Emerald ash borer National web site: http://www.emeraldashborer.info/
http://www.emeraldashborer.info/firewood.cfm
Asian longhorned beetle information: http://www.na.fs.fed.us/fhp/alb/albvideo/albvideo.shtm
Sudden oak death pest alert: http://www.na.fs.fed.us/SOD/

Attachment B: The Zip Code Project (Campground Reservation Risk Analysis)

When campers make reservations for campgrounds on federally operated lands they use the National Recreation Reservation System (NRSS at "Recreation.gov" website). APHIS, in cooperation with NRRS, collected and analyzed zip code data from campers with detections of invasive forest pests found in campgrounds. APHIS and the states have used this data to focus public outreach efforts and assist in the prevention and movement of infested firewood.

Availability of Campground Reservation Risk Analysis Files
Pest risk analysis reports derived from the National Recreation Reservation System (NRRS) database are now available through ftp site:

ftp://campsitedata:camp2009@ftp.aphis.usda.gov

The ftp site contains 2008 data that was analyzed showing numbers of visitors and visitor nights with origins within the quarantine boundaries for emerald ash borer (EAB), European gypsy moth (GM), Asian longhorned beetle (ALHB), and pine shoot beetle (PSB), for various campground destinations. Not all National Park campgrounds are included in the NRRS database as some locations use alternate reservation systems or don't process reservations on-line.

The ftp link will allow access, by both internal and external users, to the data files through their browser without compromising the security of the APHIS servers. Users can copy files to their own computers, if they wish. This information can be shared with state and federal cooperators and others who may find the information valuable.

Report files are organized by destination state of the travelers/campers. The reports list the percentage of electronic reservations for each federally-owned campground that originated from quarantined areas (based upon zip codes) for emerald ash borer (EAB), Asian longhorned beetle (ALB), gypsy moth (GM), and pine shoot beetle (PSB). This information is intended to provide an indication of relative risk for transporting firewood or other items that may contain forest pests of concern, and may be useful for planning early detection surveys.

The reports are revised or updated whenever a change in quarantine boundaries is published for the pest species included in the analysis summary. The reports currently cover reservations made between February 2003 and February 2008. APHIS is in the process of obtaining additional campground reservation data for the remainder of 2008 and will incorporate that information into the reports as it becomes available. The analysis reports were generated by the Data & Risk Management staff of the USDA-APHIS-PPQ Western Regional Office and include reports for both eastern and western states within the continental United States for which data was available in the NRRS database.

Environmental Impact Issues and NEPA Compliance

Refer to Director's Order 12 and its set of supporting documents. These can be found at http://home.nps.gov/applications/npspolicy/DOrders.cfm .

Cultural Resources Management

Refer to Director's Order 28 and its set of supporting documents. These can be found at http://home.nps.gov/applications/npspolicy/DOrders.cfm .

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Appendix E – Native Tree Species Characteristics

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Picture Keys to Common Trees and their Leaves (web links)

Common Trees of Ohio http://www.oplin.org/tree/index.html

Leaf Guide for VA Trees http://www.fw.vt.edu/dendro/forsite/key/intro.htm

Trees of VA http://www.vsu.edu/docs/bryant/commonforesttreesinvabrown.ppt

Trees of PA http://www.dcnr.state.pa.us/forestry/commontr

Vegetative Characteristics

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Vegetative Characteristics

The following tables are intended for the planning of restoration projects subsequent to natural or human-caused forest damage. They may also be useful in planning supplemental plantings prior to such occurrences where stand component and structural diversity are desirable.

Table Appendix E-1. Silvical characteristics[a] and values of several Central Appalachian hardwood tree species.

Adapted from Miller, Gary W., and James N. Kochenderfer. 1998. *Journal of Forestry* (96:7); "Maintaining species diversity in the Central Appalachians." Society of American Foresters, Bethesda, MD. P. 29.

Shade tolerance	Seed longevity	Seed periodicity	Seeding tree age	Primary regeneration mechanism: Seeds	Advanced seedlings	Sprouts	Relative wildlife food value[c]
	. . . . . years						
Very intolerant							
Black locust	Several	1-2	6			x[d]	14
Intolerant							
Black cherry	3	1-5	10	x	x	x	96
Yellow poplar	8	1	15	x		x	14
Hickories	1	1-3	25-40		x		23
Intermediate							
White ash	3	3-5	20	x	x	x	22
Sweet birch	1	1-2	40	x	x		41
White oak	0	4-10	20		x	x[e]	100
Red oak	0	2-5	25		x	x[e]	100
Chestnut oak	0	4-5	20		x	x[e]	100
Tolerant							
Red maple	1	1	4	x	x	x	51
Very tolerant							
Sugar maple	2	2-5	40		x		51
American beech	1	2-8	40			x[d]	46

[a] *From Trimble and Tryon 1967; Trimble 1975; Beck 1988; Kelty 1988; Burns and Honkala 1990.*
[b]
[c] *Value relative to oaks computed from Martin et al., 1951.*
[d] *Sprouts from wounded roots and root suckers.*
[e] *Oak sprouting becomes more important as site index declines.*

Table Appendix E-2. Trees, shrubs, and vines commonly found in Eastern forests of the U.S. with wildlife habitat and food values.

Adapted from Burns and Honkala, 1990, and Sherrill and Brittingham, 2001.

Latin Names	Common Names	Wildlife Values & Comments
--- Trees ---		
Abies balsamea	Balsam fir	Seeds eaten by finches, late spring to fall; nesting for mourning doves, robins, and others; cover; 40-60' tall; very shade tolerant; subject to many pests & diseases
Acer pennsyvanicum	Striped maple	Seeds eaten by birds and mammals in fall; 10-45' tall; grows well in shade and poorly in open sun
Acer rubrum	Red maple	Seeds eaten by birds and mammals in spring to early summer; very productive; 60-90' tall; shade tolerant
Acer saccharinum	Silver maple	Seeds eaten by birds and mammals spring to early summer; 90-120' tall; seeds can germinate immediately; shade intolerant
Acer saccharum	Sugar maple	Seeds eaten by birds and mammals in fall; 90-120' tall; very shade tolerant
Ailanthus altissima X[7]	Tree of heaven	– Invasive; do not plant or allow this tree to grow; it quickly dominates site and exhibit allelopathic control
Amelanchier spp.	Serviceberry	Fruit eaten by robins, cedar waxwings, rose-breasted grosbeaks, and other birds and mammals in early summer; 30' tall
Betula lenta and others	Black birch and others	Catkins eaten by birds; yellow birch seeds eaten by goldfinches, juncos, chickadees late summer to fall; foliage by browsers in spring and summer; nest sites; 40-70'
Carya cordiformis	Bitternut hickory	Nuts eaten by mammals fall to winter; nest sites; 80-100' tall; shade intolerant; can tolerate higher soil moistures than other hickories
Carya glabra	Pignut hickory	Nuts eaten by mammals fall to winter; nest sites; 80-90' tall; intermediate shade tolerance
Carya tomentosa	Mockernut hickory	Nuts eaten by mammals fall to winter; nest sites; 80-100' tall; shade intolerant
Celtis occidentalis	Hackberry	Fruit attracts many birds, including cedar waxwings, flickers, cardinals, and robins fall to spring; 30-60'; intermediate shade tolerance
Cornus alternifolia and others	Alternate-leaved dogwood	Fruit and cover for wildlife; 5-15' tall
Cornus florida	Flowering dogwood	Fruit eaten by many birds including cedar waxwings, catbirds, and robins in fall; 40' tall; very shade tolerant
Crataegus spp.	Hawthorn	Fruit eaten by cedar waxwings, fox sparrows, small mammals, deer fall to spring; good nest sites; 25' tall
Diospyros virginiana	Persimmon	Fruit eaten by many birds and mammals late summer to winter; 50' tall
Fagus grandifolia	American beech	Excellent food source for birds and mammals, available fall to winter; nest and den sites; 70' tall; very shade tolerant
Fraxinus americana	White ash	Seeds eaten by birds, black bears, and small mammals fall to winter; 80-90' tall; shade tolerant seedling becoming shade intolerant tree; a pioneer species

[7] X = Exotic (nonnative)

Hamamelis virginiana	Witch hazel	
Ilex opaca	American holly	Fruit draws songbirds, ruffed grouse, and deer late summer to spring; nest sites; cover; 30’ tall; very shade tolerant but fire intolerant
Ilex verticillata	Winterberry	Winter food source; 10’ tall
Juglans cinerea	Butternut	Nuts eat by mammals fall to winter; cover; 90’ tall; shade intolerant
Juglans nigra	Black walnut	Nuts eat by mammals fall to winter; cover; 100-120’ tall; shade intolerant
Juniperus virginiana	Eastern red cedar	Berries eaten by birds and mammals fall to spring; nest sites and cover; 40’ tall; shade intolerant; fire intolerant; relatively free of insect and disease
Liriodendron tulipifera	Yellow-poplar	Seeds available in fall; nest sites; 100-200’ tall depending on site quality; shade intolerant but can rapidly grow to overcome competition; it is unusually free of damage by pests
Morus rubra	Red mulberry	Fruit eaten by many birds and mammals in summer; 60’ tall; shade tolerant
Nyssa sylvatica	Black & swamp tupelos	Fruit attracts many mammals and birds; 100’ tall; black tupelo is shade tolerant while swamp tupelo is shade intolerant; both are fire intolerant
Paulownia tomentosa	Paulownia / princess tree	– Invasive; do not plant or allow this tree to grow
Pinus echinata	Shortleaf pine	Seeds available every 3-to-10 years in fall and winter; 60-130’ tall; shade intolerant; attacked by southern pine beetle and Ips beetle
Pinus rigida	Pitch pine	Seeds available every other year in fall and winter; 80-100’ tall; shade intolerant; subject to windstorm and ice storm damage; many insect problems
Pinus strobus	Eastern white pine	Seeds eaten by birds fall to winter; nest sites and cover; 100’ tall; intermediate shade tolerance; many insect and disease problems, notably the invasive white pine blister rust
Pinus virginiana	Virginia pine	Seeds available every third year or so in fall and winter; 50-75’ tall; shade intolerant
Platanus occidentalis	Sycamore	70-170’ tall depending on site and competition; intermediate shade tolerance; subject to anthracnose but generally free of pest mortality problems
Prunus serotina	Black cherry	Fruit eaten by variety of birds and mammals, summer to fall, leaves eaten by larval moths; 60’ tall; shade intolerant and fast growing; subject to many pest and disease maladies
Prunus virginiana	Chokecherry	Fruit eaten by Eastern bluebirds, grouse, mammals late summer; butterfly larvae feed on foliage; 30’ tall
Quercus alba	White oak	Very important food source for birds, mammals, and insects late summer to fall; nest sites; 100’ tall; intermediate- to shade tolerant; many insect and disease maladies
Quercus prinus	Chestnut oak	Similar characteristics to *Q. alba* but 65-80’ tall; intermediate shade tolerant
Quercus rubra	Northern red oak	Similar characteristics to *Q. alba* but 65-90’ tall; intermediate shade tolerant
Quercus velutina	Black oak	Similar characteristics to *Q. alba* but 60-80’ tall; intermediate shade tolerant

Robinia pseudoacacia	Black locust	Original range was PA to AL, and MO, AR, and OK, but now considered invasive elsewhere; 40-60' tall; very shade intolerant; is severely damaged by insects and diseases, more so than other hardwoods
Sassafras albidum	Sassafras	Fruit available in late summer; shrub-size to large tree; shade intolerant; fire intolerant
Tilia americana	American basswood	Flowers important to pollinators, fruit important to mammals, available in fall; 70-130' tall; intermediate shade tolerance but vigorous root sprouting keeps species in forest system
Tsuga canadensis	Eastern hemlock	Seeds eaten by birds and small mammals fall to winter; nest sites and cover; 70-160' tall; the most shade tolerant of all tree species; many pest problems, now notably the invasive hemlock woolly adelgid
Ulmus americana	American elm	Seeds eaten by birds and mammals; 90-125' tall; intermediate shade tolerance; subject to Dutch elm disease mortality
--- **Shrubs/Plants** ---		
Kalmia latifolia	Mountain laurel	Foliage and bark is toxic to domestic livestock; moderate cover; 10-25' tall; intermediate shade tolerance
Laportea canadensis	Wood nettle	2-3' tall
Lindera benzoin	Spice bush	Fruit eaten by wood thrush, veery, and other fall migrants in late summer; spicebush swallowtail feeds on leaves; 12' tall
Rhus typhina	Staghorn sumac	Fruit persists through winter and is an important emergency food for a variety of birds in early spring; 15' tall
Rubus spp.	Blackberry, raspberry	Fruit eaten by many birds and mammals in early- to late summer; nest sites; cover; 6' tall
Sambucus canadensis	Elderberry	Fruit in late summer; cover and nest sites for many birds, including robins and catbirds; 10+' tall
Symphoricarpos orbiculatus	Coralberry	Hummingbirds attracted to nectar; fruit eaten by songbirds and gamebirds fall to spring; nest sites; cover; 6' tall
Vaccinium spp.	Blueberries	Fruit eaten by many species summer to fall, including orchard orioles, eastern bluebirds, grouse, black bear, and small mammals; 12' tall
Viburnum spp.	Viburnums	Fruit and cover for wildlife, particularly in late summer and during fall migration; 10' tall
--- **Vines** ---		
Parthenocissus quinquefolia	Virginia creeper	Fruit for birds and small mammals late summer to spring; cover; climbing 30-50'
Smilax rotundifolia	Green briar	Low food value; poor cover
Vitis spp.	Wild grapes	Fruit eaten by birds and small mammals late summer to fall; nest sites; cover; high climber

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Appendix F – Emergency Action Procedure Checklist

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Emergency Action Procedure Checklist

Table Appendix-F-1. Forest Insect Pest and Pathogen Emergency Response Plan for Units of the National Park System Containing Eastern Forests.

☐ **Assess, diagnose and prescribe** – (Dichotomous Key p. vii, Appendix C, and Section 2.3.3)

1 - When assessing and diagnosing a forest insect pest and pathogen problem, focus on the following issues:
- Which pest and disease species are involved? (Get details)
- Which host species are being harmed? (Describe them)
- What surrounding environmental issues may be coming into play?
- Is the threatened area accessible? (Note the challenges)

2 - When prescribing, address both immediate and long-term health issues. Develop alternatives.

☐ **Review Integrated Pest Management concepts** – (Table 1.2 and Appendix D -11)

☐ **Review environmental (NEPA) clearance process** – (Review DO-12)

☐ **Concurrent with NEPA consideration, review cultural issues for National Historic Preservation Act (NHPA) Section 106 clearance process** – (Review DO-28)

☐ **Emergency Response Check-list** – (detail in Section 2.3 and Table 2.3.5)

1 - Inform people on your contact list of the developing problem
2 - Conduct a field meeting to assess and prescribe
- Include park ID team and USDA-Forest Service

3 - Consider measures to isolate or exclude the problem from other sites
4 - Initiate the NEPA process and manage public relations
5 - Contact USDA-FS
- Re: biological evaluation content and completion date
- Re: their support of the project

6 - Prepare a project proposal package
- Form FS-3400-2 (Appendix A - 3)
- Project description
- Biological evaluation
- NEPA documentation

7 - Submit the project proposal
- To NPS-Region or NPS-WASO as prearranged

8 - Contact NPS Region
- Re: their support of project; approximate decision date

9 - Prepare for field treatments
- Will work be done in-house, contract, or collaborative?

10 - Contact NPS Region
- Get pesticide use approval via PUPS
- Confirm approximate funding transfer date

--- (continued) ---

--- (continued) ---

11 - Enact field treatments

Confirm receipt of project funds
Confirm NEPA compliance completion
Receive go-ahead from Superintendent to proceed
Mobilize the incident command team
Enact public relations plan (through IC Team)
Begin field treatments
Conduct periodic treatment monitoring

12 - Gather project notes and photographs.

☐ **Keep Project Reporting in Mind**

(Use treatment monitoring data and project notes for reporting.)

1 - Submit USDA-Forest Service form "Accomplishment & Expenditures Report" to NPS-Region by mid-September via NPS-WASO annual request – (Appendix A - 5)

2 - Submit NPS on-line project reporting.

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