MAINE FOREST SERVICE
ENTOMOLOGY LABORATORY

# Spruce & Fir

## Forest Health Concerns

## Primary Insect Concerns in Spruce and Fir Silviculture

- Spruce Budworm
- Hemlock Looper
- Balsam Woolly Adelgid
- Spruce Beetle
- Brown Spruce Longhorned Beetle
- (Yellow headed spruce sawfly: spruce regeneration, esp. artificial regen)

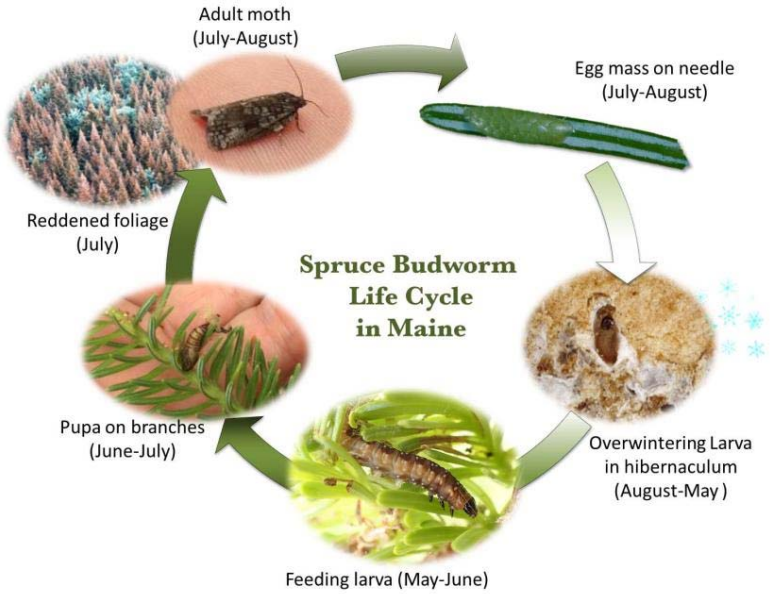
# Spruce Budworm
*Choristoneura fumiferana*

- Native moth
- Defoliator
- Cyclical populations
- Outbreaks cause significant timber-loss
  - Growth loss
  - Tree mortality

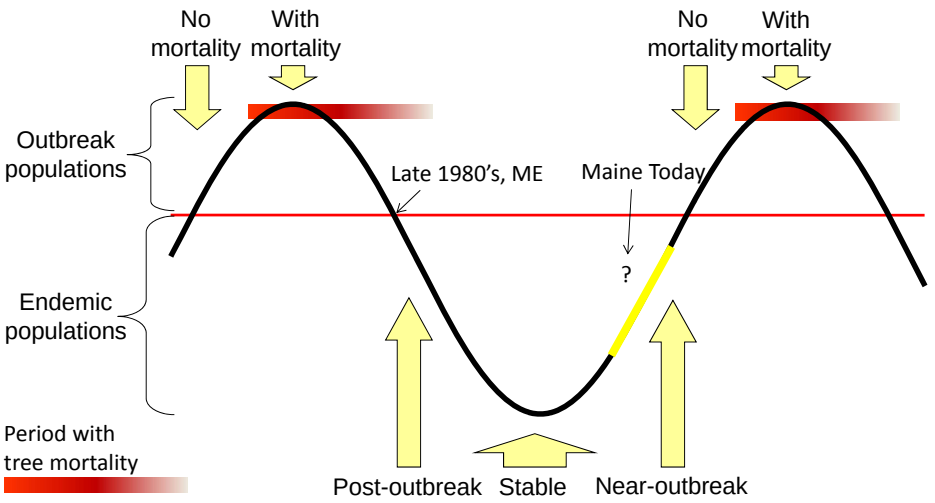
**Hosts**:

- **Fir**, White Spruce , Red Spruce, *Norway Spruce*, Black Spruce,

# Spruce Budworm



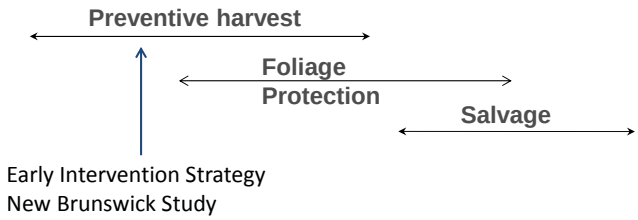
# SBW Population Cycle




Adapted from: Quebec Ministry of Forests, Parks and Wildlife Graphic

# What are Some Management Strategies?

| Endemic | Epidemic | | Endemic | |
|---|---|---|---|---|
| Preepidemic | No mortality | With mortality | Postepid. | Stable |




From: Quebec Ministry of Forests, Parks and Wildlife

# (fall*) Hemlock Looper

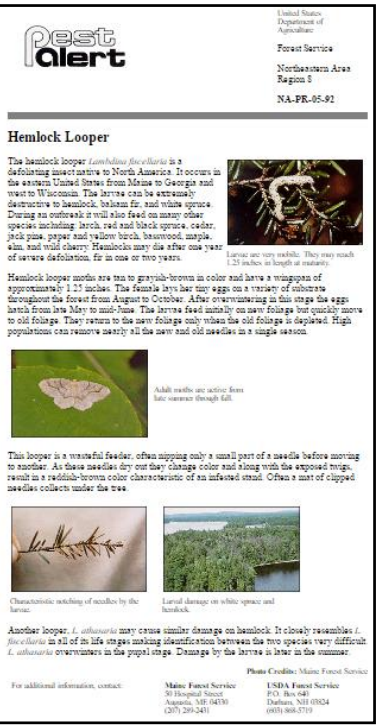
*Lambdina fiscellaria*

- Native Moth
- Defoliator
- Occasional Outbreaks

**Hosts:**

- Hemlock, Fir, White Spruce
- Others in outbreak

* Curve-lined looper (Spring Hemlock Looper): *L. fervidaria*



Pest Alert

United States Department of Agriculture

Forest Service

Northeastern Area Region 8

NA-PR-05-92

**Hemlock Looper**

The hemlock looper *Lambdina fiscellaria* is a defoliating insect native to North America. It occurs in the eastern United States from Maine to Georgia and west to Wisconsin. The larvae can be extremely destructive to hemlock, balsam fir, and white spruce. During an outbreak it will also feed on many other species including: larch, red and black spruce, cedar, jack pine, paper and yellow birch, basswood, maple, elm, and wild cherry. Hemlocks may die after one year of severe defoliation, fir in one or two years.

Larvae are very mobile. They may reach 1.25 inches in length at maturity.

Hemlock looper moths are tan to grayish-brown in color and have a wingspan of approximately 1.25 inches. The female lays her tiny eggs on a variety of substrate throughout the forest from August to October. After overwintering in this stage the eggs hatch from late May to mid-June. The larvae feed initially on new foliage but quickly move to old foliage. They return to the new foliage only when the old foliage is depleted. High populations can remove nearly all the new and old needles in a single season.

Adult moths are active from late summer through fall.

This looper is a wasteful feeder, often nipping only a small part of a needle before moving to another. As these needles dry out they change color and along with the exposed twigs, result in a reddish-brown color characteristic of an infested stand. Often a mat of clipped needles collects under the tree.

Characteristic notching of needles by the larvae.

Larval damage on white spruce and hemlock.

Another looper, *L. athasaria* may cause similar damage on hemlock. It closely resembles *L. fiscellaria* in all of its life stages making identification between the two species very difficult. *L. athasaria* overwinters in the pupal stage. Damage by the larvae is later in the summer.

Photo Credits: Maine Forest Service

For additional information, contact:

Maine Forest Service
50 Hospital Street
Augusta, ME 04330
(207) 289-2431

USDA Forest Service
P.O. Box 640
Durham, NH 03824
(603) 868-5719

# Geometrid "looper"

Measuringworm, Inchworm, Spanworm

# Hemlock Looper

- Feed on new foliage early
- Move to older foliage
- "Wasteful" feeder
- Trees with > 70% defoliation: branch, top, tree mortality
- Can kill a tree in a single season

# 1990's Assessment of Spring Looper Damage in NE

Given the same or less severe defoliation:

Trees with basal wounds did not survive as well as those without detectable wounding.

**A MATTER OF ENERGY**

**Energy Required for Metabolism Shift to Produce Anti-Infection Products**

**Energy Required for Structural Anti-infection Products**

**Energy Required to Build Barrier Zones**

**Protection is of Highest Priority for Tree**

**Protection Mechanisms Occur at the Cost of Wood Production**

W.D. Ostrofsky

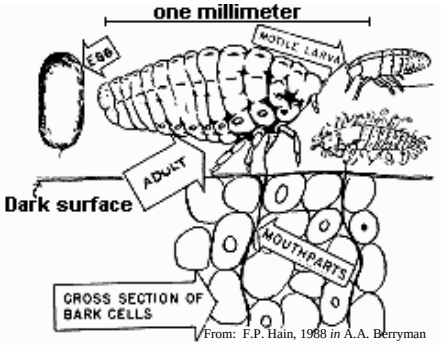
# Hemlock Looper

- Outbreaks can develop suddenly (1920's, 1960's, 1990's ME)
- Most severe in mature hemlock and fir
- MFS Fact sheet has scouting methods, action thresholds

# Balsam Woolly Adelgid

- Invasive adelgid
- Brought into US around 1900 (detected 1908 Brunswick, ME)
- Spread throughout resource w/in climate envelope in Eastern US
- Chronic damage, frequent episodes of more severe damage

# Balsam Woolly Adelgid Life History



From: F.P. Hain, 1988 *in* A.A. Berryman

- One host (fir species)
- All females
- Two generations/year
  - Warmer climate more generations
- Egg, 4 larval instars, adult
- +/- Sessile
  - 1st instar
    - Mobile (crawler)
    - Dispersal

# Damage Classified As:

**Trunk (Bole) Phase**

**Crown (Gout) Phase**

# Tree Symptoms

Piercing-sucking mouthparts
Toxic (to *Abies*) saliva

Change in wood structure
- larger cells (swelling)
- loss of conductivity (drought, needle loss, etc.)

2 general manifestations of infestation

Crown Infestation
"Gout"

# Balsam Woolly Adelgid

- Expect more damage after warm winters
- Expect surge in host mortality/decline after droughty growing seasons
- Anticipate short cutting rotation in fir
- Favor other species where possible (also reduces risks from spruce budworm)

# Spruce Beetle
## *Dendroctonus rufipennis*

- Endemic: Weakened trees
  - Overmature
  - Windthrow
  - Poor sites
- > 7” Dia
- Windthrow often ctr. of outbreak
- Epidemic can attack apparently healthy trees

# Brown Spruce Longhorned Beetle

*Tetropium fuscum*

- Non-native woodborer of spruce
- Prefers stressed trees
- Attacks apparently healthy trees
- Introduced near Halifax NS in late 1990's
- Spread throughout NS (and into NB)
- Proactive forest management may limit damage…

https://novascotia.ca/natr/forestprotection/foresthealth/sheets/BSLB-Best-Practices-ENG.pdf

**BEST MANAGEMENT PRACTICES**

Using Best Management Practices is the best way you can help protect your woodlot from the Brown Spruce Longhorn Beetle (BSLB).

Practice the following:

- ✓ Maintain a healthy forest through proper silviculture and harvest activities.
- ✓ Remove "at risk" trees (blowdown, broken tops, and weak/unhealthy trees).
- ✓ Harvest infested trees showing signs and symptoms of the BSLB.
- ✓ Process logs during late fall-winter to help reduce the risk of spread.

# …however:

"In the absence of BSLB, red spruce under stress can survive many years of reduced growth rates…and bounce back when conditions improve. **However, once a stressed spruce is infested by BSLB, it will die in one to five years.**"

NR CANADA CFS

BSLB FAQs

# BSLB vs. native spruce bark beetle

**Brown Spruce Longhorned Beetle**

Copius resin flow (maybe BSLB)

- From larvae boring from outside bark into phloem

**Spruce Bark Beetle**

Pitch tubes (Native)

- Rxn to attempt to deposit egg w/in phloem layer

# BSLB vs. native spruce bark beetle

**Brown Spruce Longhorned Beetle**

Galleries

**Spruce Bark Beetle**

Galleries

# Yellowheaded Spruce Sawfly

- Primarily a pest of plantation/ornamental
- Has required chemical control in ME on occaision (plantation)
- Looks like a caterpillar, does not respond to Btk

# Yellowheaded Spruce Sawfly

# Rooting Characteristics

Shallow-Rooted Species

Avoid Damage During Stand Entries Windthrow-prone

# Primary Disease Concerns in Spruce/Fir Silviculture

- Key message: avoid damaging residual trees
  - http://www.maine.gov/dacf/mfs/forest_health/diseases/logging_injuries.htm
- Top Rot
  - Stereum sanquinolentum (Bleeding *Stereum*) and others
- Root and Butt Rots: A lot of players!
  - Polyporus tomentosus
  - Phaeolus schweinitzii
  - Armillaria spp.
  - And others
- (Needlecast Diseases)

# Root and Butt and Top Rots: Balsam Fir

Often in trees with no detectable defect:

TABLE 28. PERCENTAGE OF BALSAM FIR TREES HAVING ROTS IN UPPER MICHIGAN

| Bole Characteristics | Top Rot | Butt Rot | Total Rot |
|---|---|---|---|
| No visible defect | 3 | 28 | 29 |
| Damaged roots | 17 | 83 | 92 |
| Woodpecker holes | 30 | 81 | 89 |
| Branch stubs, lower bole | 17 | 62 | 73 |
| Branch stubs, upper bole | 33 | 46 | 63 |
| Cracks | 22 | 64 | 73 |
| Mechanical injury | 30 | 59 | 69 |
| Flat-topped trees | 20 | 54 | 66 |

Source: Prielipp, 1952.

1965 Bakuzis and Hansen

# Balsam Fir: A Monographic Review

"In Upper Michigan the age of stand break-up varies with soil moisture, and occurs at approximately the following ages: 70 years for uplands, 80 years on transition, and 90 years in swamps. On upland sites decay enters at 30–35 years, and the quality rotation is set at 45–50 years. The quality rotation age is 55–60 years for transition areas and 65–70 years for swamps. . . . Balsam fir stands that have been suppressed severely, subjected to mechanical injury from logging or climatological factors, or exposed to fire should be closely watched These stands will ultimately have excessive cull and should be handled accordingly."

Despite variability in incidence of rot:

- Range-wide agreement that ~70-80 years = pathological rotation age
- Quality rotation age ranges from 45 years on dry sites to 65 years in wet flats.

1965 Bakuzis and Hansen

# Red Spruce & Rot

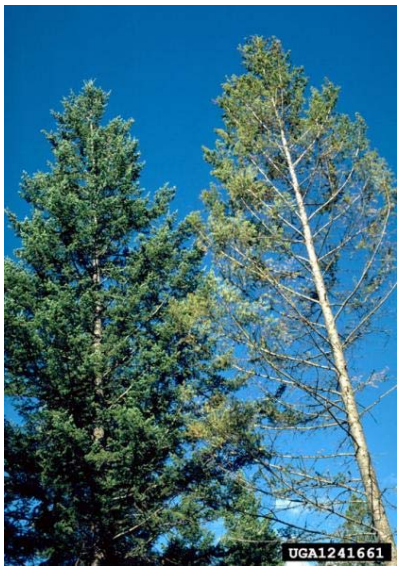
- Damaged, stressed, overmature trees susceptible to some of the same decay fungi.
- Less prevalent than in Balsam fir.
- Avoidance of wounding important

# Red Heart

- Bleeding *Stereum*
- Most common cause of 'top rot' of balsam fir
- Heart-decay
- **Enters through wounds**
- Also can infect spruce and other confiers

# Root and Butt Rot Symptoms

- Thinning crowns
- Stunted growth
- Chlorosis
- Stress cone crop




# Polyporus tomentosus

(Inonotus tomentosus, Onnia tomentosa)

- Brown cubical rot (red stained) of roots/butt logs
- White pocket in later stage
- Enters wounds
- Spread from infected trees to healthy through roots contact
- Can persist after harvest (>15 yr)
- More common in droughty, acidic, thin soils

# Phaeolus schwienitzii

- "cow pie" fungus
- Brown cubical rot
- Not a disease of the elderly
- Usu within bottom 3' of tree
- Affects heartwood of root/butt
- The end often comes with trunk breakage or windthrow

Aged conk

# Armillaria Spp.

- ~7 Spp. in NE
- Honey mushroom
- Shoestring root rot
- Survives on dead or living tissue
- White, stringy rot
- White mycelial fan
- Rhizomorphs
- Resin-soaking at base of tree
- Swelling at base of tree

# Spruce needlecast diseases

***Rhizosphaera* needlecast**

- Infects during shoot elongation

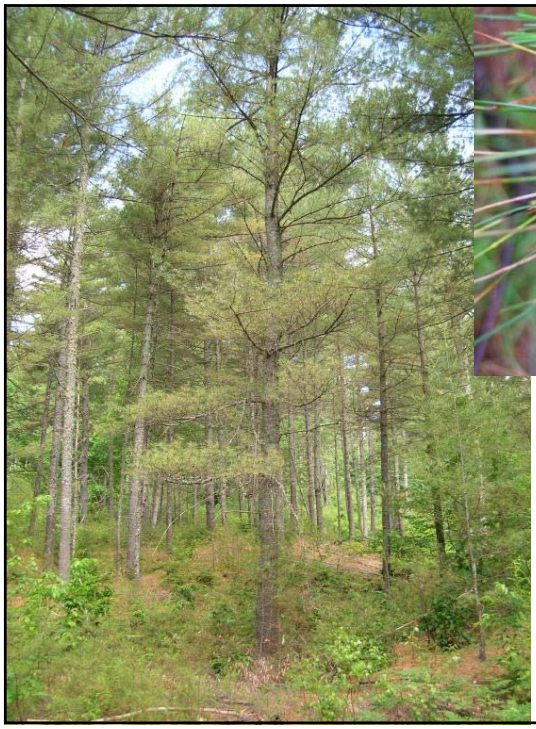
***Stigmina* needlecast**

- Can infect throughout growing season

Currently white spruce is showing more injury than other forest-spruces; unclear how significant will be to forest health; Colorado blue very susceptible

# A Foray into Associated Tree Species

- White pine needle damage
- Pine leaf adelgid
- Hemlock woolly adelgid



## White Pine Needle Disease Complex

*Lecanosticta acicola*—brown spot needle-blight

*(Mycosphaerella dearnessii)*

*Lophophacidium dooksii*

*(Canavirgella banfieldii)*

*Bifusella linearis*

WPND – Trees of all sizes and crown class categories are affected

## White Pine Needle Diseases

- Yellowing of prev yr. needles in June
- Infxn of current year late-spring to early-summer
- Needles shed in July
- Thin crowns
- Chronic stress (10+ yr in some areas)

## Pine Leaf Adelgid

- 1° host = red and black spruce
- 2 ° host = eastern white pine
- Causing growth loss and mortality in white pine
- Causes galls on spruce (red/black)

Shoot Damage on White Pine
Photo: Jensen Bissell, BSP

# Tree Impacts – NB 1950's

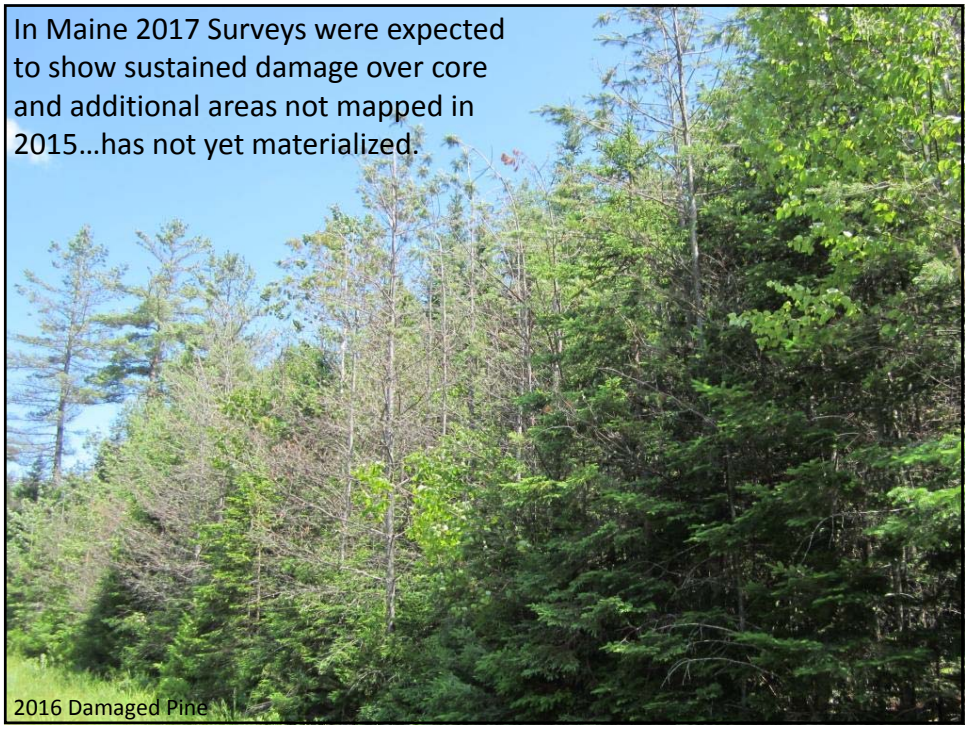
| Atlantic Canada 1940's | Stand 1 (20 yr old) | Stand 2 (40 yr old) |
|---|---|---|
| Pct Pine/Pct Spruce | 44/20 | 57/22 |
| DBH of Pine | 1"-4" | 1"- 9" |
| White pine Dead | 4% | 18% (all <5" dia) |
| White Pine Severe | 26% | 61% |

These figures represent conditions in an area where there have been intermittent heavy attacks for ten years. Mortality has been slight and confined to small trees. Loss of growth has been considerable, and a small number of measurements suggests that it will probably average five or more years of normal increment if no further attack takes place. This has tended to favour competi-

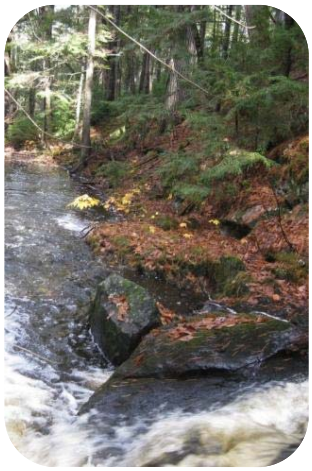
**Diameter growth loss in white pine over 10 year outbreak equivalent to 5 years of normal growth**

# When is Pine Leaf Adelgid a Problem?

- Infrequent but significant outbreaks
- Stands with mixed spruce/pine (large component of each)
- Developing stands (5' tall to small pole-sized)
- Intermediate/overtopped trees
- Worse in 2-storied stands
- Impact primarily to pine primarily
  - Growth loss
  - Mortality of young
  - BUT mature/established also impacted
- In Maine 2017 Surveys are expected to show sustained damage over core and additional areas not mapped in 2015




# Hemlock an Ecological Giant



# Threats to Hemlock Health and Regeneration

**2 - Invasive Insects**
**1 – Novel (?) Fungus**

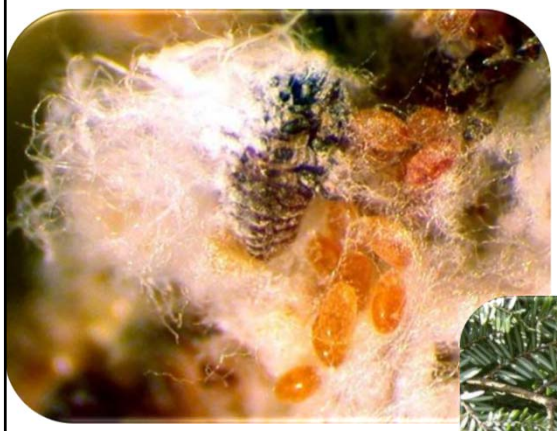
**Sometimes Hard to See!**

– crawlers are invisible, summer stage aestivates

What about natural spread?

- **March-July** (crawlers/eggs)
  - Wind and weather
  - Animals

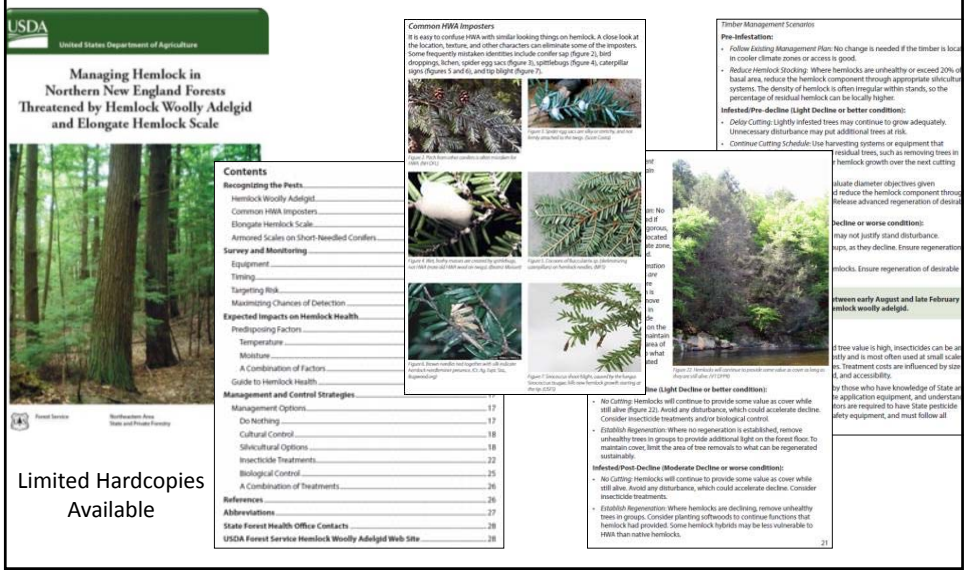
# Recognizing HWA



- Newer growth of twigs
- Best cue: white waxy filaments covering insect and her eggs—**wispy** texture

Remember:
location (hemlocks),
location (twig ends),
location (bases of needles)

# Hemlock Mgmt. Publication From USFS, ME, NH, VT



USDA
United States Department of Agriculture

Managing Hemlock in Northern New England Forests Threatened by Hemlock Woolly Adelgid and Elongate Hemlock Scale

Contents

Common HWA Imposters

Timber Management Scenarios

Limited Hardcopies Available

# Further Reading

**Forest Insects**:

Insects of Eastern Forests MP 1426 https://archive.org/details/insectsofeastern1426unit

Brown spruce longhorned beetle http://www.nrcan.gc.ca/forests/fire-insects-disturbances/top-insects/13373

Managing Hemlock in Northern New England Forests Threatened by Hemlock Woolly Adelgid and Elongate Hemlock Scale

https://www.na.fs.fed.us/pubs/detail.cfm?id=48646

Insects that Feed on Trees and Shrubs, 2nd Ed. (Johnson & Lyon, Cornell)*

**Tree Diseases**:

Diseases of Forest and Shade Trees of the United States AH 386 https://naldc.nal.usda.gov/naldc/download.xhtml?id=CAT86859738&content=PDF

Diseases of Trees and Shrubs (Sinclair, Johnson & Lyon, Cornell)*

*~$100 each (older editions and used available from used booksellers; new editions have important updates, but older editions are also excellent resources)

# Photo Credits

**Maine Forest Service unless otherwise specified.**

*Hemlock looper* Defoliation aerial, USDA FS-NA, Bugwood.org

*Balsam Woolly Adelgid*, Trunk (Bole), A. Wopat, Weyerhaeuser

*Spruce Beetle* Galleries, D. Blackford, USDA FS, Bugwood.org

*Brown Spruce Longhorned Beetle* Damaged Stand, Bob Guscott NS DNR

*Brown Spruce Longhorned Beetle* Resin Flow, J. Sweeney, NR CAN, Bugwood.org

*Brown Spruce Longhorned Beetle* Gallery, Ken Harrison, NR CAN, CFS

*Root disease* general, S.K. Hagle , USDA Forest Service, Bugwood.org

*Yellowheaded spruce sawfly* Larvae, F. Gralenski

*Polyporus tomentosus* NR Canada

*Phaeolus schweinitzii* Aged conk USDA FS Northern& Intermountian, bugwood.org