Insect Pests and Pathogens in a Changing Climate

Danielle Martin

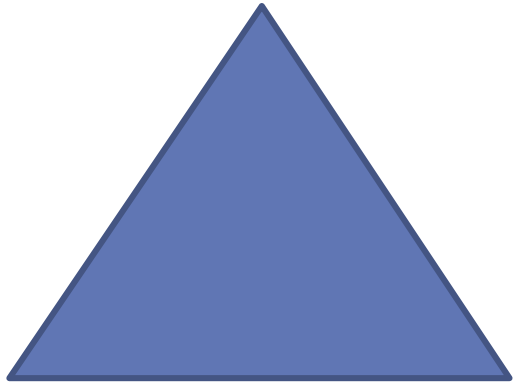
Plant Pathologist

USDA Forest Service

The Plant Disease Triangle

Host

Pathogen/Pest

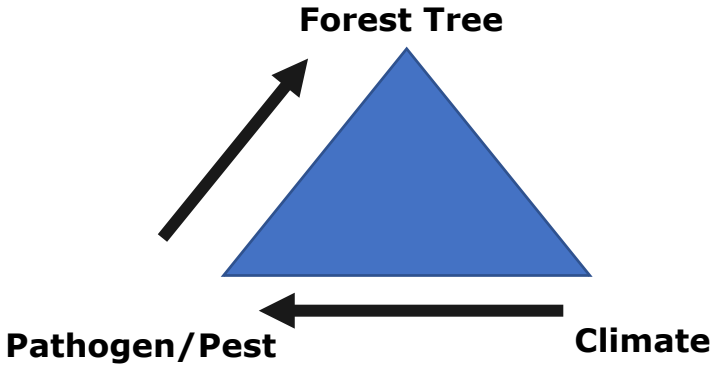


Environment

Hennon, P. E., et al. 2020. A framework to evaluate climate effects on forest tree diseases. Forest Pathology 2020;00:e12649. https://doi.org/10.1111/efp.12649

Seedling photo credit: The Week Magazine

Climate-Pathogen Model



Shorter, warmer winters

Increased overwintering insects, lower winter mortality
Increased number of life cycles completed
Expanded pest and pathogen range-higher altitudes and latitudes

Intensified biological stressors

Increased **humidity and foliar moisture**: leaf diseases such powdery mildews, anthracnose, needle diseases, invasive plants

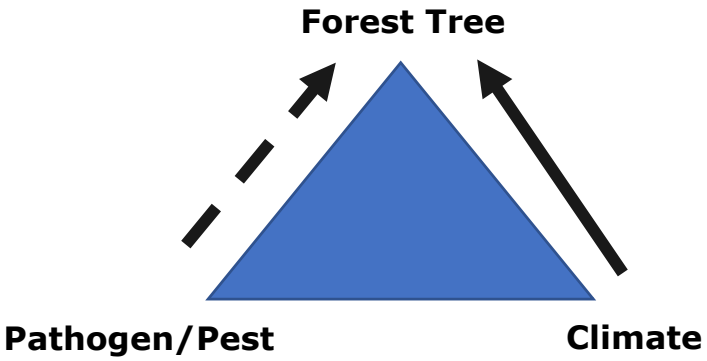
Wind and storm events-increase physical damage resulting in more decay organisms and cankers

Swanston, C., et al. 2018. Vulnerability of forests of the Midwest and Northeast United States to climate change. Climatic Change. 146(1-2): 103-116. https://doi.org/10.1007/s10584-017-2065-2

Photo credit: Munk, 2012

Leaf photo credit: Aaron Burdon

Climate-Stress



Disturbance Events

Rain vs snow: root damage, erosion, seedling survival

Changes in drought/heat stress

Contributes to decline, predisposing to infection or infestation, especially on upland sites

Increased extreme precipitation and flooding

Flooding: leading to root damage and increased root diseases, such as phytophthoras, armillaria, especially at lower elevations

Swanston, C., et al. 2018. Vulnerability of forests of the Midwest and Northeast United States to climate change. Climatic Change. 146(1-2): 103-116. https://doi.org/10.1007/s10584-017-2065-2

Climate Change Resource Center website: list of 16 insects and 7 diseases with the anticipated effects of climate change

Relevant to West Virginia:

Hemlock Wooly Adelgid

Beech Bark Disease

Oak Wilt

Asian Longhorned Beetle (ALB)

Bronze Birch Borer

Emerald Ash Borer (EAB)

Forest Tent Caterpillar

Gypsy Moth

Red Oak Borer

Twolined Chestnut Borer

Armillaria Root Disease

White Pine Blister Rust

DeSantis, Ryan D.; Moser, W. Keith. 2016. Maintenance of forest ecosystem health and vitality. In: Shifley, Stephen R.; Moser, W. Keith, eds. Future forests of the northern United States. Gen. Tech. Rep. NRS-151. Newtown Square, PA: USDA, Forest Service, Northern Research Station: 107-143. Chapter 5. https://www.nrs.fs.fed.us/pubs/50454

Haavik, L. 2019. Northeastern US Forest Pests. (February 15, 2019). U.S. Department of Agriculture, Forest Service, Climate Change Resource Center. http://www.fs.fed.us/ccrc/topics/northeastern-us-forest-pests

Hemlock Wooly Adelgid

Expected:

Warmer winters could contribute to increased HWA survival and population growth along northern range and at higher elevations

Wmer summer temperatures may reduce HWA survival in southern areas of its range

Type: Climate-pathogen

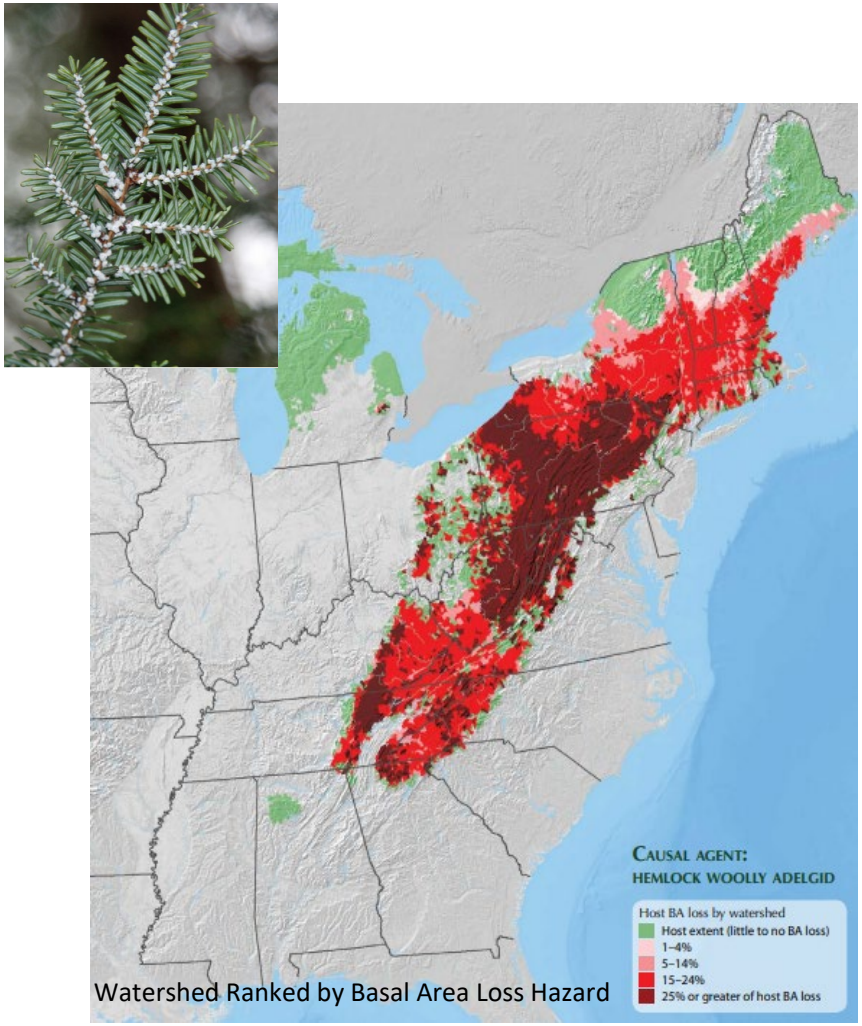
Basis of prediction:

An avg mean winter temp below -5C is needed for sufficient overwinter mortality

Warmer winters may have already altered phenology; and development rate

Along southern range, increased temp resulted in reduced feeding, maternal effects, exposure due to lack of wool covering during summer months, and elevated metabolic rates

Mitigation: Insecticide treatment including use of Imidaclorpid



Watershed Ranked by Basal Area Loss Hazard

https://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.562.2750&rep=rep1&type=pdf
https://link.springer.com/article/10.1007/s10530-017-1537-7
https://www.fs.fed.us/foresthealth/technology/pdfs/2012_RiskMap_Report_web.pdf

Case Studies

Hemlock Wooly Adelgid

Mitigation: Insecticide treatment

Imidacloprid
Available in tablet (soil) or liquid (injection)
Effective for up to 5-7 years after soil treatment

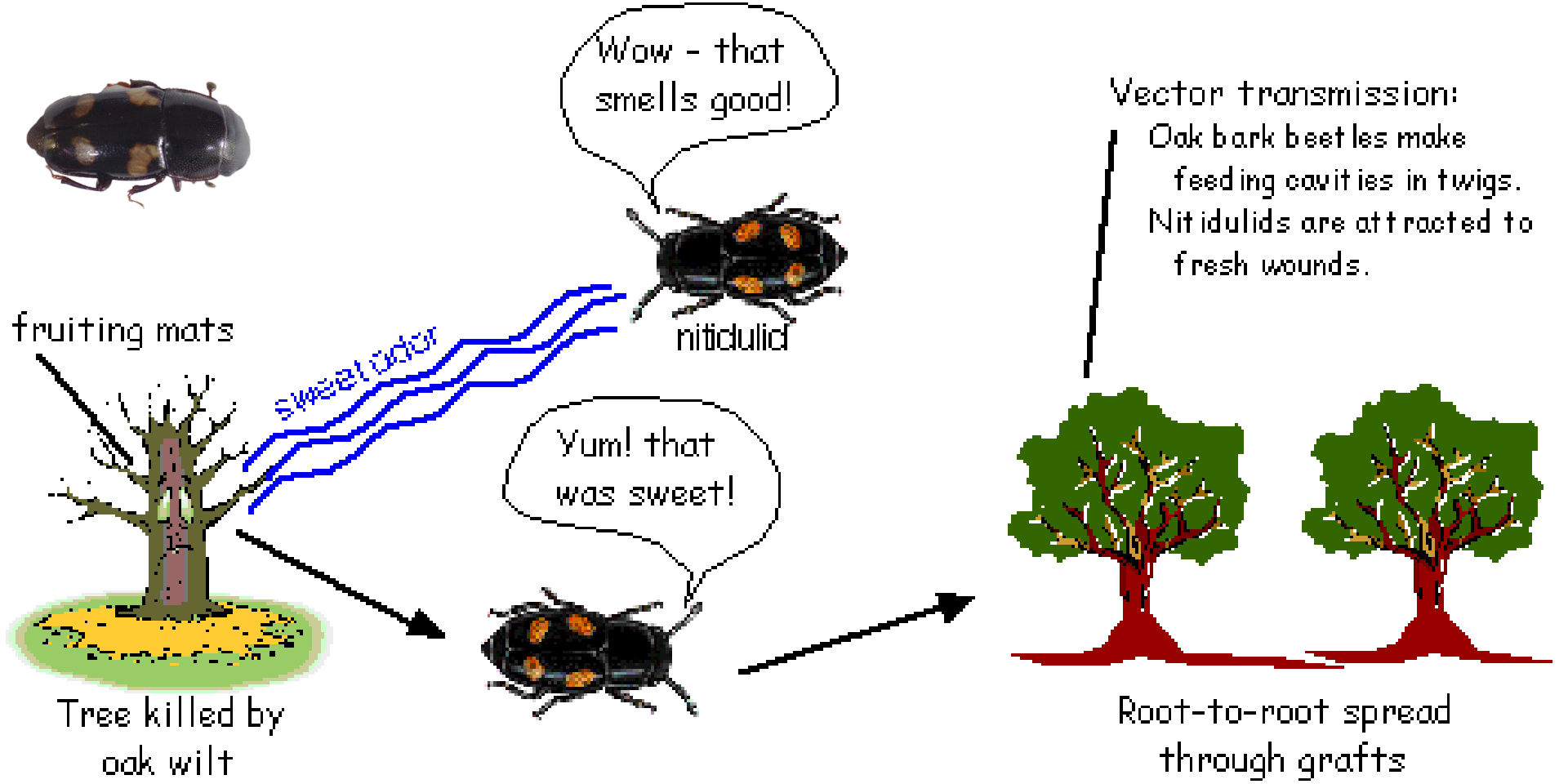
Dinoterfuran
Faster mobility within tree
Only remains active 1-2 years
Also effective against EHS.
Only available as injectable

Biocontrol
Laricobius nigrinus

Sunlight/thinning
Studies have shown that increased light can reduce HWA densities

Thinning stands may increase nutrients, but proceed with caution as can increase susceptibility to heat/frost

Brantley, S.T, A.E. Mayfield, R.M. Jetton,, et al. 2017. Elevated light levels reduce hemlock woolly adelgid infestation and improve carbon balance of infested eastern hemlock seedlings. Forest. Ecol. Manag. 385:150–160. doi:10.1016/j.foreco.2016.11.028
https://www.nrs.fs.fed.us/disturbance/invasive_species/hwa/control_management/best_management_practices/
Brissette, J.C., Kenefic, L.S., 2000. Eastern hemlock response to even- and unevenage management in the Acadian forest: results from the Penobscot Experimental Forest long-term silviculture study. In: McManus, K.A., Shields, K.S., Souto, D.R. (Eds.), Proceedings: Symposium on Sustainable Management of Hemlock Ecosystems in Eastern North America. USDA FS NFES GTR NE-267, Newtown Square, PA, USA, pp. 23–28.



Oak Wilt

Highly virulent fungal pathogen caused by *Bretziella fagacearum*

Short Range Dispersal: Root Graphs

Long Range Dispersal: Insect vectors (Nitidulid beetles), which can Spread up to 1 mile

Attracted to spore matts and to volatiles produced on fresh wounds of healthy trees

Oak Wilt

Expected: Increased incidence

Type: Climate-pathogen

Basis of prediction:
Increasing spring storms cause increased wounding, leading to more infection courts for sap-feeding beetles to cause overland spread.

Increased global temperatures extends insect vector flight periods during growing season

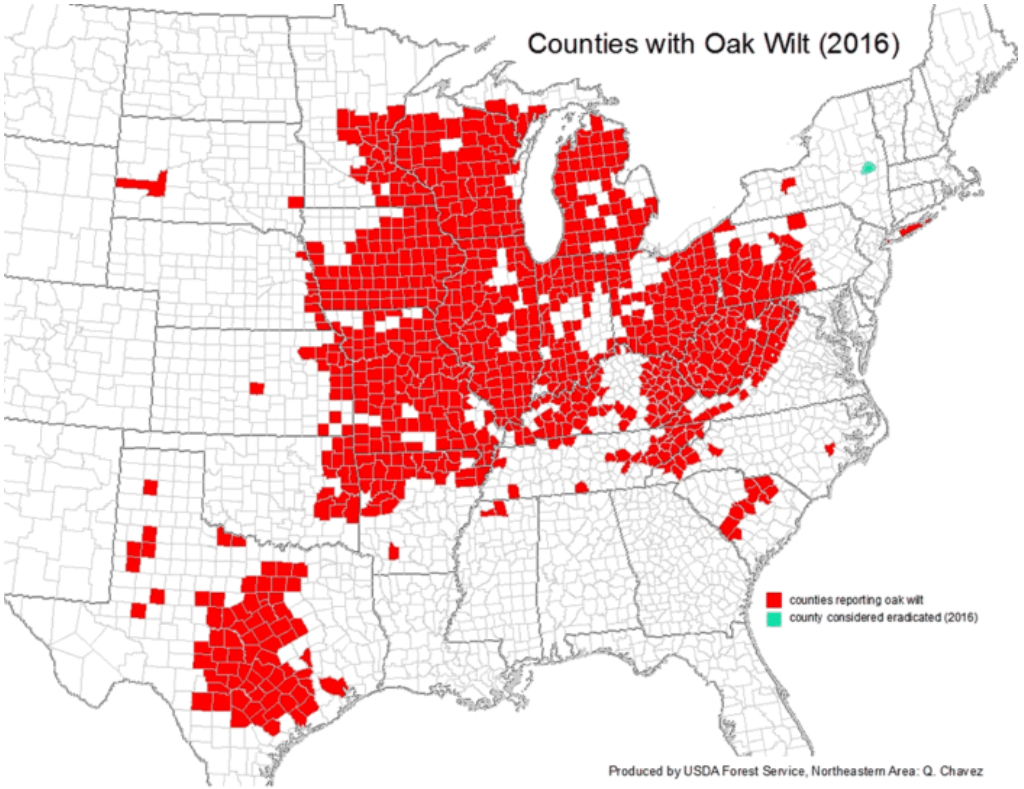
Mitigation:
Increase species diversity to reduce pocket expansion

Sanitation/control of existing disease to reduce spread

Reduce pruning and harvesting to winter months.

Glischrochilus fasciatus

Colopterus truncatus



Beech Bark Disease

Expected: American beech range expected to increase in higher elevations in SE US and lower elecations in NE US.

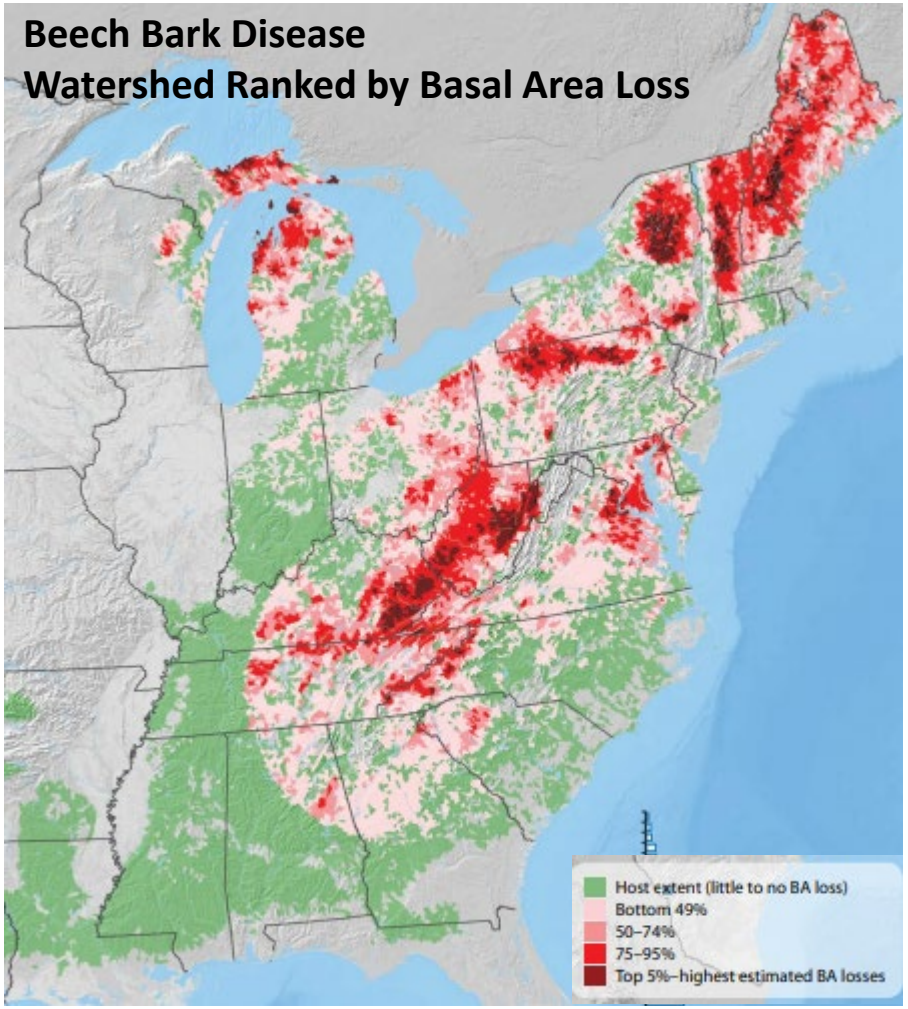
Both the scale insect and neonectria fungi are expected to increase throughout range

Type: Climate-pathogen

Basis of prediction:
Mild winters and dry autumn weather may favor establishment and infestation of the scale

More winter days above freezing may increase fungal infection

Mitigation:
Removal of diseased trees to encourage regeneration of resistant trees or of other species.
Plant disease resistant beech.



https://www.fs.fed.us/foresthealth/technology/pdfs/2012_RiskMap_Report_web.pdf.

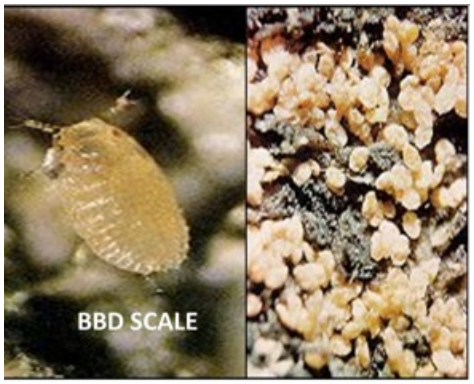
https://www.mdpi.com/1999-4907/8/5/155/htm

Case Studies
Beech Leaf Disease

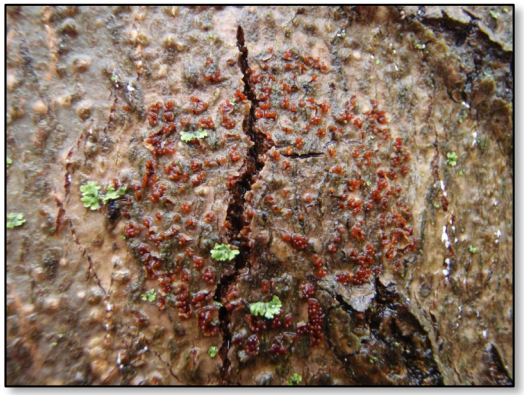
Beech Bark Disease

Expected: American beech range expected to increase in higher elevations in SE US and lower elevations in NE US.

Both the scale insect and neonectria fungi are expected to increase throughout range



Type: Climate-pathogen



Basis of prediction:

Mild winters and dry autumn weather may favor establishment and infestation of the scale

More winter days above freezing may increase fungal infection

Mitigation:

Removal of diseased trees to encourage regeneration of resistant trees or of other species.
Plant disease resistant beech.

https://www.mdpi.com/1999-4907/8/5/155/htm

What can we do about it?

- **Monitoring:** Early detection and action
- **Forecasting:** Models and risk analysis

- **Planning and mitigation:**
- **Promote** healthy and vigorous trees
- Increase **species and age class diversity** to promote growth and resilience to mortality
- Use appropriate **silvicultural interventions** to increase tree vigor and lower pathogen and insect pest impacts under predicted climate scenarios (thinning to reduce humidity, removing unhealthy trees)
- Select **resistant species** or families from specific breeding programs

Thank you! Any questions?

Danielle Martin
Forest Pathologist
Morgantown Field Office
Danielle.k.martin@usda.gov