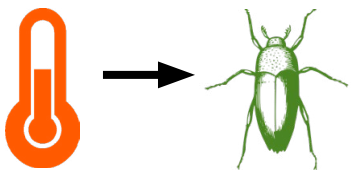
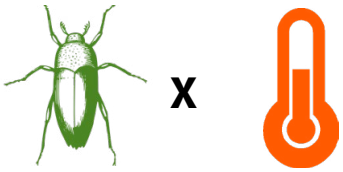
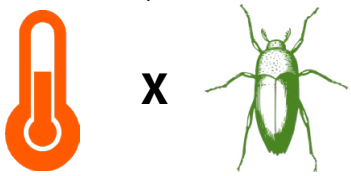
Northeast RISCC Management
Regional Invasive Species & Climate Change
Management Challenge

Forest Pest Risk is Heating Up

Summary

Insect pests and pathogens, and climate change, each threaten forest health. But what happens when the two are combined? Climate change brings pests to new areas, makes pests more damaging, reduces trees' defenses to pests, and can alter how forests recover after pest disturbance. Strategies for managing the combined impacts of forest pests and climate change include preventing new pest introductions, resisting pest spread by treating individual trees and diversifying forest stands, promoting more resilient forests that can rebound from pests, and helping forests transition to a state better adapted to our future climate.

How does climate change affect forest pests?

Table 1	Interaction	Example
	**Climate brings a pest to a new area** (1: Climate brings Pest) 	Hemlock woolly adelgid's (*Adelges tsugae*, HWA) spread is limited by cold winter temperatures, but warming winters and rapid adaptation to cold are expanding HWA's range and increasing its reproductive rates.
	**A minor pest becomes virulent with climate change** (2: Pest X Climate) 	Scale insects, which damage trees by eating their sap, survive and reproduce more in warm environments. Warming allows invasive (e.g. hemlock elongate scale, *Fiorinia externa*) and native (e.g. gloomy scale, *Melanaspis tenebricosa*) scale insects to reach high densities and damage host trees.
	**Climate stress makes trees more vulnerable to pest outbreaks** (3: Climate X Pest) 	Gypsy moths (*Lymantria dispar*) defoliate several tree species, but preferentially feed on oaks (*Quercus spp.*). Outbreaks cause more damage and mortality to oaks that are already stressed by drought.
	**Climate change alters the trajectory of recovery after tree mortality** (4: Pest then Climate) 	Emerald ash borer (*Agrilus planipennis,* EAB) attacks North American ash (*Fraxinus spp.*) and has become the costliest exotic insect in the U.S. Coupled with climate change, trees killed by EAB are replaced by other species resulting in permanantly altered ecosystems (e.g. converting black ash swamps to non-forests).

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Learn more at:
risccnetwork.org

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NYISRI New York Invasive Species Research Institute
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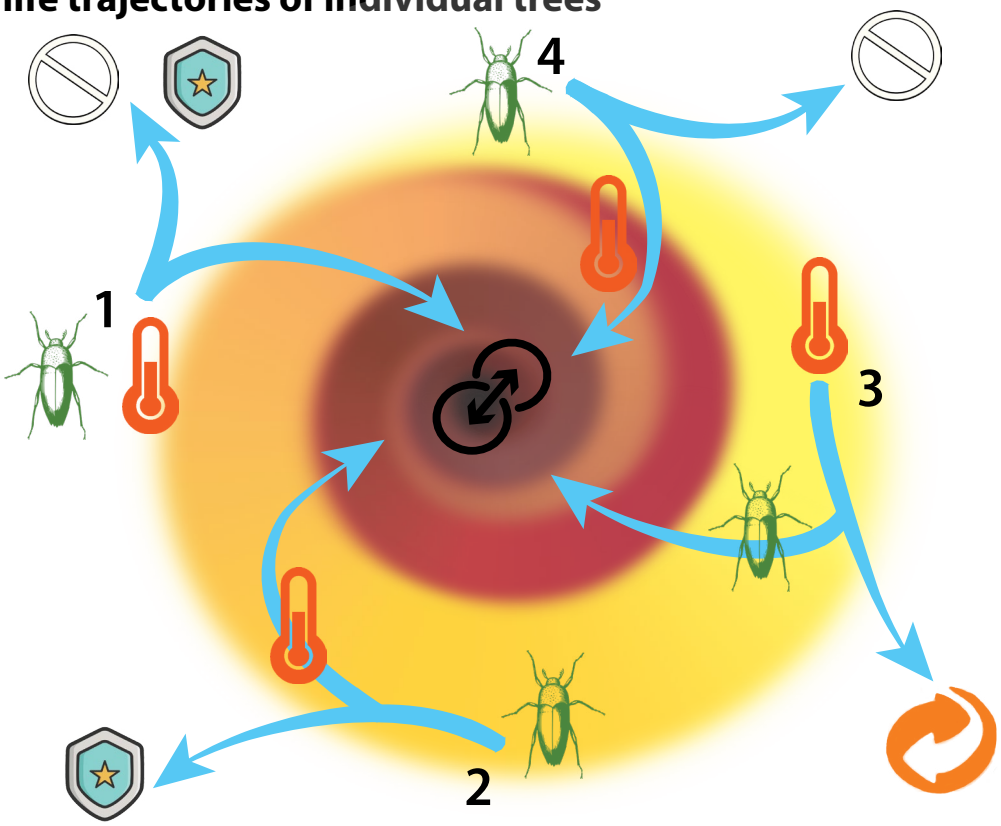
https://doi.org/10.7275/p217-7g43

Forest death spiral - visualizing life trajectories of individual trees

Figure 1. The tree mortality spiral, adapted from Franklin et al. (1987), illustrates how single or multiple stressors can push individual trees towards death (i.e. towards the center of the spiral), and how management actions (see below) can pull trees back to health.

(1) Climate change brings a pest to a new area, **(2)** a minor pest becomes virulent with climate change, **(3)** climate stress makes trees more vulnerable to pest outbreaks, or **(4)** climate change alters recovery after tree mortality.

Examples of each interaction type are in Table 1. Management actions depend on the stage of invasion and type of climate X pest interaction.



Management Actions

PREVENTION

- Support policies that reduce introductions of novel pests, such as switching to pest-free packaging and restricting live-plant imports
- Spread the word about slow-the-spread campaigns such as Don't Move Firewood and engage your networks in monitoring forests for novel pests

RESISTANCE

- Eradicate small pest populations when possible
- Work with a licensed pesticide applicator to treat individual trees or special groves
- Remove hazard trees near trails and infrastructure
- Work with your forester to promote tree species diversity and/or reduce the abundance of host species for specific pests

RESILIENCE

- Work with your forester to increase stand vigor and diversity, for example by thinning
- Monitor pest populations for early-warning signs of outbreak.
- Utilize the National Phenology Network's forecast tool to identify when insects will reach life stages critical for monitoring and management.
- Consider leaving host trees as a seed source for regeneration and then as wildlife habitat after mortality

TRANSITION

- When mortality is widespread, consider managing the forest for a warmer future. For example, consider diversifying tree species composition at the landscape level with particular attention to climate resilient species. Want to learn more? Check out https://forestadaptation.org/
- Salvage harvesting isn't always necessary: dead and dying trees provide wildlife habitat and diversify the forest structure.

References: Aukema et al. 2011 PLOS One 6(9): e24587; Campbell & Sloan 1977. For. Sci. M19; Franklin et al. 1987 BioScience 37:550-556; Franks & Just 2020 Insects 11:142; Lombardo & Elkinton 2017 Ecol Evol 7:5123-5130; Lovett et al. 2016 Ecol Apps 26:1437-1455; McAvoy et al. 2017 Forests 8:497; Paradis et al. 2007 Mitig Adapt Strat Glob Change 13:541–554; Simler-Williamson et al. 2019 Ann Rev Ecol Evol & Syst 50:381-403; https://ag.umass.edu/home-lawn-garden/fact-sheets/elongate-hemlock-scale; Youngquist et al. 2017 Wetlands 37:787-799; https://www.usanpn.org/data/forecasts; https://www.caryinstitute.org/science/tree-smart-trade; https://usfs.maps.arcgis.com/apps/MapTour/index.html?appid=ade657567ff445d5bb3aaa7d898d9fb9; https://www.risccnetwork.org/dont-move-fire-wood; https://forestadaptation.org/assess/ecosystem-vulnerability/new-england; https://forestadaptation.org/sites/default/files/NE_NEnNY_Species_final.pdf