GROWING KNOWLEDGE

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Forewarned is forearmed

Research-backed 'Pheno Forecasts' help growers know when to expect pest activity

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The shift to warmer temperatures in the spring months means renewed activity and growth, including new leaves, flower buds, and, unfortunately, renewed activity of plant pests. Fortunately, nursery growers and gardeners have a new tool to help them — forecasts of when to expect pest activity at their given location.

Since 2020, researchers at the Oregon Integrated Pest Management Center at Oregon State University (OSU) have been collaborating with the USA National Phenology Network (USA-NPN, **USANPN.org**), based at the University of Arizona, to deliver forecasts of pest activities and establishment risk in user-friendly and interactive formats.

These "Pheno Forecasts" use the science of the seasons, or phenology, to support nurseries, arborists, and growers with early detection efforts and the management of existing populations in the conterminous United States.

Here we introduce our Pheno Forecasts for the emerald ash borer (*Agrilus planipennis*, EAB), Japanese beetle (*Popillia japonica*, JPB), and spotted lanternfly (*Lycorma delicatula*, SLF; Figure 1, this page). We provide examples of forecasts and describe the resources and tools available to you, including how you can report on these species in your area. Pest forecasts may support nurseries, arborists, and growers with early detection efforts and the management of existing populations.

The creation of a Pheno Forecast

Pheno Forecast maps predict the timing of problematic insects and other pests that may negatively impact the nursery industry and other United States agriculture sectors. They are based on the amount of warmth an organism needs to receive in the spring to prompt its activity.

For many species, this amount of warmth has been established by researchers. For others, work must be done to figure out what cues insects to begin activity or transition from one life cycle stage to another.

Figure 1. From top: Emerald ash borer, *Agrilus planipennis.* PHOTO COURTESY OF DAVID CAPPAERT, BUGWOOD.ORG Japanese beetle, *Popillia japonica.* PHOTO COURTESY OF DAVID CAPPAERT, BUGWOOD.ORG Spotted lanternfly, *Lycorma delicatula.* PHOTO COURTESY OF LAWRENCE BARRINGER, PENNSYLVANIA DEPARTMENT OF AGRICULTURE, BUGWOOD.ORG

The models for EAB, JPB, and SLF were developed using previously published data on how temperature affects their development and survival. In general, pests develop more quickly when temperatures are warm; however, they have limits — temperatures that are too cold or too hot can restrict their development and survival. By incorporating this information, the models can predict both where and when to expect the pest (Barker et al. 2020).

Pheno Forecast maps for EAB, JPB, and SLF show where important pest activities are expected in areas at risk of establishment — i.e., those that are not too cold or hot for development and survival. The life cycle stages forecasted are those during which management actions are most effective. These maps are updated daily and are available for the entire year, allowing you to anticipate activity several months into the future.

Emerald ash borer (EAB)

Native to Asia, EAB is a wood-boring beetle that causes significant harm to ash trees (*Fraxinus* spp.) in hardwood forests and urban landscapes. EAB was first detected in the U.S. in 2002 and now occurs in at least 37 states. The invasive pest was first detected on the West Coast in Forest Grove, Oregon, in 2022 and now occurs in four counties in Oregon (Washington, Yamhill, Clackamas, and Marion).

EAB is responsible for the death of tens of millions of ash trees across the United States, with an estimated economic impact in the billions of dollars. If left to spread, it will continue to have devastating effects on both urban and natural forest ecosystems. For example, the beetle is expected to decimate stands of Oregon ash (*F. latifolia*), which plays a crucial role in wetland and riparian ecosystems in the Pacific Northwest (Shaw et al. 2025).

In the larval stage, EAB feeds on tissues under the bark of ash trees, disrupting the plant's nutrient and water transport and eventually killing the tree. Insects are difficult to treat in this stage and can feed up to two years before pupating and then emerging as adult beetles. Adult beetles can travel about half a mile from their tree after emerging, but may disperse longer distances when transported via firewood or other forestry products.

Treatments for EAB are applied to control adult beetles on infested trees and to reduce the spread of the pest to nearby areas. Adults lay eggs approximately 14 days after emergence, so treatment is critical in this window. Collections of EAB resources can be found at OSU Extension at **TinyURL.com/OSUEAB** and the EAB Information Network at **TinyURL.com/EABInfoNetwork**. For specific information on preferred treatment options in your region, we recommend contacting your local extension agent.

Pheno Forecasts for adult emergence and egg hatch of EAB (Figure 2, this page) are particularly relevant for surveillance and for managing existing populations with pesticide treatments and parasitoid introductions. For example, forecasts for adults can help state surveillance teams and arborists detect beetles in Oregon where EAB has recently arrived.

Japanese beetle (JPB)

Native to Japan, JPB is an invasive beetle that was first discovered in the United States in 1916. Their numbers grew rapidly in the 1950s and 1960s on the East Coast as home lawns became popular. The beetle is considered a top pest of turfgrass and has caused large-scale destruction to field crops, berries, fruit trees, vegetables and a wide array of ornamental plants (Stoven et al. 2021). Since the Japanese beetle was found in Oregon in 2016, the Oregon Department of Agriculture (ODA) has led eradication efforts to prevent it from becoming widely established in the state.

Figure 2. Pheno Forecast map for EAB for May 9, 2025. Colors indicate the status of adult emergence. The status of a location is determined by comparing local degree day accumulations to an established degree-day accumulation threshold for the life-cycle stage. Areas of the U.S. that lack color are predicted to have temperatures that are too extreme for development or survival. MAP COURTESY OF NATIONAL PHENOLOGY NETWORK

Figure 3. Pheno Forecast map for SLF for May 9, 2025. Colors indicate the status of egg hatch. The status of a location is determined by comparing local degree day accumulations to an established degree-day accumulation threshold for the life-cycle stage. Areas of the U.S. that lack color are predicted to have temperatures that are too extreme for development or survival. MAP COURTESY OF NATIONAL PHENOLOGY NETWORK

Immature JPB grubs feed on the roots of plants, particularly grasses. This feeding can severely prune roots, limiting the plant's ability to acquire water and resulting in large patches of dried, dead grass. In their adult stage, beetles feed on plant foliage, skeletonizing the leaves by feeding between leaf veins. They also occasionally feed on other plant tissues such as flower petals.

Treatments for JPB include hand removal of adult beetles by shaking infested plants over a jar of soapy water to remove and kill the beetles. Commercial pheromone traps are available, though their success is limited and mostly useful for monitoring rather than control. For specific information on preferred treatment options, download the "Animal and Plant Health Inspection Service's Managing the Japanese Beetle: A Homeowner's Handbook" at **TinyURL.com/JPBHandbook** or contact your local Extension agent.

Pheno Forecasts of adult emergence of JPB may help with surveillance because adults are more detectable than grubs, which occur underground. Forecasts of egg hatch, which occurs approximately four weeks after first adult emergence, may help to manage young grubs with products such as Bt (*Bacillus thuringiensis*), milky spore, and beneficial nematodes.

Spotted lanternfly (SLF)

Native to China, SLF is an invasive planthopper that threatens several major agriculture crops in the United States, including grape, stone fruit, hops, and hardwood trees. This pest was first detected in the United States in Pennsylvania in 2014 and subsequently spread to at least 13 additional states.

SLF will lay eggs on virtually any surface, which makes it easy for people to spread the egg masses to new locations. Most states are considered at risk of SLF, particularly in areas where invasive populations of tree of heaven (*Ailanthus altissima*), its preferred host plant, are present.

As of 2024, there is no established population of SLF in Oregon. However, the state has multiple high-value industries that may be affected, including wine grapes, nursery and tree crops, small fruits and timber (Mermer et al. 2021).

SLF damages plants by sucking sap from trunks, stems, and branches as well as by depositing a sticky residue that leads to mold growth. This damage weakens the plant, which reduces crop yields and makes the plant more susceptible to stressors such as extreme cold and other pests.

Treatment options for SLF include killing adults and scraping off and destroying overwintering egg masses before eggs hatch. For specific information on preferred treatment options, visit PennState Extension's Spotted Lanternfly Management Guide website at **TinyURL.com/SLFGuide** or contact your local extension agent.

Pheno Forecasts for SLF (Figure 3, Page 42) may help to detect insects and slow their spread to new locations. Forecasts of egg hatch provide insight into when nymphs will appear, which may help detect SLF because nymphs are easier to observe than cryptic egg masses. Forecasts for adults may also »

help with detection and with timing treatments that target adults on infested trees, which may also reduce the spread of the pest.

Other forecasts

USA-NPN Pheno Forecasts and notifications are available for 14 additional insect pests and several plant species:

- Apple maggot (*Rhagoletis pomonella*) — adult emergence
- Asian longhorned beetle (*Anoplophora glabripennis*) — adult emergence
- Bagworm (*Thyridopteryx ephemeraeformis*) — caterpillar emergence
- Bronze birch borer (*Agrilus anxius*) — adult emergence
- Eastern tent caterpillar (*Malacosoma americanum*) — caterpillar emergence
- Hemlock woolly adelgid (*Adelges tsugae*) — presence of eggs, presence of active nymphs
- Lilac borer (*Podosesia syringae*) — adult emergence
- Magnolia scale (*Neolecanium cornuparvum*) — crawler emergence
- Pine needle scale (*Chionaspis pinifoliae*) — crawler emergence
- Spongy moth (*Lymantria dispar*) — caterpillar emergence
- Winter moth (*Operophtera brumata*) — caterpillar emergence
- Buffelgrass (*Pennisetum ciliare*) — 50% green-up
- Red brome (*Bromus rubens*) — flowering, senescence
- Winter wheat (*Triticum aestivum*) — vegetative and reproductive stages

Access forecasts at **USANPN.org/Data/Maps/Forecasts**.

Learn more about pests in learning modules, also other resources

To support volunteers in identifying and reporting on these pests, the USA-NPN offers Phenology Learning Modules for SLF and EAB (Figure 4, this page), with modules in development for JPB and other pests. Explore the modules at **Learning.USANPN.org**.

Forecasts for single locations

Two options are available for end users who want forecasts for single locations. Users can explore the forecasts with the USA-NPN's Visualization Tool (**Data.USANPN.org/Vis-Tool**), which allows a user to zoom in on maps and click on a location to see the forecast for the corresponding 2.5-km pixel. Additionally, a model app at **USPest.org** allows end users to obtain predictions of phenology for EAB, JPB, and SLF in addition to 22 other invasive pests for a weather station of interest.

Get notified when pests are active in your area|

You can receive advance warning of management-relevant activity for your pest of interest by signing up to receive email notifications at **USANPN.org/Data/Forecasts**. Notifications are delivered both two weeks and six days before the activity will occur at your location.

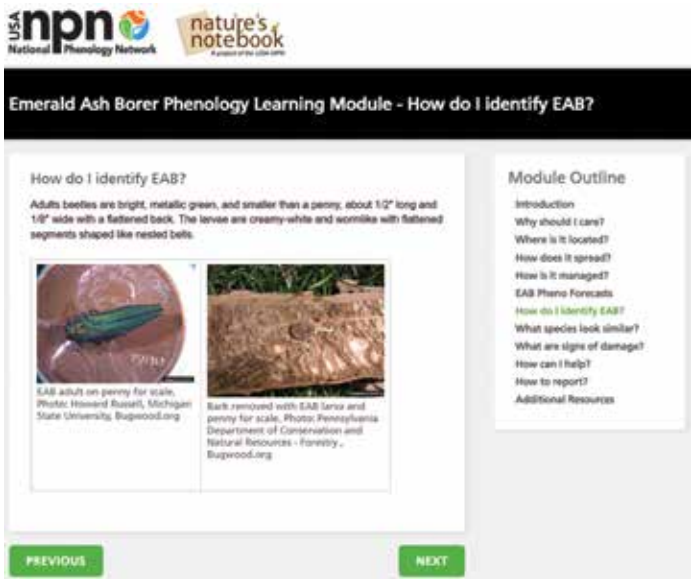

Figure 4. Screen capture of the Emerald Ash Borer Phenology Learning Module. COURTESY OF NATIONAL PHENOLOGY NETWORK

Report pest activity at your site this season

Tracking when EAB, SLF, and JPB undergo life cycle changes in your area can help you choose the best time to perform management activities and may serve as an early warning indicator of trouble brewing among your trees or crops. You can track the timing of activity in these pests and over 1,800 other plant and animal taxa using Nature's Notebook (**USANPN.org/NN**), the plant and animal phenology monitoring program offered by the USA-NPN. The USA-NPN uses observations submitted through Nature's Notebook to validate and improve the Pheno Forecast maps.

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