

Invasive Forest Pests in the United States

Community Impacts and Opportunities for Tree-SMART Trade



People and Communities Depend on Trees for Health and Resilience

Towns and cities are investing in trees as low-cost natural infrastructure to help contend with the intensifying effects of climate change and urbanization. Trees cool neighborhoods, reduce flooding, filter air pollution, and store carbon dioxide – a greenhouse gas. Local economies benefit from the wildlife habitat, forestry, and recreation enterprises that trees and forests support. Pollution removal alone by US trees provides human health benefits worth \$6.8 billion per year.¹ Unfortunately, these same trees are threatened by unintentionally imported forest pests, and the risk of new invasions is intensifying.

Imported Forest Pests Jeopardize Trees and Cost Billions of Dollars Every Year

Forest pests (insects and diseases) are imported to the US as a preventable consequence of global trade. The number of imported forest pests in the US increases each year (Figure 1). Imported pests affect all US states and cost local governments and homeowners billions of dollars every year (Figure 2). Solid wood packaging material, such as pallets, and imported live plants are the two largest sources of imported forest pests in the US. The rapid expansion of global trade raises the risk that new highly damaging forest pests will arrive in the US.

Five Actions Can Help Stem the Flow of Damaging Forest Pests to the US

Growing reliance on both trees and trade makes imported forest pests the most pressing, and under-appreciated, forest health issue in the US today. Five high-priority policy actions that build on proven prevention measures can reduce the arrival and establishment of new forest pests.



(2)

IMPACTS

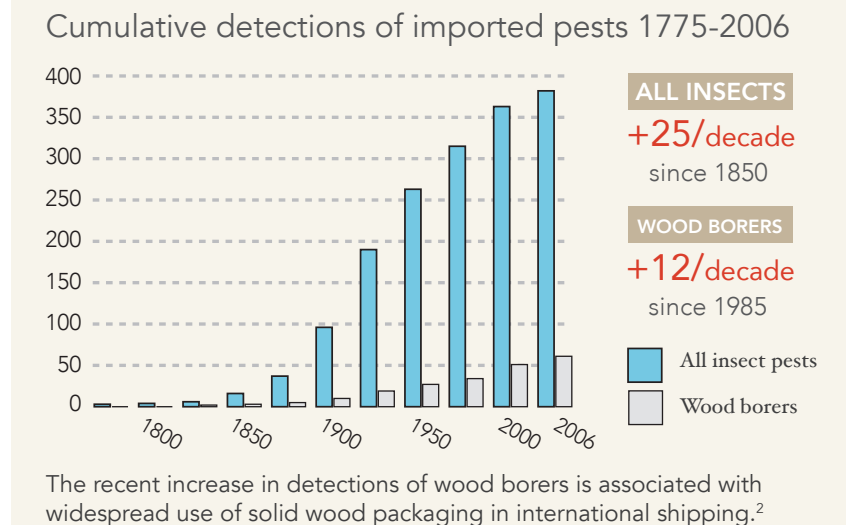
Municipalities and Homeowners Incur Most of the Billions of Dollars in Annual Costs From Imported Pests

The loss of trees transforms neighborhoods and landscapes, chipping away at the benefits trees provide to people and nature. On average, 25 new damaging insect pests become established in the US each decade, causing billions in annual damages.^{2,3} Under the current system, homeowners, local governments, and the federal government are left subsidizing most of the costs of unclean international trade.

The economic impacts of imported forest pests in the US vary by sector and range from \$150 million to \$2 billion per sector per year (Figure 2). Homeowners and local municipalities shoulder the largest share of these costs. Local governments are saddled with the costs of treating live trees to prevent infestation, removing dead trees, and re-planting. Homeowners lose property value when mature trees become infested and die, or when trees must be removed to prevent further spread of the pest.

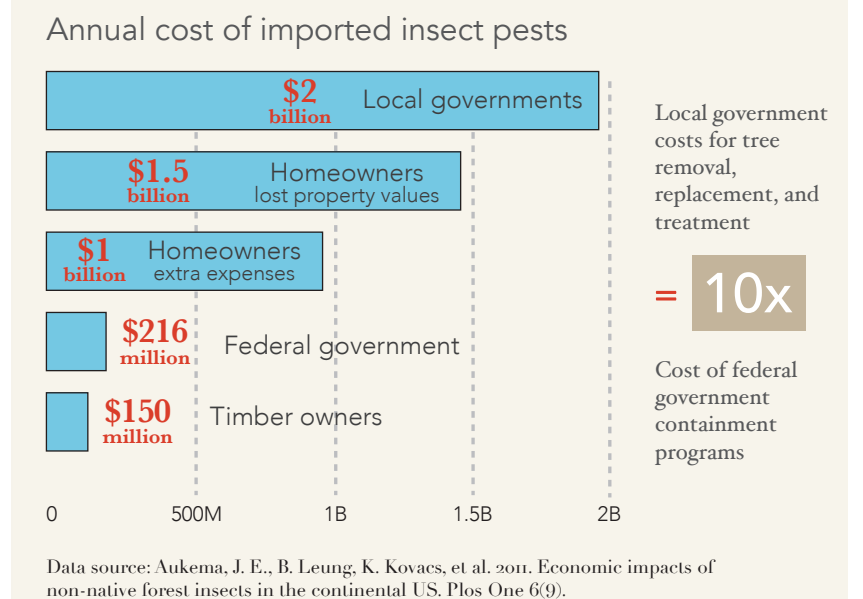
“The total costs for emerald ash borer could reach \$12.7 billion by 2020.”

The numbers in Figure 2 likely underestimate the true costs of forest pests because they exclude tree mortality caused by imported diseases (for example, chestnut blight and sudden oak death) and do not account for loss of ecosystem services that are not easily quantified with a price tag (for example, climate change mitigation or human health and wellbeing).³



Data source: Aukema, J.E., McCullough, D.G., Von Holle, B., Liebhold, A.M., Britton, K., Frankel, S.J. 2010. Historical accumulation of nonindigenous forest pests in the continental US. *Bioscience* 60(11):886-897.

Figure 1



Data source: Aukema, J. E., B. Leung, K. Kovacs, et al. 2011. Economic impacts of non-native forest insects in the continental US. *Plos One* 6(9).

Figure 2

(3)



Along the Cherochala Skyway in NC, stands of eastern hemlock are dying due to the hemlock woolly adelgid. Red spruce are being planted to help fill the gap left by the dying hemlocks.

Pests Can Decimate Entire Species of Trees in Just Decades

Imported forest pests are the only forest health threat that can decimate entire tree species within a few decades. Imported forest pests virtually eliminated mature American chestnut from the forest canopy and destroyed many of the American elms that lined city streets.

“On average, 25 new insect pests become established in the US each decade, causing billions in annual damages.”

In 2010, whitebark pine became the first widespread tree to become a candidate for endangered species listing, due to an imported disease and other stressors. Eastern hemlock and all 16 native North American species of ash trees are currently facing long odds to persist in the face of imported insect pests.

The Problem is Widespread with Many Hard-Hit States

The problem of imported forest pests is widespread with damaging forest pests occurring in all US states (Figure 3). Throughout the US, many communities have lost treasured trees in devastating local outbreaks. Yet several states have been particularly hard-hit in recent years. Some examples are provided on page 6.

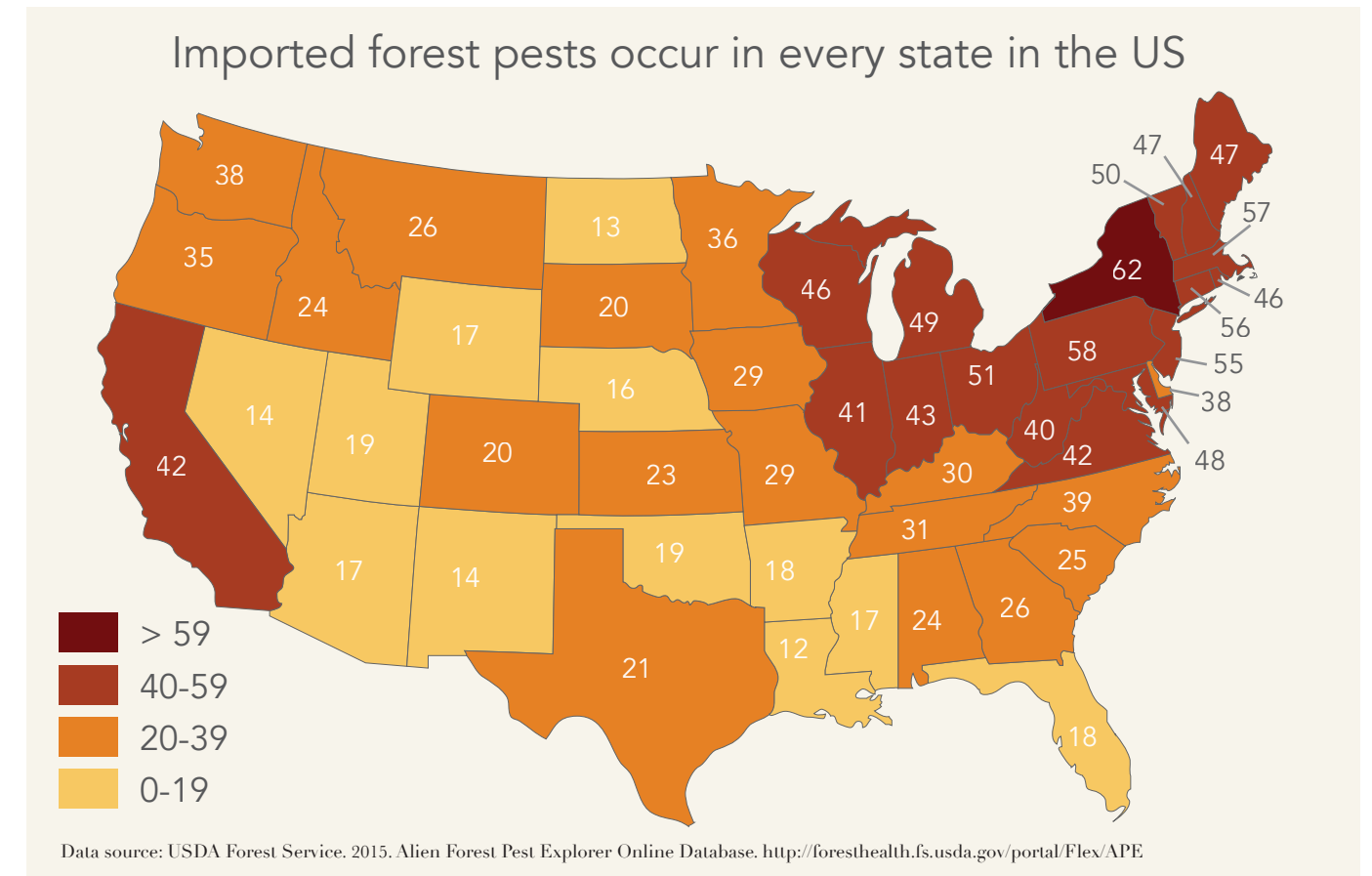


Figure 3

Emerald Ash Borer The costliest pest so far

The emerald ash borer is the most destructive and costliest forest pest to invade the US. Local governments spend an estimated \$850 million per year for removal or insecticide treatment of ash trees. Responding to this invasion could cost \$12.7 billion through 2020.

This iridescent green beetle is native to Asia. It was first detected in the US near **Detroit, MI** in 2002, and probably arrived on solid wood packaging material in the 1990's. As of 2019, infestations have been reported in 34 states. At risk are an estimated 8 billion ash trees in forests, and millions more trees in cities and other residential areas.



States with emerald ash borer

Hemlock No trees, no trout?

Since the 1920's, an imported hemlock pest, the hemlock woolly adelgid, has been slowly removing this tree from eastern forests. Hemlock trees are important for the survival of trout and other cold-water fishes. They provide deep shade along creeks, maintaining the pockets of cold water these fish need.

When hemlock trees die, stream temperatures rise. In eastern US forests, there is no other tree that fills the role of hemlock.

Shenandoah National Park, VA
This area was home to hemlock trees that were more than 3 centuries old. Today as many as 80% of the park's hemlock trees have died due to hemlock woolly adelgid.

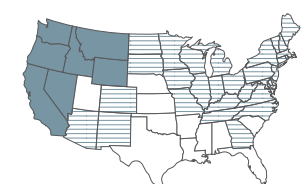


States with hemlock woolly adelgid

Whitebark Pine A tree on the edge

Whitebark pine is the first widespread tree to be eligible for protection as an endangered species. The threats to this tree include white pine blister rust, an imported fungus that attacks many pine species in the US, and is particularly devastating to whitebark pine. These slow-growing trees are found at the highest elevations in harsh alpine environments. They reduce erosion and provide food and shelter for birds and mammals.

Crater Lake National Park, OR
Nearly half of the park's whitebark pine were expected to be lost to white pine blister rust by 2050. Now additional whitebark pine are succumbing to a native pest, the mountain pine beetle.



States with white pine blister rust
 States with white pine blister rust & whitebark pine

Examples of states hard-hit by imported forest pests

NY

- ☆ With 62 imported tree pests, New York has the most of any state.
- ☆ Asian longhorned beetle was first detected in the US in 1996 in Brooklyn. Outbreaks followed elsewhere in New York City and Long Island; some have been eradicated.
- ☆ Hemlock woolly adelgid ravaged the largest remnant of old-growth forest in New York City and has spread throughout the southern half of the state.
- ☆ Other active threats include emerald ash borer, gypsy moth, beech bark disease, Sirex wood wasp, winter moth, Dutch elm disease, dogwood anthracnose, oak wilt, spotted lanternfly, and butternut canker.

MA

- ☆ Neighborhoods in Worcester lost their urban canopy due to an outbreak of Asian longhorned beetle.
- ☆ Emerald ash borer threatens to do additional major damage to forests and community trees throughout the state.
- ☆ Winter moth has severely damaged many forests and neighborhood trees on Martha's Vineyard, Cape Cod, and across the eastern part of the state.
- ☆ Additional active threats include hemlock woolly adelgid, beech bark disease, Dutch elm disease, gypsy moth, dogwood anthracnose, and butternut canker.

NC

- ☆ The forests of Great Smoky Mountains National Park and the Blue Ridge Mountains have suffered from a succession of invasive pests, including balsam woolly adelgid, hemlock woolly adelgid, beech bark disease, dogwood anthracnose, and emerald ash borer.
- ☆ Laurel wilt disease has invaded the southern part of the state.
- ☆ Butternut canker and thousand cankers disease are causing severe damage to butternut and walnut trees.

FL

- ☆ Laurel wilt is killing bay and laurel trees throughout the state, and threatens fragile forest habitat in Everglades National Park.
- ☆ Laurel wilt is also threatening commercial avocado trees.

MI

- ☆ Emerald ash borer was first detected in the US in Michigan in 2002, and continues to ravage valuable ash trees in forests and communities throughout the state.
- ☆ Additional active threats include gypsy moth, Dutch elm disease, beech bark disease, dogwood anthracnose, Sirex wood wasp, and hemlock woolly adelgid.

OH

- ☆ Emerald ash borer has inflicted major damages in cities such as Cincinnati and is established throughout the state.
- ☆ As of 2019, there is an active outbreak of Asian longhorned beetle in southwestern Ohio, and forests are also being damaged by hemlock woolly adelgid, gypsy moth, thousand cankers disease, dogwood anthracnose, and butternut canker.

ID

- ☆ White pine blister rust is endangering whitebark pine.
- ☆ Balsam woolly adelgid has damaged as much as 153,000 acres of fir trees in a single year in this state, and continues to damage tens of thousands of acres each year.

CA

- ☆ Sudden oak death is attacking oaks and tanoaks across northern California.
- ☆ Polyphagous & Kuroshio shot hole borers have damaged many species in southern California, including sycamores, willows, oaks, maples (including boxelder), and commercial avocado trees.
- ☆ Other threats include balsam woolly adelgid and Port-Orford-cedar root disease.



Whitebark pine trees live in sensitive alpine habitats at high elevations. They are threatened by white pine blister rust, an imported disease, as well as mountain pine beetle, a native insect. The dead whitebark pine trees pictured here near Esmeralda Basin, WA likely succumbed to a combination of the imported and native pests.

Impacts of Imported Forest Pests are Expected to Worsen

The impacts of existing imported forest pests are expected to worsen over time. Scientists forecast that approximately 825 million acres, or 63% of the nation's forestland, are at risk for additional mortality of host trees due to the spread of pests that have already been imported into the country. Twenty-five million acres are predicted to experience more than 20% loss of host tree cover in forests through 2027.^{4,5} These figures do not include damage from new pests that are likely to be introduced in the decades ahead.

"Throughout the US, communities have lost treasured trees in devastating local outbreaks."

Tree-SMART Trade: Policies and Practices to Prevent Imported Forest Pests



WHAT

WHY

HOW

Switch to pest-free packaging materials for international shipments to the US.

Reduce the fastest growing pathway for highly damaging pests by changing the packaging that commodities are shipped in. Current shipping costs for wood packaging do not reflect the true costs of transmitting pests.

- Initial actions:
 - Provide trade incentives to importers that switch to non-solid-wood packaging.
 - Update the Environmental Impact Statement on wood packaging. The most recent final Statement is from 2003. Since that time new alternatives to solid wood packaging have been developed, and the damage from wood-boring insects has increased dramatically.
 - Increase import fees for use of solid wood packaging materials. The fees should reflect the true costs of tree loss and pest mitigation efforts due to pests transmitted via wood packaging. Use revenue for pest prevention and surveillance efforts.
- Encourage more businesses to switch to non-solid-wood packaging such as plywood, oriented strand board, or metal racks to reduce pest threats, and to stay ahead of potential regulatory pressures.
- Ultimately, eliminate solid wood packaging using procedures established in international trade agreements, implemented through modification of ISPM15* or through a new ISPM*.

Minimize new pest outbreaks by expanding early detection and rapid response programs.

Early detection and rapid response decreases the likelihood that a new pest arriving in the US will become established and cause damage. Current funding for these programs is inadequate.

- Establish a robust national early detection and rapid response task force for forest pests that integrates programs of APHIS*, the Forest Service, the Department of the Interior, states and tribes, using a risk-based framework to target expanded surveillance efforts.
- Fund the establishment of an early detection and rapid response task force.
- Improve the mechanism through which APHIS* can quickly access funding for emergency eradication when a new tree pest outbreak is discovered.
- Every two years, assess the cost of responding to newly established pests and adjust the President's budget accordingly, to fully fund early detection and rapid response.

Augment international pest prevention programs with key trade partners.

Working with trade partners helps prevent pest importation at the source.

- Increase the use of pre-clearance partnerships to prevent pests from leaving countries of origin. These programs use APHIS* employees abroad to ensure that shipments are pest-free before they are shipped to the US.
- Provide technical assistance to trading partners to minimize unintentional non-compliance (i.e., faulty equipment or technique).
- Expand programs abroad like the "Sentinel Plant Network"* to identify future pests and pathways. Species identified as high risk to US trees should be targeted in inspection and surveillance programs.

Restrict the importation of live plants in the same genera as native woody plants in the US.

Mitigate the largest pathway for highly damaging pests, using existing authority and regulatory framework established to address this problem.

- Expand the list of plants in the "Not Authorized for Importation Pending Pest Risk Assessment" (NAPPRA*) category to include all genera of plants that have native woody species in the US.

Tighten enforcement of penalties for non-compliant shipments.

Because of low penalties, failure to comply with wood packaging regulations is a low cost of doing business.

- Increase penalties on importers who violate wood packaging regulations, and levy the penalties consistently.
- Temporarily freeze import authorizations for specific importers for items that consistently fail to comply.

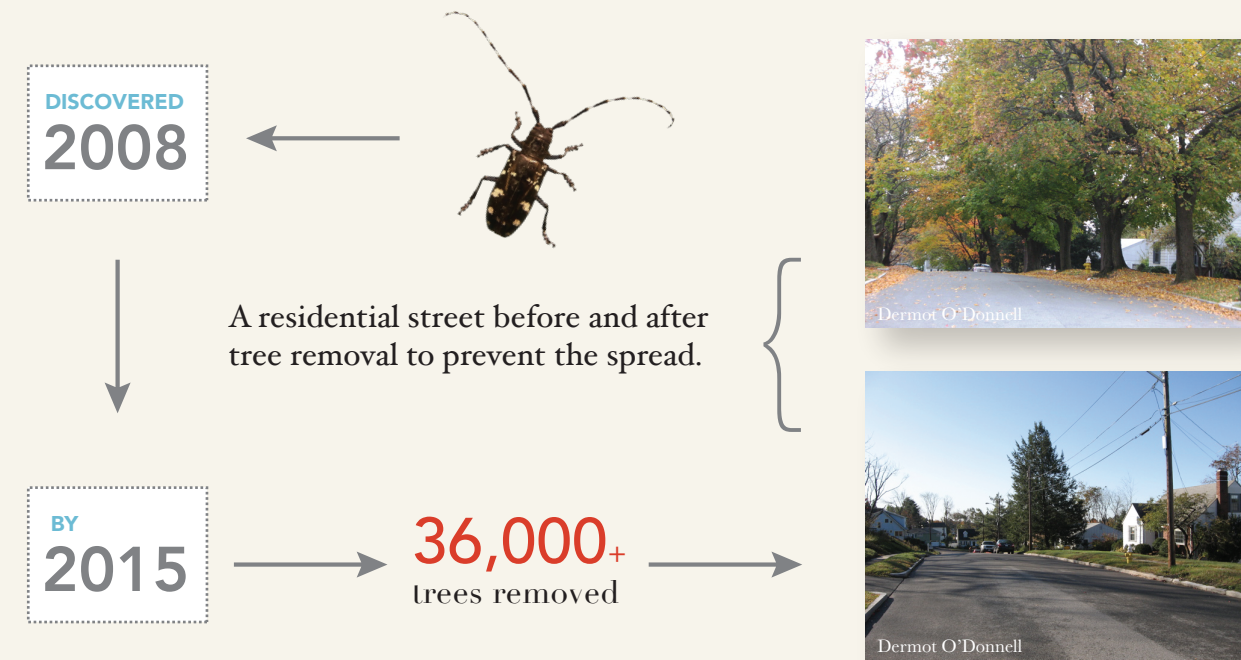
Policies are color-coded to reflect who is responsible for each action.

- **USDA-APHIS**
- **USDA-Secretary of Agriculture**
- **Business/Private Sector**
- **Office of Management & Budget, Executive Branch**
- **Congress**

*Terms defined in the glossary on page 15.

A City Transformed

Worcester, MA & the Asian Longhorned Beetle



Annual benefits of Worcester's urban trees

	ENERGY	Cut down on energy use by providing shade, lowering summertime temperatures, and reducing windspeeds	\$989,814
	CO2	Decrease atmospheric carbon by capturing and storing CO2	\$37,789
	AIR QUALITY	Improve air quality by filtering pollutants and releasing oxygen	\$226,366
	STORMWATER	Reduce stormwater runoff and pollutants entering local water bodies	\$236,116
	PROPERTY VALUES	Increase property values by 3-7%	\$905,769

Data source: Freilicher, M., et al. 2008. Trees in peril: Responding to the Asian longhorned beetle. University of Massachusetts, Amherst.

"Pollution removal alone by US trees provides human health benefits worth **\$6.8 billion per year.**"¹



Solid wood packaging materials, such as pallets and crates, are the fastest-growing source of highly damaging pests. (L) Inspector examines solid wood packaging, (R) Emerald ash borer larva carving a gallery.

SOURCES

Solid Wood Packaging and Nursery Plants Shipped From Other Countries are the Largest Sources of Imported Forest Pests

Forest pests arrive in the US on the ships, trains, airplanes, and trucks that carry cargo and passengers. Imported pests cross our borders and are transported to locations with climatic conditions and plants similar to those of the pest's origin, but which lack the natural enemies and plant defenses that keep the pest in check. Most of our recent damaging pests originated in Asia, and have been transmitted both directly from the origin and indirectly via other trade partners. The global mixing of goods in the complex web of trade means any international trade partner could convey a damaging pest. Since the 1980's,

"More than 90% of the wood-boring insects that have recently invaded the US were conveyed in wood packaging."

increases in containerized shipping as well as escalating trade with Asia, especially China, has been associated with the movement of highly damaging pests.

Solid wood packaging materials, including pallets and crates, are the fastest-growing source of highly damaging pests. Wood-boring insects, such as Asian longhorned beetle and emerald ash borer, can hide within the wood packaging, catching a free ride to a new favorable habitat. More than 90% of the wood-boring insects that have recently invaded the US were conveyed in wood packaging.⁶ Wood-boring insects tend to be particularly effective at killing trees swiftly and are the most costly pests.³ For example, emerald ash borer, which is the most expensive pest to date in the US, costs \$850 million per year in local government expenses, \$380 million in lost property values, \$350 million in homeowner expenses, \$38 million in federal government expenses, and \$60 million in timber losses.³



On Martha's Vineyard, MA, hundreds of acres of oak trees have been killed by winter moth, an imported forest pest that is spreading throughout MA and into neighboring states. Winter moth attacks many hardwoods including oak, maple, basswood, and elm.

International shipments of plants for sale by nurseries represents another large pathway for transmitting forest pests.⁶ Insects and diseases can hitch a ride on these plants and then, after planting, move to nearby native trees.

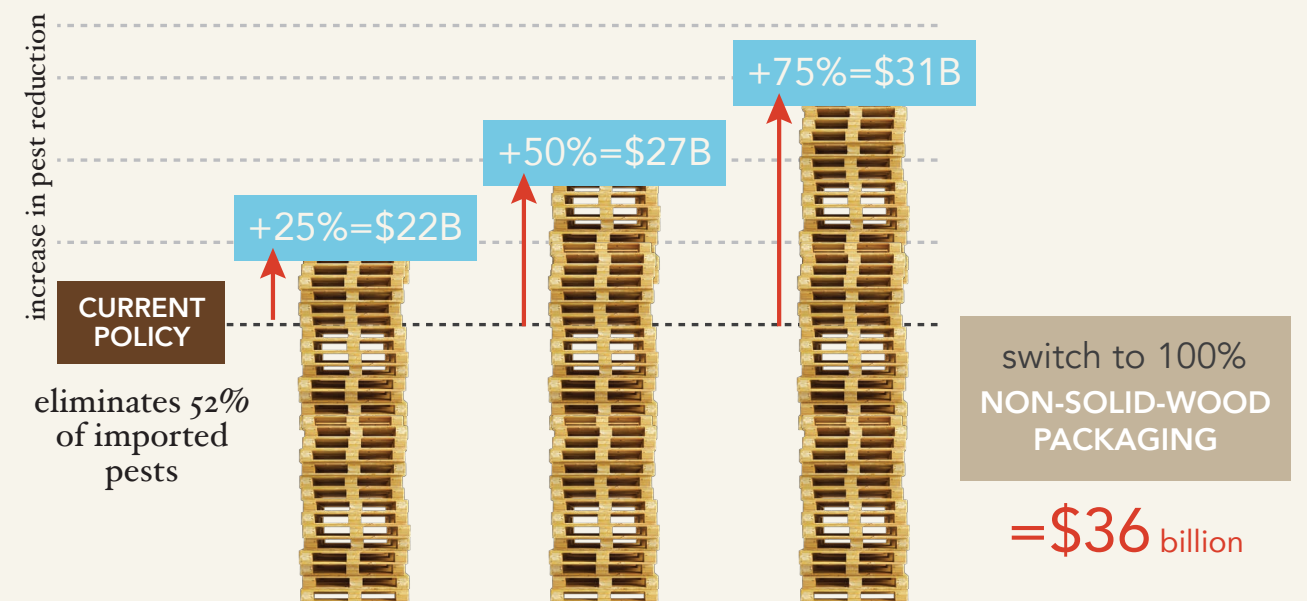
Historically, nearly 70% of damaging forest insects and pathogens are estimated to have arrived in the US by this pathway.⁶ Two well-known examples are hemlock woolly adelgid, the sap-feeding insect threatening hemlock trees, and sudden oak death, a disease that killed 50% of infected California tanoaks within 11 years after establishing.⁷

SOLUTIONS

Tree-SMART Trade Would Protect Trees, Benefit Communities, and Save Billions of Dollars Annually

The current patchwork of international, national, state, and local regulations and protocols that form our national pest prevention system provides important benefits but does not adequately protect US forests from new and costly imported pests. The five high-priority actions outlined in pages 8 and 9 build on existing practices and policies to strengthen prevention and achieve Tree-SMART Trade. Together, these actions would help stem the tide of invasive forest pests and provide very large economic, ecological, and community benefits.

Increase in pest reduction = Increase in economic benefits



Drilling into Solid Wood Packaging

Switching to non-solid-wood packaging is the most effective way of preventing the future importation of damaging forest pests, and is likely to result in large net economic benefits.

The current international standard for solid wood packaging material, ISPM15, requires either heat-treatment or fumigation to reduce pest infestation. Recent studies indicate that these procedures are at most 52% effective at eliminating pests. Because some pests can survive the treatment, pests can re-infest packaging after treatment and untreated packaging can be fraudulently marked as compliant.⁸ Despite its low effectiveness, ISPM15 is projected to provide \$11 billion in net benefits to the US by 2050.⁹ However, this low effectiveness of protection means that in the coming decades, rapidly expanding global trade will bring a wave of new wood-boring insects, far exceeding the number that are already here.⁹

Less-risky alternatives to solid wood packaging exist and are currently being used by some companies. Among the alternatives that are not subject to USDA regulation are plywood, press board, oriented strand board, parallel strand lumber, and metal frames.

But completely switching to alternative materials to prevent transmitting pests will take time. Meanwhile,

improving the effectiveness of treatments combined with partial switching to alternative materials will still provide benefits. A 25% increase in effectiveness above current levels, whether achieved by improving the efficacy of treatments or by switching to alternative materials, would eliminate 65% of pests transmitted via solid wood packaging and provide an estimated \$22 billion economic benefit in the US through 2050. Increases in effectiveness of 50% and 75% would produce economic benefits of \$27 billion and \$31 billion, respectively.

Completely eliminating this pathway by switching to non-solid-wood packing would provide an estimated benefit of \$36 billion through 2050. These total economic benefits do not consider the costs of implementing the more effective regulations and pest-free packaging materials. The cost of implementing the current ISPM15 procedures is estimated at about \$5 billion through 2050,⁹ but the cost of improving the procedures or switching to non-solid-wood packing has not, to our knowledge, been recently evaluated. Nonetheless, these calculations suggest that even if strengthening the procedures tripled the cost, there would still be a substantial net economic benefit.



Exit hole of citrus longhorned beetle illustrates pest transmission via imported plants. International shipments of plants for sale by nurseries are a major pathway for transmitting forest pests. Approximately 2.5 billion plants per year are imported into the US, and a small fraction of those are capable of transmitting forest pests.

Even with improved prevention measures, it is important to collect and routinely analyze data as well as evaluate program efficacy. International trade agreements have a dual mission of reducing movement of harmful pests and pathogens while facilitating trade. These two objectives can be in opposition given that the risk of pest introductions increases with trade volume. With growing international trade and the increasing costs of forest pests, it is important to periodically re-assess whether current US policies are achieving the right balance between facilitating the movement of goods and protecting the nation’s natural resources from new invasions and impacts.

“Tree-SMART Trade would provide very large economic, ecological and community benefits.”

SUMMARY

Imported forest pests threaten US trees and the vast benefits they provide to people and nature. Current US and international policies aimed at preventing introductions have positive effects, but more action is needed to reduce the influx of pests in the face of rapidly expanding global trade. The five prevention measures in Tree-SMART Trade can reduce the establishment of new forest pests, protect forests and trees, and shift costs to the source of the pests, thereby alleviating the economic burden borne disproportionately by homeowners and municipalities.

GLOSSARY

- ISPM** – International Standards For Phytosanitary Measures, developed by the International Plant Protection Convention.
- ISPM15** – Intended to reduce the arrival of wood-boring and phloem-feeding pests in wood packaging material.
- NAPPRA** – A list of plants that are Not Authorized for import Pending Pest Risk Analysis, administered by USDA-APHIS. The rationale for establishing the list was to provide a mechanism for rapidly responding to a changing landscape of risk and knowledge.
- Sentinel Plant Network** – International collaborations in which US trees and other plant varieties are grown abroad and are monitored for pest susceptibility, to provide an early warning system for new and emerging pest and pathogen risks.
- USDA-APHIS** – US Department of Agriculture Animal and Plant Health Inspection Service. US Government agency tasked with facilitating trade while preventing the arrival and establishment of imported pests and pathogens.

The information in this research and policy summary is based primarily on the following paper:
 Lovett, G.M., Weiss, M., Liebhold, A., Holmes, T.P., Leung, B., Lambert, K.F., Orwig, D.A., Campbell, F.T., Rosenthal, J., McCullough, D.G., Wildova, R. Ayres, M.P., Canham, C.D., Foster, D.R., LaDeau, S.L., Weldy, T. 2016. Non-native forest insects and pathogens in the US: Impacts and policy options. Ecological Applications. DOI 10.1890/15-1176.1

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Graphics & Design:
 L. Tumblety, Cary Institute of Ecosystem Studies

For additional information on forest pests and pathogens visit:
www.hungrypests.com/what-you-can-do
foresthealth.fs.usda.gov/portal
treeimprovement.utk.edu/pdfs/Fading_Forests_III.pdf

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Steel Wool

Tree-SMART Trade: Protecting Environmental and Economic Benefits of US Forests

5 policy actions that will help prevent new forest pests.

- S**witch to pest-free packaging materials for international shipments to the US.
- M**inimize new pest outbreaks by expanding early detection and rapid response programs.
- A**ugment international pest prevention programs with key trade partners.
- R**estrict the importation of live plants in the same genera as native woody plants in the US.
- T**ighten enforcement of penalties for non-compliant shipments.



A team of scientists completed the most comprehensive synthesis to date of the ecological and economic impacts of imported forest insects and pathogens. They concluded that preventing future invasions is crucial for stemming this costly and ecologically damaging problem. Based on that research, Cary Institute and the Science Policy Exchange developed this summary and are proposing five Tree-SMART Trade actions that will help safeguard trees and alleviate the economic burden on local governments and communities.