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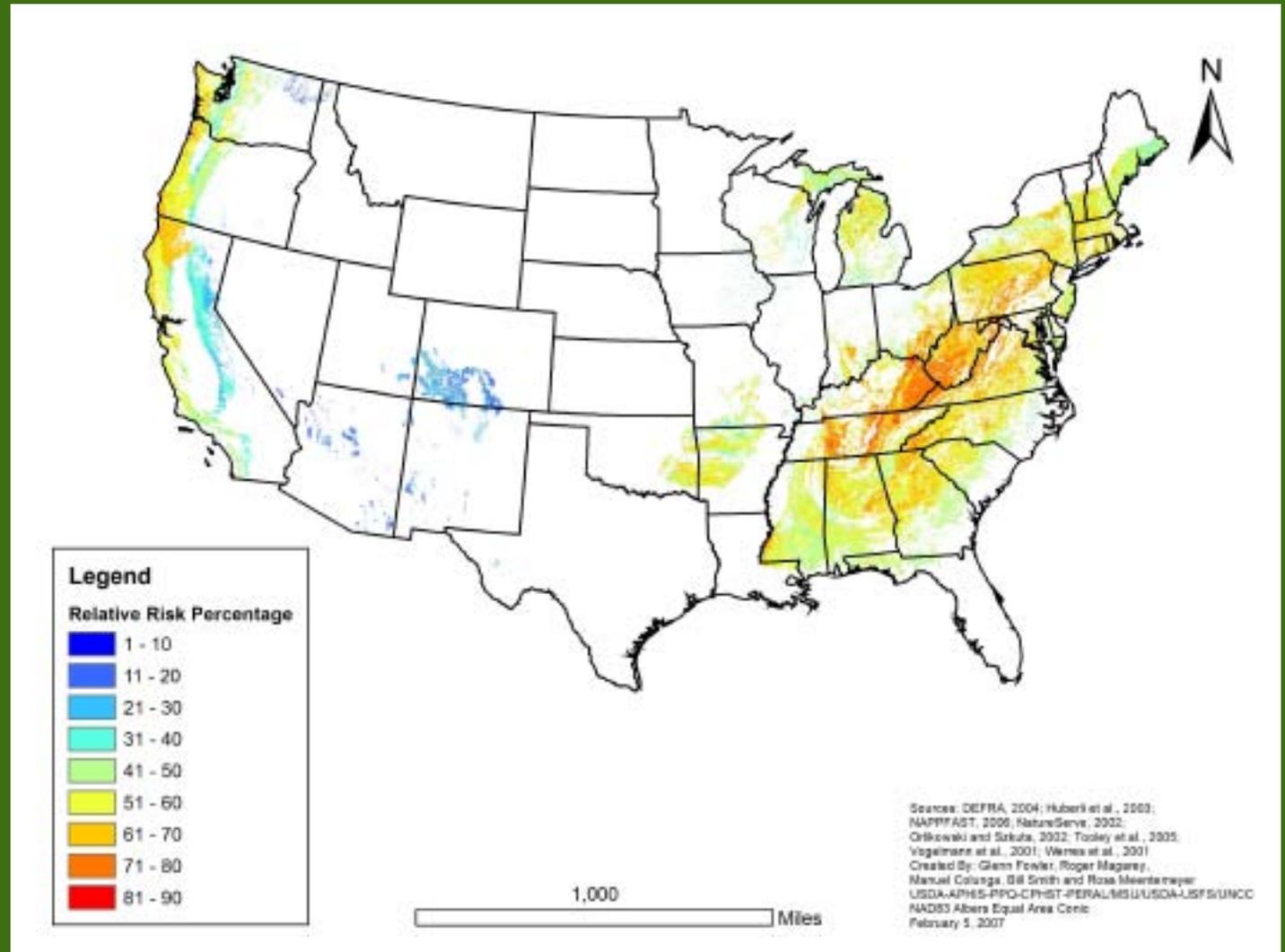
How to Stop Invasive Insects and Diseases
from Devastating U.S. Forests

A Report from The Nature Conservancy's
Global Forest Partnership, Forest Health Program

COVER PHOTOGRAPH Port-Orford-cedar is a major component of the unique plant communities of southwest Oregon. The tree is also a beautiful landscape plant and its timber has a high value. Port-Orford-cedar has been virtually eliminated from lower elevations by a disease introduced on imported plants early in the 20th century.
© Oregon Department of Forestry

AREAS AT RISK TO SUDDEN OAK DEATH (RIGHT)

At least 40 North American tree, shrub and herb species are susceptible to sudden oak death, a disease thought to have been imported on nursery stock. If sudden oak death is transported to eastern states—and there have been several close calls already—species of oak, black walnut and sugar maple, as well as rhododendrons and mountain laurel, might be killed. Oaks alone comprise 38 percent of the total hardwood saw timber volume in the United States and their timber value is estimated to be \$3 billion annually.



Executive Summary

Invasive insects and plant diseases are taking a disastrous toll on U.S. forests. From the spread of sudden oak death through California's woodlands, to the fungus steadily killing eastern dogwoods, to the standing ghosts of dead Fraser fir on mountain peaks in North Carolina, infestations of our nation's forests by invasive insects and diseases are widespread and on the rise.

Imported nursery stock—trees, shrubs, garden plants, roots and cuttings brought in from other countries for sale to the U.S. consumer—is one of two chief pathways that bring invasive insects and diseases into American forests. Once the pests are established, their eradication is, at a minimum, costly and politically difficult. Often it is simply impossible. These infestations not only damage forests but also threaten to cost private landowners, state governments, municipalities and a range of timber- and horticulture-related businesses billions of dollars.

The U.S. Department of Agriculture's Animal and Plant Health Inspection Service (APHIS) is the primary agency tasked with preventing the entry of potentially invasive pests and pathogens via nursery plants and other pathways. Thanks to an emphasis in federal policy and international agreements on facilitating trade, combined with the globalization of the economy, however, the number of nursery plants imported into the United States has skyrocketed in recent years. The existing APHIS regulations governing plant imports date from more than a generation ago, and were crafted to deal with a much lower volume of imports from a much more limited set of exporting nations. They do not afford adequate protection in today's changed economic environment.

In fact, APHIS regulates imports of fruits and vegetables more tightly than it regulates imports of living plants. But imported living plants clearly pose the greater risk of spreading pests and diseases

because the infested plants are already suitable hosts for the pest; the plants are placed in nurseries where many other potential hosts are in close proximity; and then, as they are planted by consumers, the plants are transported into landscapes around the country.

APHIS's current approach to stopping invasive insects and diseases is inadequate to the task. Currently, the agency restricts plant imports only after it undertakes a meticulous risk assessment process—a process so slow that the invaders are often well-established by the time the agency acts to stop them. Furthermore, the risk assessments address known pests only, even though many of the most damaging pests have been unknown to science at the time of their introduction. Indeed, millions of potentially damaging pests and diseases remain unknown today.

Aware of these shortcomings, APHIS is widely expected to move toward an approach that relies on

improved pest management practices by importers and their overseas suppliers—referred to as “clean stock” programs. More immediately, APHIS intends to create a temporary holding category, which it calls “Not Approved Pending Pest Risk Assessment” (NAPPRA). The creation of a NAPPRA category would allow APHIS to suspend importation of suspected pest carriers until a full risk assessment has been completed.

Although APHIS’s proposals tend in the right direction, the agency will not succeed in fulfilling its obligations to protect U.S. forests and trees unless it moves much more assertively in implementing NAPPRA and in developing more comprehensive programs. For example, APHIS proposes under its new NAPPRA regulations to assume that plant imports are safe until an abbreviated assessment process identifies a specific disease or insect that may be imported. But harmful insects and diseases imported in the past were often unknown to science until they began killing American trees. Moreover, the number and variety of plant species imported makes such an approach too slow.

The Nature Conservancy recommends a five-point implementation plan for NAPPRA that would enable APHIS to effectively prevent future infestations, while saving public funds and relieving some of the regulatory backlog that currently hampers the agency.

1. Publicly adopt a high level of pest protection as a national mandate.
2. Create a temporary holding category for imported plants (NAPPRA) and immediately put into it all imported plants and cuttings except those plants with exceptional characteristics that indicate safe importation can continue. To be exempt from the NAPPRA list, plants should at a minimum a) have been widely imported in the past with few interceptions of known pests or diseases and b) be characterized by stable conditions of production and import (volume, origin, cultivation techniques) so that past experience remains a reasonable guide to future risk. Plants on the NAPPRA list could still be imported as tissue culture or seeds, under an approved clean stock program, or under strict quarantine.
3. Create a process that allows reasonably fast decision-making to remove from NAPPRA plants posing little risk.
4. Speed up the pest risk analysis process by first assessing the likeliest pathways of infestation.
5. Work with stakeholders and Congress to secure more resources for risk analyses, prompt

regulation updates, improved methods of detection and pest control and outreach.

The Nature Conservancy believes that such an approach to NAPPRA would be an important first step toward an integrated approach, one that would engage all stakeholders in solving the problem of forest pests introduced on living plants. The organization invites a broad and inclusive discussion of this proposal and other approaches that fairly balance risk, trade and the value of America’s native forests.



U.S. FORESTS FACE A NEW ARMY OF KILLERS: invasive insects and diseases that are arriving on imported nursery plants. For example, many beech trees (above left) are suffering from an imported fungus that is carried by an invasive scale insect and kills the tree (above right). Infestations of foreign insects and diseases have risen sharply in recent years because of the burgeoning international trade in nursery plants.

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I. Forests Under Siege

Imports of Non-Native Pests and Pathogens Are on the Rise

American forests are under attack by invasive, tree-killing insects and disease-causing organisms that originated in other countries. According to the U.S. Department of Agriculture's Animal and Plant Health Inspection Service (APHIS), more than 400 non-native insects and 24 non-native pathogens are now permanently established in North American woodlands.¹

Imported plants, cuttings and seeds, brought to the United States by nurseries for sale to the public, have repeatedly served as the pathway that allows devastating pests to reach our country.² Of the 25 most damaging forest pests introduced since the mid-1800s, 18 are believed to have arrived on nursery stock. Half of the 18 serious pests associated with nursery stock entered the country in the past 35 years (Table 1). With no specialized predators or resistant hosts to keep them under control, these pests can spread aggressively and raise havoc with our forests.

APHIS and USDA Forest Service reported in 2000 that 5 percent of known exotic insects and half of the exotic pathogens “threaten the health, productivity, stability, merchantability and . . . very existence of some trees and forests.”³

And that report didn't reflect damages inflicted by the Asian longhorned beetle, emerald ash borer or sudden oak death—the three non-native invaders that the U.S. government has spent \$420 million since 1997 trying to eradicate or contain.⁴ Those efforts have been not only expensive but also politically challenging, since they have required cutting down mature trees in yards, parks and alongside streets. While the success of Asian longhorned beetle control in Chicago and Hoboken, New Jersey, shows the value of such efforts, New York City and the many locations afflicted with emerald ash borer have not received the necessary funding to stop these insects. Thus the United States has fallen far short of what is needed to con-

trol just these three invasive pests, much less the full range of introduced insects and diseases.

Imported Plants: An Invitation for Trouble

Imported nursery stock poses a particular hazard because these plants often harbor insects and diseases that prove to be invasive in our forests, yet the invaders can be difficult to spot during inspection by APHIS at the U.S. border. Difficulties with inspection include the relatively small percentage of plants inspected (presently less than 2% of an exponentially increasing volume of imports), and the fact that many diseases and pests that live under bark can be difficult to detect in an inspection. Because the pests and pathogens arrive on live hosts, they can survive a relatively long time. In many cases, they survive long enough to arrive at a nursery, where they can spread to other plants, including new host plants, or even develop new



DISEASES AND INSECTS that arrive on imported nursery plants pose a particular hazard because they enjoy a built-in free ride: their hosts are distributed to nurseries all over the country and then planted by unsuspecting consumers. These imported geraniums are infected with a non-native pathogen that kills potatoes, tomatoes, peppers and other important crops. © USDA APHIS

characteristics by breeding with related diseases or insects already present

The other significant problem with imported nursery stock is that these plants are distributed all over the United States. Many end up planted in places where it is a short hop to local forests.

Unfortunately, the diversity of U.S. forests makes them particularly susceptible to these kinds of invasions. Representatives of almost every type of vegetation that occurs worldwide can be found within the United States or its territories; for example, more than 150 of America's tree genera are shared with Europe or Asia.⁵ In addition, thou-

sands of non-native plant species are grown for horticulture, Christmas trees and other uses, and still others have established themselves in the wild.⁶ This combination of native and non-native species across the United States provides ample opportunities for imported pests to find suitable hosts.⁷

Yet despite these risks, the United States currently imposes very few restrictions on imports of nursery stock. This is a significant departure from earlier policies, with potentially catastrophic consequences.

In the past, imported plants were subjected to stringent regulations intended to prevent the introduction of plant pests. APHIS strictly regulated the number and types of plants imported, typically limiting imports to either seed or fewer than 100 plants. It also fumigated all imported plants to kill insect pests. Finally, APHIS restricted or prohibited imports of plants that might carry pathogens that fumigation could not control.

Today, APHIS allows unlimited numbers of plants to be imported into the United States, even if those plants have not been analyzed regarding their pest risk. One reason for this relatively unrestricted flow is the requirement under international trade agreements that APHIS justify any permanent regulation by first completing a pest risk analysis that evaluates specific, named pests.

In fact, APHIS regulates imports of fruits and vegetables more tightly than living plants, even

The Mandate to Stop Plant Pests and Diseases

Under the Plant Protection Act of 2000 (7 U.S.C. 7701, et seq.), APHIS is charged with facilitating trade in items that pose a risk of harboring plant pests “in ways that will reduce, to the extent practicable, as determined by the Secretary [of Agriculture], the risk of dissemination of plant pests or noxious weeds.” APHIS is to base decisions affecting trade in these goods on sound science. Furthermore, APHIS is authorized to take actions to eradicate or contain plant pests or noxious weeds that are new to the country or not widespread. In so doing, APHIS may “hold, seize, quarantine, treat, apply other remedial measures to, destroy, or otherwise dispose of” any plant, article, or means of conveyance that the Secretary has reason to believe threatens to assist the survival or dispersal of that plant pest or noxious weed. “Plant pest” is defined to include plant disease organisms.

though pests that arrive on living plants are more likely to survive and spread. This discrepancy probably arose from APHIS’s past focus on threats to American agriculture. This has now been expanded to include natural resources, but live plant rules are still under revision. The less-effective regulations governing nursery plants unfairly ignore the risk to the \$231 billion forest products industry, as well as to municipalities and homeowners.

Additionally, APHIS relies almost entirely on visual inspection of the imported plants to detect a limited set of organisms already known to be dangerous. Although inspection takes place at a specialized plant inspection station, it remains an

inadequate safeguard. To quote APHIS in a recent description of its program, published in the Federal Register,⁸ “[Visual] inspection may not always provide an adequate level of protection against quarantine pests, particularly if the pest is rare, small in size, borne within the plant, an asymptomatic plant pathogen, or not yet recognized and regulated as a quarantine pest.”⁹ As Table 1 illustrates, the American people are paying a heavy price for this change in policy, which supports trade without attention to its consequences.

Meanwhile, the flow of foreign plants into the United States continues to grow. Some 450 million plants were imported into the United States in

1993.¹⁰ More than 2 billion plants were imported in 2005.¹¹ A 2006 analysis noted that China plans to ramp up its exports of live plants substantially in the next few years.¹²

Compounding the problem is a lack of staff at APHIS, a shortcoming well recognized by the agency itself and many of its stakeholders. In brief, while the volume of incoming shipments of plants has increased dramatically, APHIS staff and budget have not increased commensurately. There is a shortfall in the number of inspectors, risk analysts, regulatory analysts and other key staff positions.

As a result, APHIS cannot initiate needed amendments to its regulations to reduce pest risks

TABLE 1
Recent Introductions of Damaging Insects and Diseases Via Imported Nursery Stock

INSECT OR PATHOGEN	HOSTS	APPROXIMATE DATE INTRODUCED
Dogwood anthracnose	Flowering and Pacific dogwoods	Before 1976 ¹⁴
Sudden oak death	Oaks and other hardwood and coniferous trees; numerous hardwood shrubs	Actual time unknown, but best estimate is during the 1980s ¹⁵
Bromeliad weevil	more than 12 native species of bromeliads (air plants)	Before 1989 ¹⁶
Citrus longhorned beetle	Variety of hardwood species	1999; 2001 ¹⁷ (believed to have been eradicated)
lobate lac scale	more than 120 species in 44 families of woody plants	1999 ¹⁸
Asian cycad scale	Cycads	Probably 2000 ¹⁹
Erythrina gall wasp	Trees and shrubs in the Erythrina genus (coral trees; native coral bean in the southwest, red cardinal shrub in the southeast, and wiliwili tree in Hawaii)	2004 ²⁰
`o`hia rust	Trees in Myrtaceae family, including `o`hia (the dominant native tree in Hawaii)	2004 in Hawaii ²¹ ; earlier in Florida ²²
Cycad blue butterfly	Cycads	2005 ²³

in a timely manner. Staffing shortfalls are particularly troublesome because of the extensive risk analyses that must be conducted before a regulation may be updated. Only in emergencies does APHIS act before completing a risk assessment. According to the agency itself,¹³ this lack of resources has delayed evaluations of a significant number of pests that could be introduced to the United States via imports of nursery plants.

High Ecological Stakes

Because U.S. trees and plants did not evolve with the invaders from other continents, they often have limited genetic resistance to them.²⁴ In some cases, imported insects and diseases virtually eradicate American plant species from their natural habitat (Table 2). Such was the case with chestnut blight, which between 1900 and 1950 all but elimi-

nated the native chestnut tree from eastern forests and set off a cascade of changes not only to forest composition but also to the diversity of plants and animals throughout the East.

Today, many forests and plants are at similar risk:

- A fungal disease, dogwood anthracnose, is steadily eliminating the eastern, or flowering, dogwood from North American forests. Dogwood fruits are a valuable food source for migratory birds and mammals, and the twigs are browsed by a variety of animals.²⁵ The tree's fallen leaves provide a significant amount of calcium to forest soils.²⁶ It is also a beloved ornamental tree of suburban yards in the most densely settled portion of the East Coast
- A pathogen from tropical South America known as 'o'hia rust threatens the most abundant and

widespread tree species in Hawaiian forests — 'o'hia trees. At least six additional species of trees and shrubs endemic to Hawaii are also vulnerable to the foreign rust, including one federally listed endangered species, nioi (*Eugenia koolauensis*). 'O'hia forests protect the state's watersheds and provide essential habitat for all surviving Hawaiian honeycreeper birds, including 14 species that appear on the federal or state endangered species lists.

- The introduced bromeliad weevil (*Metamasius californica*) is killing native bromeliads (air plants) throughout southern Florida's forests. Already, the state has declared two species of bromeliads endangered because of the impact of the weevil. The weevil appears likely to spread to all vulnerable parts of Florida, including Big Cypress National Preserve and Everglades National Park.

The consequences of uncontrolled infestations can be both profound and permanent. As trees die, forest productivity often declines, especially when the tree species that fill the gaps are themselves prone to insects and diseases. If a new tree species becomes dominant, its fallen leaves and branches release different nutrients into the soil, which can further influence which species grow well and which do not. The rapid die-offs that follow in the wake of insect and disease invasions can also dis-

TABLE 2
Native Tree Species That Have Been or Are Being Virtually Eliminated by Imported Insects and Diseases

SPECIES	IMPORTED INSECT OR PATHOGEN	DATE INTRODUCED
western white pines	white pine blister rust	early 20 th century
flowering dogwood	dogwood anthracnose	before 1976
Port-Orford-cedar	Port-Orford-cedar root disease	approximately 1920
American chestnut	chestnut blight	late 19 th century
butternut	butternut canker	1930s



THE INFAMOUS CHESTNUT BLIGHT that all but eradicated chestnut trees from Eastern forests in the last century got its foothold in the U.S. by hitching a ride. The disease arrived on imported trees from Japan that were sold through the nursery trade sometime around 1900. See sidebar, at right.

© Andrej Kunca, National Forest Centre - Slovakia, www.forestryimages.org

rupt a forest's hydrology, increase vulnerability to wildfire and increase soil erosion.²⁷ Eventually, the cycle of disturbance and change can so alter a forest's ecology that it cannot support its original complement of native wildlife, and its beauty and economic usefulness may be irreparably damaged.

While we can prevent non-native pests and pathogens from arriving, once they are here, the options for controlling them are limited and unpopular. Tree bark shelters many pests from sprays and other control agents. Cutting down infected trees often meets with public opposition, especially when it occurs in urban and suburban

The Demise of the Chestnut

First detected in New York City in 1904, chestnut blight probably entered the eastern forests of the United States from Japanese chestnut trees imported as nursery stock in the late 1800s.²⁸ Within 50 years, chestnut blight had spread throughout the chestnut's range from Maine to Alabama. Despite efforts to control the pathogen soon after its discovery, the blight caused the death of trees constituting one-quarter of the standing timber in eastern forests.²⁹

The chestnut produced large crops of nuts each and every year, unlike the oaks, hickories and other trees that have replaced it. Scientists may never be able to quantify exactly how important those nuts were to wildlife, partly because wildlife biology was not well-developed at the turn of the 20th century and partly because widespread timber harvesting compounded the effects of chestnut blight. Historical accounts and old photographs, however, clearly indicate that wildlife was much more abundant before the blight decimated the chestnut. The disappearance of the chestnut probably drastically reduced populations of black bears and turkeys. The American chestnut also provided timber, food, tannin and wood products that were important to early European settlers.³⁰



settings. Even when control measures are successful, forests suffer from cutting, spraying and injecting. The forest may lose decades or even centuries of growth.

Mounting Economic Costs

As of early 2007, no published study has tallied the total economic costs exacted by non-native for-

est pests and pathogens. Those costs include not only the expenditures of public agencies to control invasive species but also the value of destroyed timber, a decrease in nature tourism and declines in property values. The impairment of key ecological services provided by forests, such as water filtration and prevention of soil erosion, creates additional costs, such as the need for greater purification by

public water utilities. Invading insects and diseases also reduce the ability of our commercial forests and preserves to sustain wildlife, which may force public agencies to spend more time and resources on protecting endangered species.

A general understanding of how these economic damages mount can be deduced from the examples of a few individual pests, imported on nursery plants, that are currently invading U.S. forests:

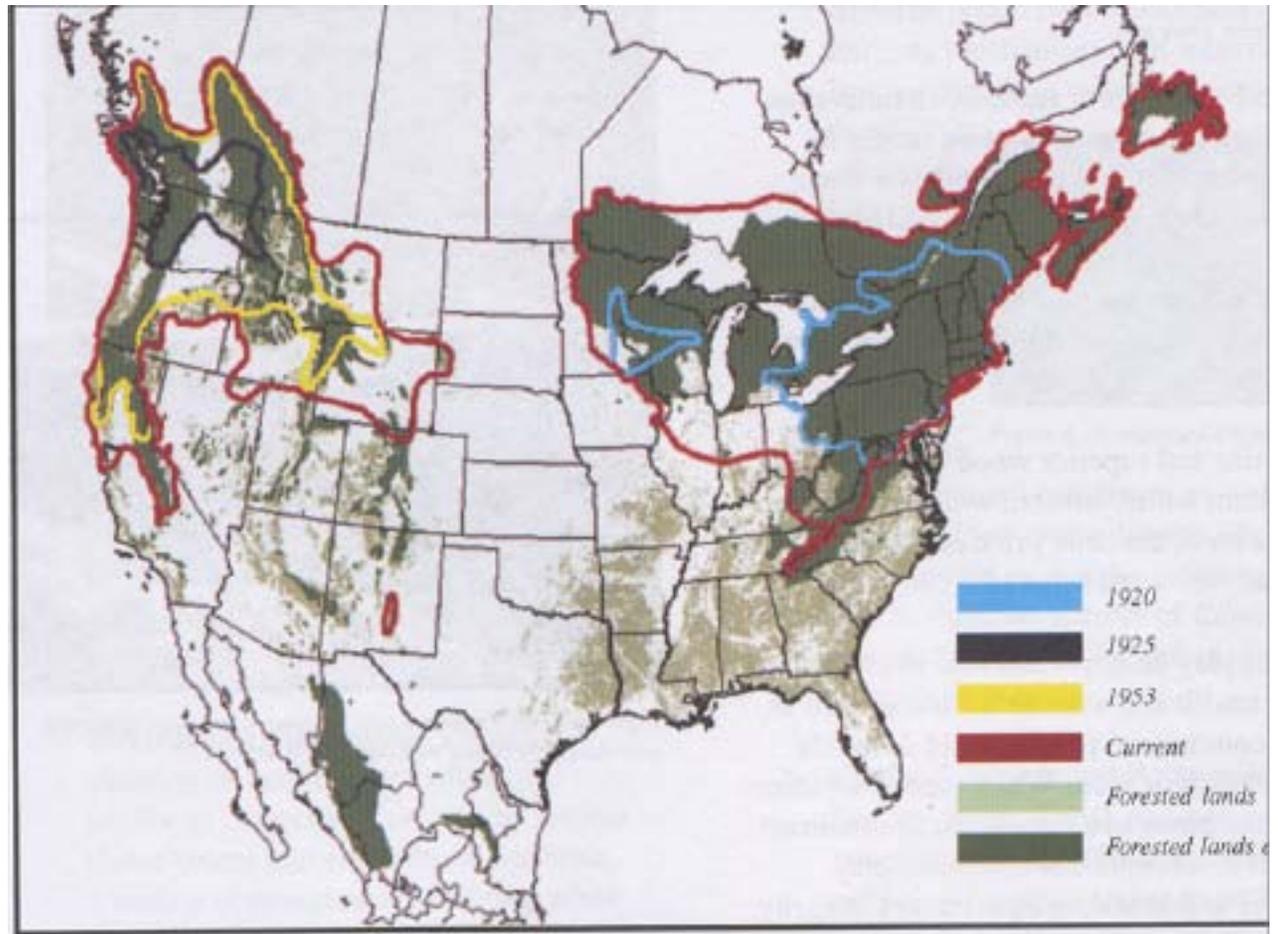
- **Sudden Oak Death:** At least 40 North American tree, shrub and herb species are susceptible to the imported disease known as sudden oak death. More than 1 million trees in California and southwestern Oregon have died already³¹, and millions more are at risk along a 1,500-mile stretch of the Pacific Coast. In 2004, millions of nursery plants exposed to the disease were shipped throughout the country. APHIS adopted more stringent regulations to prevent a repetition of this event. However, small numbers of infected plants continue to be found in nurseries.

If sudden oak death is transported on nursery stock to eastern states, several species of oak, black walnut and sugar maple, as well as rhododendrons and mountain laurel, might be killed (see inside front cover). Oaks alone comprise 38 percent of the total hardwood saw timber volume in the United States.³² The timber value of oaks is estimated to be \$3 billion annually.³³

- White Pine Blister Rust:** White pine blister rust was introduced early in the 20th century on pine seedlings imported for forestry plantings.³⁴ The disease attacks a dozen North American tree species³⁵, including one of the most important timber species in the West: western white pine.³⁶ In the first half of the 20th century, authorities spent more than \$100 million in a largely futile effort to contain the disease.³⁷ White pine blister rust is believed to have killed or damaged 80 to 95 percent of western white pine, sugar pine and eastern white pine (see map). Forests on 9 million acres in Idaho, Montana, Oregon, Washington and California have been affected by losses that range from reduced timber values because of damaged wood to the death of both mature and seedling trees.³⁸ In some areas, the Douglas-fir and grand fir trees that have replaced white pines experience chronic poor health and are vulnerable to native root diseases and insects.³⁹

The USDA Forest Service has spent decades breeding rust-resistant pines for the western timberlands, an endeavor described as “expensive but promising.” However, there are credible concerns that the pathogen might evolve to overcome these forms of resistance.⁴⁰

- Citrus Longhorned Beetle:** The citrus longhorned beetle kills a wide range of hardwood species, including maple, oak, willow and poplar. The beetle was discovered in 2001 on quaran-



THE SPREAD OF WHITE PINE BLISTER RUST

A century after its introduction, white pine blister rust is now reaching mountaintop ecosystems where it is attacking key tree species such as the bristlecone pine (far left)—a species that can live up to 4,000 years. Indeed, the disease is now affecting a dozen North American tree species and has spread throughout much of the northern United States.

Map © USDA Forest Service

Photo (far left) © John Dittli

What Is a Forest Worth?

Urban and rural forests cover one-quarter of North America, sustaining biological diversity and providing clean air and water to hundreds of millions of people. Forest products and related industries employ more than 1.6 million people and contribute \$231.5 billion to our nation's economy.⁴³ Forests also provide enjoyment to millions of hikers, campers, hunters, anglers, birders and other recreational users, whose activities and buying habits contribute tens of billions of dollars to local economies. Perhaps most important, our forests—urban, suburban, rural and wild—are part of our national heritage, providing beauty and shade to our homes and comfort to our spirits.

tined, imported maple trees in a plant nursery near Seattle. During the summer of 2002, APHIS and the Washington Department of Agriculture cut and chipped 1,000 trees located on nearby city streets and in yards—in hopes of eradicating this dangerous pest⁴¹ Subsequent surveys appear to confirm that the insect was eradicated, but government agencies remain concerned and vigilant.

As these examples illustrate, the costs of invasive insects and diseases introduced via imported nursery stock go far beyond federal dollars expended in efforts to control them. First, there are direct losses to horticultural importers when newly introduced pests damage their crops. Second, quarantines imposed to contain the pest can require the destruction of nurseries' inventory and the disruption of sales. Third, as the pest becomes established and spreads, landowners unrelated to the original importer suffer economic losses from the reduced productivity or outright death of infected trees and shrubs. Finally, the removal of infested trees creates substantial burdens not only on federal agencies but also on state governments, municipalities and homeowners. For example, although not introduced via nursery stock, the Asian longhorned beetle is a non-native insect currently causing great damage in New Jersey and New York. If it spreads, it could create an estimated \$669 billion in costs for municipalities across the nation.⁴²



IN 2002, FEDERAL AND STATE AGENCIES cut and chipped some 1,000 trees in a neighborhood outside Seattle (before and after, above) to eradicate a voracious invasive insect: the citrus longhorned beetle, which was discovered on imported maple trees at a local nursery. State agencies, municipalities and private landowners often bear significant financial burdens—through no fault of their own—when imported nursery plants carry insects and diseases into the country. © Washington State Department of Agriculture

II. An Inadequate Game Plan

Proposals by APHIS Do Not Go Far Enough

In 2004, APHIS published an Advance Notice of Proposed Rulemaking (ANPR) in the Federal Register⁴⁴ in which it stated, "... [current import] conditions are believed to have led to several pest introductions in recent years." To address the problem, APHIS has proposed modifying Quarantine-37 (Q-37), the federal quarantine regulating the importation of nursery plants, roots, bulbs, seeds and other plant products into the United States. This proposal is still under consideration, and the agency expects to request public comments on a series of specific proposals over coming years. APHIS is widely expected to move toward an approach that relies on so-called "clean stock" programs, in which importers and their overseas suppliers implement better pest management.

But all of this will take years to develop and implement. In the meantime, we need temporary regulations to slow the flood of imported pests while we build a comprehensive system. As a first

step in the revision of the Q-37 regulations, APHIS proposes creating a category called "Not Approved Pending Pest Risk Assessment," abbreviated as NAPPRA. This would be a temporary holding category for plants that are suspected of harboring damaging pests. The plants in NAPPRA would be listed as host/origin combinations, meaning a specific species from a specific place, such as rhododendrons from China.

APHIS has said that the NAPPRA category provides the flexibility needed to act quickly under international trade agreements. Since the combinations of a given plant produced in a given nation or region (called plant/origin combinations in the rest of this report) are placed in the NAPPRA category on an interim basis, the agency is not required to complete a pest risk analysis before taking this action.

But the NAPPRA approach is likely to fail to reduce either the flow of pests or APHIS's work backlog unless the criteria for placing plants in NAPPRA are altered. In its initial characterization of the approach, APHIS proposed that plants be placed in the NAPPRA category only if they meet all three of the following criteria:

- There is credible evidence that one or more specific pests has the potential to cause ecological or economic harm; and
- the pests can be identified and defined; and
- the pests are not already present or widely distributed in the United States.

If a plant/origin combination does not meet all three of the above criteria, it will not go into the NAPPRA category.

Furthermore, APHIS also proposes a phased approach to the use of the NAPPRA category.

The Elements of an Effective Importation Plan

The United States can participate in international trade in nursery plants and protect its forests, but only if it develops a comprehensive pest detection and containment system that includes at least the following components:

1. Phase in regulations, both in U.S. policy and through international trade organizations, that ensure that only pest-free plants are shipped in international trade.
2. Improve the identification of potential pests. For example, ask botanical gardens overseas to monitor their plantings of North American species for pests and diseases.
3. Develop contingency plans for eradicating any outbreaks of the pests so identified.
4. Provide incentives to producers to implement clean stock programs and to shift to plant types that are unlikely to transport pests, such as tissue culture plantlets.
5. Inspect plants at their places of origin, before they are shipped to the United States.
6. Strengthen quarantines of imported plants to prevent the escape of any pests.
7. Create an insurance program under which nurseries that participate in clean stock and early detection programs can be reimbursed for losses suffered when pests damage inventory despite the nurseries' best efforts.
8. Improve measures to prevent the movement of infected nursery stock within the country.
9. Charge a modest user fee for the full range of plant imports to help fund the overall pest prevention and eradication programs.

Developing a comprehensive approach that meets the requirements of international trade agreements will be time consuming. In the short term, APHIS should institute the temporary NAP-PRA category to free up time and resources for the development of a long-term, effective system.

First, NAPPRA would include only the small group of plant/origin combinations that are known hosts to internationally recognized quarantine pests and that have not yet been imported into the United States. Later, APHIS would expand NAPPRA to include plants that are hosts to internationally recognized quarantine pests and are infrequently imported to the United States. It would also include plants from countries that do not institute adequate safeguards to prevent the introduction of the quarantine pest. Finally, after years of collecting and analyzing plant import data, APHIS would add to NAPPRA all plants that had not been assessed or otherwise regulated.



APHIS's TENTATIVE PROPOSALS don't address the problem of imported pathogens that evolve into more harmful forms once they arrive. Scientists have found as many as five species of the pathogenic genus *Phytophthora* (see sidebar, p. 15) on a single nursery plant—an indication that the pathogen mutates and hybridizes on the nursery plants themselves. © Canadian Food Inspection Agency; thanks to California Oak Mortality Task Force

Why APHIS's Proposal Does Not Go Far Enough

Although NAPPRA itself is an excellent idea, the approach to its implementation proposed by APHIS doesn't address four key realities of invasive insects and pathogens.

- **The proposal does not address species unknown to science.**

Conservationists and government officials are increasingly confronting damage caused by organisms that were unknown to science at the time of their introduction. Table 3 lists several examples of serious forest pests that were unknown when they arrived in the United States. But APHIS proposes to build its program based on lists of known pests or organisms. Specifically, criterion two for inclusion in NAPPRA specifies that pests must be identified and defined. At present this can occur only by the slow risk assessment process or by the unfortunate experience of past harmful introductions. In the future, a network of scientists and botanical gardens could track infestations on North American tree species planted abroad, but such data will not be available for years. Thus, APHIS's approach will fail to prevent introductions of a group of pests known to have caused damage in the past and likely to cause significant damage to our trees and forests in the future.

TABLE 3

Serious Forest Pests Unknown to Science at the Time of Their Introduction

• <i>Cryphonectria parasitica</i>	chestnut blight
• <i>Discula destructiva</i>	dogwood anthracnose
• <i>Phytophthora lateralis</i>	Port-Orford-cedar root disease
• <i>Phytophthora ramorum</i>	sudden oak death
• <i>Sirococcus clavigignenti-juglandacearum</i>	butternut canker



OREGON OFFICIALS AND THE U.S. FOREST SERVICE are trying to eradicate sudden oak death by cutting and burning all host trees near the site of the infestations. APHIS has the authority to temporarily halt plant imports until it can assess how much risk certain species and places of origin pose to U.S. forests, which would help avoid expensive and damaging control efforts like those shown above. © Oregon Department of Forestry

Scientific Justification for the NAPPO Regional Standard

A concept paper developed by the Plants for Planting Panel of the North American Plant Protection Organization (an organization that coordinates efforts among Canada, the United States and Mexico to protect each country's plant resources from regulated plant pests, while facilitating international and intraregional trade)⁵¹ notes that risk assessments based on lists of known quarantine pests do not address adequately numerous uncertainties, including the following:

- Many potential pests are obscure or unknown and most pathogens are poorly understood.
- The impact of insects and pathogens in their native environment is an unreliable indicator of their behavior in a new ecosystem.
- There is great potential for genetic change or variability in pests and hosts.

In addition, countries' reliance on visual inspection at the ports is undercut by the failure of resources to keep pace with the rapidly increasing volume of imports.

It is quite likely that unknown or poorly known organisms will continue to enter the United States, since scientists know little about several biological groups that include many plant pests. The number of insects, mites and other arthropods on Earth is unknown. Estimates range from a few million to tens of millions, but fewer than 1 million have been described.⁴⁵ Only an estimated 7 percent of fungal species have been described and studied.⁴⁶ Native ranges are unknown for many of the organisms that have been described. APHIS acknowledged this low level of knowledge in the 2004 ANPR.

- **The proposal does not address the unpredictable behavior of invasive insects and pathogens.**

Even when an organism is known to science, its behavior in its native environment is an unreliable indicator of its behavior in a new ecosystem. "Experience shows that the pestilence of an organism cannot be predicted from its status in its native country," wrote William Wallner, a forest pathologist with the USDA Forest Service. "For example, only 18 percent of immigrant insects and mites in the United States behaved exactly as one would have expected from their behavior in their country of origin."⁴⁷ According to another report, among 212 significant plant pest species that were reviewed, only 73 had been expected to be pests based on their

behavior elsewhere. The other two-thirds surprised agricultural officials with their virulence.⁴⁸

- **The proposal does not address the risks posed by hybridizing insects and pathogens.**

A further complicating factor is the potential for introduced organisms to hybridize with related species. The resulting hybrids can have new characteristics that allow them to increase their virulence, displace native species and modify or expand host ranges.

As the British forest pathologist Clive Brasier has pointed out numerous times, nurseries holding a range of plants imported from countries around the world offer ideal situations to promote hybridization of any pathogens that have accompanied the plants into the nursery. "As many as five different *Phytophthora* species have been isolated from a single potted nursery alder seedling," he writes. "This indicates a considerable potential for evolution—via hybridization between species—of entirely new or genetically modified forest *Phytophthora* species."⁴⁹

Brasier's reference to the genus *Phytophthora* is particularly apt as this genus has caused immense damage in forests, including the current sudden oak death syndrome on the Pacific Coast. According to Dr. Everett Hansen, of Oregon State University, 11 different genotypes of *Phytophthora ramorum*—

APHIS'S PROPOSED NEW REGULATIONS won't stop new, damaging diseases like sudden oak death (infected plants, right) from slipping into the United States because the regulations don't consider pathogens that are not yet well known. By contrast, The Nature Conservancy's plan does address the risk from insects and pathogens not yet known. © Above: Jennifer Parke, Oregon State University
Below: Diseased plants in a nursery; © Jonathan Jones, USDA APHIS.

the pathogen that causes sudden oak death—have been found on infected plants in Oregon nurseries. In California nurseries, Dr. Matteo Garbelotto, of the University of California at Berkeley, has identified six separate genotypes of the pathogen. This genetic variability within nursery populations is likely the result of multiple introductions and subsequent hybridization.

- **The proposal doesn't acknowledge the resource issues that constrain APHIS**

The APHIS proposal keeps the burden of proving risk on the agency and allows continued imports until that burden is met. Yet it seems all but certain that APHIS will continue to face staffing shortfalls, which will inevitably delay additions of even high-risk species to the NAPPRA list.



A Brief Biology of *Phytophthora*

The genus *Phytophthora* includes many of the world's most destructive plant diseases, including the species that caused the Irish potato blight in the mid 1800s as well as the cause of today's sudden oak death. In an invaded plant, the *Phytophthora* organism penetrates the spaces between plant cells and even the cells themselves, eventually infesting much of the plant's tissue.

Phytophthora species have shown the ability to shift hosts, sometimes infesting species previously thought to be resistant. The genus is not closely related to fungi, but shares a lineage with brown algae (better known as diatoms).⁵⁰

III. Common-Sense Measures That Can Stop Invasive Insects and Pathogens

Given the pace of invasive insect and disease introductions and the acknowledged weaknesses of the current program, APHIS needs to move quickly to close the door on these imported invaders. APHIS should do so by making significant improvements to the Q-37 regulations within the next three to four years. Specifically, APHIS should make realistic assessments of risk and shift its focus to prevention. A five-point approach would make this possible.

- 1. APHIS should adopt a goal of allowing fewer than one new forest pest to enter the country via the nursery stock pathway during a 30-year period.**

Achieving this goal will be challenging—more than 10 pests have entered the country via nursery stock in the past 30 years—but the American people deserve nothing less.

Publicly adopting a high level of protection is essential. Such a stance not only acknowledges the real costs of invasive insects and pathogens, but also ensures that APHIS remains in compliance with the terms of international trade agreements. Under the agreements, the United States government is allowed to set its acceptable level of risk and can then adopt more stringent measures, as long as it can demonstrate that those restrictions are necessary to achieve the clearly stated goal.⁵²

- 2. By the end of 2007, APHIS should put in place a rule establishing a temporary holding category for plants suspected of harboring damaging pests—NAPPRA—and immediately put into that category all imported whole plants and cuttings except those that meet a narrowly defined set of exemptions. Plants in the NAPPRA category could continue to be imported under certain conditions, outlined below.**

Such an approach is needed because nearly all imported plants present a significant risk of bringing damaging pests and pathogens with them. APHIS should work with stakeholders and scientific experts to determine if these risks can be minimized before imports are allowed.

While a plant is in the NAPPRA category, APHIS should allow imports of it only if it is imported in the form of tissue culture or seed; or if it is held in quarantine at a secure containment facility long enough to ensure that it is pest- and disease-free; or if it is imported from a third-party certified clean stock program.

The secure containment facilities should be under the supervision of APHIS or a state department of agriculture. If a state accepts the burden of supervising such facilities, APHIS should grant authority to the state to reject any import deemed too risky. The agency should also allow participating states to charge a fee for quarantine service.

In assessing plants that could be exempted from the NAPPRA category, it is important to consider the rapidly changing structure of the horticulture industry worldwide. Pest interception records from plant/origin combinations that have been imported in the past could provide some predictive value as to whether those plant/origin combinations might be safe in the future. But even plant/origin combinations with few past interception records may not reflect present or future risk.

There are at least three additional criteria that need to be examined. First, the volume of imports of a given plant/origin combination may have increased radically in recent years. If one assumes that the probability of a pest being found on any given individual plant remains constant, increasing the volume of plants imported increases the overall probability that an introduction will occur. But as volumes of plants produced increase in a given region, it is likely that there will be changes in plant rearing practices that may increase risks. Changes in plant-rearing practices in the country of origin is a second factor that must be considered. Finally, as global trade moves insects and diseases to new parts of the world, there may be new pests or diseases available for transport to the United States, even from long-time trading partners. For example, *Phytophthora kernoviae* is a plant disease now present in Europe that is not native to that continent. All three criteria must be assessed along with past pest



USDA APHIS relies on visual inspections alone to detect pests and diseases on imported plants. Unfortunately, many damaging insects or diseases are likely to escape detection, so this strategy by itself cannot protect U.S. forests. The citrus longhorned beetle kills a wide range of hardwood species. Its larvae are two inches long, but they have escaped detection by U.S. inspectors several times.

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interception records in deciding whether even plant/origin combinations with a history of importation can be exempted from NAPPRA. It is vital that imports of new plant species or imports of

well-known species from new nations or regions be included in NAPPRA.

The Nature Conservancy recommends that to be eligible for exemption from NAPPRA, a plant

must at minimum a) have been widely imported in the past from a specific region or country with few interceptions of pests or diseases, and b) be characterized by stable conditions of production and import (number of plants imported, cultivation techniques, pest and pathogen environment in the origin country), so that past experience remains a reasonable guide to future risk.

3. APHIS should create a process that allows reasonably fast decision-making to remove from NAPPPRA plants posing little risk.

A speedy review will get low-risk plants back on the market with little delay.

4. APHIS should speed up and improve its pest risk analysis by first assessing likely and broadly defined pathways of infestation.

APHIS faces a huge backlog of risk assessments in part because it targets those studies too narrowly—for example, for one or a few genera of plants to be imported from a single country. The Nature Conservancy recommends that APHIS define these pathways broadly. One approach might be to evaluate risks and determine effective measures to counter pests associated with any bare-root woody plants from a particular region, for example East Asia. Alternatively, APHIS might assess pests associated with roots or stems, without limiting the

study to particular kinds of plants or geographic regions of origin. A third approach might be to determine how to prevent the presence on any imported plant of a particular type of pest, such as a fungal pathogen. By assessing the highest-risk pathways first, the agency can use its resources most efficiently. Defining these pathways broadly minimizes the number of separate assessments needed.

5. APHIS and its stakeholders must work together to secure a substantial increase in resources for the agency to undertake risk analyses, update regulations promptly, improve pest detection and control and engage in outreach to producers, importers and partners in state and federal agencies.

With adequate staff resources, the agency could not only speed up its risk assessment and regulatory processes, but also develop a more comprehensive program for ensuring that imported plants are free of damaging pests. APHIS also could work more closely with all affected interests to raise awareness about the risk of pests that travel on plants that are moved from place to place.

Over the long term, APHIS should aim to put in place requirements that ensure that plants imported into the United States are free of virtually all pests. Such pathway regulations might be most effective if implemented for all trading countries,

under the leadership of the International Plant Protection Organization. The International Union of Forest Research Organizations has called for such a pathway approach for nursery stock.

The differences between this effective approach to NAPPPRA, the APHIS approach and the current situation are summarized in Table 4.

IV. Conclusion

APHIS acknowledges that the current situation of unfettered plant importation is costing Americans and American forests dearly. The agency is moving in the right direction by suggesting changes to quarantine regulations, and there are indications that APHIS may move toward a desperately needed comprehensive pathway approach. The NAPPRA proposal is intended to create the time and free up the regulatory resources needed to design a quality comprehensive regulation. But the current proposal for NAPPRA is inadequate.

If the agency’s proposed criteria had been in place 30 years ago, for example, they still would not have blocked the arrival of sudden oak death nor the importation of the emerald ash borer, because neither was well known at the time of its introduction.

There is a solution: Take preventive measures to keep the harmful invaders out. The United States need not continue to suffer economic and ecological damages at the hands of imported insects

and diseases. A few regulatory modifications will enable APHIS to take account of risks *before* damage occurs, rather than after the invasion is under

way. The agency can make these modifications without violating international trade agreements or unfairly restricting the sale of nursery plants.

TABLE 4
Comparison of Proposals for Preventing Future Pest Infestations

	CURRENT RULES	APHIS PROPOSAL	NATURE CONSERVANCY PROPOSAL
Prevents well-known insects and pathogens from invading U.S. forests	●	●	●
Prevents likely insects and pathogens from invading U.S. forests		●	●
Addresses the risk of new or little-known insects and pathogens invading U.S. forests			●
Addresses the risk of hybridization of insects and pathogens			●
Addresses the risk of harmful behavior of formerly benign organisms			●
Meets obligations of international trade agreements	●	●	●
Helps relieve regulatory backlog at APHIS		●	●

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Mail: P.O. Box 4370, 60 Nowelo St. Hilo, Hawaii 96720-0370, 808-933-8121 ext. 115. FAX: 808-933-8120 alarosa@fs.fed.us. Pers. comm.
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Mail: P.O. Box 4370, 60 Nowelo St. Hilo, Hawaii 96720-0370, 808-933-8121 ext. 115. FAX: 808-933-8120 alarosa@fs.fed.us. Pers. comm.
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This report was prepared by Faith Campbell, Senior Policy Representative, and Frank Lowenstein, Director of The Nature Conservancy's Forest Health Program, with much-appreciated input and advice from co-workers and partners. Edited by Danielle S. Furlich.



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