

Fading Forests: the Threat of Exotic Forest Pests to North American Ecosystems



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American forest ecosystems are under siege



Urban Sprawl

Population explosion and Baby Boomer retirements



Forest fragmentation and preservation

Water and adjacent lands

Damming, Draining, Channeling, Canalling Restoring

Bottomland Restoration in west Tennessee

Tennessee-Tombigbee Canal

Hoyt's Creek area in Montana

Drained

Climate Change

Changes in glaciers due to climatic warming

1913

2005

Glacier National Park
Sperry Glacier

Era of Biological Pollution

English Sparrow

Dutch Elm Disease

Eurasian Water Milfoil

Japanese stilt grass

Wild Boar

Asian Longhorned Beetle

Zebra Mussel

North American natural resources are being assaulted from the land, air, and sea



How did things ever get so far, so unfortunate, so unnecessary?

Tree species recorded by Naturalist John Bartram's first trip through Pennsylvania (1749)



- White and Black Oaks
- White Pine
- Chestnut
- Spruce (Eastern Hemlock)
- Hickory
- Sugar Maple
- Linden
- Pitch Pine
- Elm
- Beech
- White Walnut (Butternut)



Franklin B. Hough Report Upon Forestry (1878)


First Federal Publication on Forestry

North Carolina geologist (William Carr) reported dying American chestnuts in the Catawba River Valley region

Phytophthora cinnamomi, an exotic root rot disease, was determined as the causal agent many years later




Gypsy moth intentionally imported into the country and released (1869)



Became a problem within a decade; State and Federal governments began control efforts by 1890

Massive reforestation and afforestation effort in the late 1800s

- White pine blister rust entered North America on multiple shipments of nursery stock from Europe in the late 1800s
- The pathogen attacks nine North American white (five-needle) pine species causing stem girdling that eventually kills the tree



Mortality in whiteback pine from white pine blister rust

Tree Planting

J. Sterling Morton
Founder of Arbor Day

In 1904, mortality in mature chestnut trees was noticed in the Bronx Zoo and confirmed as a new disease "chestnut bark disease" or "chestnut blight"



Chestnut blight

In reality, the chestnut blight fungus was probably imported in the late 1800s on Japanese chestnuts

At the turn of the 20th century, four serious pests, chestnut blight, *Phytophthora* root rot, European gypsy moth, and white pine blister rust had become established in American forests

Due to the destruction inflicted by white pine blister rust, the Plant Quarantine Act was passed in 1912 regulate the entry and interstate movement of known carriers of insect pests and diseases

Although the Plant Quarantine Act has been amended and eventually USDA APHIS was created in 1971, exotic forest pests have increasingly become established in American forests

Species- or genera-specific exotic pests that kill hosts

Butternut Canker Disease

Urban

Forest

Dutch Elm Disease

Chestnut Blight

Species- or genera-specific exotic pests that kill hosts

European Beech Scale

Beech Bark Disease Complex

Hemlock Woolly Adelgid

Balsam Woolly Adelgid

Port-Orford-Cedar Root Rot

Exotic pests with a wide host range



Could Sudden Oak Death eventually reduce Coast Redwood as Chestnut Blight destroyed American Chestnut?



What will happen if Sudden Oak Death reaches oak-dominated eastern forests?



Exotic pests that spread on both coasts



White Pine Blister Rust

Dogwood Anthracnose Disease

Exotic pests that don't always kill



Chestnut gall wasp

Asiatic oak weevil

Japanese beetle

Ambrosia beetles (a bunch of them)

Exotic Pests introduced over the last 30 years



Asian Longhorned Beetle

Emerald Ash Borer

Pine Shoot Beetle

Exotic pests introduced over the last 30 years

Sudden Oak Death

Dogwood Anthracnose Disease

Lobate lac scale

Sirex woodwasp

Asian ambrosia beetle (kills chestnut seedlings)

Shot-hole borers and *Ophiostoma fungus*

Tree species recorded by Naturalist John Bartram's first trip through Pennsylvania (1749) and their exotic pests (2009)

- White and Black Oaks – Gypsy Moth, Sudden Oak Death
- Eastern White Pine – White Pine Blister Rust
- American Chestnut – *Phytophthora cinnamomi*, Chestnut Blight, Chestnut Gall Wasp, Asian Ambrosia Beetle
- Spruce (Eastern Hemlock) – Hemlock Woolly Adelgid
- Hickory
- Sugar Maple – Pear Thrips, Asian Longhorned Beetle
- Linden – Basswood Thrips
- Pitch Pine – Pine Shoot Beetle, Sirex woodwasp
- Elm – Dutch Elm Disease (2 strains)
- Beech – Beech Bark Disease Complex
- White Walnut (Butternut) - Butternut Canker

The cumulative effect is alteration of forests as we know them today

Exotic Forest Pest Problems

Attention is often focused on the host species as trees dominate the landscape

Exotic Forest Pest Problems really are forest ecosystem problems

Above ground level
 all flora and fauna
 associated with the
 host species are
 affected

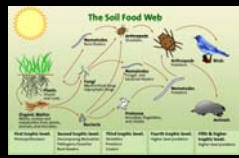
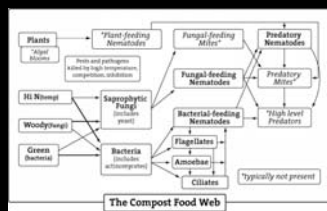


Energy chain

Above ground level
 Exotic Plant Pests
 can fill forest and canopy gaps

Their presence will
 compromise ecosystem
 structure and function and will
 complicate restoration efforts

Below ground level
 removal or decrease in abundance
 of host species will alter food chains
 and energy cycles

Short and long term effects are unknown

Exotic Forest Pest Situation is predicted to only get worse

Hitchhiking to America

International Trade is projected to only increase – too many containers for APHIS to check

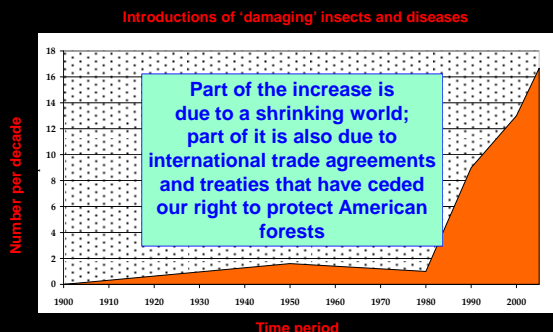
The Pamela
Largest container ship in the world (321m long)

Declining support for APHIS

Year	Number APHIS Inspectors per \$US Imported Goods (Left Axis)	APHIS Budget (\$US per Year) per \$US Imported Goods (Right Axis)
1975	11.5	0.0035
1980	3.5	0.0010
1985	2.5	0.0008
1990	2.0	0.0007
1995	1.8	0.0006
2000	1.5	0.0005

From A.N. Auclair, D.O. Oryang, R.D. Magarey, and D.M. Borchert, presented at International Plant Health Risk Analysis Workshop, October 24-28 2003, Niagara Falls, Canada

Introductions of damaging forest insects and diseases by decade



Are we selling the future of the country's natural heritage when entering into international treaties and agreements that put them at risk?



Purchase of Manhattan from the Lenape Indians for \$24 worth of goods
1624



There are solutions!



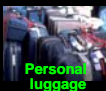
- Prevention
 - Stop or reduce the flow of pests coming into the country
- Control
 - address the most serious exotic pests with the goal of control sufficient for restoration to occur
 - prepare to address pests that haven't emerged as problems yet
- Restoration
 - Restore decimated species to the landscape
 - Preserve germplasm to ensure local adaptability of restoration seedlings
- Education
 - Educating the general public
 - K-12 education

Improved Policy for Prevention

Three major and two minor pathways into the country
Pathways within the country



Nursery stock



Personal luggage



Solid Wood



Ship Superstructure



Solid Wood Packing Material

Control Options

- Developing or selecting for host resistance
- Biological control
- Integrated pest management, e.g., Slow-the-Spread Program with gypsy moth
- Cultural control
- Chemical control

Developing White Pine Blister Rust Resistance

- There is a low level of natural genetic resistance in all of native white pine species
- Long-term breeding programs were initiated by the USDA Forest Service (1950s) and others
- Resistant seedlings are now available for western white, eastern white, and sugar pines
- Selection for resistance has begun for whitebark pine



White pine blister rust



Genetic test of whitebark pine seedlings

Photographs provided by
Dr. Richard Sniezko
Dorena Genetic Resource Center
USDA Forest Service

The Return of American Chestnut

- The American Chestnut Foundation and Connecticut Experiment Station are on the verge of providing blight-resistant chestnuts for reintroduction to eastern forests
- The first test plantings of blight-resistant American chestnuts were established in 2009 on southern National Forests led by Dr. Stacy Clark, U. S. Forest Service and supported by the UT Tree Improvement Program

Blight susceptible genotype

Blight resistant genotype

Photographs provided by Dr. Fred Hebard, The American Chestnut Foundation

Blight-resistant American chestnut plantings

Dr Stacy Clark
USDA Forest Service

Survival and growth after one summer

Restoration of Butternut

Multidisciplinary, Multi-agency effort

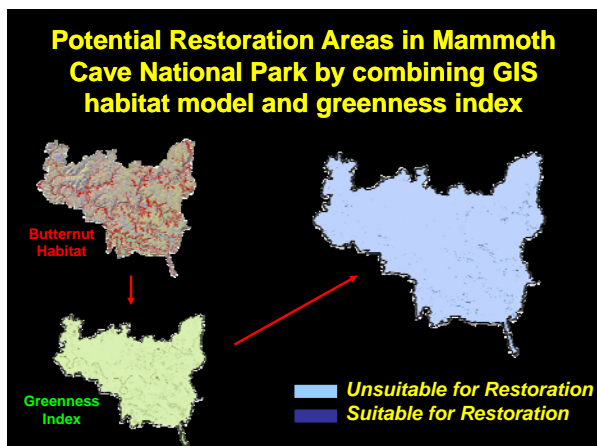
Butternut Coalescing Disease

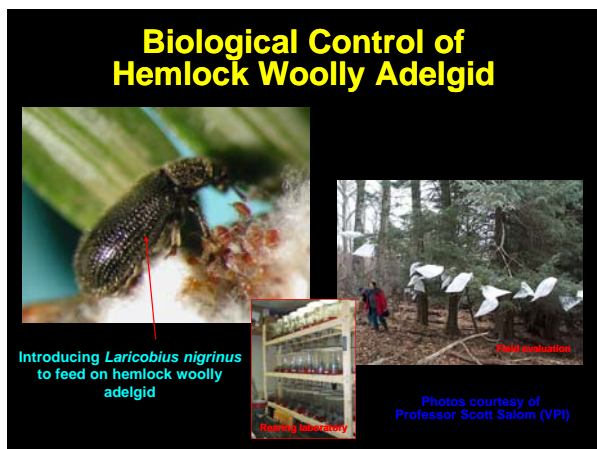
Resistance testing

Phytogeography

Nursery Research

DNA analysis to detect hybridization with Japanese heartnut





Restoration

- Mass propagation of (resistance) materials
– Seed Orchards
- Understanding host species biology, nursery and field
- Site preparation
- Post planting maintenance

Seed Orchards

Field

Site preparation

Post planting maintenance

Preservation of Genetic Resources

When pest control is achieved, restoration of extirpated populations should use germplasm that is locally adapted



Preservation of Genetic Resources

Working with the USDA ARS National Genetic Resources Program for seed/pollen/tissue preservation



Cryogenic or conventional storage



Seed



Tissue Culture



Pollen

National Center for Genetic Resources Preservation

Storage of seed collections



USDA Forest Service, Regional Genetic Resources Programs
Ex situ preservation plantation of Fraser fir from the Great Smoky Mountains National Park



Plantation near Rhineland, WI

Education
Changing American attitudes




Forest destruction by exotic pests doesn't leave a lunar landscape

The cumulative effect of Exotic Forest Pests on America's forests is often overlooked because the forest still appears green to the American public



K-12 Natural Resources Education



Integration of Biological Pollution into K-12 curricula and into State Standards




The Forestry Primer

- Over 4 million copies distributed
- 14 lessons aimed to educate people, particularly school children, on the forest situation in the U. S.
 - History of U. S. Forests
 - Forest Use
 - Forest Management
 - Forest Pests
 - Chestnut Blight
 - White Pine Blister Rust



Without education, children won't be able to discern differences in the causes of forest destruction and appreciate the threat of exotic forest pests to ecosystem integrity



Pine Beetle (native)White Pine Blister Rust (exotic)





Lingering attitude of European immigrants toward natural resources and pattern of North American colonization and use of natural resources



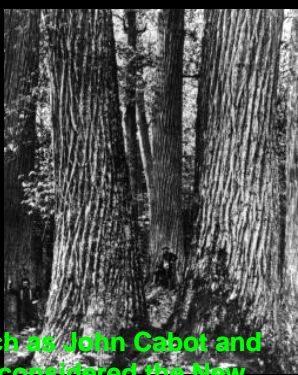
Society based on capitalism



Innocence, Ignorance, and Ignoring



Colonial Attitudes



Early Explorers, such as John Cabot and Sir Francis Drake, considered the New World forests to exist without end

Legend of Inexhaustibility (Jenks Cameron, 1928)



Myth of Superabundance (Secretary of Interior Stewart Udall, 1963)

Manifest Destiny

19th Century term used to designate the belief that the United States was destined, even divinely ordained, to expand across the North American continent until reaching the Pacific Ocean



Pattern of colonization

Forest land cleared for pasture, exhausted, eroded, and abandoned for new land in the West




Same pattern of use for other natural resources



American Mindset combined with Capitalism





Innocence
The use (and abuse) of America's forests and natural resources was often considered as "God's Will"

Besides, the forest was inexhaustible!!


~~Innocence~~

↓

Ignorance


George Perkins Marsh
Man and Nature
(1864)

The fountainhead of American conservation



Early Warning

"... In the United States, the ravages of imported insects injurious to cultivated crops, not being checked by the counteracting influences which nature had provided to limit their devastations in the Old World, are much more destructive here than in Europe."





George Perkins Marsh
Man and Nature (1864)

Ignorance

Chestnuts and the related Allegheny chinkapins were noticed to be dying along stream and rivers in the Cumberland Mountains of Tennessee (1865)


People thought that the Confederate prisoners of war brought 'something' back with them from the North




~~Ignorance~~

↓


Ignoring




White pine blister rust



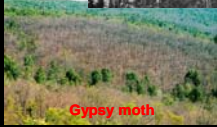
Bark Woodwasp




Chestnut blight




Emerald Ash Borer



Gypsy moth



Sudden Oak Death



I DON'T KNOW WHAT I'M DOING

America's Response to Climate Change may be a good barometer of the public's willingness to change and properly address exotic pests

Agreement

Faith Thompson
Campbell
The Nature Conservancy
and
Scott E. Schlarbaum
The University of
Tennessee