Introductions and Pathways of Non-Native Forest Insects and Diseases in the West

??

Steve Seybold

Chemical Ecology of Forest Insects

Pacific Southwest Research Station

Davis, California

Outline

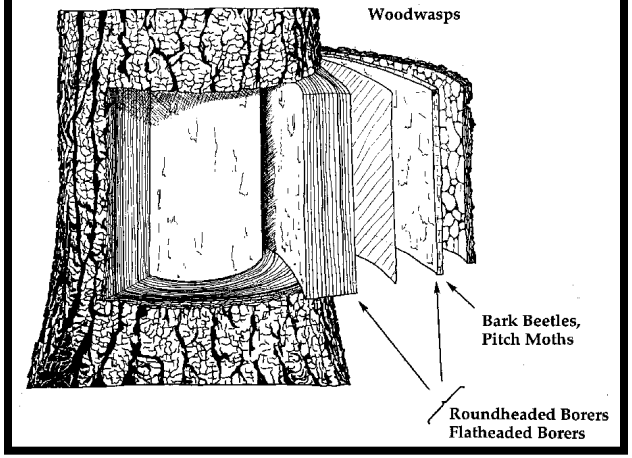
I) Brief introduction to forest insect groups

II) Non-native forest insects and diseases from a western perspective: History and pathways

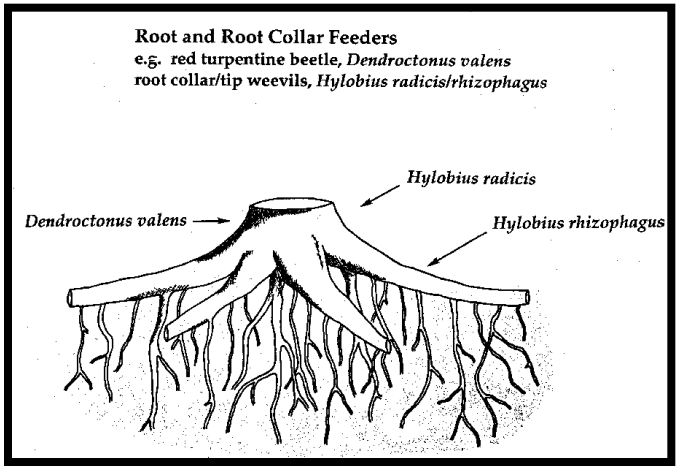
III) Themes, trends, and blatant speculation

IV) Summary/Wrap Up

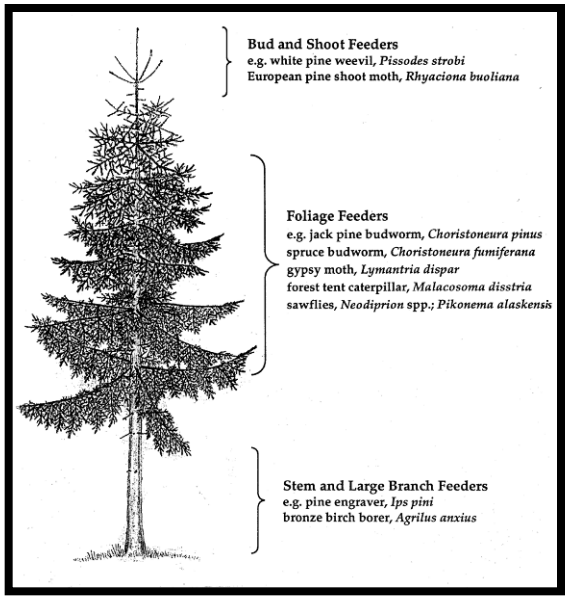
Typical Feeding Groups of Forest Insects



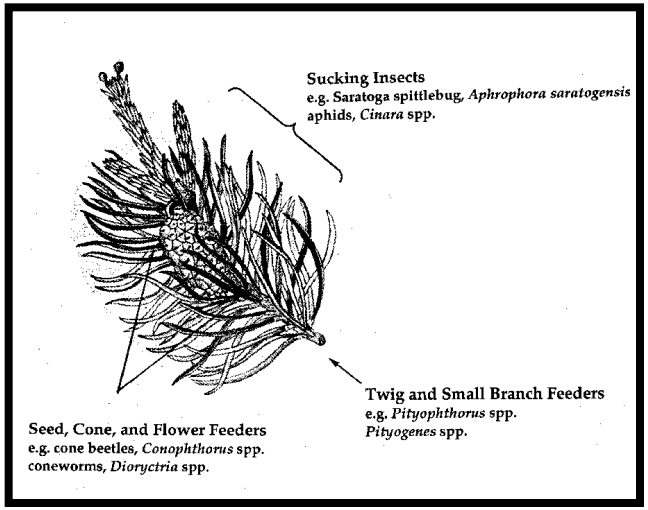
Phloem/xylem Feeders
Main Stem



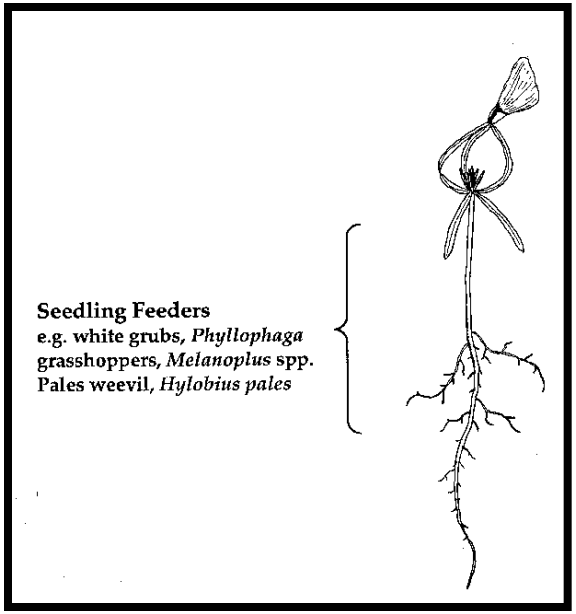
Phloem/xylem Feeders
Roots and Root Collar



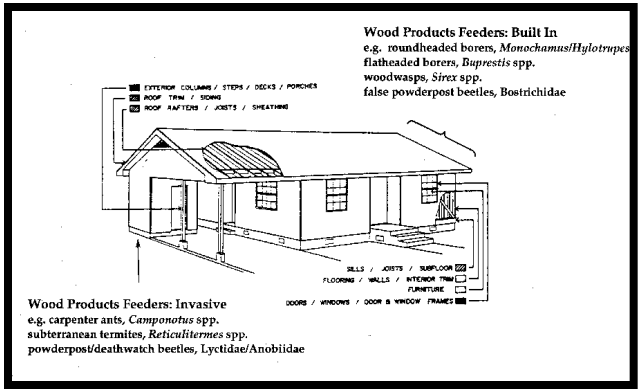
Foliage Feeders



Twigs and Branches



Seedlings



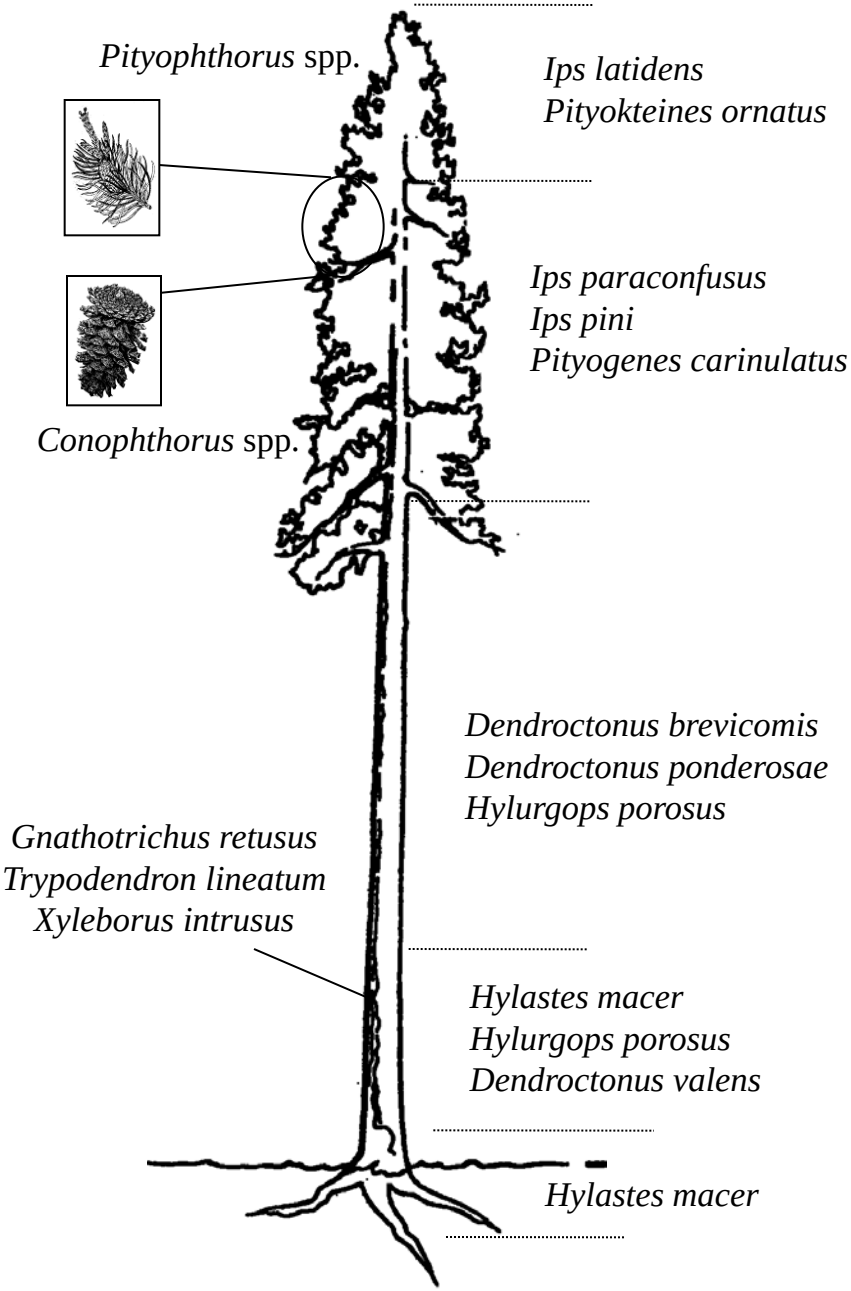
Finished Wood Products

Impacts of Feeding Groups of Forest Insects

Table 2. Ranking insect feeding guilds (with select examples) according to their potential impact on host plant fitness.

Herbivore guild	Potential impact on host growth and reproduction
Gall formers: leaves Cynipidae, Cecidomyidae, Psyllidae	Least
Gall formers: twigs/stems Adelgidae, Cynipidae	
Folivores: end of season or prior-year's leaves Diprionidae	
Folivores: beginning of season/current-year leaves Geometridae, Lasiocampidae, Lymantriidae, Tortricidae	
Sap feeders: leaves/twigs/branches Aphididae, Coccidae, Diaspididae	
Phloem/sapwood/pith borers: twigs/branches/shoots Buprestidae, Cerambycidae, Curculionidae, Olethreutidae	
Root sap feeders Cicadidae	
Root free feeders Curculionidae, Scarabaeidae	
Folivores: middle-late season Arctiidae, Lymantriidae, Notodontidae, Saturniidae	
Folivores: both current and prior year's leaves Diprionidae, Lymantriidae	
Sap feeders: stem phloem/xylem Aphididae, Coccidae, Diaspididae	
Phloem/cambium/sapwood borers: root and root crown Buprestidae, Curculionidae, Scolytidae	
Phloem/cambium/sapwood borers: main stem Buprestidae, Cerambycidae, Sesiidae, Scolytidae	Most

From: Mattson, W.J. *et al.* (1988) Defensive strategies of woody plants against different insect-feeding guilds in relation to plant ecological strategies and intimacy of association with insects, *In*: W.J. Mattson, J. Levieux, and C. Bernard-Dagan, eds., *Mechanisms of Woody Plant Defenses Against Insects, Search for Pattern*, pp. 1-38, Springer-Verlag, New York.



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I) Brief introduction to forest insect groups

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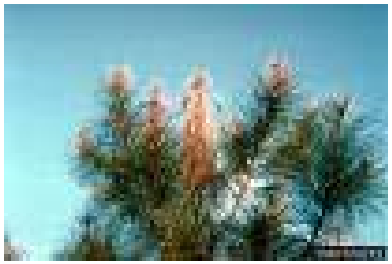
Examples of Exotic Fungal Tree Pathogens that have become Established in Natural Forest Ecosystems in the Western U.S.

Part 1

Courtesy of D.M. Rizzo, UC-Davis

Pathogen	Disease name	Host genus	Indigenous location	Exotic location	Introduced
Ceratocystis fimbriata var. *platanus*	Sap stain	*Platanus* spp.	Eastern North America	CA (Modesto only)	1970s?
Cronartium ribicola	White pine blister rust	*Pinus* spp., *Ribes* spp.	Asia	WA, OR, MT, ID, CA, NV, AZ, CO, WY	1910
Cryphonectria parasitica	Chestnut blight	*Castanea spp.*	Asia	most western states with chesnut plantings	?
Discula destructiva	Dogwood anthracnose	*Cornus* spp.	unknown	WA, OR, CA, BC	Late 1970s?
Fusarium circinatum	Pitch canker	*Pinus* spp.	Mexico, Southeastern North America	CA	Mid-1980s?

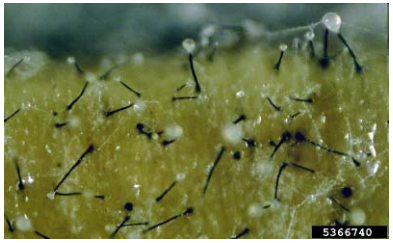


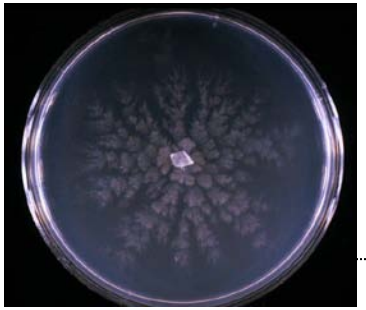
Examples of Exotic Fungal Tree Pathogens that have become Established in Natural Forest Ecosystems in the Western U.S.

Part 2

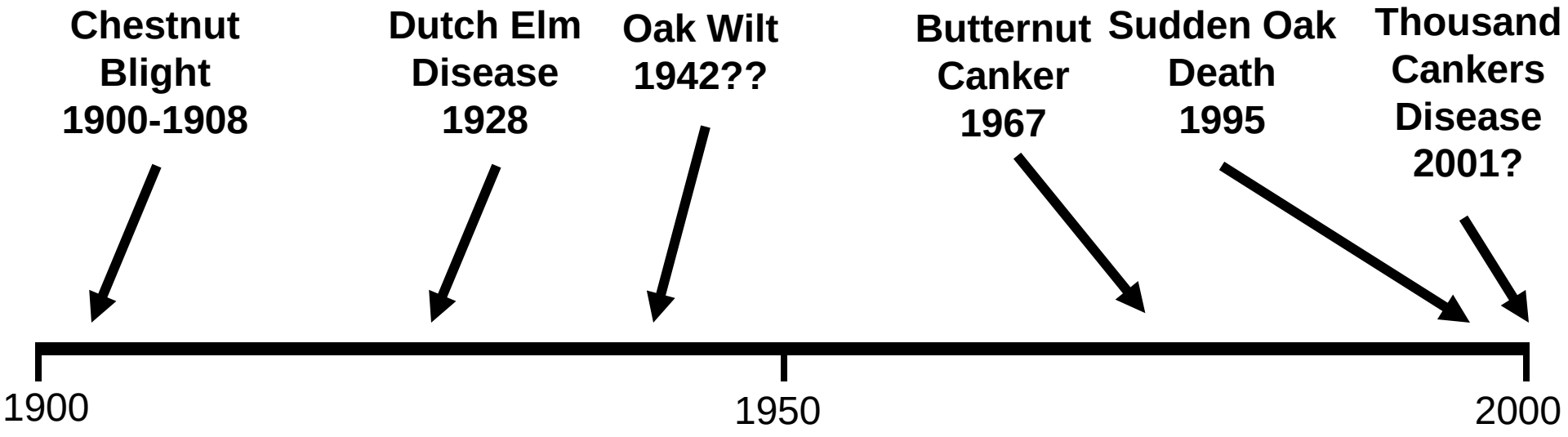
Courtesy of D.M. Rizzo, UC-Davis

Pathogen	Disease name	Host genus	Indigenous location	Exotic location	Introduced
Melampsora larici-populina	Poplar leaf rust	*Populus* spp.	Europe	NW US, Canada	?
Ophiostoma novo-ulmi, O. ulmi	Dutch elm disease	*Ulmus* spp.	Asia?	Most western states with elm plantings	?
Phytophthora cinnamomi	Phytophthora root rot	Many hosts	New Guinea?	CA	1800s?
P. ramorum	Sudden oak death	Many hosts	unknown	CA, OR	1980s?
P. lateralis	Port-Orford-cedar root disease	*Chaemaecyperus, Taxus*	Unknown (Taiwan?)	OR, CA, (WA ornamentals only)	1940s





"Hard" Times for Hardwoods: A History of Devastating Tree Diseases in the U.S. from Non-Native Pathogens



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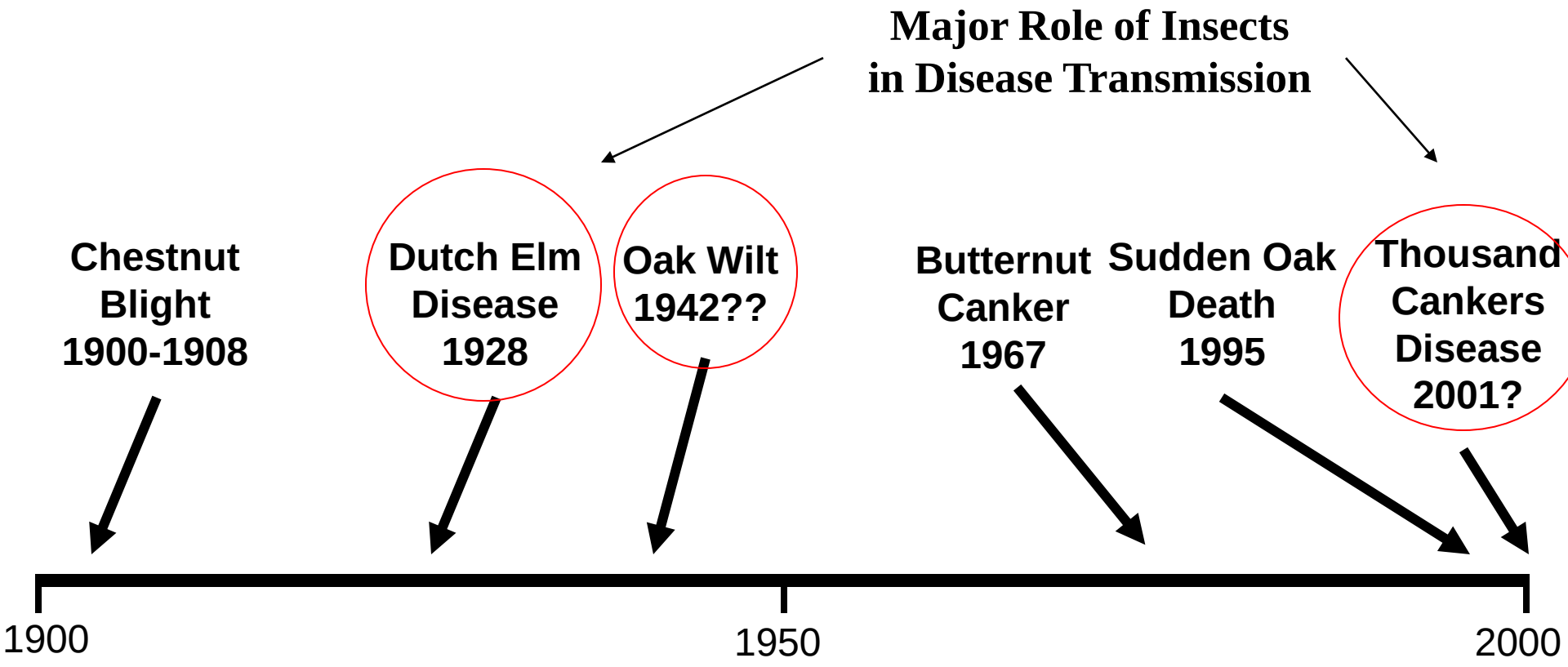


Examples of Host Resistance Programs for Invasive Forest Insects and Diseases

Forest Diseases

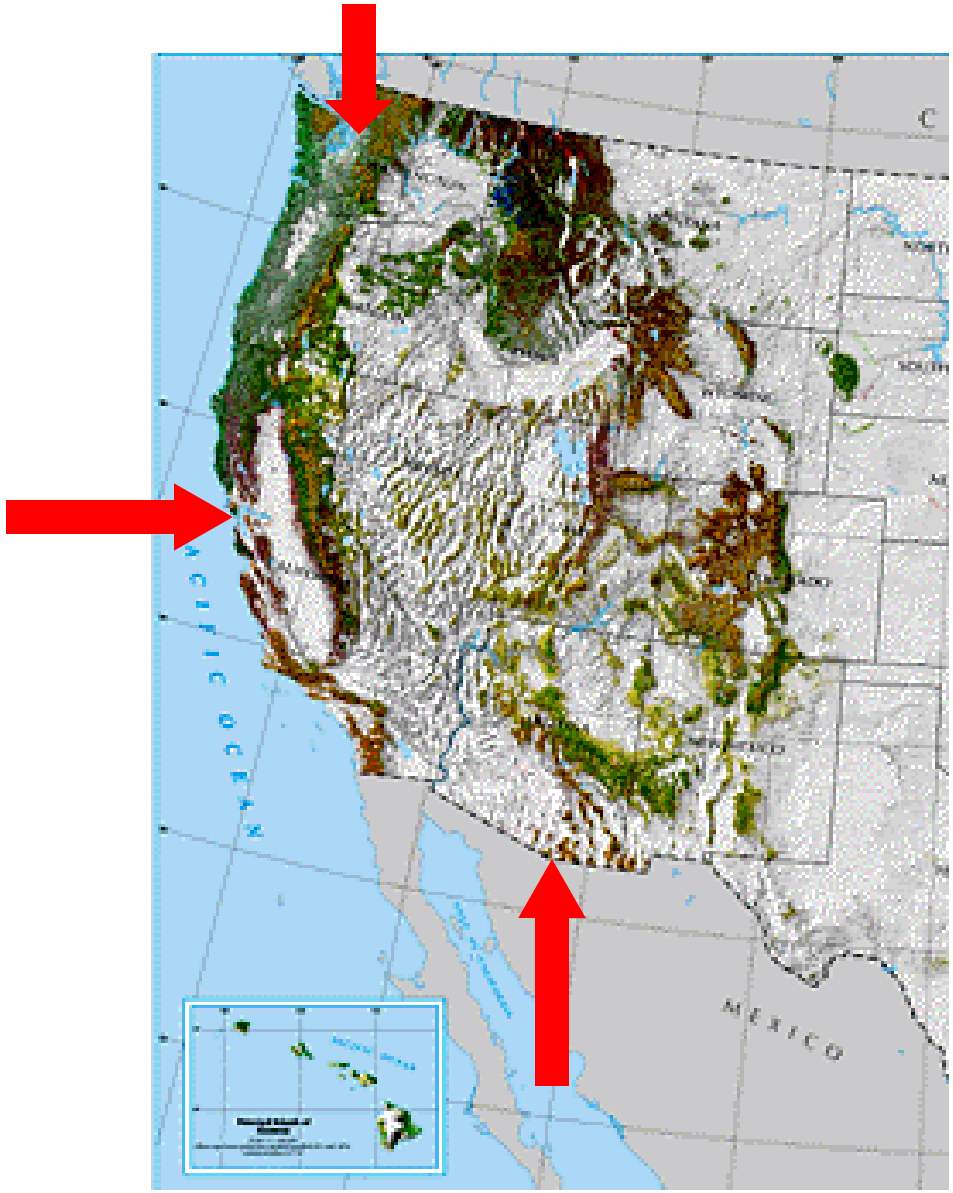
Chestnut blight
Dutch elm disease
Pitch canker
Sudden oak death (just initiated)
White pine blister rust

Forest Insects

None

Pathways of Introduction to the Western U.S.

Perspective: Geographically and Politically External



Historic External Pathways for Non-Native Forest Insects and Diseases

1) Nursery stock—Most diseases, foliage-feeding and sap-sucking insects

{Nursery stock can be large trees too!}

2) Solid wood packing material—Most woodboring and phloem-boring insects; some pathogens (e.g., *O. ulmi*)

Historic External Pathways for Non-Native Forest Insects and Diseases

1) Firewood??

October 21, 2009
Albertson's Grocery Store,
Alpine, CA
San Diego Co.

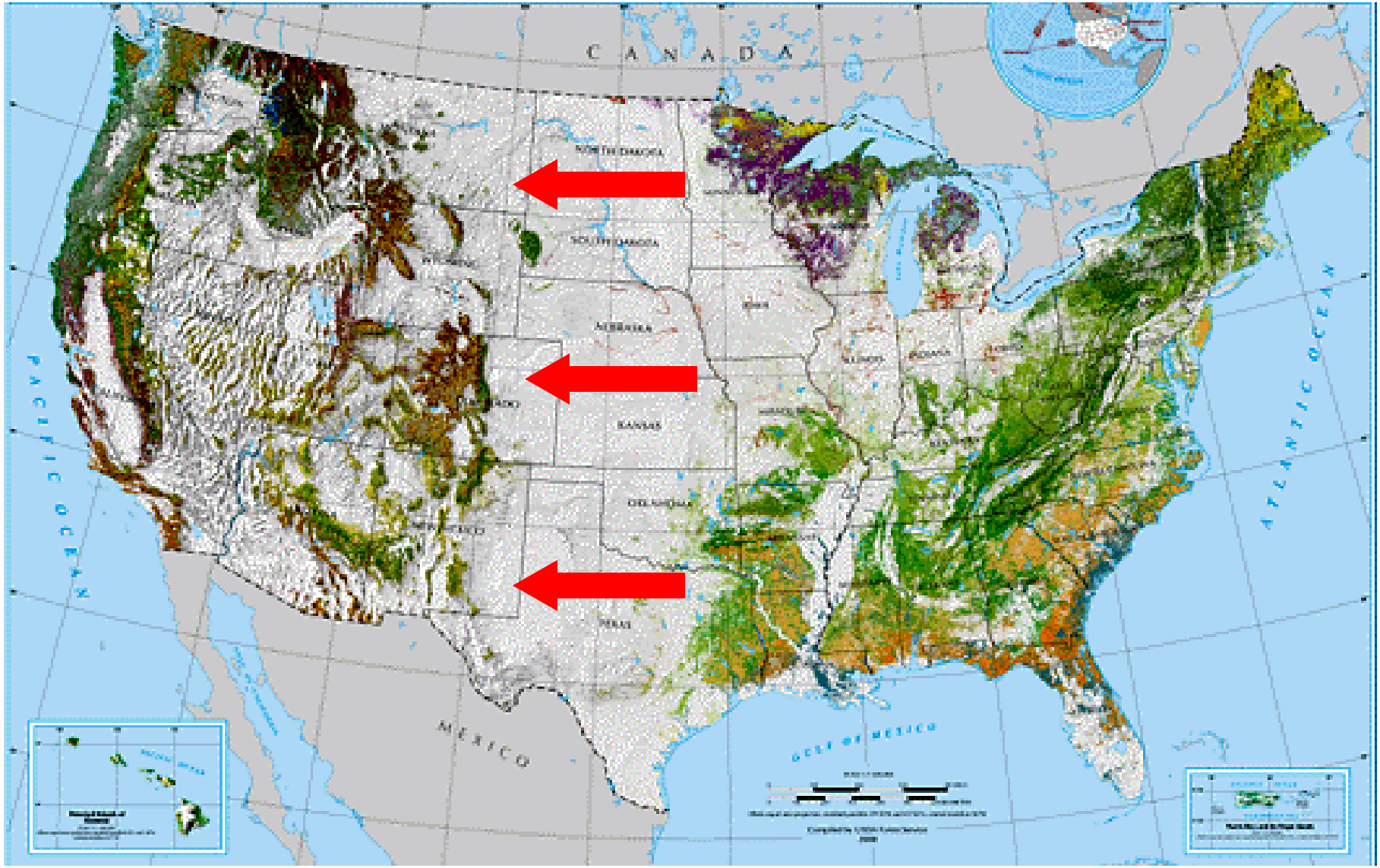

homelife
European
white birch
kiln-dried, quick start and steady burn
all natural with very low moisture level for better burn-through
virtually mold, mildew and insect free
0 41163 46840 5
DISTRIBUTED BY SUPERVALU INC.
EDEN PRAIRIE, MN 55344 USA
PRODUCT OF ESTONIA
WOOD ORIGIN: ESTONIA
USDA PERMIT NO. P40-08-00114
SUPERVALU QUALITY
Guaranteed
We're committed to your satisfaction and guarantee the quality of this product.
Contact us at 1-877-932-7948, or www.supervalu-ourownbrands.com.
Please have package available.

Increasing number of "No-Burn" days in western U.S. cities and communities

What are the long-term prospects for firewood use in the western U.S.?

Pathways of Introduction to the Western U.S.

Perspective: Geographically and Politically Internal



Pathways of Introduction to the Western U.S.

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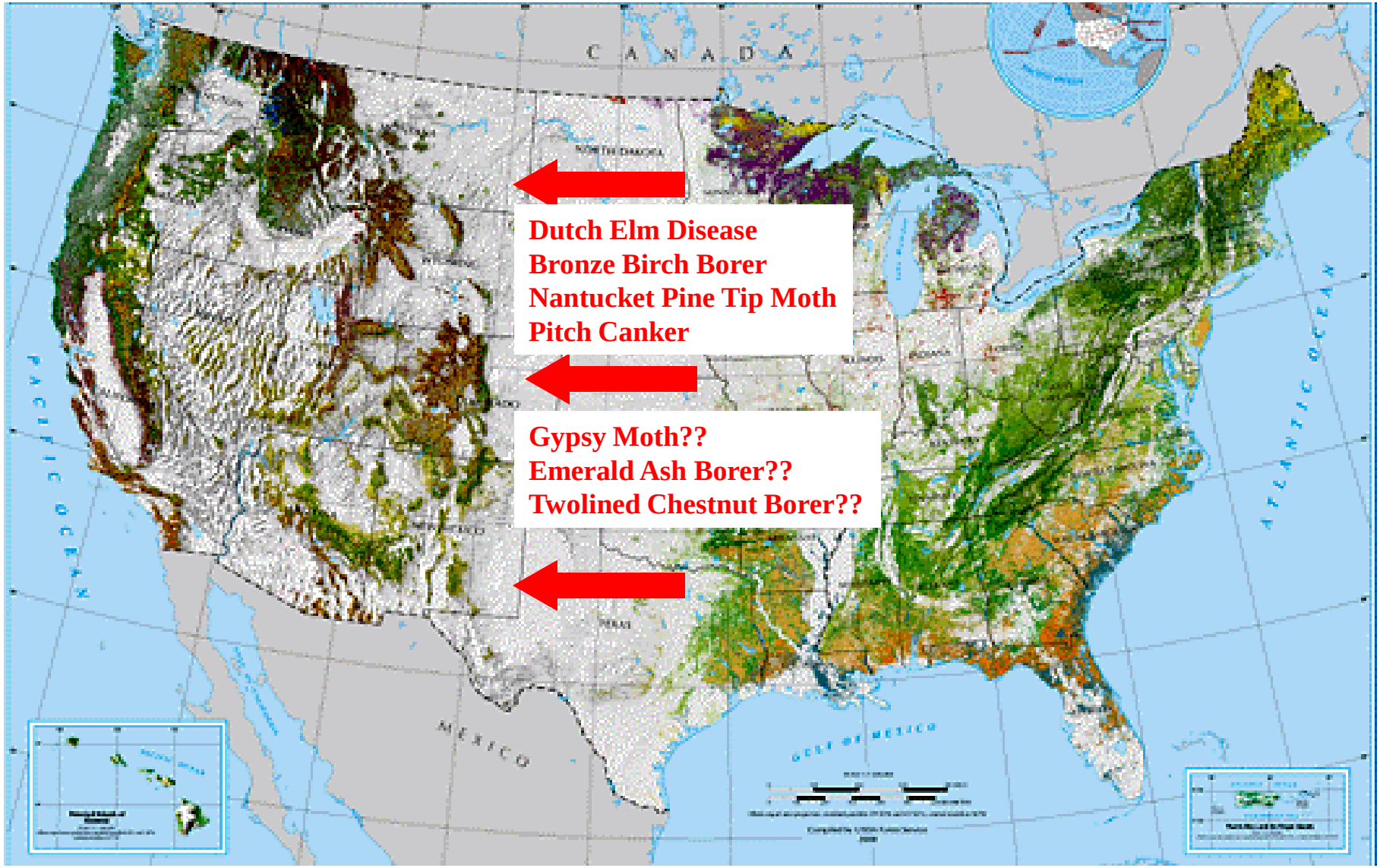
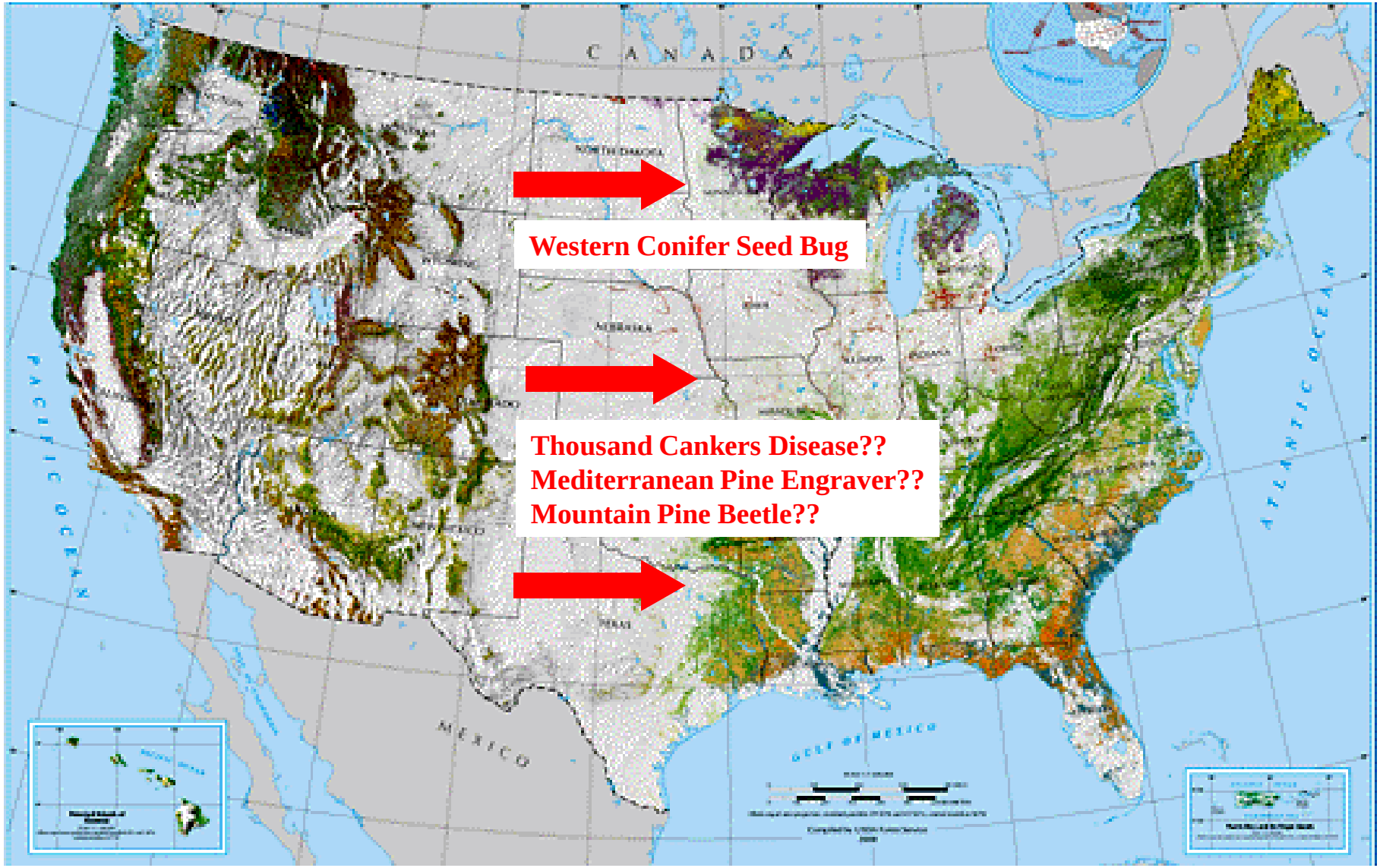
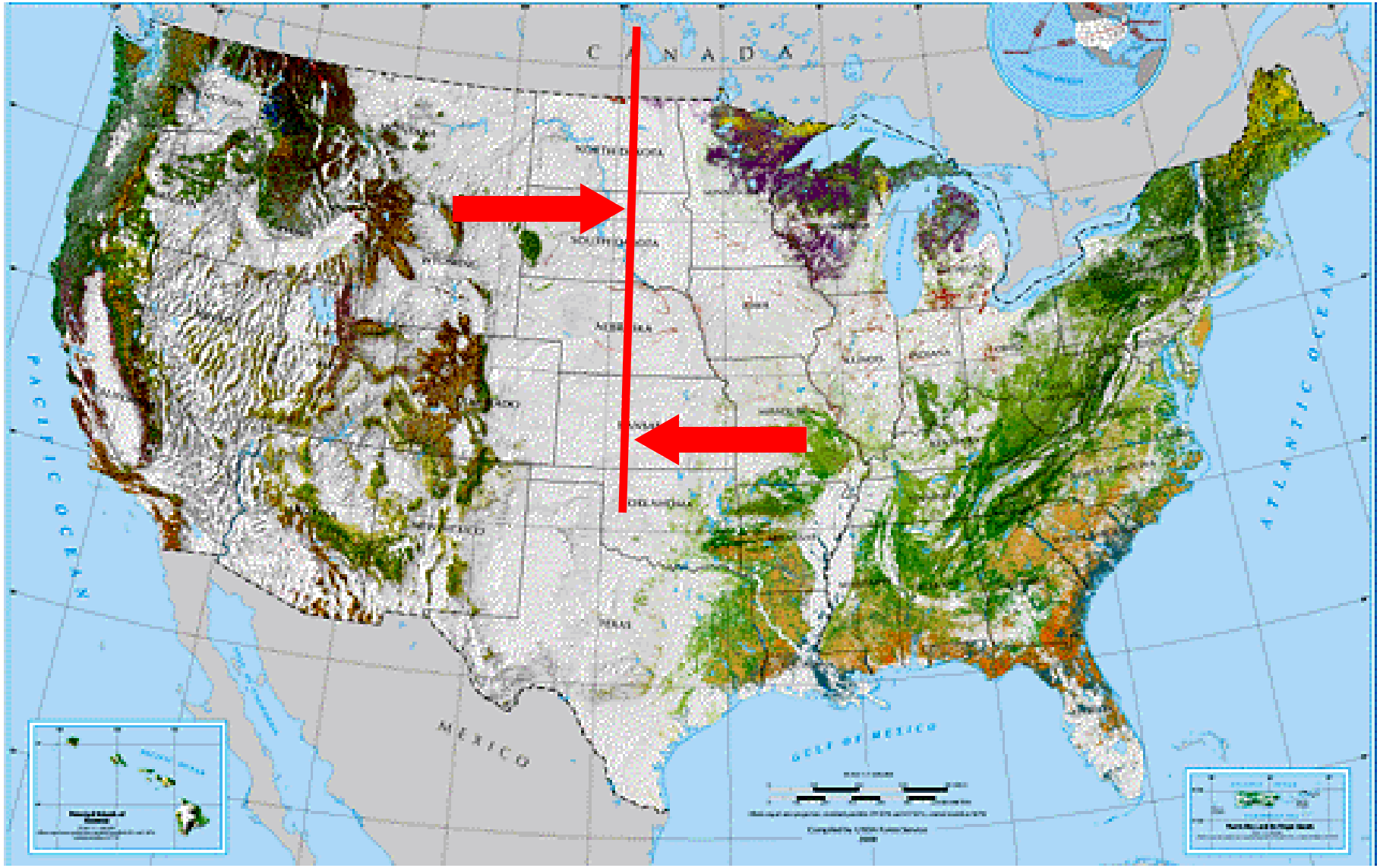


Pathways of Introduction to the Eastern U.S.

Perspective: Geographically and Politically Internal



The Great Plains (and the Rocky Mountains) have Served as a Natural East-West Barrier for the Movement of Forest Insects and Diseases



Examples of Pathways for Long-Distance Movement of Native and Non-Native Forest Insect and Disease Pests within the U.S.

Nursery Stock

Christmas Tree Shipments

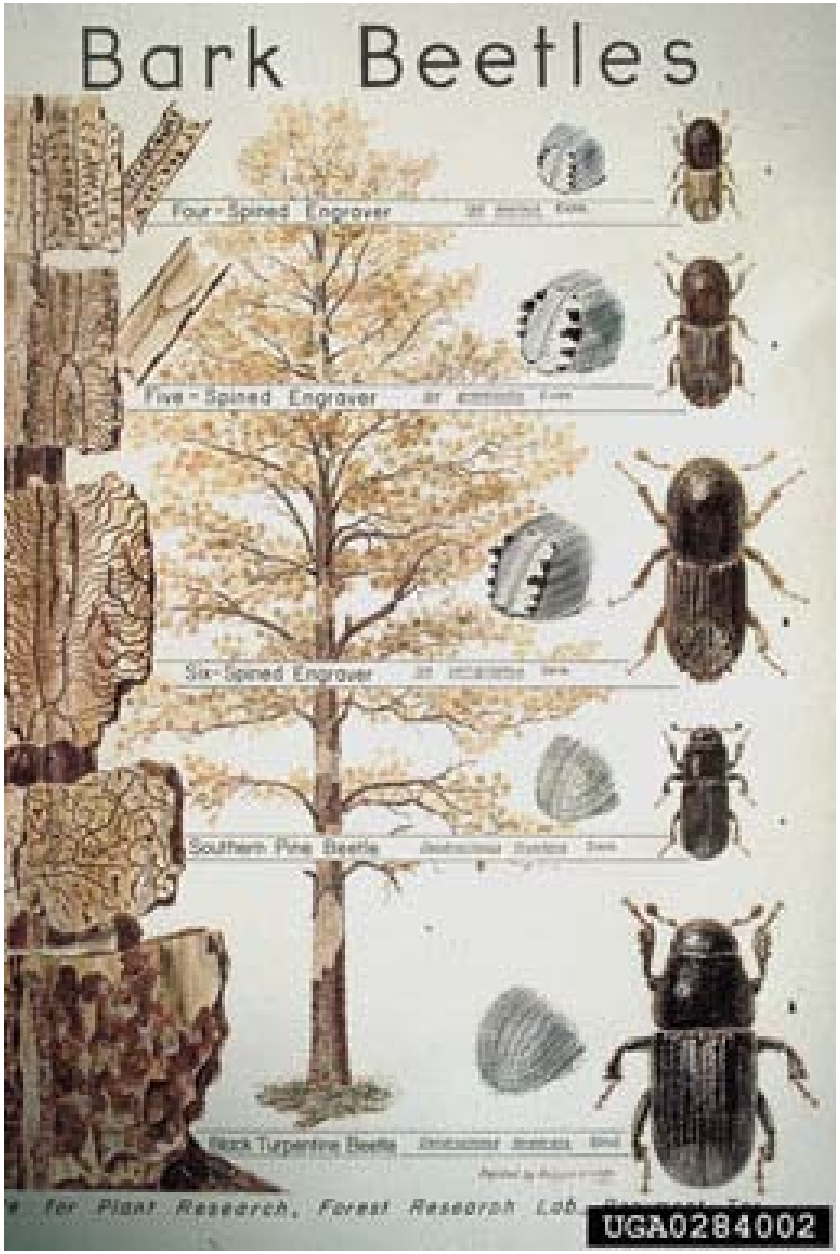
Firewood

Examples of Pathways for Long-Distance Movement of Native and Non-Native Forest Insect and Disease Pests within the U.S.

Wholesale Interstate Movement of Logs

Log Home Logs

Interstate Movement of Wooden Pallets



Barked Wood Products Harbor
Not One, but Many
Species of Insects or Pathogens

“= Species Complexes”

Examples of Habitats that Enhance the Short-Distance Movement of Native and Non-Native Forest Insect and Disease Pests within the U.S. "Islands within the Prairie Ocean"

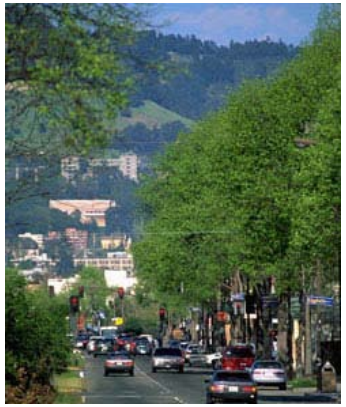
Shelterbelt Plantings

Christmas Tree Plantations

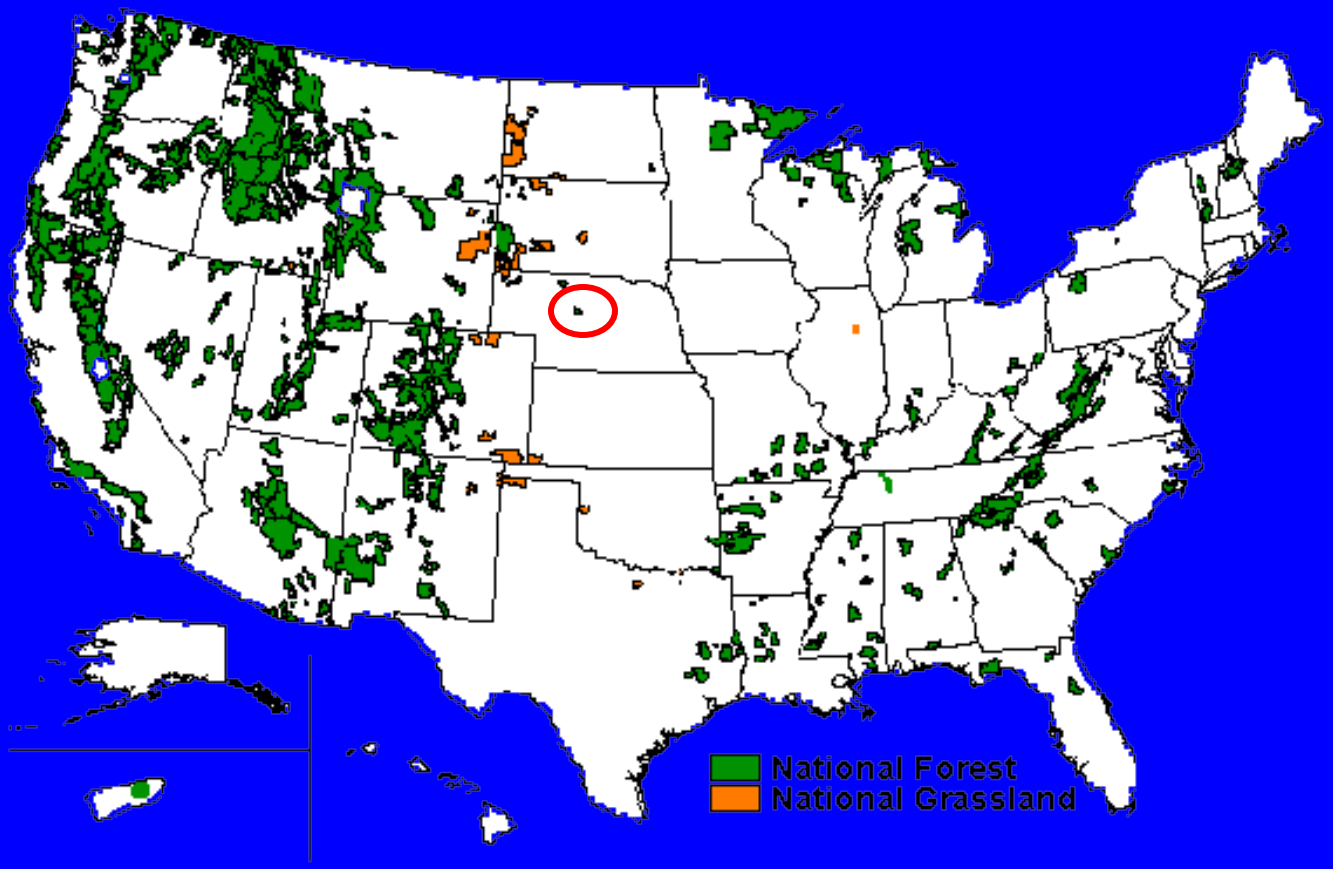
Nurseries

Artificial Forests e.g. Nebraska NF

Urban/Landscape Plantings/Parks and Arboreta

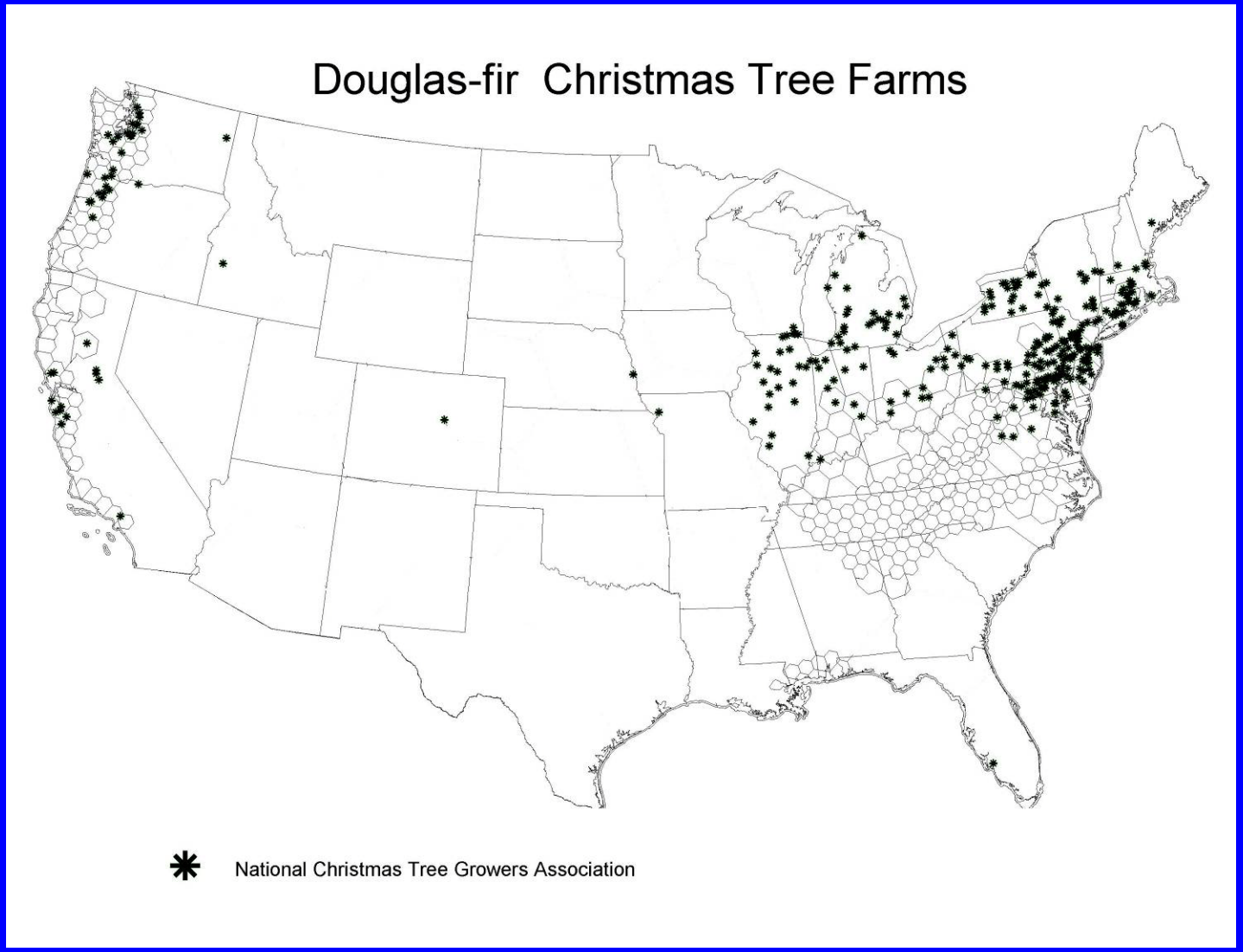


Nebraska National Forest—Bessey Ranger District



Currently contains 22,000 acres of coniferous forest. The three major tree species are ponderosa pine, eastern red cedar, and jack pine. The forest was planted in 1902 in previously unforested terrain. A nursery maintained in conjunction with the forest ships trees throughout the midwest.

Douglas-fir Christmas Tree Plantations Represent Islands of "Exotic" Hosts Spread Across North America



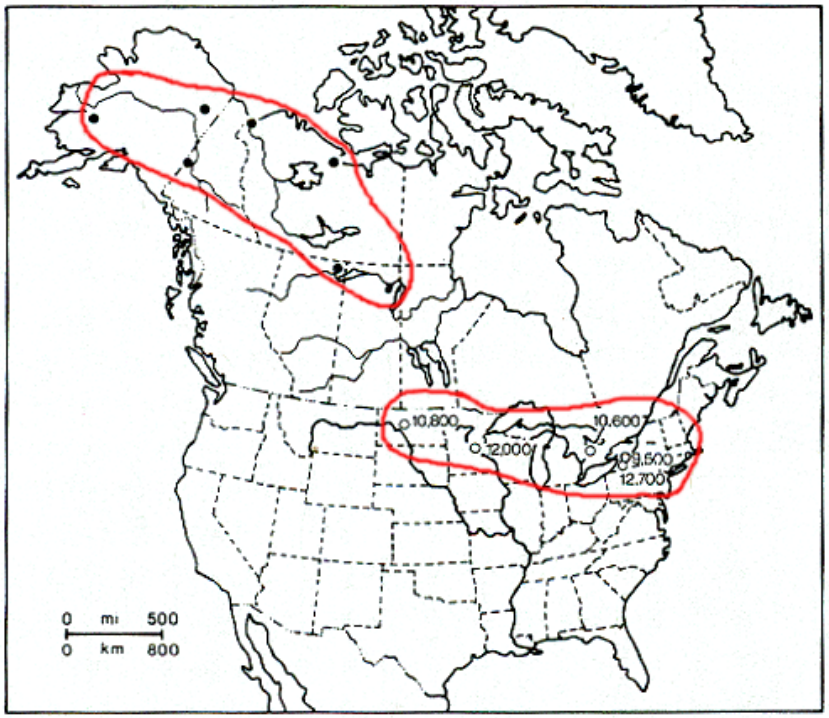
Two Key Points Regarding Invasive Species

1) **Biodiversity is a consequence of geographic isolation enforced by barriers such as oceans, mountains, deserts**

2) **Plant and animal distributions have changed radically over geological or paleontological time scales without any assistance from humans**

Natural Movement of Native Forest Insects over Geologic Time Scales: North American Glaciation Altered Host Distributions

Natural Movement of Native Forest Insects over Geologic Time Scales: The White Spruce Bark Beetle: *Carphoborus andersoni*



Modern (black circles) and Late Wisconsin fossil localities (open circles) of the scolytid *Carphoborus andersoni* Swaine.

The fossil record indicates that this conifer-feeding bark beetle occurred between 10,000 and 70,000 years ago in the midwestern and northeastern U.S., but now only occurs in the far northwestern corner of the North American continent

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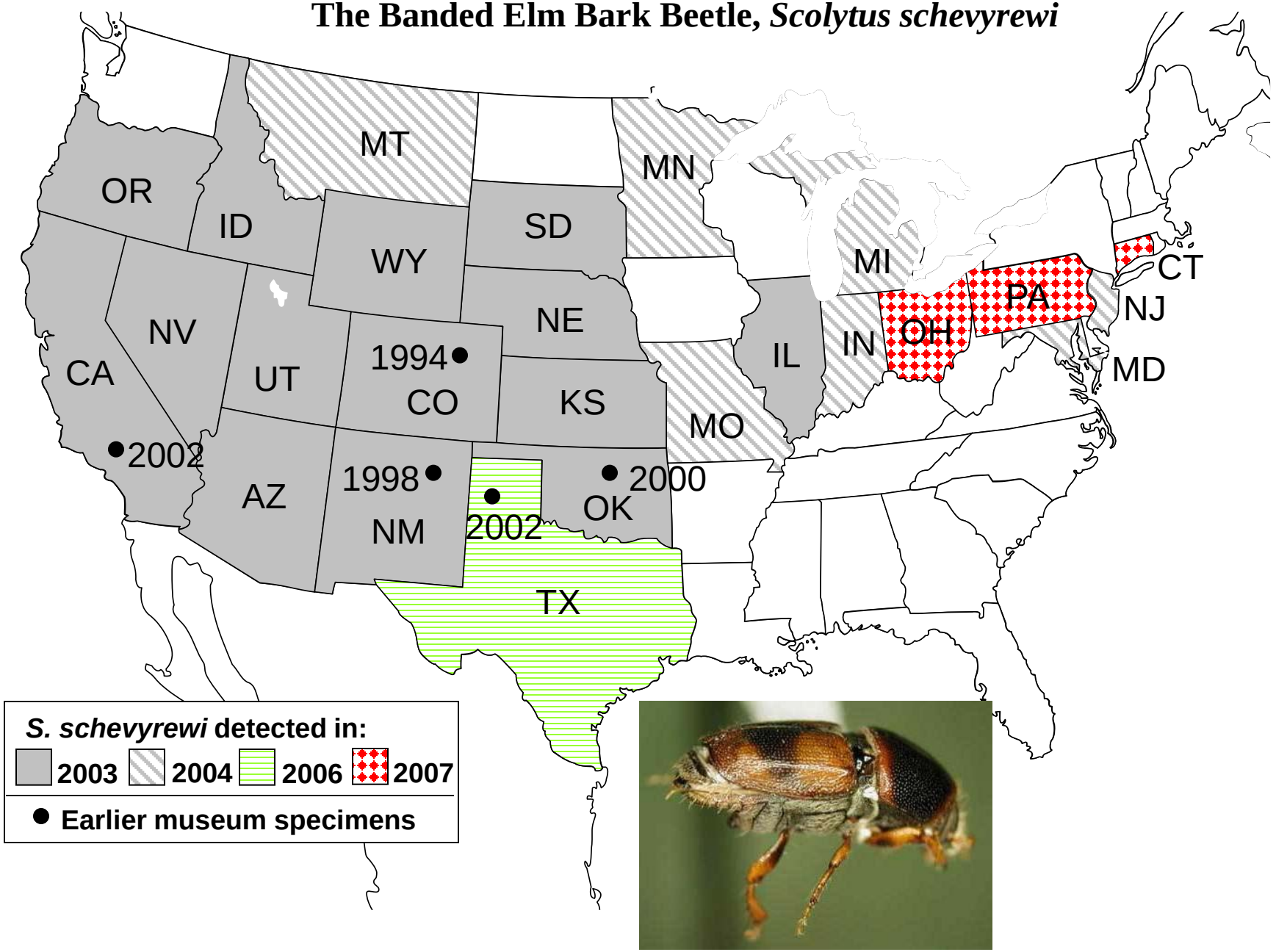
Trend No. 1: Nearly Simultaneous Manifestation of Non-Native Species at Numerous Locations

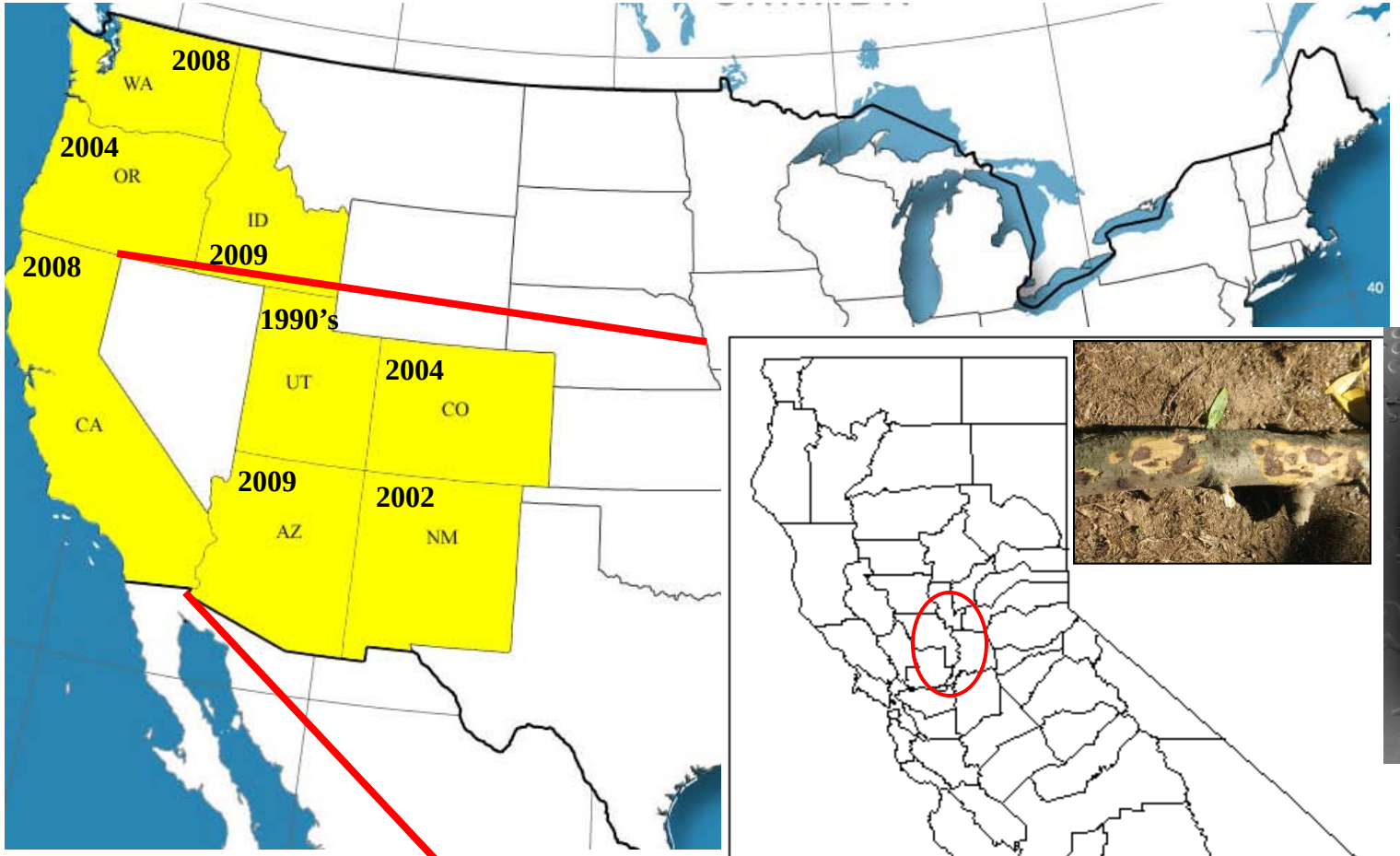
—Banded elm bark beetle in 2003

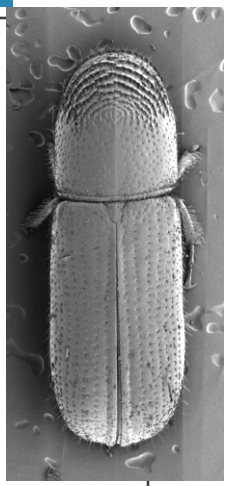
—Walnut twig beetle/thousand cankers disease in 2007

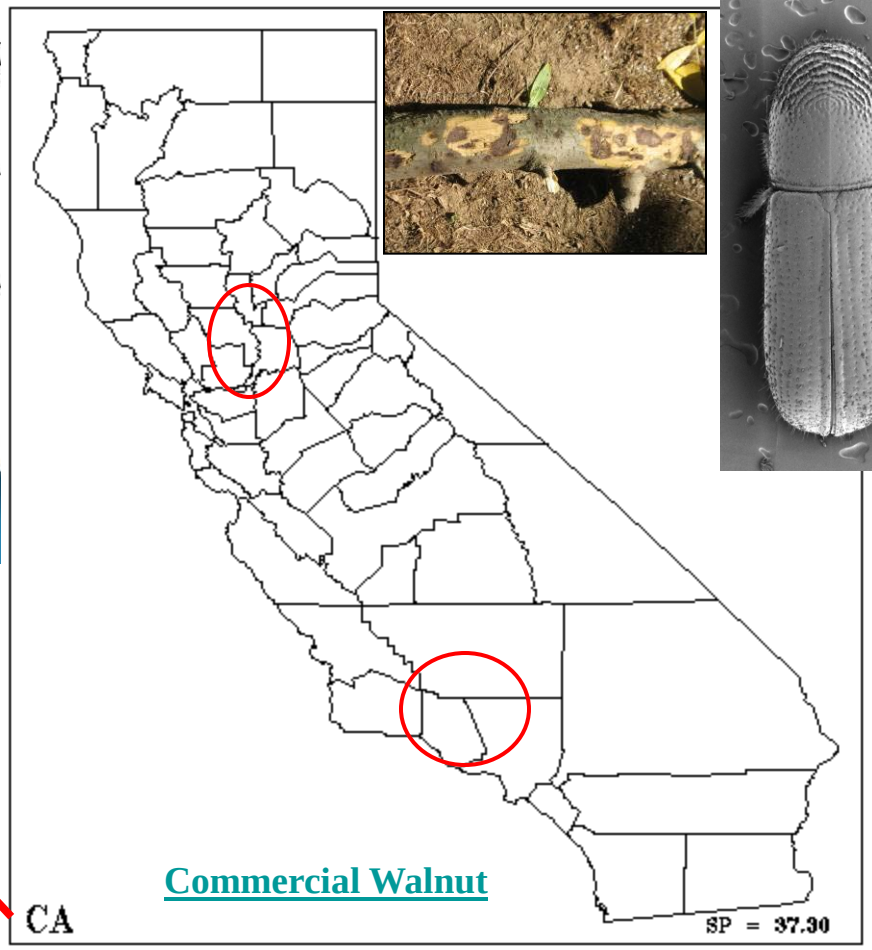
The Banded Elm Bark Beetle, *Scolytus schevyrewi*



Distribution of Walnut Twig Beetle/Thousand Cankers Disease Complex







Western Distribution Data Courtesy of
N.A. Tisserat, Colorado State University

Trend No. 1: Nearly Simultaneous Manifestation of Non-Native Species at Numerous Locations

—Increasing awareness of non-native species by the general public and in the regulatory, resource management, and scientific communities

—Improvements in detection techniques and commitment of more resources to detection

—“Internet Effect:” Modern transportation rapidly and efficiently distributes invasive species

The Emergence of Mega-Warehousing and Inland Transit Centers

Walmart Distribution Center, Porterville, Tulare Co.

The interface between international and domestic shipping

The Emergence of Mega-Warehousing and Inland Transit Centers

International Trade and Transportation Center, Shafter, Kern Co.

"…...Shafter is also home to the International Trade and Transportation Center (ITTC), built to facilitate easier Central Valley access to ports in Long Beach and Los Angeles via the Burlington Northern Santa Fe railway.[5]"

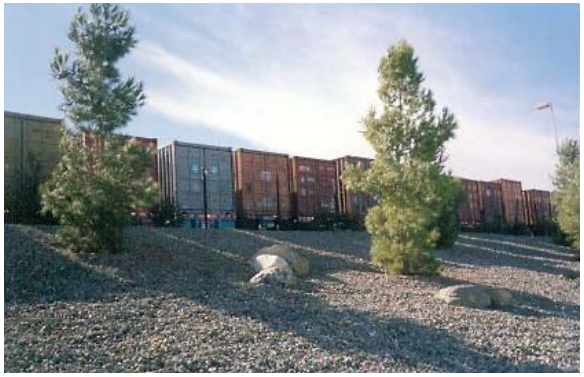
http://en.wikipedia.org/wiki/Shafter,_California From Wikipedia, the free encyclopedia

The Emergence of Mega-Warehousing and Inland Transit Centers

Debris from international and domestic shipping

Gap Distribution Center, Fresno, Fresno Co.

Ikea Warehouse, Grapevine, Kern Co.



Landscaping (exotic pines) provides potential hosts for non-native species

Trend No. 2: The Increasing Number of Cases of Non-Native Species that Share a Common Host Presents New Ecological Interactions with New Management Implications ("Invasives upon Invasives")

—Mediterranean pine engraver and redhaired pine bark beetle in California

—Banded and European elm bark beetles throughout the western U.S.

—Sudden oak death and goldspotted oak borer in California?

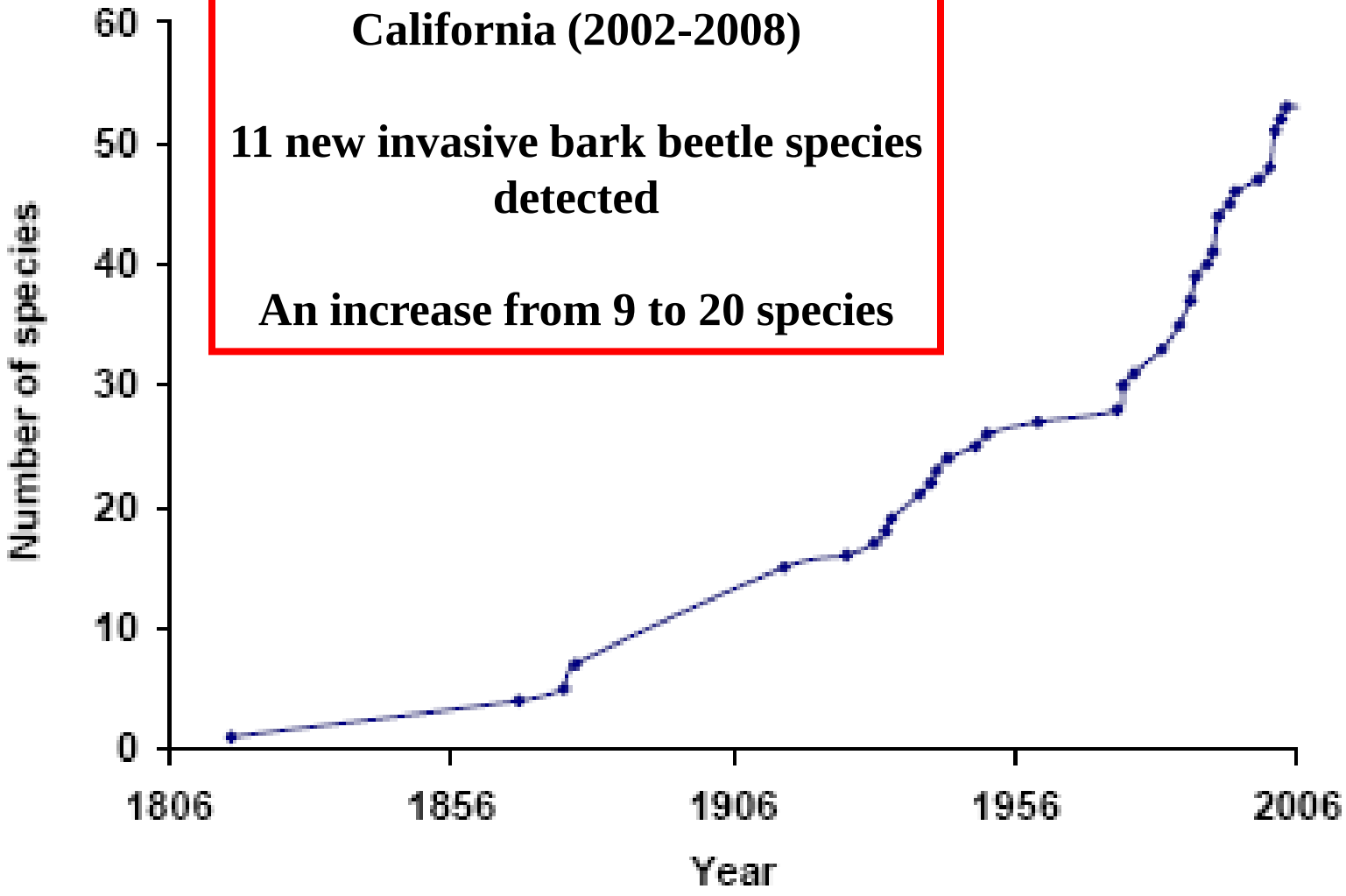
An exponential increase in the number of species:

The bark beetle invasion

California (2002-2008)

11 new invasive bark beetle species detected

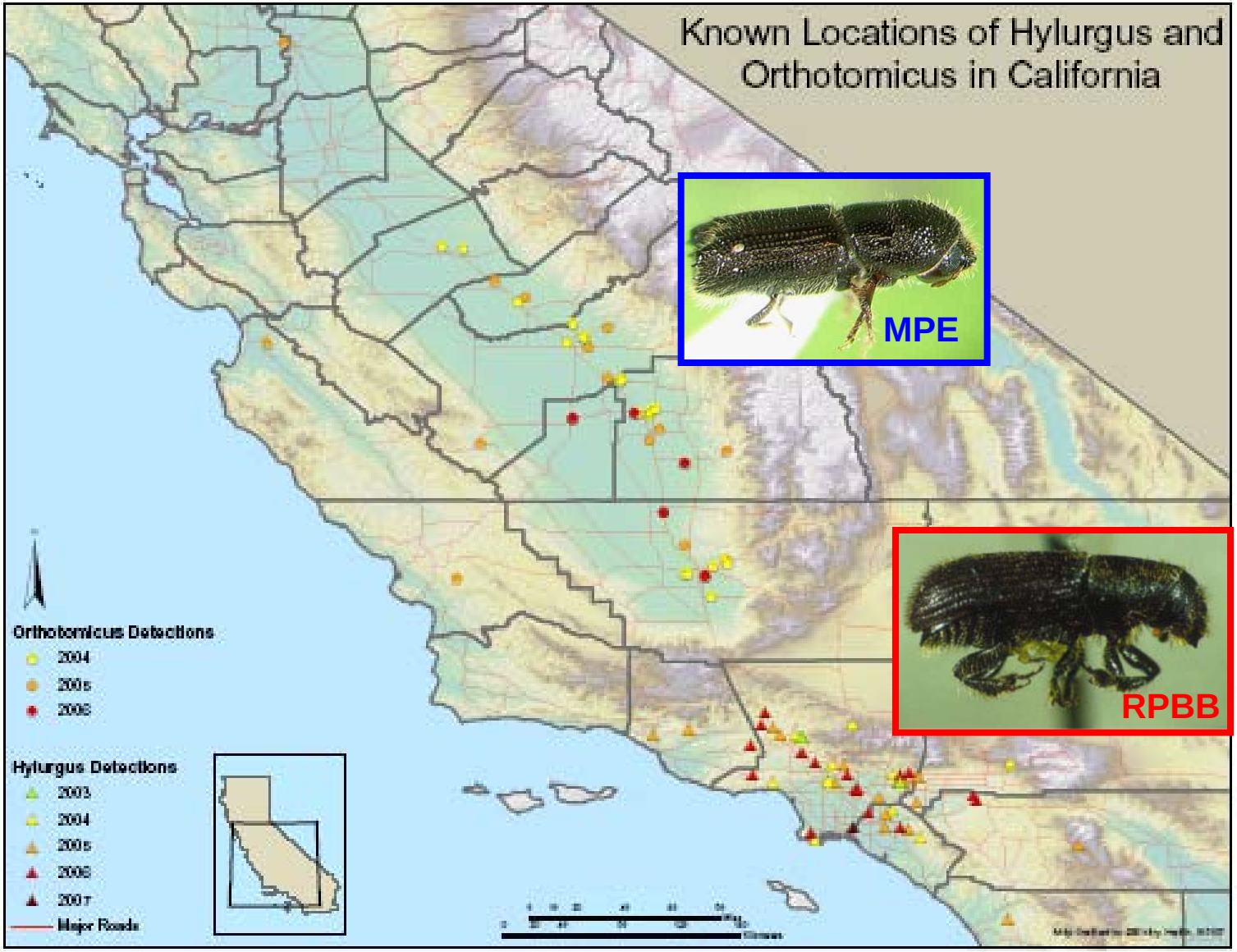
An increase from 9 to 20 species



Lee *et al.* (2007)

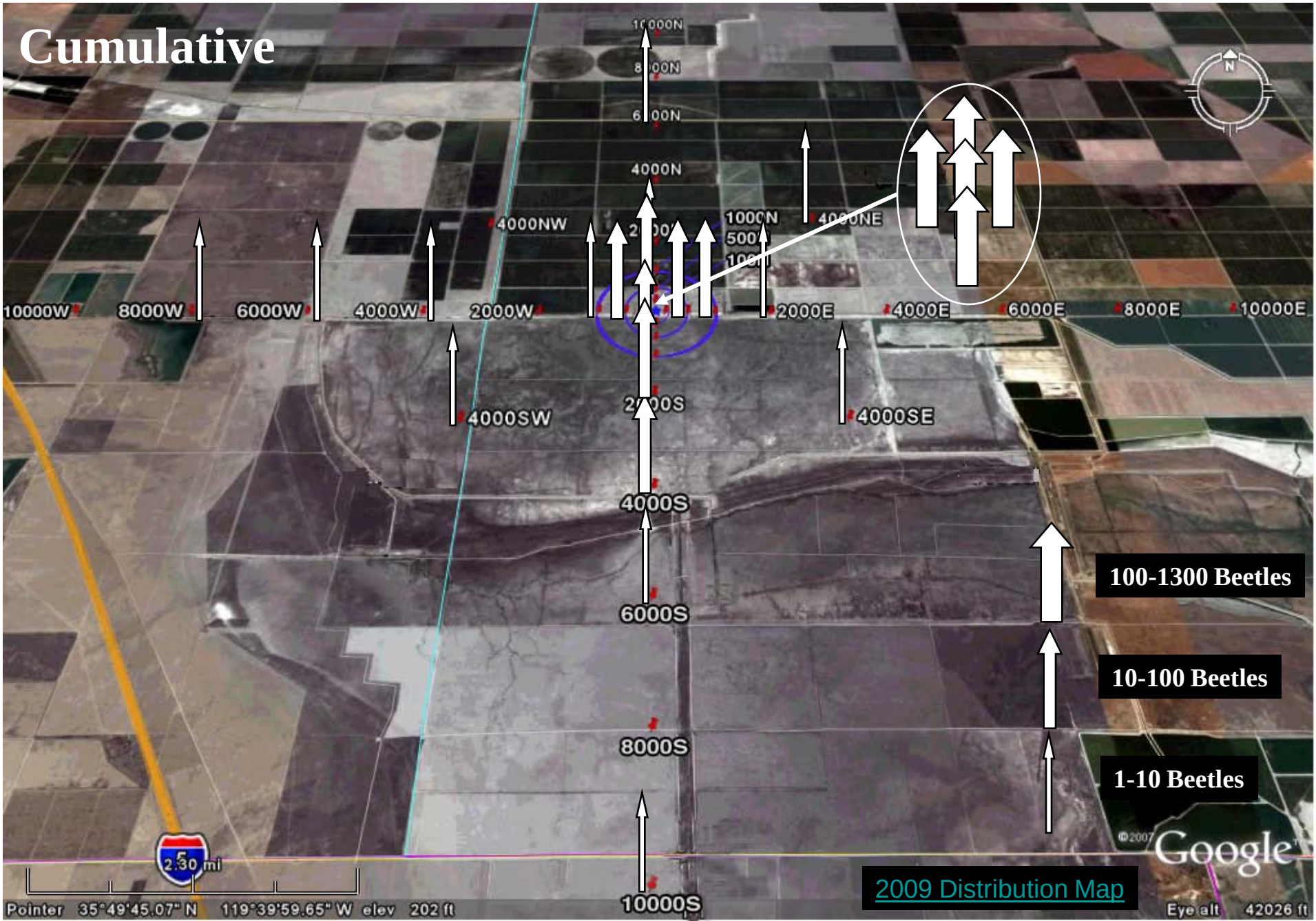
California Distribution

First Significant Invasive Bark Beetles on Pines in Western U.S.

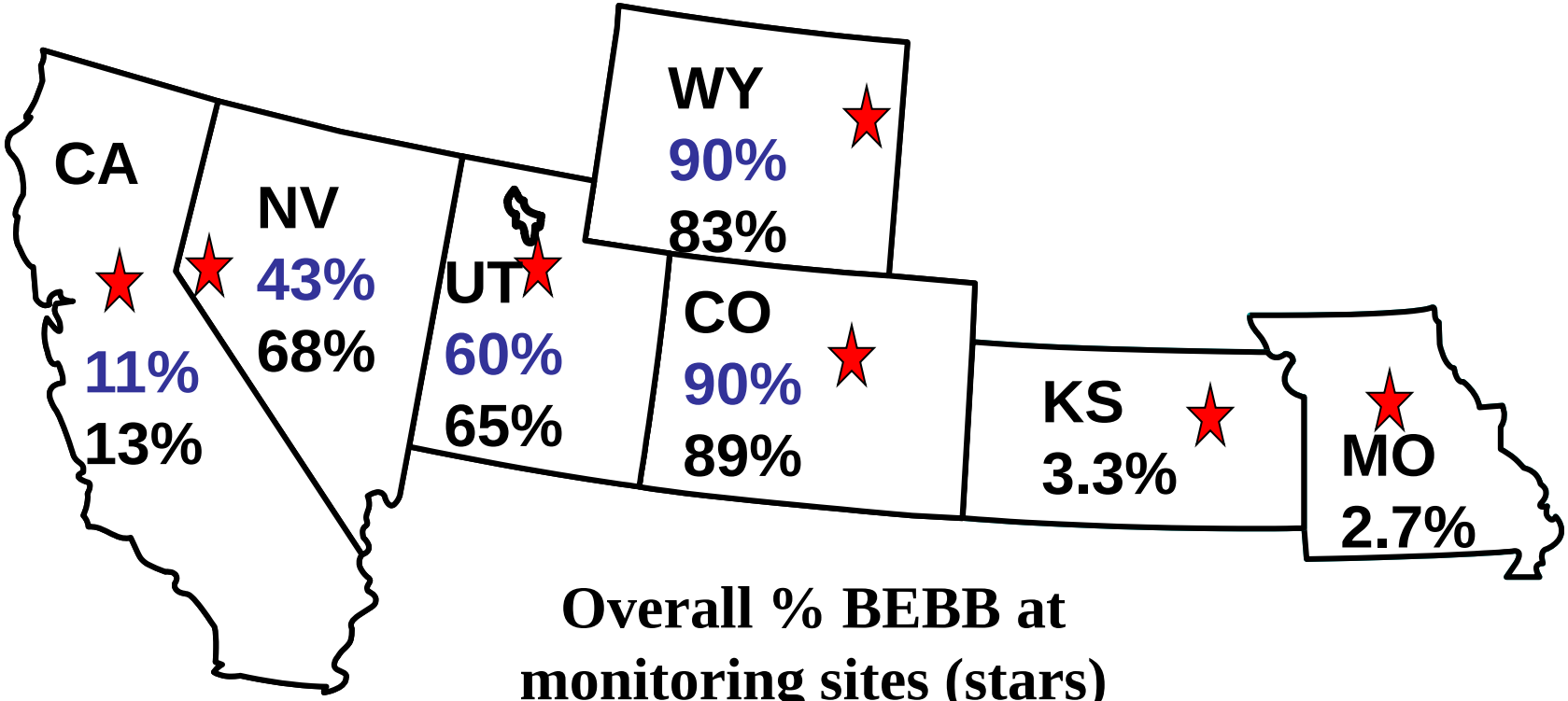


Spatial Partitioning

Med. Pine Engraver--2008 Mark Recapture Study



Interacting Invasive Species
Example 2
Competitive Displacement of the European elm bark beetle by the banded elm bark beetle



Overall % BEBB at monitoring sites (stars)

2006
2007

$$\frac{\#BEBB}{\#BEBB + \#EEBB}.$$

Lee *et al.* (2009) *Ann. Ent. Soc. Am.* 102: 426-436

Interacting Invasive Species Example 3

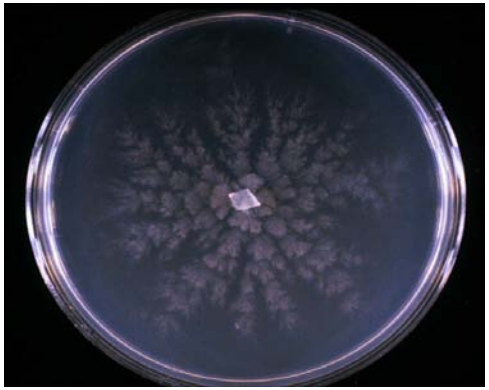
Could the distributions of sudden oak death and the goldspotted oak borer converge in coastal southern California?

How might the pests interact on coast live oak?

Contrasting Sudden Oak Death and the Goldspotted Oak Borer

Areawide Mortality

Stem Symptoms



SOD

GSOB

“Trend” No. 3: Is there the Potential for Small Populations of Seemingly Innocuous Non-Native Species to Sit Dormant and then Expand Later?

UCDAVIS News & Information

Bugs in Boxes Shed Light on Biological Invasions
September 18, 2009

Flour beetles are helping scientists understand the spread of invasive species. (Brett Melbourne/University of Colorado, Boulder)

Alan Hastings (UCD) and Brett Melbourne (CSU) suggest that the variability in the rate of spread of a model species in artificial habitats (landscapes) implies that we should not be "lax about a species that appears not to spread fast because it might suddenly spread dramatically."

http://www.news.ucdavis.edu/search/news_detail.lasso?id=9236

Take Home Messages: Non-Native Forest Insects and Diseases in the West

—Biodiversity has been on the move for tens and hundreds of millions of years driven by past changes in global climate

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{Ultimately, humans cannot “freeze-frame” biodiversity—it is dynamic overall long time scales}.

Take Home Messages: Non-Native Forest Insects and Diseases in the West

—Biodiversity has been on the move for tens and hundreds of millions of years driven by past changes in global climate.

—Humans have added a new dimension and accelerated the process of the homogenization of the flora and fauna of the world

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—Complexes of non-native forest insects and diseases on the same host may present new and extremely difficult challenges for managers of forest and shade tree resources

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—Biodiversity has been on the move for tens and hundreds of millions of years driven by past changes in global climate

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—Complexes of non-native forest insects and diseases on the same host may present new and extremely difficult challenges for managers of forest and shade tree resources

—Disciplined and overwhelming oversight or banning of inter- and intra-national pathways such as firewood, solid wood packing material, and nursery stock is the only way to effectively address the non-native forest insect and disease problem in the future

Final Thought: Non-Native Species

In his seminal book, *The Invasion Ecology of Animals and Plants*, Charles Elton (1958) stated:

"we are living in a period of the world's history when the mingling of thousands of kinds of organisms from different parts of the world is setting up terrific dislocations in nature..."