

A close-up photograph of three longhorn beetles (Cerambycidae) on a tree trunk. The beetles are dark with light-colored spots and long antennae. They are positioned vertically on the trunk, with one at the top, one in the middle, and one at the bottom. The background consists of green leaves and a blurred tree trunk.

# Ecology of invasive species, consequences on society

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HONR 208D, 04/30/18

# Invasive Species?

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Worksheet: Part I

Please list the first words (associations) that come to your mind

(30 sec)

# Invasive Species

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“a **non-native species** whose **introduction** does or is likely to **cause** economic or environmental **harm** or harm to human, animal, or plant health”

(National Invasive Species Management Plan, 2006)

# Native vs. ...

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Alien

Exotic

Non-indigenous

Introduced

Naturalized



Non-native

Worksheet: Part I

Which one can be invasive?

# Native vs. Non-native

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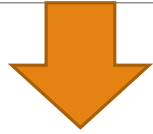
a species which has been introduced 5 years ago?

20 years ago?

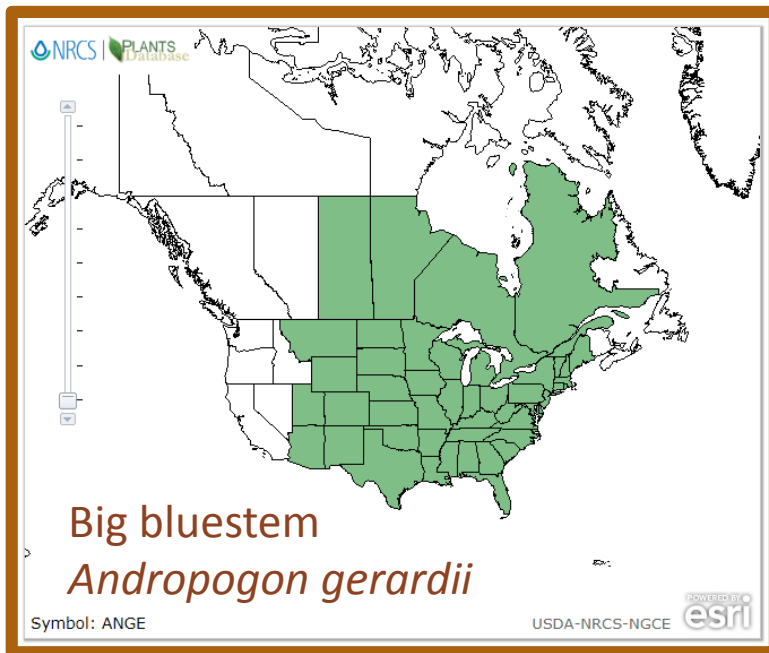
100 years ago?

500 years ago?

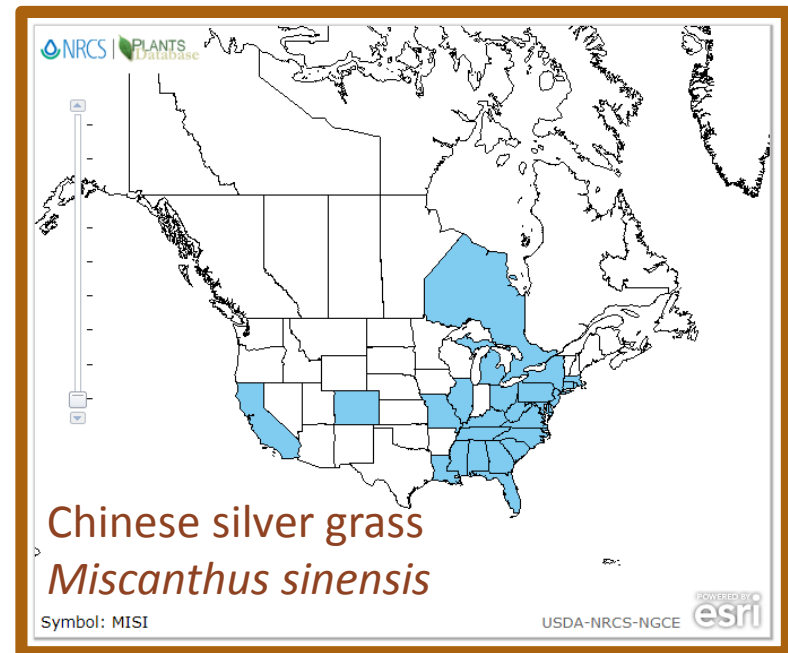
# Native vs. Non-native



Before European Settlement



After European Settlement



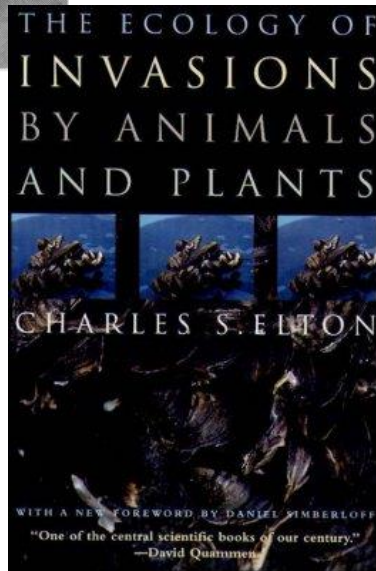
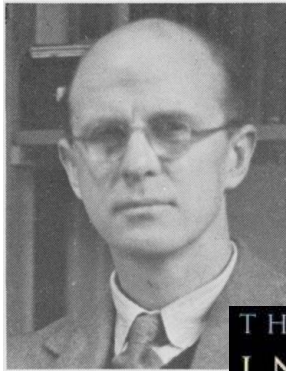
# The First Permanent European Settlements in North America

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Country	Name of Settlement	Present-Day Location	Year First Settled
Spain	St. Augustine	Florida	1565
England	Jamestown	Virginia	1607
France	Quebec	Canada	1608
Holland	New Amsterdam	New York	1624
Sweden	New Sweden	New Jersey	1638



# Charles Elton (1900-1991)



“...About 1929, a few African mosquitoes accidentally reached the north-east corner of Brazil, having probably been carried from Dakar on a fast French destroyer. They managed to get ashore and founded a small colony in a marsh near the coast—the Mosquito Fathers as it were. At first not much attention was paid to them, though there was a pretty sharp outbreak of malaria in the local town, during which practically every person was infected. For the next few years the insects spread rather quietly along the coastal region, until at a spot about 200 miles farther on explosive malaria blazed up and continued in 1938 and 1939, by which time the mosquitoes were found to have moved a further 200 miles inland up the Jaguaribe River valley. It was one of the worst epidemics that Brazil had ever known, hundreds of thousands of people were ill, some twenty thousand are believed to have died, and the life of the countryside was partially paralyzed..”

Worksheet. Part II.

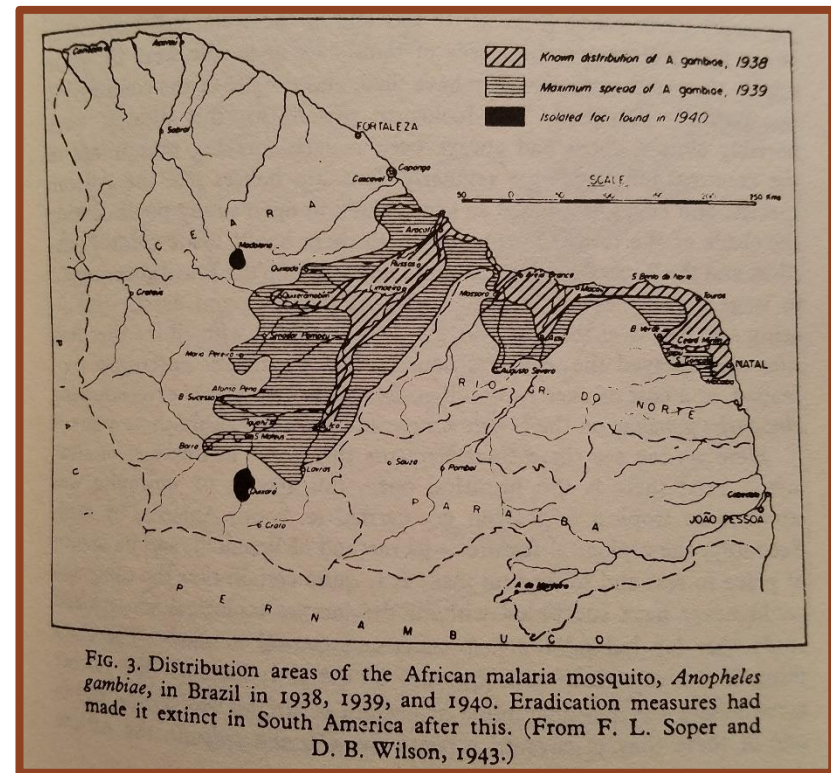


# Elton (1958): *The ecology of invasions by animals and plants*

Worksheet. Part II.

- Was it intentional introduction? Yes/No
- Were these mosquitoes invasive species? Yes/No

- **Non-native**
- **Caused harm**



# Invasive Insects

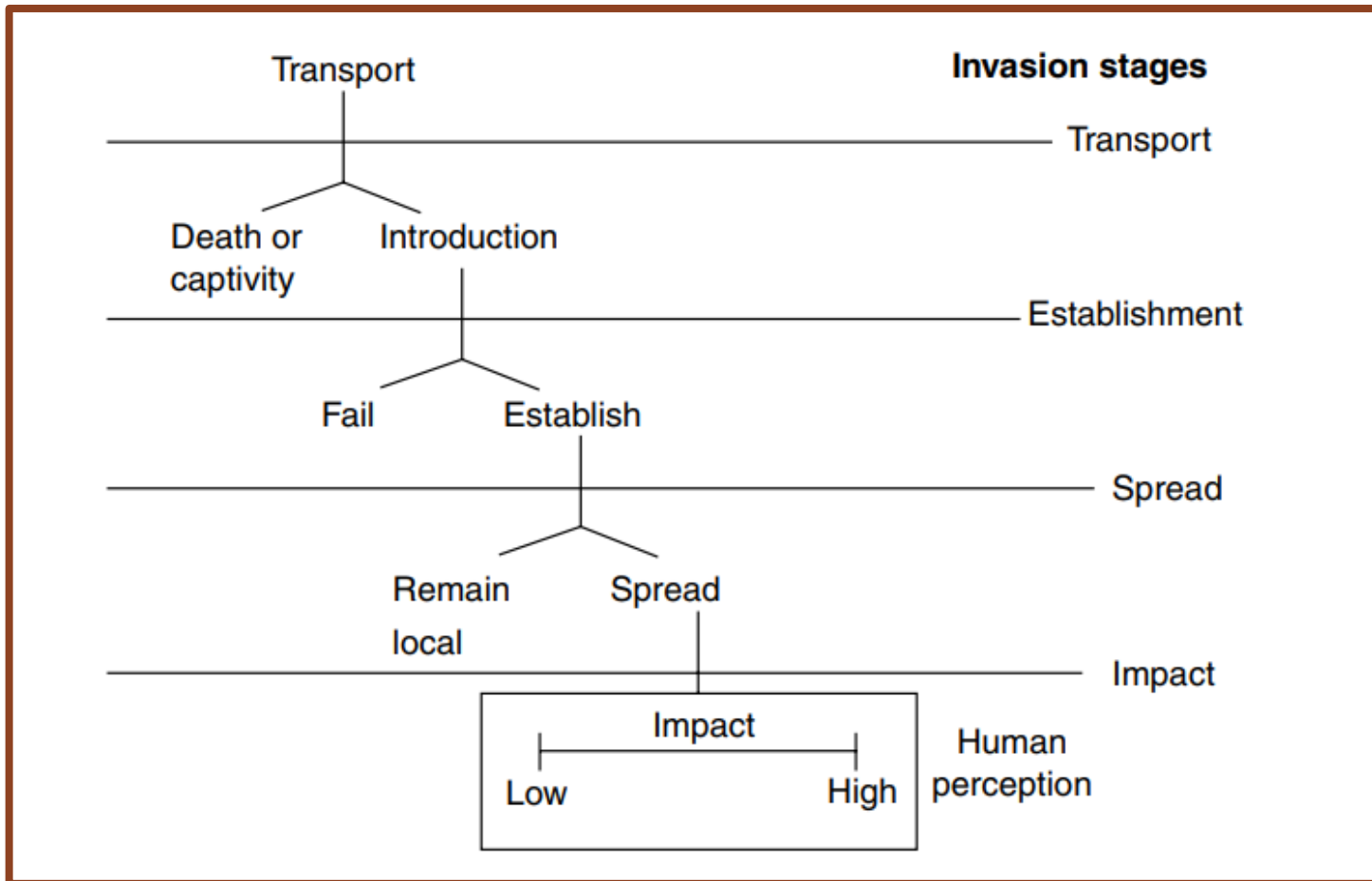
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[https://www.youtube.com/watch?v=HAY\\_UsGjyZk](https://www.youtube.com/watch?v=HAY_UsGjyZk)

Entomological Society of America, published on March 2013:

“This video was the winner of the INSTRUCTION category of the 2012 ESA YouTube Your Entomology contest. The video by Ellen Schofield and David Andow of the University of Minnesota uses animation to explain the harm of invasive species for outreach programs.”

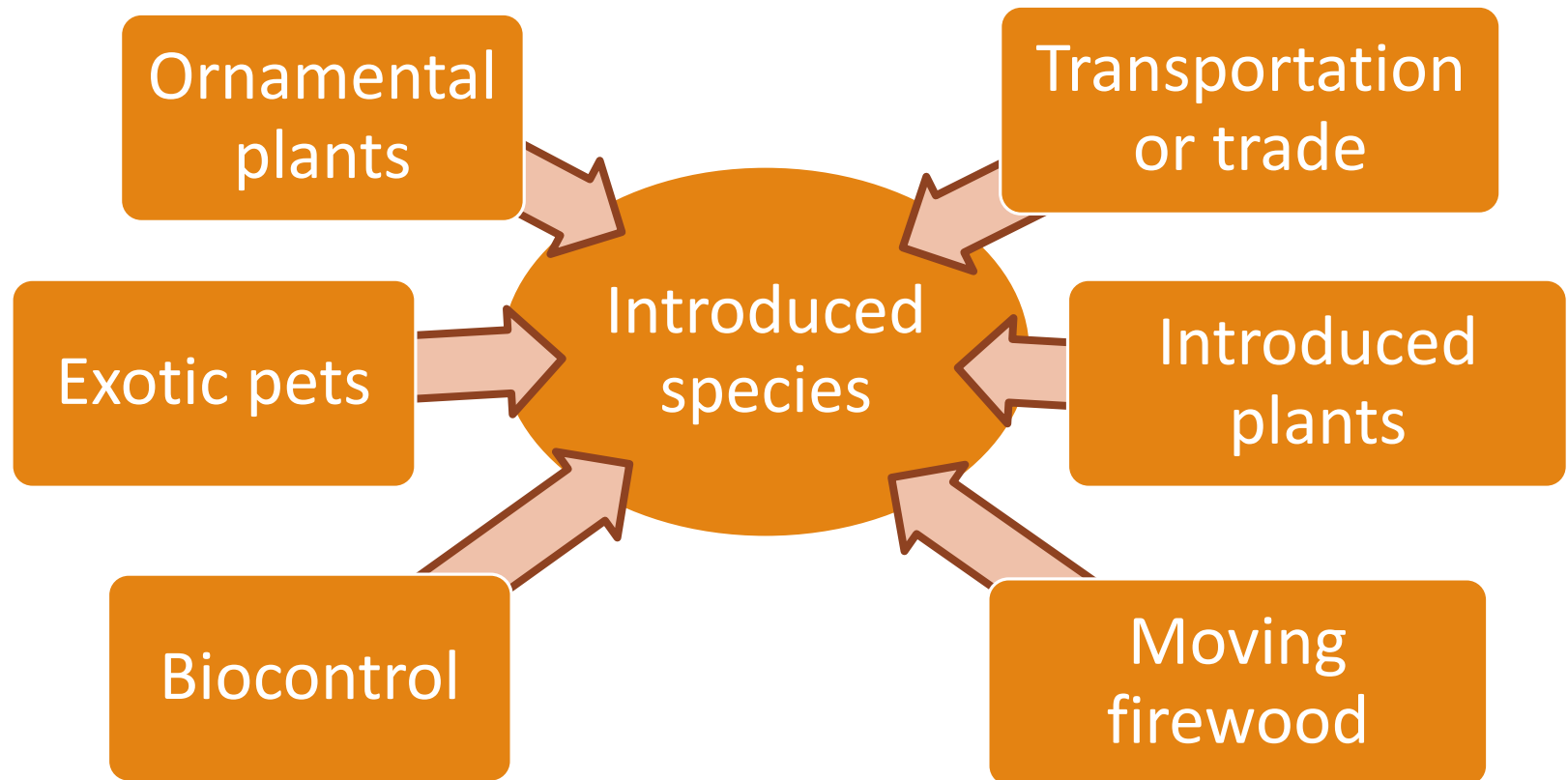
# Stages of Invasion



# Modes of Introduction

Deliberate

Accidental



# Invasive Species Are Still Hitching Rides on Tsunami Debris

## RESEARCH

### BIOGEOGRAPHY

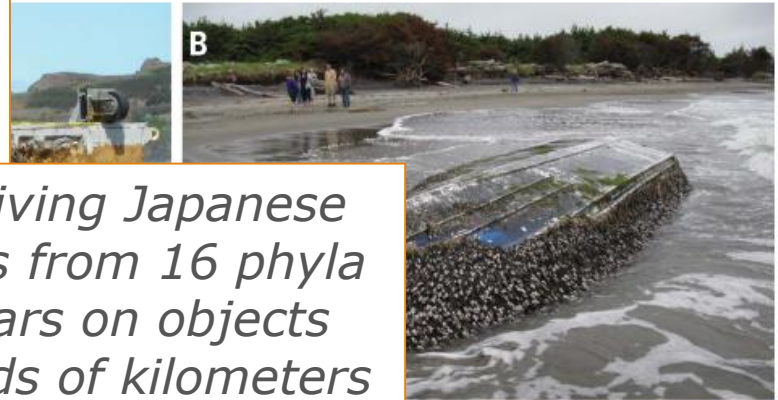
## Tsunami-driven rafting: Transoceanic species dispersal and implications for marine biogeography

James T. Carlton,<sup>1,2\*</sup> John W. Chapman,<sup>3</sup> Jonathan B. Geller,<sup>4</sup> Jessica A. Miller,<sup>3</sup> Deborah A. Carlton,<sup>1</sup> Megan I. McCuller,<sup>1,†</sup> Nancy C. Treneman,<sup>5</sup> Brian P. Steves,<sup>6</sup> Gregory M. Ruiz<sup>6,7</sup>

The 2011 East Japan earthquake generated a massive extraordinary transoceanic biological rafting event with We document 289 living Japanese coastal marine species over 6 years on objects that traveled thousands of kilometers to the shores of North America and Hawai'i. Most of th

ent across all object types (figs. S7 and S8). We documented peak richness in 2012 to 2014 for each object type and region (fig. S7 and fig. S4), 2 to 3 years after debris entry into the Western Pacific Ocean. Strong spring pulses were evident for both landings and species accumulation for each year between 2012 and 2016 (Fig. 2 and fig. S2). These pulses were most pronounced in the Pacific Northwest (5) and were associated with springtime southwesterly or downwelling-favorable winds.

Temporal analyses of a subset of 110 JTMD objects that were most thoroughly sampled for macrobiota [higher-resolution objects (JTMD-



*"..We document 289 living Japanese coastal marine species from 16 phyla transported over 6 years on objects that traveled thousands of kilometers across the Pacific Ocean to the shores of North America and Hawai'i.."*

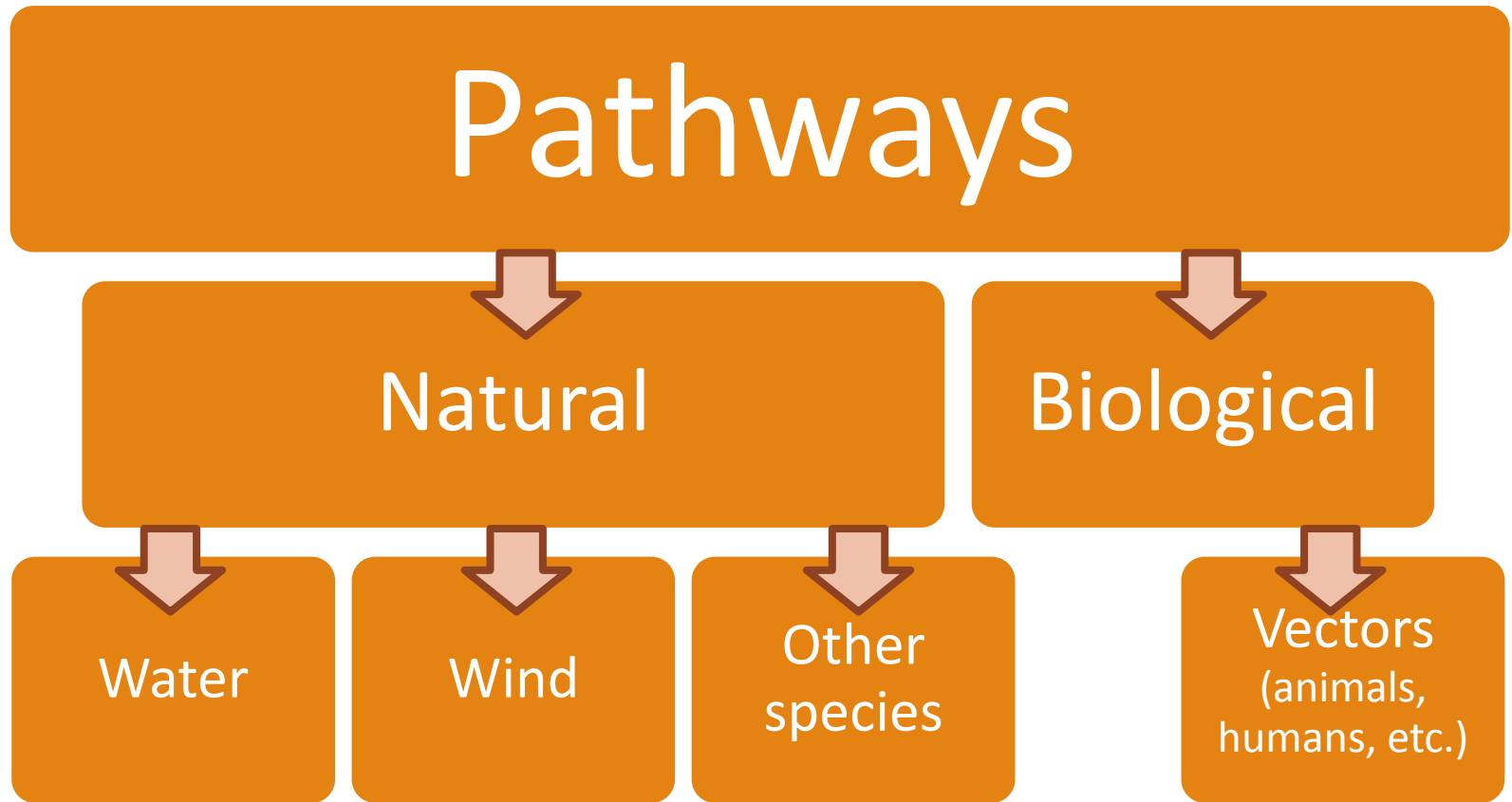


**Fig. 1. Japanese tsunami marine debris rafts and associated biota.** (A) Fisheries dock (JTMD-BF-1) (4) from the Port of Misawa, Aomori Prefecture,

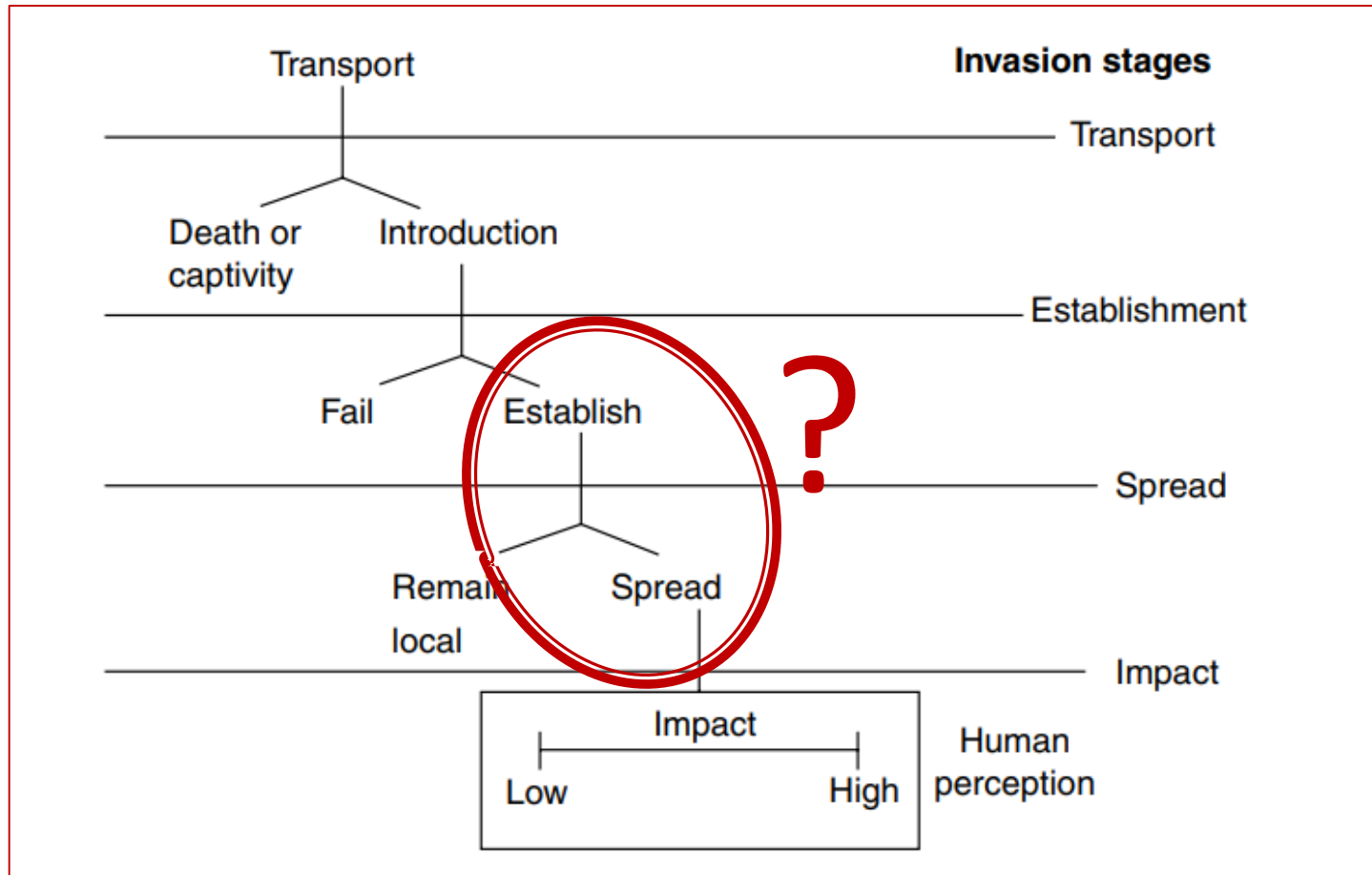
Peninsula, Pacific County, Washington (photograph by A. Pleus). (D) Post-and-beam wood (JTMD-BF-297) from Tōhoku coast, Honshu, washed ashore 1 April

# Spread From the Point of Introduction

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# Stages of invasion





# Invasion Hypotheses

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- Catford *et al.* (2009) summarized 29 leading hypotheses

## ESTABLISHMENT

- **P**ropagule pressure
- **A**biotic characteristics of the receiving environment

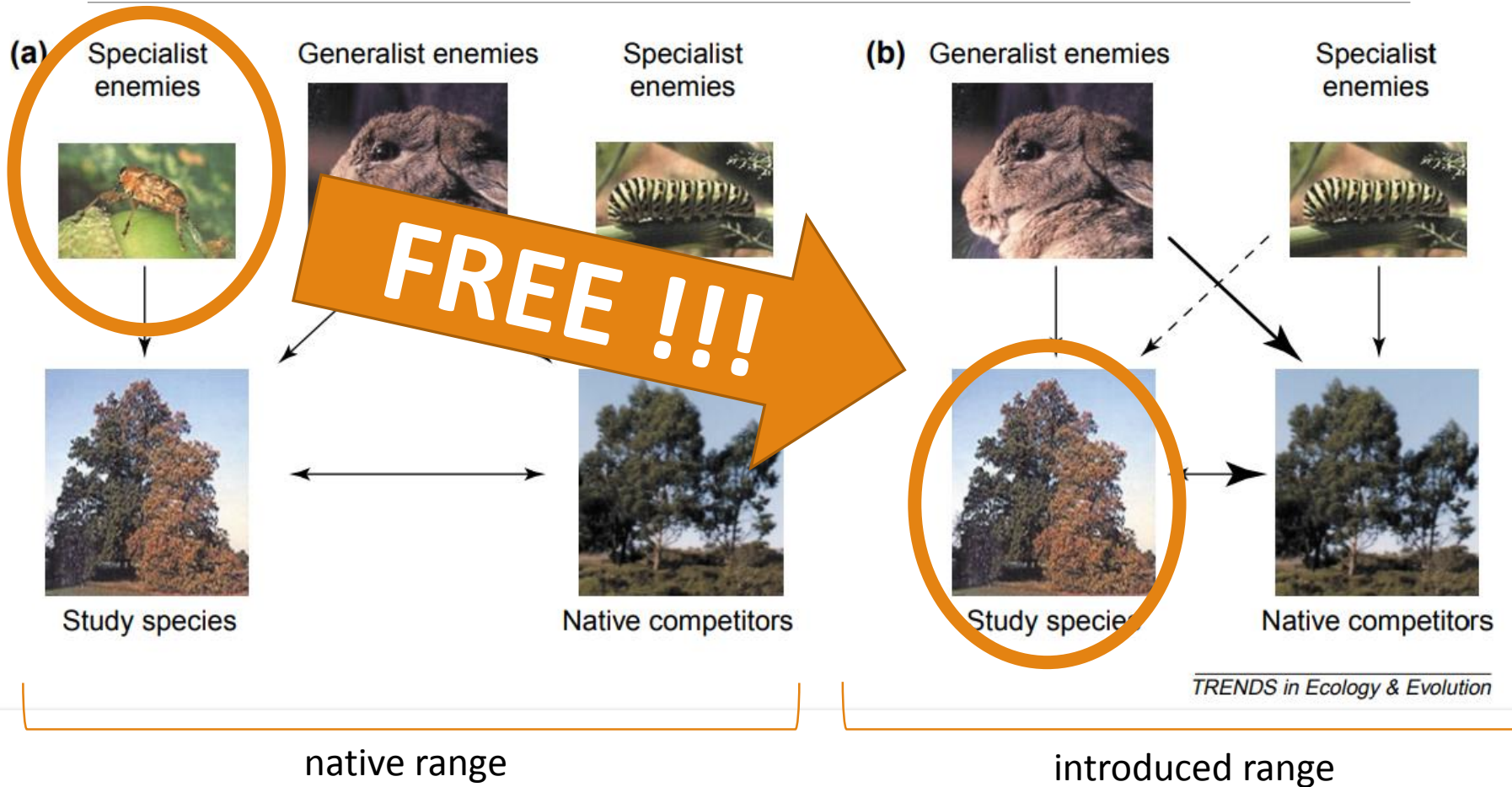
- **B**iological characteristics of the invading species
- **B**iological characteristics of the community/ecosystem

- **H**uman Release  
invading species benefits from no/low landscape maintenance

## ABUNDANCE



# Enemy release hypothesis



# The Human Release Hypothesis

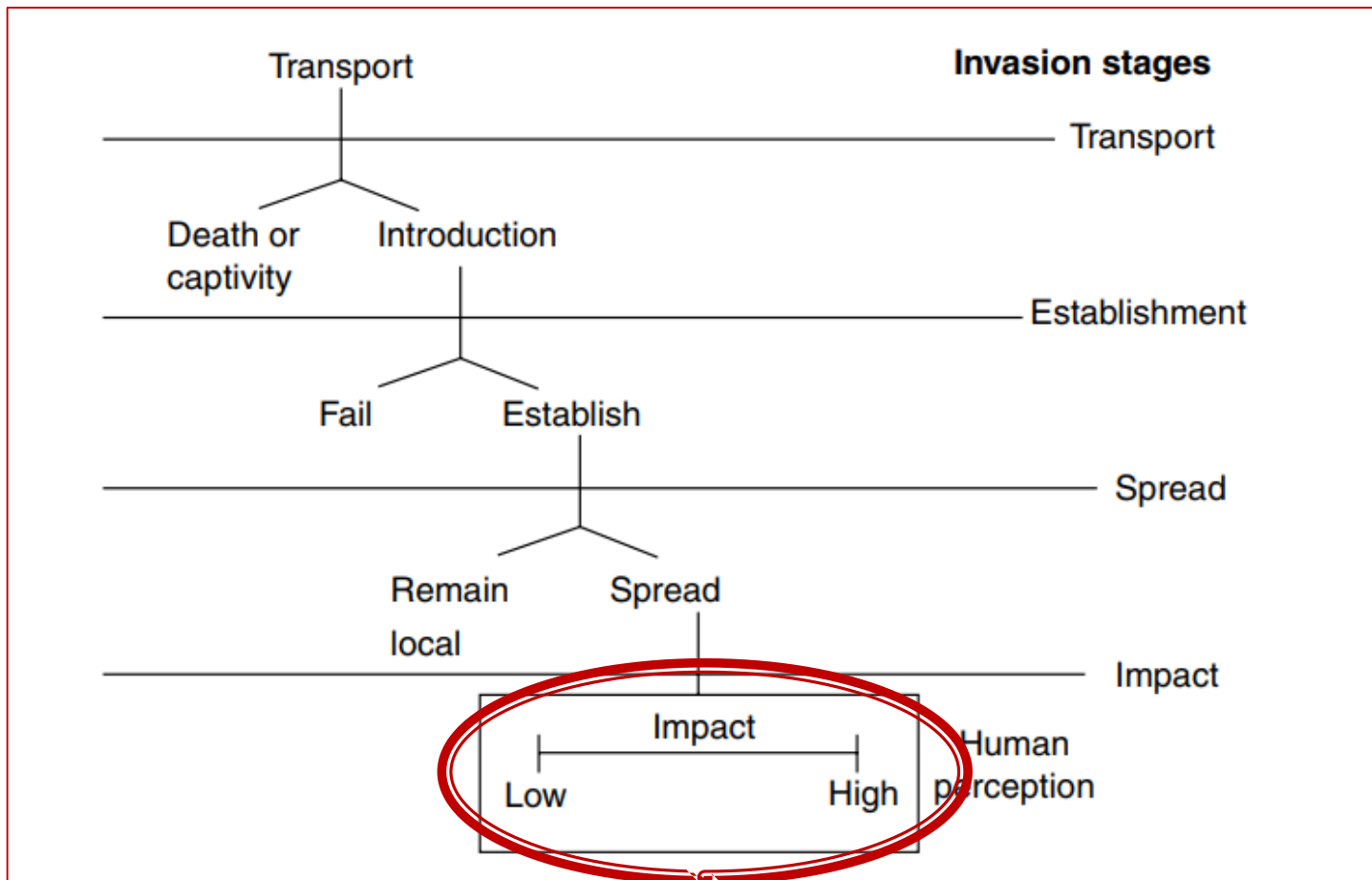
introduced range  
(Argentina)



native range  
(Germany, Spain)

- The sweetbriar rose *Rosa rubiginosa* L.
- A global invader

# Stages of invasion



# Impact of Invasive Species

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- ❖ Biological invasions are the second largest threat (after habitat destruction) to population and species decline.
- ❖ Exotic species have contributed to the decline of 42% of U.S. endangered and threatened species (because of hybridization between closely related exotic and native species). (Schmitz and Simberloff 1997)
- ❖ ~ 50,000 exotic species already are known to exist in the U.S. (Pimental et al. 2000)
- ❖ The annual cost of all invasive species within the United States to be more than US\$137 billion (Pimental et al. 2000) - more than all other natural disasters combined.

# Impact of Invasive Species

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## Ecological problems

Resource acquisition and utilization

Altered trophic structure

Influence on fire regimes

Altered disturbance frequency and intensity

## Economic problems

Forest and crop arthropod pests - the estimated annual costs associated with them are \$2.1 and \$13.9 billion respectively (Pimentel et al., 2005)

A single outbreak of medfly may cost millions of dollars to eradicate

# Invasive Species: Common Characteristics

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- Fast growth
- Rapid reproduction
- High dispersal ability
- High phenotypic plasticity
- High ecological tolerance
- Generalists
- Pioneer species



Gypsy moth larva



# Lepidoptera: Gypsy moth

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- Native to Europe
- It was introduced into Massachusetts in 1869
- It did not spread rapidly in the eastern United States until the late 1960's
- In Maryland:
  - The first gypsy moth appeared in 1959
  - The first egg mass was discovered in 1971
  - The first extensive defoliation occurred in 1981
- Oaks are preferred host trees



# Coleoptera: Emerald Ash Borer

- Native to Asia; likely arrived in the US in packing material
- It was first detected near Detroit, Michigan, in 2002
- Since then it has killed more than 100 million ash trees in the US
- In 2003 it was detected in a nursery in Prince George's County
- It escaped quarantine zones in Prince George's County and by 2015 it had arrived in Baltimore



- The total population of ash the entire metropolitan area surrounding Baltimore exceeds 6 million trees (Maryland Department of Natural Resources)
- According to estimates by USDA the loss of ash trees in Baltimore could exceed \$200 million dollars.



# Hymenoptera: Sirex Woodwasp

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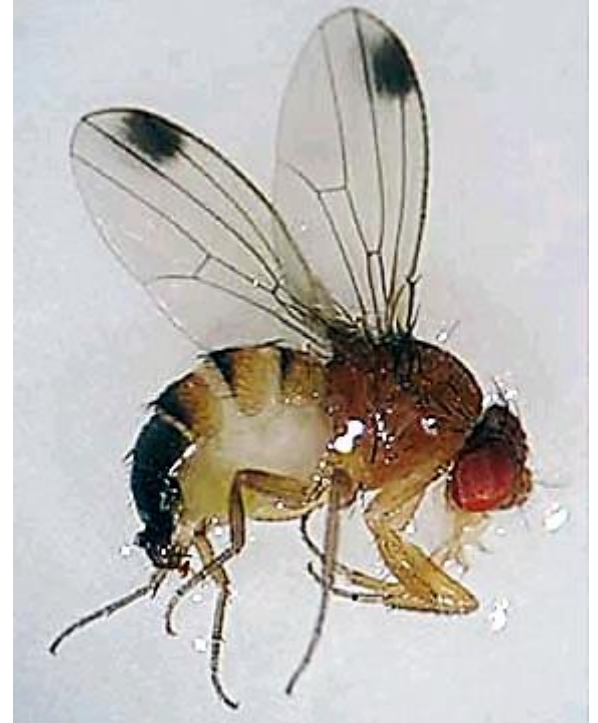
- Native To: Eurasia
- First detected in New York in 2004
- Accidentally introduced through imported wood products
- One of the top 10 most serious forest insect pests worldwide
- Primarily attacks pine species



# Diptera: Spotted Wing Drosophila

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- Native to Asia
  - It was first reported in 1916 in mainland Japan
  - Several decades later it was detected in Europe, North America, and South America
- In the USA it was first detected in Hawaii around 1980
  - Its mainland invasion started in California in 2008
  - By 2012, damage from *D. suzukii* was reported in 35 states, as well as in Canada
- Attacks a wide variety of soft-skinned fruits and berries (raspberry, blueberry, cherry, etc.)





# Spotted Wing Drosophila: control





# Spotted Wing Drosophila: control





# Hemiptera: Spotted Lanternfly

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- An emerging highly invasive insect pest
- Native to China
- Invaded Korea in 2004
- Detected in Berks County, PA in 2014
  
- It has rapidly spread to 13 counties in PA
- Fall 2017: detected in New York and Delaware
- January 2018: detected in Virginia
- **Maryland???**



# Spotted Lanternfly: Host plants and plant damage

Sap-feeder

Over 70 host plants:

- **Apple**
- Plum
- Cherry
- Peach
- Apricot
- **Grape**
- Pine
- Tree of heaven (preferred tree host)
- ..... and many many others....

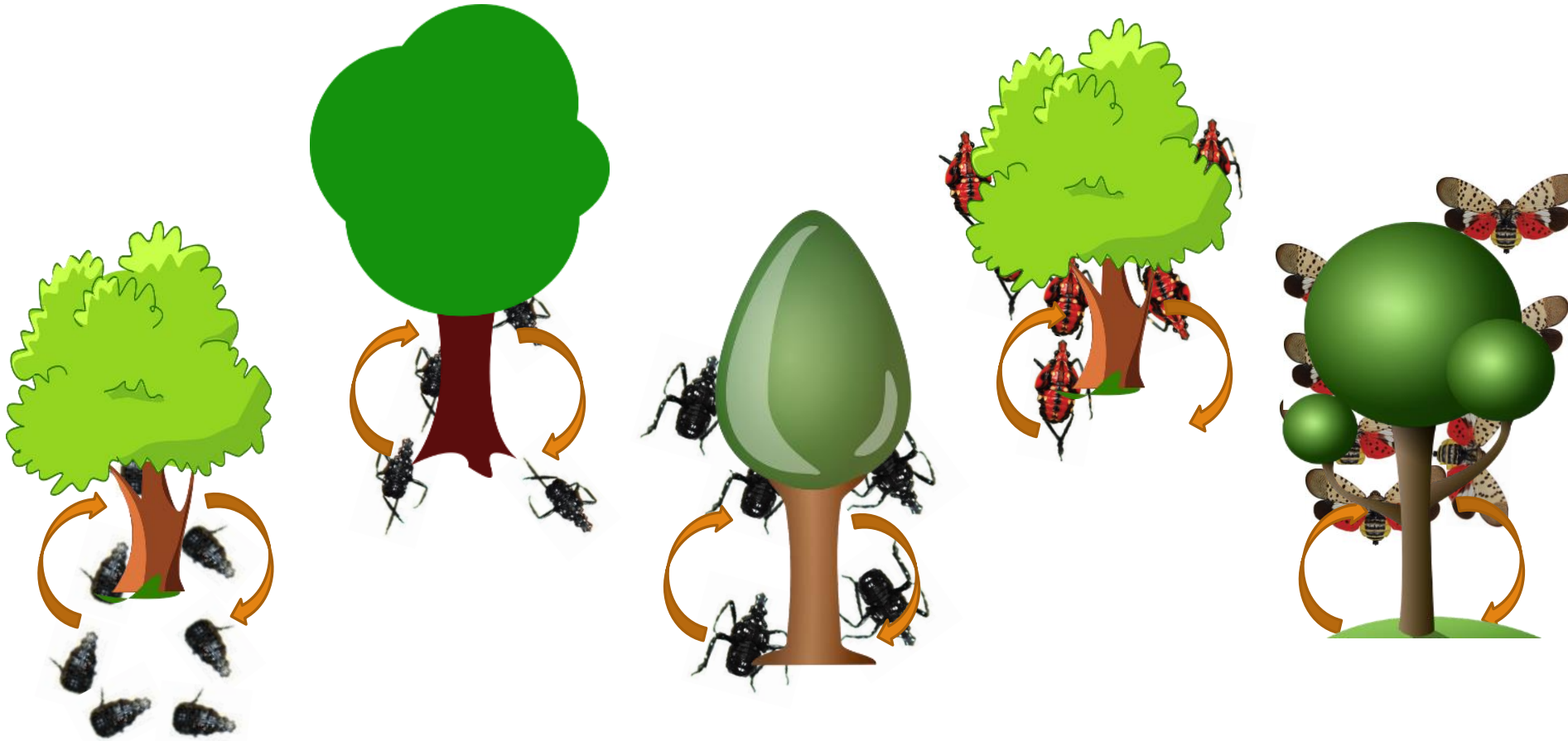
Consumes  
phloem sap

Create a sugary  
substance (honeydew)



# Spotted Lanternfly: Falling-ascending cycle

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# Spotted Lanternfly: Modes of Dispersal

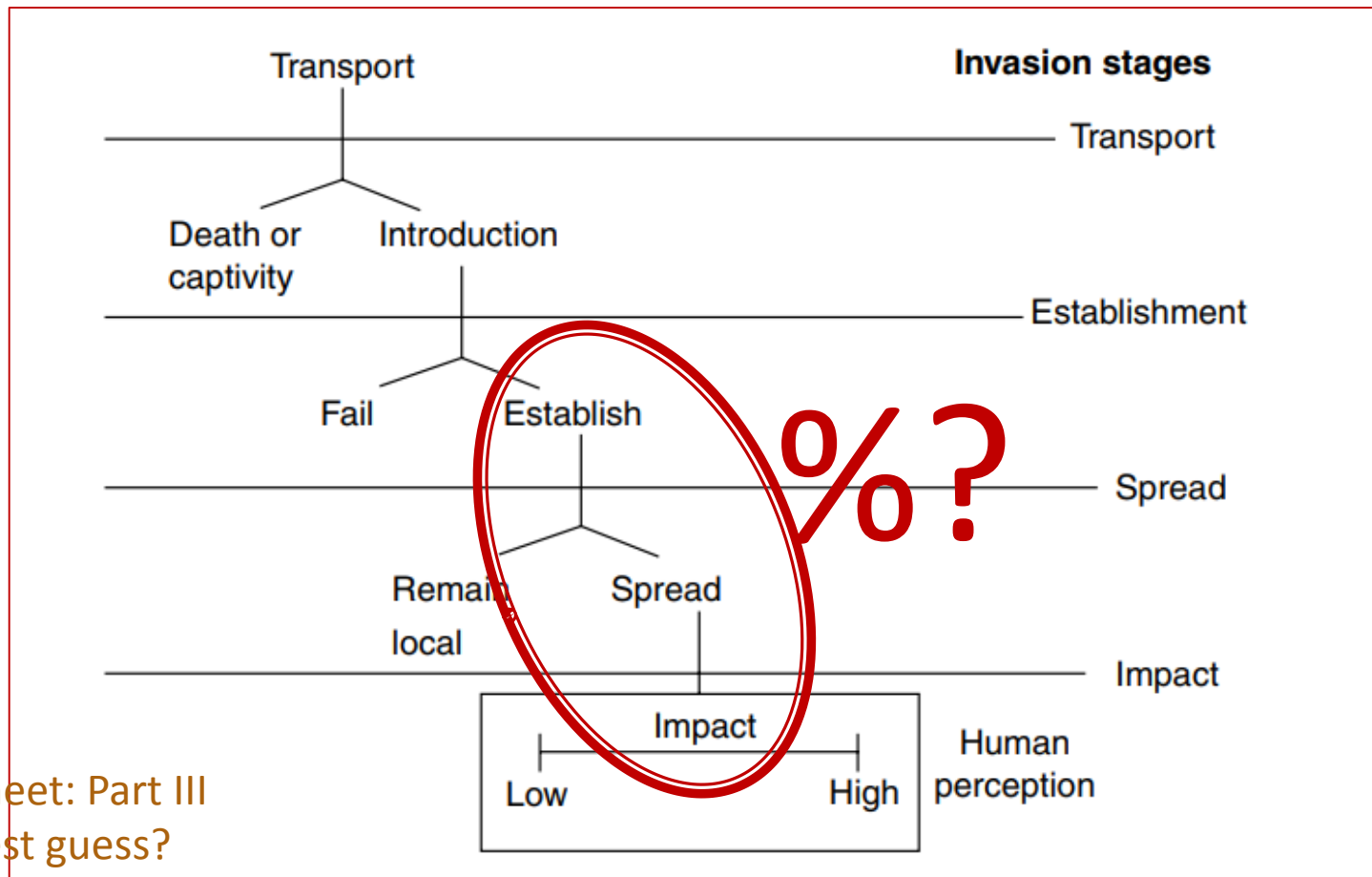
- One of the most aggressive leaf-hopping pest in Mid-Atlantic region
- Very high potential to breed and increase its population size
- It can be spread long distances by any material (including manmade material) containing egg masses:

- ❖ trunked tree
- ❖ stones
- ❖ vehicles
- ❖ yard furniture
- ❖ farm equipment, etc.



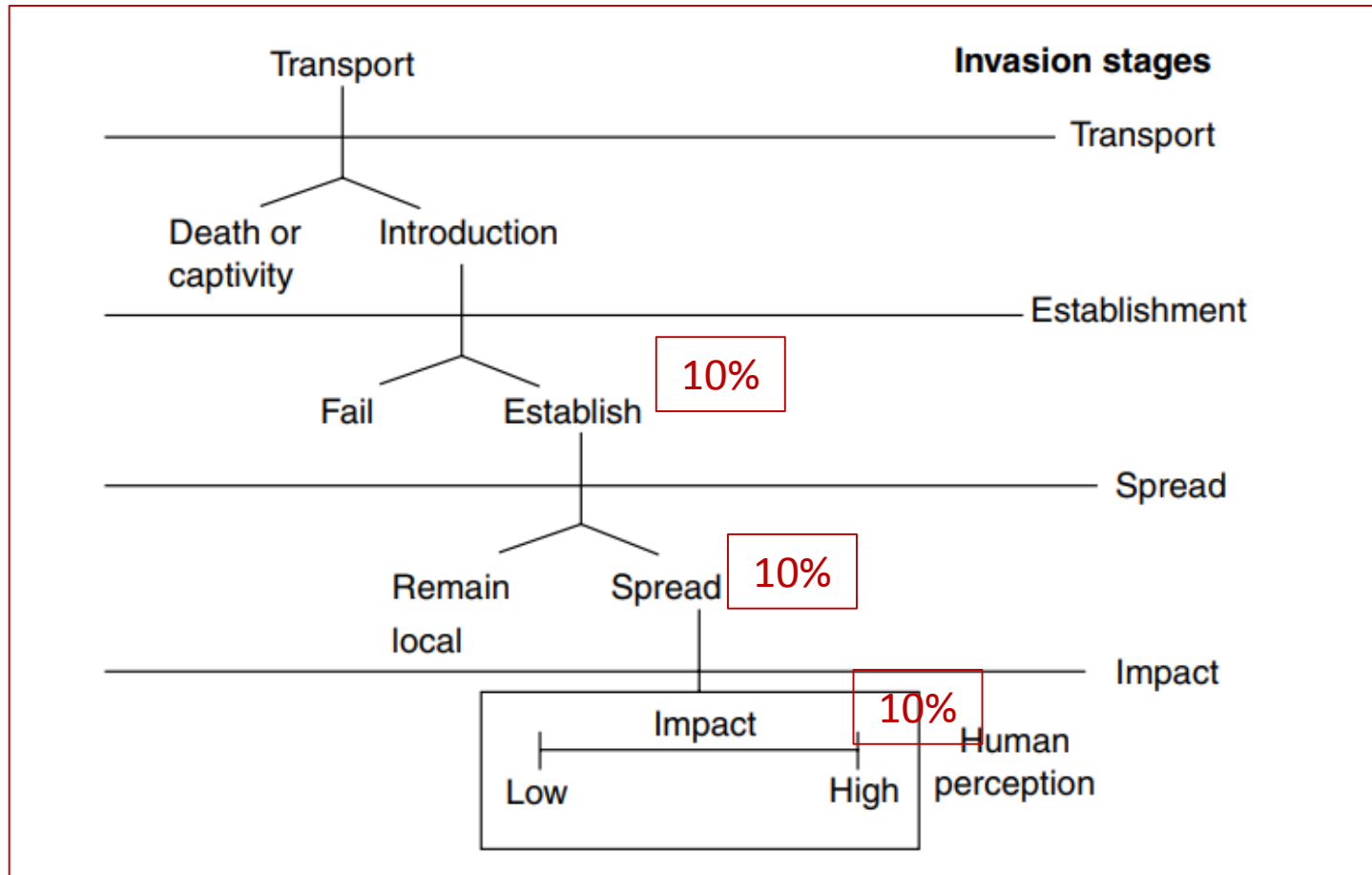


# Stages of invasion



Worksheet: Part III  
Your best guess?

# Stages of invasion



# Control and management

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Prevention

Early detection

Eradication

# Eradication

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## Mechanical control

- Heavy equipment, power and hand tools
- Draught animals
- Prescribed fire, explosives
- Manual removal

## Cultural control

- Educating people
- Actions that minimize the spread of invasive species

## Biological control

- Use of natural enemies
- Encouraging succession (for invasive plants)

## Chemical control

- Manipulation of water or soil chemistry
- Pesticides and herbicides

# At a local scale

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- Options for homeowners:
  - avoiding purchasing invasive landscaping plants
  - replacing invasive garden plants with non-invasive alternatives
- Aquarium keepers:
  - avoiding introducing exotic fish and other aquatic species into local water reservoirs
- Owners of exotic pets:
  - these pets may become invasive if they escape or are released
- Boaters:
  - clean boat and trailers thoroughly before transporting them to a different body of water
- Hikers:
  - clean their boots to get rid of weed seeds and pathogens which may have become attached

# Quick Review

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- Do all the introduced species become invasive? Yes/No
- Do invasive species cause only economic problems? Yes/No
- Are invasive insects typically specialists? Yes/No
- Do invasive insects usually lack natural enemies? Yes/No
- Are high reproduction and high dispersal typical characteristics of invasive insects? Yes/No
- Is biocontrol the only effective method against invaders? Yes/No

# More about invasive species...

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□ USDA

[www.invasivespeciesinfo.gov](http://www.invasivespeciesinfo.gov)



□ Invasive and Exotic Species of North America

[www.invasive.org](http://www.invasive.org)



□ EDDMapS

[www.eddmaps.org](http://www.eddmaps.org)



□ University of Maryland Extension

<https://extension.umd.edu/hgic/invasive-insects-0>



# Image credits and resources

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USDA

Maryland Cooperative Extension

<https://www.nhbs.com/the-ecology-of-invasions-by-animals-and-plants-book>

<http://www.socialstudiesforkids.com>

<https://oceanservice.noaa.gov>

<https://www.ecori.org/natural-resources/2015/6/23/gypsy-moth-caterpillars-take-ri-by-storm>

Louis-Michel Nageleisen, Département de la Santé des Forêts, [Bugwood.org](http://Bugwood.org)

<http://bugoftheweek.com/blog/2017/4/29/good-bye-ash-trees-of-the-potomac-emerald-ash-borer-eab-iagrilus-planipennisi>