



Ecology of invasive species, consequences on society

Alina Avanesyan

Postdoctoral Associate

Dr. Bill Lamp's lab

HONR 208D, 05/06/19

Class Activities

BIOL 2020: Ecology of invasive species, consequences on society

Worksheet

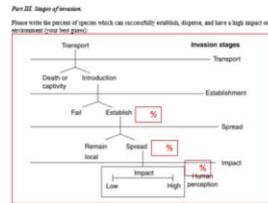
Part I. Invasive species: definition, introduction, establishment

In the provided space below, please list the five words (associations) that come to your mind when you hear "invasive species" (20 sec)

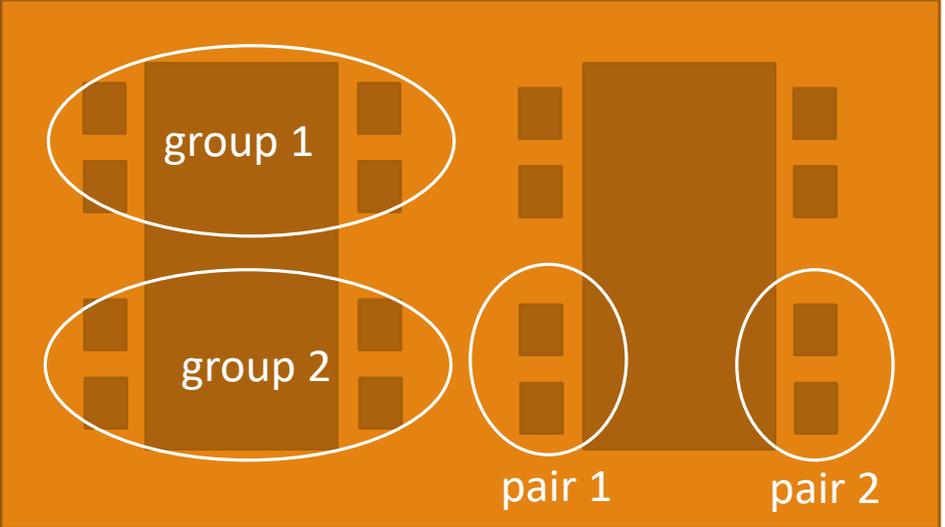
- Please compare your list in pairs and pick 7 unique associations (20 sec)
- Please compare your list in groups and pick 7 unique associations (20 sec)
- Please watch the video and check matches to your list (2 min)
- Please compare your matches with formal definitions of the seven species (2 min) (see "You're the chef")

Part II. Charles Elton (1918): The ecology of invasions by animals and plants

"...ABOUT 1920, a NEW KIND OF invasions accidentally reached the north east corner of Brazil, having probably been carried from China to the French Antilles. They managed to get across and founded a small colony in a remote spot like coast-forest islands. Fathers as it were. As first our much attention was paid to them, though there was a pretty steady outbreak of malaria in the local zone, being being generally very severe. The spread of the pest was slow, the search against it was slow, and the pest was slow to spread other parts along the coastal region, such as a spot about 200 miles distant the epidemic outbreak blazed up and continued in 1918 and 1919, to which time the mosquitoes were found to have moved a further 200 miles inland up the Amazon River valley. In two one of the most 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 paralysed."

YES | NO



group 1

group 2

pair 1

pair 2

Learning Objectives

By the end of today's class you will:

- know what invasive species are
- be able to differentiate between native and non-native species
- be able to name at least one invasive insect

Invasive Species? Worksheet: Part I

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

HONR 208D: Ecology of invasive species, consequences on society

Worksheet

Part I. Invasive species: definition, introduction, establishment.

In the provided space below, please list the first words (associations) that come to your mind when you hear “invasive species” (30 sec)



Invasive Species? [Worksheet: Part I](#)



Please compare your lists in pairs and pick 5 unique associations
(30 sec)

Please compare your lists in groups and pick 5 unique associations
(30 sec)

Please watch the video and check matches in your list
(2 min)

Invasive Species? [Worksheet: Part I](#)

Please compare your lists in pairs and pick 5 unique associations
(30 sec)



Please compare your lists in groups and pick 5 unique associations
(30 sec)

Please watch the video and check matches in your list
(2 min)

Invasive Species? [Worksheet: Part I](#)

Please compare your lists in pairs and pick 5 unique associations
(30 sec)

Please compare your lists in groups and pick 5 unique associations
(30 sec)



Please watch the video and check matches in your list
(2 min)

Invasive Insects

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.”

Invasive Species

“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)



Please compare your matches with formal definition of invasive species (2 min) (use 'Yes/No cards')

Invasive Species



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

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(National Invasive Species Management Plan, 2006)



Please compare your matches with formal definition of invasive species (2 min) (use 'Yes/No cards')

Native vs. Non-native

a species which has been introduced 5 years ago?

20 years ago?

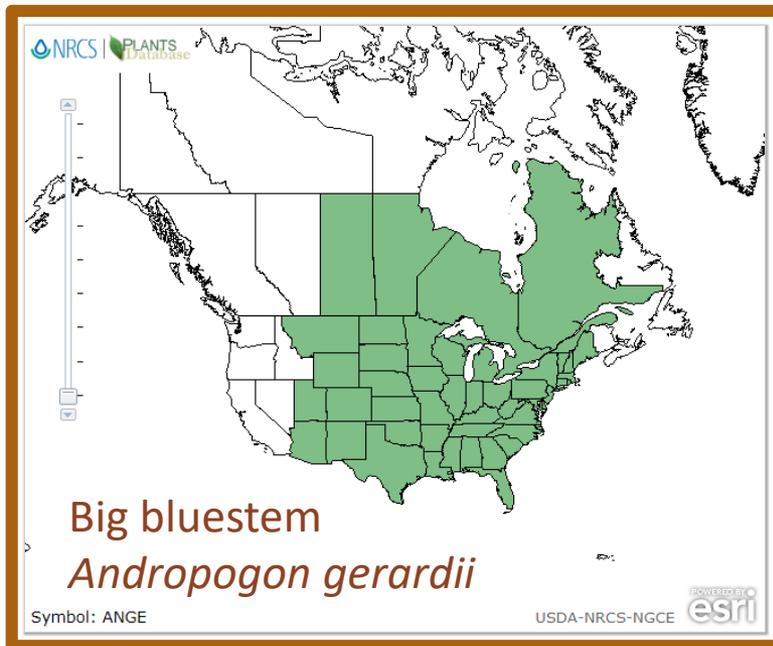
100 years ago?

500 years ago?

Native vs. Non-native



Before European Settlement



After European Settlement

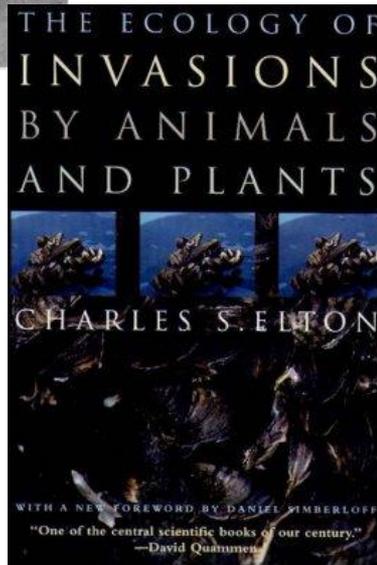
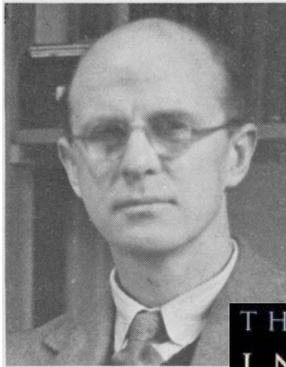


The First Permanent European Settlements in North America

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)



Part II. Charles Elton (1958): *The ecology of invasions by animals and plants.*

“...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 paralysed..”

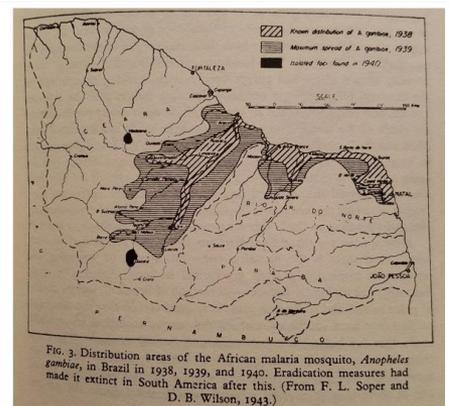


FIG. 3. Distribution areas of the African malaria mosquito, *Anopheles gambiae*, in Brazil in 1938, 1939, and 1940. Eradication measures had made it extinct in South America after this. (From F. L. Soper and D. B. Wilson, 1943.)

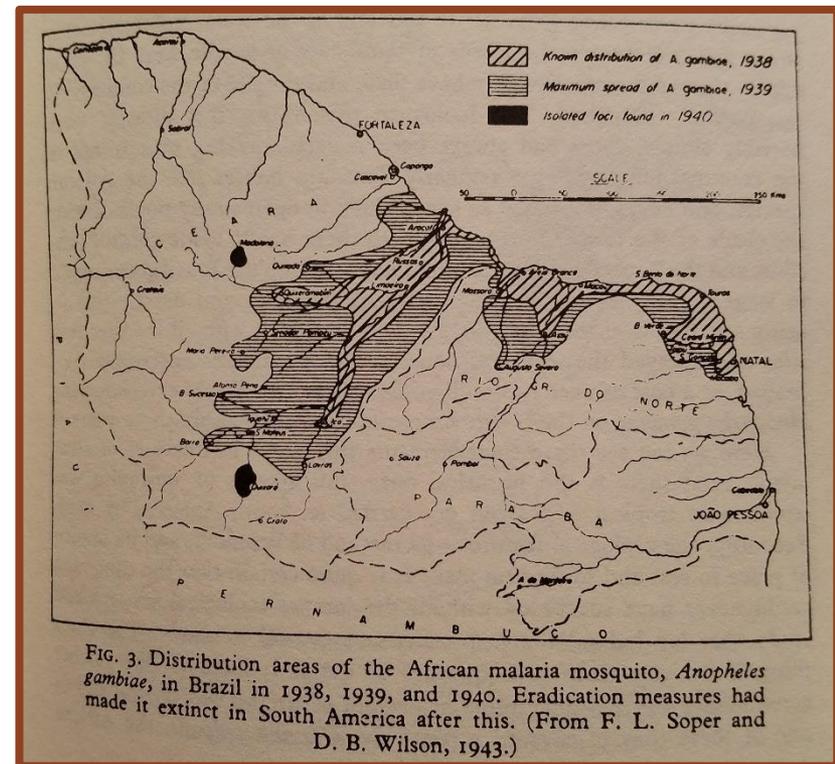
Worksheet. Part II.

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

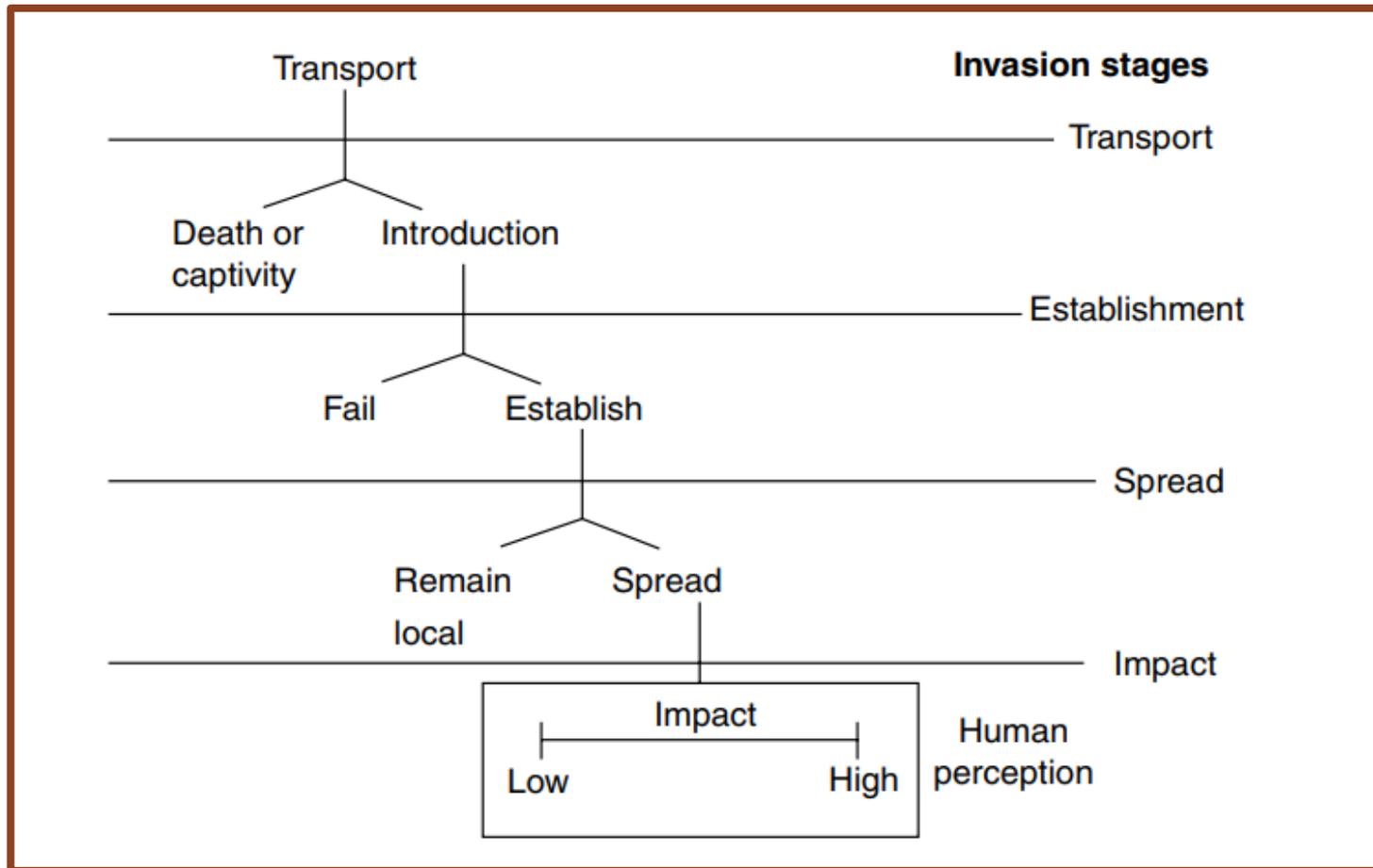
Worksheet. Part II.

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

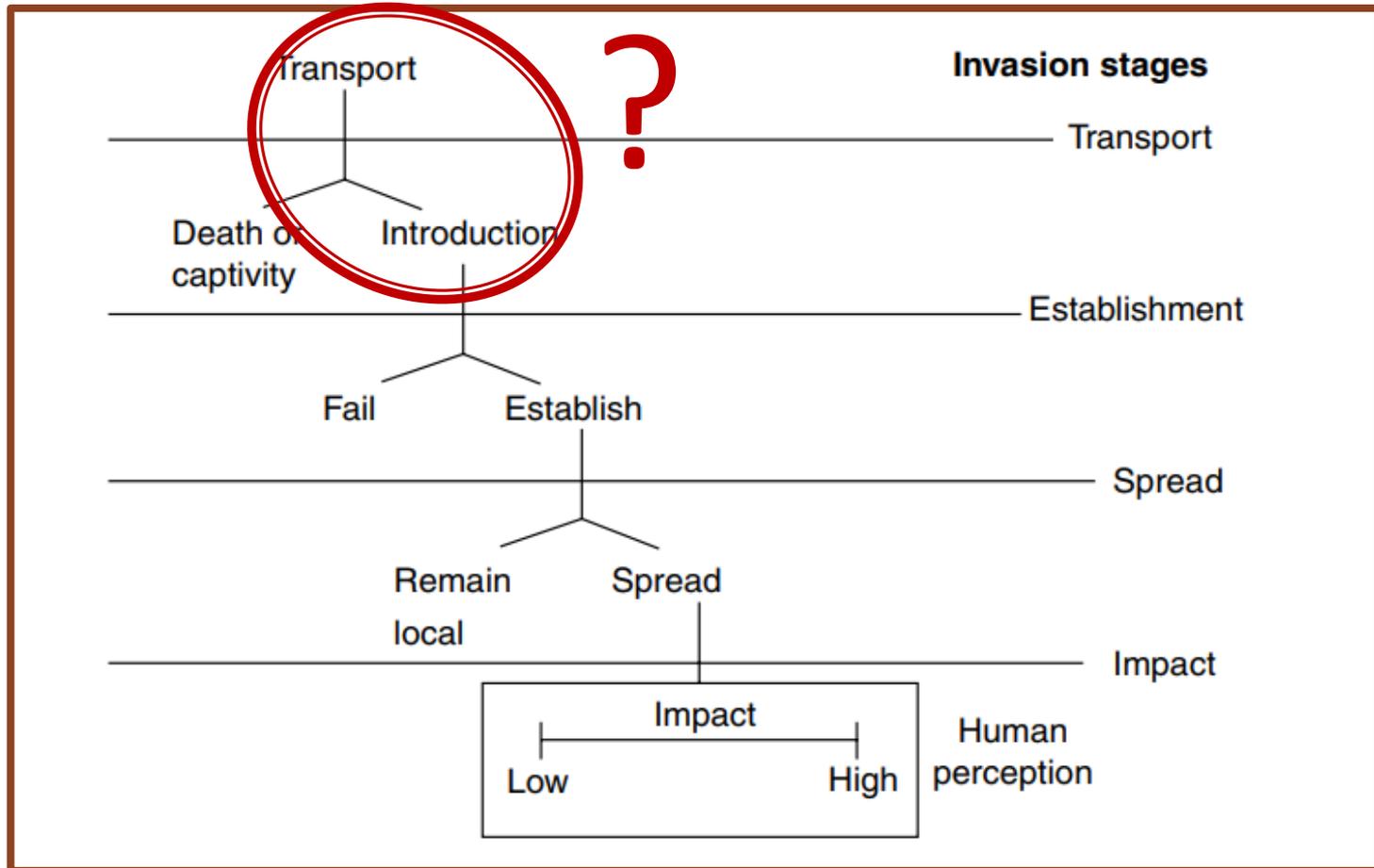
- Non-native**
- Caused harm**



Stages of Invasion



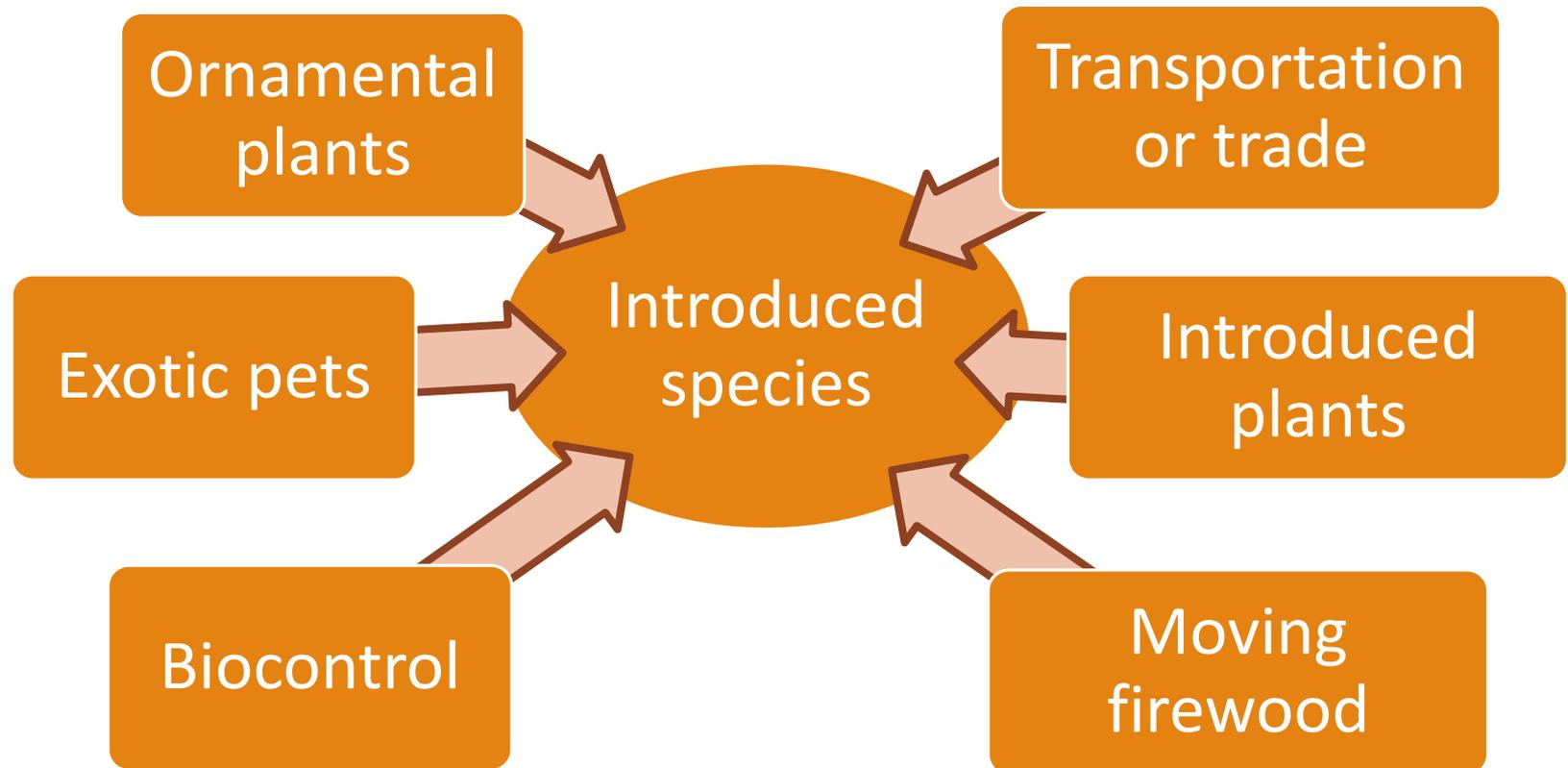
Stages of Invasion



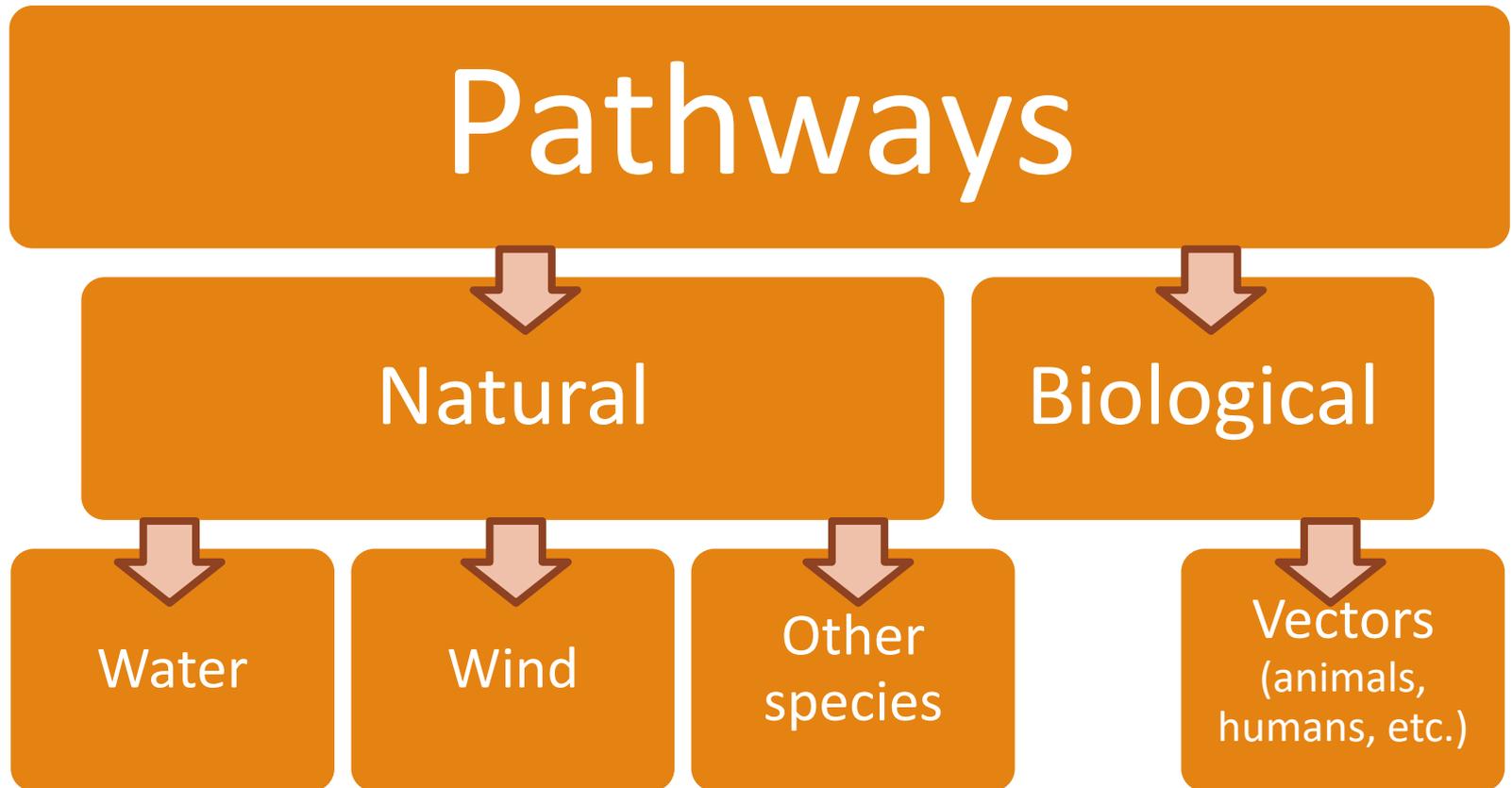
Modes of Introduction

Deliberate

Accidental



Spread From the Point of Introduction



Invasive Species Are Still Hitching Rides on Tsunami Debris

RESEARCH

BIOGEOGRAPHY

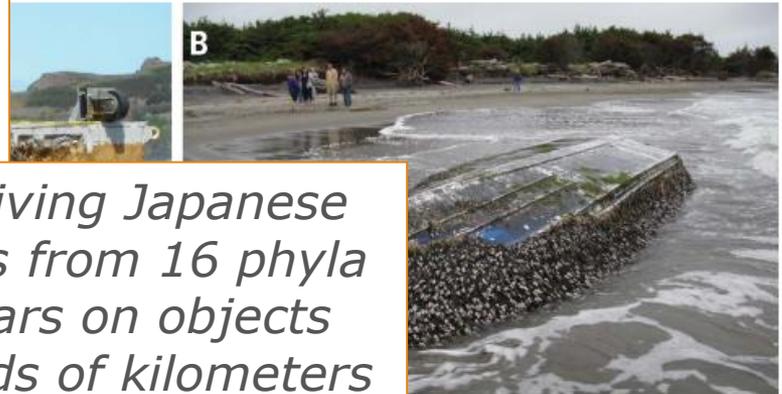
Tsunami-driven rafting: Transoceanic species dispersal and implications for marine biogeography

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

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 the

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

Video:

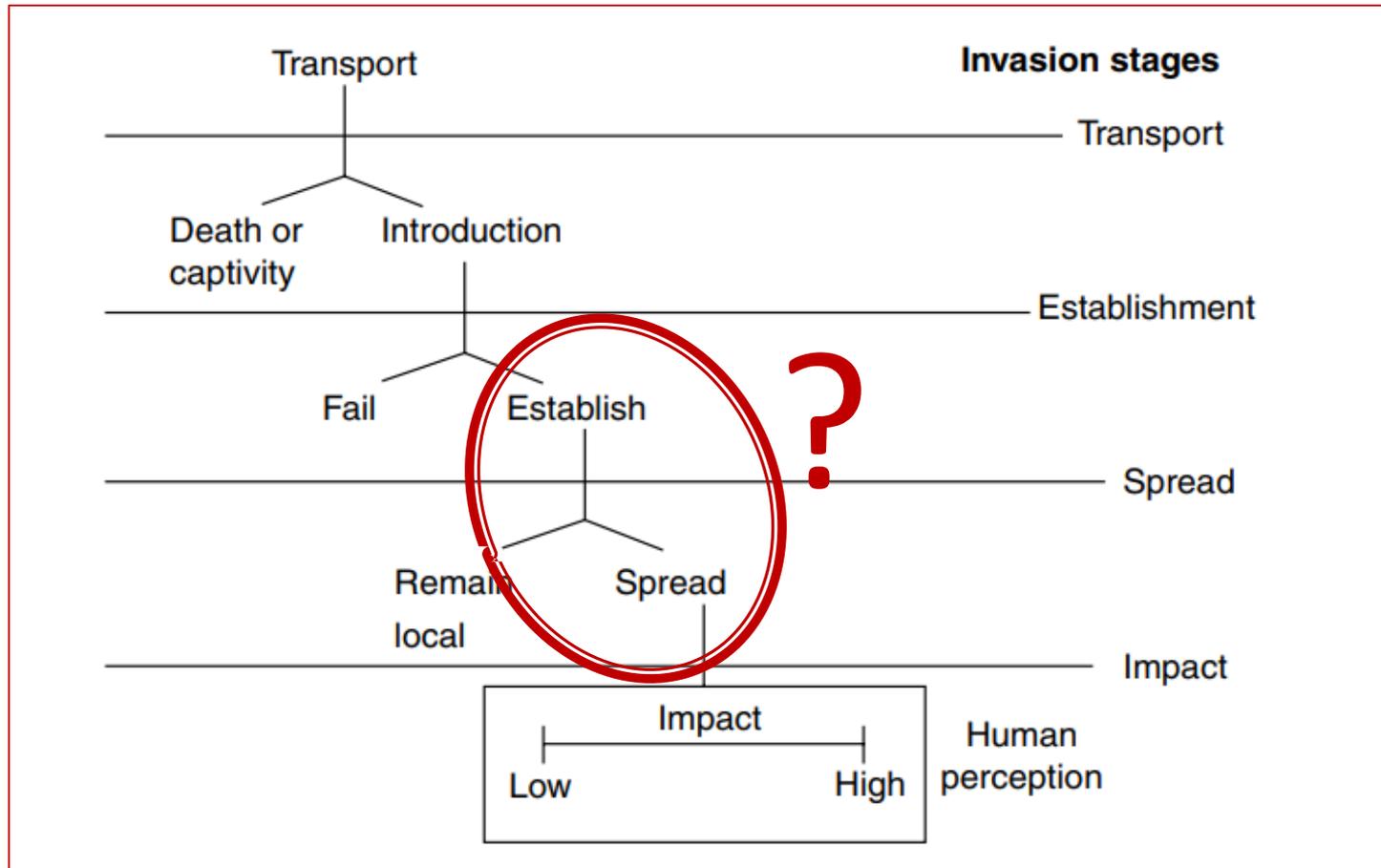
<https://www.youtube.com/watch?v=L3QGiPpXaC0>

Carlton et al. Science 29 Sep 2017

Invasive Species

- Do all introduced species successfully establish? (Yes, **No**)
- Do all introduced species spread from the point of introduction? (Yes, **No**)

Stages of invasion



Invasion Hypotheses

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

ESTABLISHMENT

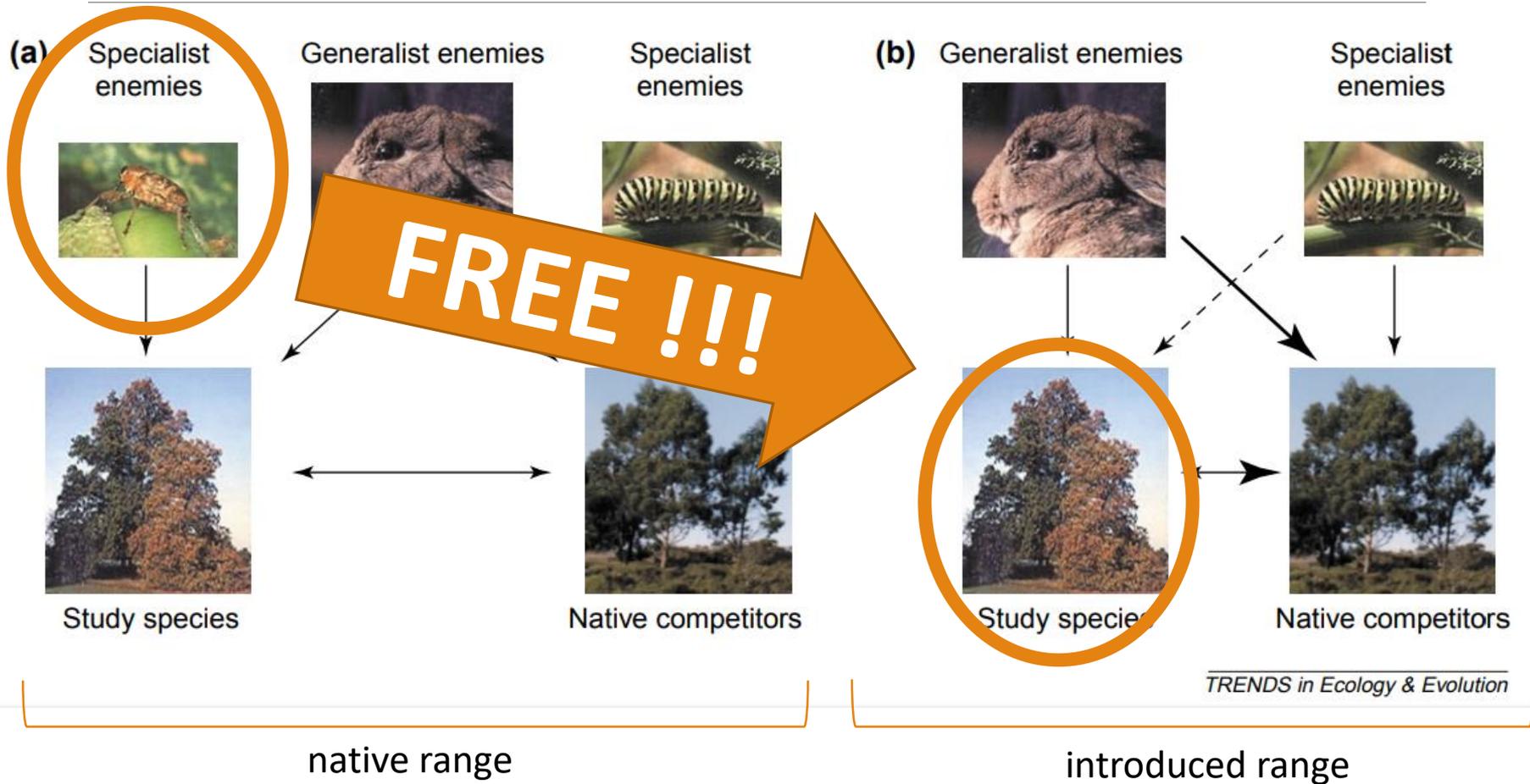
- **P**ropagule pressure
- **A**biotic characteristics of the receiving environment

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

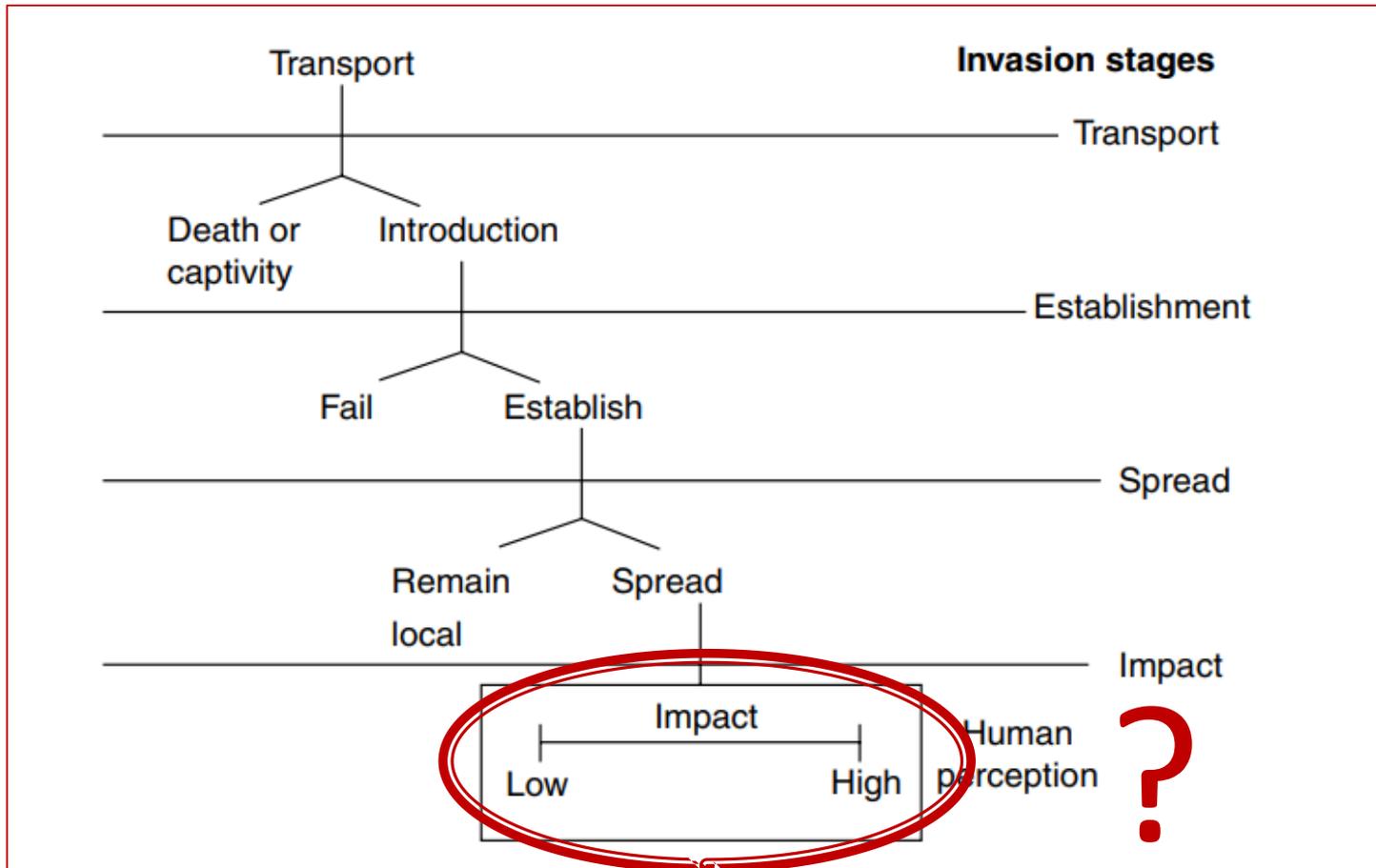
- **H**uman **R**elease
invading species benefits from no/low landscape maintenance

ABUNDANCE

Enemy release hypothesis



Stages of invasion



Impact of Invasive Species

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

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



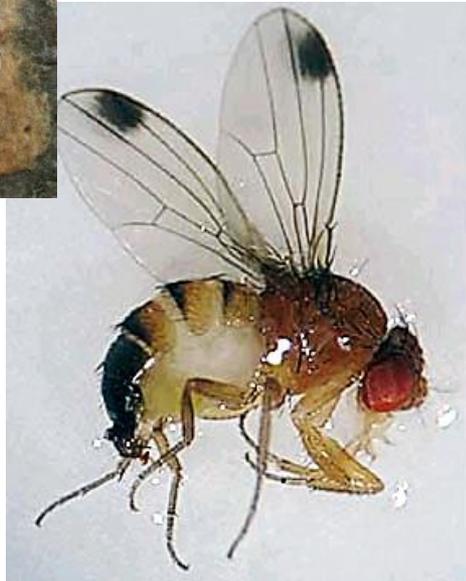
Gypsy moth larva

Invasive Insects

➤ Gypsy moth



➤ Spotted Wing Drosophila



➤ Emerald Ash Borer



➤ Sirex Woodwasp

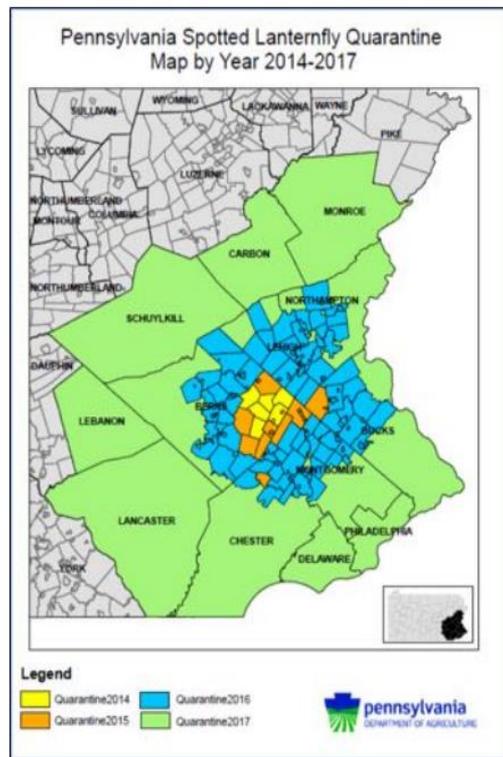
Hemiptera: Spotted Lanternfly



- An emerging highly invasive insect pest
- Native to China
- Invaded Korea in 2004
- Detected in Berks County, PA in 2014

Where is spotted lanternfly in the US and how fast will it spread?

Invasion process



Pennsylvania – Berks (2014) now in 13 counties, established

Delaware – New Castle (2017), established

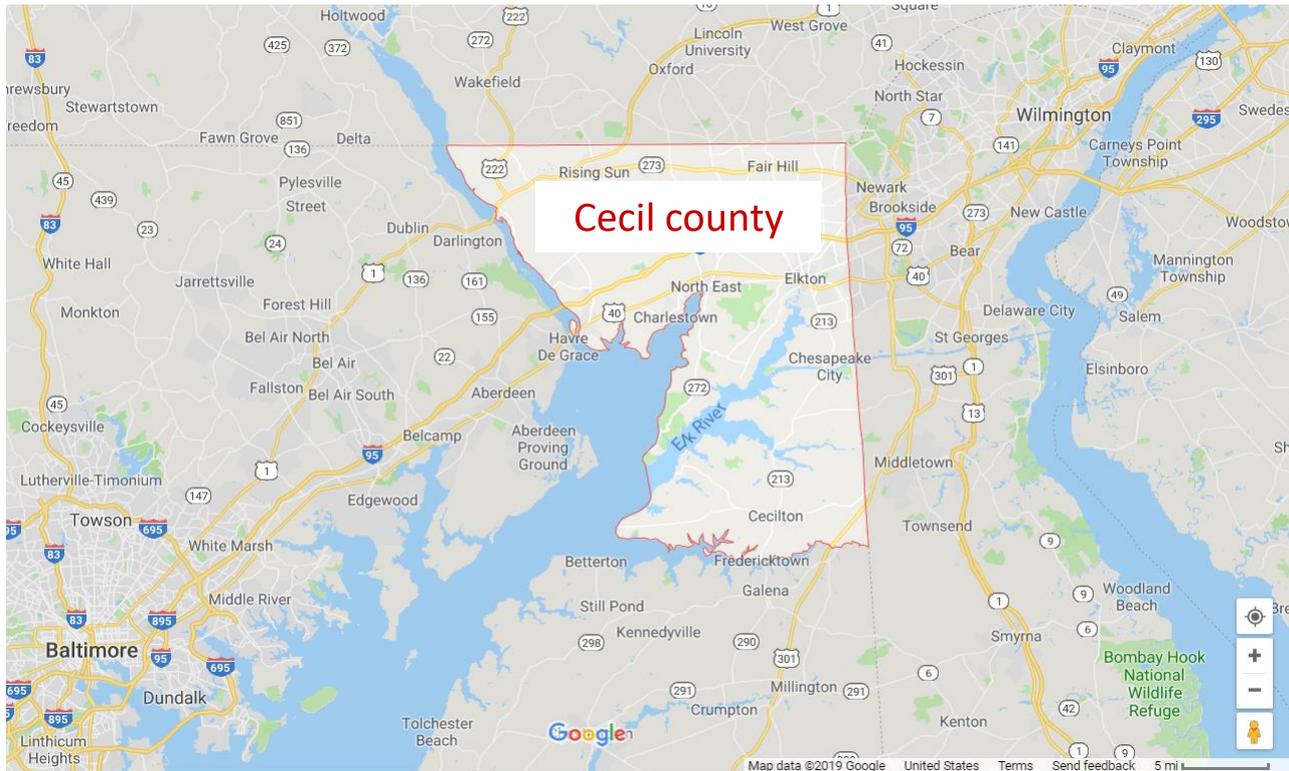
New Jersey – Hunterdon, Mercer and Warren Counties (2018) established

New York – Albany, Suffolk and Yates (2018)

Virginia - Frederick County (2018), established

Massachusetts (2019)

Spotted Lanternfly in Maryland!



▪ October 2018: first confirmed spotted lanternfly in Maryland!

Life stages of spotted lanternfly



Eggs

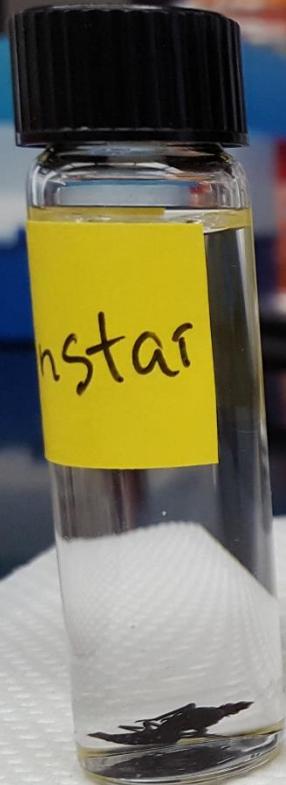
1st
instar

2nd
instar

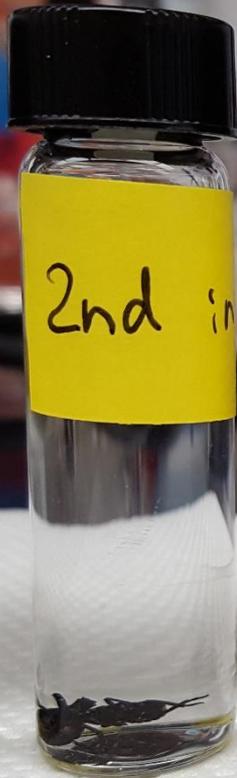
3rd
instar

4th
instar

Adult



1st
instar



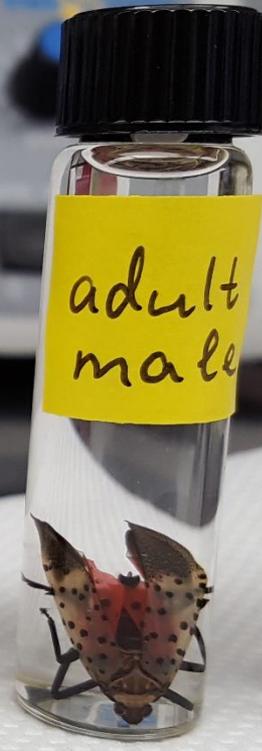
2nd
instar



3rd
instar



4th
instar



Adult
male



Adult
female

Modes of SLF 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.



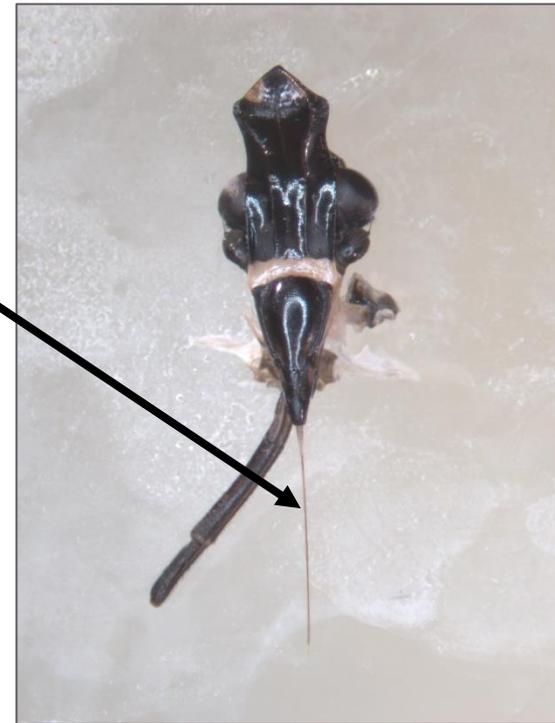
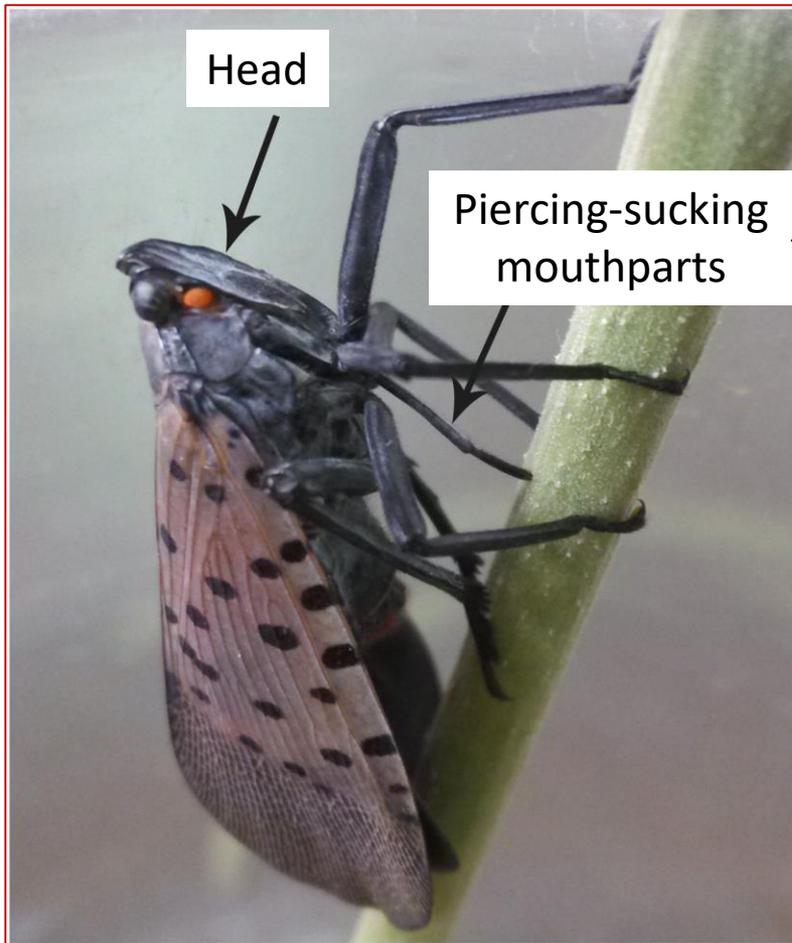
Host plants

Sap-feeder

SLF can utilize over 70 host plants:

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

How does the lanternfly eat and damage plants?



Sap- feeders

Plant damage

Consumes
phloem sap

Reduction in
photosynthesis

Weeping wounds

Decreasing
plant's growth



Plant damage



Create a sugary substance (honeydew)

Attract other insects - ants, wasps, etc.

Colonized by sooty mold -> blackening of parts of the plant







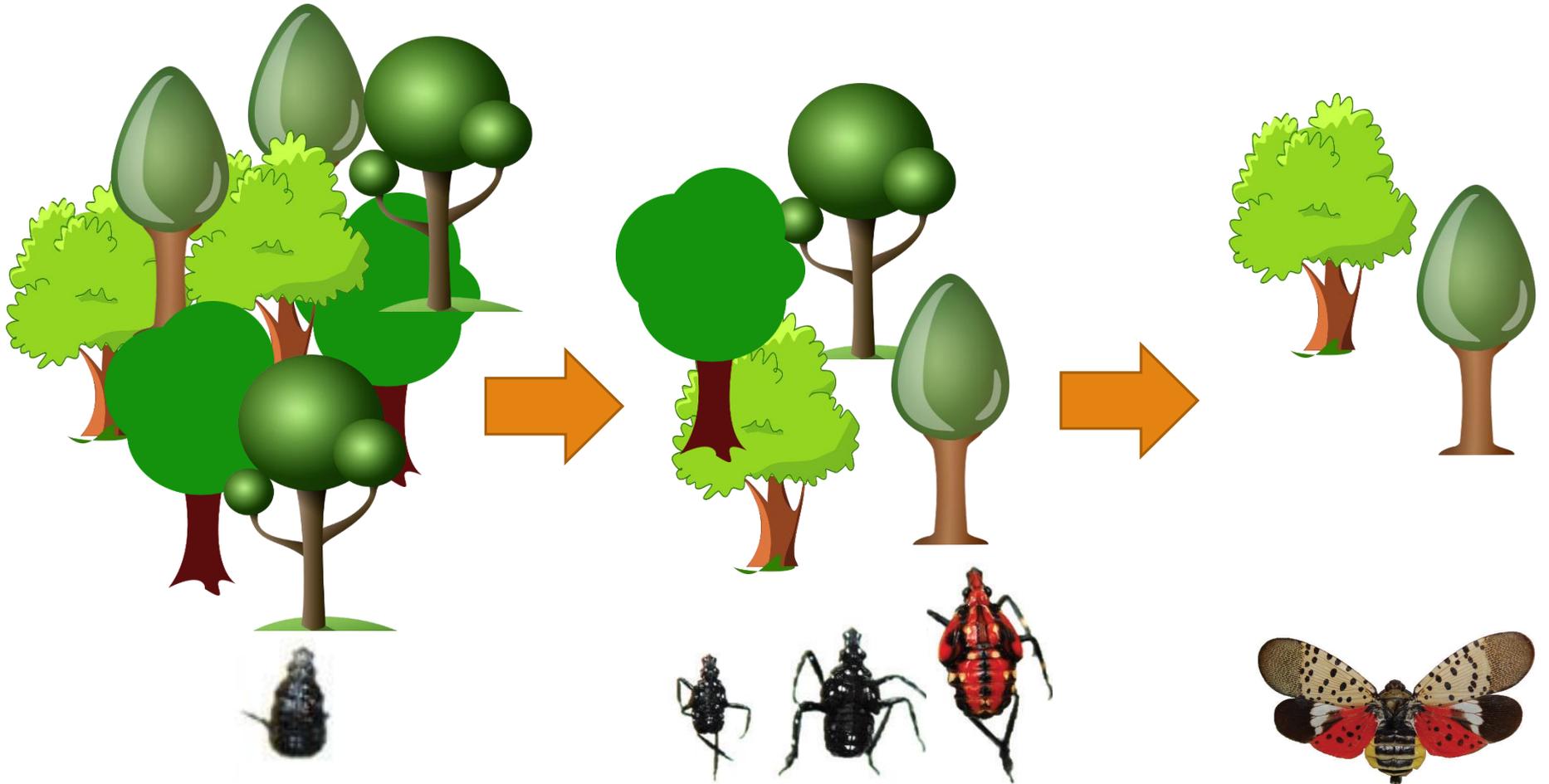




Behavior on host trees



Seasonal behavior



May-June

June-August

September-December

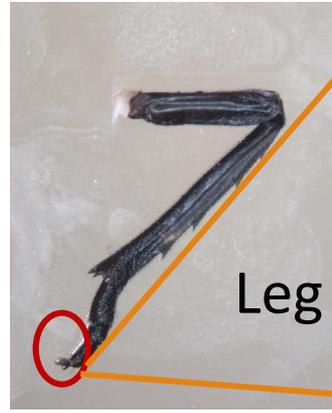
Behavior on host trees



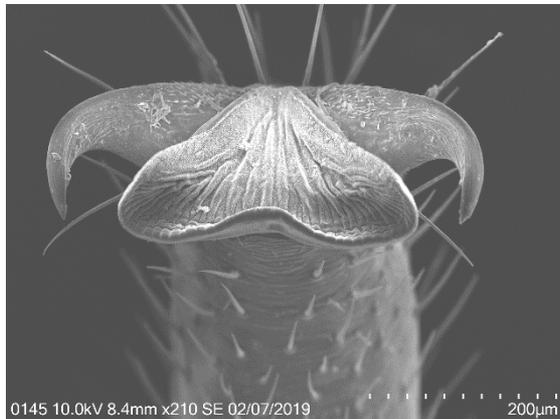
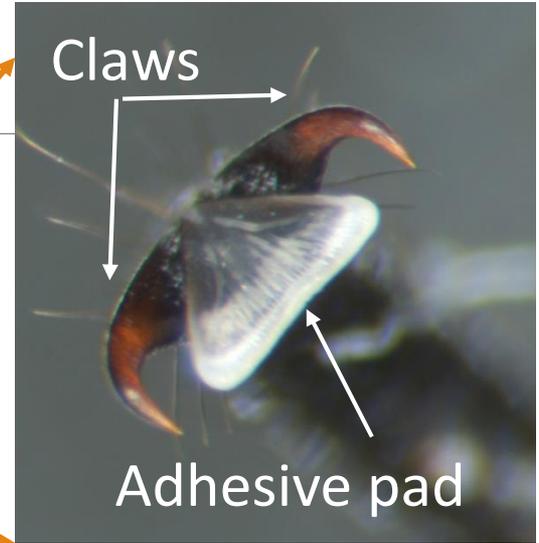
Behavior on host trees



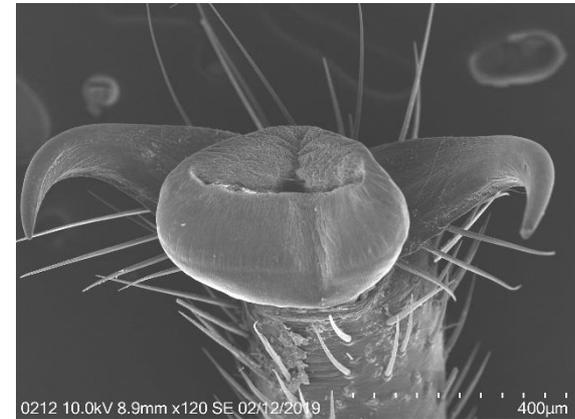
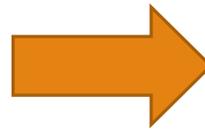
Holding on to the host trees



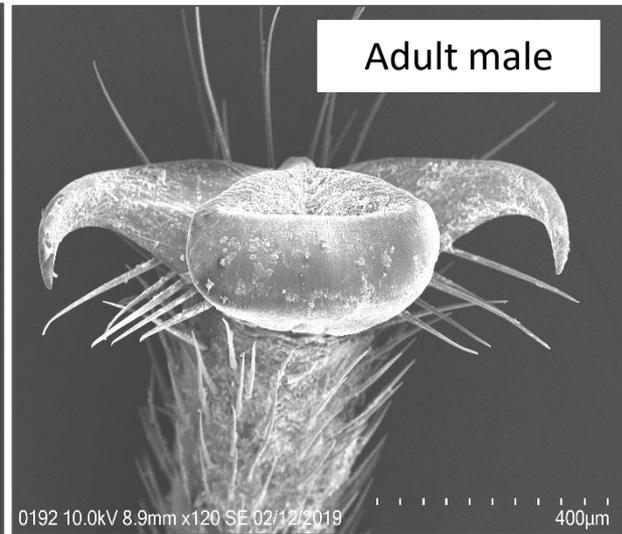
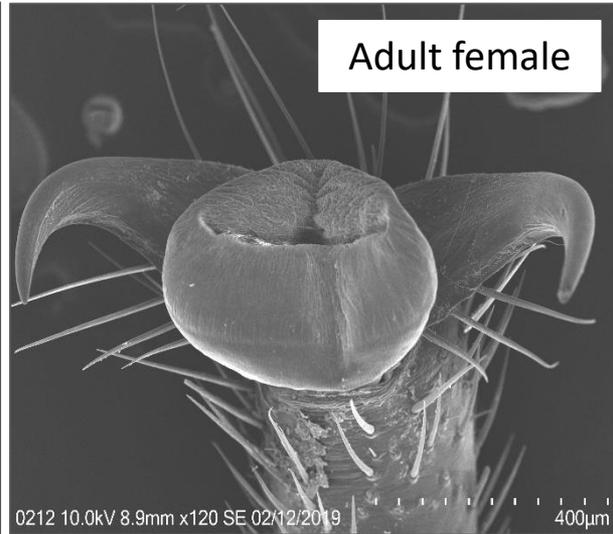
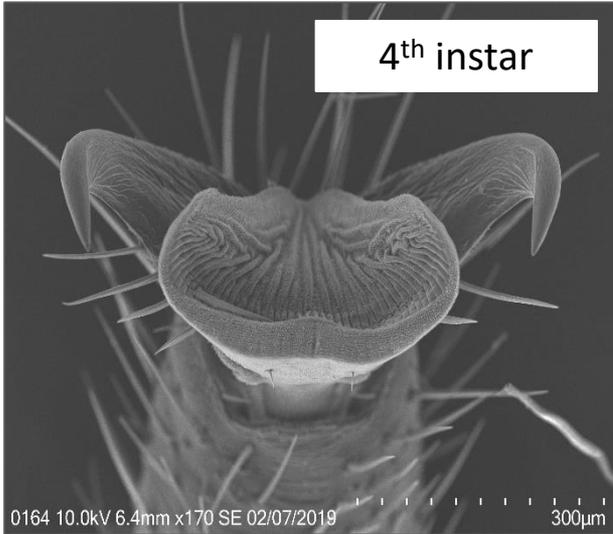
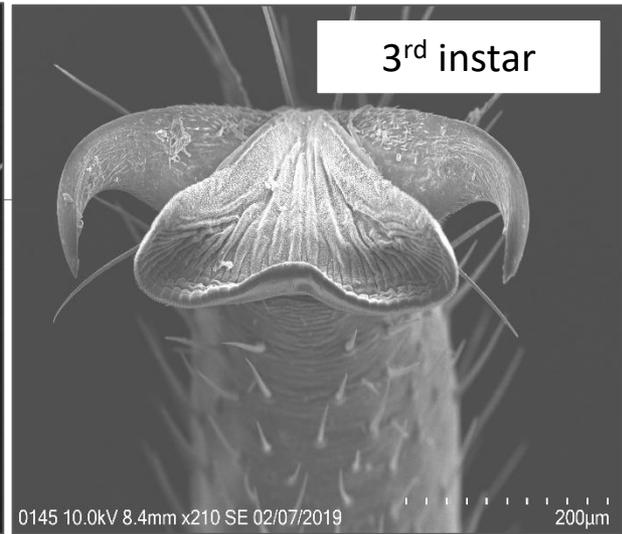
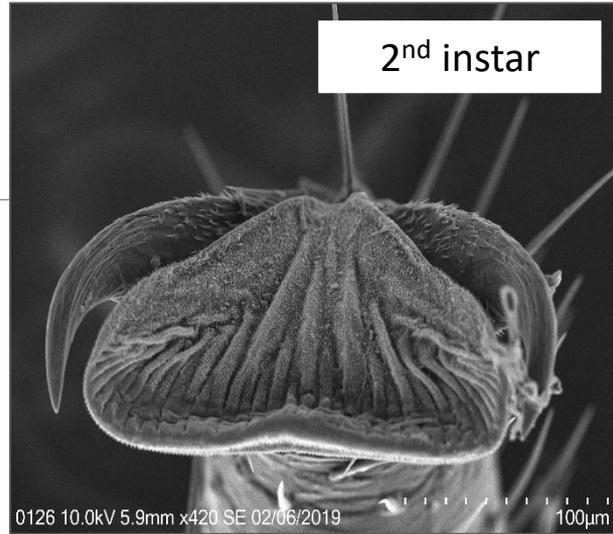
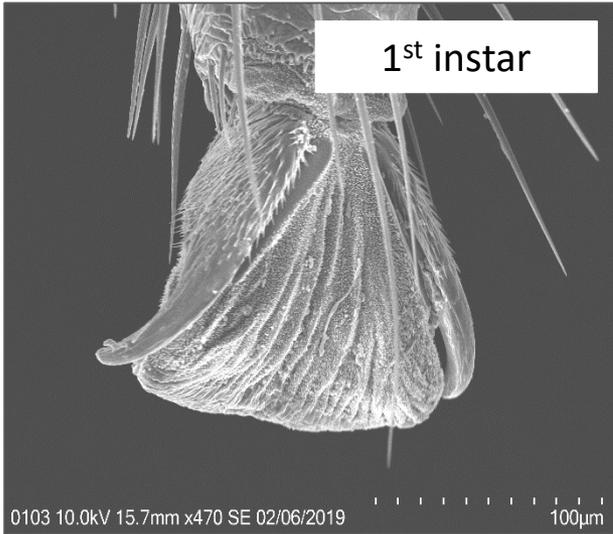
Leg tip



Lanternfly resting



Lanternfly moving



Management strategies in PA



Band trees to catch nymphs

Did you know?

In the spring, spotted lanternfly nymphs crawl up trees to find a place to feed— stop them by banding trees with sticky paper or tape.



Pennsylvania Department of Agriculture



PennState

Scrape eggs

Eggs should be scraped off of trees, posts, stones, houses, and anywhere else you find them!

Use a plastic card, putty knife, or stick to scrape eggs downward into a bottle or bag.

Eggs can then be killed by putting them in rubbing alcohol, smashing them, or burning them.

Removes 30-50 eggs per mass

Link to video:

<https://extension.psu.edu/how-to-remove-spotted-lanternfly-eggs>

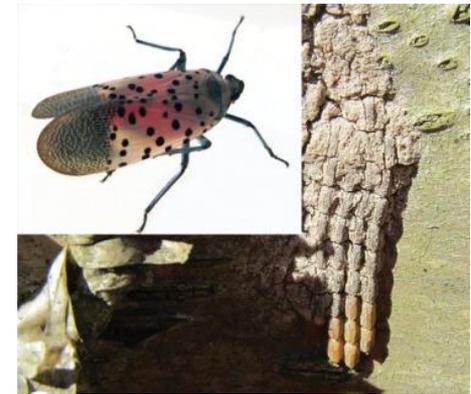


PA Dept. Ag.



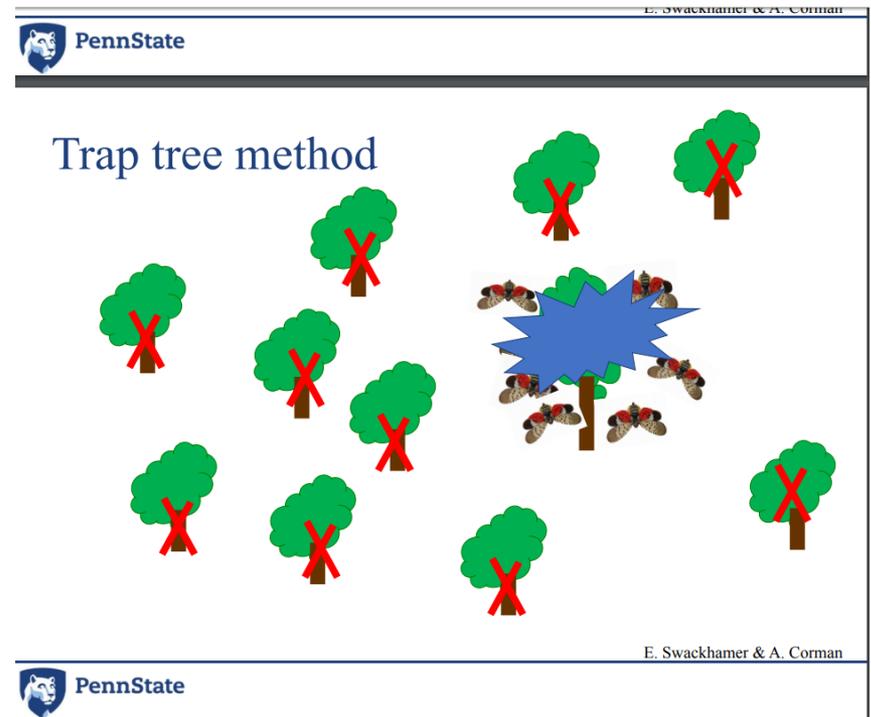
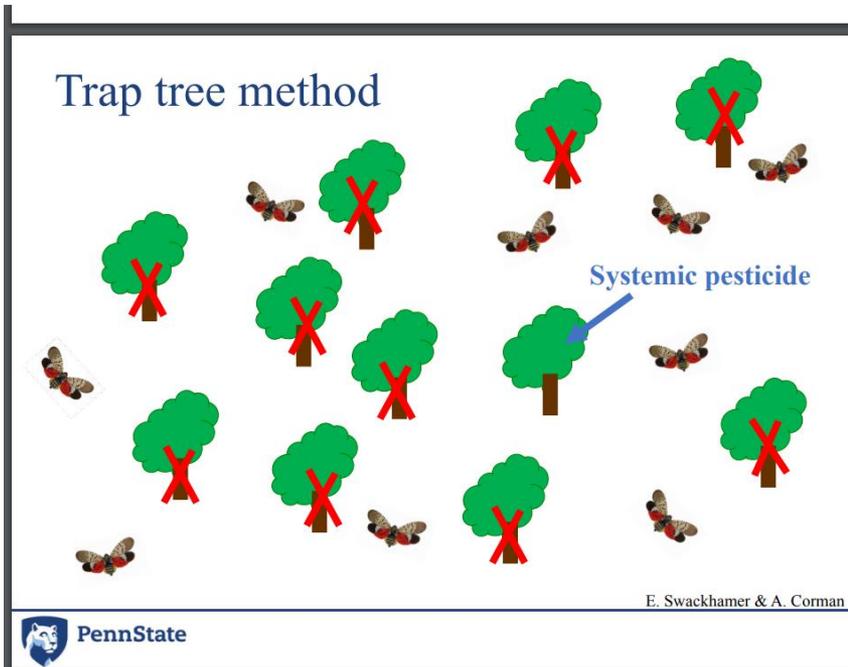
Biological control

Indigenous natural enemies including spiders, mantises, and assassin bugs are now attacking and killing lanternflies



A tiny wasp called *Ooencyrtus kuvanae* was imported in 1908 to control gypsy moth. It was taken a liking to spotted lanternfly and now parasitizes and kills eggs of the lanternfly.

Use trap-trees to reduce populations



Use trap-trees to reduce populations



Monitoring and scouting



Egg masses: on tree trunks, stones, etc.



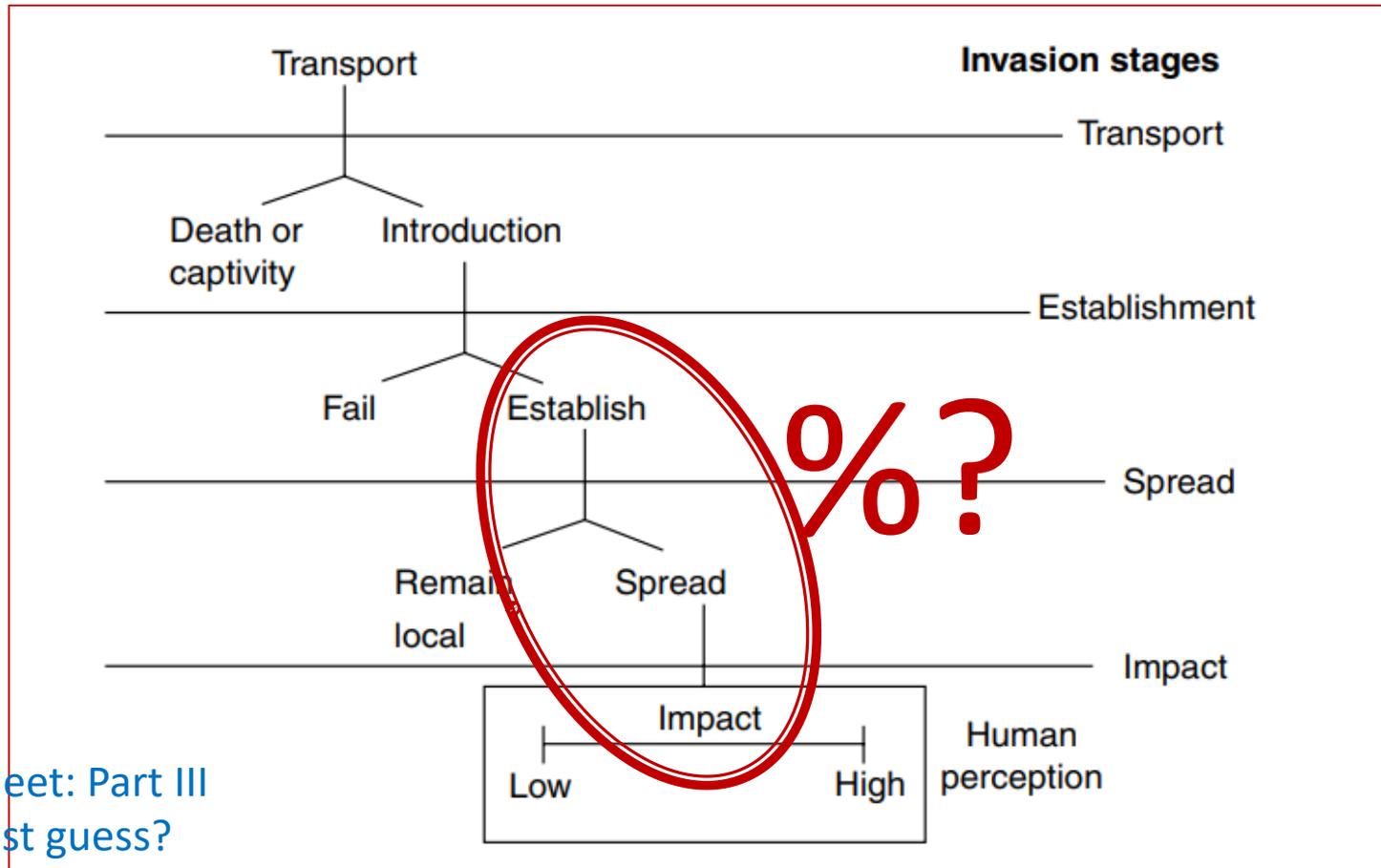
Adults: in clusters on tree trunks



1st instar: close to the ground, plant shoots, stems, etc.

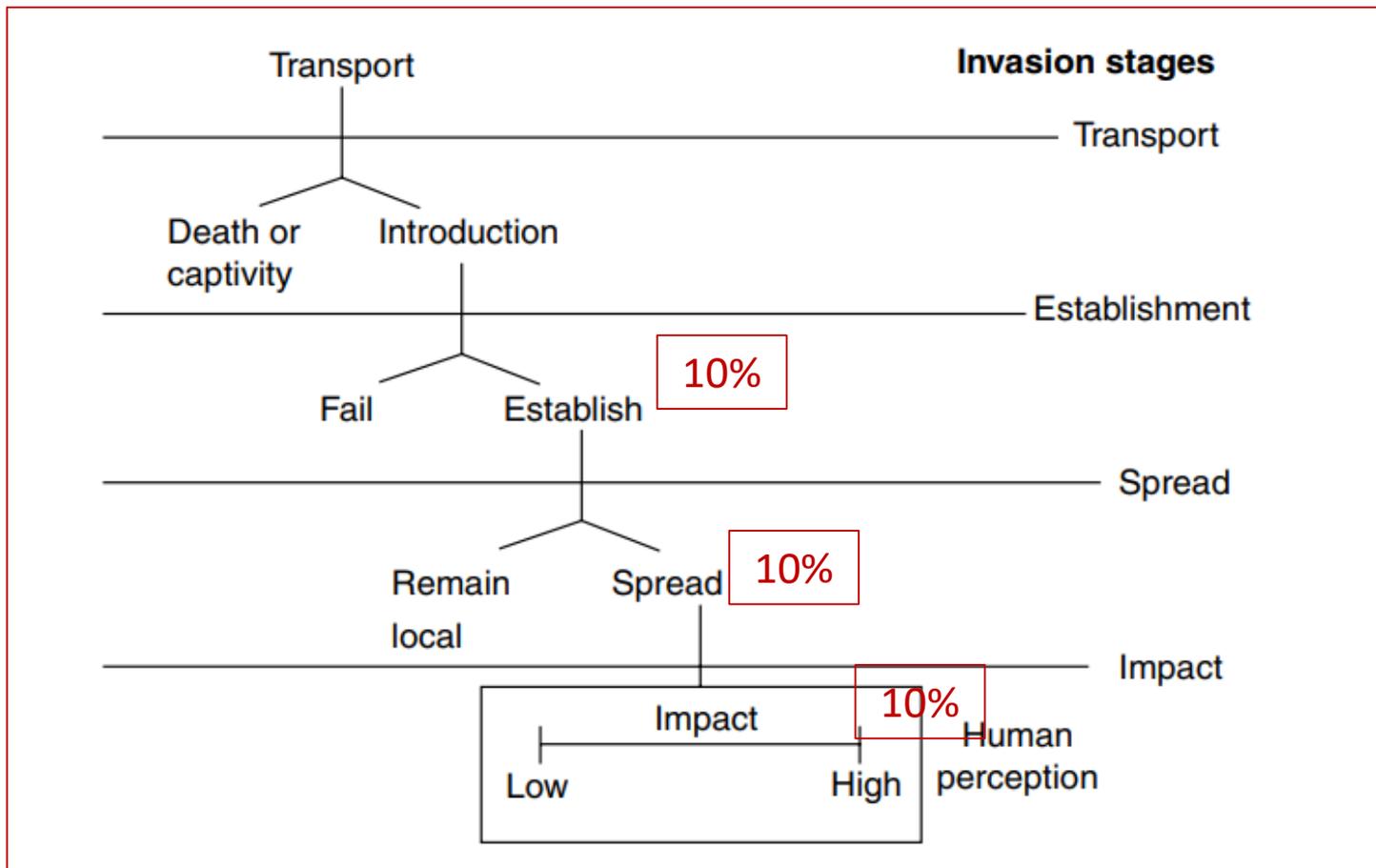
2-4th instars: plant leaves, stems, tree trunks

Stages of invasion



Worksheet: Part III
Your best guess?

Stages of invasion



Control and management

Prevention

Early detection

Eradication

Quick Review

- 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

The End

Please name at least one
invasive insect species



More about invasive species...

□ USDA

www.invasivespeciesinfo.gov



□ Invasive and Exotic Species of North America

www.invasive.org



□ EDDMapS

www.eddmaps.org



□ University of Maryland Extension

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



Image credits and resources

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