



Spotted Lanternfly: a New Invasive

Danielle Kirkpatrick and
Tracy Leskey

USDA-ARS

Appalachian Fruit Research Station



PennState

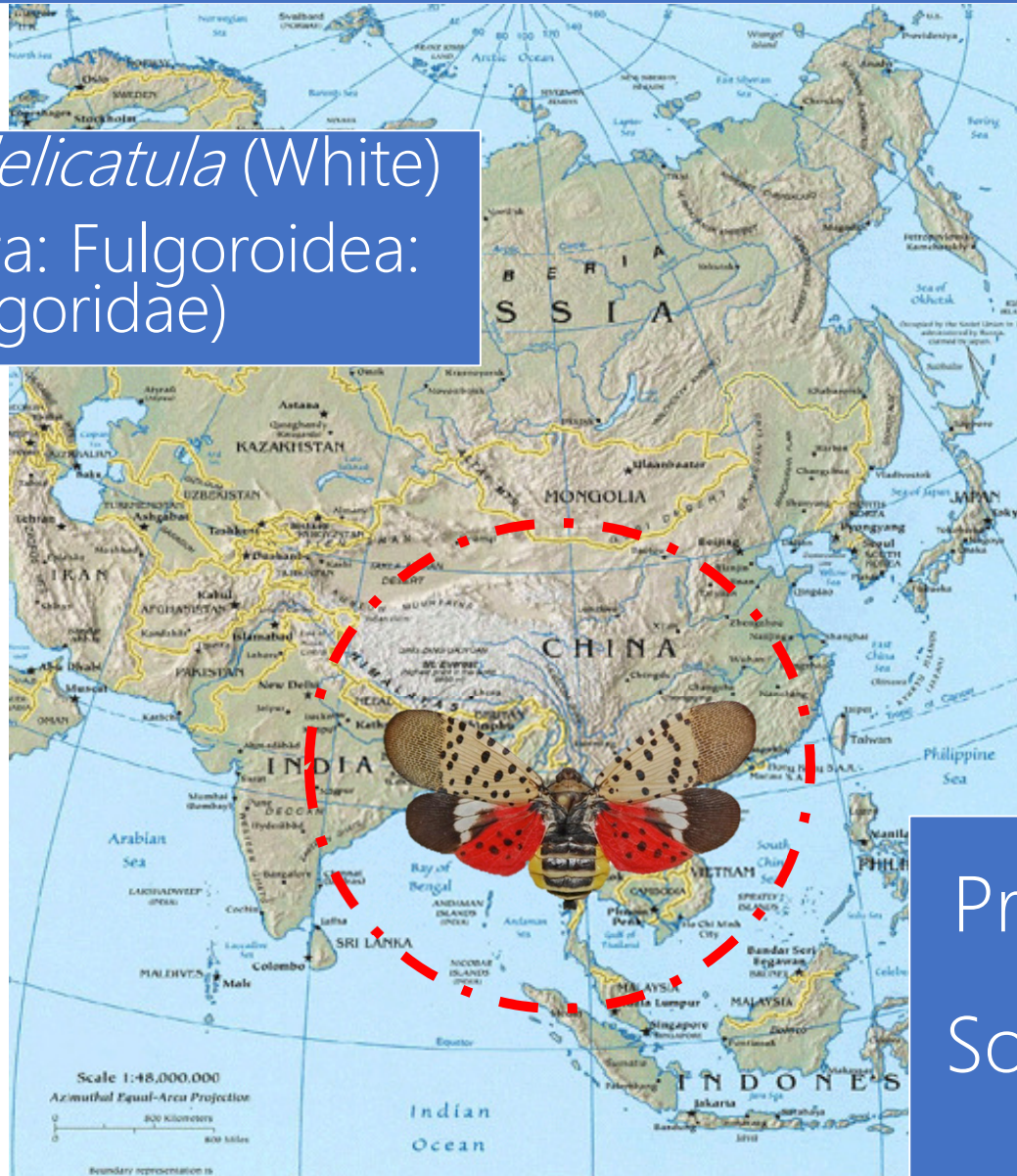
VT VIRGINIA
TECH™



RUTGERS

SLF is an Invasive Species in the USA

Lycorma delicatula (White)
(Hemiptera: Fulgoroidea:
Fulgoridae)



Present in China,
India, Japan,
South Korea, and
Vietnam

SLF first detection and quarantine

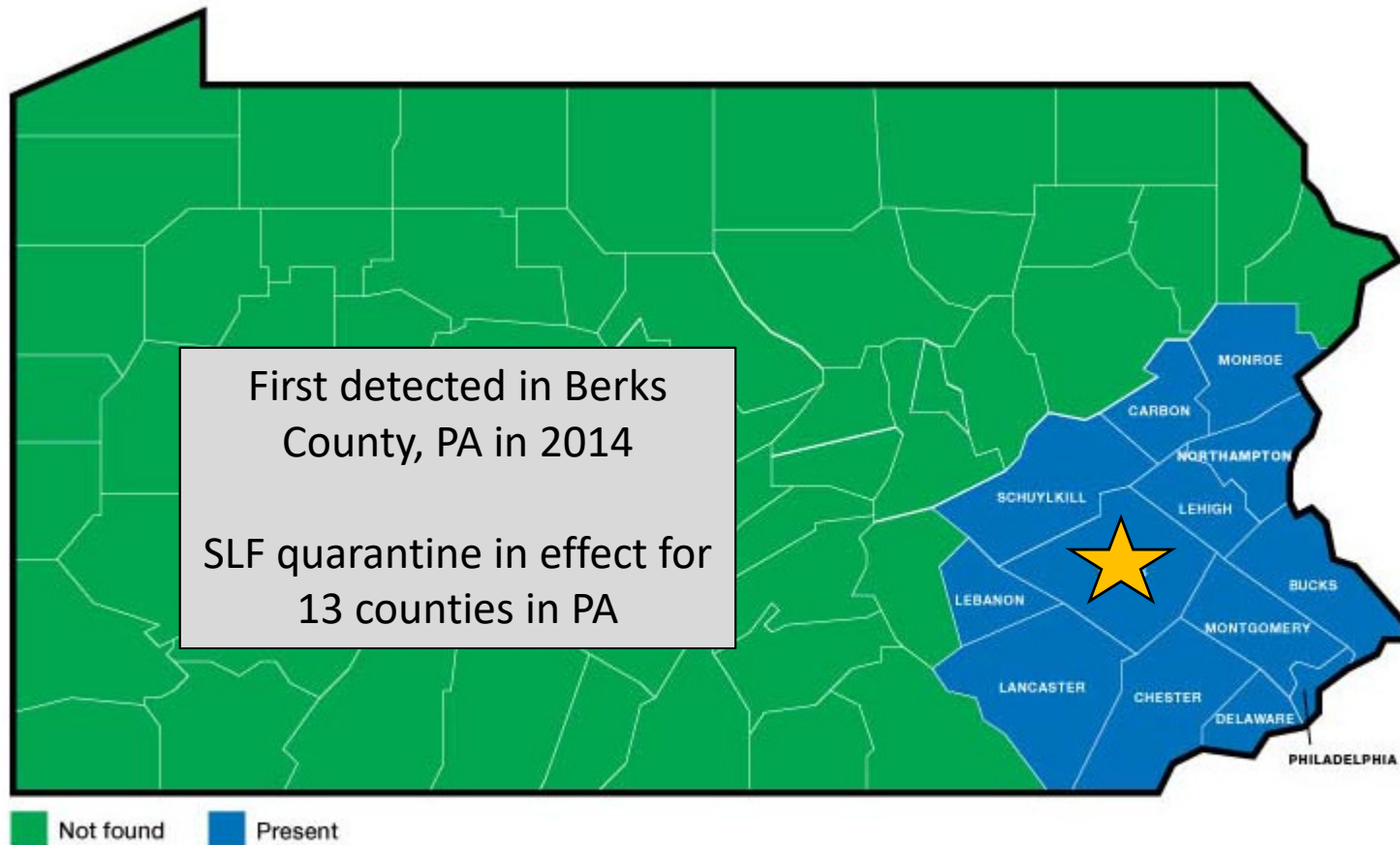
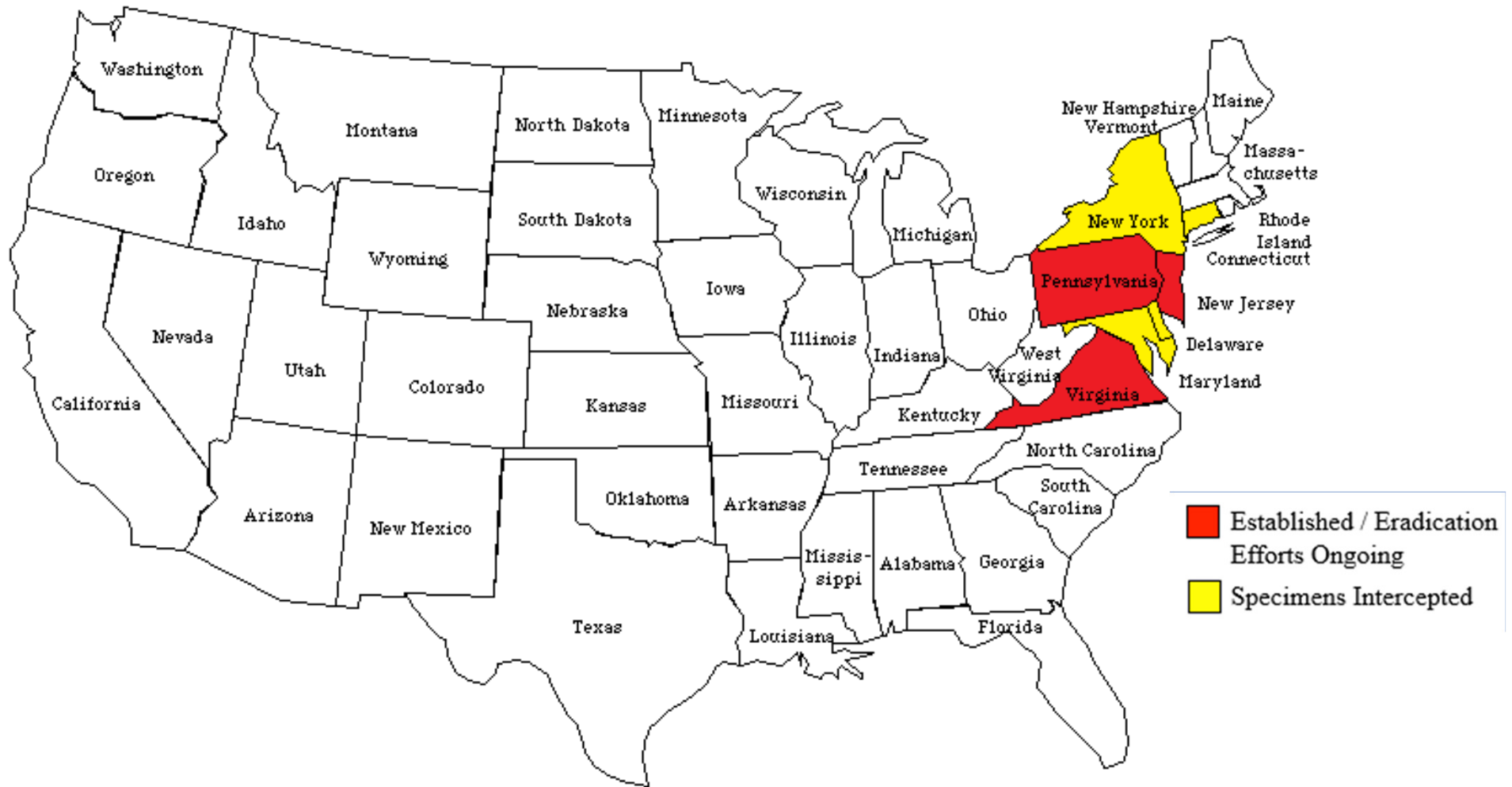


Figure 2. The distribution as of September 20, 2018, of SLF in Pennsylvania, indicated in blue. Check the Pennsylvania Department of Agriculture's website for updated distribution information.

Current Distribution of SLF in the USA

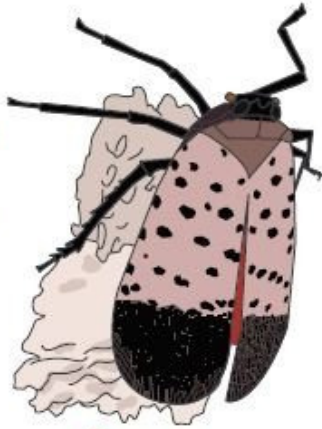


Established populations in Pennsylvania, New Jersey and Virginia

Specimens Intercepted in New York, Delaware, Maryland and Connecticut

SPOTTED LANTERNFLY LIFE CYCLE

EGG LAYING
September —
December



EGGS
October — June



**HATCH AND
FIRST INSTAR**
May — June



**SECOND
INSTAR**
June — July



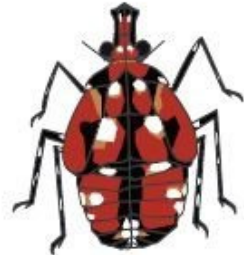
ADULTS
July —
December



THIRD INSTAR
June — July



FOURTH INSTAR
July — September



Illustrations by Colleen Witkowski

How to Identify the Invasive SLF



E. Swackhamer



PA Department of Agriculture



PA Department of Agriculture



PA Department of Agriculture



PA Department of Agriculture

- A. Egg masses
- B. Early nymph
- C. Late nymph
- D. Adult, wings closed
- E. Adult, wings open

Nymphal Stages of SLF



Photo: H. Leach, PSU

Nymphal Stages of SLF



Photo: Dalton Ludwick



Photo: PA Dept. of Agriculture

- Early stage nymphs (1st-3rd instars) have black bodies and legs with white spots
- Only a few centimeters long
- Strong jumpers; will jump when frightened
- Tend to feed on the new growth of a plant, such as stems and foliage

Nymphal Stages of SLF



- Late stage nymphs (4th instars) have bright red bodies with black stripes and white spots
- Last nymphal stage before becoming adults
- About ½ inch long
- Strong jumpers; will jump when frightened

Adult SLF



Photo: Mike Houtz



- Adults are about 1" long
- Females tend to be slightly larger than the males

Adult SLF



Photo: Emelie Swackhamer

Group of adult SLF feeding at the base of a tree

Adult SLF Feeding on Grapevine

Video: Erica Smyers, PSU



Adult SLF



- Early season (left) vs. late season (right) female SLF
- Females build up fat bodies towards end of summer to prepare for egg laying

Potential to Cause Economic Damage

- **Direct effects**

- Phloem feeders; reported to feed on over 65 species of plants
- Knowledge gaps in host range in the US
- Projected to become a serious pest of timber, ornamental trees, tree fruit, stone fruit, grapes, hops and small fruit such as blueberries
- Feeding could potentially shock trees and cause decline



Spotted lanternfly feeds on soybean



Spotted lantern fly feeds on corn



Spotted lanternfly feeds on alfalfa



Potential to Cause Economic Damage

- Indirect effects of feeding
 - Excrete large amounts of honeydew while feeding
 - Sooty mold outbreak on the leaves and fruit
 - May exacerbate yellow jacket problems



Photo: H. Leach, PSU



Photo: H. Leach, PSU

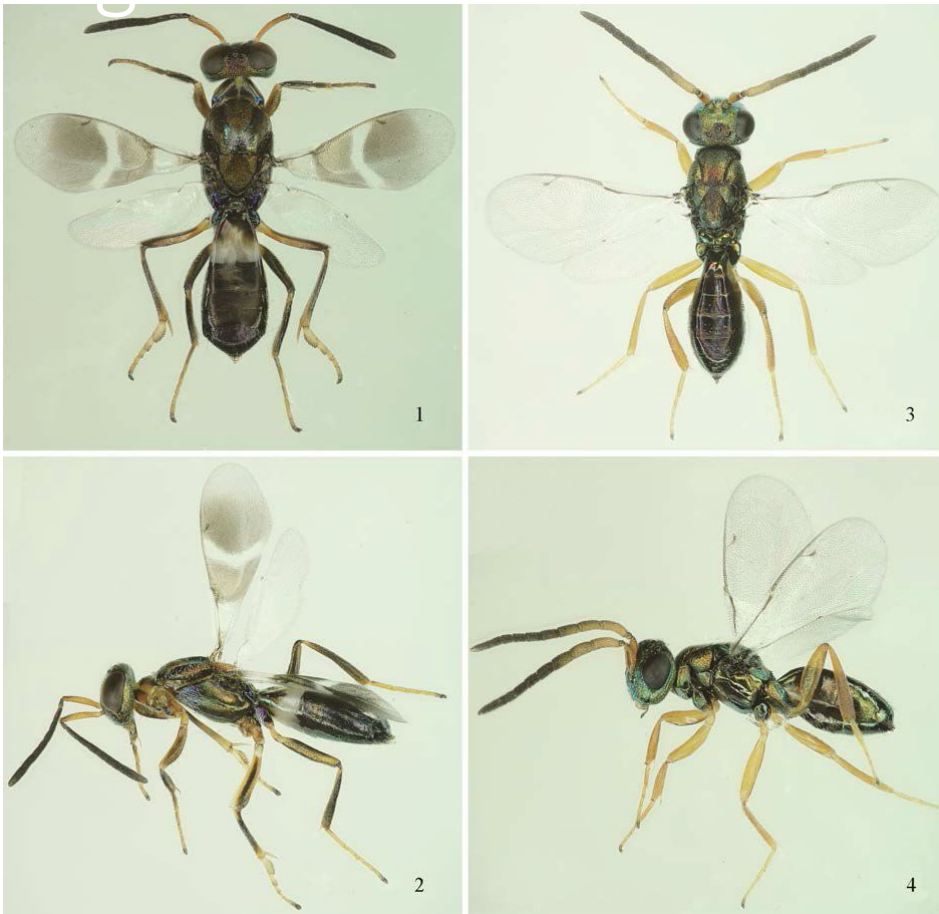


Host plants	Family	Korean name	Stage	Degree of damage ¹
<i>Actinidai chinensis</i>	Actinidiaceae	양다래	nymph	+++
<i>Rhus javanica</i>	Anacardiaceae	붉나무	nymph	+++
<i>Rhus verniciflua</i>	Anacardiaceae	옻나무	nymph	++
<i>Aralia elata</i>	Araliaceae	두릅나무	nymph	+++
<i>Aralia cordata</i>	Araliaceae	맛두릅나무	nymph	+++
<i>Metaplexis japonica</i>	Asclepiadaceae	박주가리	nymph	+
<i>Alnus hirsuta</i>	Betulaceae	산오리나무	nymph	+
<i>Betula platyphylla</i>	Betulaceae	자작나무	adult	+++
<i>Arctium lappa</i>	Compositae	우엉	nymph	++
<i>Quercus aliena</i>	Fagaceae	갈참나무	nymph	++
<i>Juglans mandshurica</i>	Juglandaceae	가래나무	adult, nymph	++++
<i>Juglans nigra</i>	Juglandaceae	흑호두나무	nymph	++
<i>Juglans sinensis</i>	Juglandaceae	호두나무	nymph	+
<i>Pterocarya stenoptera</i>	Juglandaceae	중국굴피나무	nymph	+
<i>Maackia amurensis</i>	Leguminosae	다릅나무	nymph	+
<i>Magnolia obovata</i>	Magnoliaceae	일본목련	nymph	++
<i>Magnolia kobus</i>	Magnoliaceae	목련	nymph	+
<i>Cedrela fissilis</i>	Meliaceae	유럽참죽나무	adult, nymph	++++
<i>Toona sinensis</i>	Meliaceae	참죽나무	adult, nymph	++++
<i>Toona sinensis 'Fleming'</i>	Meliaceae	호주참죽나무	adult, nymph	++++
<i>Morus alba</i>	Moraceae	뽕나무	nymph	++
<i>Morus bombycis</i>	Moraceae	산뽕나무	nymph	++
<i>Rosa hybrida</i>	Rosaceae	장미	nymph	+
<i>Rosa multiflora</i>	Rosaceae	찔레나무	nymph	++
<i>Rosa rugosa</i>	Rosaceae	해당화	nymph	++
<i>Rubus crataegifolius</i>	Rosaceae	산딸기나무	nymph	++
<i>Sorbus commixta</i>	Rosaceae	마가목	nymph	+
<i>Sorbaria sorbifolia</i>	Rosaceae	쉬팡나무	nymph	++
<i>Evodia danielii</i>	Rutaceae	쉬나무	adult, nymph	++++
<i>Phellodendron amurense</i>	Rutaceae	황벽나무	adult, nymph	++++
<i>Populus koreana</i>	Salicaceae	물향찰나무	adult	++
<i>Philadelphus schrenckii</i>	Saxifragaceae	고광나무	nymph	++
<i>Picrasma quassioides</i>	Simaroubaceae	소테나무	adult, nymph	++++
<i>Ailanthus altissima</i>	Simaroubaceae	가죽나무	adult, nymph	++++
<i>Firmiana simplex</i>	Sterculiaceae	벽오동	nymph	++
<i>Styrax obassia</i>	Styracaceae	죽동백나무	nymph	+
<i>Styrax japonica</i>	Styracaceae	때죽나무	adult, nymph	++
<i>Angelica dahurica</i>	Umbelliferae	구릿대	nymph	+
<i>Parthenocissus quinquefolia</i>	Vitaceae	미국담쟁이덩굴	adult, nymph	++++
<i>Vitis amurensis</i>	Vitaceae	머루	adult, nymph	++++
<i>Vitis vinifera</i>	Vitaceae	포도	adult, nymph	++++

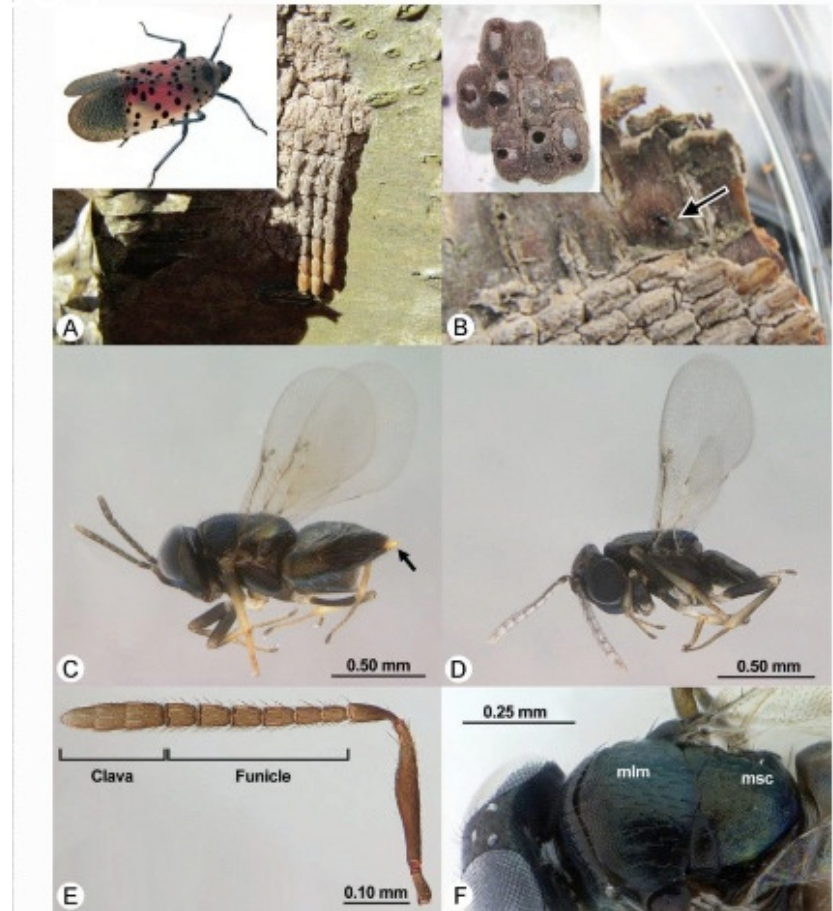
¹Degree of damage; ++++: very serious, +++: serious, ++: middle, +: weak

- Host list from researchers in South Korea
- Includes grape, walnut and some rosaceous plants
- Don't have a good handle on the impacts on tree fruit
- Future studies will aim to narrow down US host range and obligatory hosts for nymph development and egg laying

Potential Biological Control Agents



Anastatus orientalis



Ooencyrtus kuvana

Present in North America
Introduced for biological control of gypsy moth
Has been recovered from eggs in PA

What don't we know?

- We have very little information on their biology, ecology and behavior
- We have no monitoring tools for this species in any cropping system
- What is the host range? Is tree of heaven an obligatory host? Must they feed on this species in order to complete their nymphal development or for adults to reproduce?
- Do SLF feed on apple? What impact will their feeding on have on young trees/vines and on developing fruit buds? Do they transmit diseases?
- What are best materials for managing adults and nymphs?
- Biological control?

A photograph showing a large number of spotted beetles, likely scarab beetles, clustered together on a forest floor. The beetles have a light-colored body with numerous dark spots. They are surrounded by green leaves and some brown debris. The text is overlaid on the left side of the image.

Ongoing
Research
Efforts:
proof of
concept for
future studies

- Trapping study
- eDNA study
- Gut content analysis

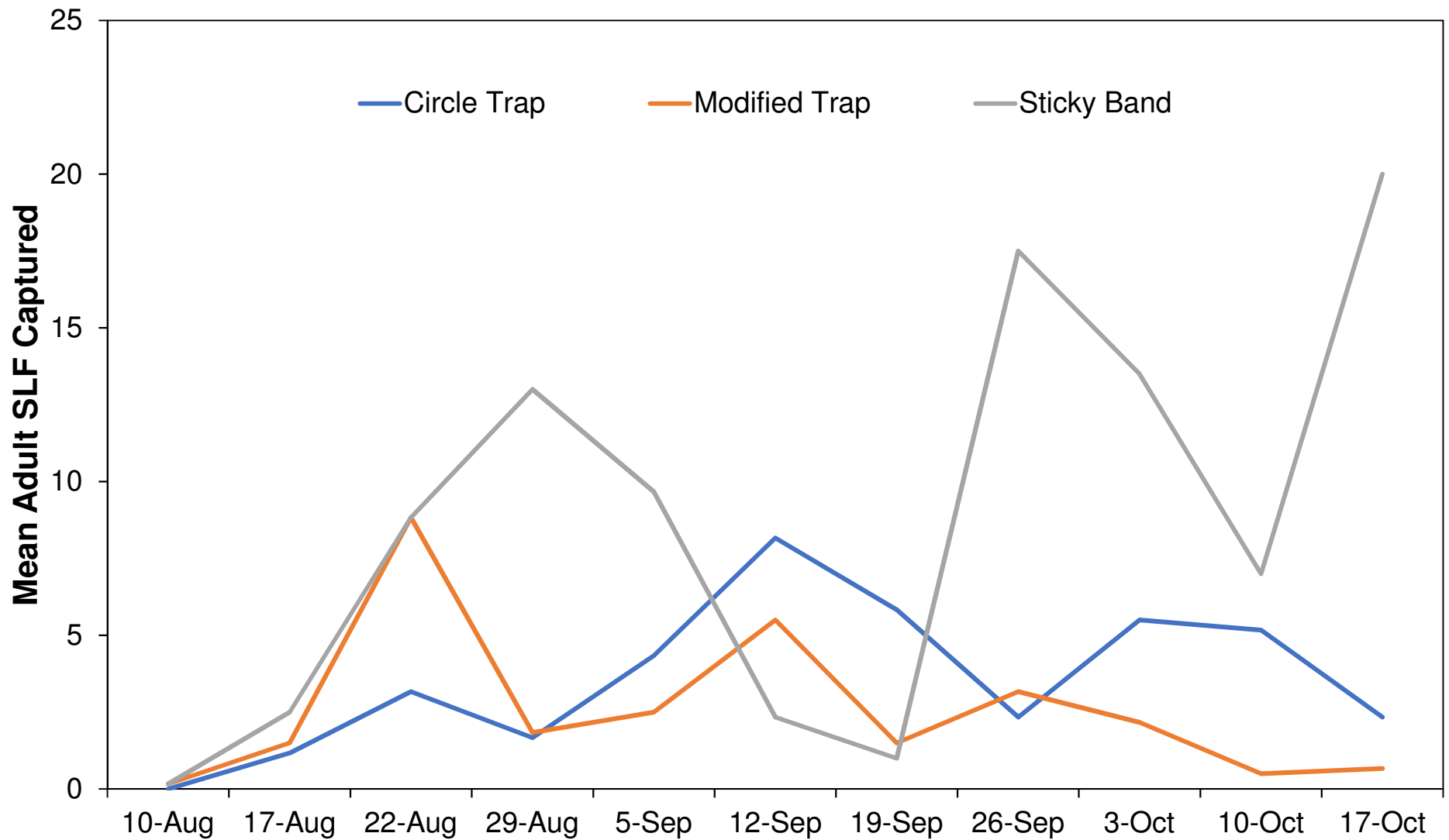
Preliminary Trapping Study



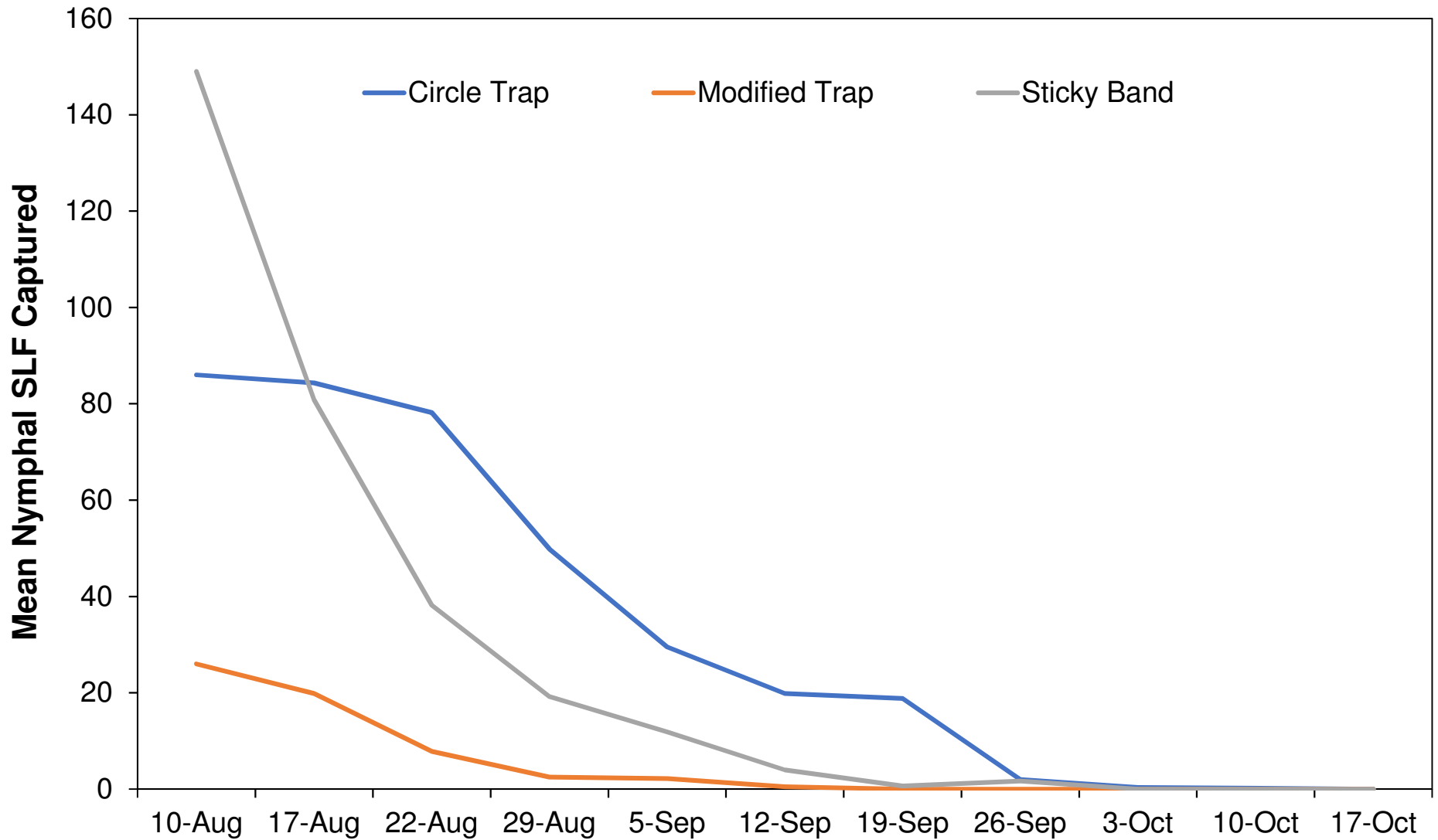
- 2 sites – Winchester, VA (lower population) and Reading, PA (higher population density)
- 3 trap types, baited and unbaited
- Traps checked weekly and captures recorded
- Sticky bands and lures replaced weekly



Adult Captures



Nymph Captures – Reading, PA



Trapping Study Results

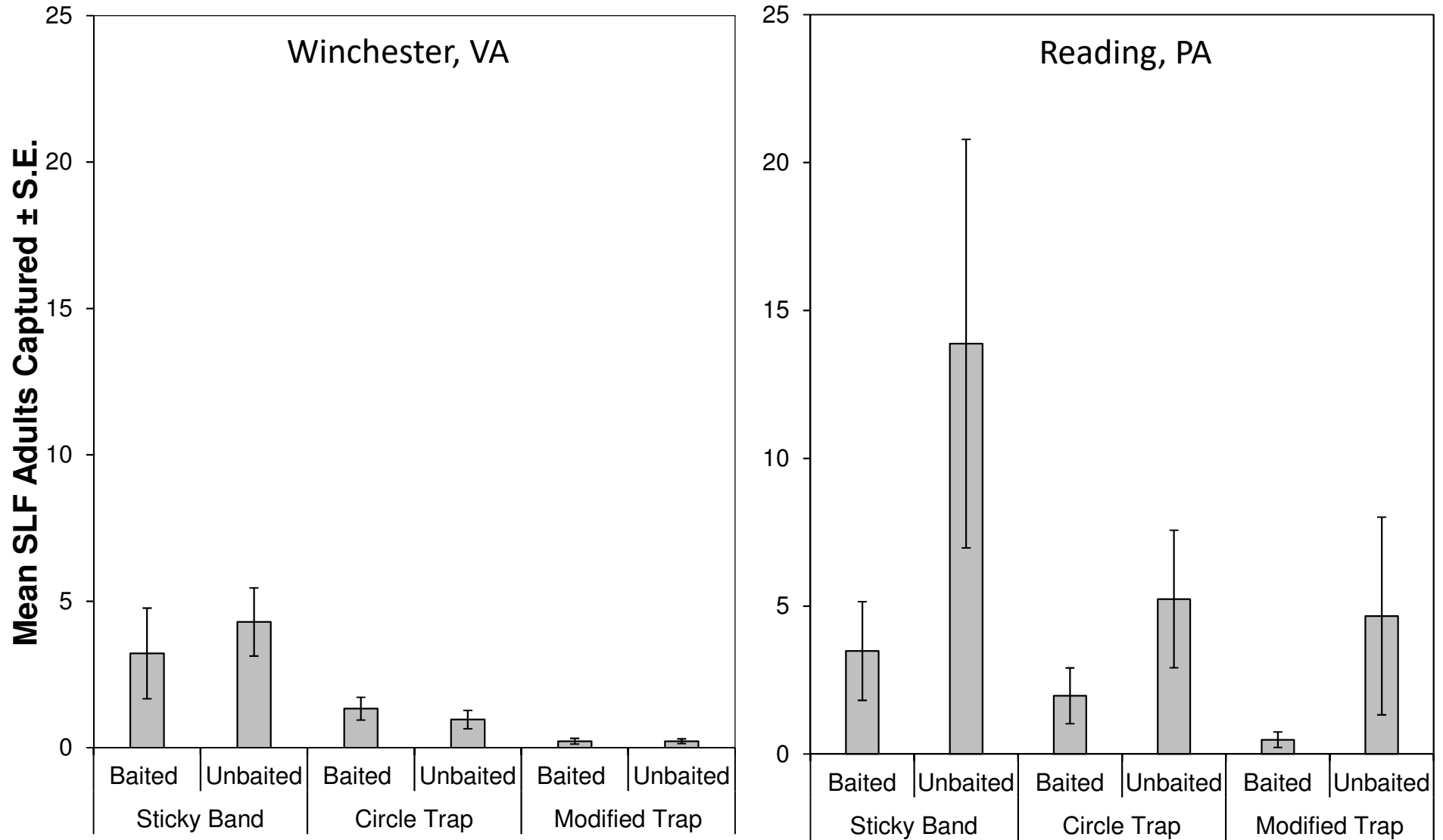




Photo: H. Leach, PSU

Sticky band traps:
effective for capturing
nymphs and adults
throughout season



Non-target captures of vertebrates and invertebrates creates a potential problem with using sticky bands

Better options moving forward?



Photo: H. Leach, PSU

How DNA from snow helps scientists track elusive animals

Researchers are using environmental DNA to help monitor and measure populations of rare snow-dwelling species like Canadian lynx.

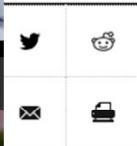


BIOLOGY

Scientists Pick Up the Genetic Scent of Stinkbug Invaders

New method that tests for insect DNA on farm produce could “revolutionize” agricultural pest surveillance

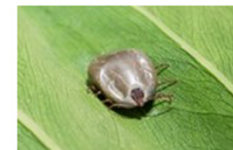
By Daniel Ackerman on July 12, 2018



READ THIS NEXT



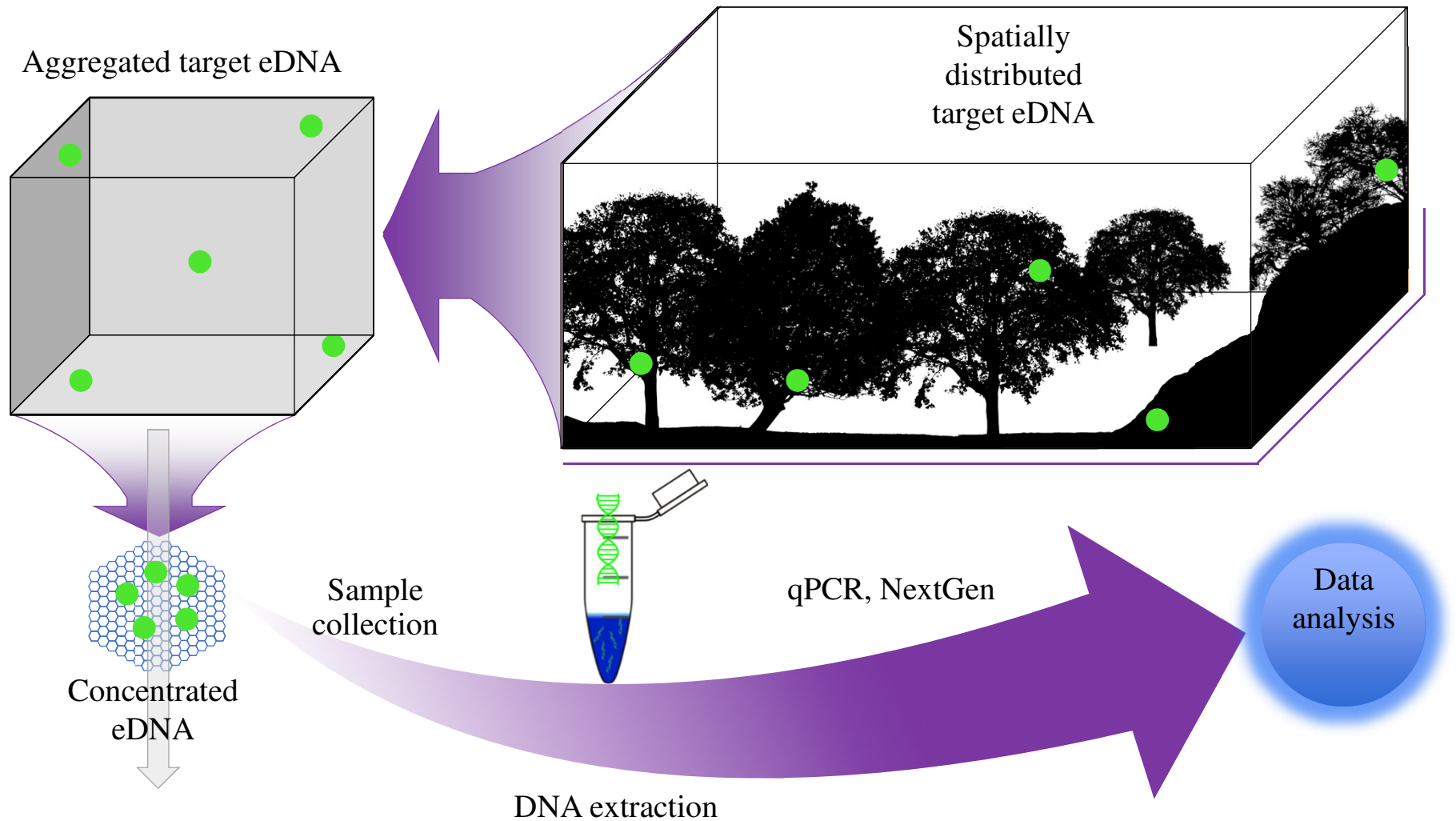
You're about to get bugs, America. B won't be man-fac



Tick Discovery Hi How Few Answer about These Pest



eDNA Collection Methods





eDNA Collection Methods:

1. Aggregate target DNA using water
2. Isolate eDNA using qPCR
3. Compare against database of known DNA sequences to identify the organism that left it behind

Preliminary eDNA Results

Week 1	Site 1	Site 2	Site 3
Apple			x
Grape			x
Peach	x		
Tree of Heaven			x
Walnut			x

x	Positive SLF eDNA detection
	Negative SLF eDNA detection
	No sample collected

Week 2	Site 1	Site 2	Site 3
Apple			
Grape		x	
Peach			x
Tree of Heaven	x	x	
Walnut	x		x

Week 3	Site 1	Site 2	Site 3
Apple			
Grape			
Peach	x		
Tree of Heaven			
Walnut			



Gut Content Analysis Methods

Gut Content Analysis of a Phloem-Feeding Insect, *Bactericera cockerelli* (Hemiptera: Triozidae) FREE

W. Rodney Cooper ✉, David R. Horton, [Thomas R. Unruh](#), [Stephen F. Garczynski](#)

Environmental Entomology, Volume 45, Issue 4, 1 August 2016, Pages 938–944,

<https://doi.org/10.1093/ee/nvw060>

Published: 06 June 2016 **Article history** ▼

- Plant DNA can be detected in phloem-feeding insects
- PCR-based methods to identify what plant species had previously been fed upon
- Gut content analysis is extremely sensitive to even the smallest amount of DNA
- Previous studies used whole insects; due to large size of SLF have to dissect out the guts for analysis
- Able to see visible amplicons using ITS
- Able to get a number of plant sequences from SLF specimens



Gut Content Analysis Preliminary Results



Plant	Identity	Sequences
<i>Portulaca</i> sp. (Purslane?)	99.7% pairwise identity	4/19 sequences
<i>Solanum</i> spp. (Nightshade plants)	95.7% identity	2/19
<i>Ailanthus altissima</i> (Tree of Heaven)	99.5% identity	1/19 sequences
<i>Medicago</i> spp. (Alfalfa?)	100% identity	1/19 sequences

- Able to see visible amplicons using ITS
- Able to get a number of plant sequences from SLF specimens
- Need dedicated dissection area for SLF to prevent contamination
- Future studies can help narrow down host range

Ongoing Research and Outreach Efforts

Insecticides for control applications

			Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Destroy egg masses														
Use sticky bands to capture spotted lanternfly														
Registered insecticides can be effective ¹														
Avoid moving gravid (fertilized) females ²														
Avoid moving viable egg masses ²														
Treat most tree-of-heaven (<i>Ailanthus altissima</i>) trees with herbicide ^{1,3}														
Treat tree-of-heaven "trap" trees with systemic insecticides ^{1,4}														
Trade name	Active ingredient	Class												
Imidan 70WP	phosmet	Organophosphate												
Scorpion 35SL	dinotefuran	Neonicotinoid												
Brigade 10WSB	bifenthrin	Pyrethroid												
Mustang Maxx 0.8EC	zeta-cypermethrin	Pyrethroid	4 fl. oz.	C, I	1	12	<7	Yes, 2(ee)						
Closer 2SC	sulfoxaflor	Sulfoximine	5.75 fl oz.	S, C, I	7	12	7	2(ee) pending						
Actara 25WDG	thiamethoxam	Neonicotinoid	3.5 oz	S, C, I	5	12	7	Yes, 2(ee)						
Assail 30SG	acetamiprid	Neonicotinoid	5.3 oz	S, C, I	3	48	<7	Yes, 2(ee) nymph only						
Carbaryl 4L	carbaryl	Carbamate	2 qt	C, I	7	12	7	No						





Conclusions & Future Directions

- **Adults and nymphs** can be trapped
 - Evaluate trap design with future experiments
 - Limit non-target captures
- **eDNA** is an effective **tool** that can be used for SLF to detect adventive populations
- **Gut content analysis studies** can help identify host range
- Future studies will build on the preliminary data collected to help fill current knowledge gaps
- Develop better recommendations and best management practices for growers and homeowners

Acknowledgements

- Leskey Lab
- Demian Nunez
- Layne Leake
- Laura Nixon
- Aya Ibrahim
- Heather Leach, PSU Extension
- Julie Urban, PSU
- Mark Sutphin, VT Extension
- Anne Nielsen, Rutgers Univ
- Julie Lockwood, Rutgers Univ
- Dina Fonseca, Rutgers Univ
- Rafael Valentin, Rutgers Univ
- Rodney Cooper, USDA-ARS

