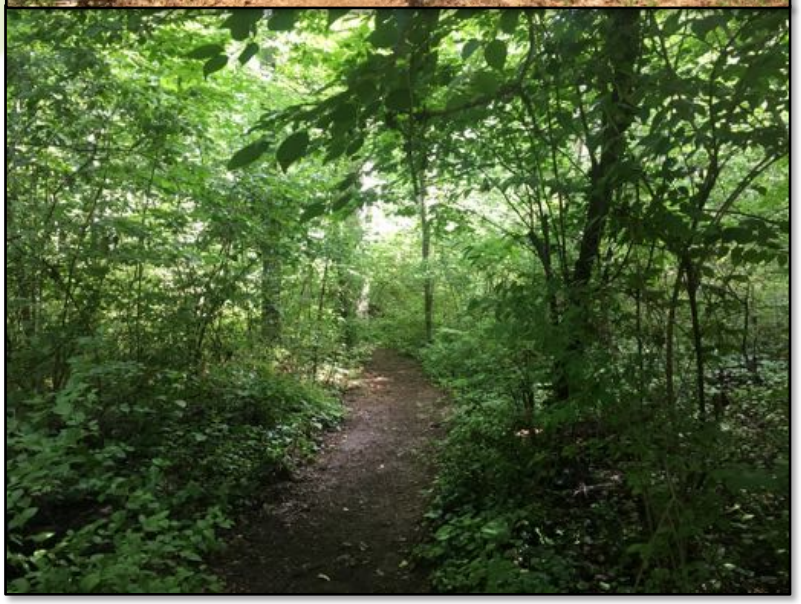
Leaf long and prosper?
Shedding light on invasive shrubs in eastern deciduous forests

Dr. Erynn Maynard-Bean

Postdoctoral research

Ecosystem Science & Management Dept.

PennState



Leaf long and prosper?
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Dr. Margot Kaye
Associate Professor of Forest Ecology
Ecosystem Science & Management Dept

Dr. Eric Burkhart
Plant Science Program Director
Shaver's Creek


Ligustrum spp.
border privet


Euonymus alatus
burning bush

Non-native, invasive shrubs

Lonicera maackii
Amur honeysuckle

Lonicera morrowii
bush honeysuckles

Berberis thunbergii
Japanese barberry

Shedding light on invasive shrubs in eastern deciduous forests of North America

Why do we care about invasive shrubs?

Do invasive shrubs have extended leaf phenology across the range? (Leaf long?)

What are some impacts of novel leaf phenology?

Is there an advantage to novel leaf phenology? (Leaf long and prosper?)

Shedding light on invasive shrubs in eastern deciduous forests of North America

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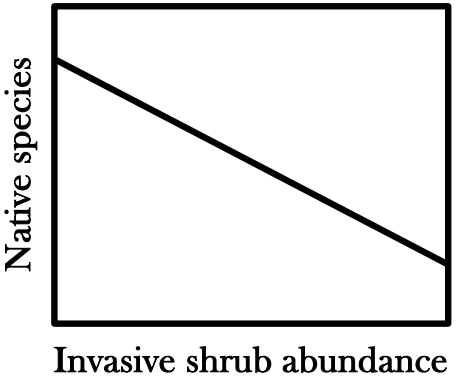

Observational: Woods 1993, Collier et al 2002, Link et al 2018






Observational: Woods 1993, Collier et al 2002, Link et al 2018

Experimental: Gould & Gorchov 2000, Miller & Gorchov 2004, Watling et al 2011, Hanula and Horn 2011a, 2011b, Ward et al 2017

INVASIVE PLANT SCIENCE AND MANAGEMENT

WSSA

Invasive Plant Science and Management

cambridge.org/inp

Research Article

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Author for correspondence:
Erynn Maynard-Bean, 220 Forest Resources Building, University Park, PA 16802.
(Email: eem212@psu.edu)

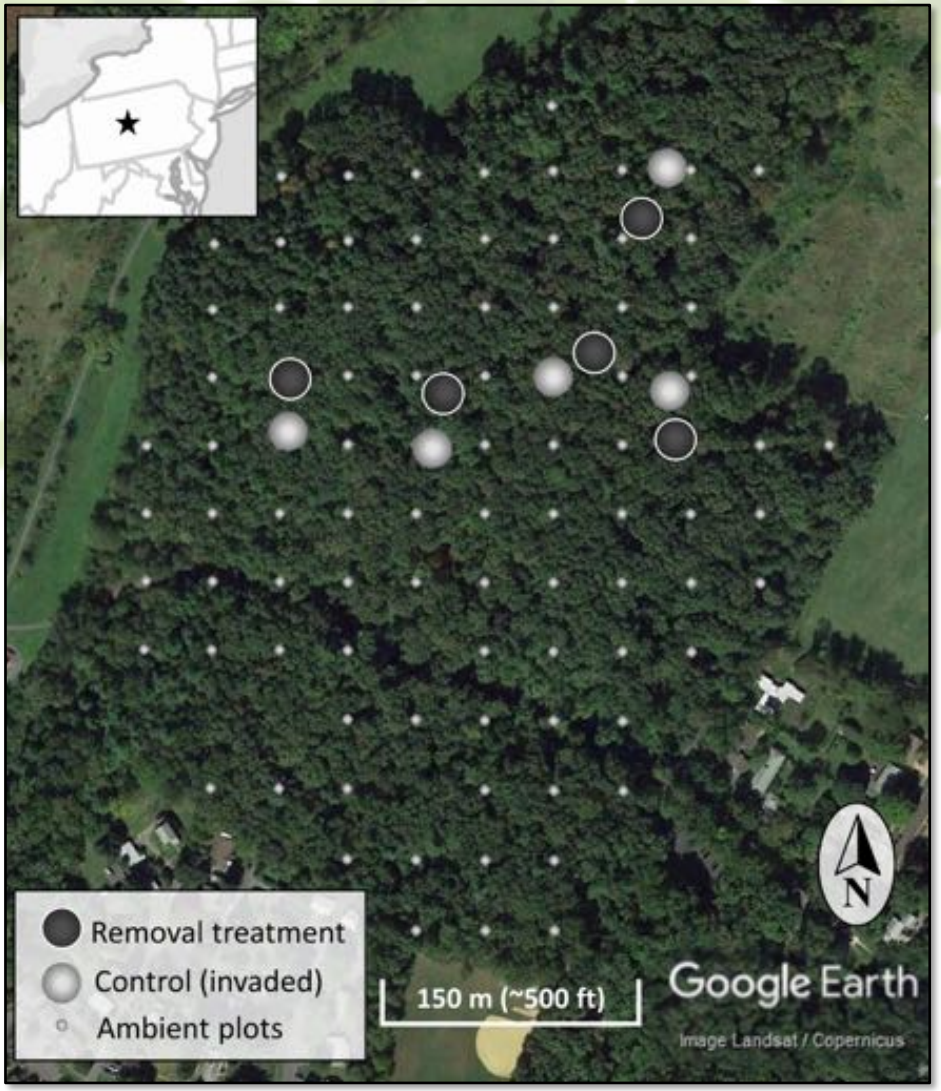
Invasive shrub removal benefits native plants in an eastern deciduous forest of North America

Erynn Maynard-Bean[1] and Margot Kaye[2]

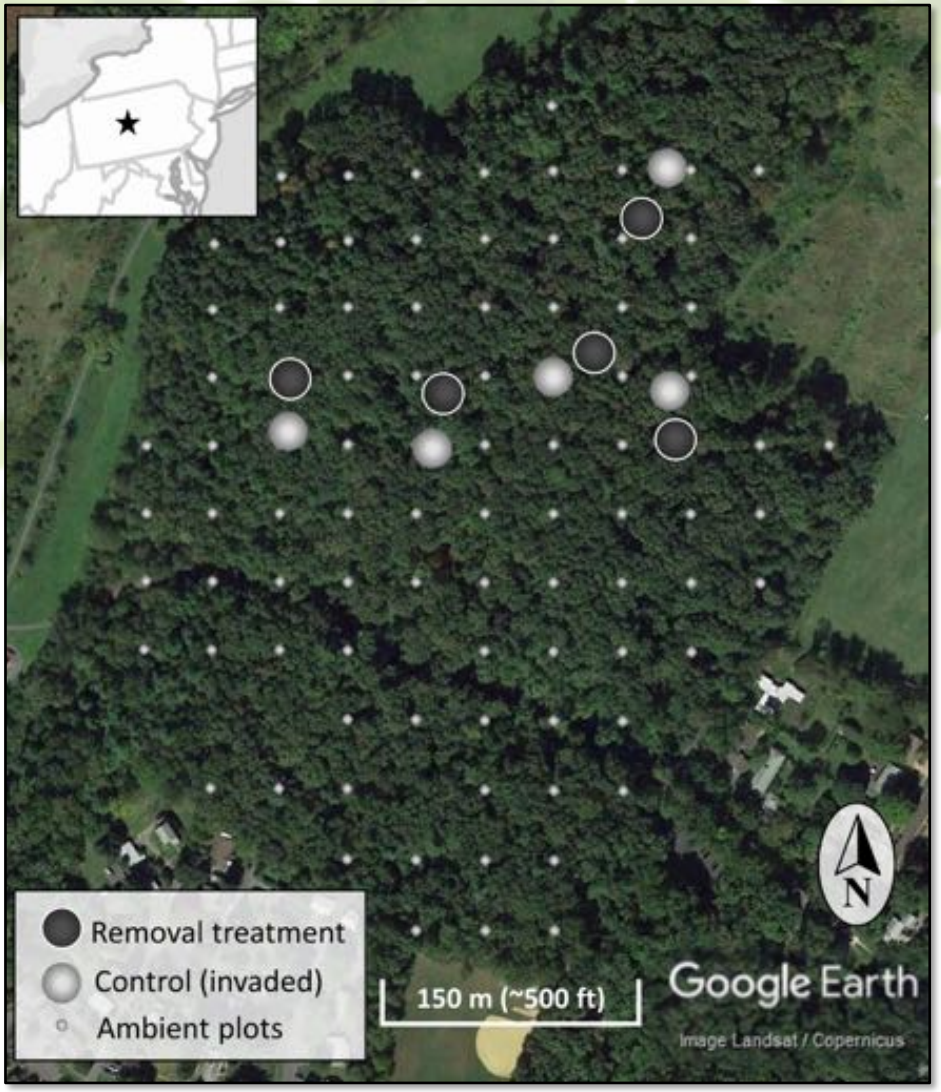
[1]PhD Candidate, Intercollege Graduate Degree Program in Ecology, Pennsylvania State University, University Park, PA, USA and [2]Associate Professor of Forest Ecology, Department of Ecosystem Science and Management and Intercollege Graduate Degree Program in Ecology, Pennsylvania State University, University Park, PA, USA

Abstract

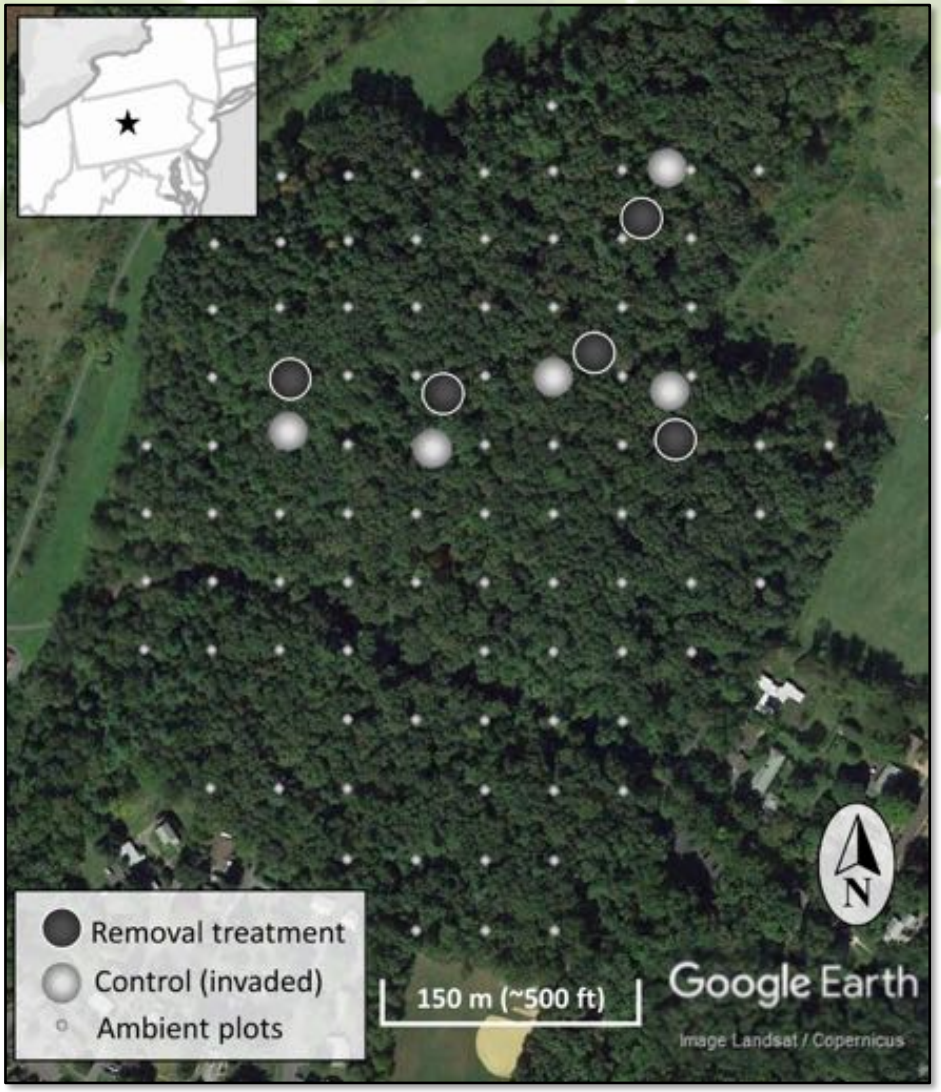
In eastern deciduous forests of North America, invasive shrubs are increasing in richness and abundance at the expense of native species across taxa. Invasive shrubs create an understory that is more dense than both recent and historical preinvasion conditions. Interest in invasive shrub removal to restore native habitat is growing, but our understanding of natural regeneration following treatment of a diverse invasive shrub community is lagging. Using an invasive shrub removal experiment, we provide insight into the effect of repeated removal of a suite of 18 invasive shrub species dominated by border privet (*Ligustrum obtusifolium* Siebold & Zucc.). In 2009, invasive shrubs were removed from five 20-m-diameter treatment plots, each with a paired control plot. Seven years later, we find an increase in plant diversity, native understory species abundance, and overstory tree species regeneration for individuals under a meter in height. For plants 1 to 4 m in height, the removal treatment has a positive effect on understory woody species, but there has been no change in regenerating overstory trees. A lack of overstory tree regeneration to greater heights is not surprising, given the time frame and the closed-canopy conditions. However, other factors, such as white-tailed deer



Initiated 2009
20 m diameter
18 species removed


Removal treatment
Control (invaded)
Ambient plots
150 m (~500 ft)
Google Earth
Image Landsat / Copernicus
N

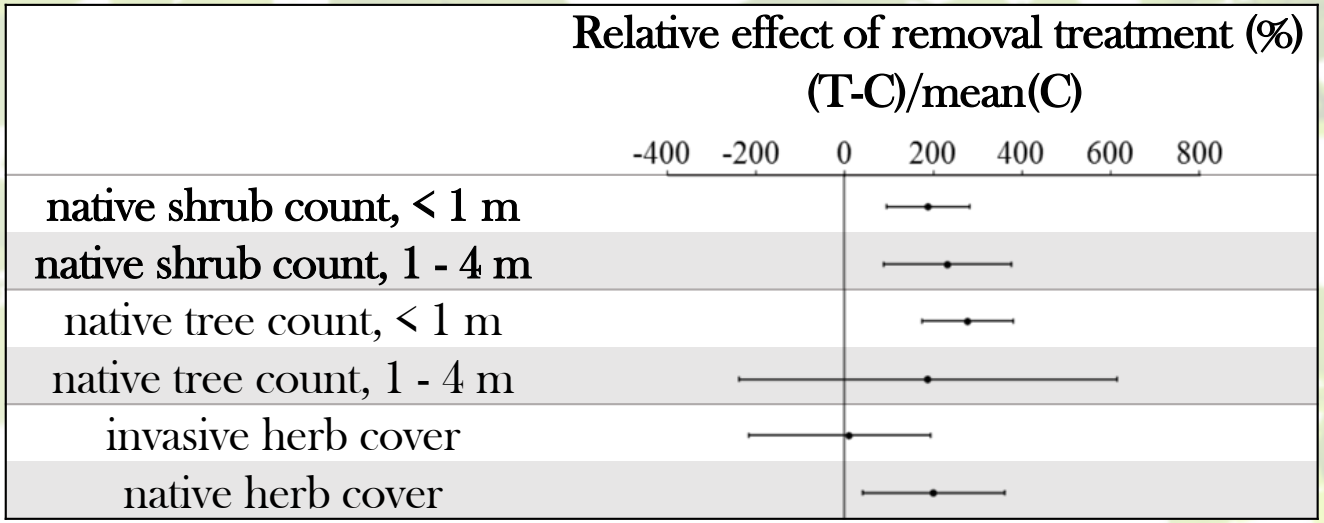

a. Removal treatment, plot 6
c. Removal treatment, plot 3



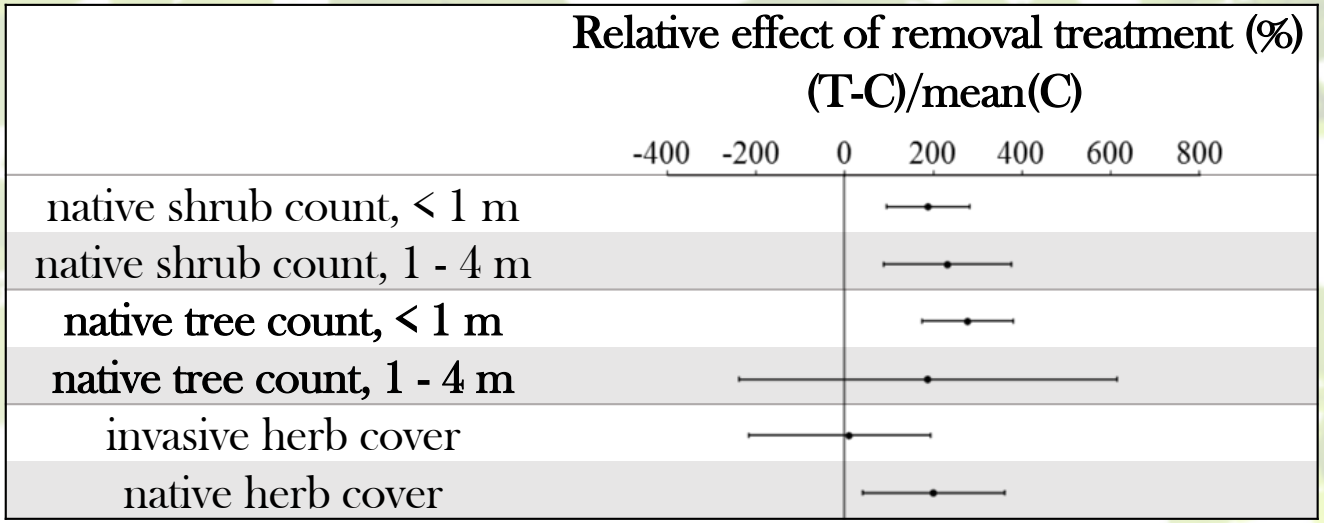
Response of the native community to removal

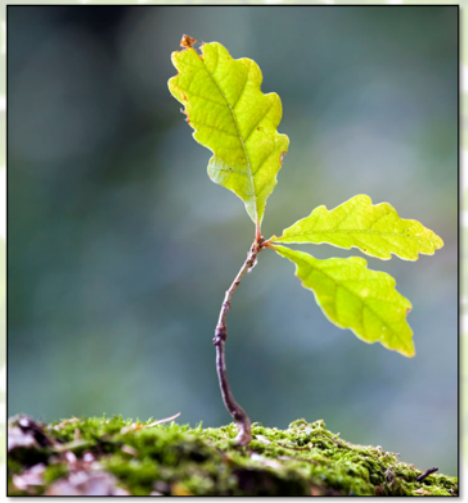
Estimate of invasive shrub impacts

The removal treatment increased native shrubs

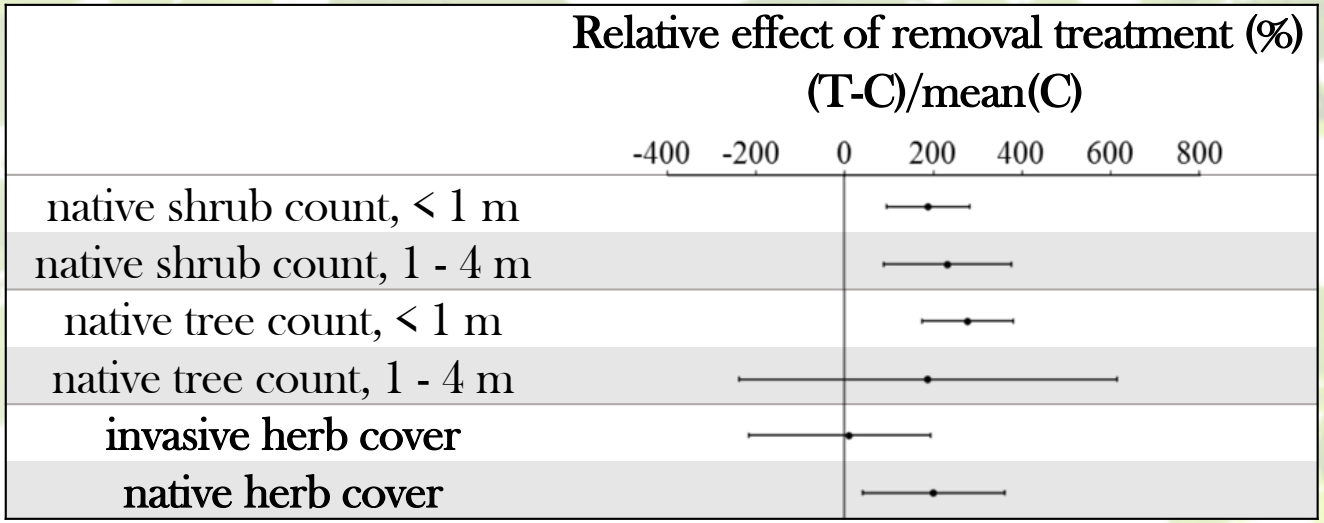


The removal treatment increased canopy tree regeneration





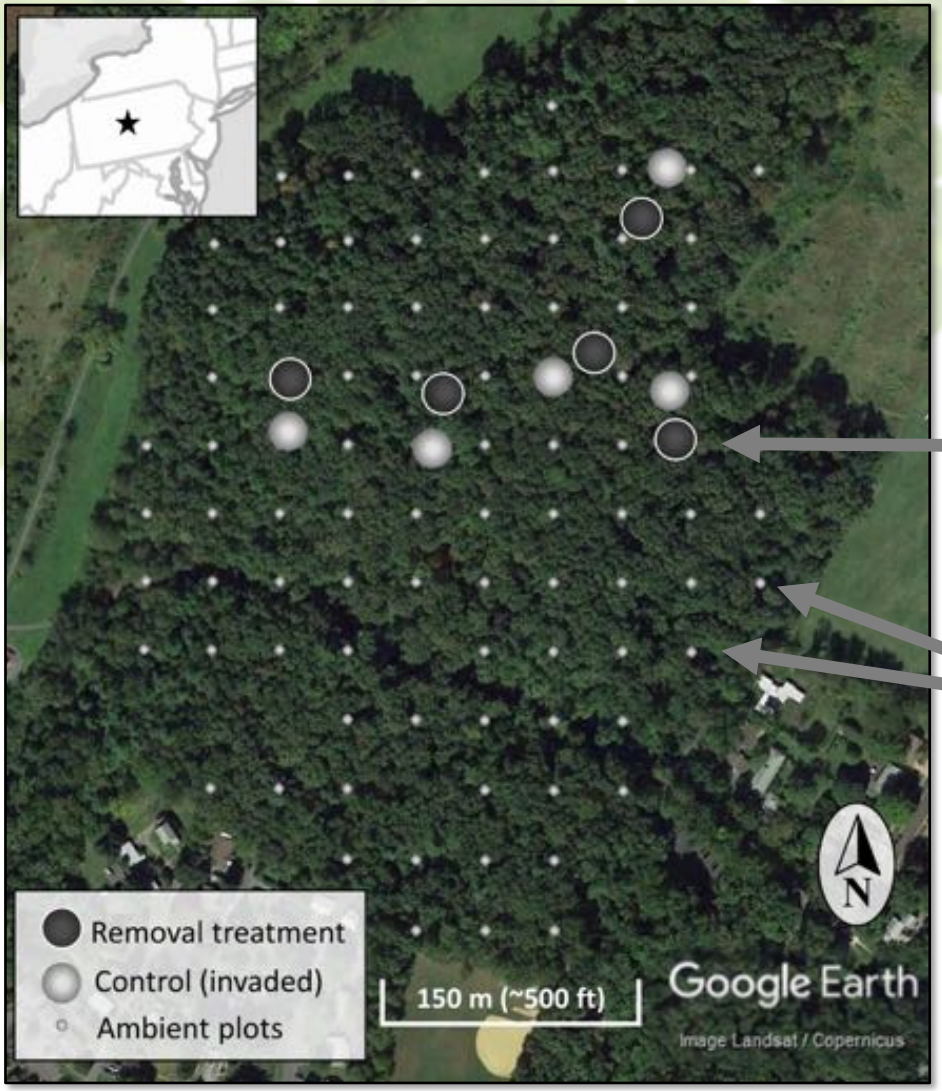
The removal treatment increased native herbaceous species, but not invasives



Plant diversity
(Shannon-Wiener index)
30.6% [9.9, 51.3]







How well is the native community responding relative to uninvaded portions of the forest?

Native understory plants:

Removal treatments
47.4 % cover
[32.1, 63.4]

Unmanaged, uninvaded forest
17.4 % cover
[11.9, 24.4]

Why does observational sampling underestimate?

Ligustrum spp.
border privet

Non-native, invasive shrubs

Euonymus alatus
burning bush

Lonicera maackii
Amur honeysuckle

Lonicera morrowii
bush honeysuckles

Berberis thunbergii
Japanese barberry

Ligustrum obtusifolium, border privet
Lonicera spp, bush honeysuckles
Viburnum dilitatum, linden viburnum

Lonicera morrowii, bush honeysuckle
with native *Lindera benzoin,* spicebush

Does my research matter??

Studies quantifying extended leaf phenology

0 – 4 weeks earlier

2 – 6 weeks later

McEwan et al. 2009, Harrington et al. 1989, Xu et al. 2007, Fridley 2012

Shedding light on invasive shrubs in eastern deciduous forests of North America

Why do we care about invasive shrubs?

Do invasive shrubs have extended leaf phenology across the range?

What are some impacts of novel leaf phenology?

Is there an advantage to novel leaf phenology?

Shady Invaders
Citizen Science Campaign

USA npn
National Phenology Network
Taking the Pulse of Our Planet

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Special thanks to Tyler Wagner for statistical training and consultation!

Shady Invaders
Citizen Science Campaign

USA npn National Phenology Network
Taking the Pulse of Our Planet

From 2015 – 2018:
> 8,000 observations,
804 shrubs,
384 sites

Native shrubs

- spicebush (*Lindera benzoin*)
- mapleleaf viburnum (*Viburnum acerifolium*)
- flowering dogwood (*Cornus florida*)
- gray dogwood (*Cornus racemosa*)
- black haw (*Viburnum prunifolium*)
- alternateleaf dogwood (*Cornus alternifolia*)
- southern arrowwood (*Viburnum dentatum*)
- hobble-bush (*Viburnum lantanoides*)

Invasive shrubs

- Japanese barberry (*Berberis thunbergii*)
- Amur honeysuckle (*Lonicera maackii*)
- multiflora rose (*Rosa multiflora*)
- burningbush (*Euonymus alatus*)
- privet (*Ligustrum* sp.)
- Morrow's honeysuckle (*Lonicera morrowii*)
- Tatarian honeysuckle (*Lonicera tatarica*)

Leaf emergence

153 sites
911 observations

Leaf off

72 sites
589 observations

Native shrubs

Invasive shrubs

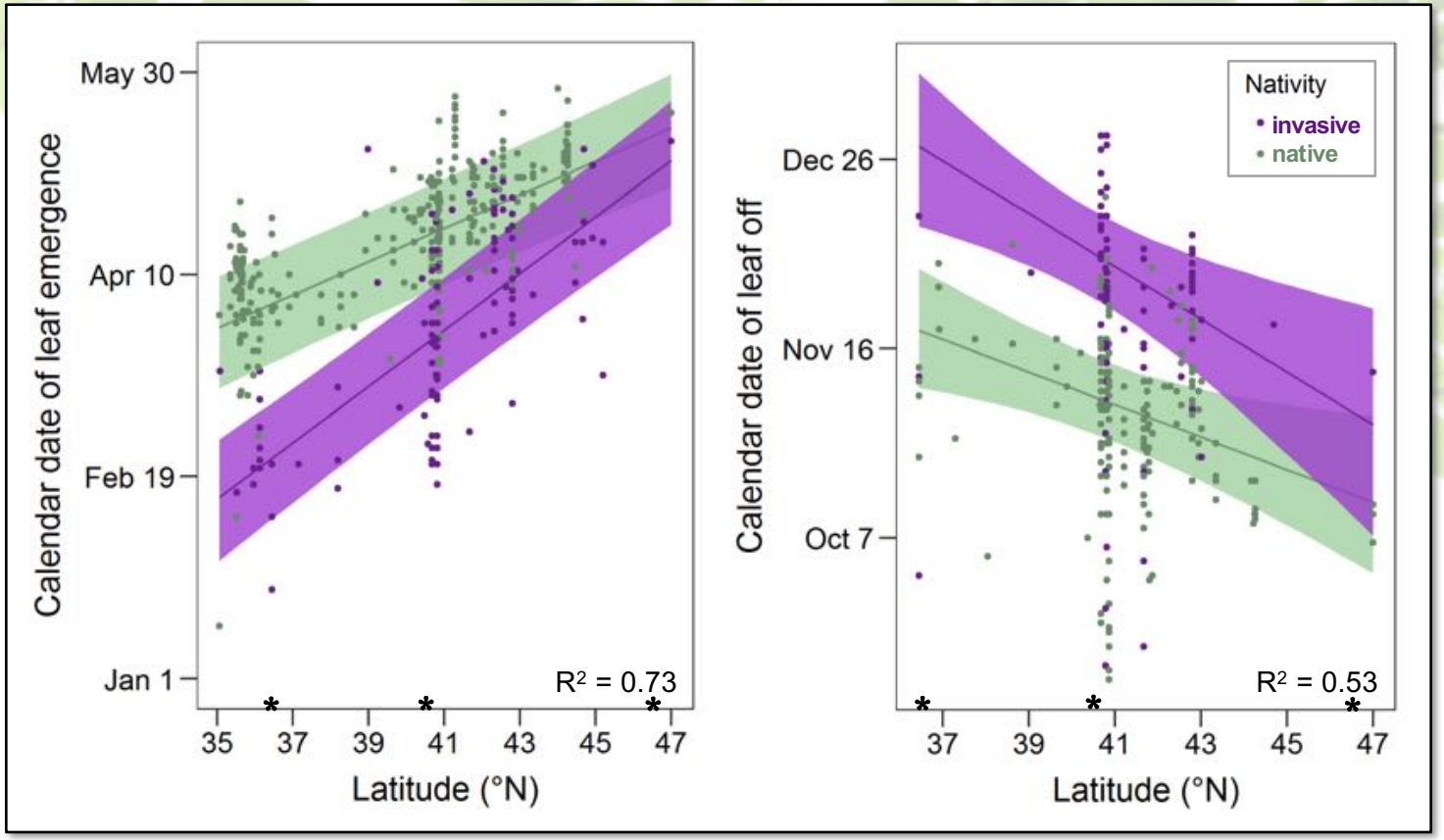
Leaf emergence and leaf off across latitude by nativity

Days earlier:

36.5°N
38.1 days
[25.7, 50.8]

40.5°N
26.6 days
[15.7, 37.8]

46.5°N
9.5 days
[-3.7, 23.0]



Days later:

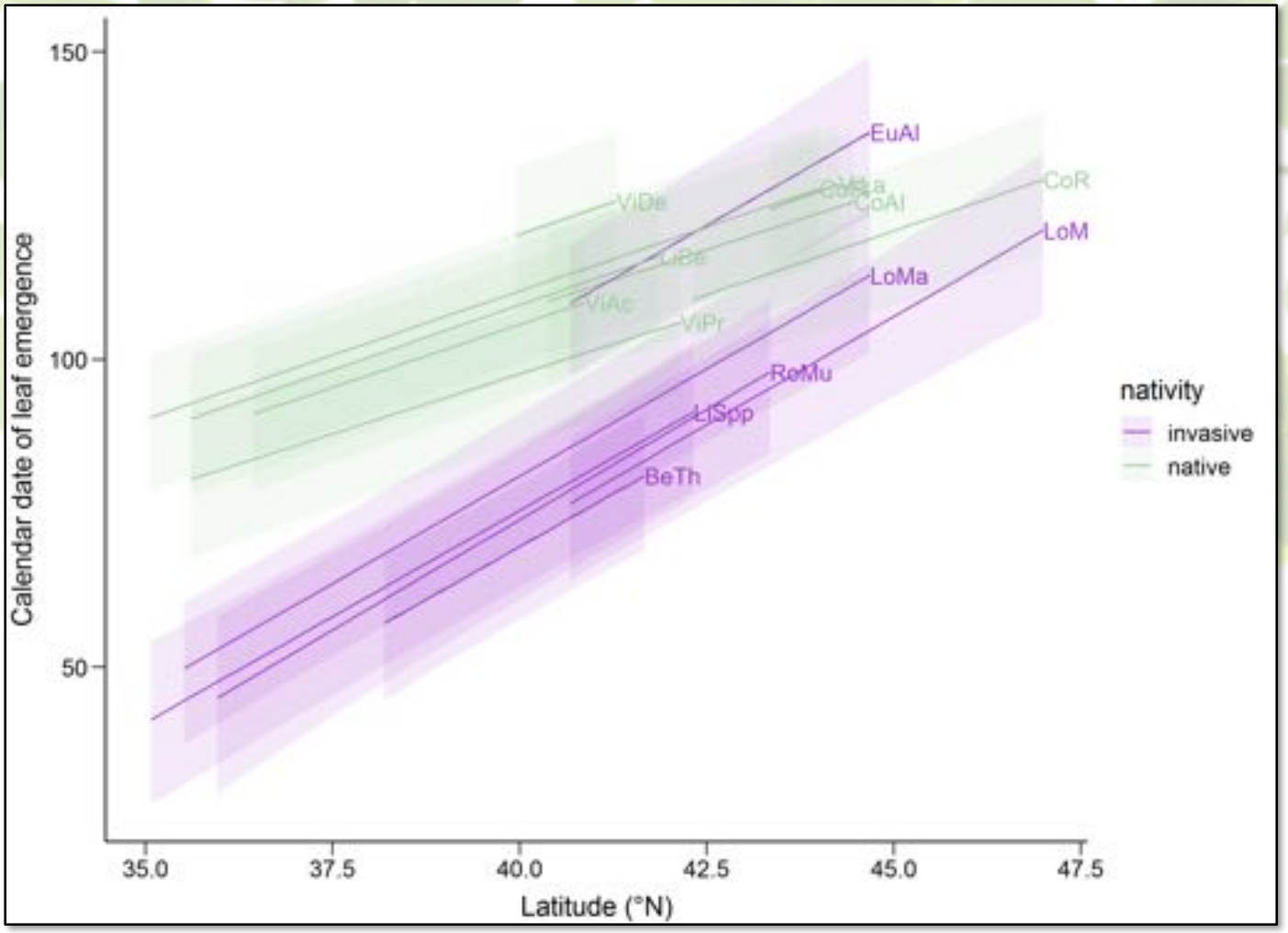
36.5°N
38.9 days
[17.4, 57.5]

40.5°N
30.3 days
[19.2, 41.2]

46.5°N
17.4 days
[-10.8, 40.1]

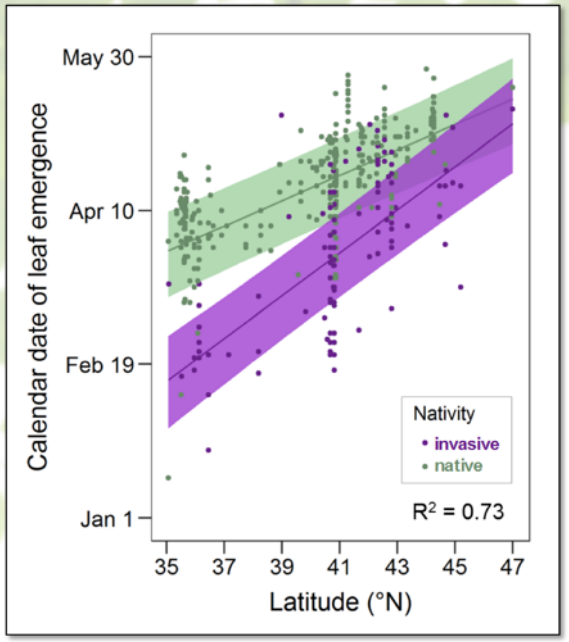
Species-specific differences

Leaf emergence across latitude by species



Common name	code
alternateleaf dogwood	CoAl
Amur honeysuckle	LoMa
blackhaw	ViPr
burningbush	EuAl
bush honeysuckle	LoM
flowering dogwood	CoFl
gray dogwood	CoR
hobblebush	ViLa
Japanese barberry	BeTh
mapleleaf viburnum	ViAc
multiflora rose	RoMu
northern spicebush	LiBe
privet	LiSpp
southern arrowwood	ViDe

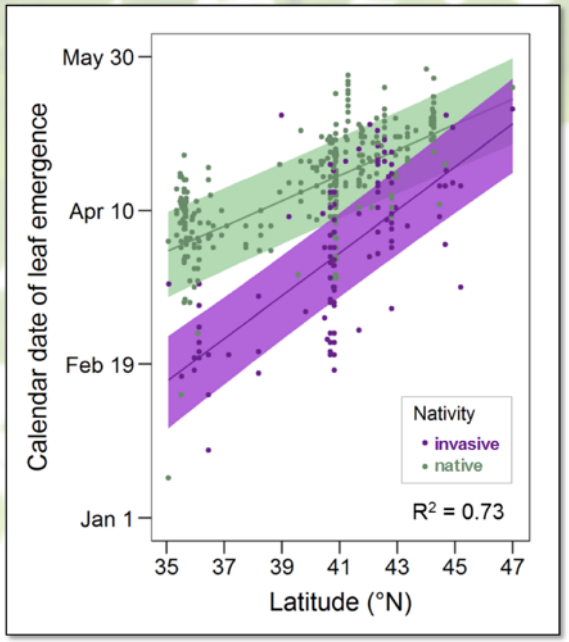
Leaf emergence and environmental cues



Accumulated warmth, AGDD (Jan - Mar)

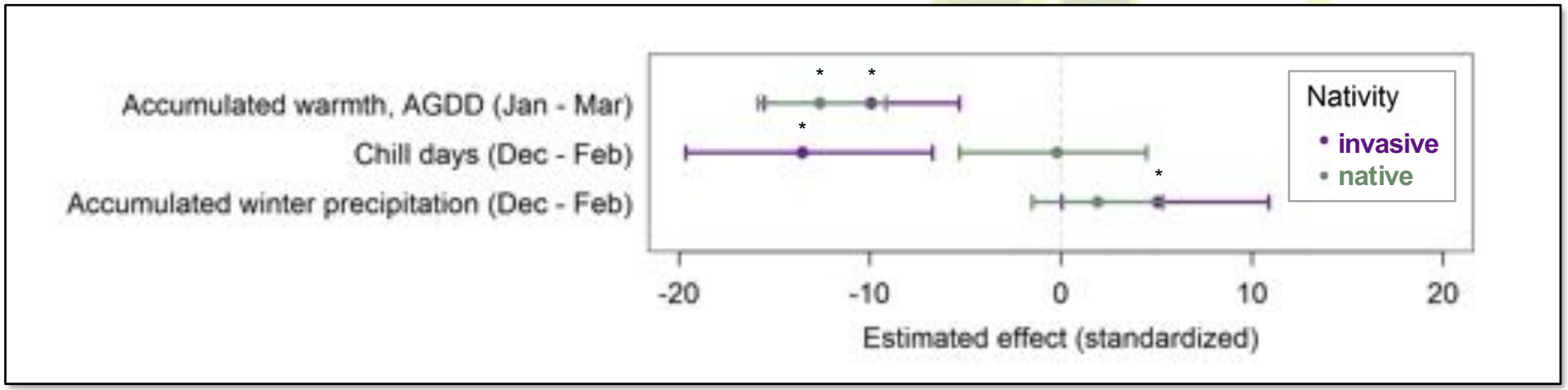
Chill days (Dec - Feb)

Accumulated winter precipitation (Dec - Feb)



Leaf emergence and environmental cues

<u>Spring warming (AGDD)</u>: forest carbon and productivity and predictions under climate change



Shedding light on invasive shrubs in eastern deciduous forests of North America

Why do we care about invasive shrubs?

Do invasive shrubs have extended leaf phenology across the range?

What are some impacts of novel leaf phenology?

Understory light availability

Is there an advantage to novel leaf phenology?

Hypothesis: Invasive shrubs allow less light infiltration than natives, especially in the spring and fall.

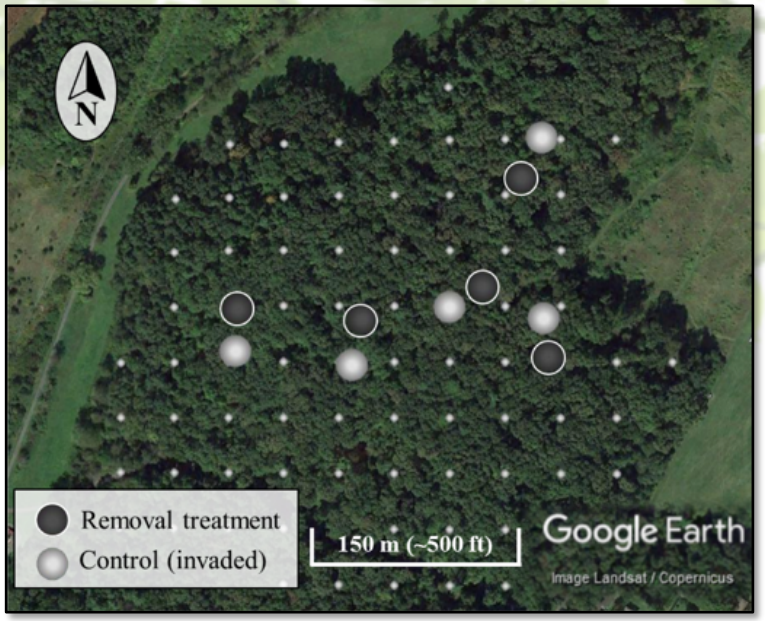
PennState

Center for Landscape Dynamics

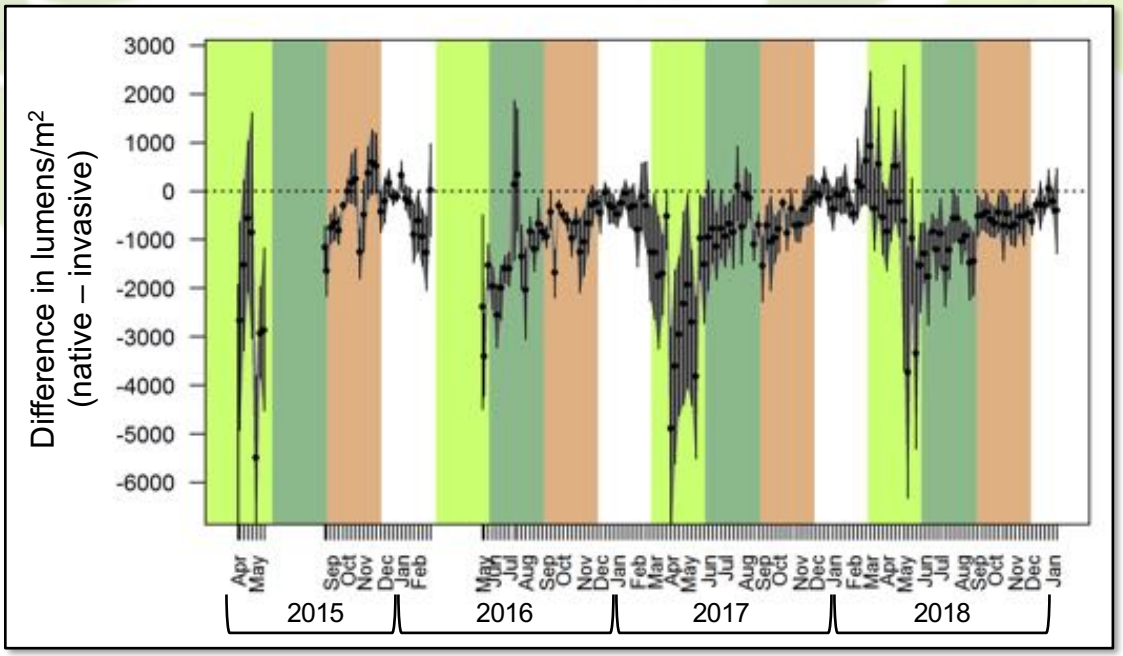
HOBO Pendant 8K
Data Loggers

Light energy

lumens/m^2
200 – 1200 nm
Apr 2014 – Jan 2019



Difference in light energy below invasive and native shrubs (effect of invasive shrubs on light energy infiltration at 0.5 m)



Hypothesis: Invasive shrubs allow less light infiltration than natives, especially in the spring and fall.

season	lumens/m^2
all	-891 [-1,072, -735]
spring	-1,981 [-2,604, -1,380]
summer	-1,038 [-1,221, -845]
fall	-547 [-660, -429]
winter	-257 [-372, -151]




Light influences:

Seed germination, plant growth and reproduction, ectothermic species behavior and development

Litter decomposition, nutrient cycling, fire behavior






Light influences:

Seed germination, plant growth and reproduction, ectothermic species behavior and development

Litter decomposition, nutrient cycling, fire behavior

Jesse K. Kreye, Ph.D.

Assistant Professor of Fire and Natural Resources Management

202 Forest Resources Building

University Park, PA 16802

Email: juk1097@psu.edu

Work Phone: 814-863-2509

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What are some impacts of novel leaf phenology?

Is there an advantage to novel leaf phenology? (Leaf long and prosper?)

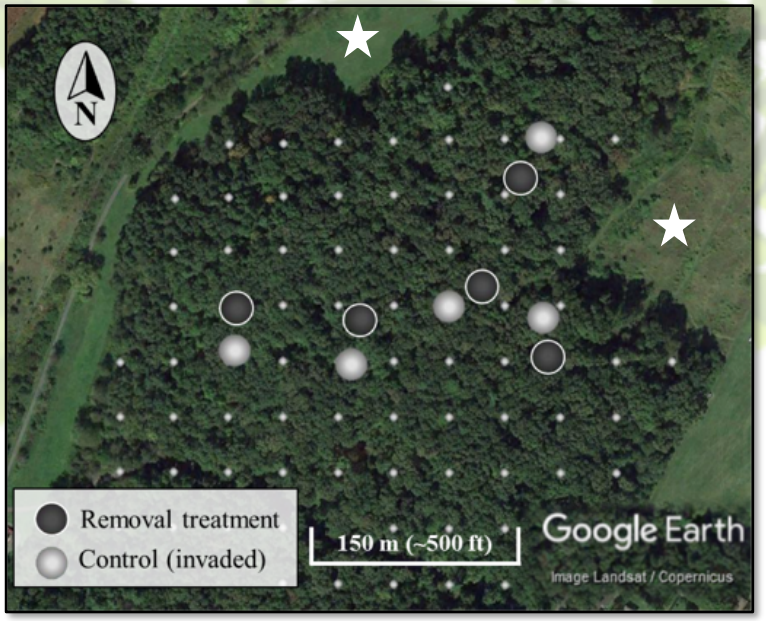
Photosynthesize longer

PennState
Huck Institutes of the Life Sciences

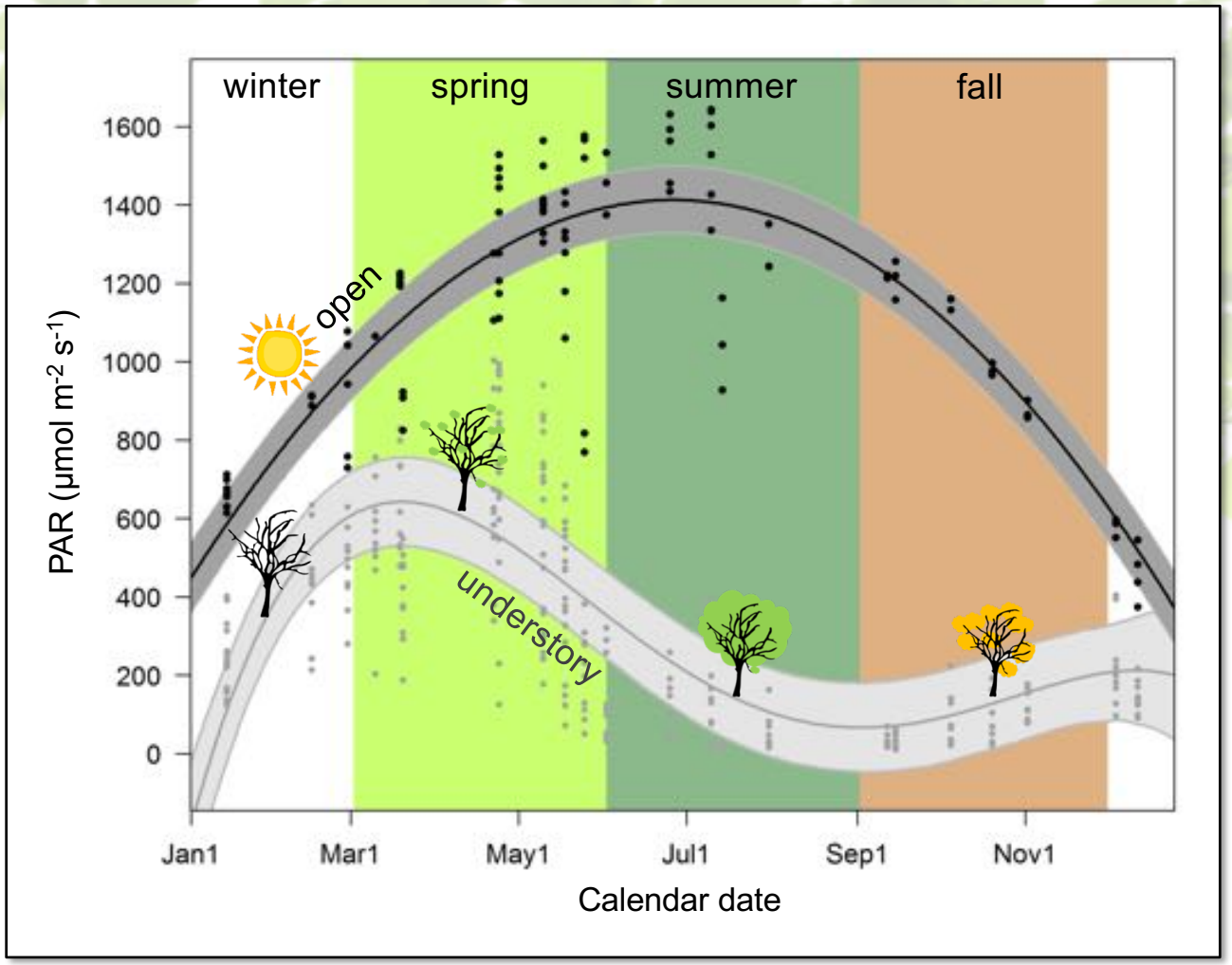
Graduate Research Innovation Award

Photosynthetically active radiation (PAR)

μmol m^{-2} s^{-1}
400 – 700 nm
Mar 2016 – Jan 2019



Seasonal photosynthetically active radiation (PAR) midday



open, $R^2 = 0.83$
understory, $R^2 = 0.67$

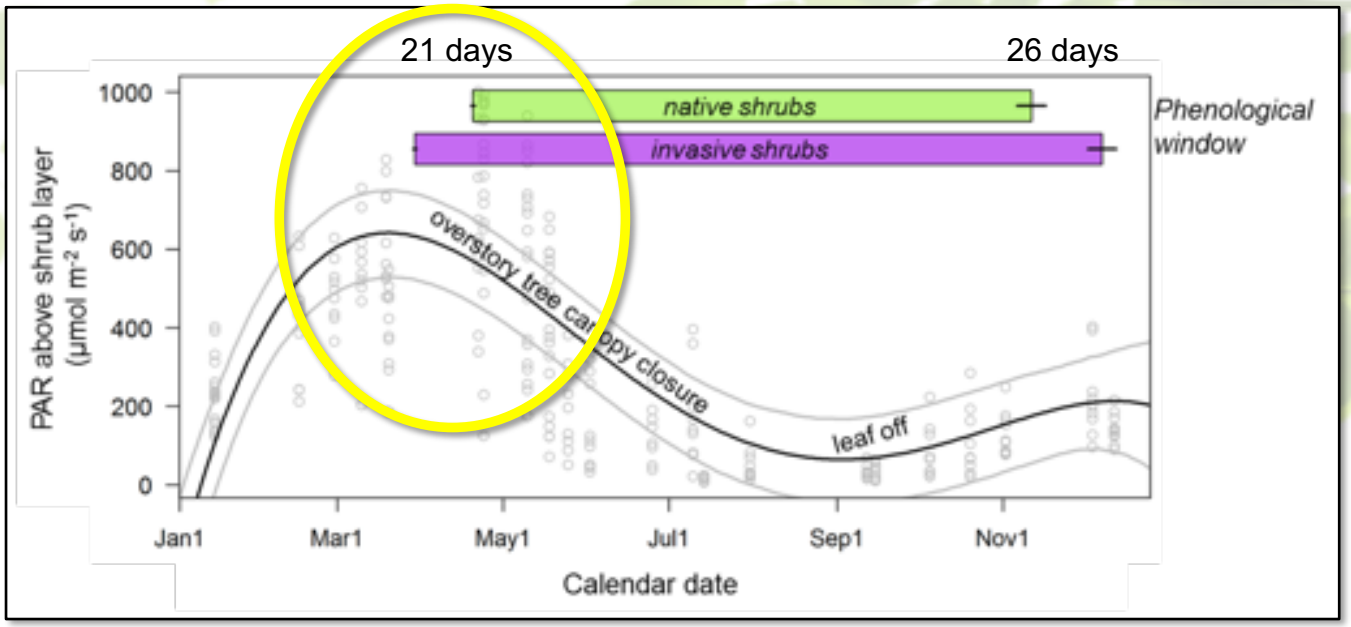
Phenology observations

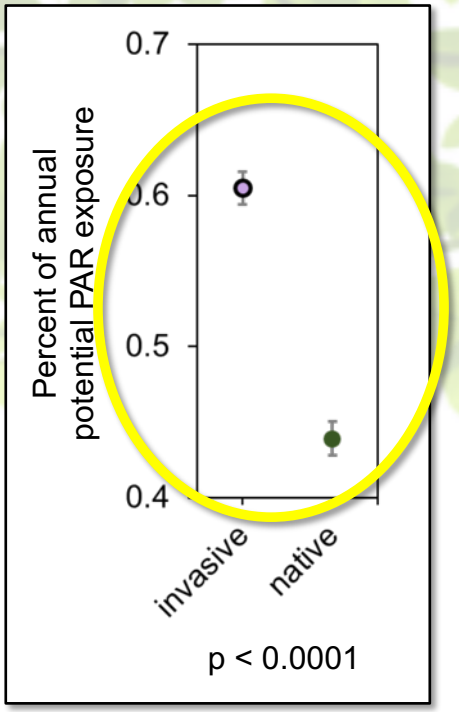
← 3 sites

9 species:

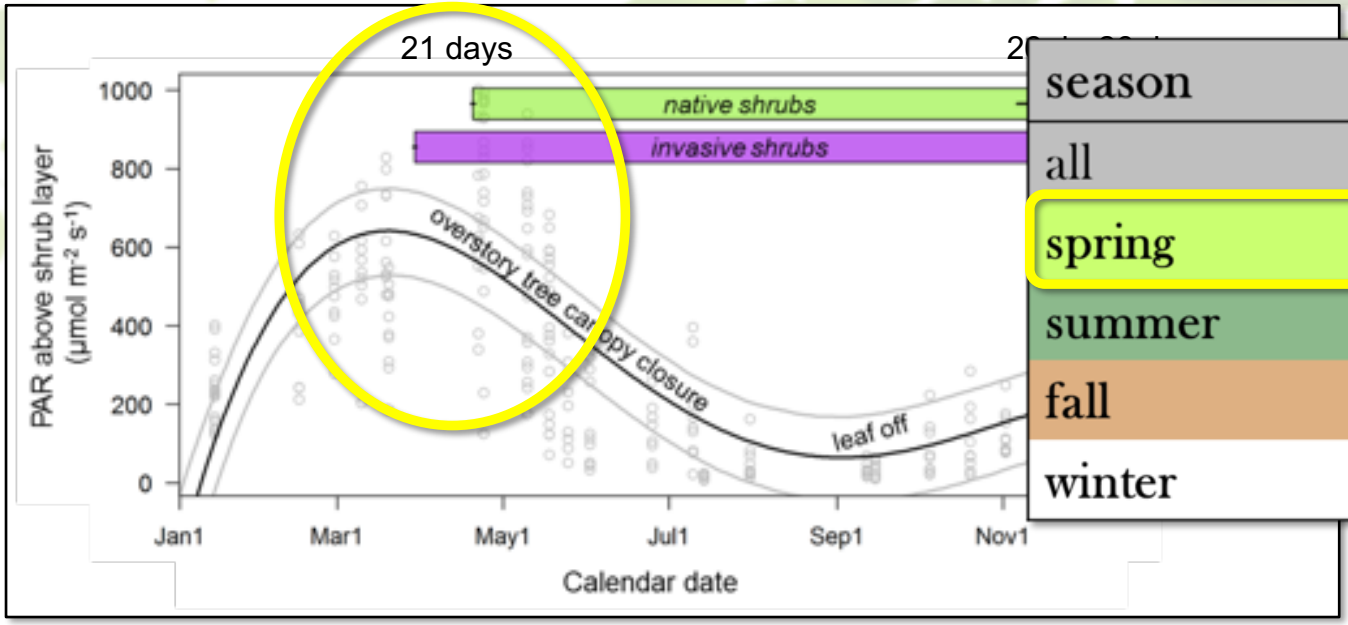
Common name	Scientific name	Species code	n
invasive			86
Japanese barberry	*Berberis thunbergii* DC.	BeTh	18
winged burningbush	*Euonymus alatus* (Thunb.) Siebold	EuAl	18
common privet	*Ligustrum obtusifolium* Siebold & Zucc.	LiOb	19
Amur honeysuckle	*Lonicera maackii* (Rupr.) Herder	LoMa	18
Linden viburnum	*Viburnum dilitatum* Thunb.	ViDi	13
native			69
bigfruit hawthorn	*Crataegus macrosperma* Ashe.	CrMa	18
spicebush	*Lindera benzoin* L.	LiBe	14
mapleleaf viburnum	*Viburnum acerifolium* L.	ViAc	19
blackhaw	*Viburnum prunifolium* L.	ViPr	18

Leaf phenology and understory light availability (PAR)





benefits



impacts

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benefits

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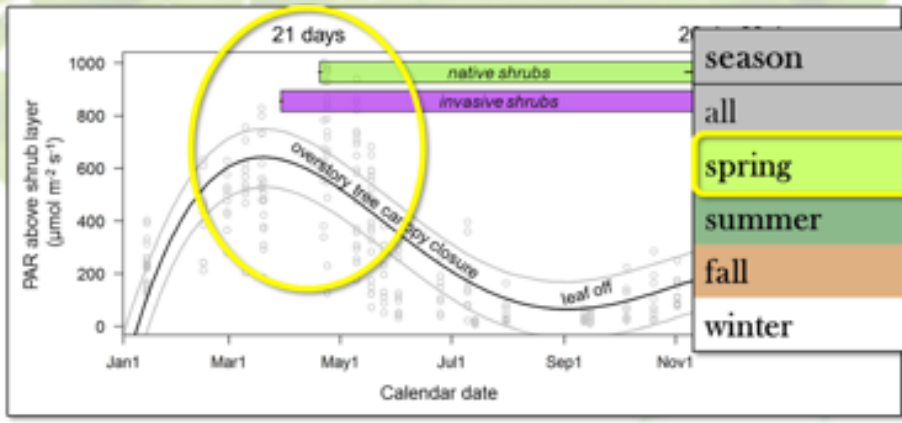

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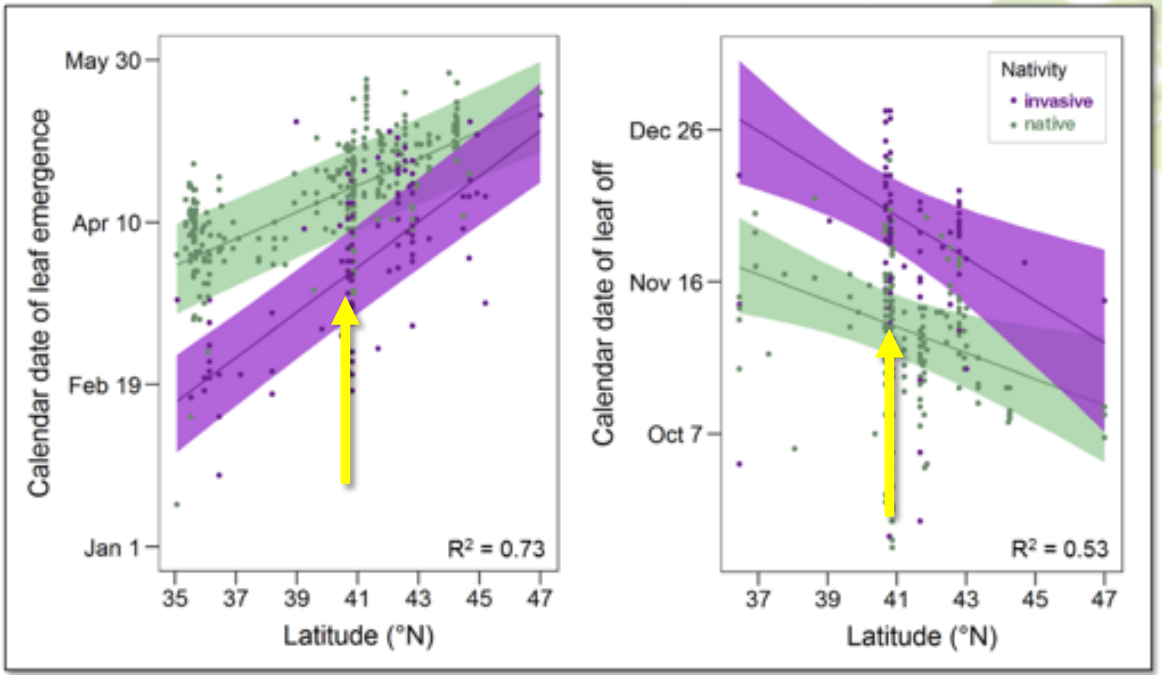

citizen science project

unified framework

Research funding:

NSF DDIG

Penn State Center for Landscape Dynamics

Huck Graduate Research Innovation Award

Funding me:

Grad. Assistant, Shaver's Creek

Service Assistant, Ecology IGDP

Teaching Assistant, ESM Dept

ARCs Scholarship

Committee:

Margot Kaye, co-adviser

Eric Burkhart, co-adviser

Dave Eissenstat

Dave Mortensen

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Sky Templeton, and

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Tyler Wagner

Laura Leites

PENN STATE ECOLOGY