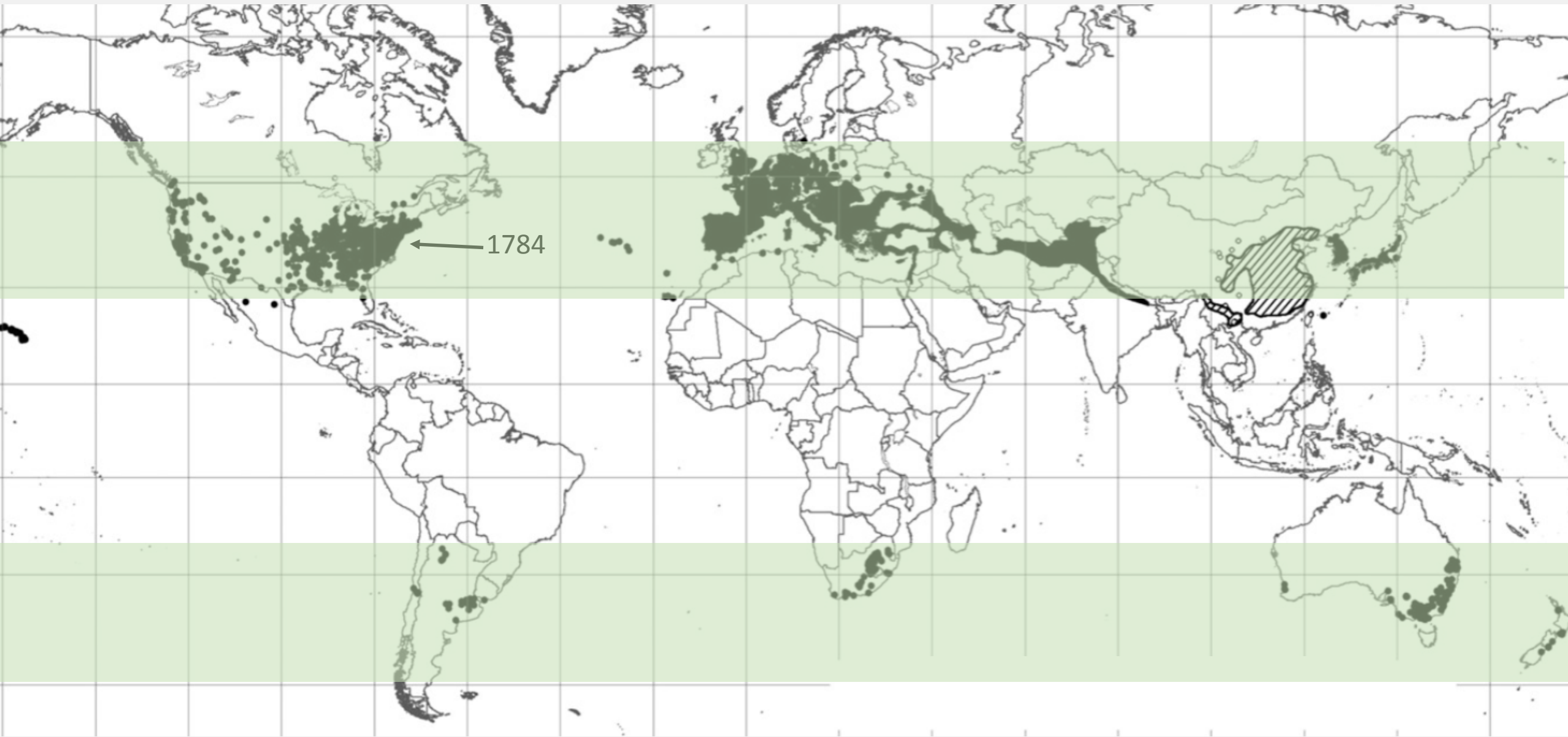


*Ailanthus altissima* (tree-of-heaven) and *Verticillium* wilt

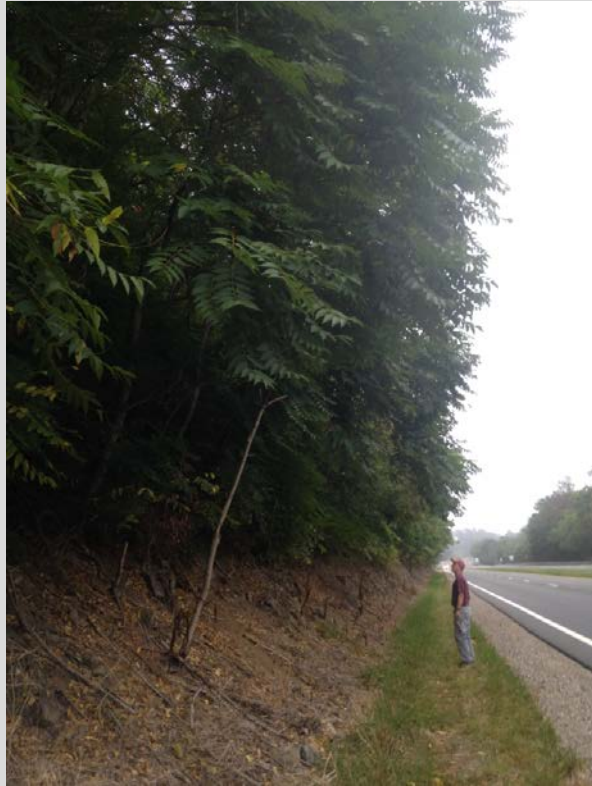
Rachel Brooks, Scott Salom, & Anton Baudoin

# Current distribution



# Ailanthus in Virginia

Roadways



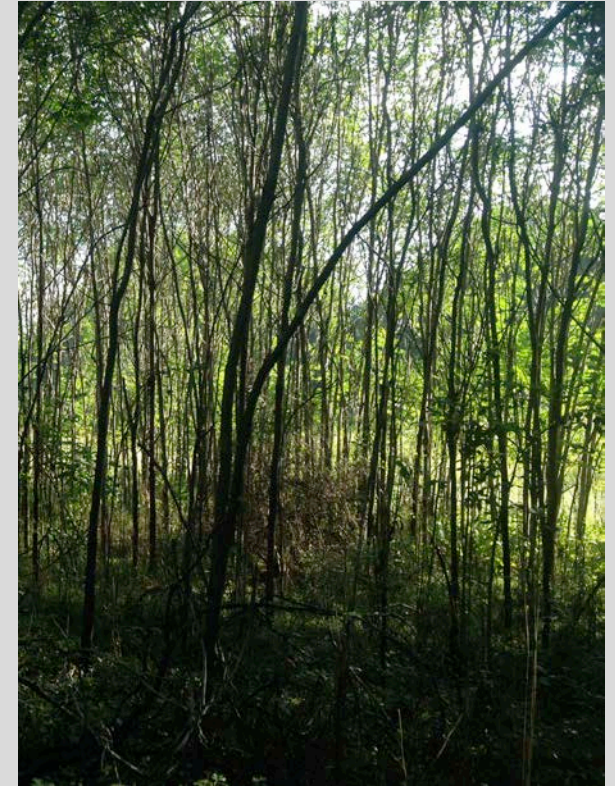
Forests



Urban areas



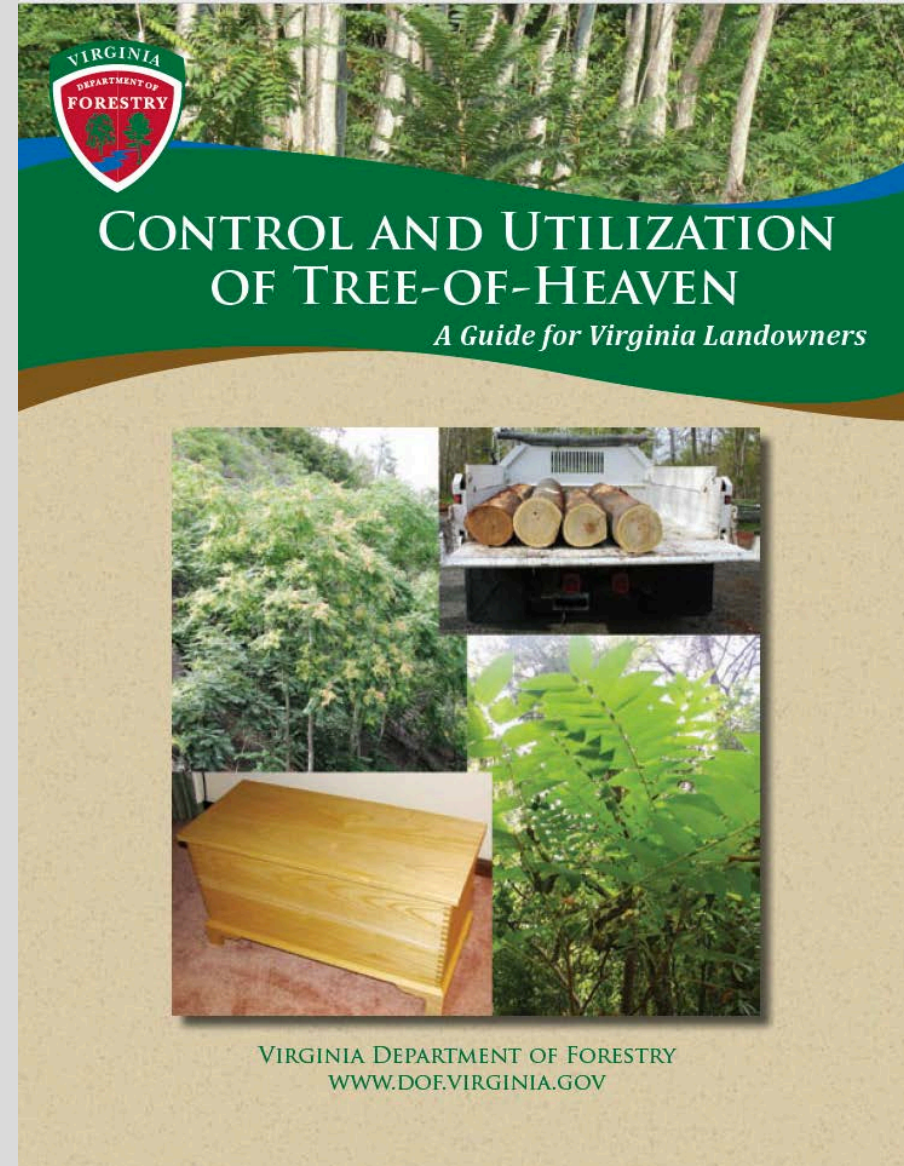
Agricultural lands



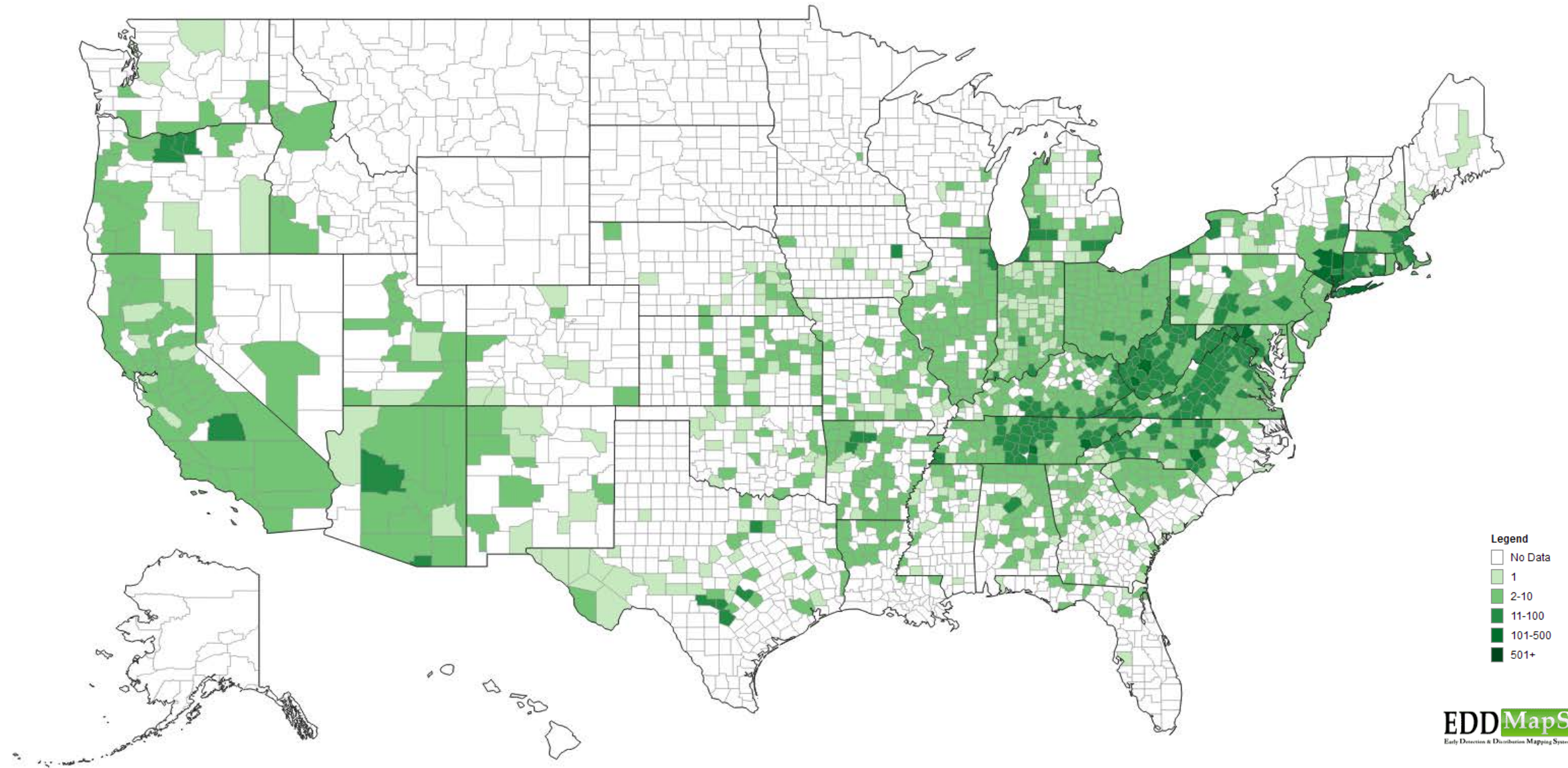
# Current Control Options

General “rules”:

- Combination of mechanical and chemical treatment
- Target seed-bearing trees first
- Resurvey and retreat yearly
- Costly and time consuming

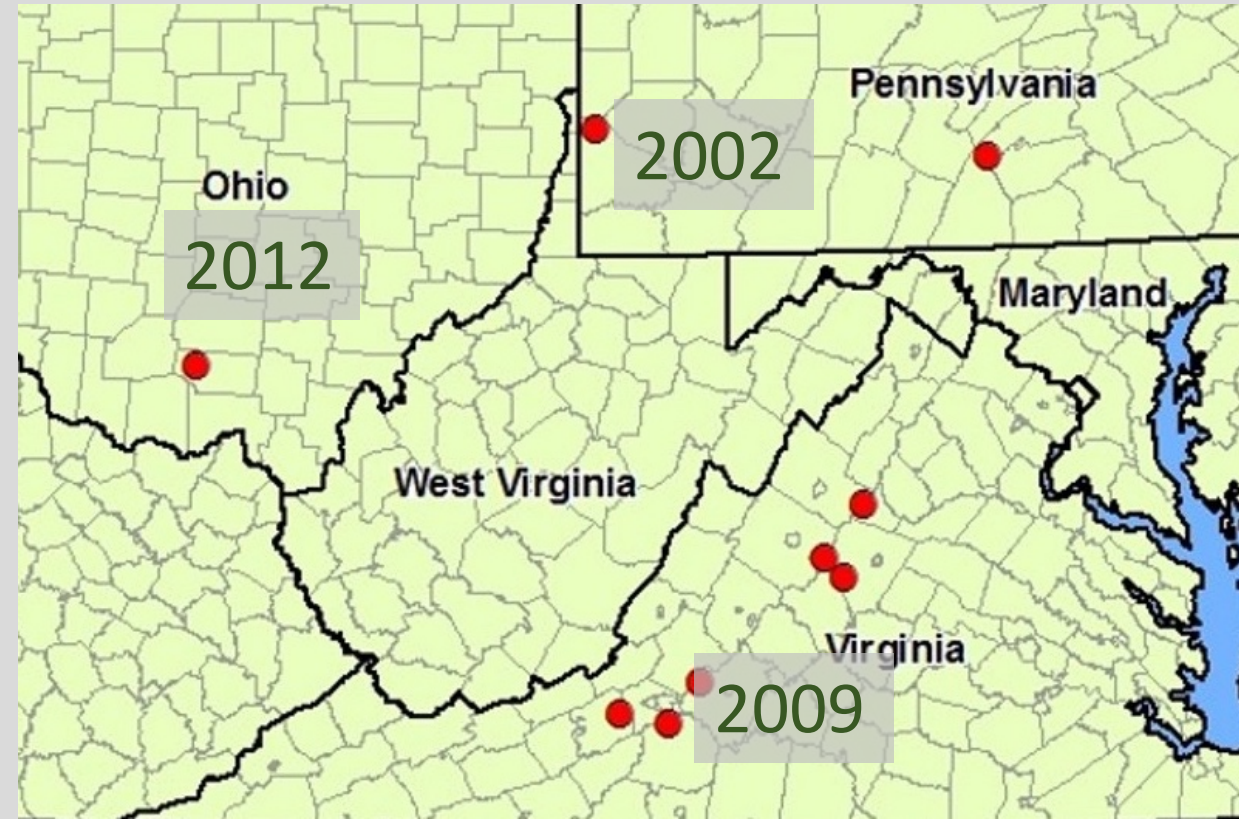


# Today



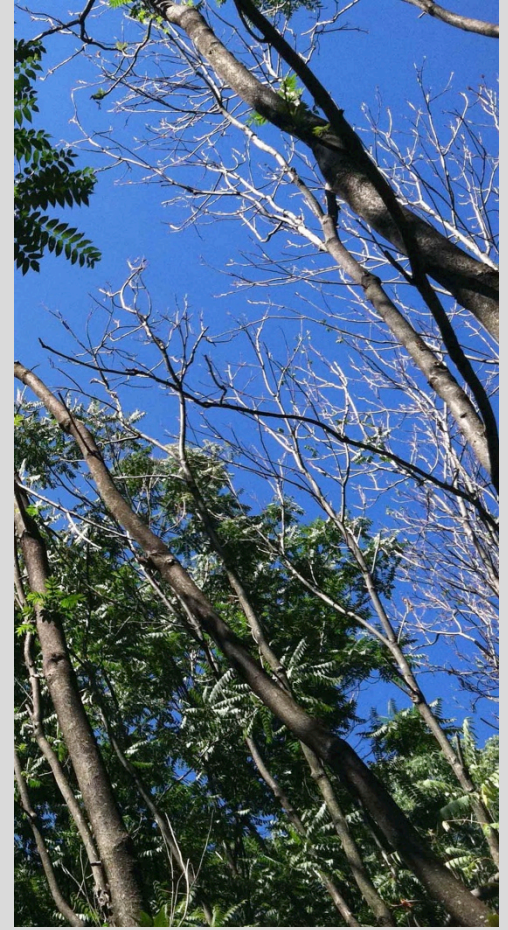
# Areas of decline

Causing severe damage only on *Ailanthus*



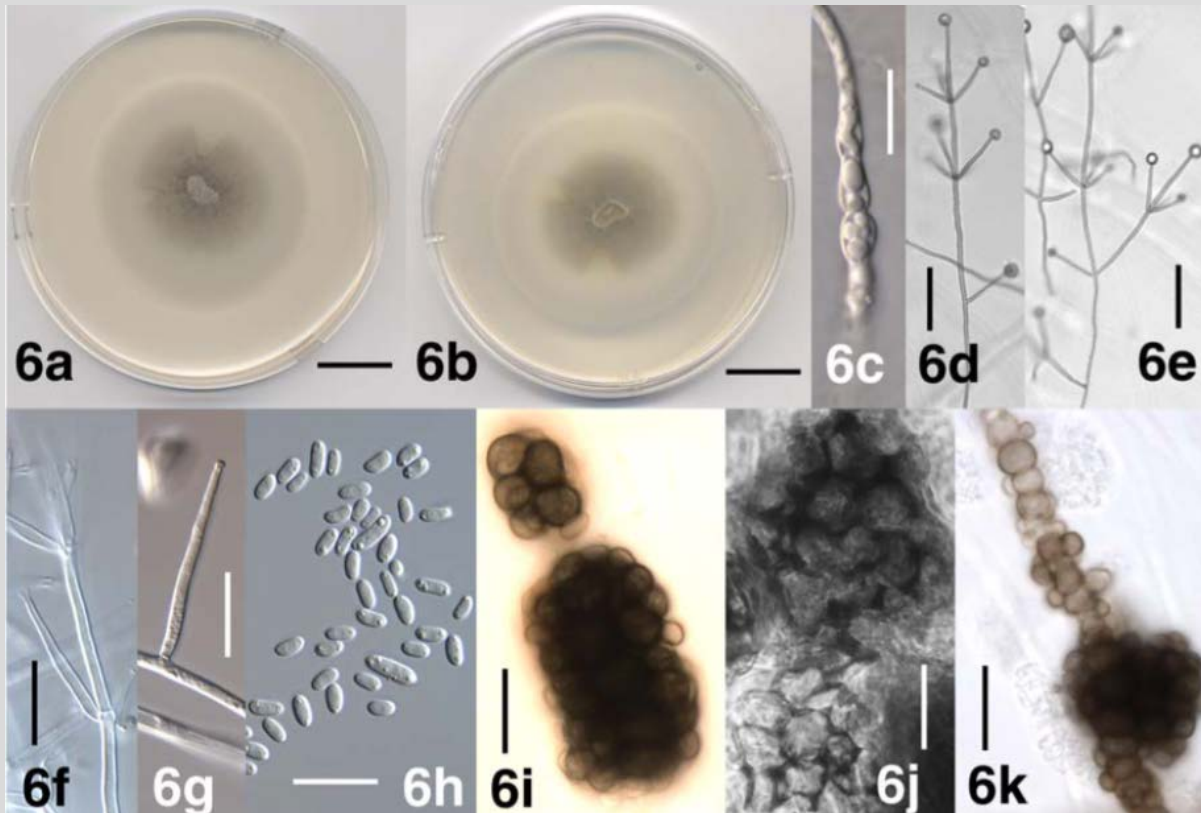
(Schall and Davis 2009, Snyder et al 2013, Snyder et al 2014, Rebbeck et al 2013)

# Disease symptoms

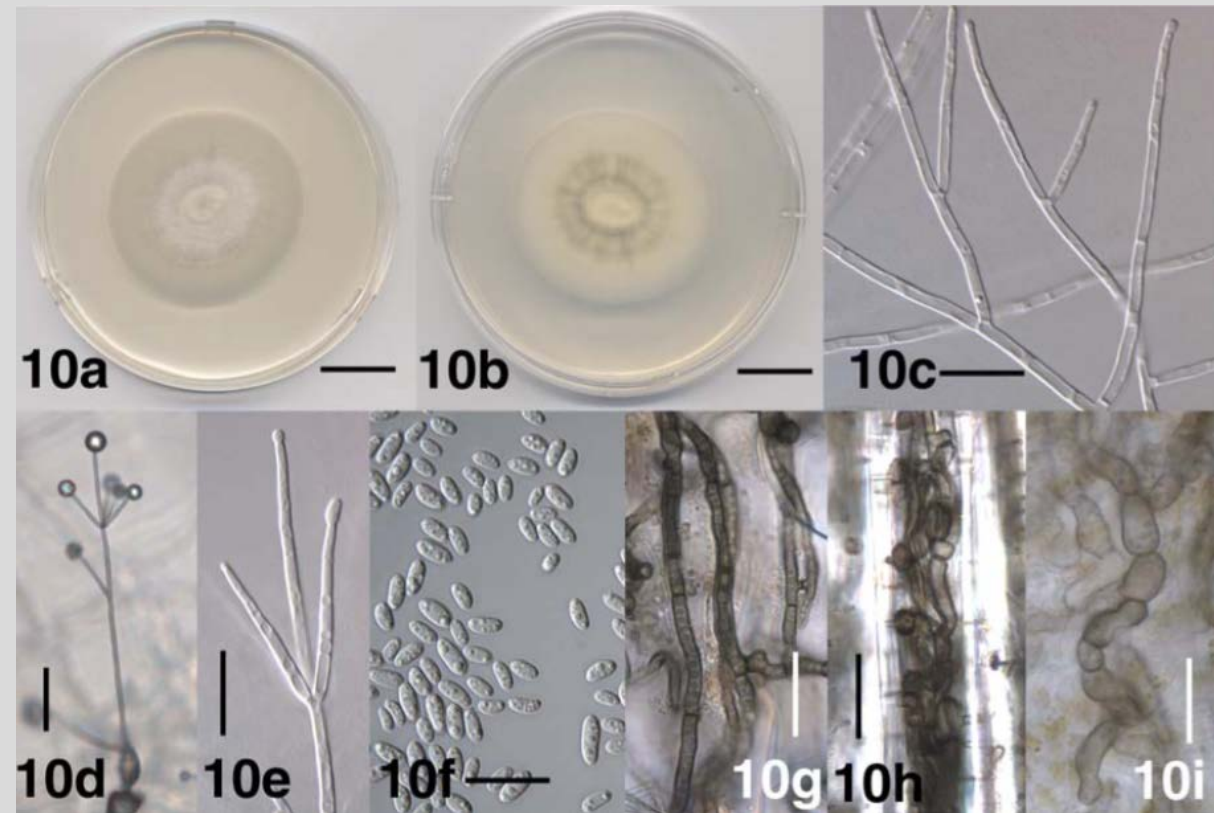


# Verticillium wilt disease

*Verticillium dahliae* (Vd)

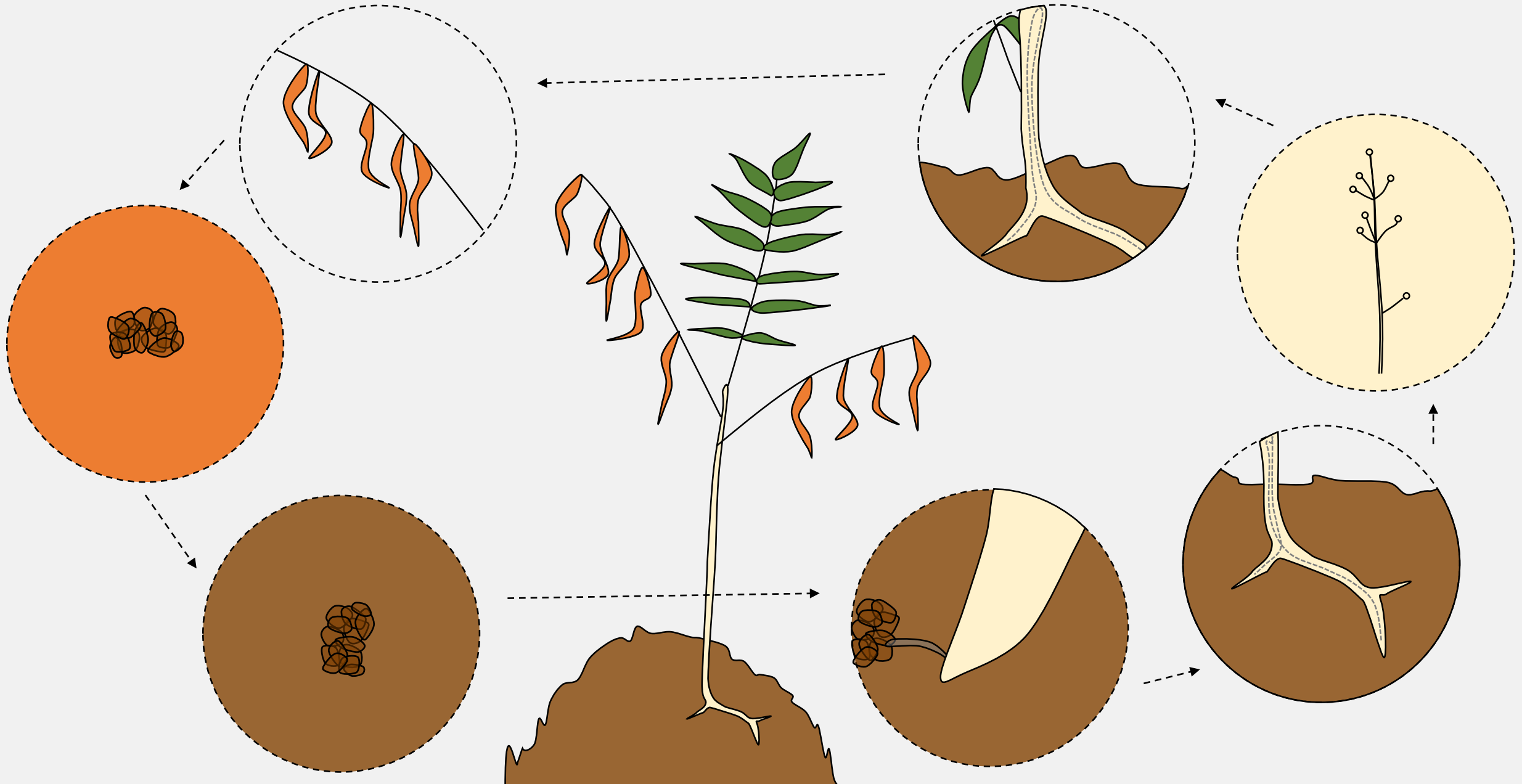


*Verticillium nonalfalfae* (Vn)



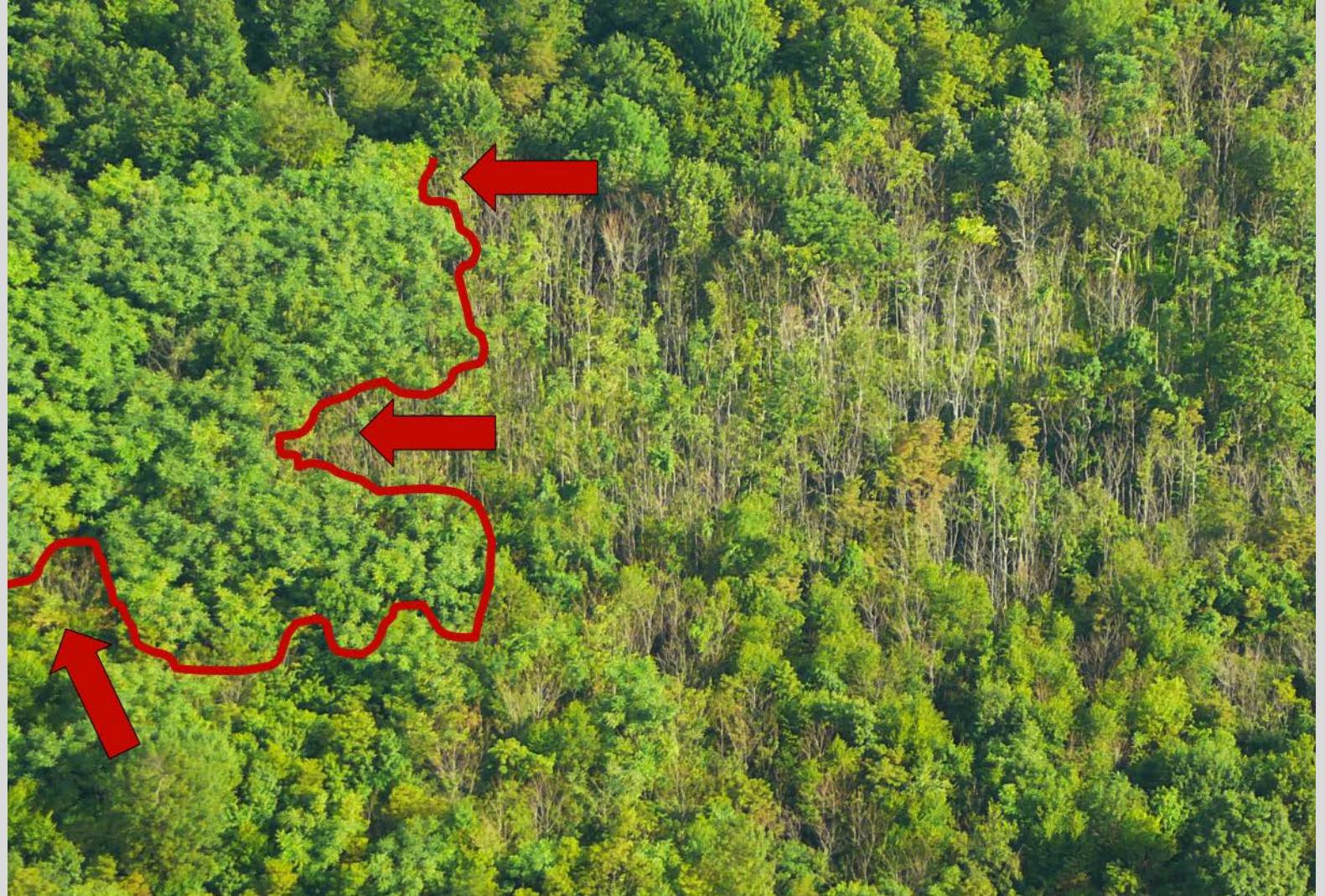


# Verticillium wilt disease cycle



# Studies in PA are promising!

- $V_n > V_d$
- Spreads through roots
- Host specific
- Inoculation is easy
- Inoculation can occur year round
- Effectively removes *Ailanthus* from a forest

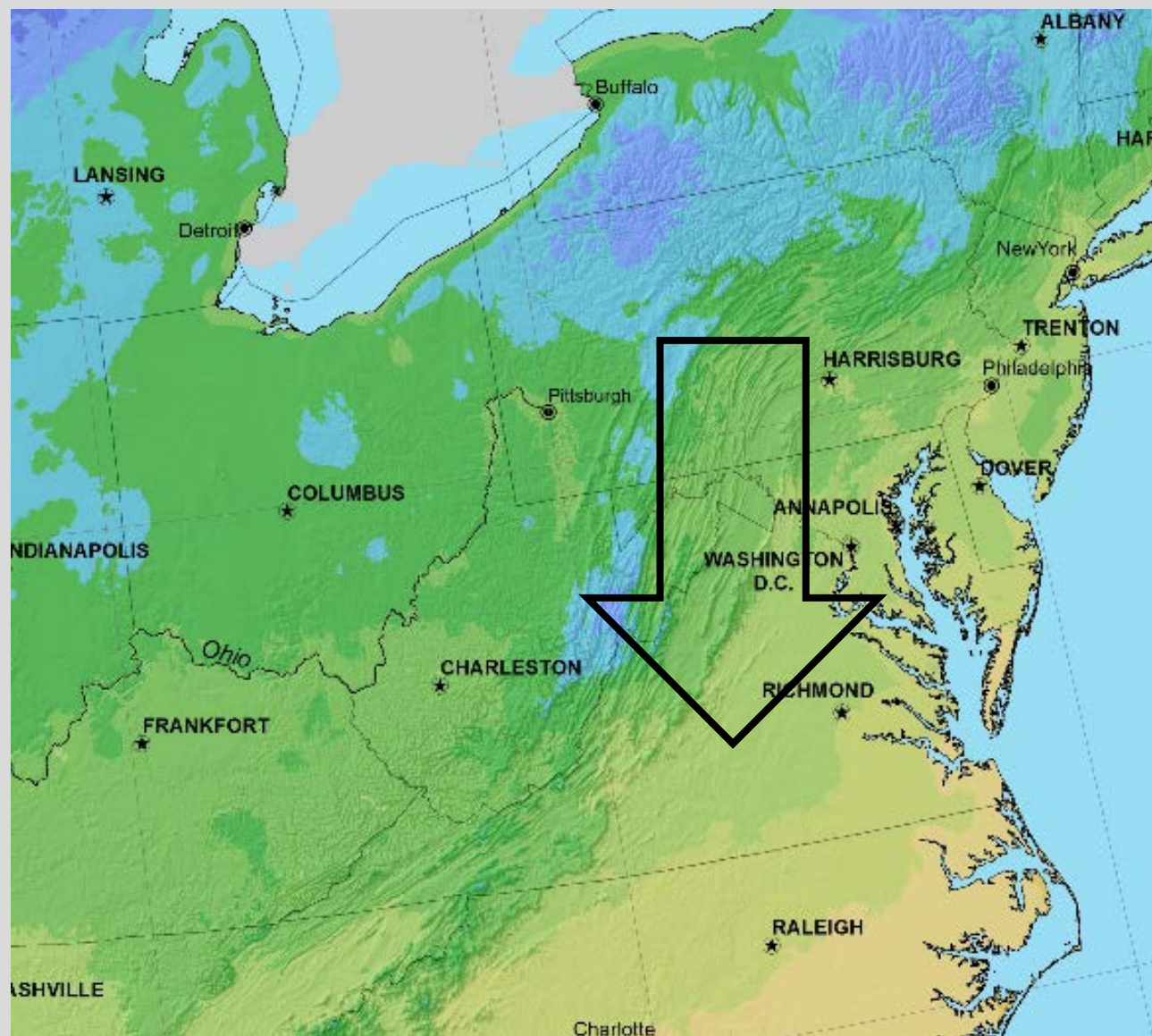


(Schall and Davis 2009, Kasson et al 2014, O'Neal and Davis 2015, Schall 2008)

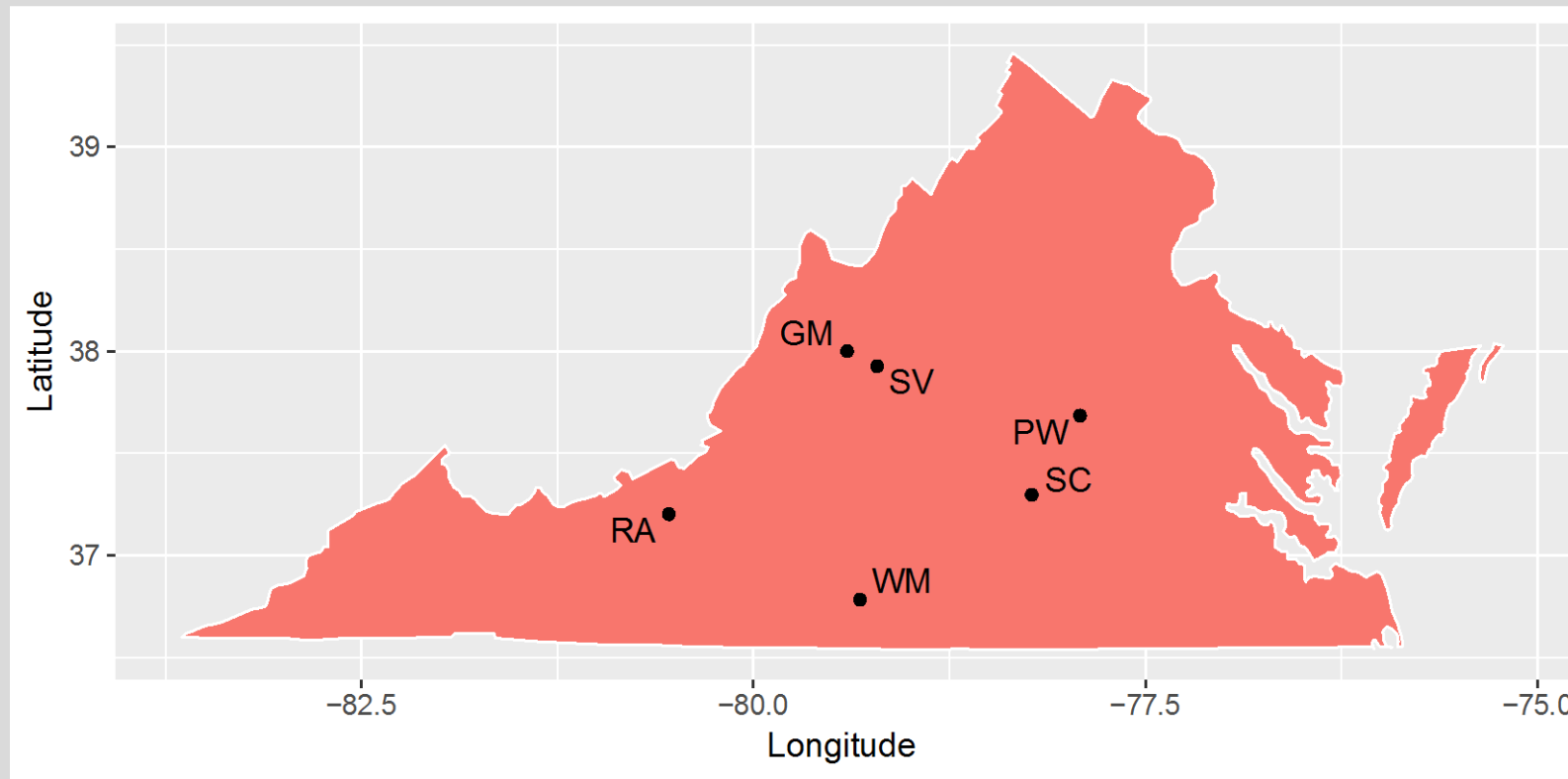
# My research: regional inoculations

Are *Verticillium* fungi effective biocontrol agents in Virginia?

Are there any variables that might limit their success?

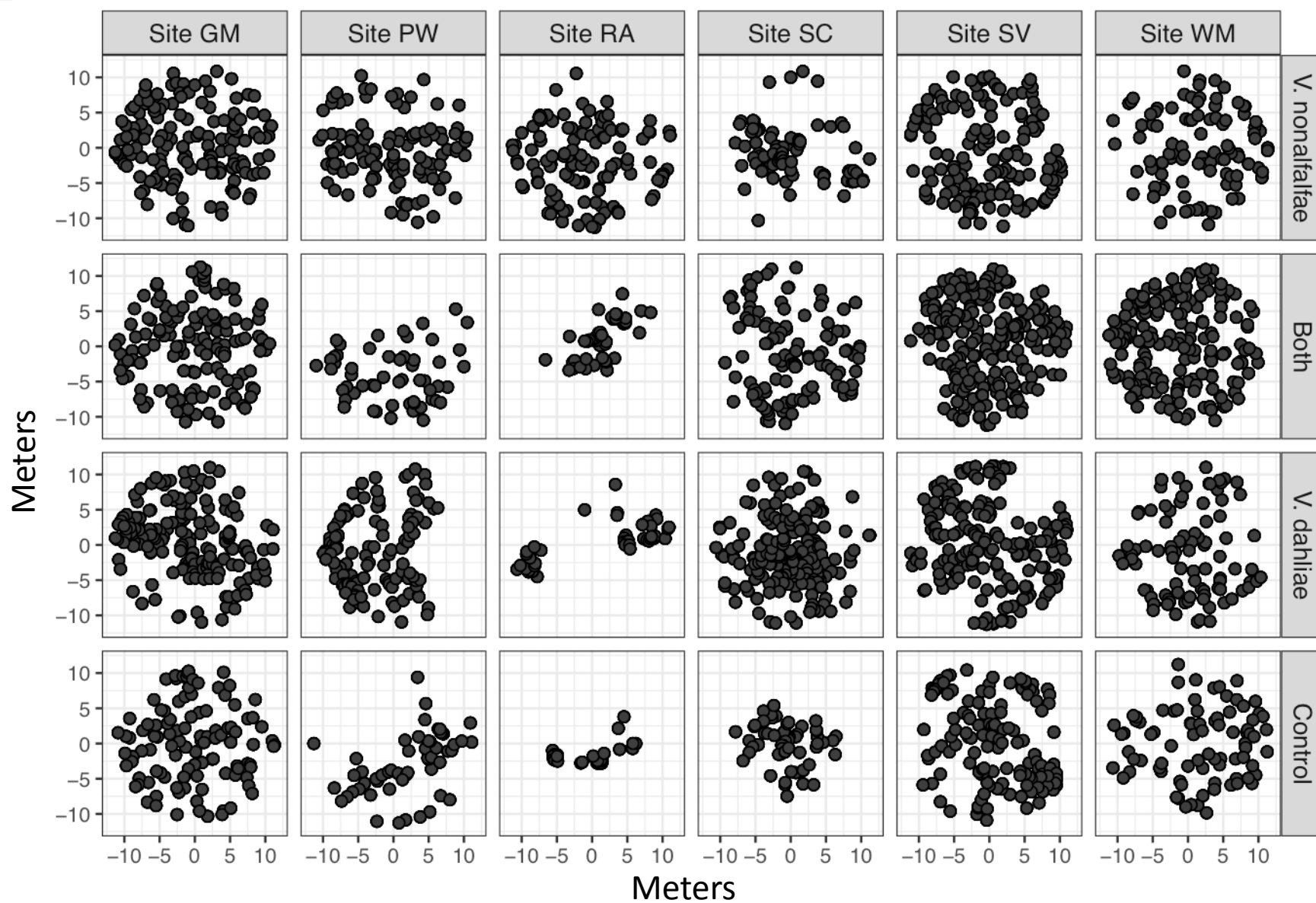


# VA specific sites

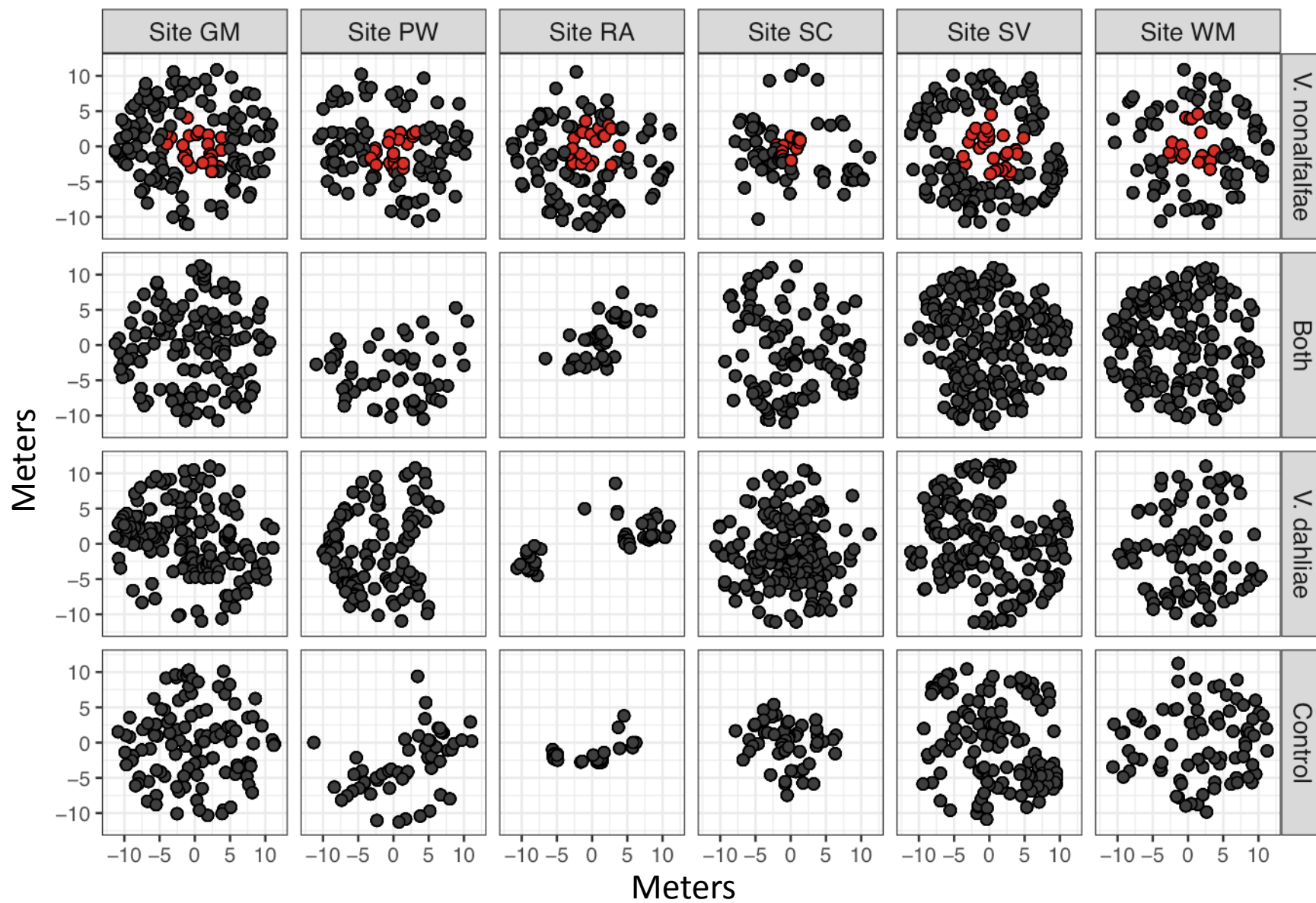


- Radford Army Ammunition Plant (RA)
- Little North Mountain WMA (GM)
  - McCormick Farm AREC (SV)
  - Powhatan State Park (PW)
- Sailor's Creek Battlefield State Park (SC)
- White Oak Mountain WMA (WM)

# Site layout

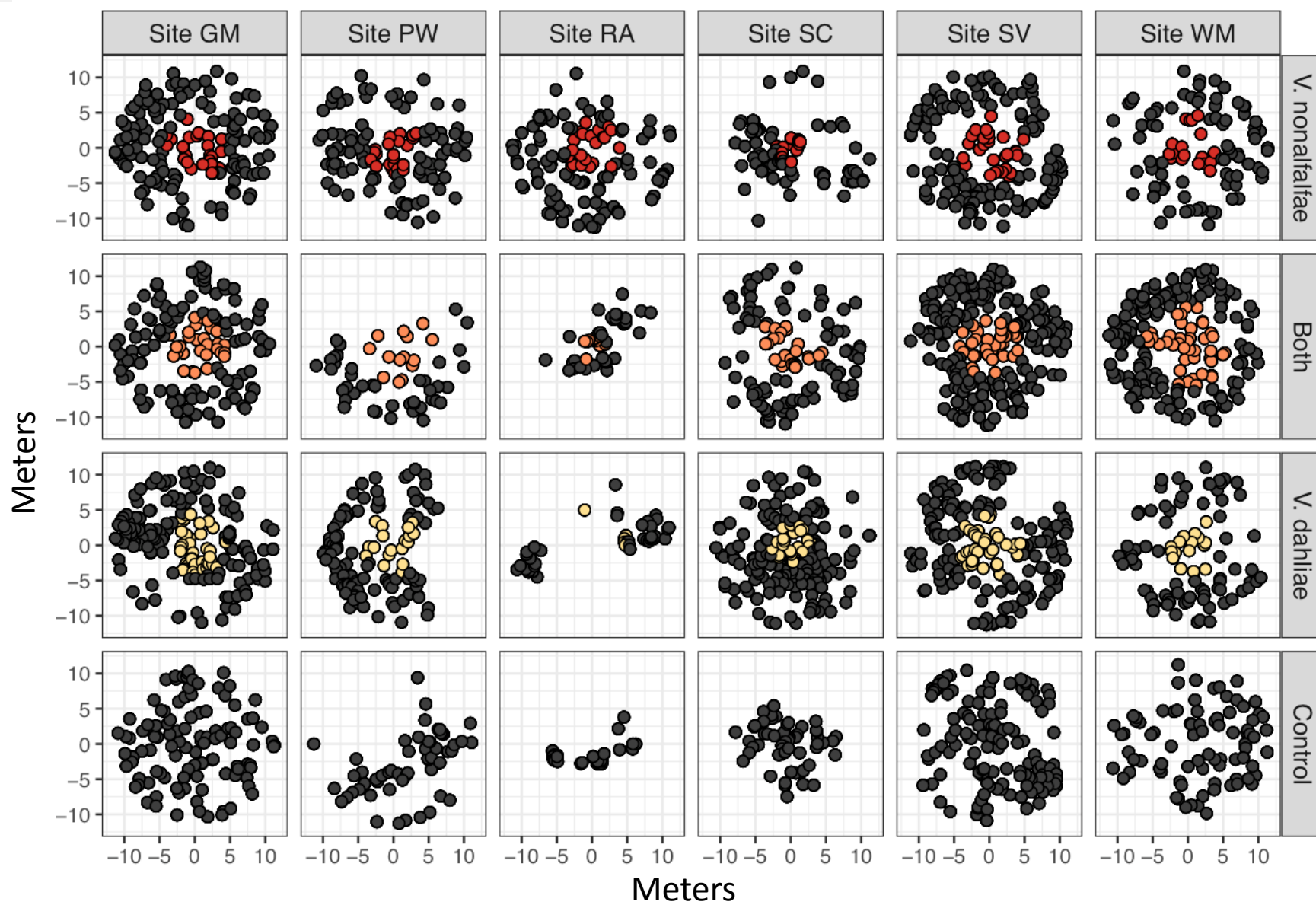


# Site layout



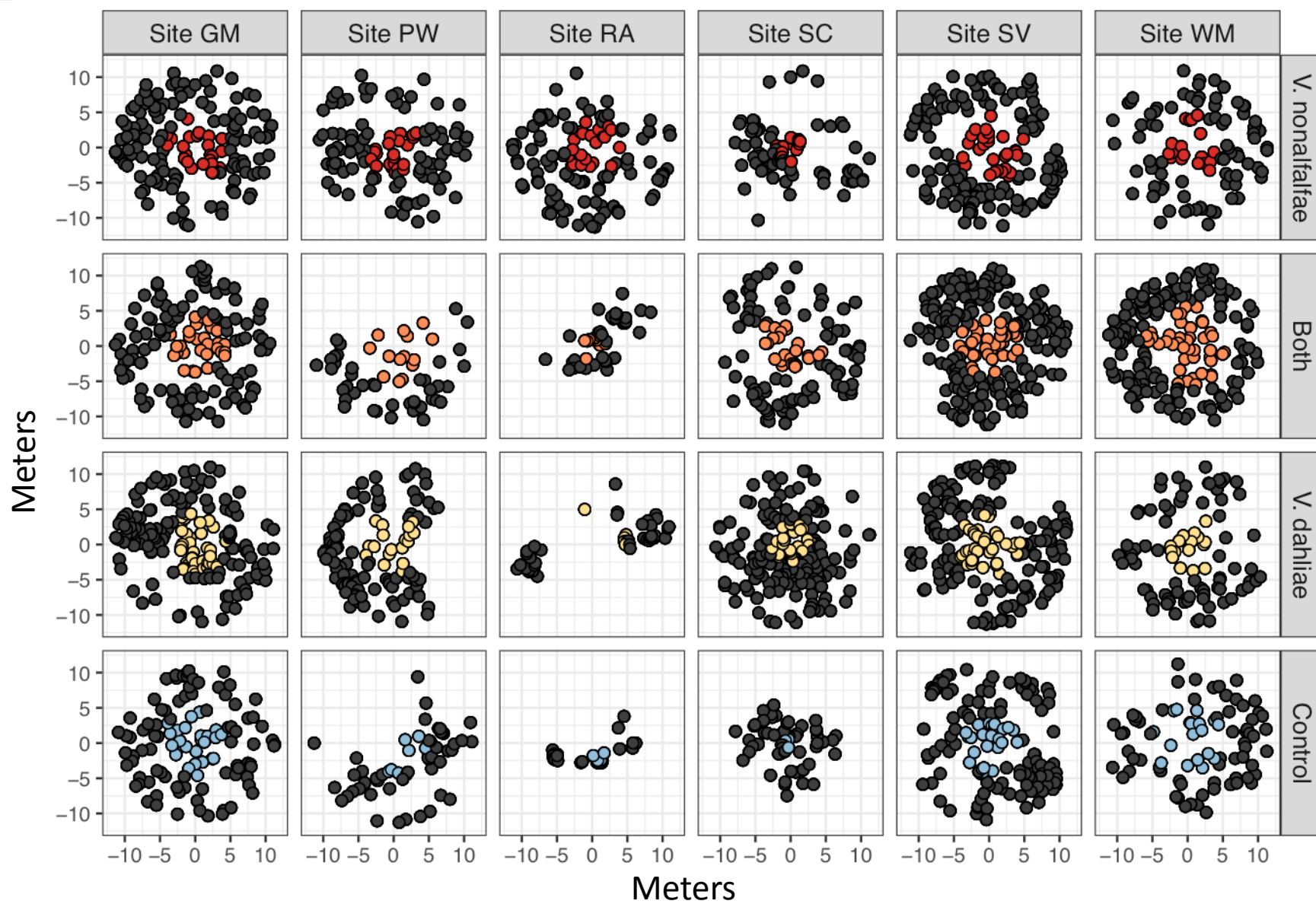


# Site layout

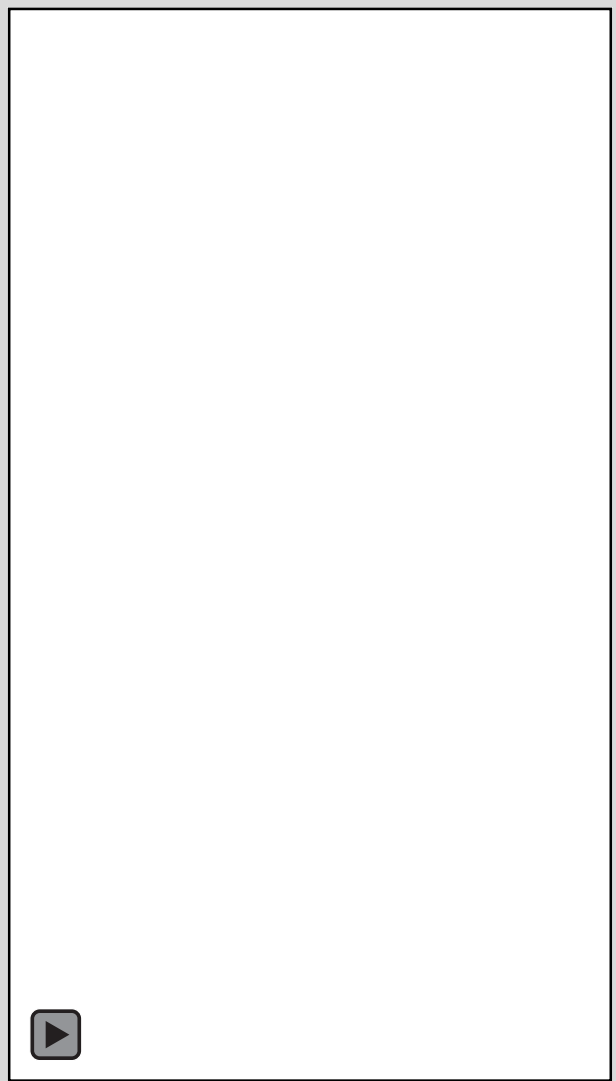
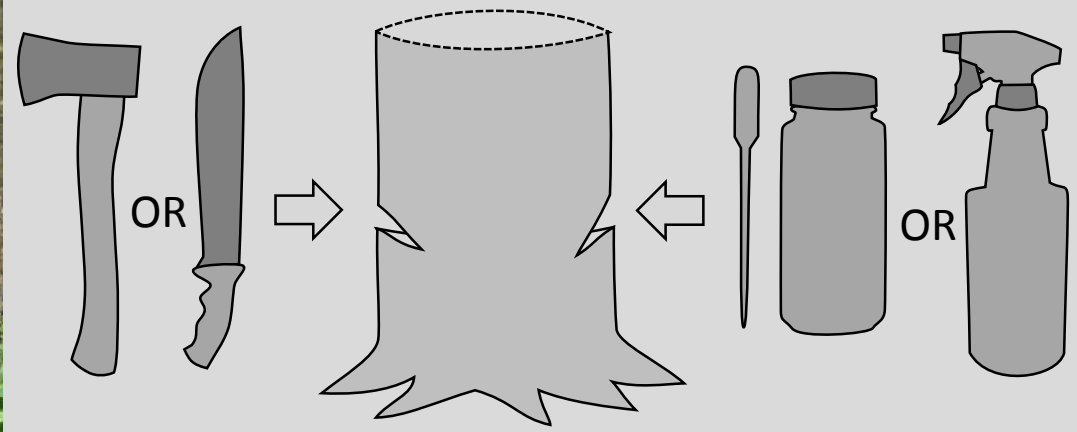




# Site layout



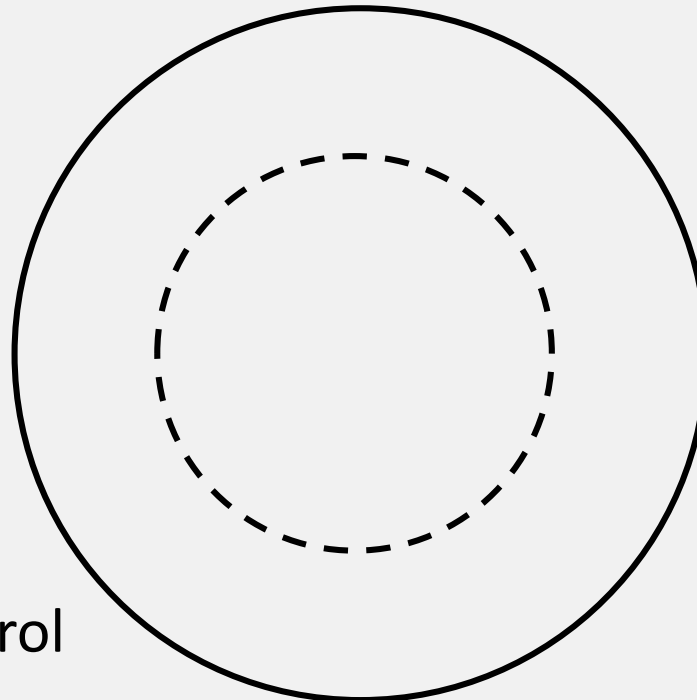
# Hack n squirt inoculation method



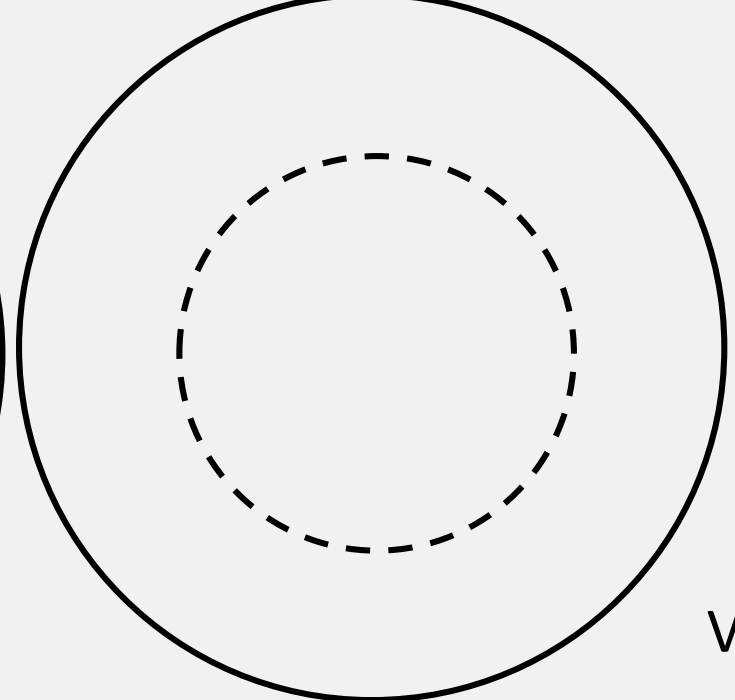
(Photo Courtesy of Wayne National Forest)

0  
Months Post  
Inoculation  
(May 2017)

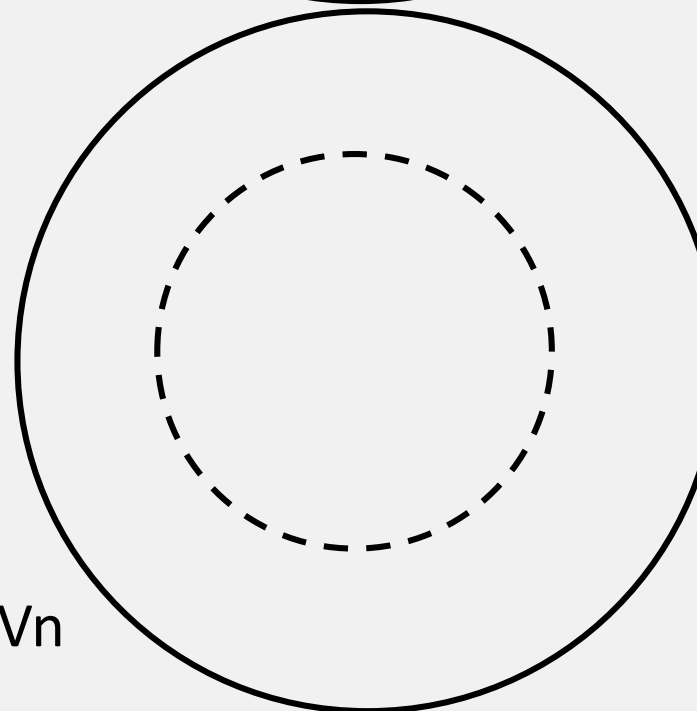
Control



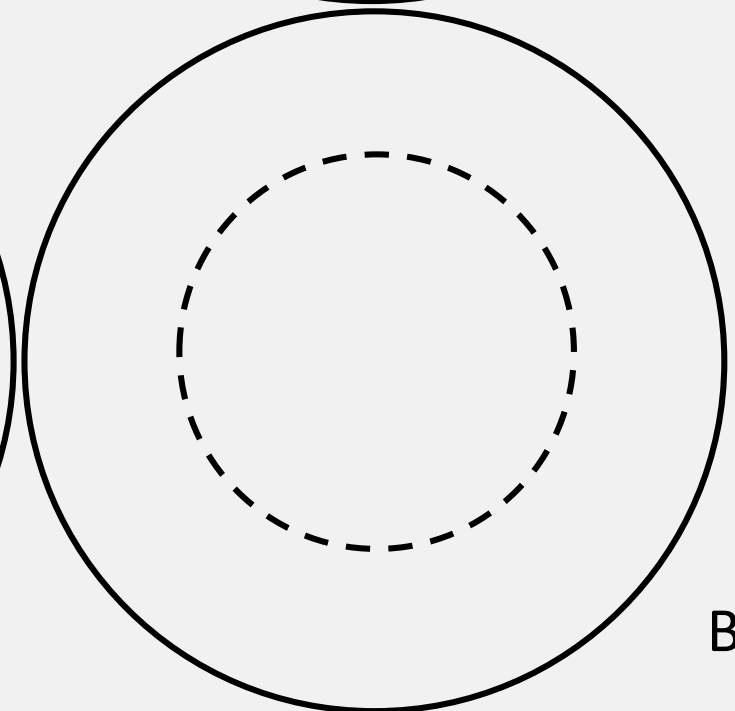
Vd



Vn

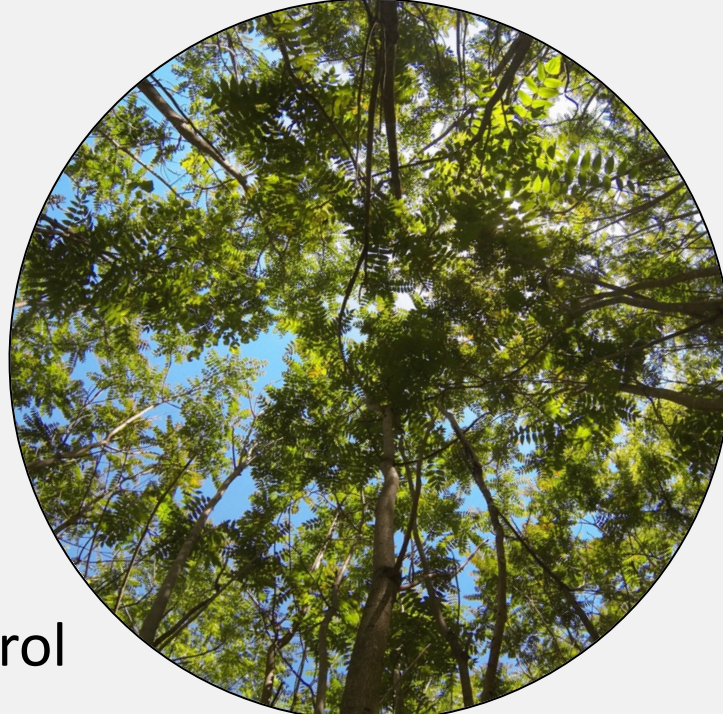


Both



0  
Months Post  
Inoculation  
(May 2017)

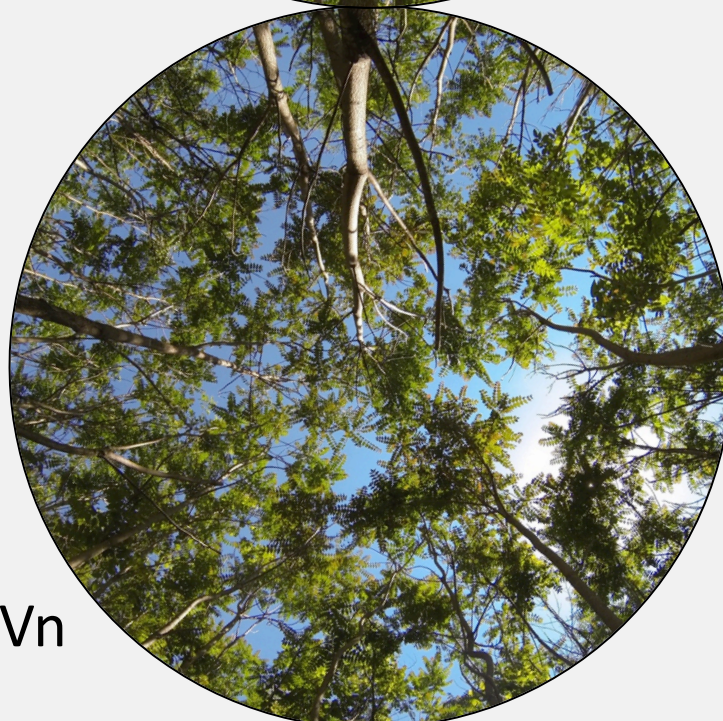
Control



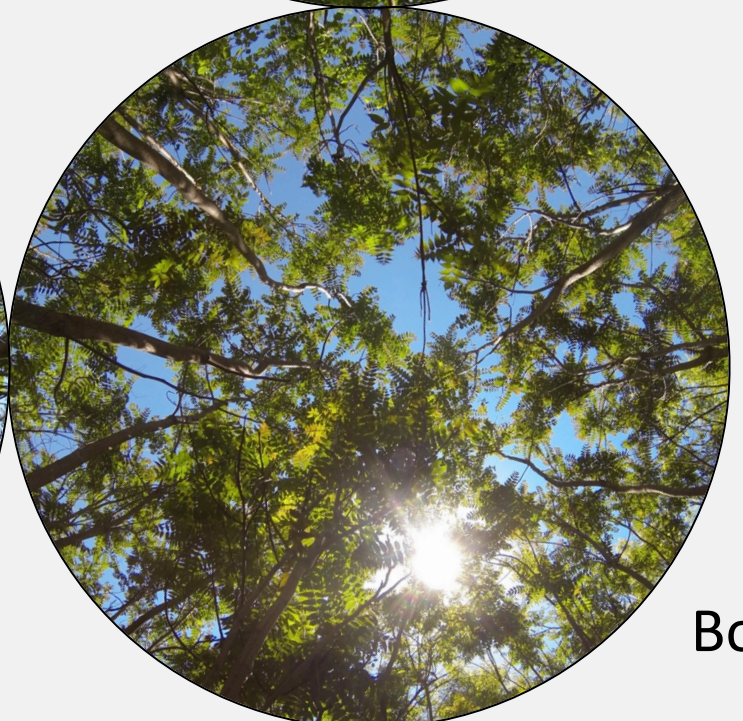
Vd



Vn

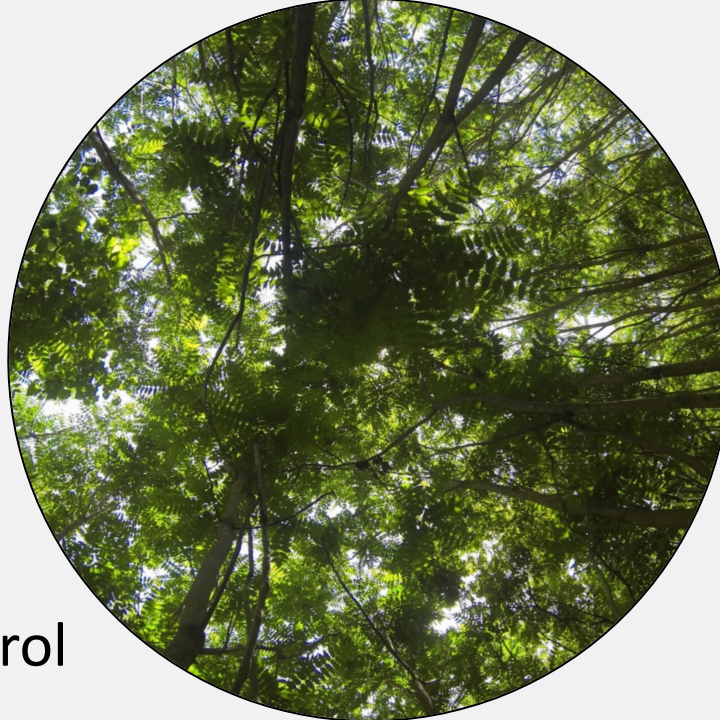


Both



1  
Months Post  
Inoculation  
(June 2017)

Control



Vd



Vn

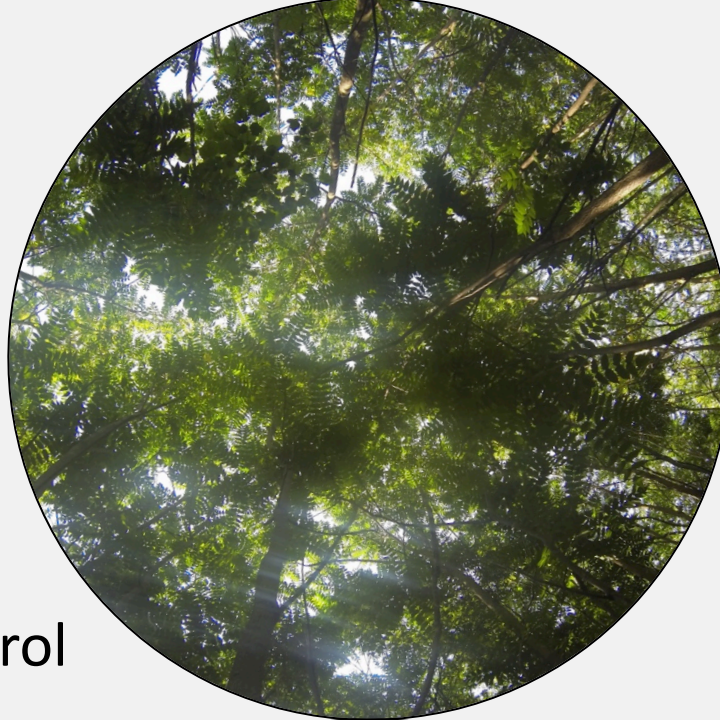


Both



2  
Months Post  
Inoculation  
(July 2017)

Control



Vd



Vn

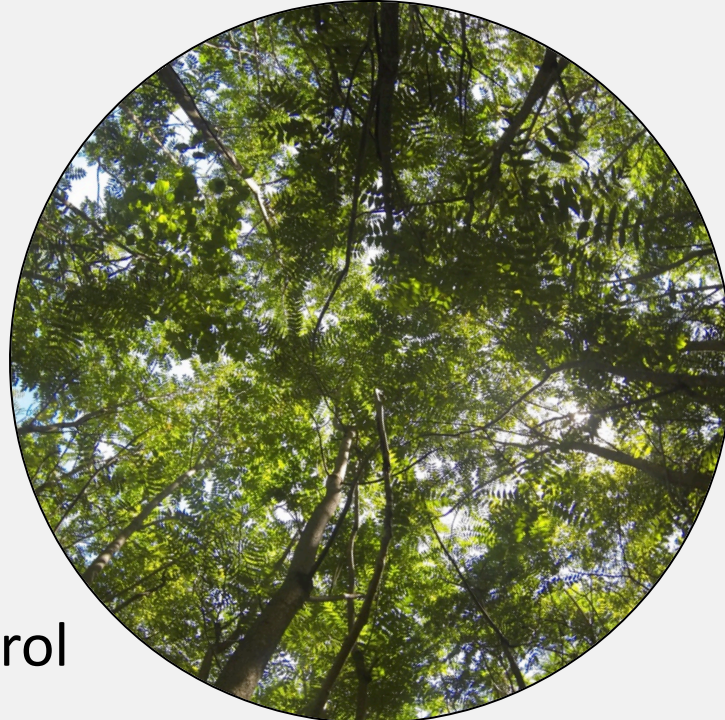


Both



3  
Months Post  
Inoculation  
(Aug 2017)

Control



Vd



Vn



Both



13  
Months Post  
Inoculation  
(June 2018)

Control



Vd



Vn

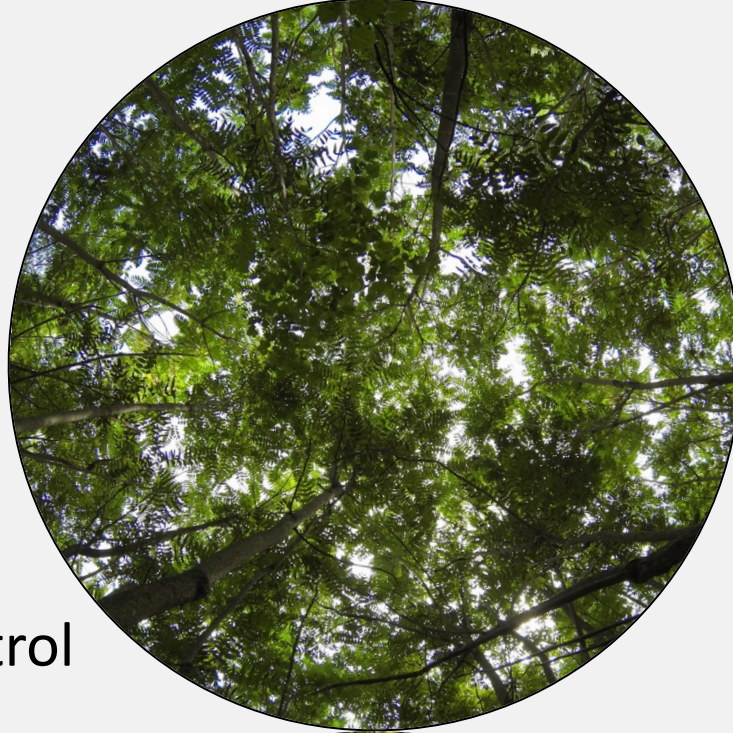
Both





15  
Months Post  
Inoculation  
(Aug 2018)

Control



Vd



Vn



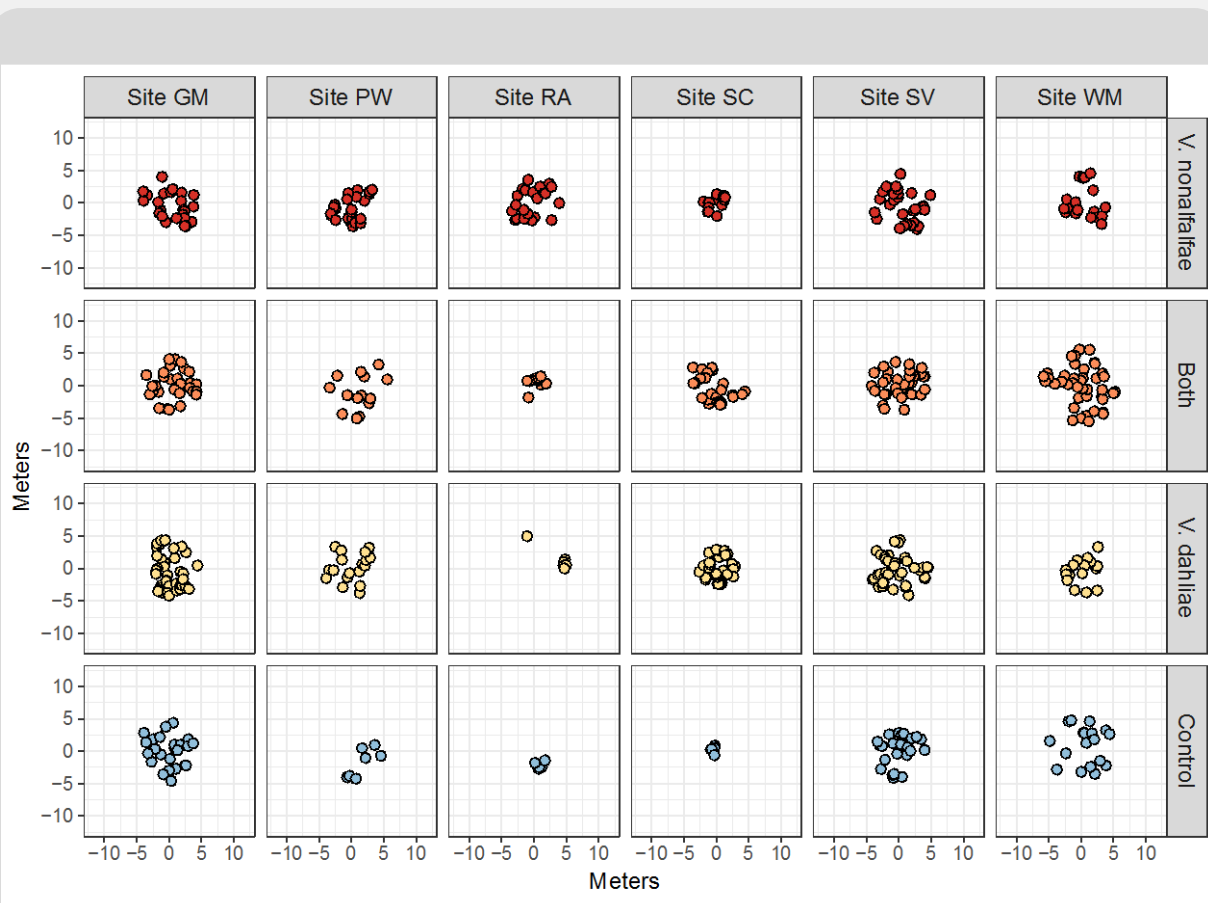
Both

From Above  
(14 months  
post  
inoculation)

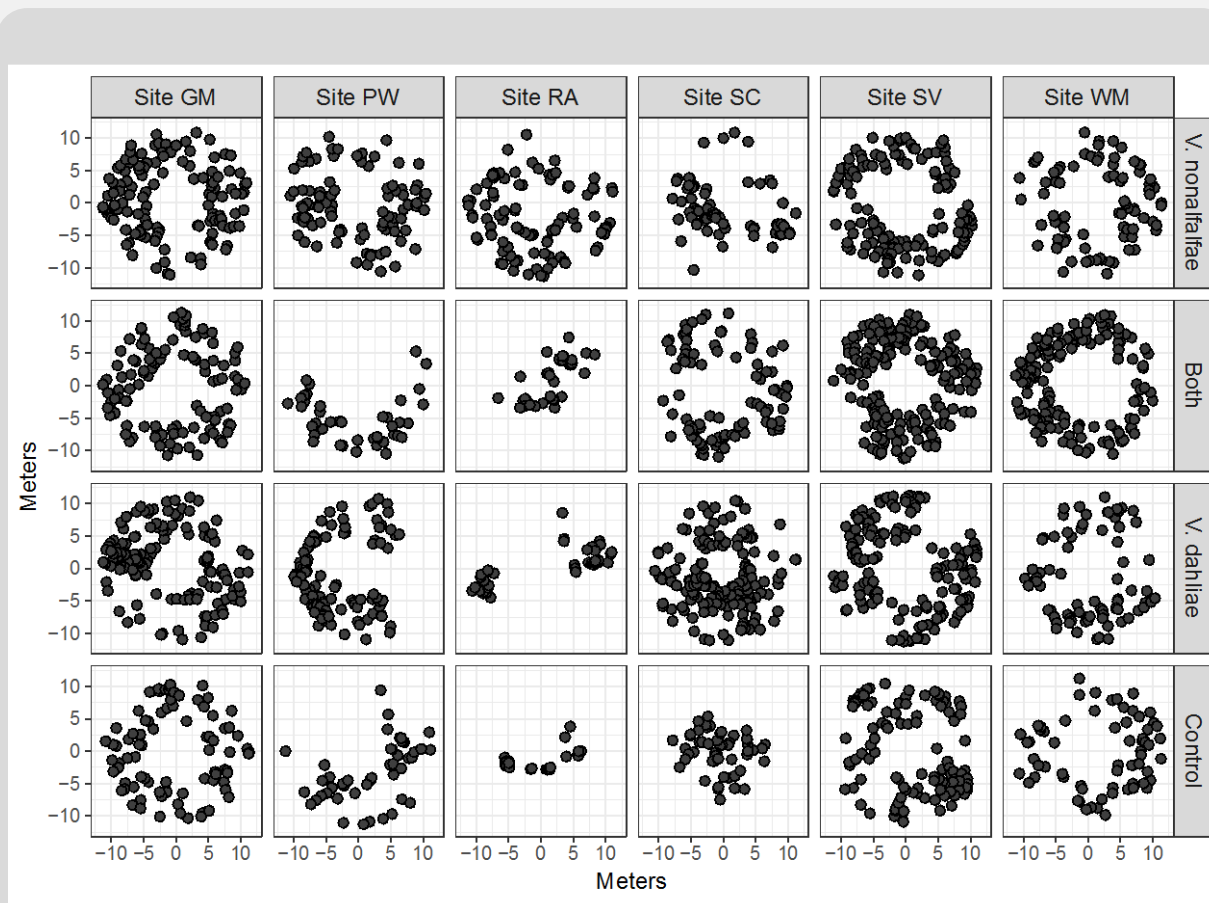


(Kevin Heffernan VA DCR)

# Preliminary results



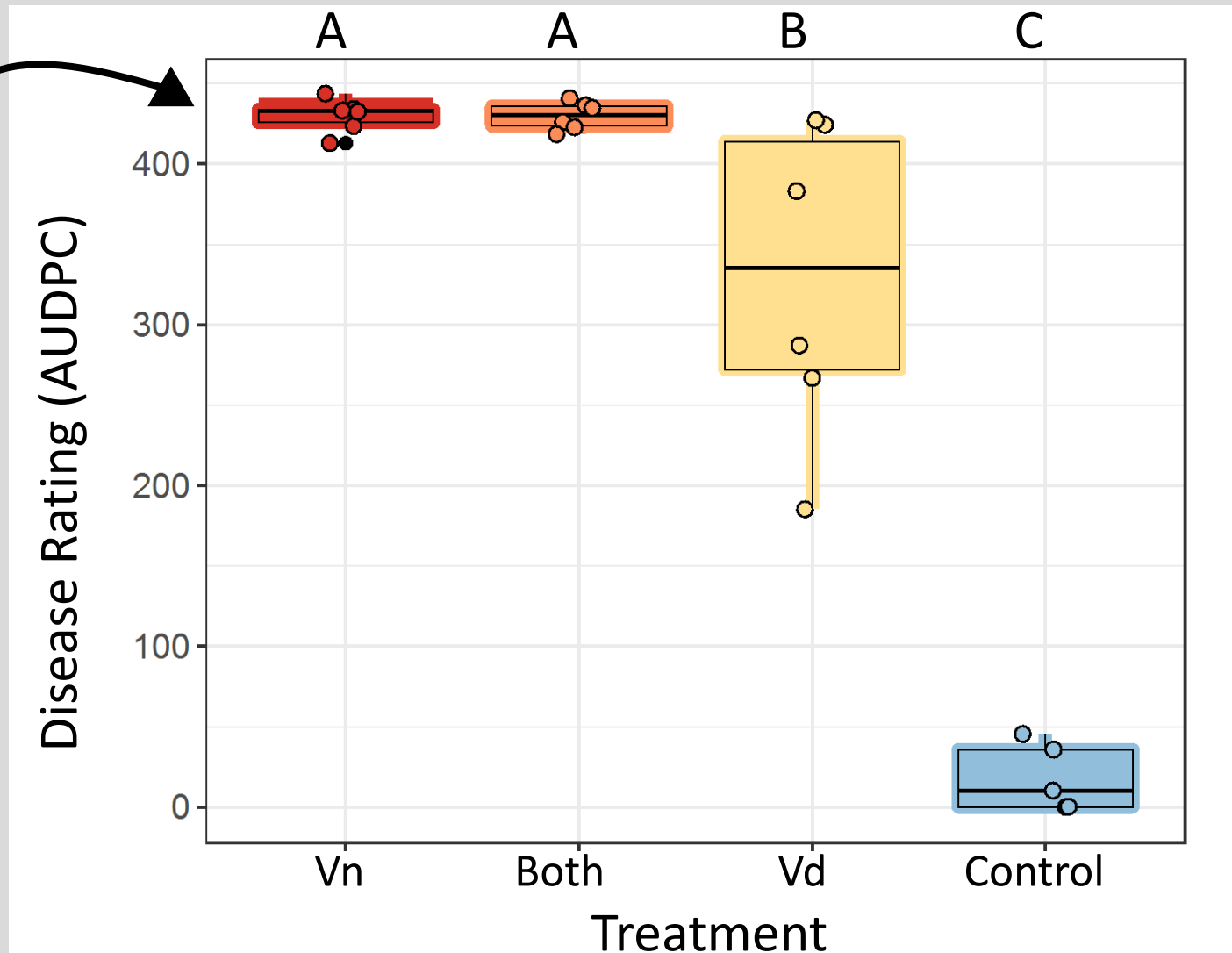
Which direct inoculation treatments are most effective?



Which treatments are effective at spreading (if any)?

# Which direct inoculation treatments are most effective?

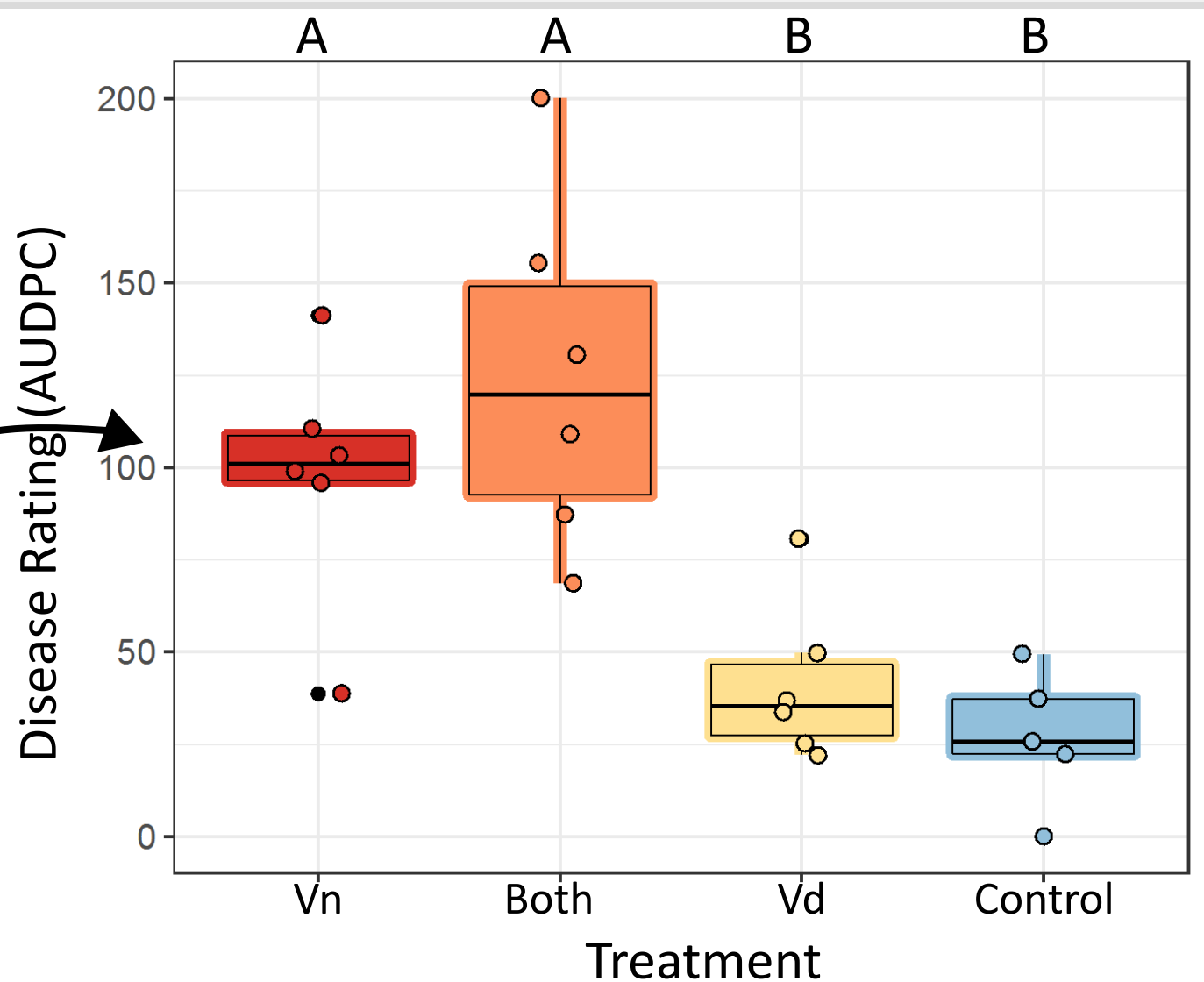
100% dead  
or dying!



Vn and Both treatments are the most effective!

AUDPC~treatment+site  
F(8,14)=32.64,p=0.0000009

# Which treatments are spreading (if any)?



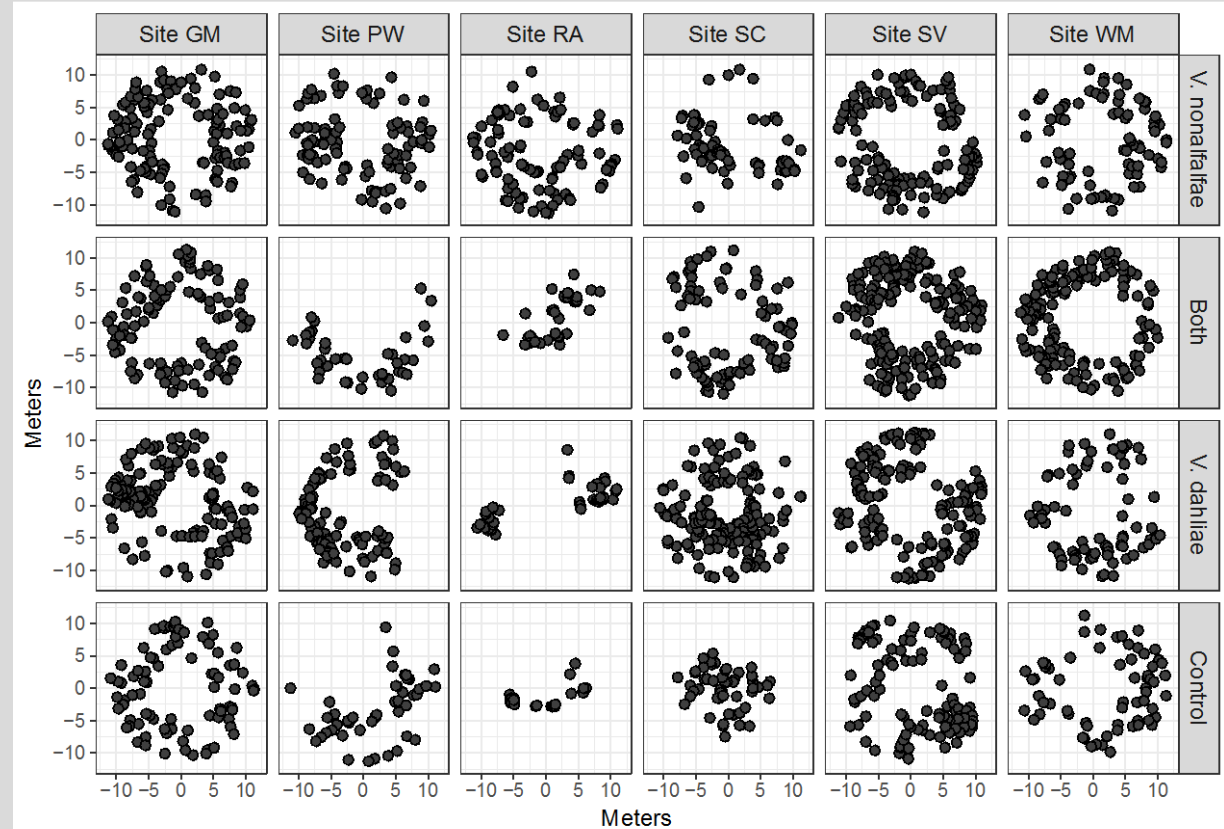
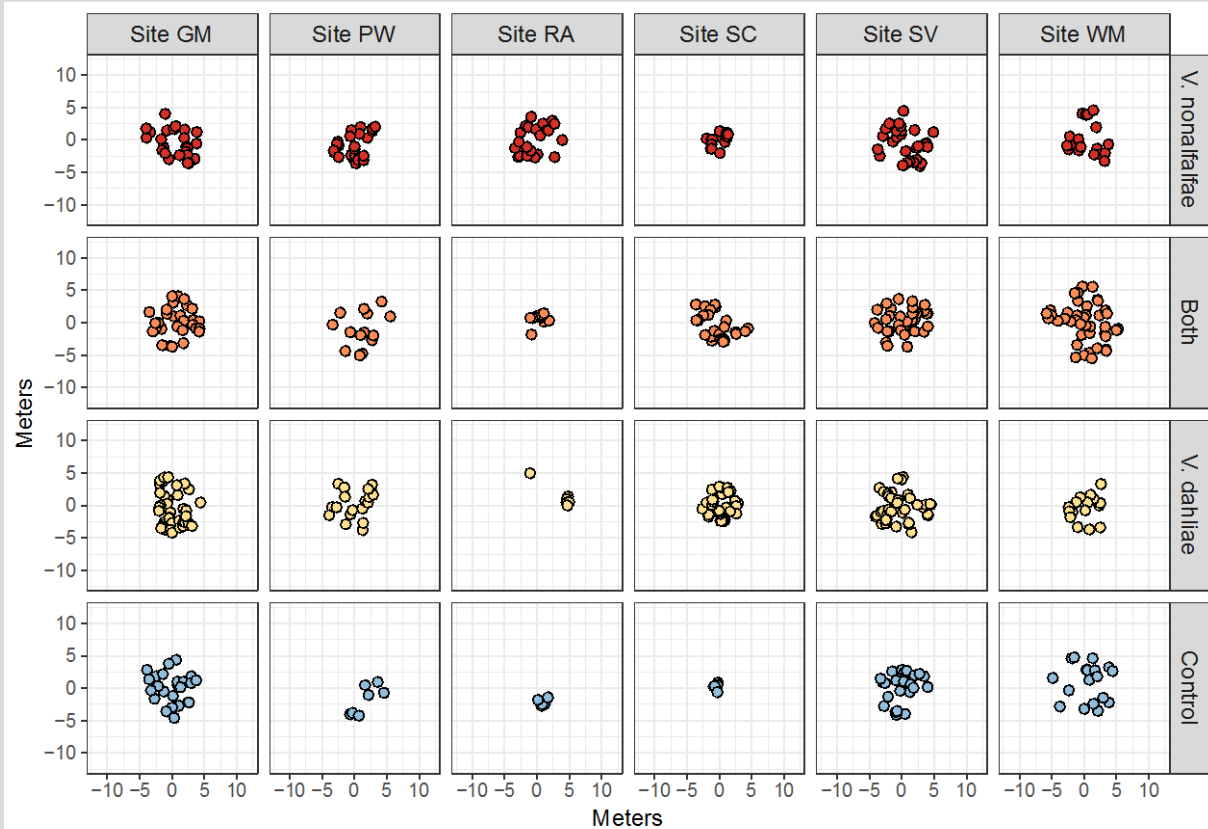
Vn and Both are both spreading!

AUDPC~treatment+site  
 $F(8,14)=4.797, p=0.005287$

~50% dead  
or dying!

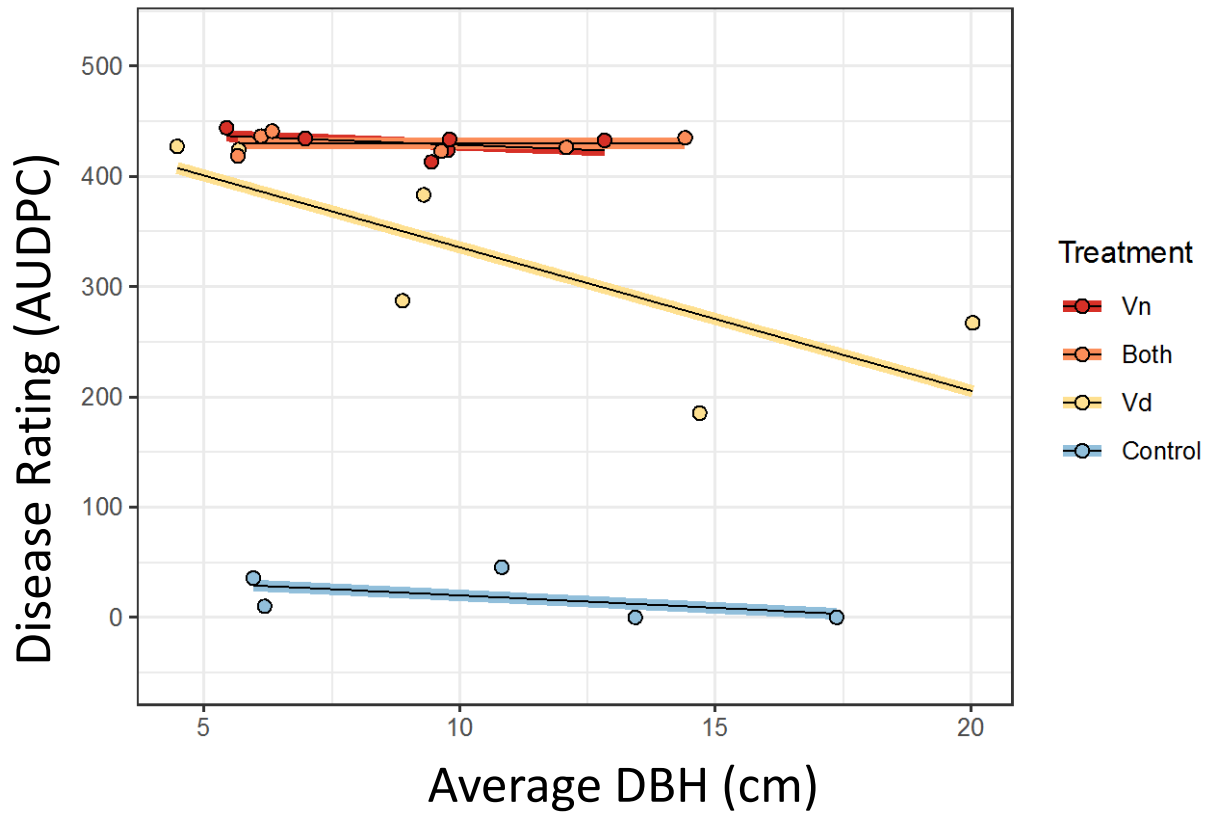
# Are there any variables that might limit this regionally?

- Stand: Average DBH (diameter at breast height)
- Temperature: Average temperature
- Moisture: Total rainfall



# DBH, temperature, or rainfall?

## Direct inoculations



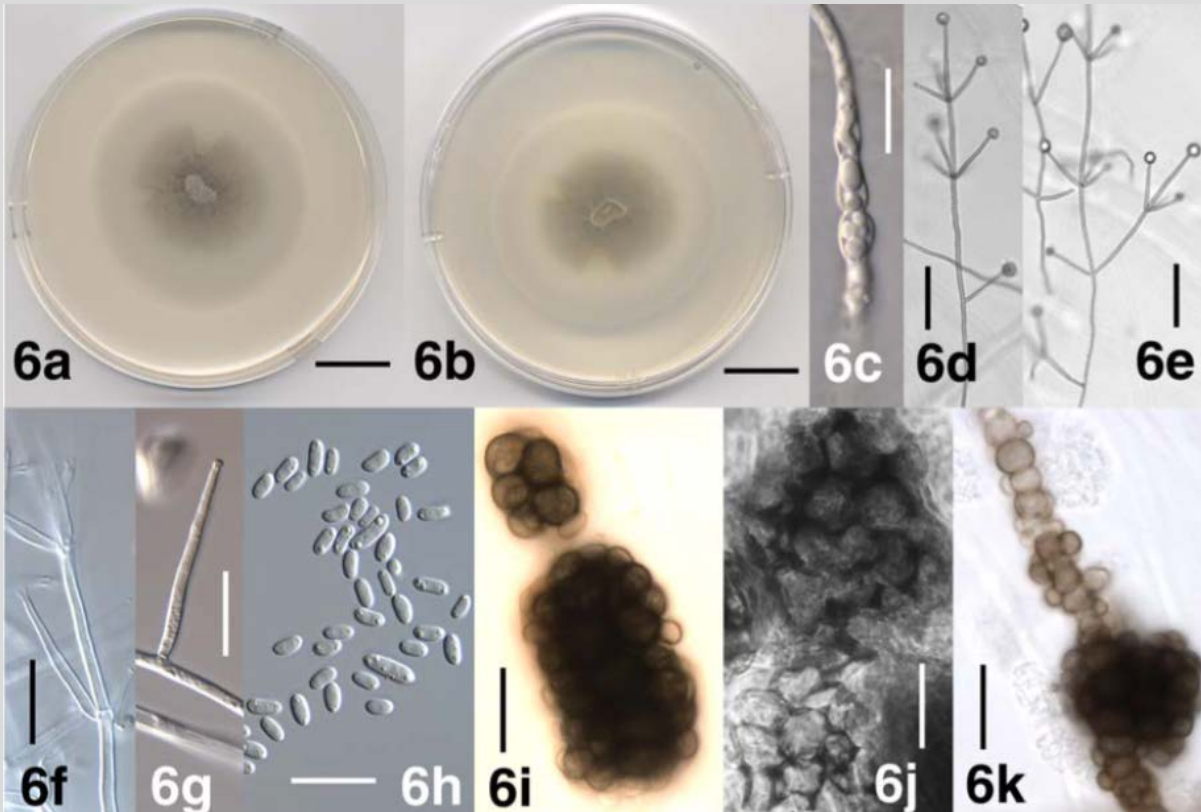
DBH *may* slow down disease progression

## Spread

No variables play a significant role in disease spread!

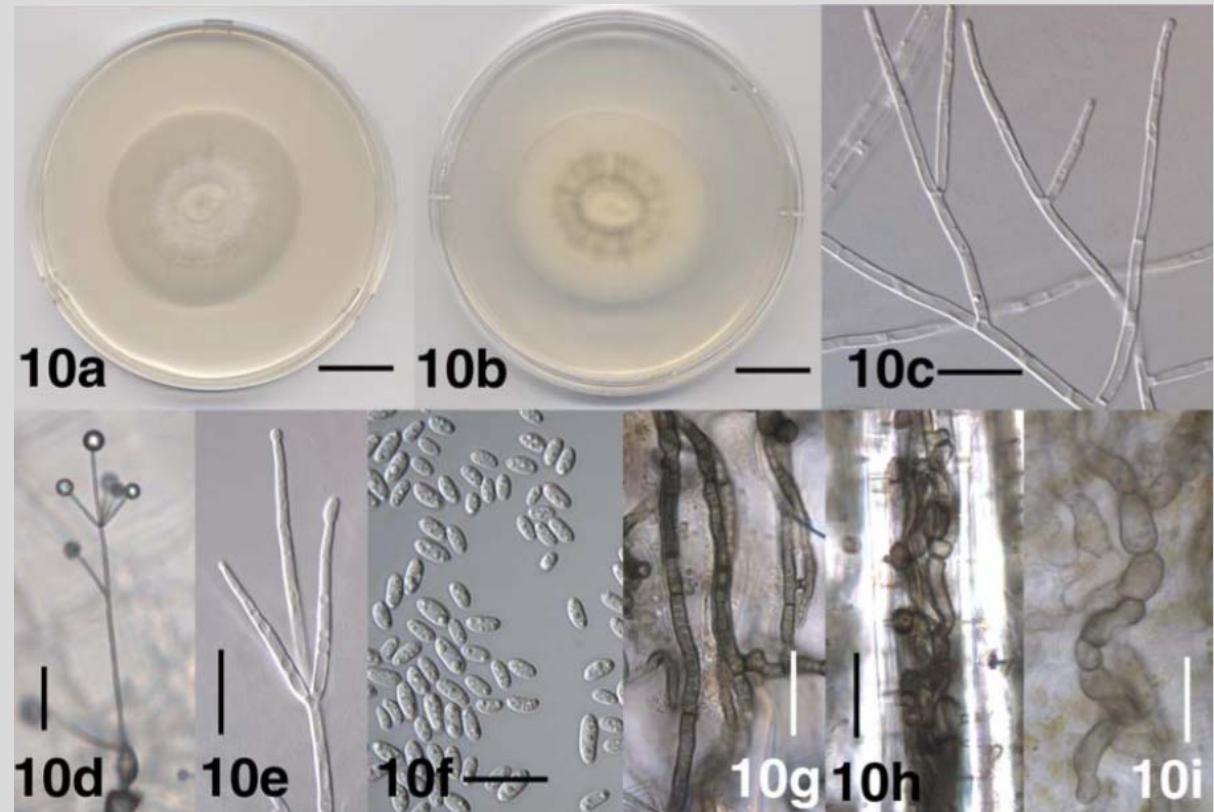
# What is “both” treatment?

*Verticillium dahliae* (Vd)



3%

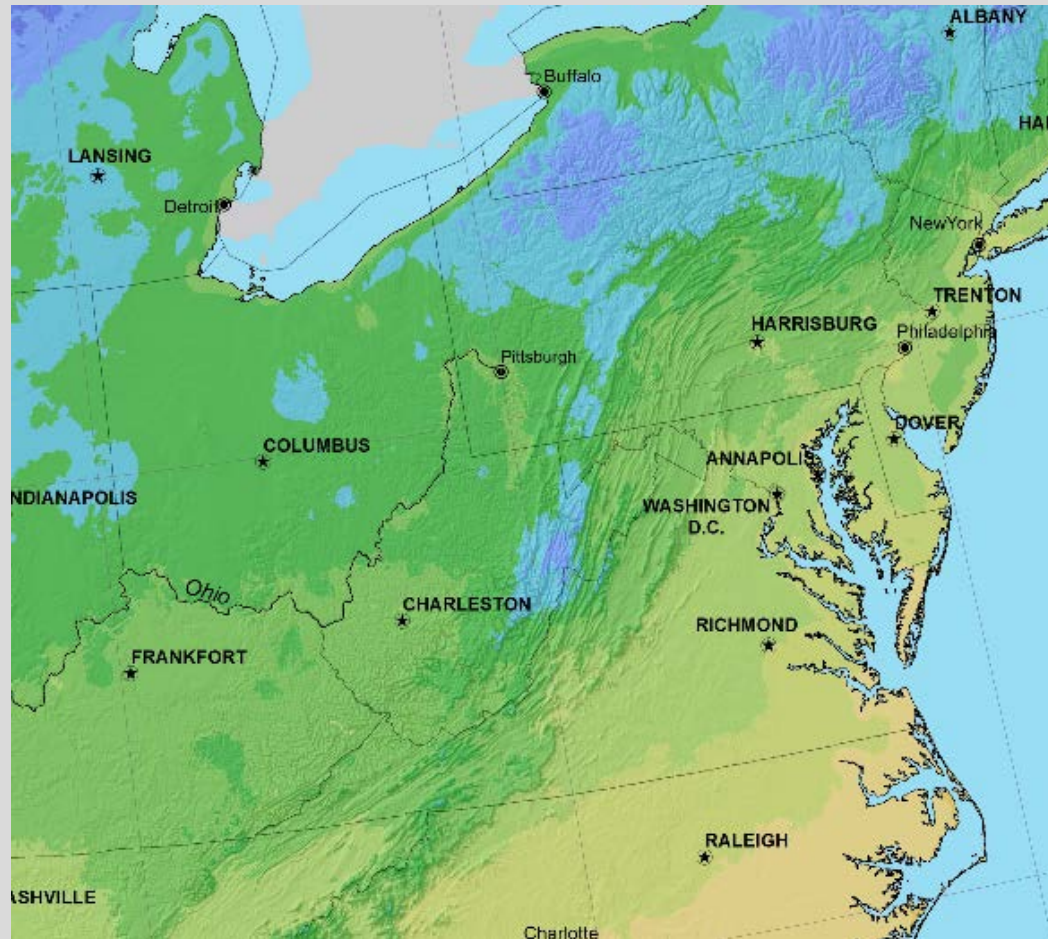
*Verticillium nonalfalfae* (Vn)



97%



# Preliminary results are promising!



Vn appears ideal with no indication it wouldn't be effective regionally!  
(1 more field season left)

# Vn biocontrol next steps



Environmental Topics

Laws & Regulations

About EPA

Search EPA.gov



CONTACT US

SHARE



## Pesticide Registration

### Requirements

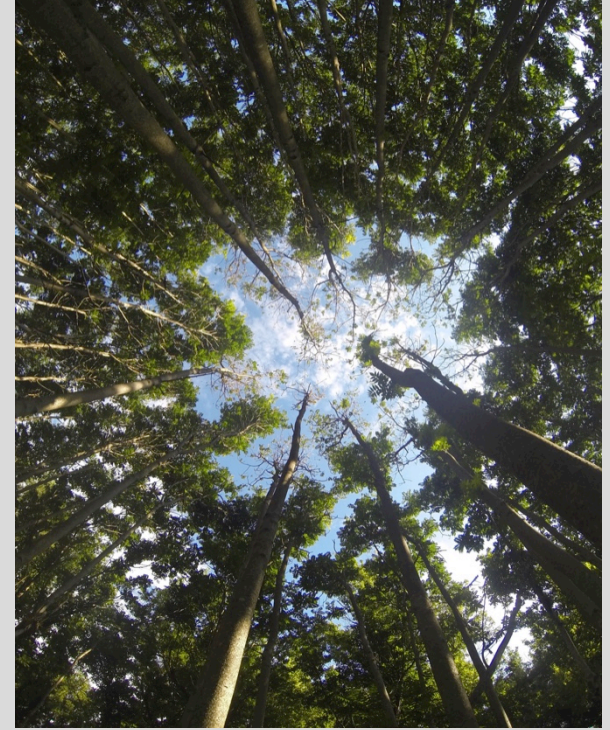
#### Requirements for All Applicants

- [Overview of Requirements for Pesticide Registration and Registrant Obligations](#)
- [Data Requirements](#)
- [Labeling](#)
- [Forms](#)

#### Additional Requirements for **Biopesticides**

- [Additional Considerations for Biopesticide Products](#) (Chapter 3 of the Pesticide Registration Manual)

# Acknowledgements

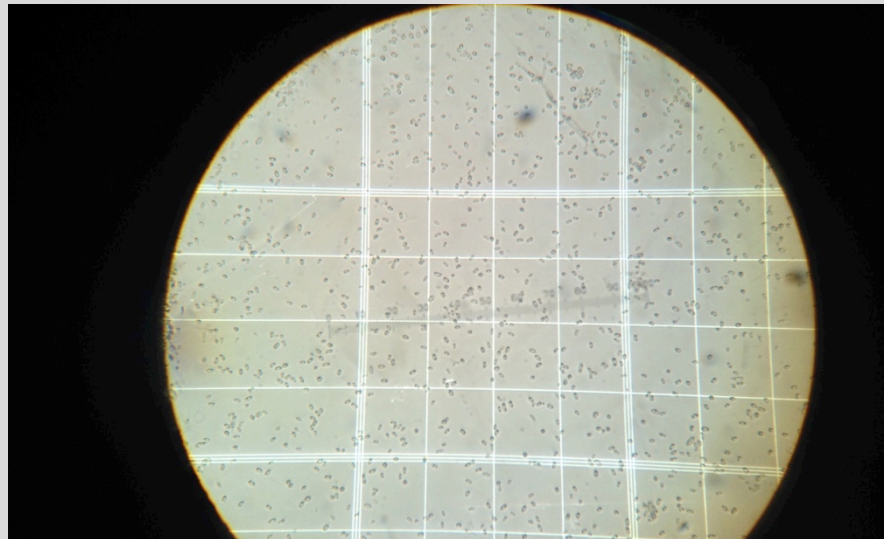
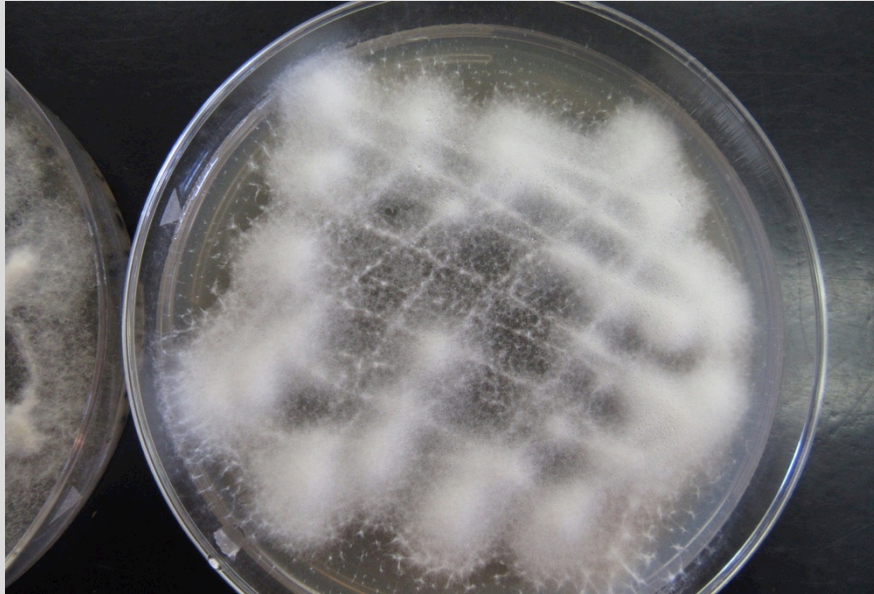


- Committee: Scott Salom, Anton Baudoin, Matt Kasson, & Jacob Barney
- Field help: Tom McAvoy, Lainey Metz, Caleb Gore, Ryan Mays, Jamie Buttler, Andrew Dechaine, Jeremiah Foley, Holly Wantuch, & Max Ragozzino
  - Funding: US Forest Service Grant 15-CA-11420004-161
- Field Sites: Virginia State Parks & Wildlife Management Areas, Shenandoah Valley AREC, Radford Army Ammunition Plant  
Contact info: [rkbrooks@vt.edu](mailto:rkbrooks@vt.edu)

# Registration Process

- Goal: registration as a minor use pesticide
- USFS taking lead
  - Cooperative agreement with Dr. Charu
  - APHIS has approved a quarantine permit to import *V. nonalfalfae* into the ARS lab
  - Sylvan Bioproducts, PA has expressed interest in producing fungal inoculum
  - Obtained APHIS funds for additional host-range testing
  - Prelim agreement developed with the EPA in 2018
  - Est. ~3+ years until potential registration

# Inoculum preparation

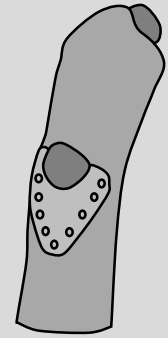
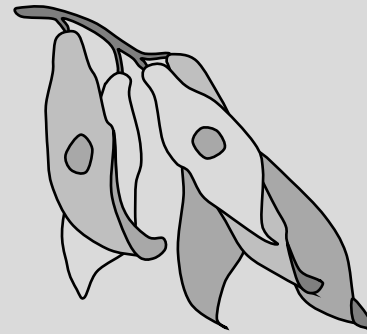
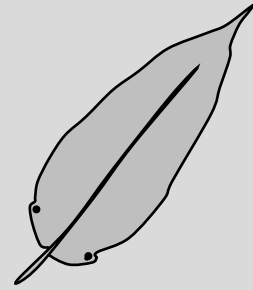
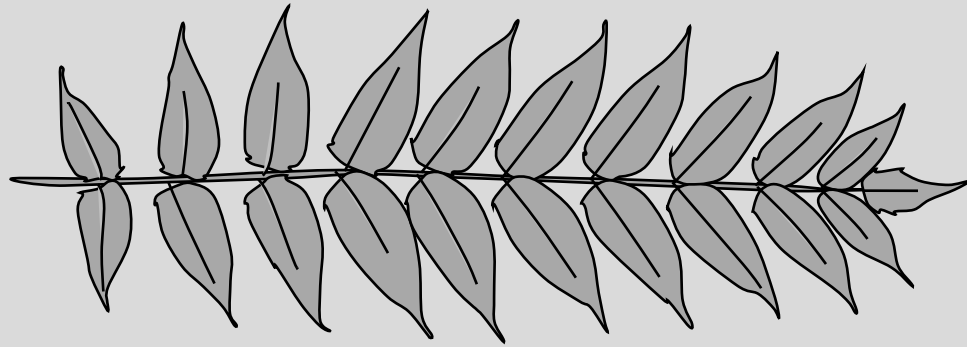


# *Agrilus smaragdignifrons*



(Hoebeke 2017, Photos: R. Rieder NJ Dept of Ag)

# *Ailanthus altissima* (tree of heaven)





# Biological vs chemical control

	<b>Biological Control</b>	<b>Chemical Control</b>
--	---------------------------	-------------------------

--	--	--

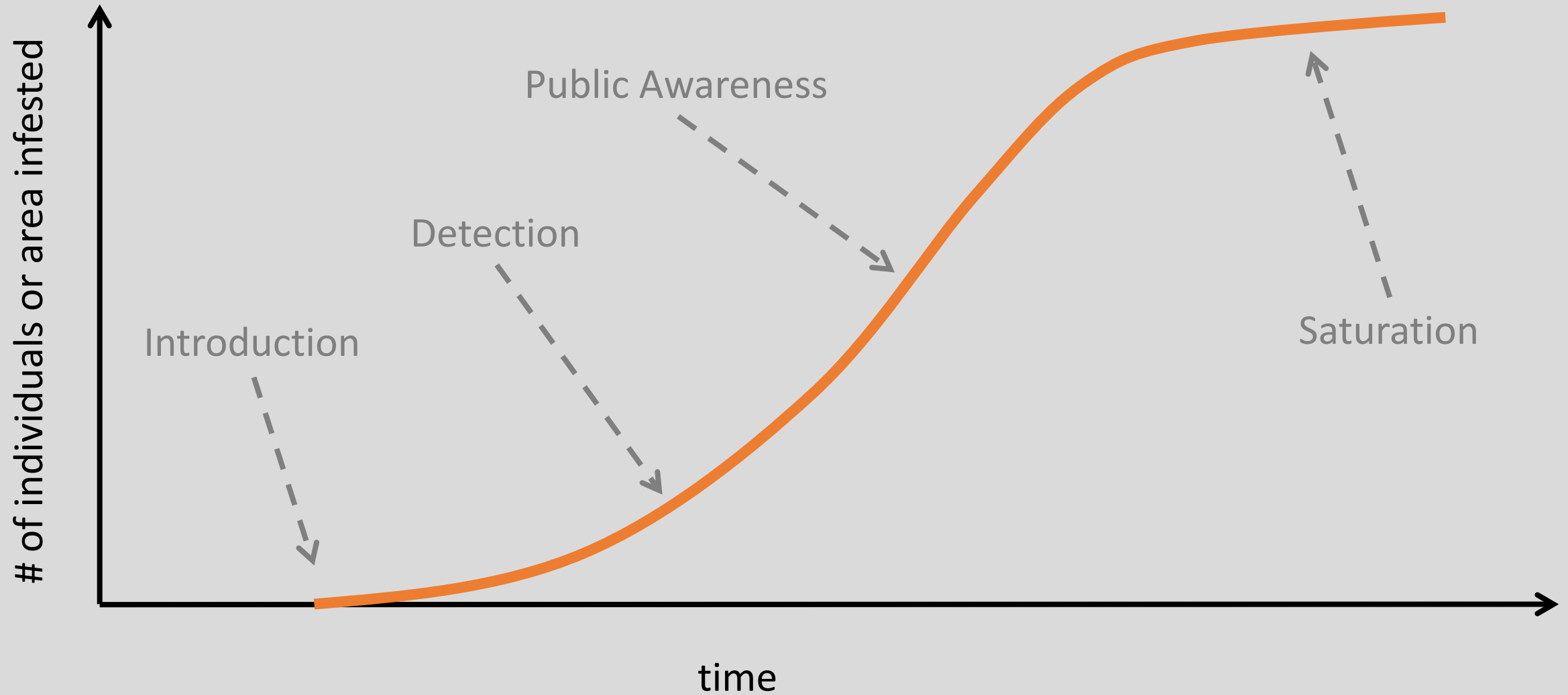


# Obtain permission for release

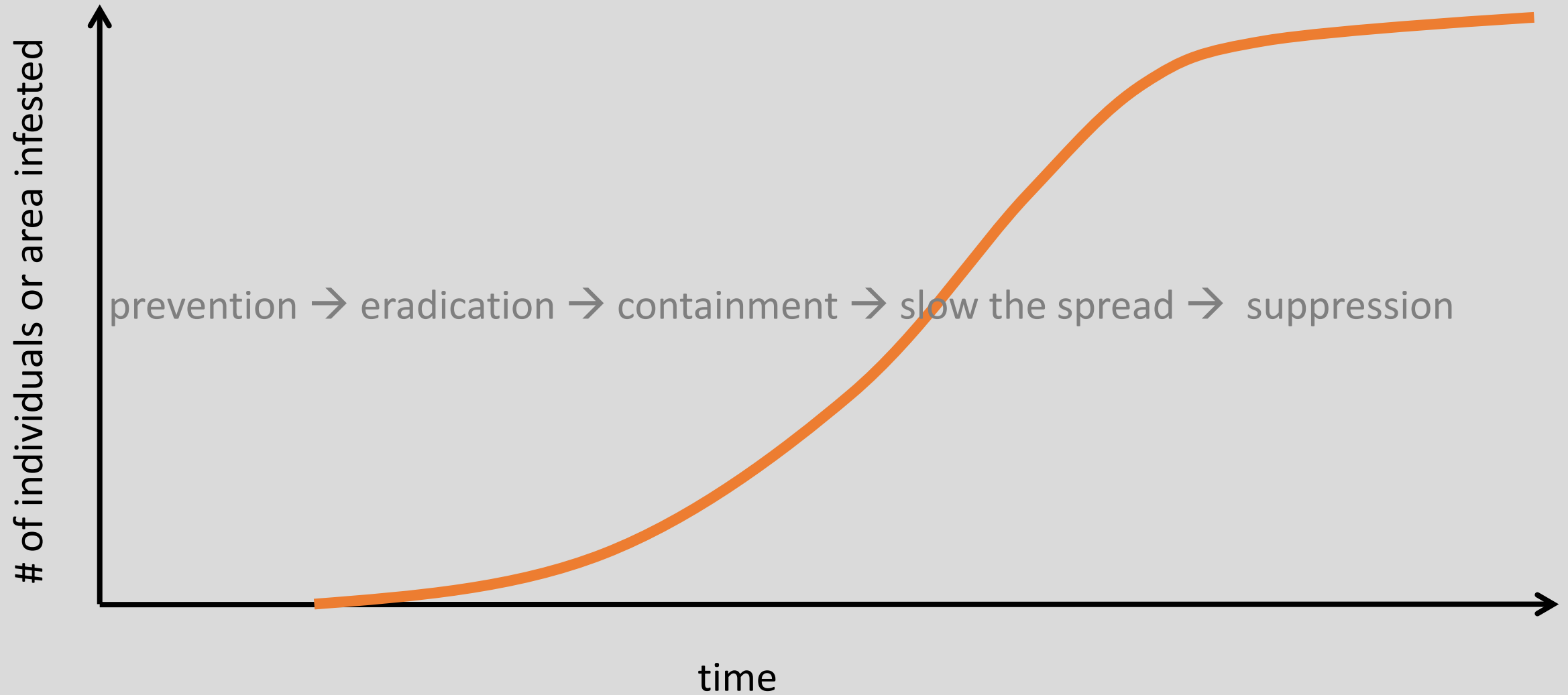
- All documents submitted in 2018
- USDA APHIS Plant Protection & Quarantine (PPQ) and the Technical Advisory Group for Biocontrol Agents of Weeds (TAG) advisory committee will review
  - Pending government response



# The invasion curve

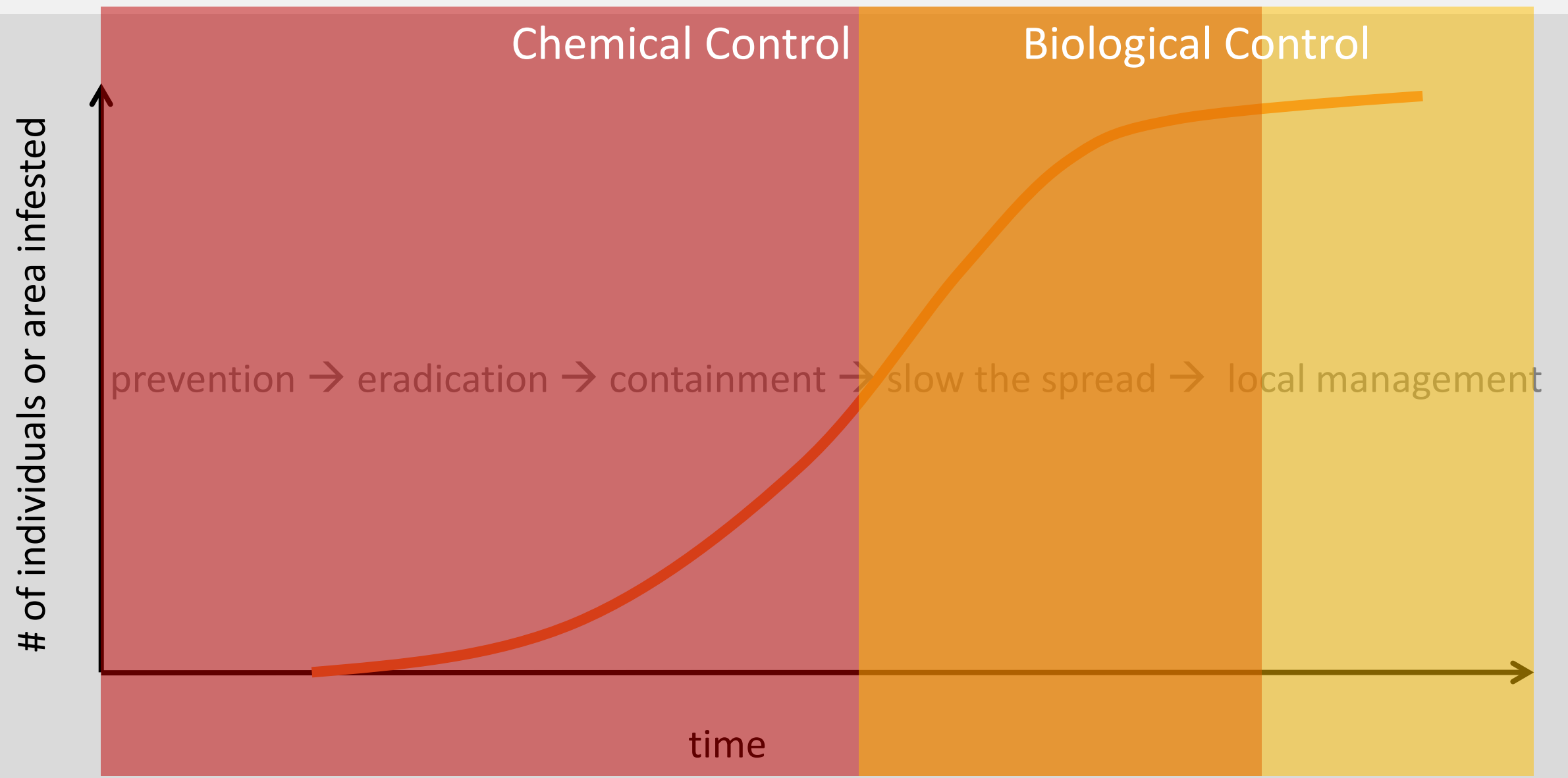


# Where are we with Ailanthus?





# The invasion curve: management tools





# Biological vs Chemical Control

	<b>Biological Control</b>	<b>Chemical Control</b>