



# Gypsy moth outbreak accelerates regional oak loss

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# Acknowledgements

- Insects of Doom Team: Jackie Hatala-Matthes, Val Pasquarella, Joe Elkinton, Dave Orwig, Danelle Laflower, Greta VanScoy, Savanna Brown, Emma Conrad-Rooney, Sofia Kruszka, Sam Matson, Nathan Oalican, Rich MacLean, Meg MacLean, Jen Chandler
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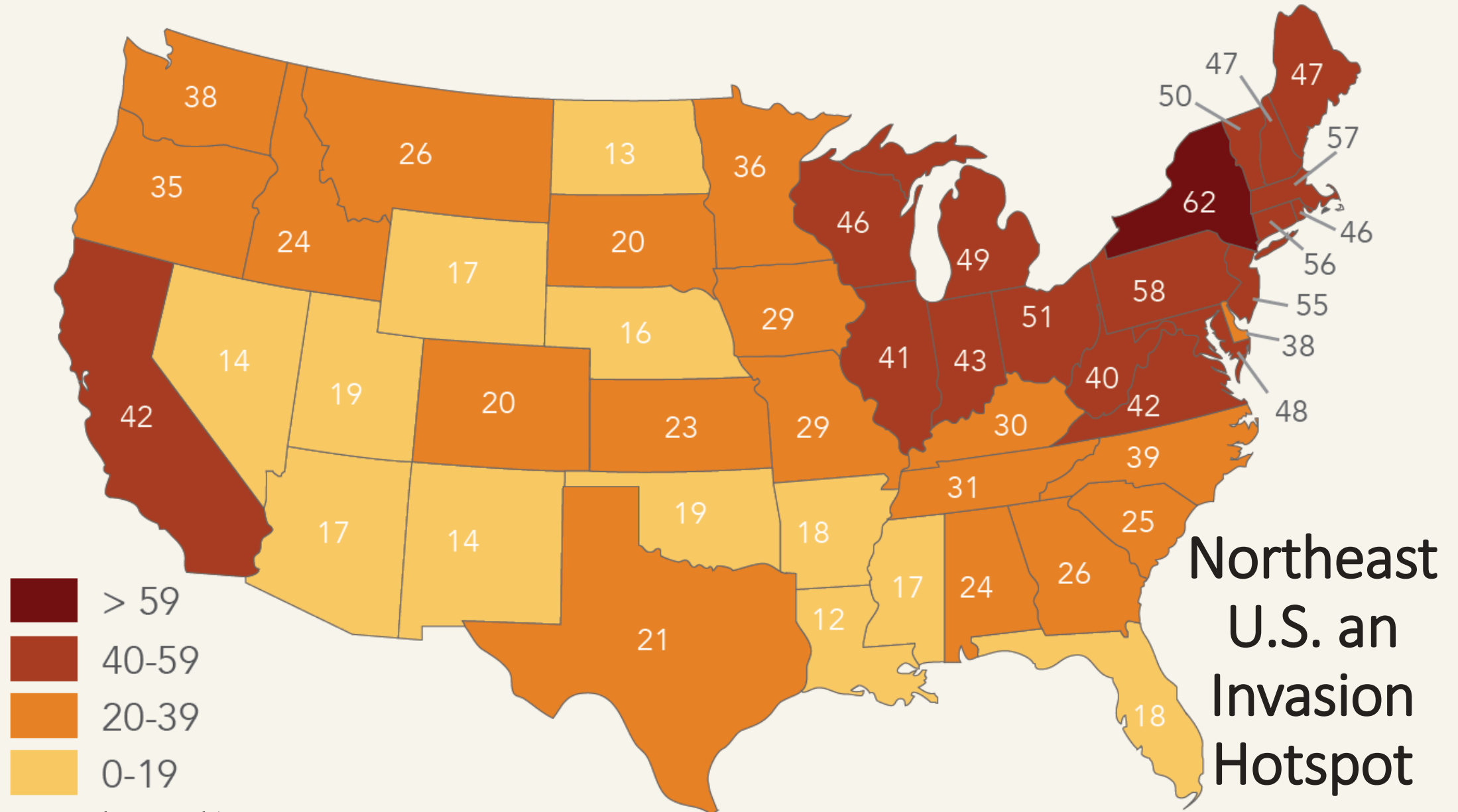
# Invasive Insects: a major global change driver

Can eliminate an entire tree species

Long-term effects on forest composition & productivity



# Imported forest pests occur in every state in the US



Lovett et al. 2016, Ecol Apps

Data source: USDA Forest Service. 2015. Alien Forest Pest Explorer Online Database. <http://foresthealth.fs.usda.gov/portal/Flex/APE>



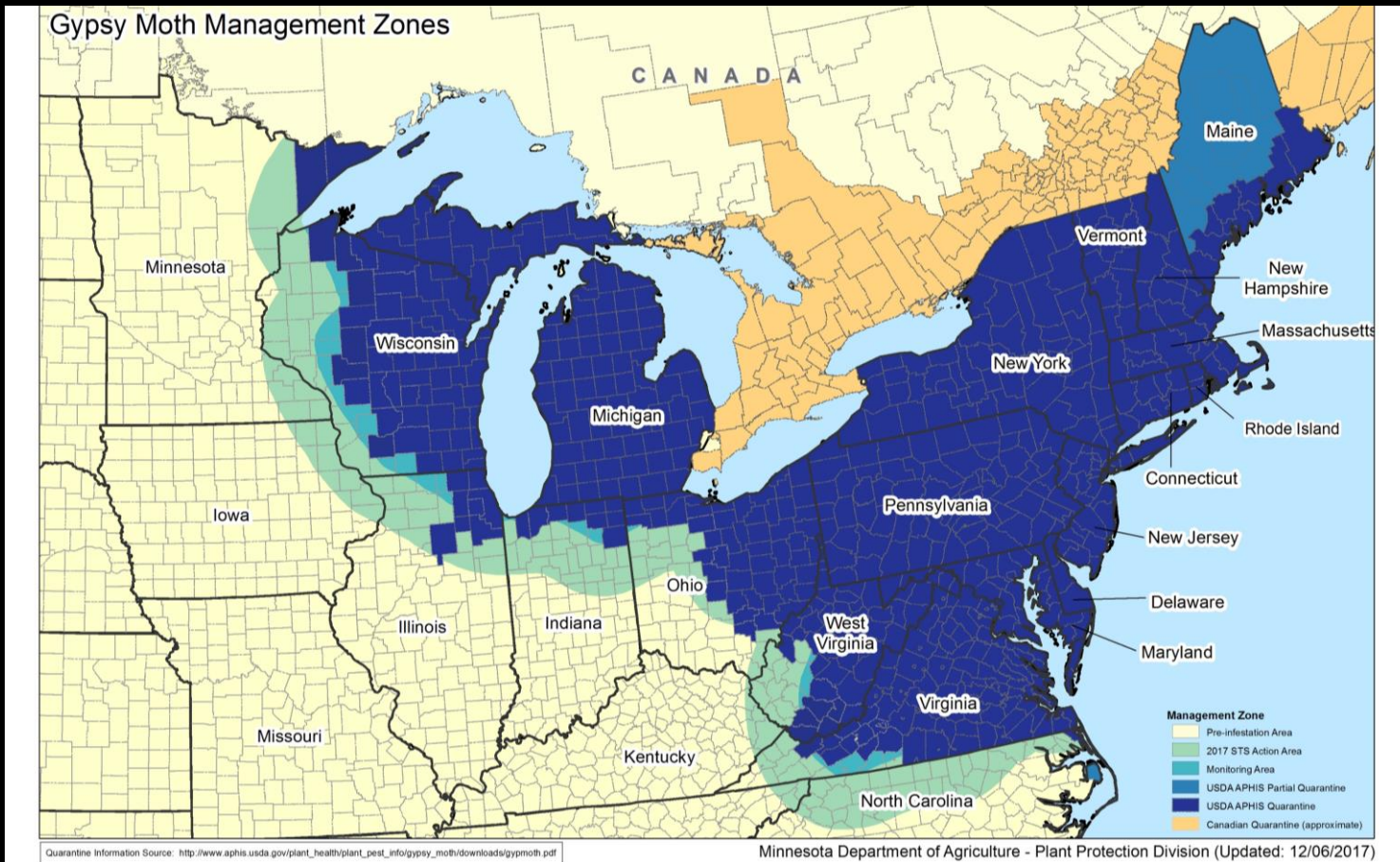
# How does the recent gypsy moth defoliation alter forest biomass and composition?

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- Background on gypsy moth
- Detecting defoliation with satellites
- Connecting satellite data with on-the-ground impacts: central Massachusetts study
- Results and implications for oak
- Next steps







## Life History

- Spring defoliator
- 1 generation per year

## Impacts

- Generalist, but oaks and aspens preferred
- 1-2 years of defoliation tolerated
- Mortality increases with defoliation frequency and additional stressors.



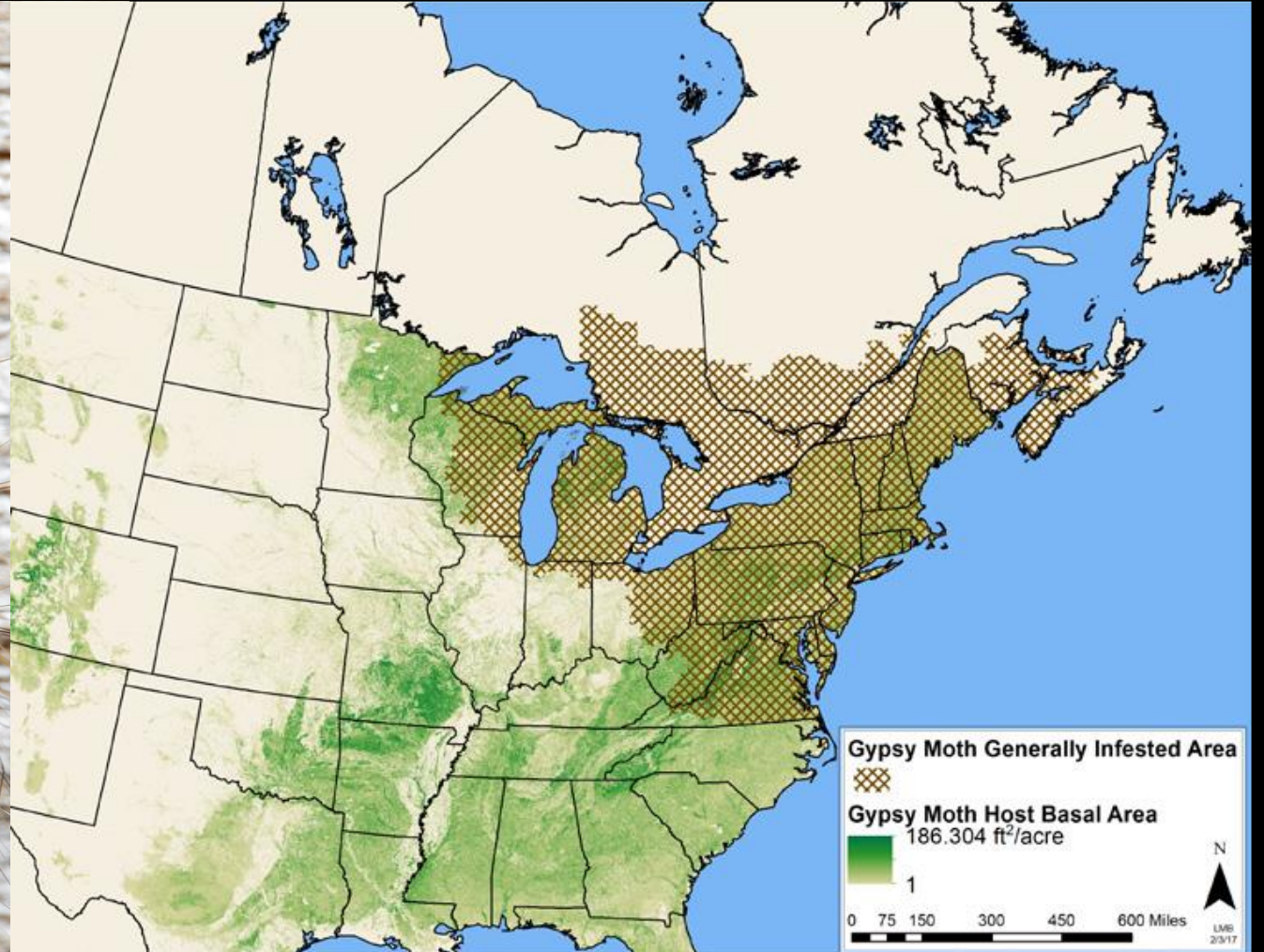
Gypsy Moth  
(*Lymantria dispar*)



# Gypsy moth: here since 1869



Photo: N. Oalican





# 25 years of happiness: *Entomophaga maimaiga*



Photo: A. Hajek







**Gypsy moth outbreak  
2016 - 2018**



# How does the recent gypsy moth defoliation alter forest biomass and composition?

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1. What was the defoliation pattern across New England?
2. How much does mortality increase with increasing defoliation frequency?
3. What species and sizes of trees were most likely to die?



# How does the recent gypsy moth defoliation alter forest biomass and composition?

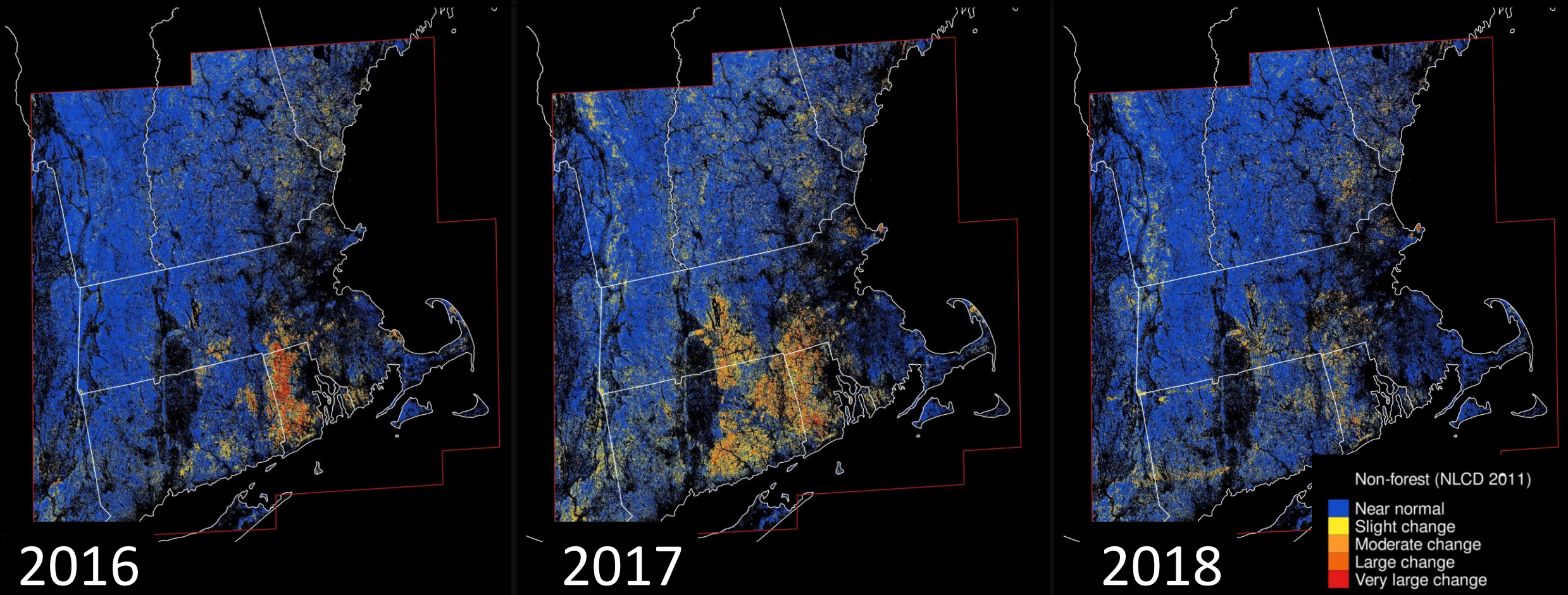
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1. What was the defoliation pattern across New England?



# Defoliation estimated by Landsat

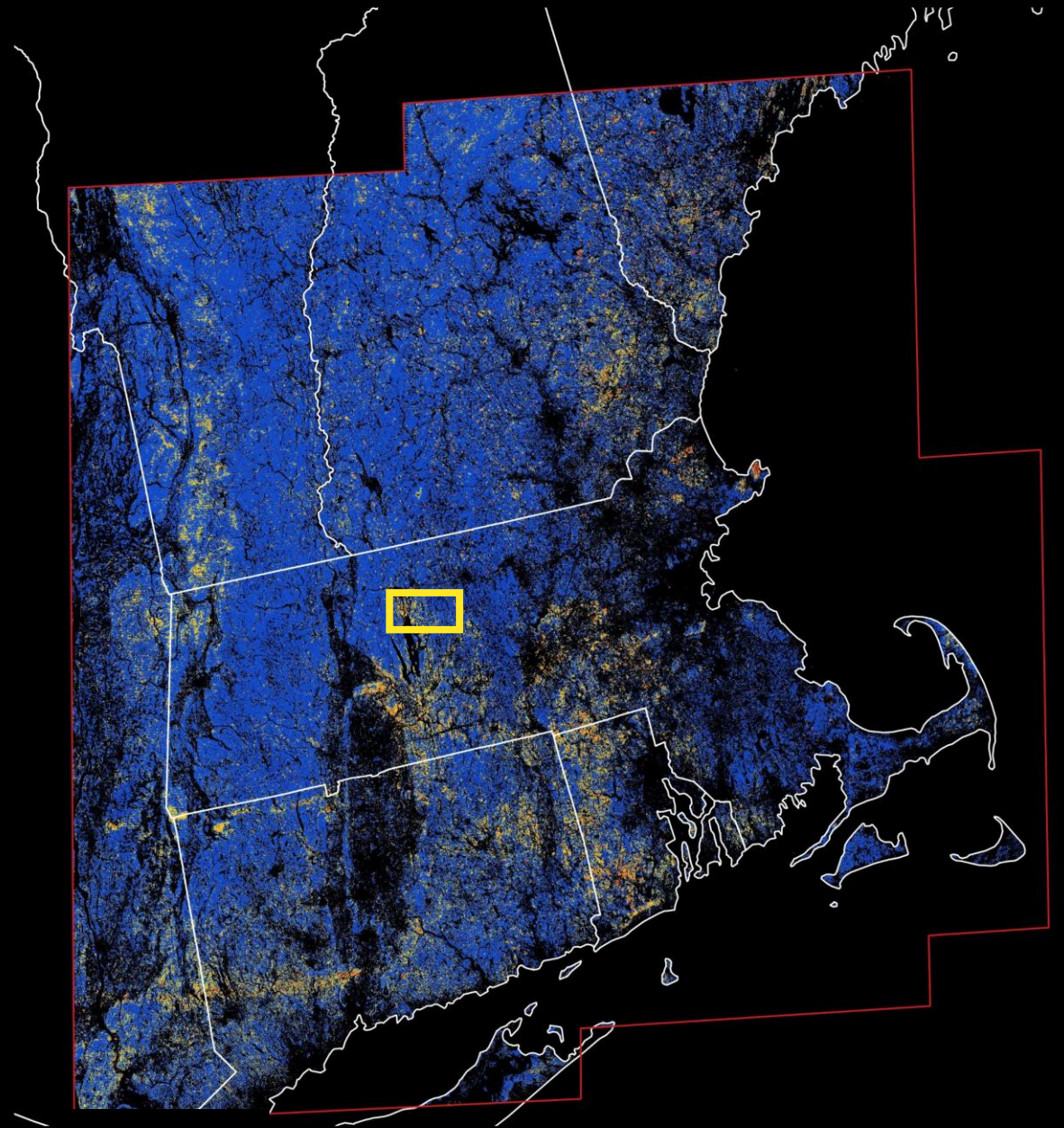
Pasquarella, V.J., Bradley, B.A., & Woodcock, C.E. 2017 Near-real-time monitoring of insect defoliation using Landsat time series. *Forests* 8(8), 275; doi:10.3390/f8080275.





**How does the recent  
gypsy moth defoliation  
alter forest biomass  
and composition?**

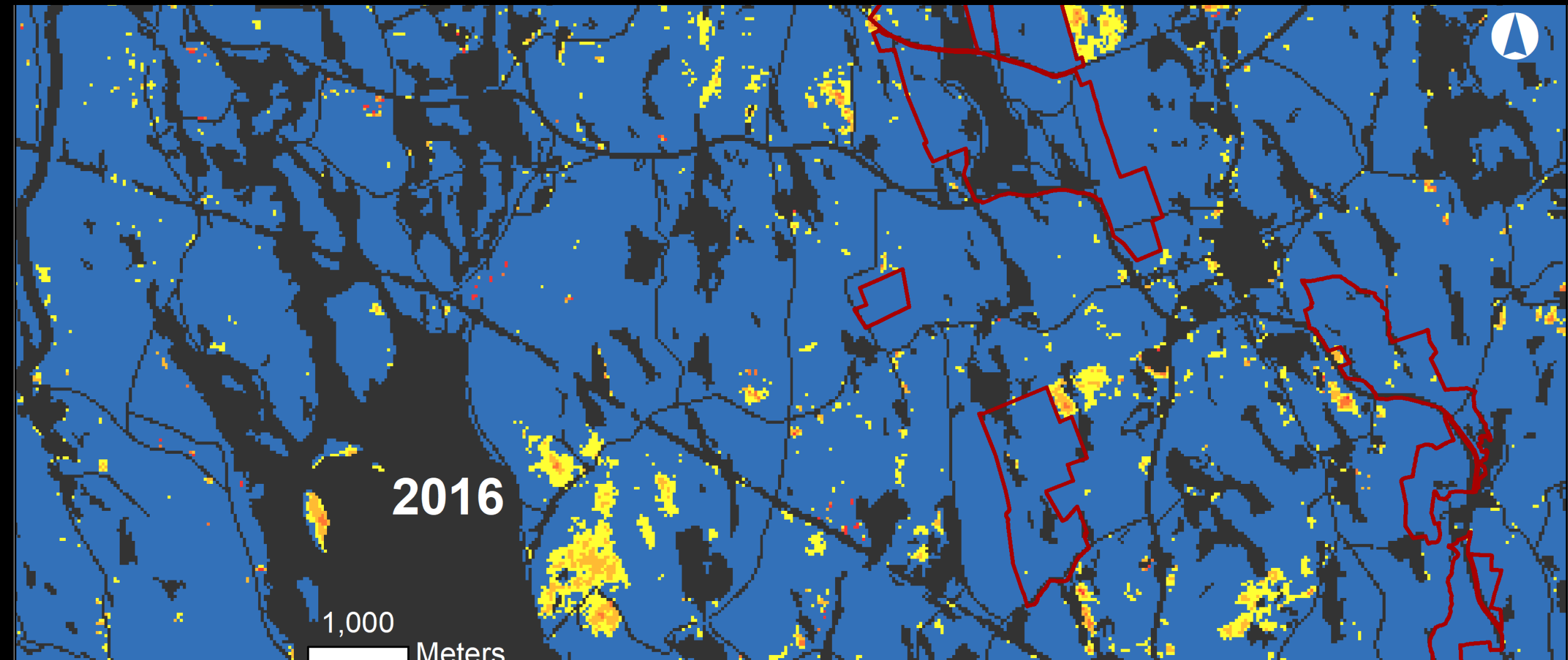
**Focused study in  
central Massachusetts**



**2018**

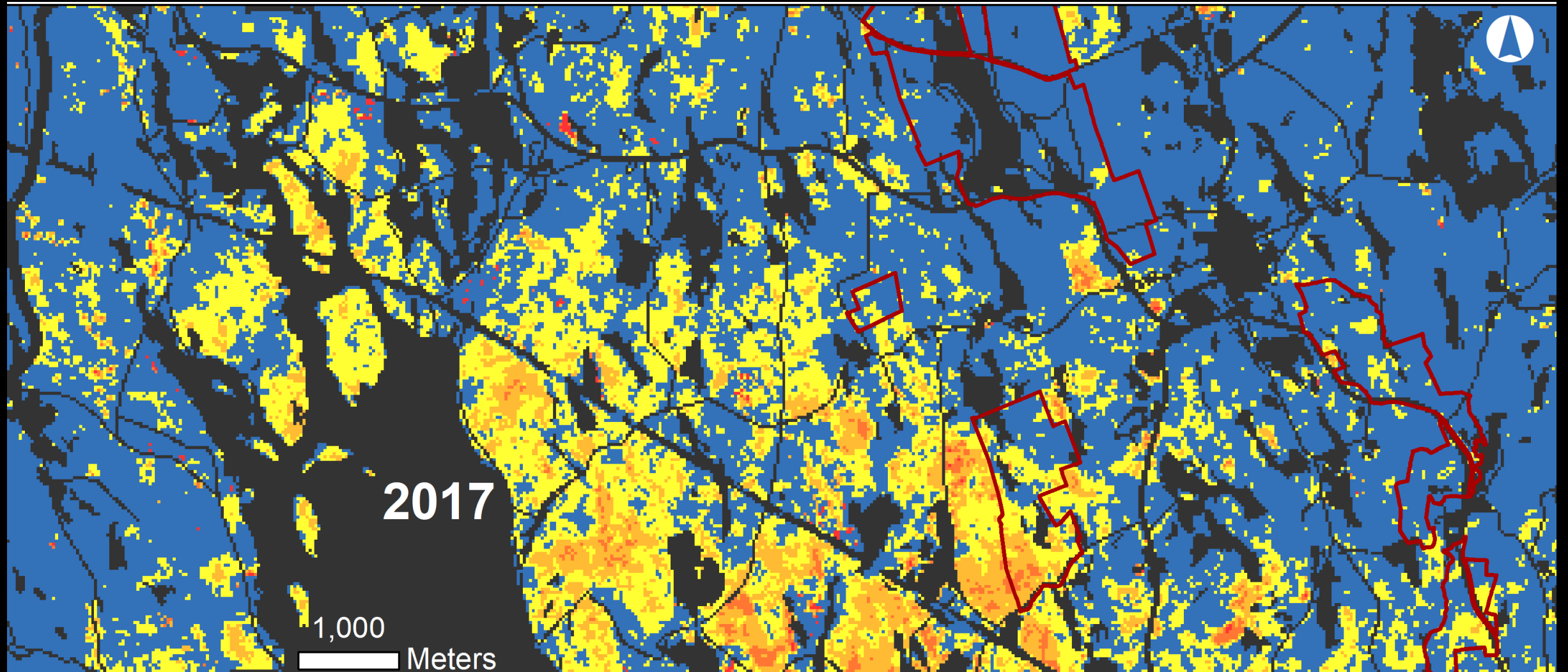


# Differing defoliation frequency



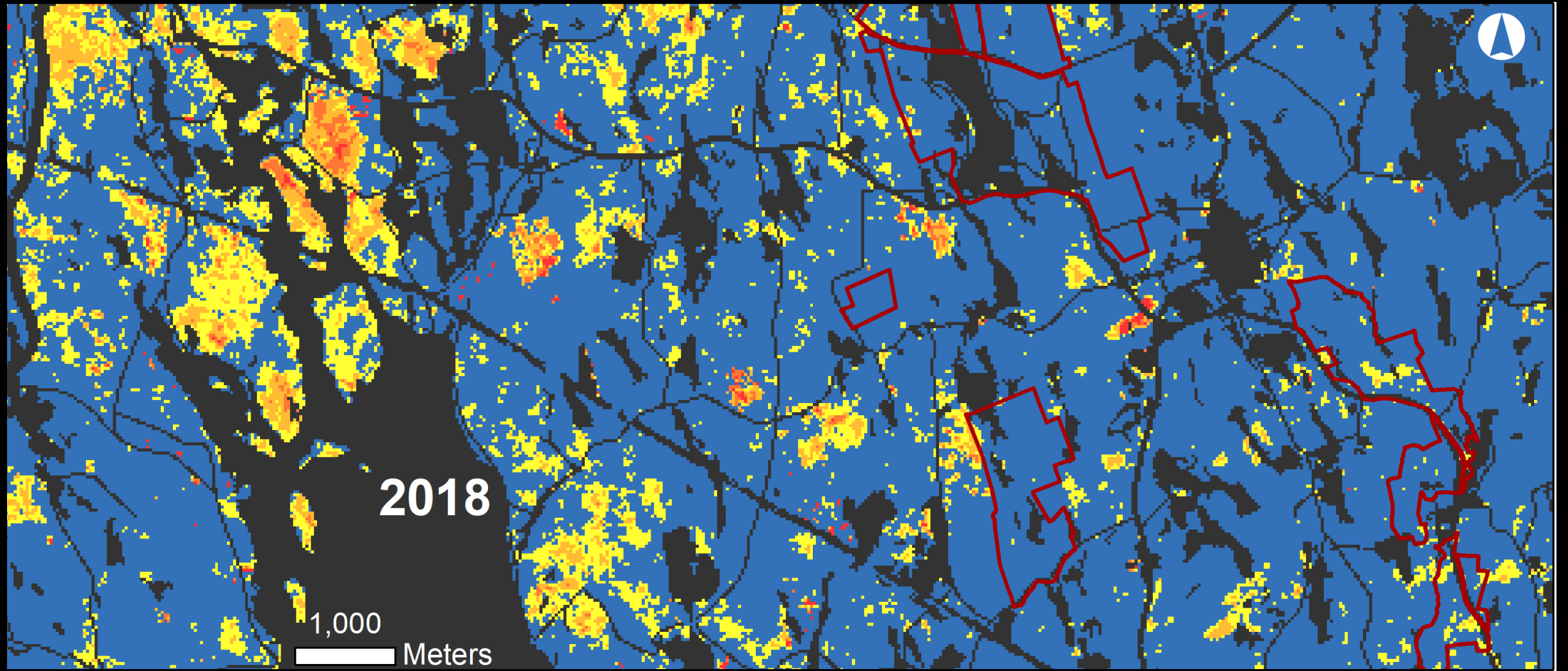


# Differing defoliation frequency



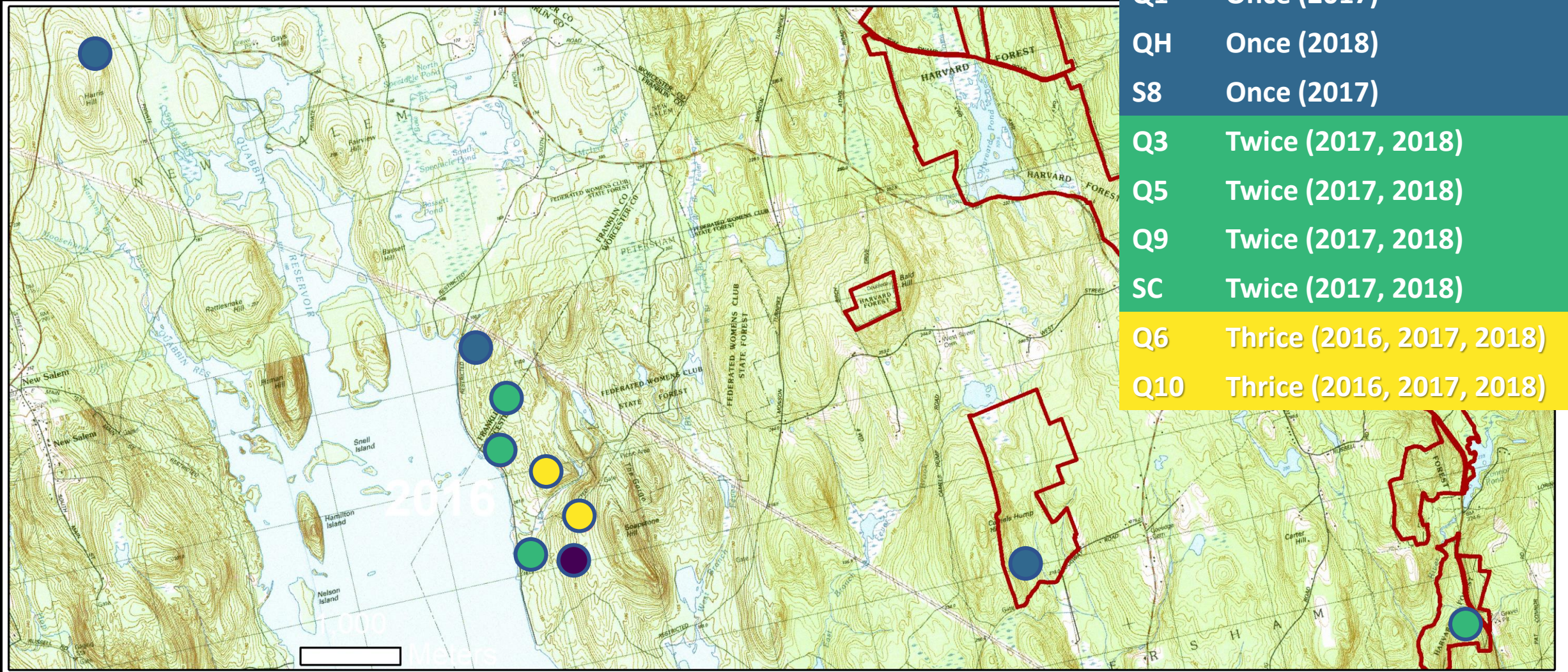


# Differing defoliation frequency





# 10 permanent plots



Plot	Defoliation frequency
Q8	None
Q1	Once (2017)
QH	Once (2018)
S8	Once (2017)
Q3	Twice (2017, 2018)
Q5	Twice (2017, 2018)
Q9	Twice (2017, 2018)
SC	Twice (2017, 2018)
Q6	Thrice (2016, 2017, 2018)
Q10	Thrice (2016, 2017, 2018)







What  
did we  
find?



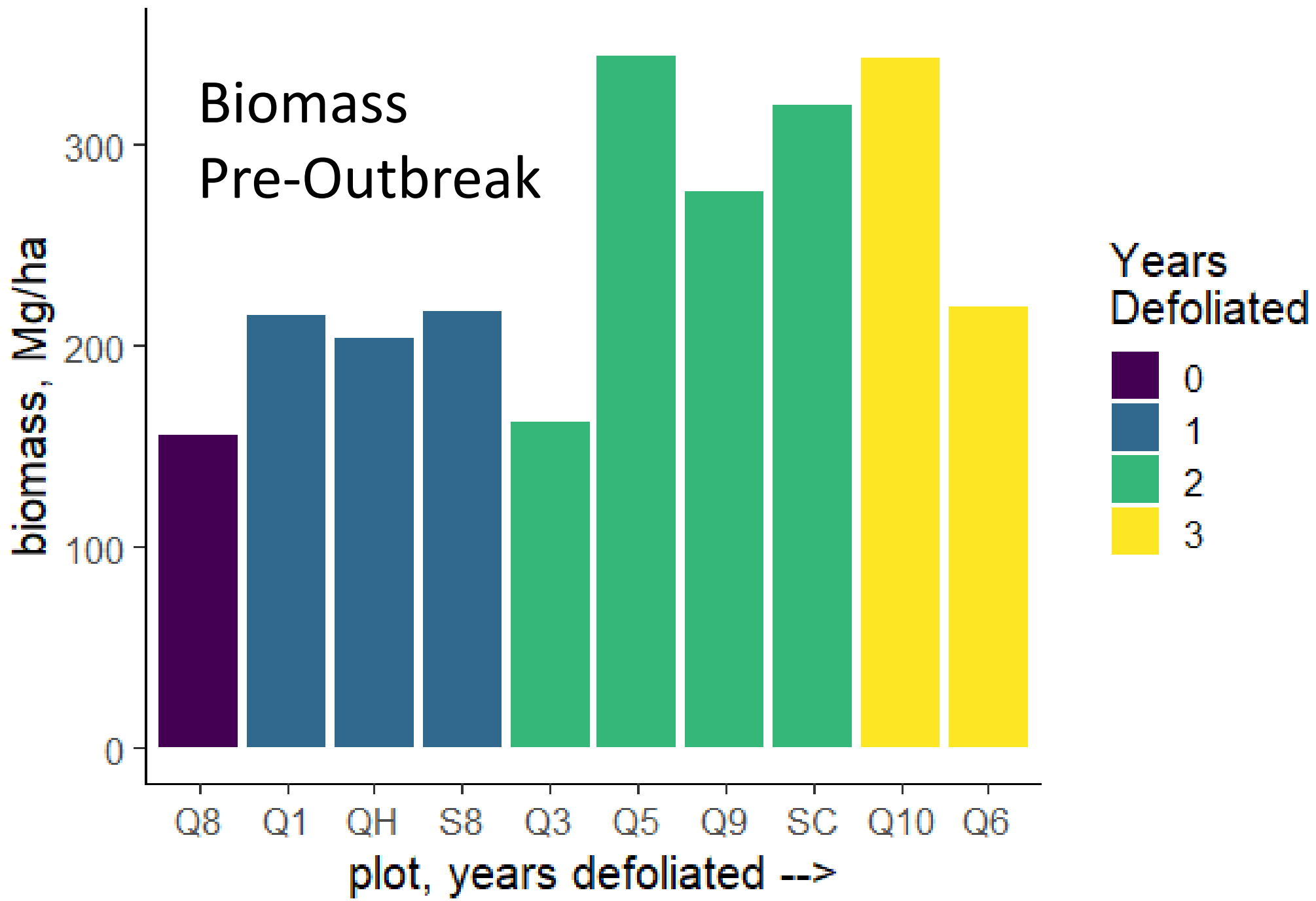


# **How does the recent gypsy moth defoliation alter forest biomass and composition?**

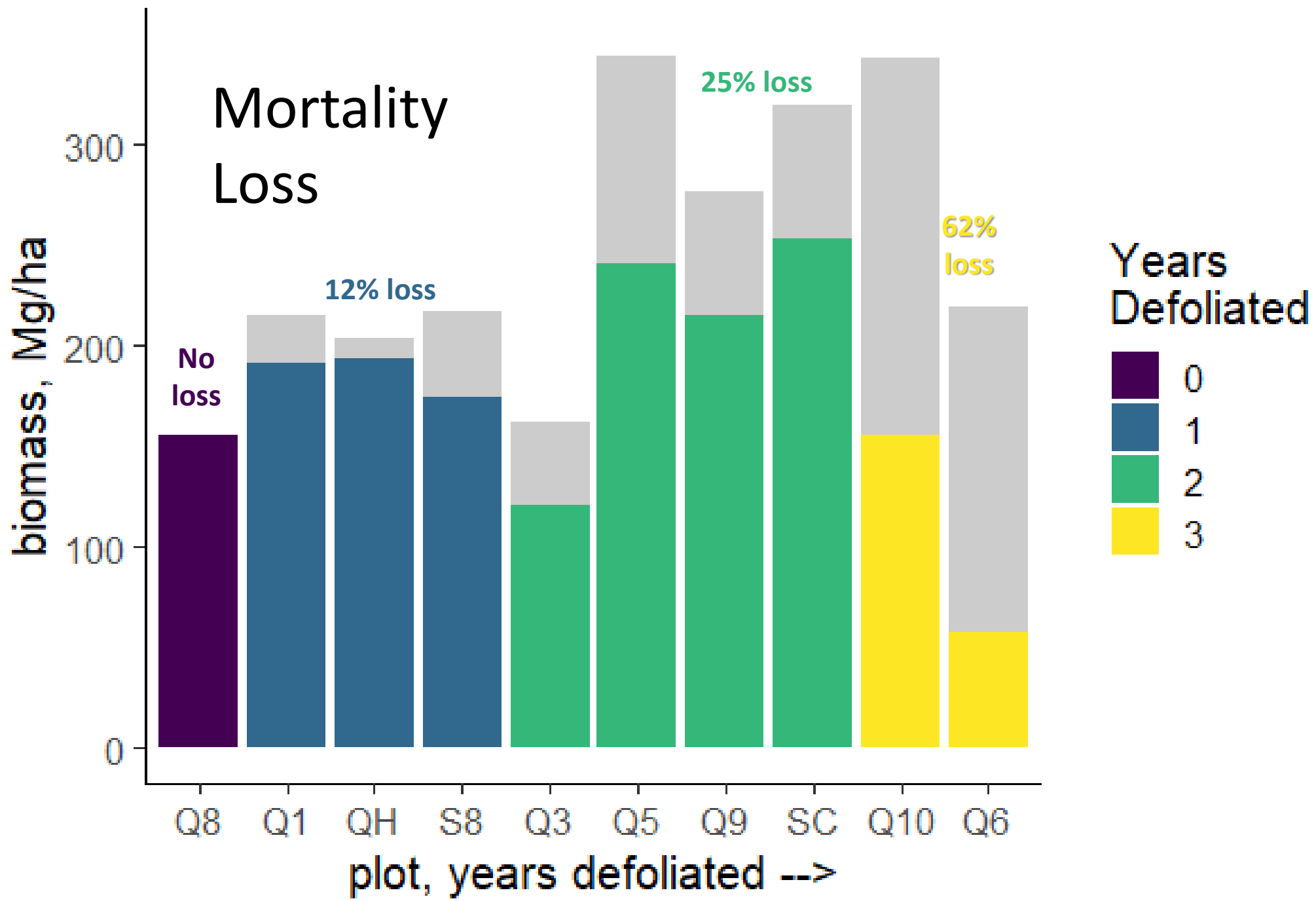
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2. How much does mortality increase with increasing defoliation frequency?











# How does the recent gypsy moth defoliation alter forest biomass and composition?

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3. What species and sizes of trees were most likely to die?

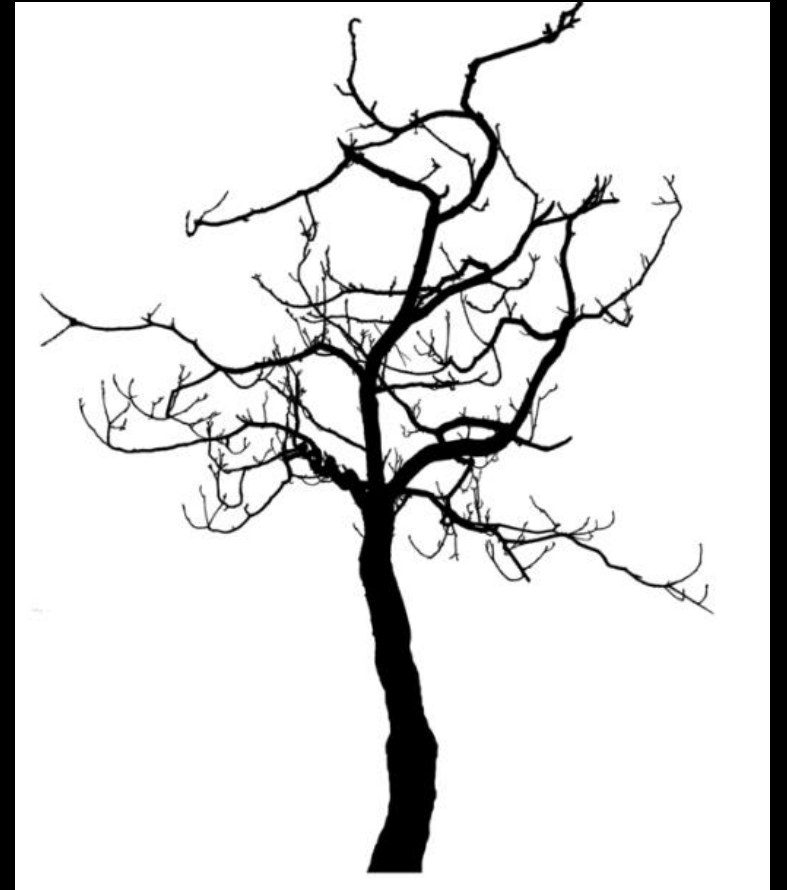


Yes, it really is all about oak.

Across all 10 plots,

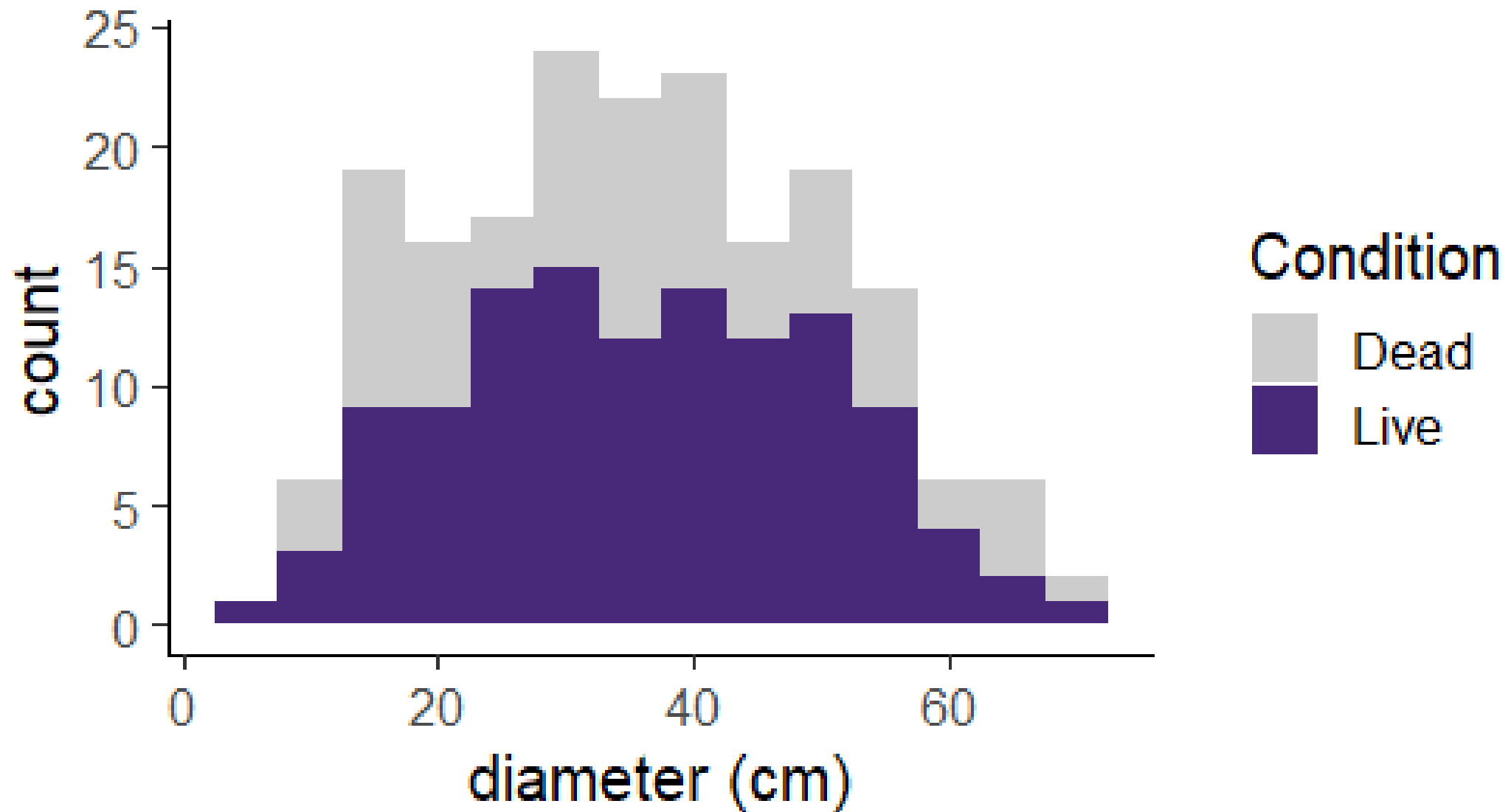
39% of oaks dead

8% of all other trees dead

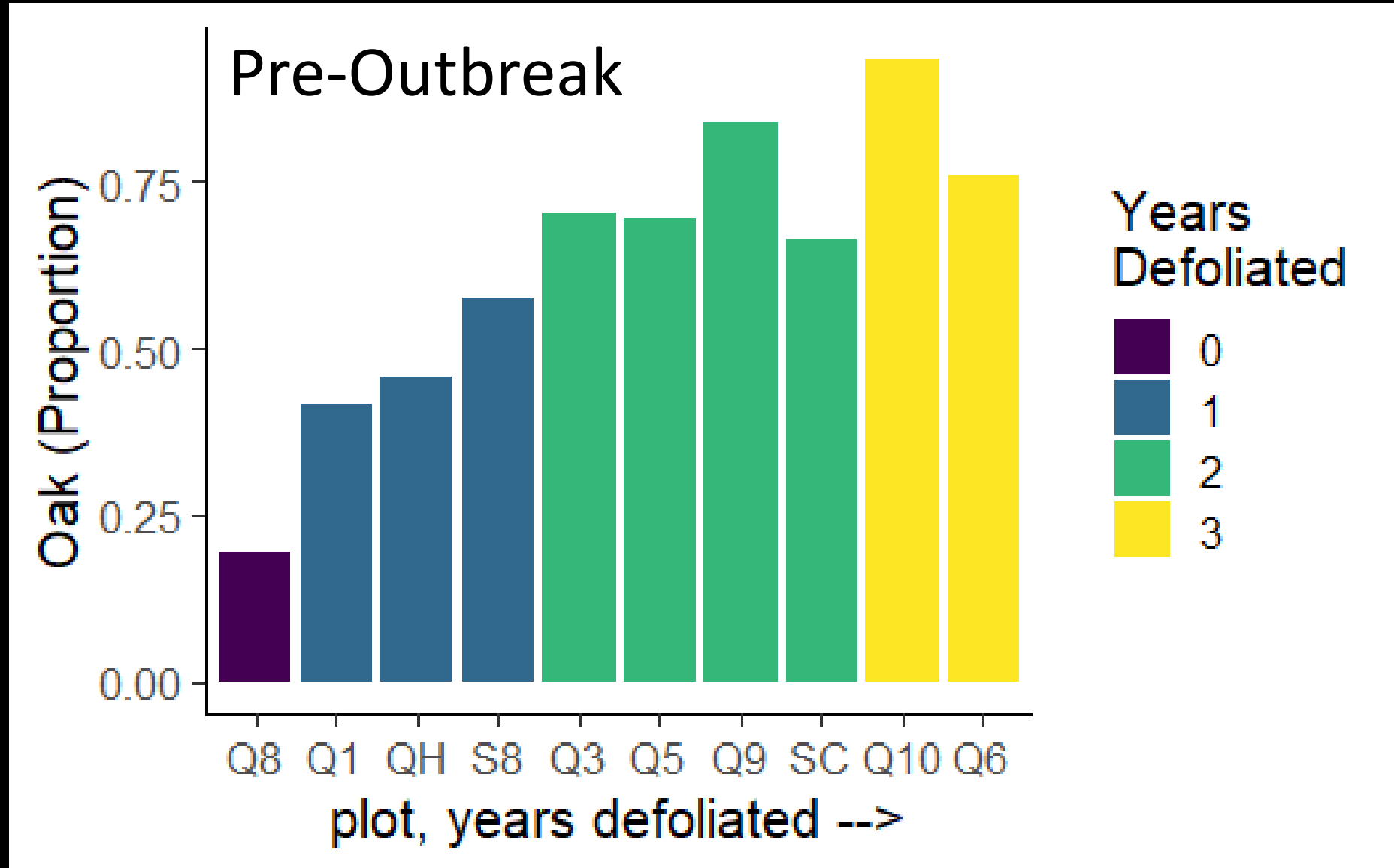




# Gypsy moth killed all sizes of oaks

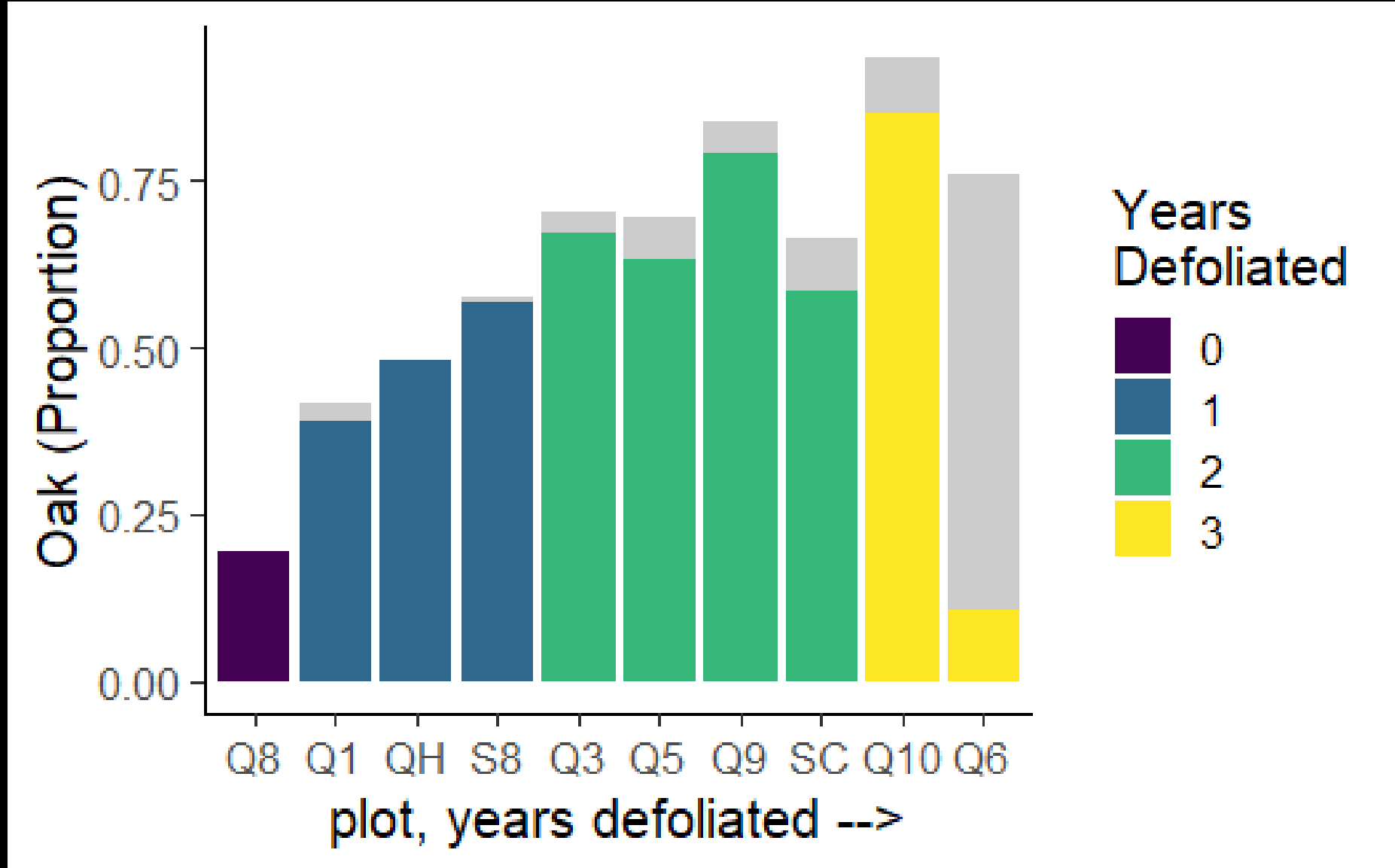


# Gypsy moth defoliation frequency increased with oak dominance





# Does gypsy moth accelerate oak loss?



# Summary of results



- Mortality increased with defoliation frequency. A few trees died after just one defoliation, and losses increased to 25% after 2 defoliations, and >60% after 3 defoliations
- Nearly all trees that died were oaks: 40% of the oaks are gone
- Mortality was spread across all sizes of oaks
- Gypsy moth defoliation frequency increased with increasing oak importance in the forest
- In most sites, the surviving overstory is still oak-dominated, but will it regenerate?



Why does  
this matter?



G. VanScoy with 141 cm red oak in Pepperell, MA Oct. 2019. Photo: D. Orwig



# Oak is awesome!

- Timber
- Habitat/mast
- Big tree

# And declining

- Lack of regeneration
- Fire regimes
- Timber harvest
- Climate
- Gypsy moth?

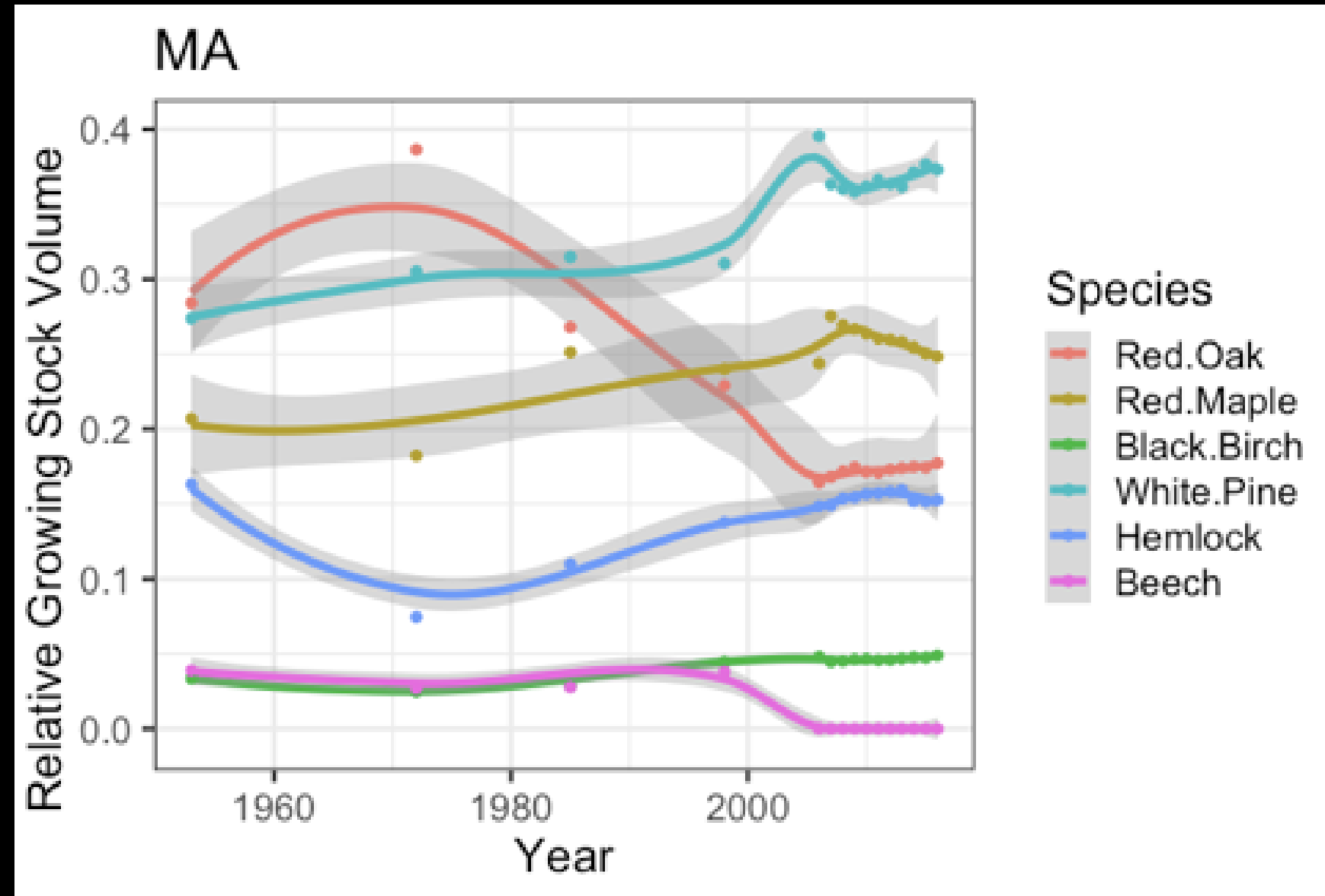


G. VanSoy with 141 cm red oak in Pepperell, MA Oct. 2019. Photo: D. Orwig



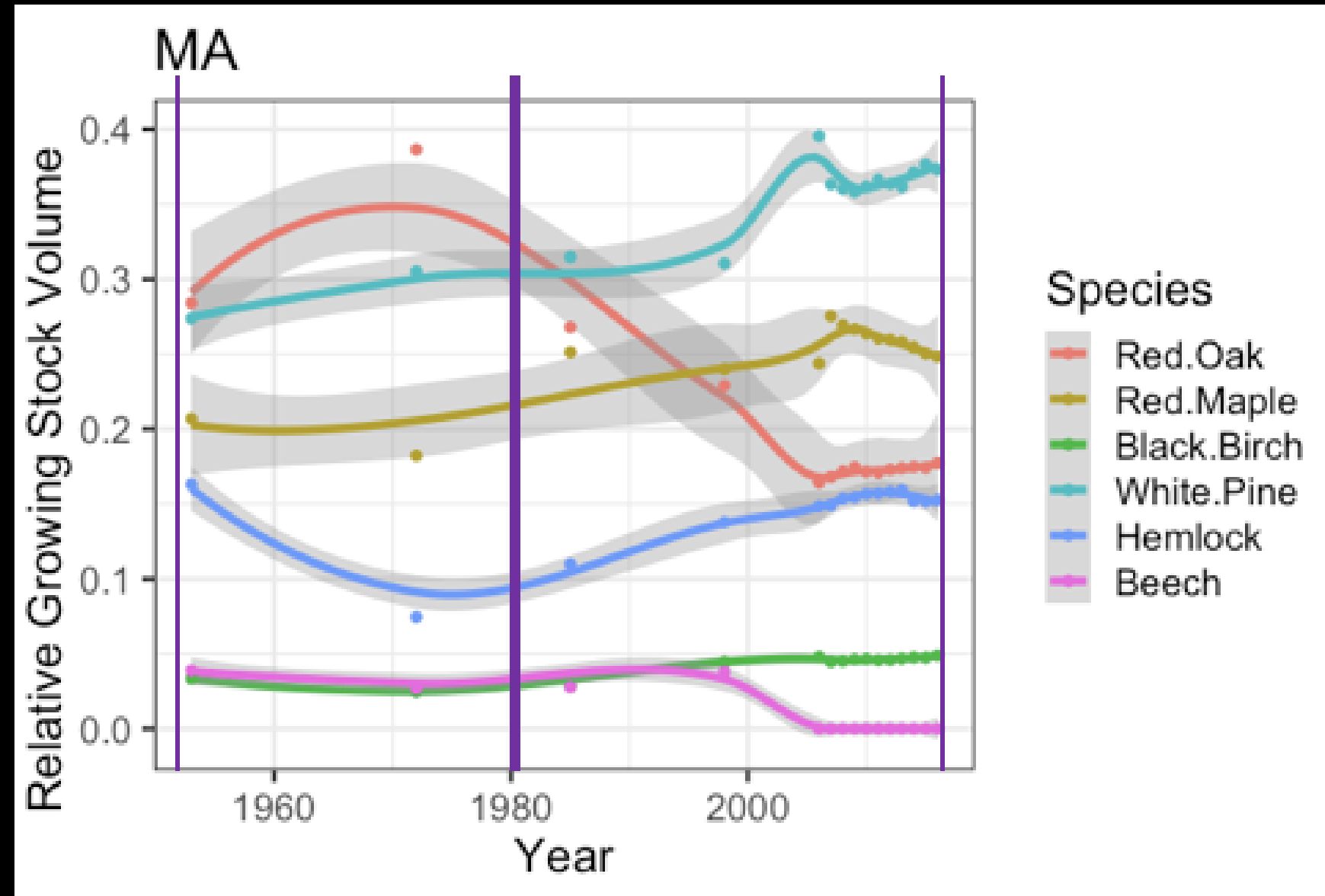
# Does Gypsy moth accelerate oak loss?

USFS Forest Inventory & Analysis data 1950s- recent.



# Does Gypsy moth accelerate oak loss?

USFS Forest Inventory & Analysis data 1950s- recent.



Years >500,000  
acres defoliated in  
Massachusetts  
(USFS Gypsy Moth  
Digest):

1953

1980-82

2017

<https://www.fs.usda.gov/naspf/program/s/forest-health-protection/gypsy-moth-digest>



# Future Directions of this Research

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What are the ecosystem consequences of oak dieback & mortality?

- Add defoliation severity, and dieback to analysis
- Going forward: re-visit permanent plots over 5-25 years
- Going backward: Analyze tree-ring data from plots

How might the consequences of this outbreak differ from past outbreaks?





A low-angle photograph looking up at a dense forest canopy. The sky is a pale, overcast blue. Sunlight filters through the leaves, creating a bright, hazy glow in the lower right quadrant. The tree trunks and branches are dark and silhouetted against the sky, with some green leaves visible. The overall mood is serene and natural.

Thank you!

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