Management priorities to limit the impacts of Emerald Ash Borer on US street trees

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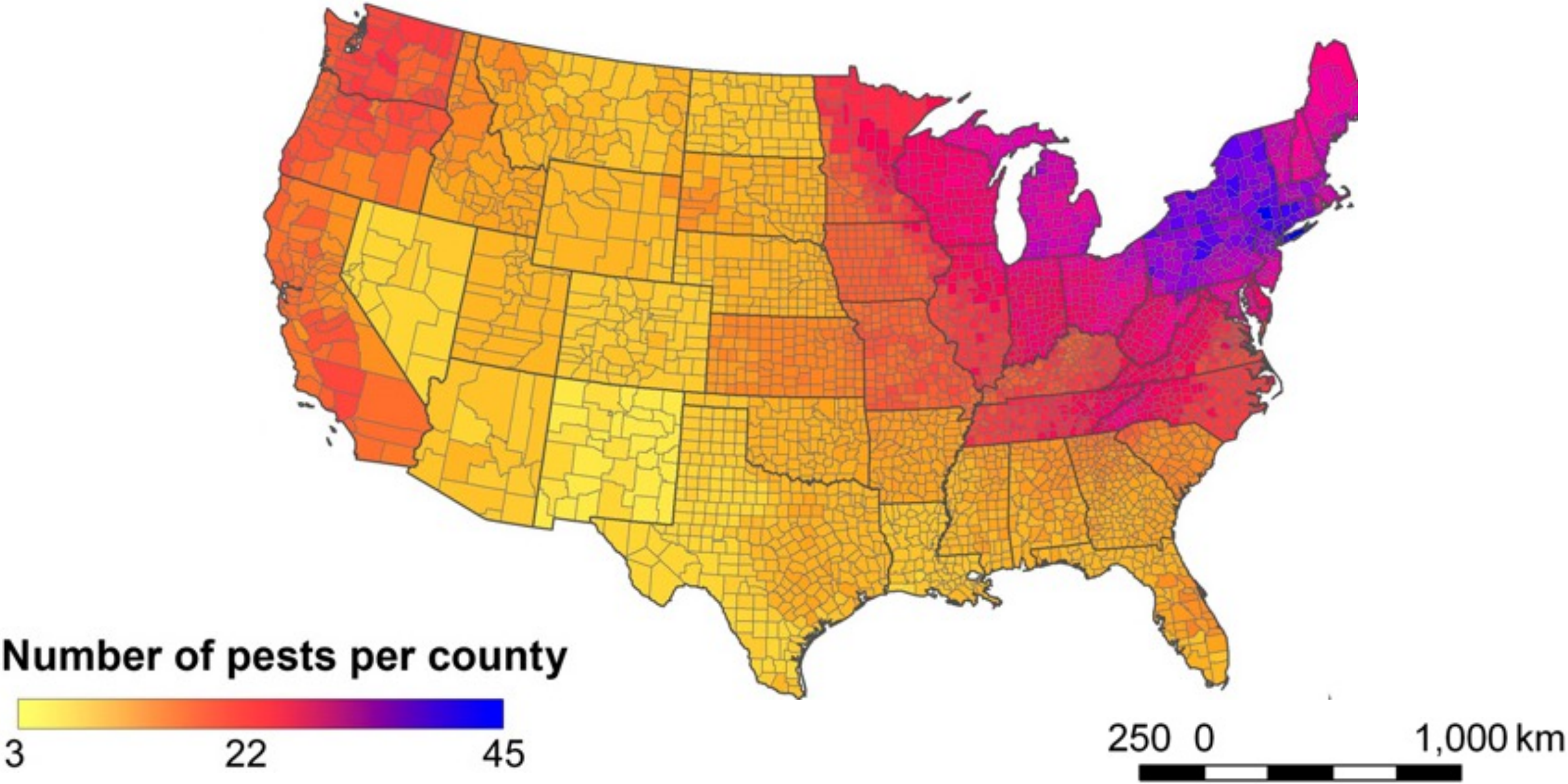
1. Economic impacts of pests on street trees

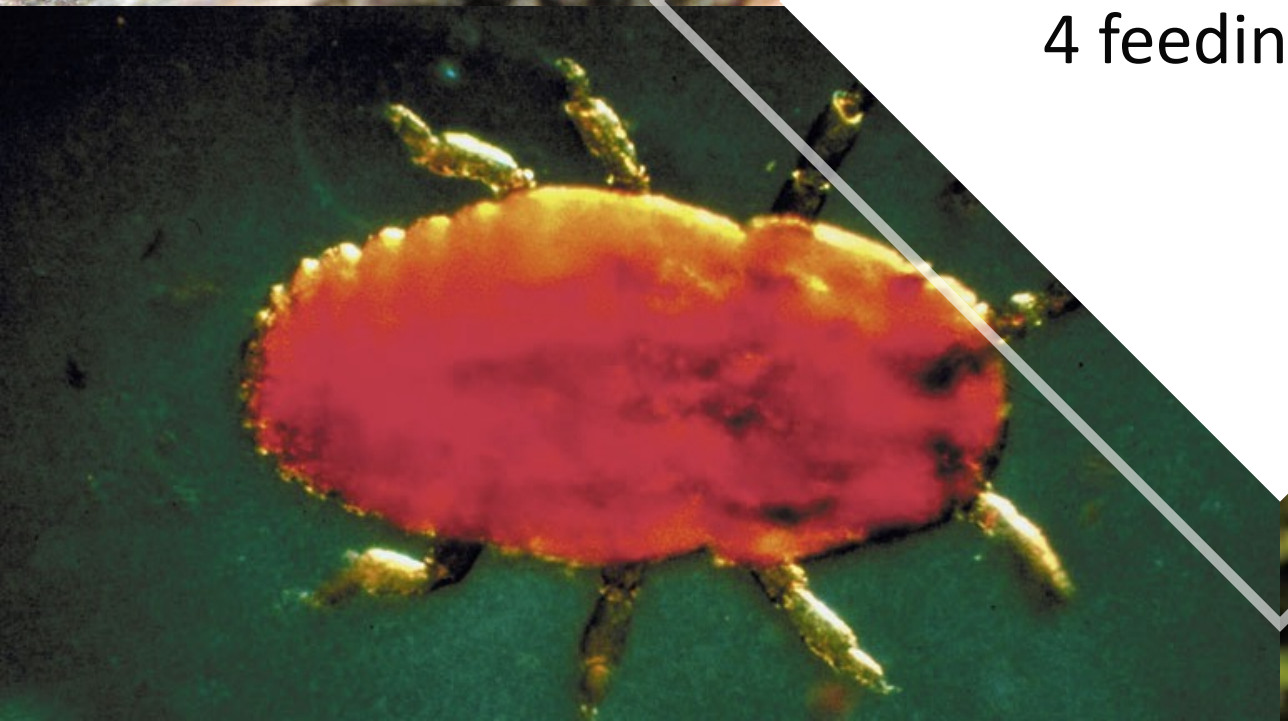
2. Optimal spread management for emerald ash borer

Hudgins et al., 2022, Journal of Applied Ecology; Hudgins et al., 2024, Conservation Science and Practice

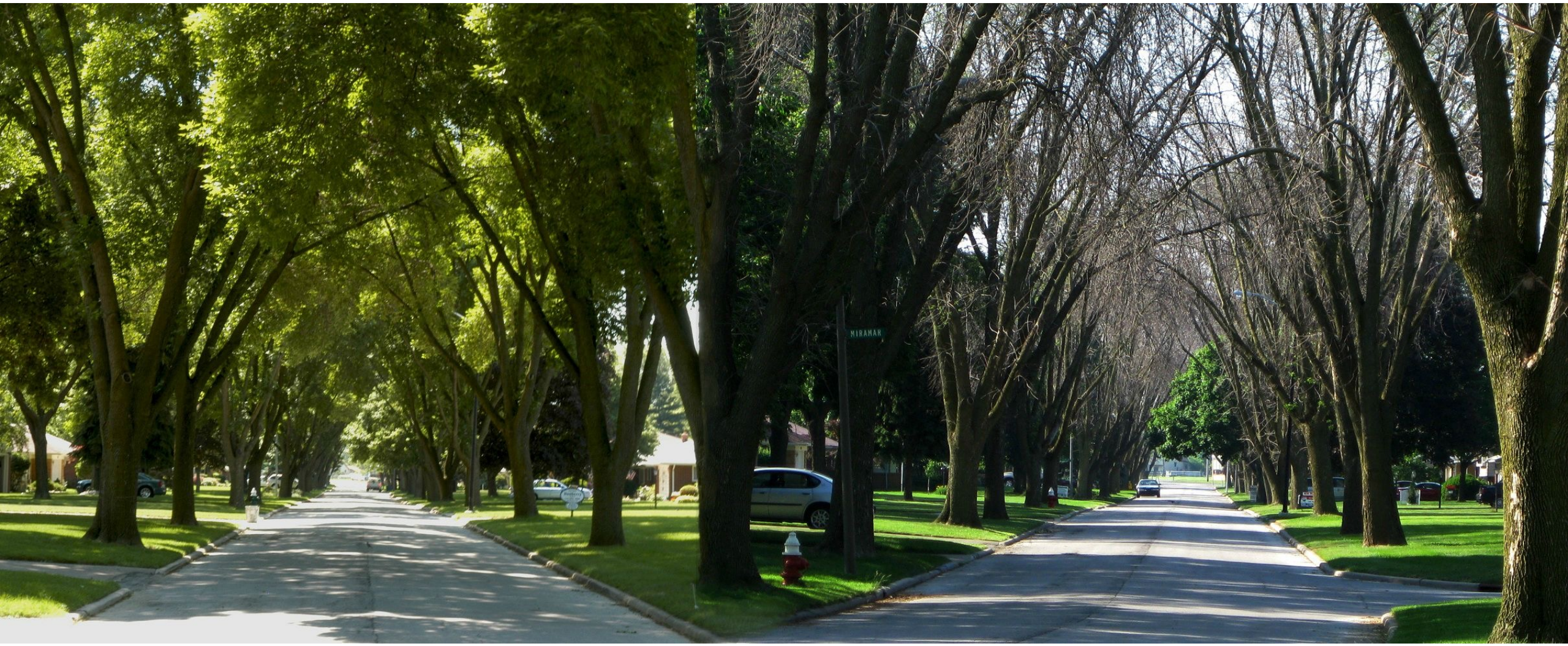


Liebhold et al. 2013 Div*ers. Distrib.*

Major damaging pests: 4 feeding guilds



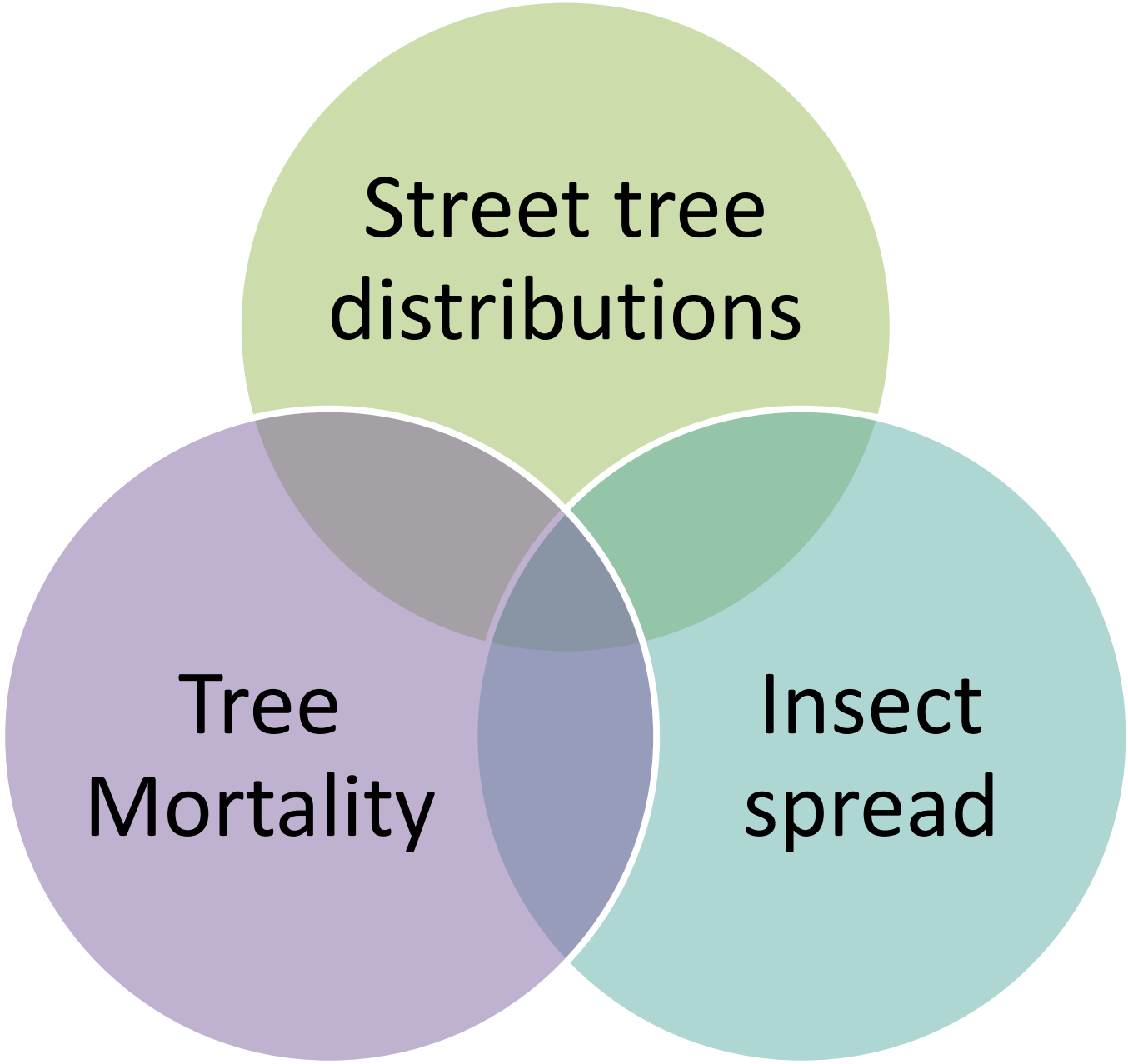
Nature-based solutions under threat



Treehuggerswinnipeg.com

1. Hotspots of pest-induced US urban tree death, 2020-2050

Hudgins, E.J., Koch, F. H., Ambrose, M. J., & Leung, B.
(2022) *Journal of Applied Ecology*

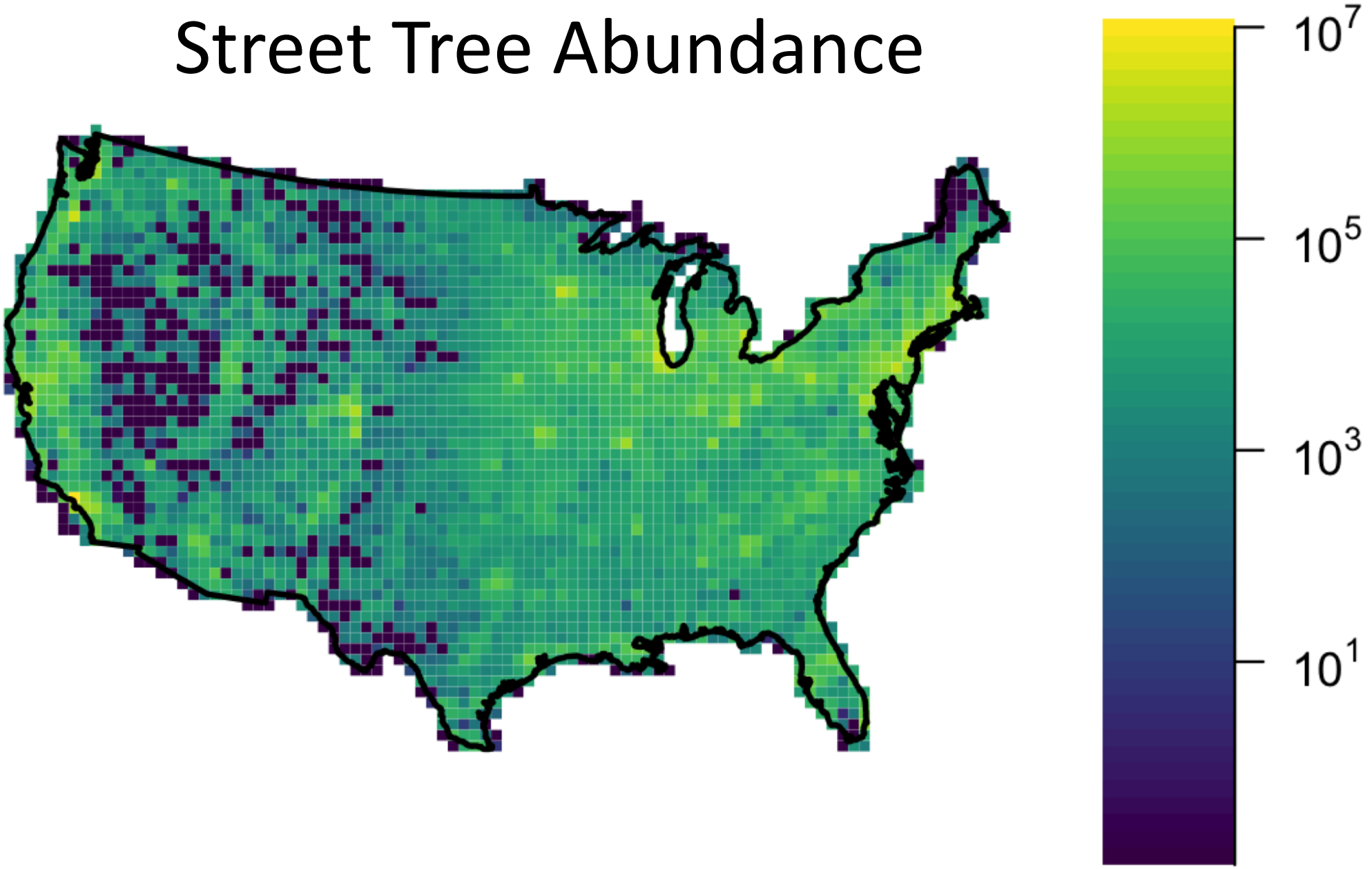


Hudgins, E.J., Koch, F. H., Ambrose, M. J., & Leung, B. (2022). *Journal of Applied Ecology*

Extrapolating from 600 to ~30,000 communities

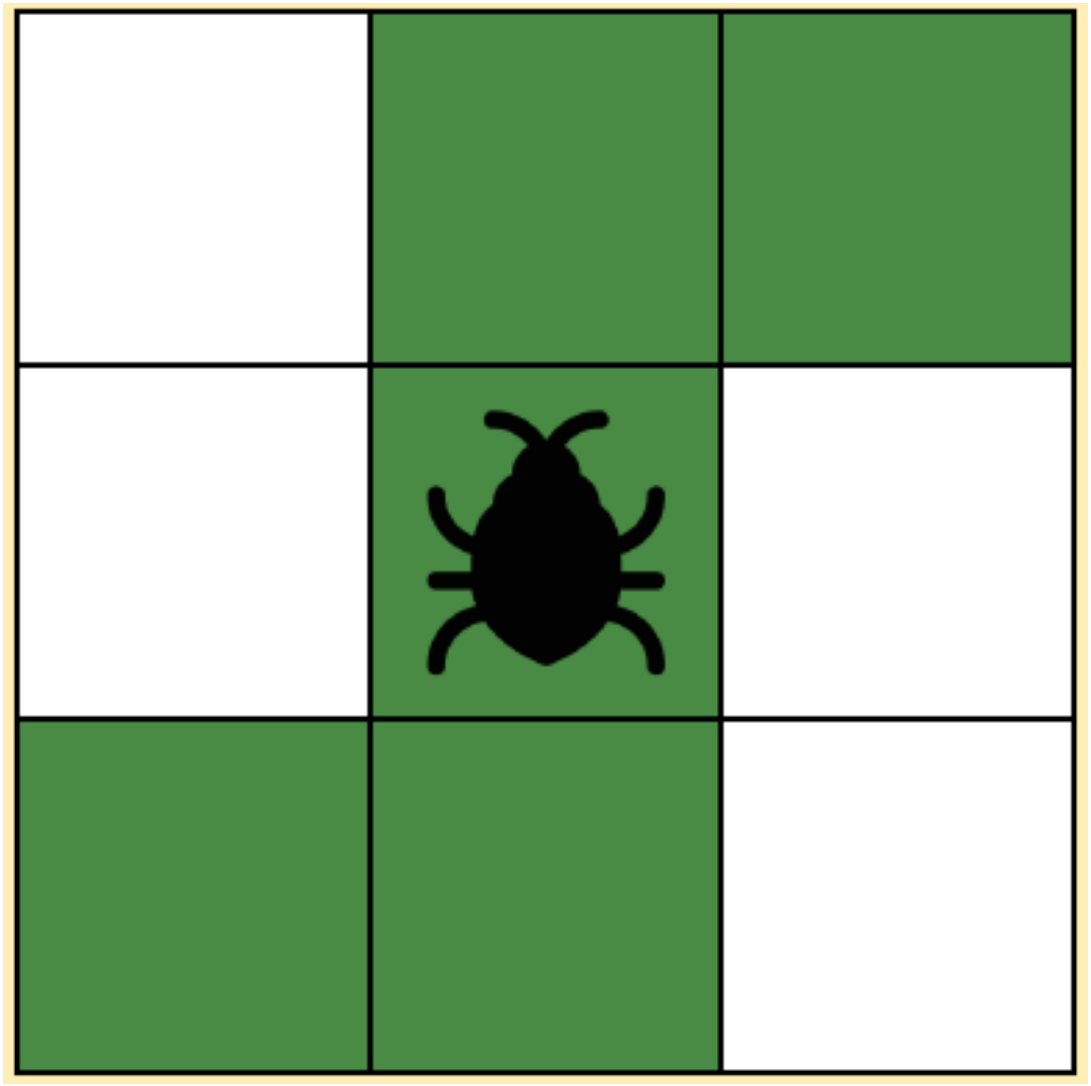
Koch et al. (2018) *Forest Ecol. Manage.*

Street Tree Abundance



Hudgins et al. (2022). Journal of Applied Ecology

Simulated Invasion Dynamics



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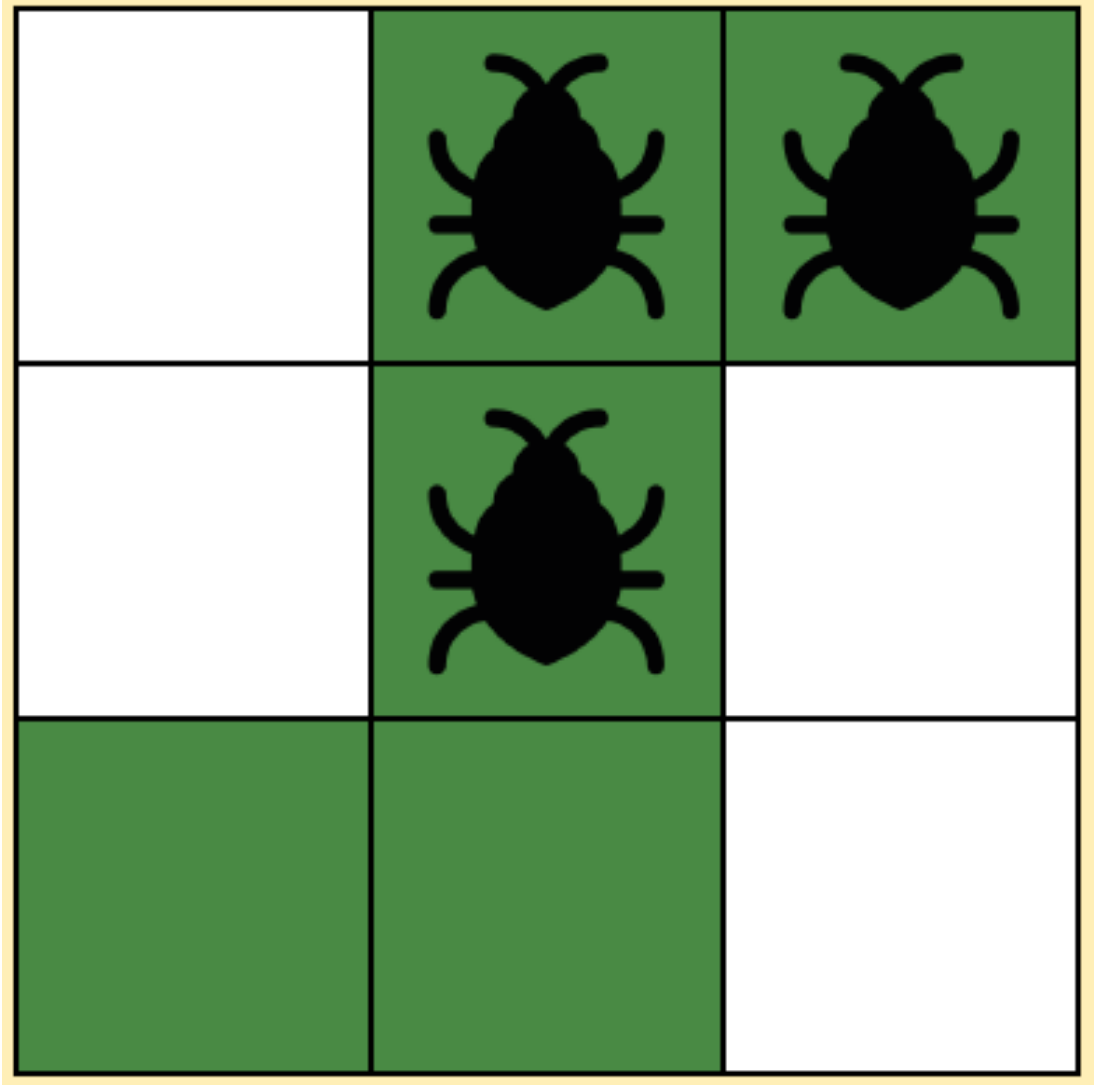
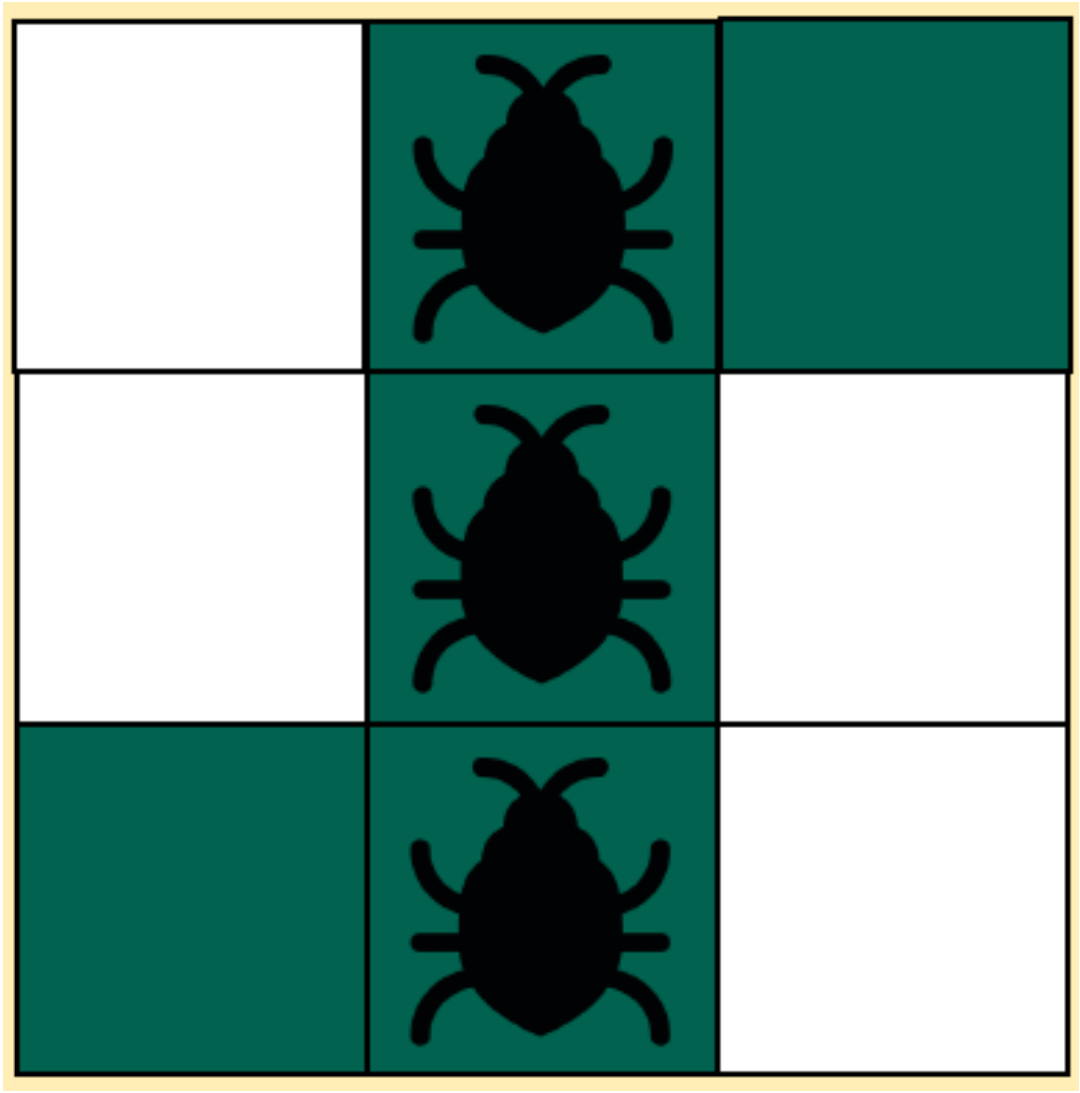


True Invasion Dynamics



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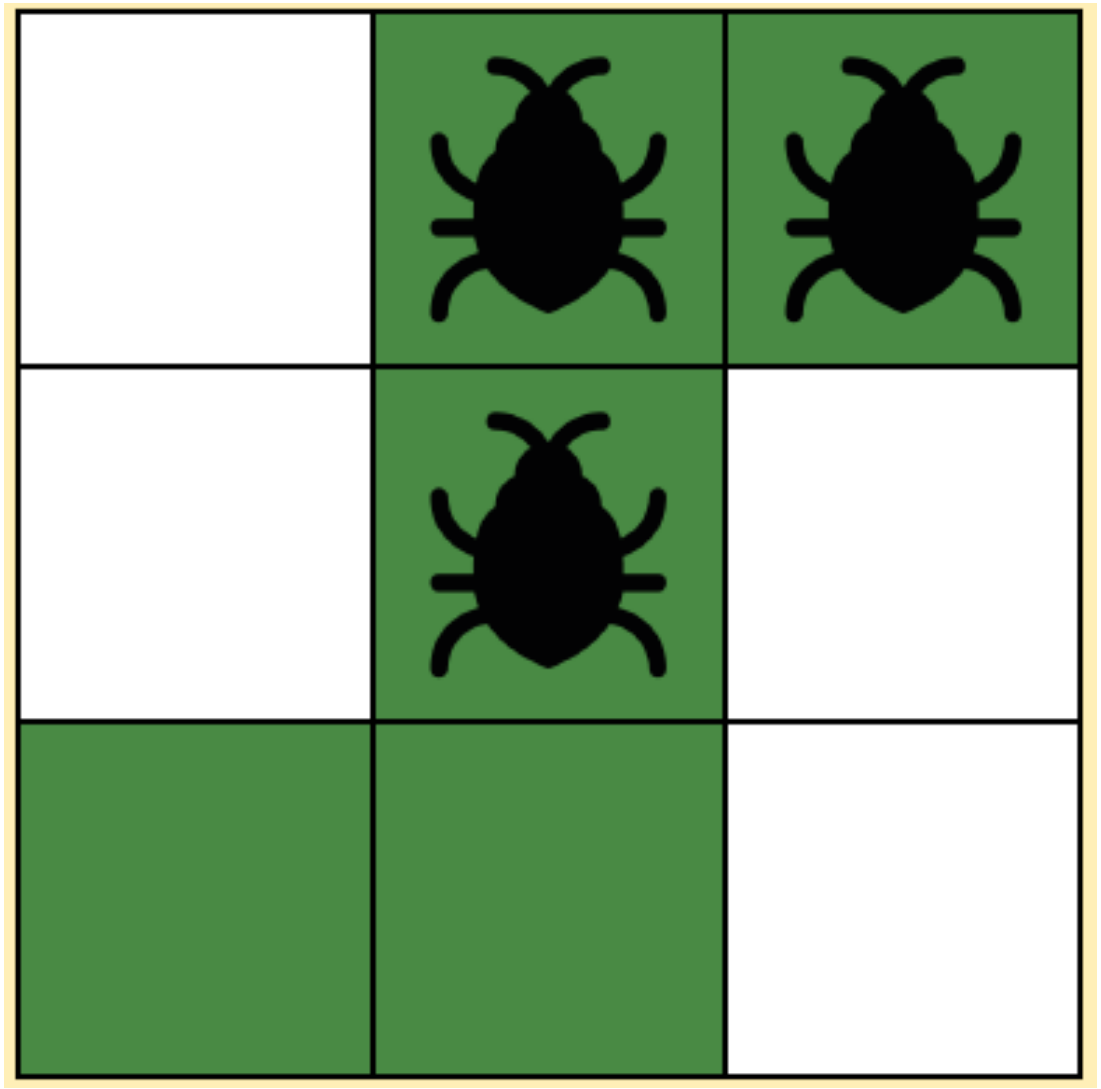

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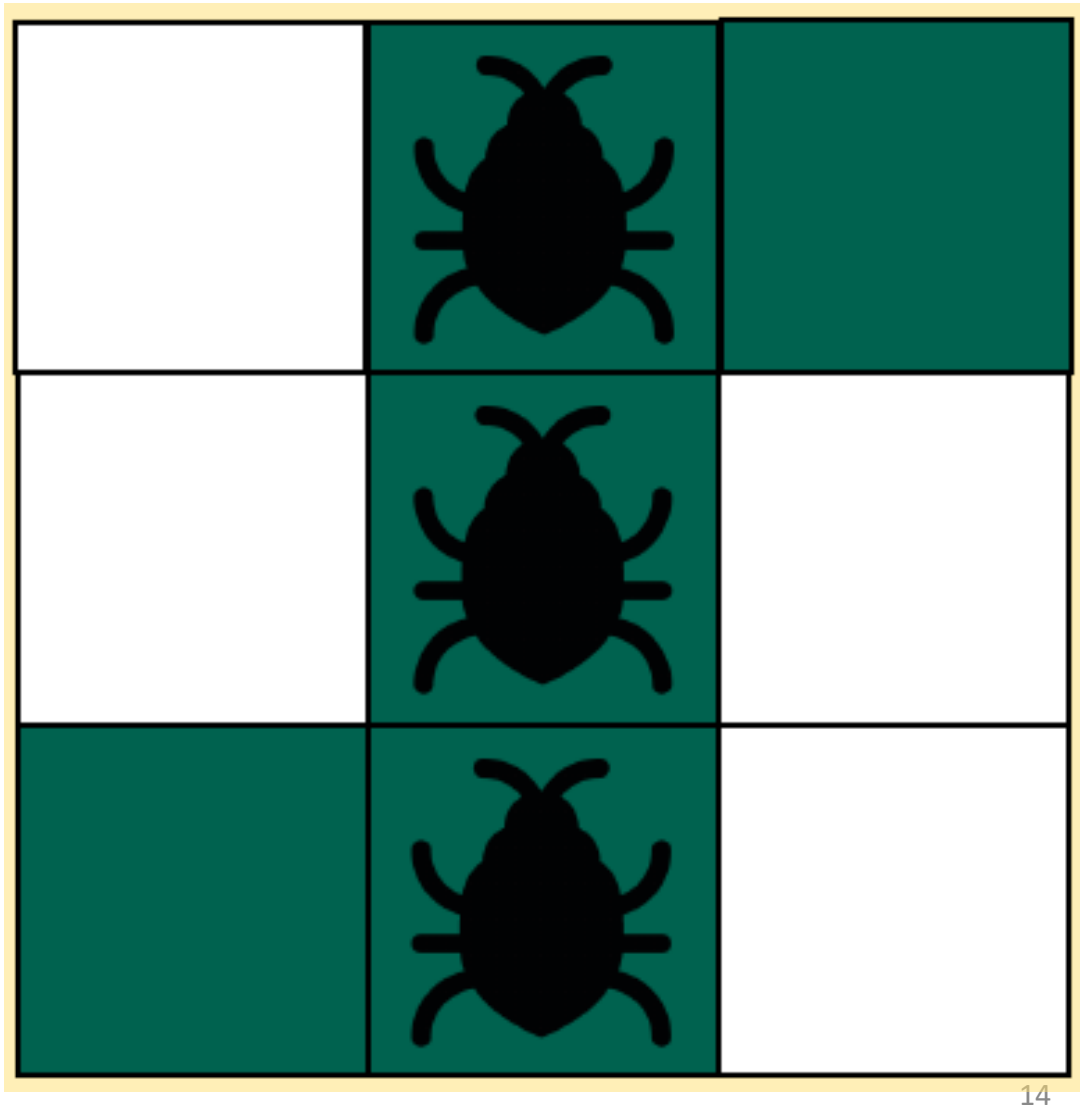
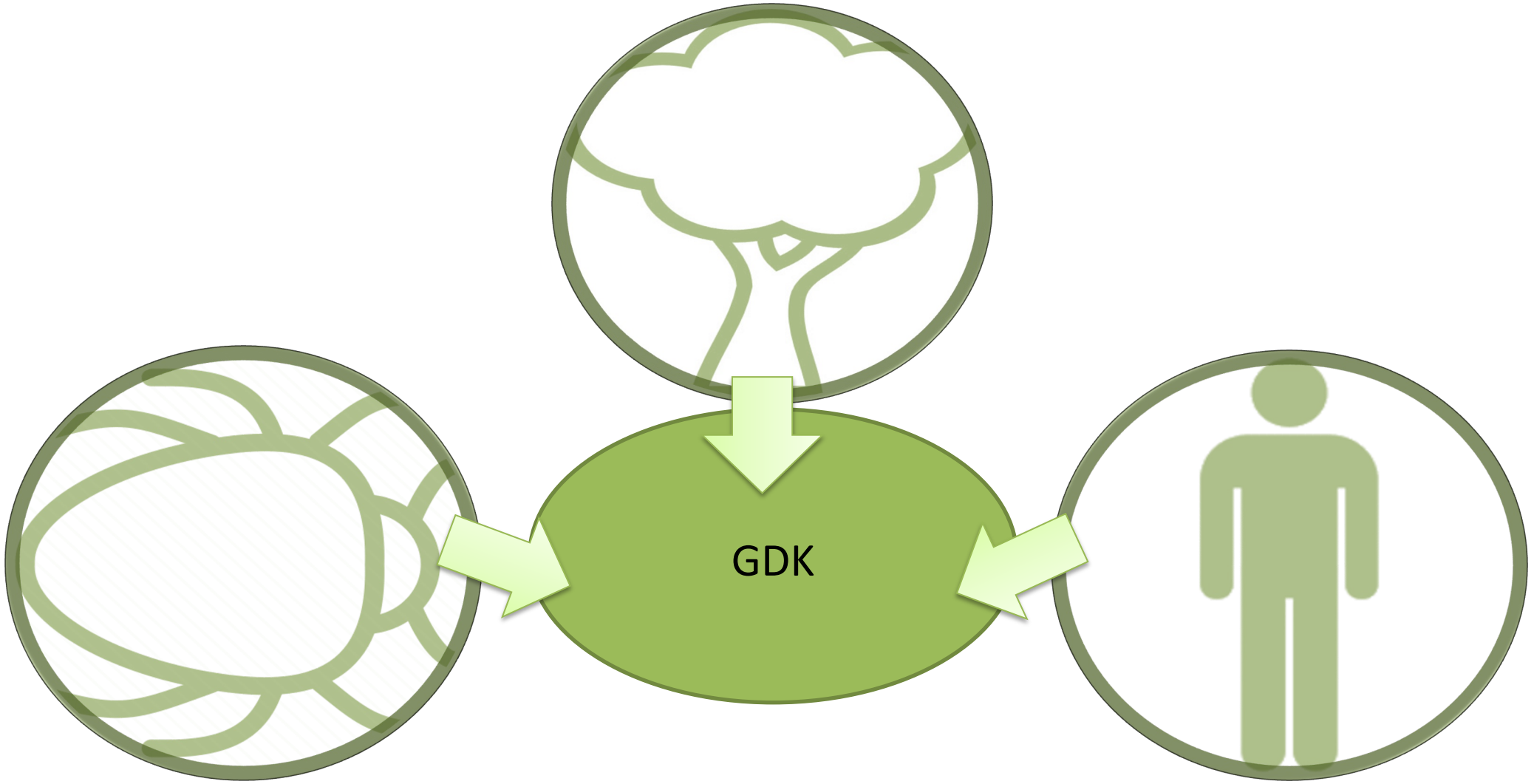
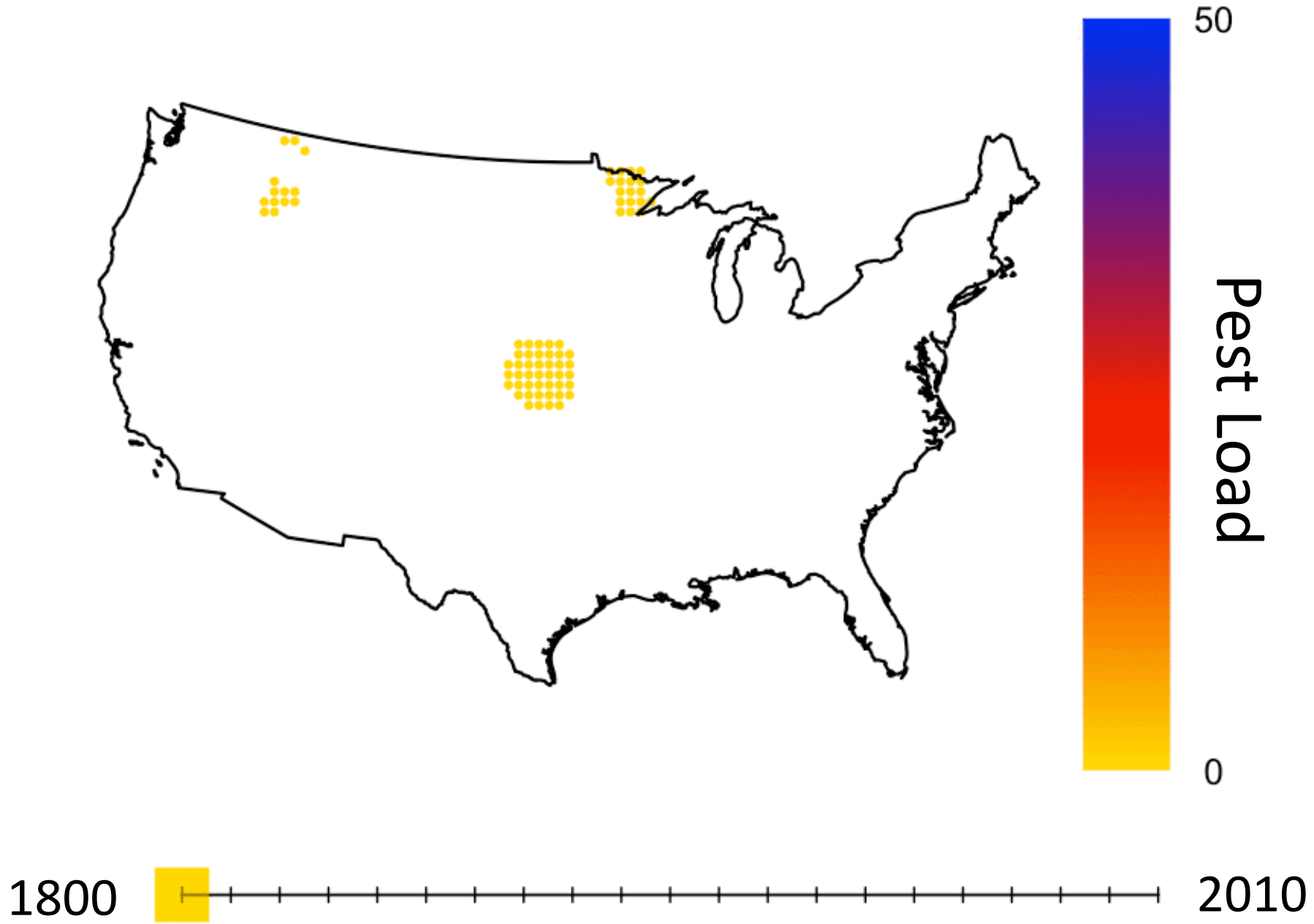


Generalized Dispersal Kernel

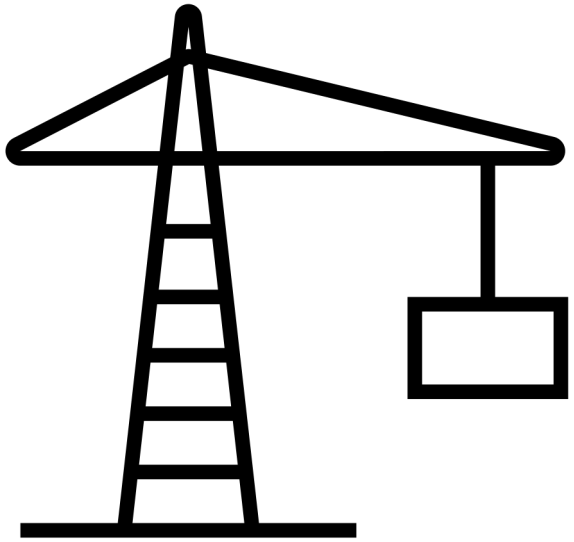


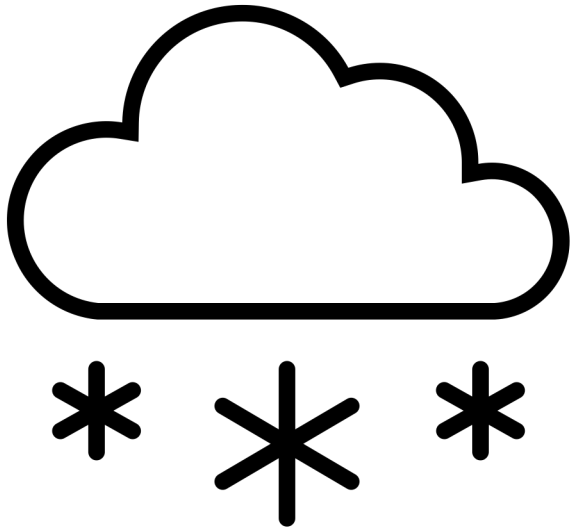
Hudgins et al. (2017) *Ecology Letters*



Hudgins et al. (2017) *Ecology Letters*

Species-specific model correction

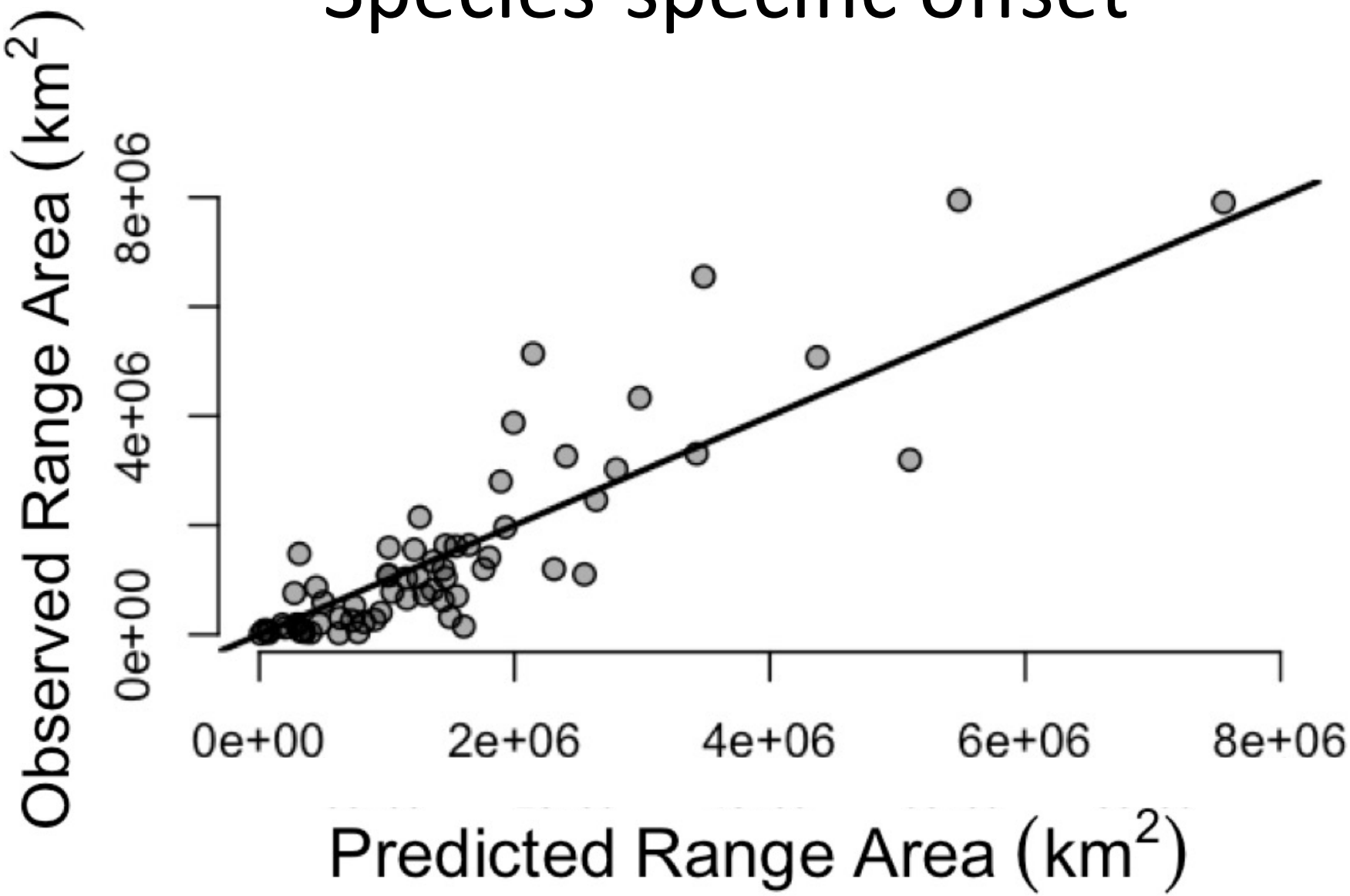




http://www.carolinamountain.org

Hudgins, Liebhold & Leung (2019) *Ecological Applications*

Species-specific offset



Hudgins, Liebhold & Leung (2019) *Ecological Applications*

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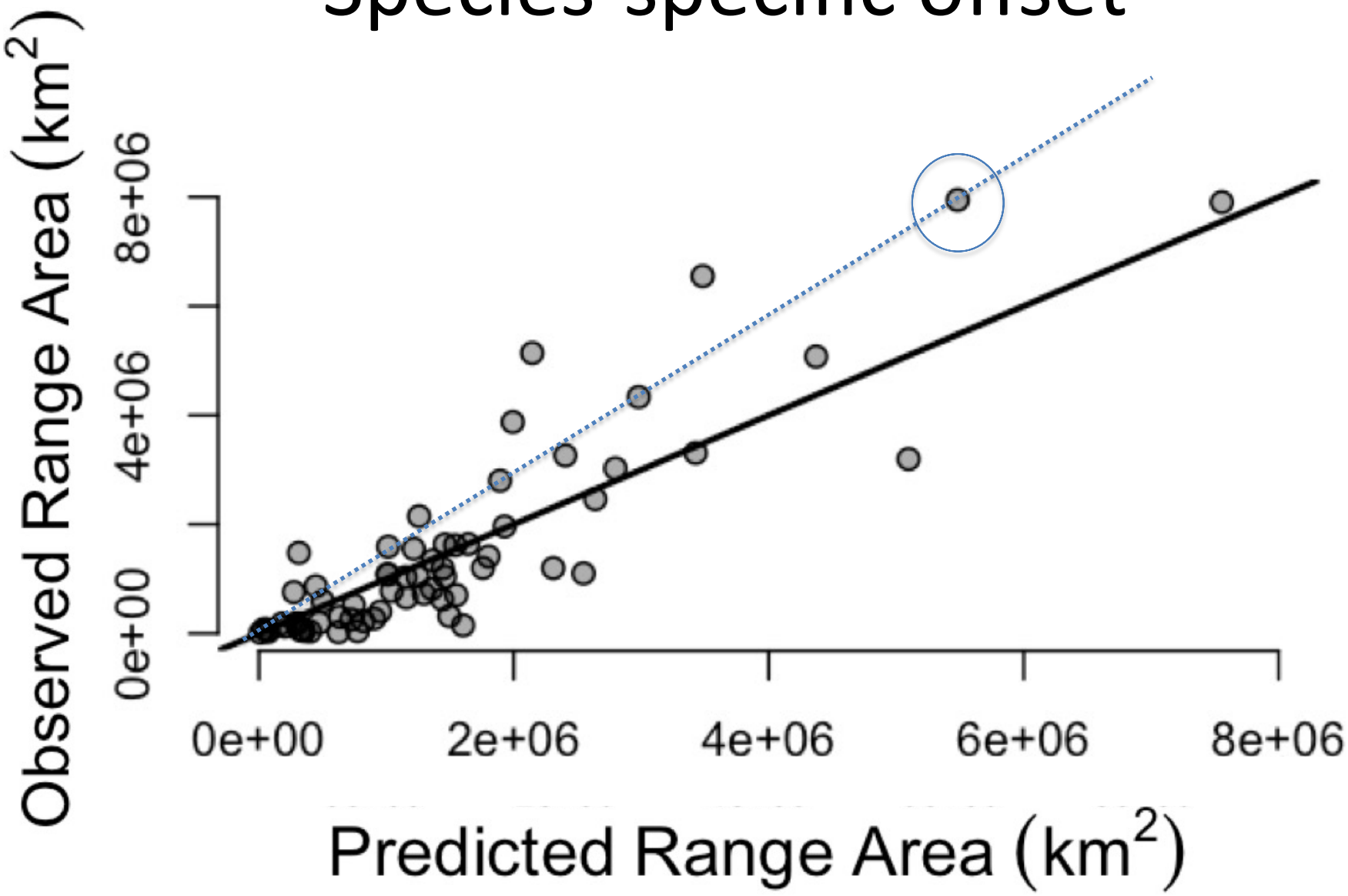
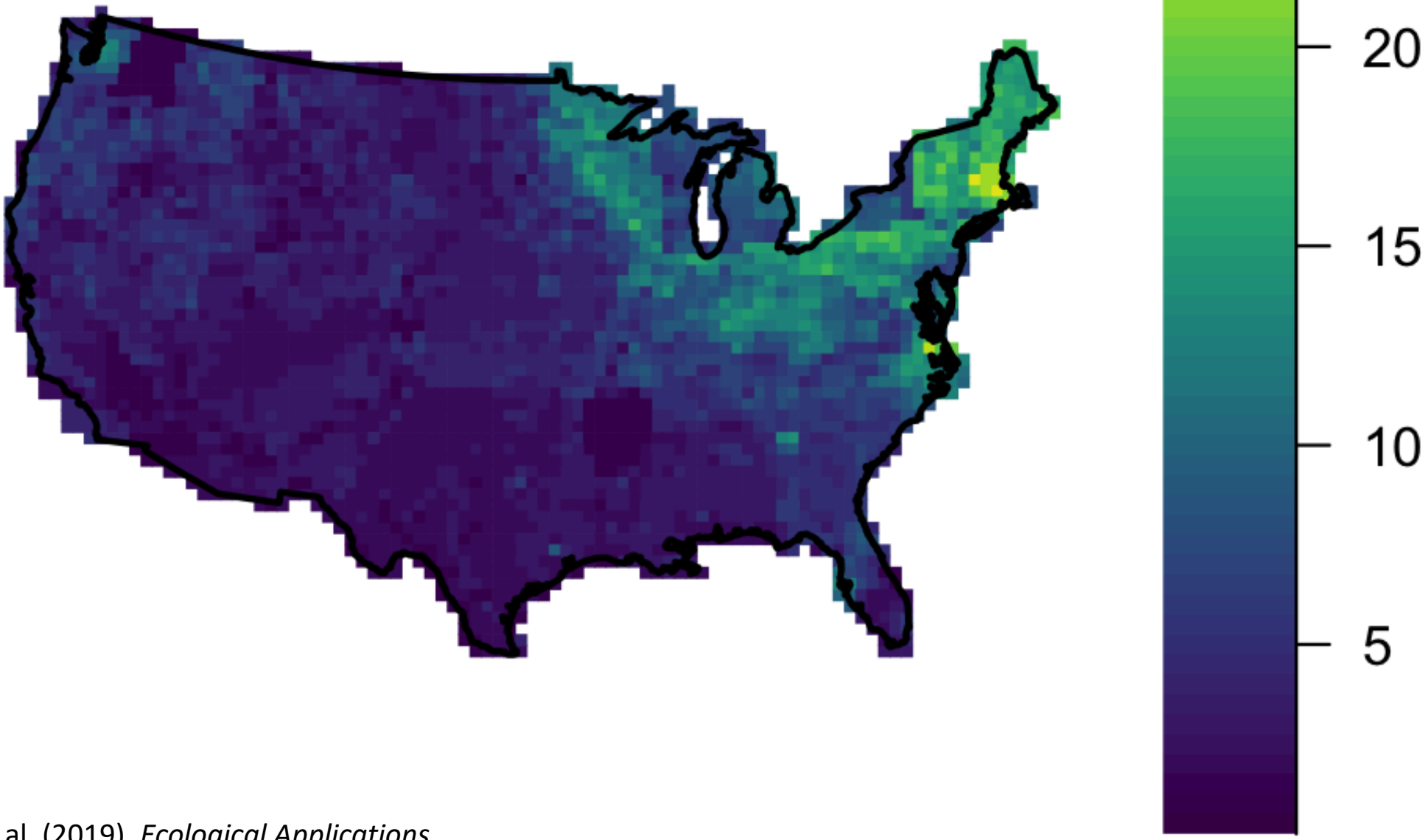


Hudgins, Liebhold & Leung (2019) *Ecological Applications*

Future insect spread



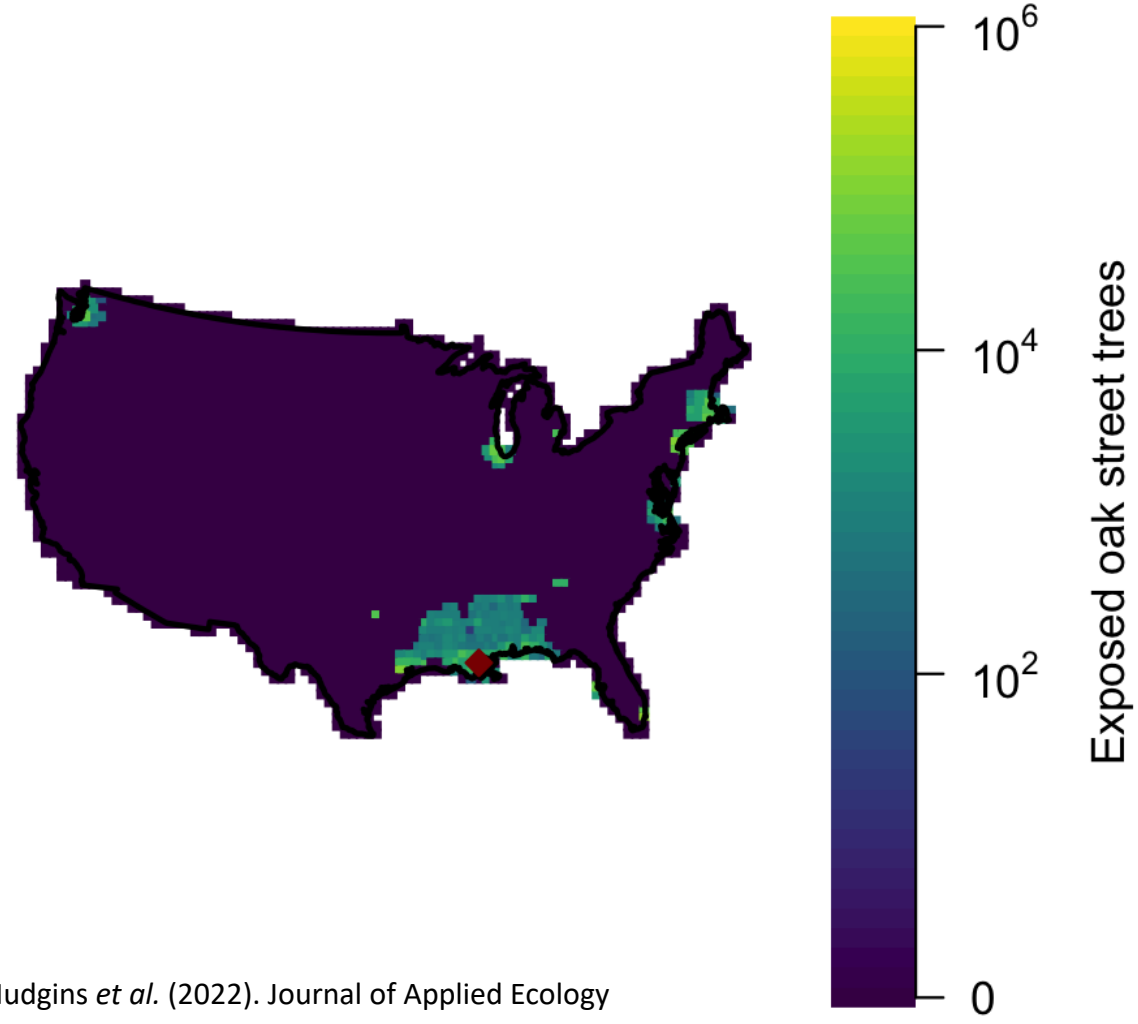
From Hudgins et al. (2019). *Ecological Applications*

Extrapolation to non-established species

A future Asian wood borer of maple and oak →

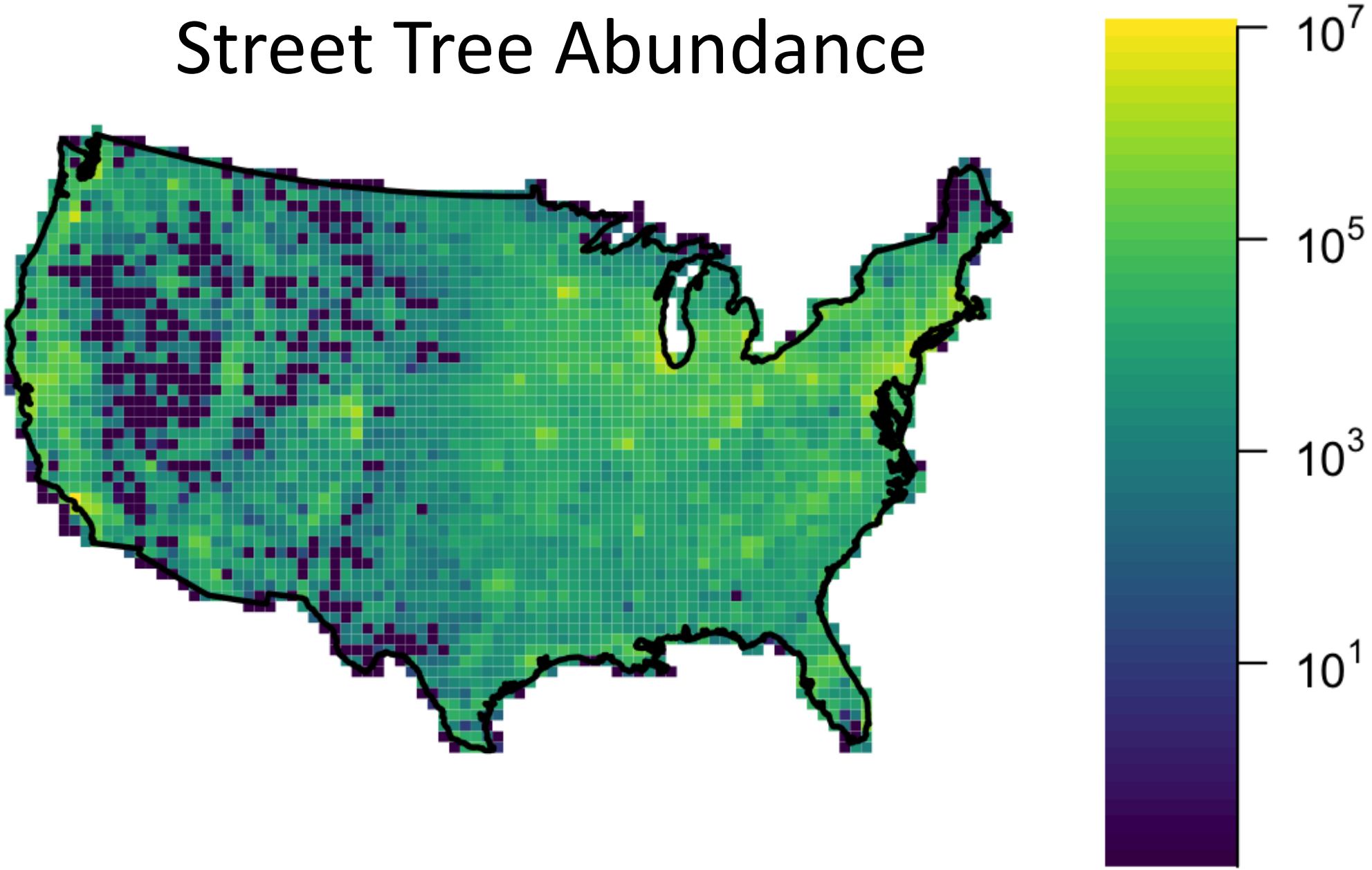
~US$5 B in predicted damages (2020-2050)

Citrus longhorned beetle (*Anoplophora chinensis)*



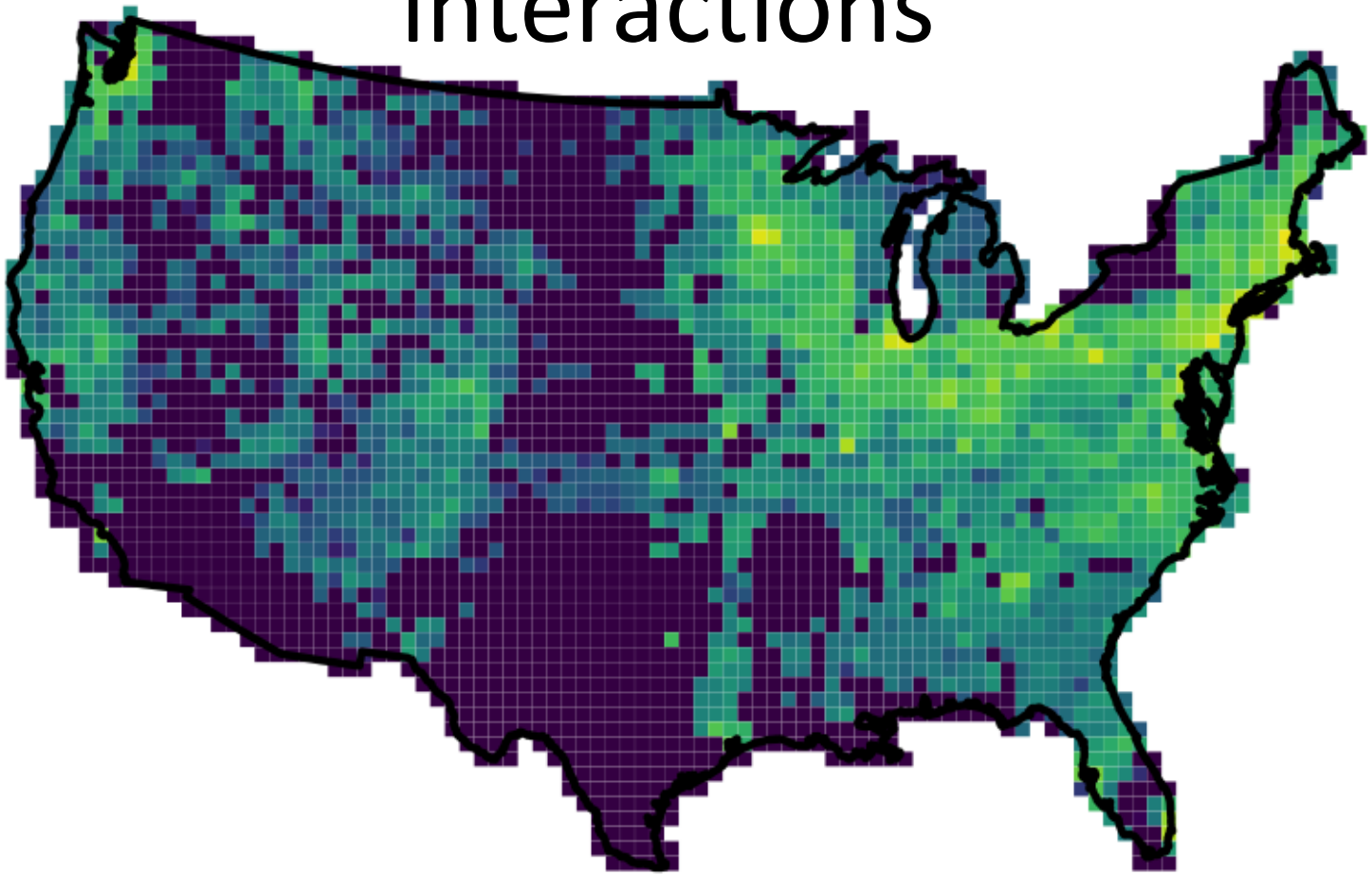
Hudgins *et al.* (2022). Journal of Applied Ecology

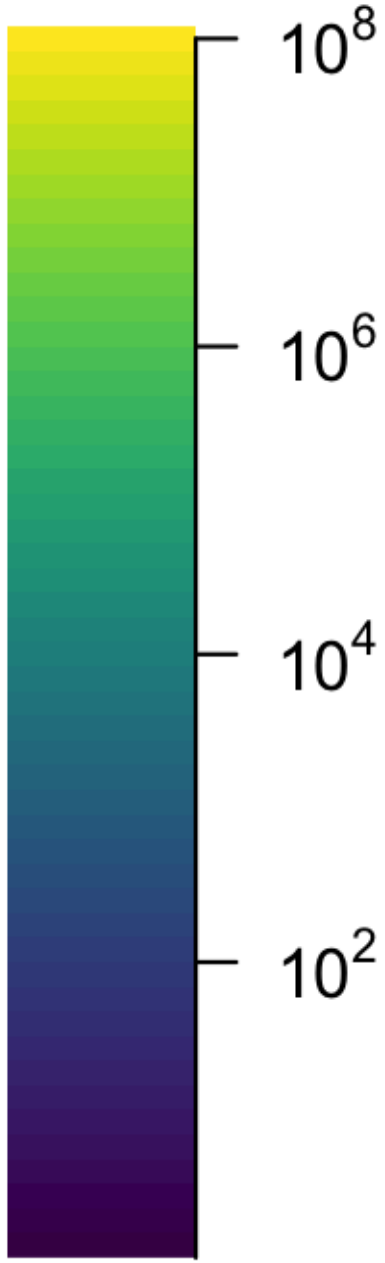
Street Tree Abundance



Hudgins et al. (2022). Journal of Applied Ecology

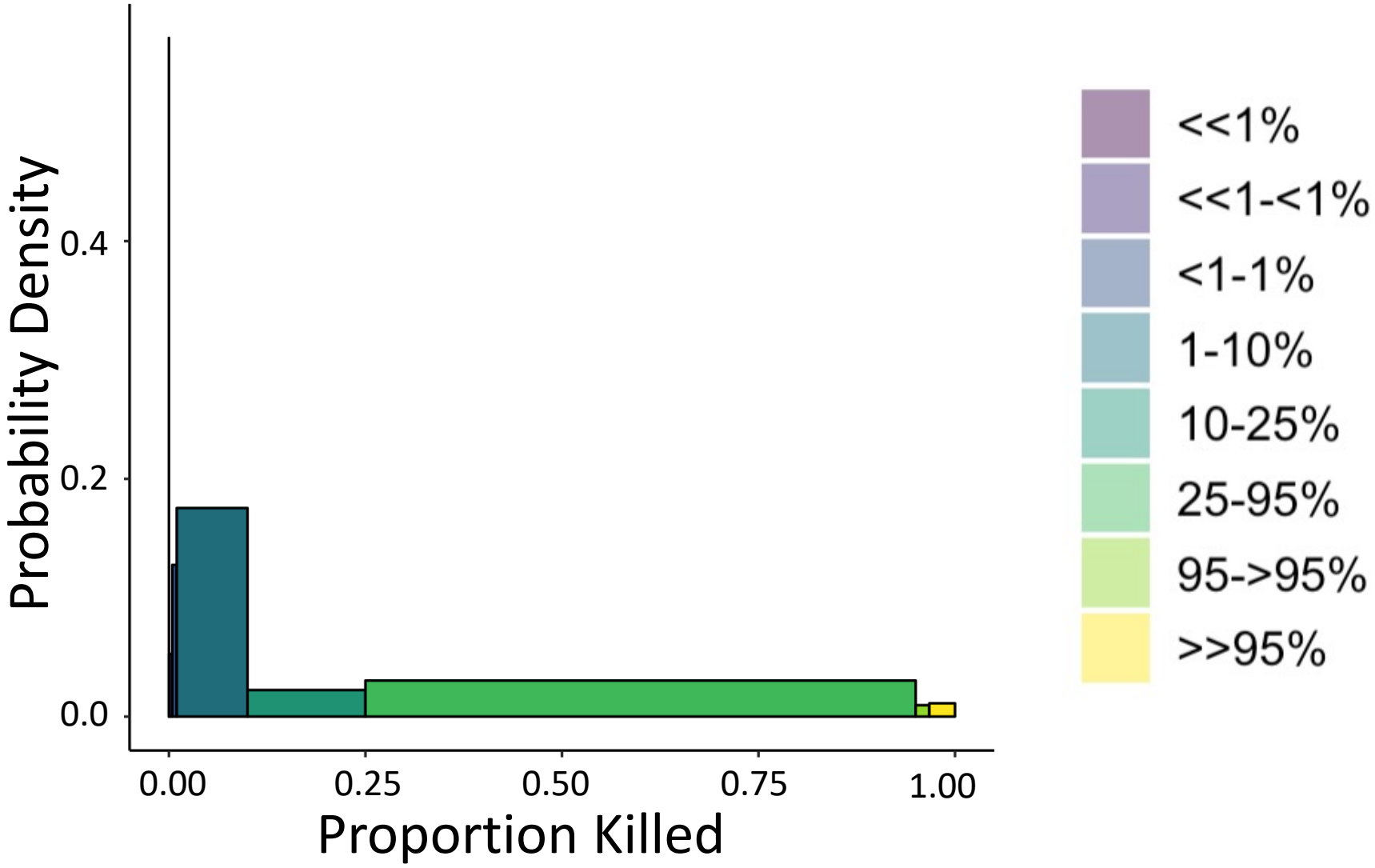
Future street tree-insect interactions



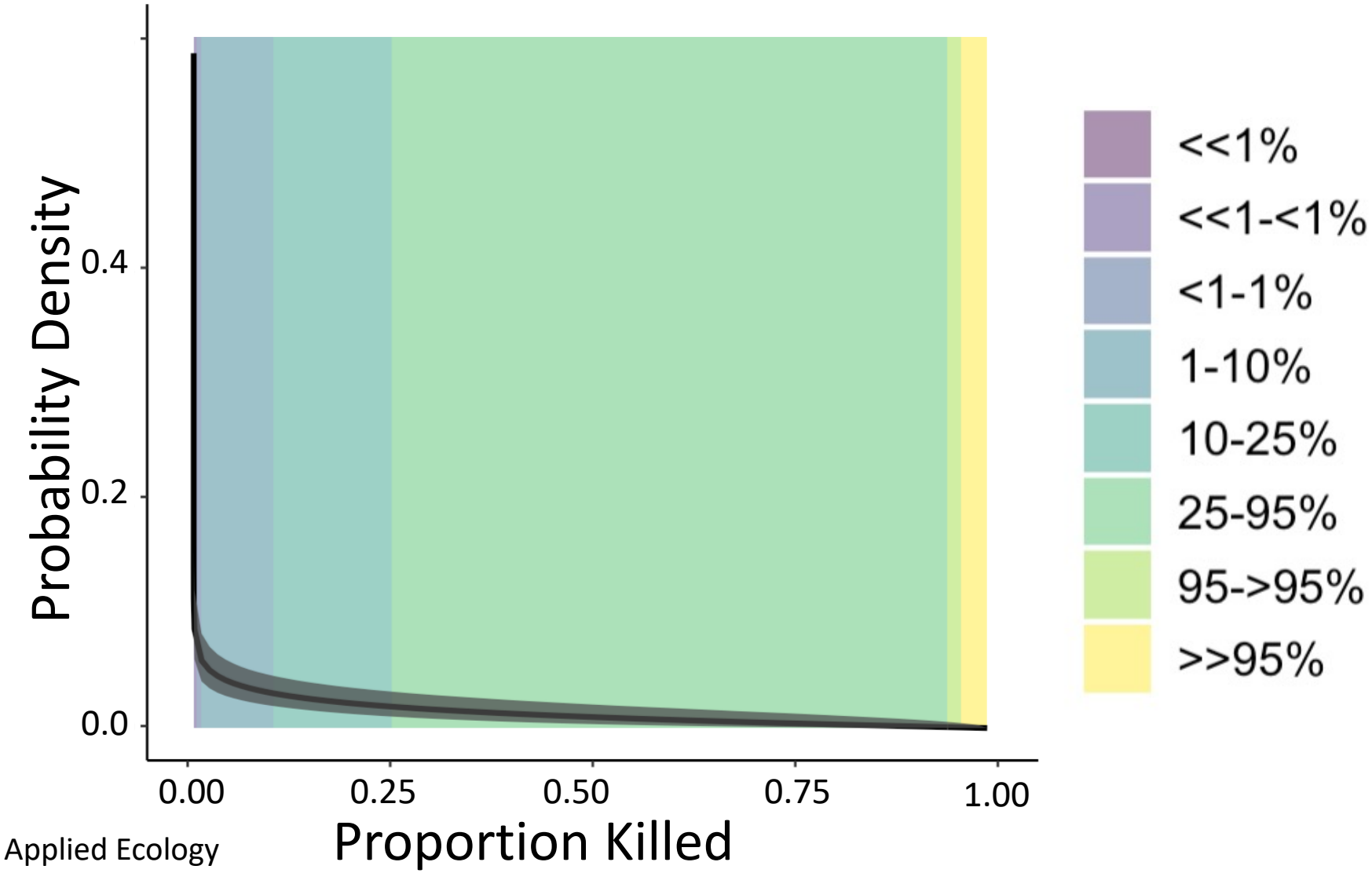


Hudgins et al. (2022) *Journal of Applied Ecology*

Street Tree Mortality



Street tree mortality



Hudgins *et al. 2022* Journal of Applied Ecology

Damage estimates to 2050

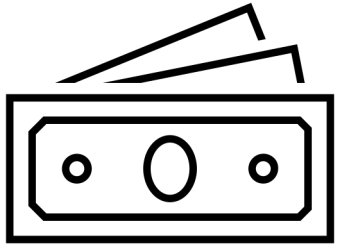
1.5M trees killed

94% in 23% of communities

$31M USD/yr, $907M total

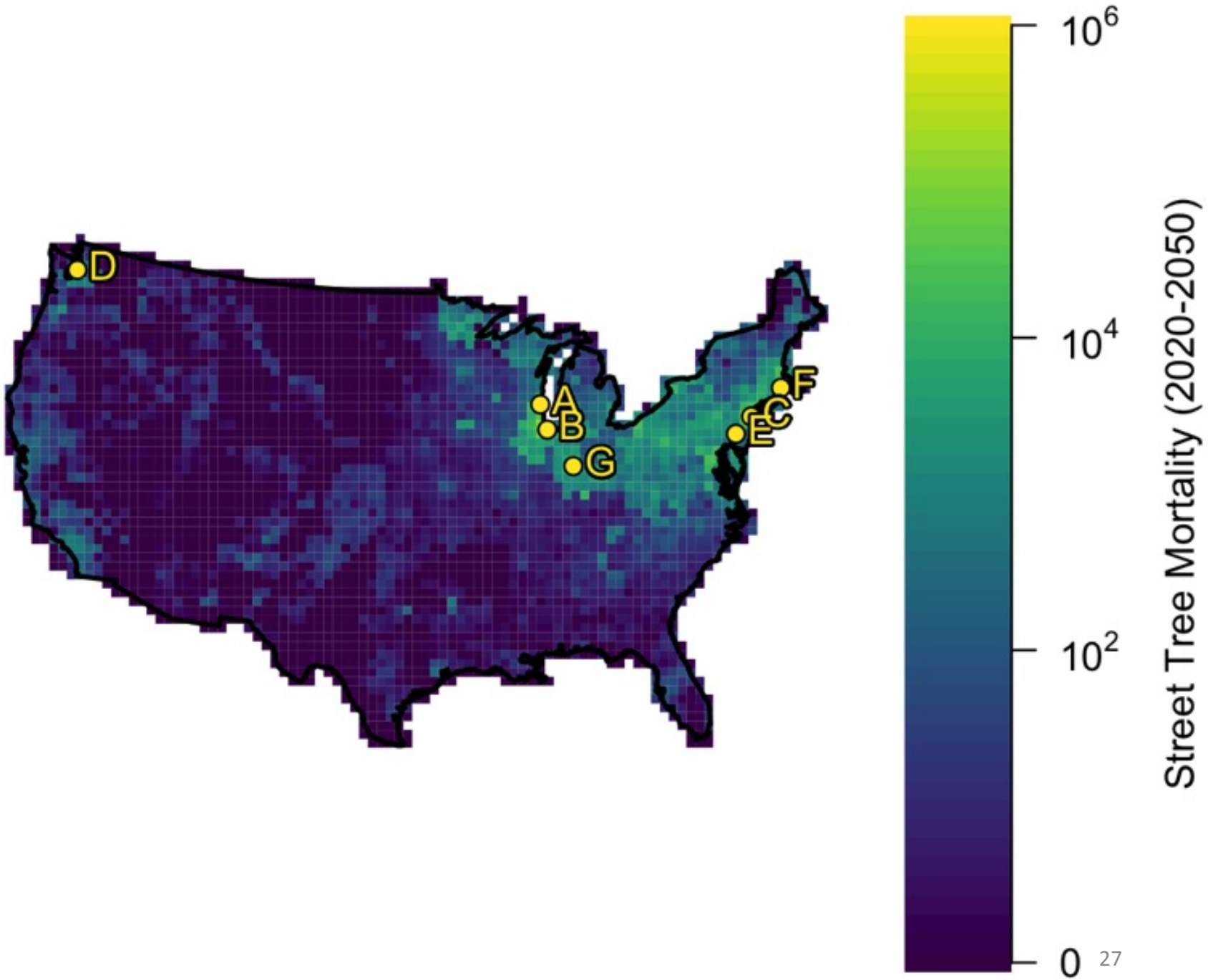
Hudgins *et al.* 2022. Journal of Applied Ecology

Triblive.com



damages up to $13M

A. Milwaukee, WI
B. Chicago Region, IL
C. New York City, NY
D. Seattle, WA
E. Philadelphia, PA
F. Warwick, RI
G. Indianapolis, IN



Hudgins *et al.* 2022. Journal of Applied Ecology

So far

- Focused on getting the best estimate of the current situation
- Descriptive rather than prescriptive
- Doesn’t take into account which management options are available, budget, and interactive effect of spread

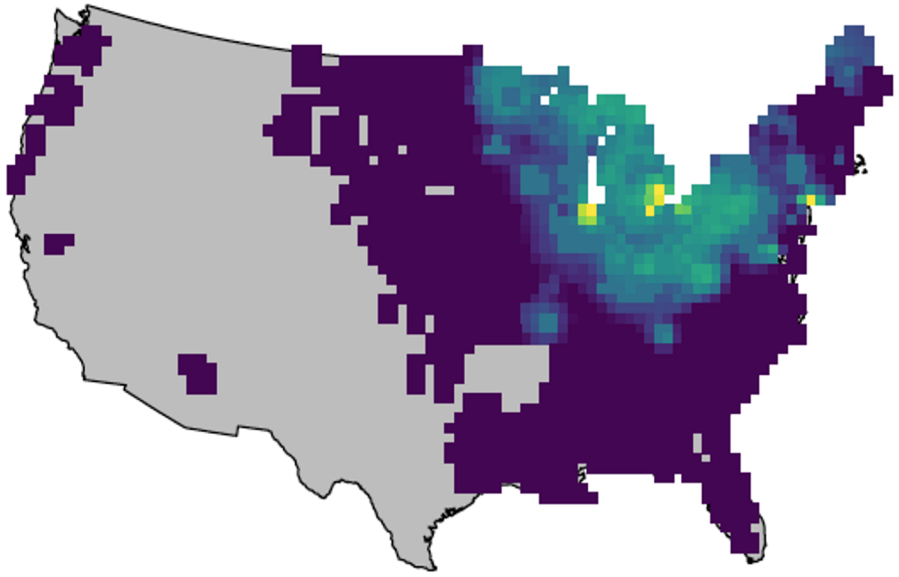
1. Recap: Economic models of invasion impacts

- Most future US street tree impacts will be due to emerald ash borer
- Most impacts in urban centres in Midwest and Northeast

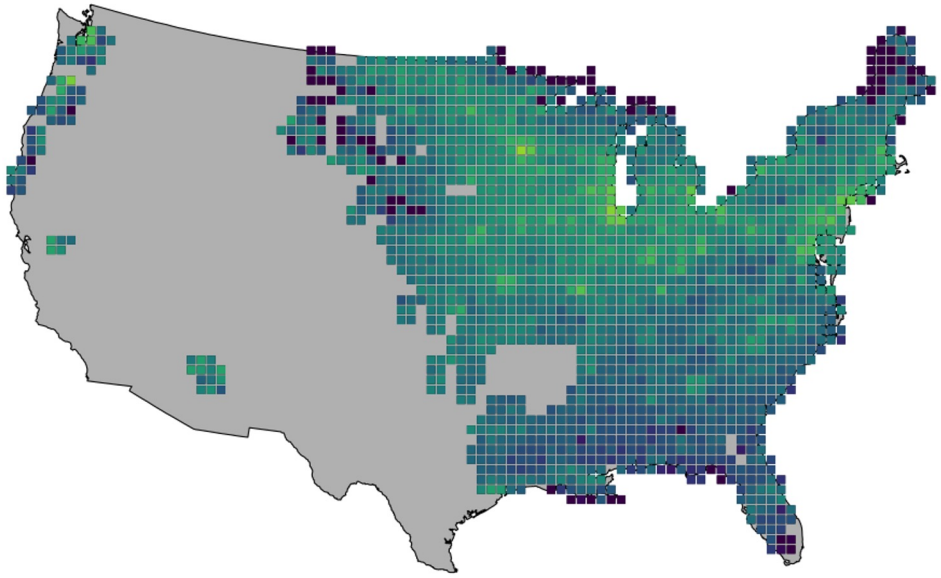
2. Optimal Emerald Ash Borer management

Hudgins, E.J., Hanson, J.O., MacQuarrie, C., Yemshanov, D., McDonald-Madden, E., Holden, M., Baker, C., Bennett, J.R., *2024. Conservation Science and Practice.*

Predicted EAB density



Predicted street ash

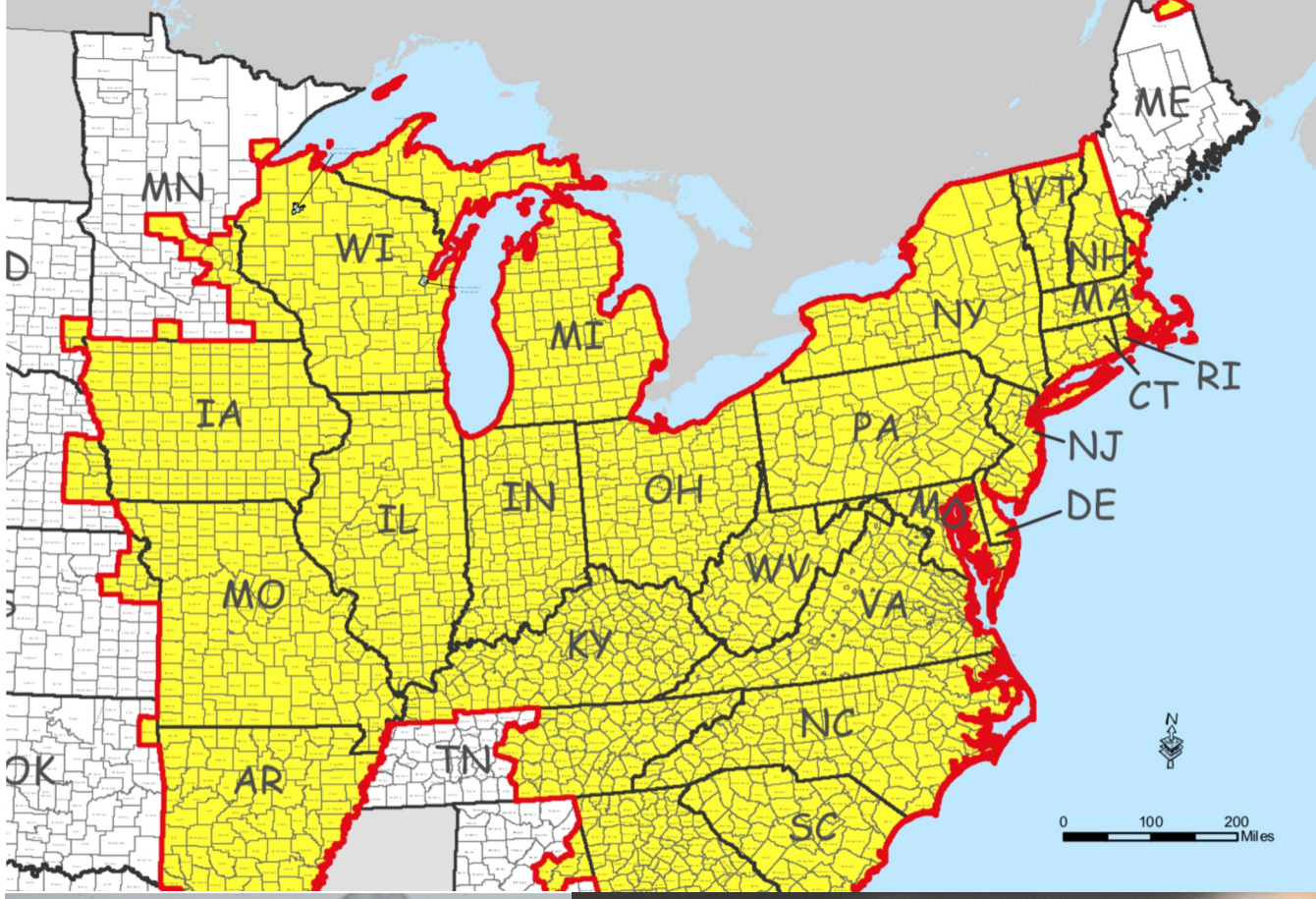


Management Actions

Immigration Quarantine

Emigration Quarantine

Biological control release

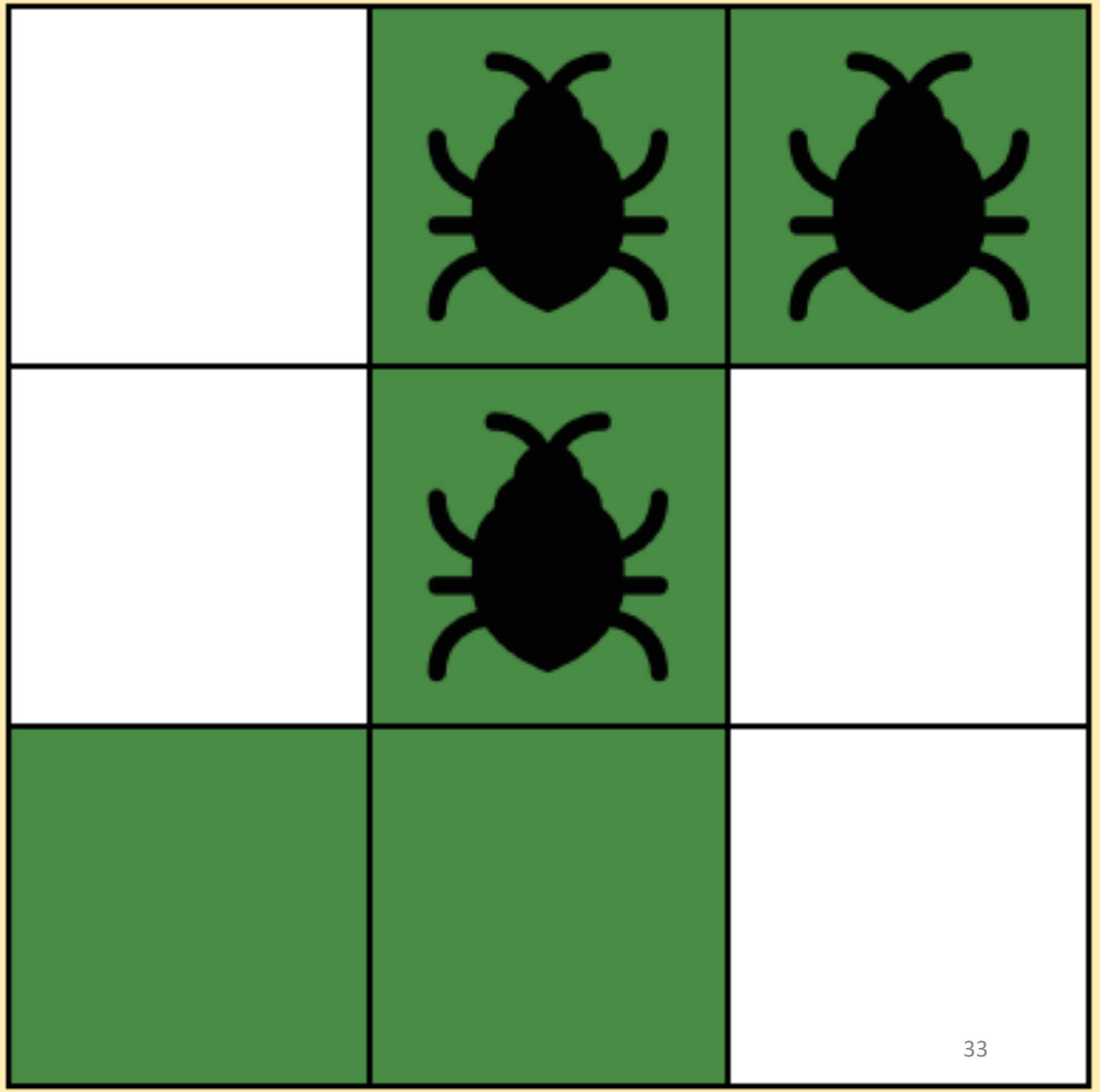


Rationale

Immigration Quarantines limit **dispersal in**

Emigration Quarantines limit **dispersal out**

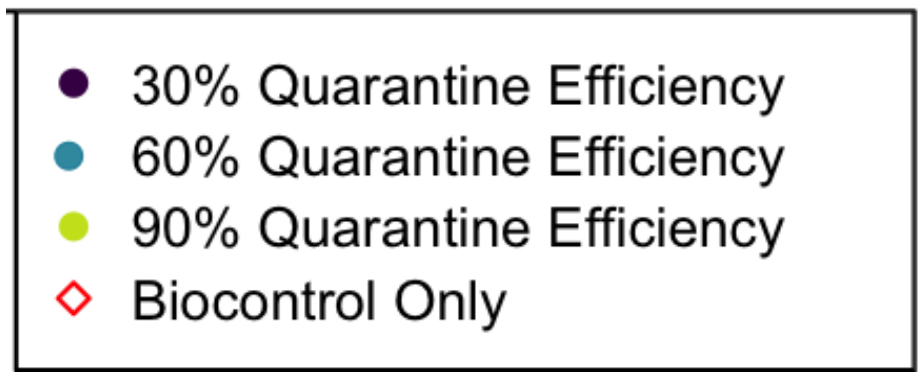
Biological control reduces **focal densities**

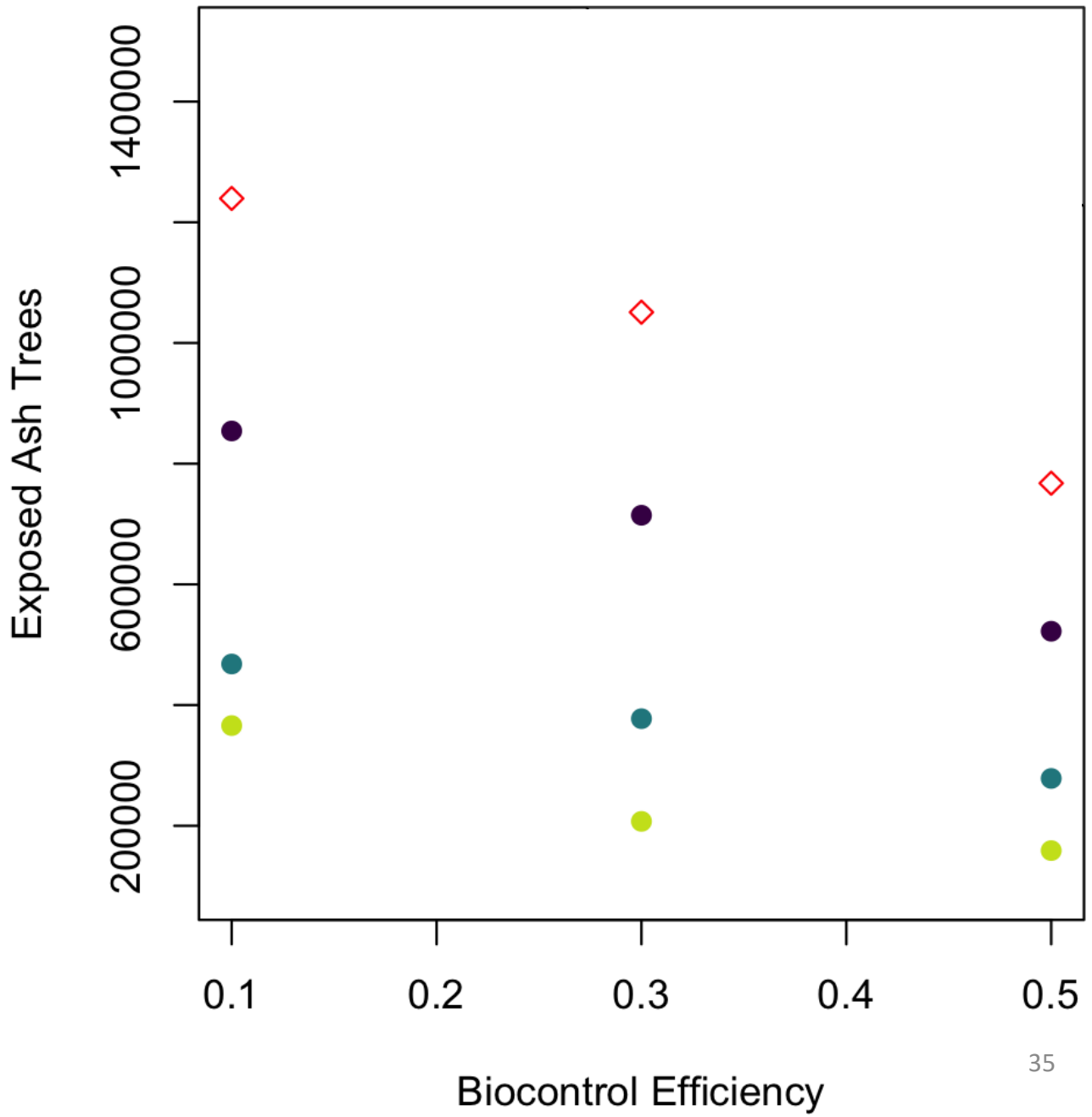


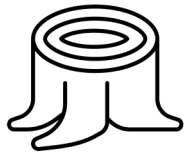
Parasitoid spread

Parasitoids reach 50% of max effectiveness after 1 timestep, 100% after 2 timesteps

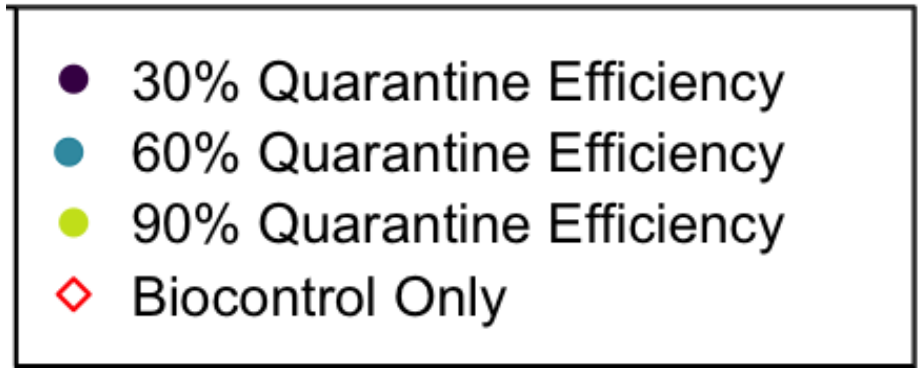
Parasitoids can disperse to neighbouring cells after 5 years

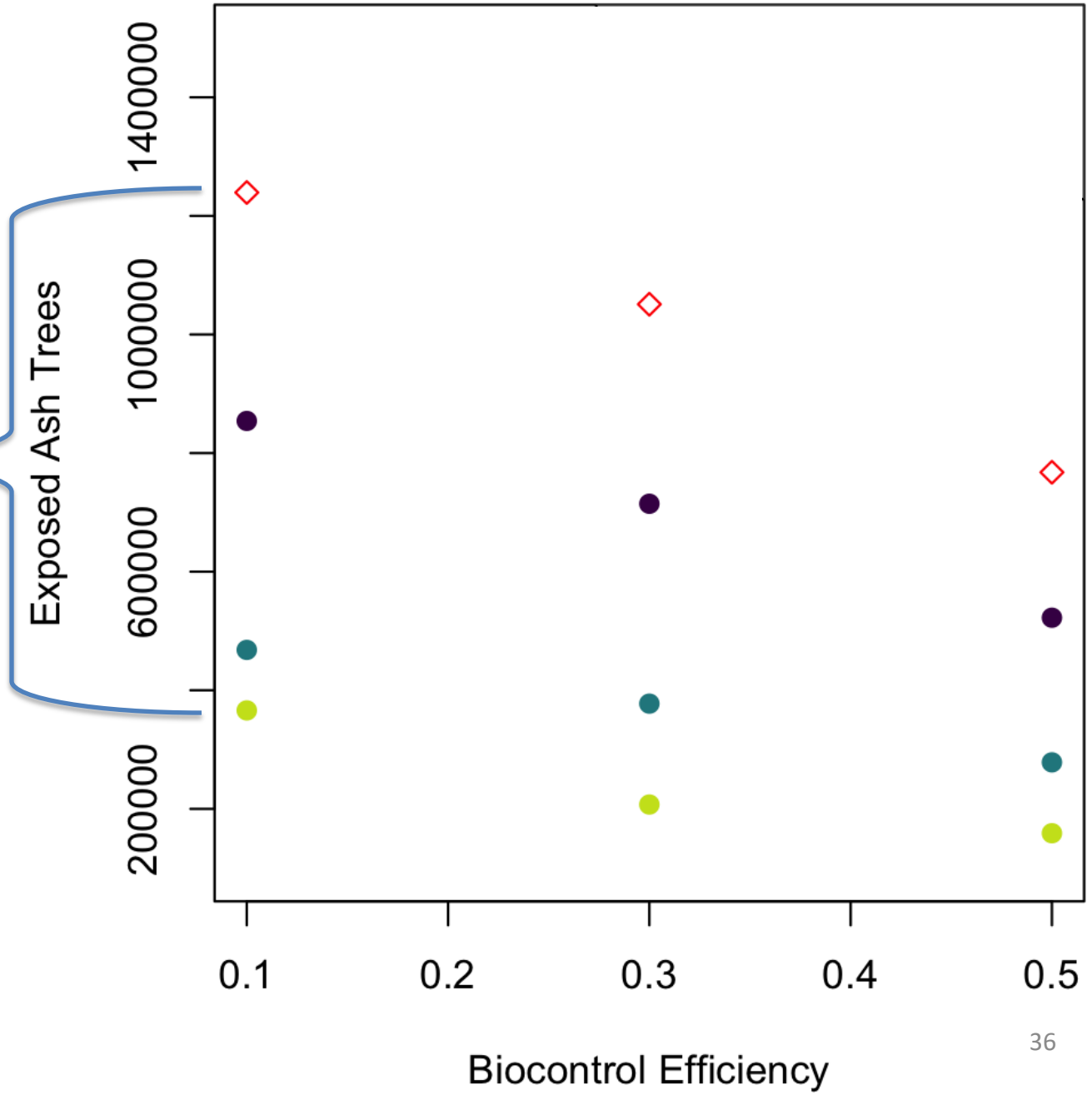

30% Quarantine Efficiency
60% Quarantine Efficiency
90% Quarantine Efficiency
Biocontrol Only


Exposed Ash Trees
200000
600000
1000000
1400000
0.1
0.2
0.3
0.4
0.5
Biocontrol Efficiency

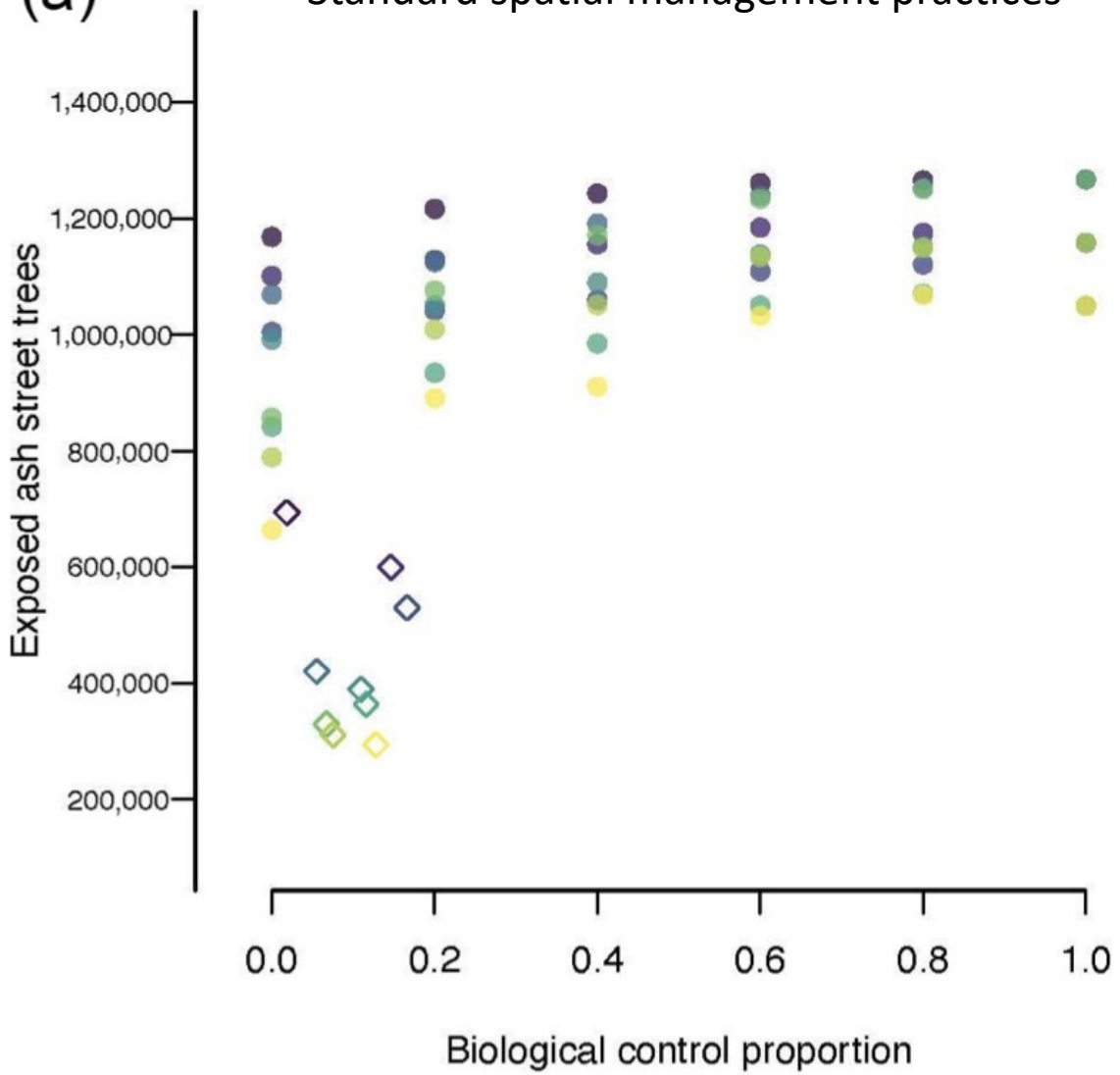


Up to **1 million street trees** saved in the next 30 years

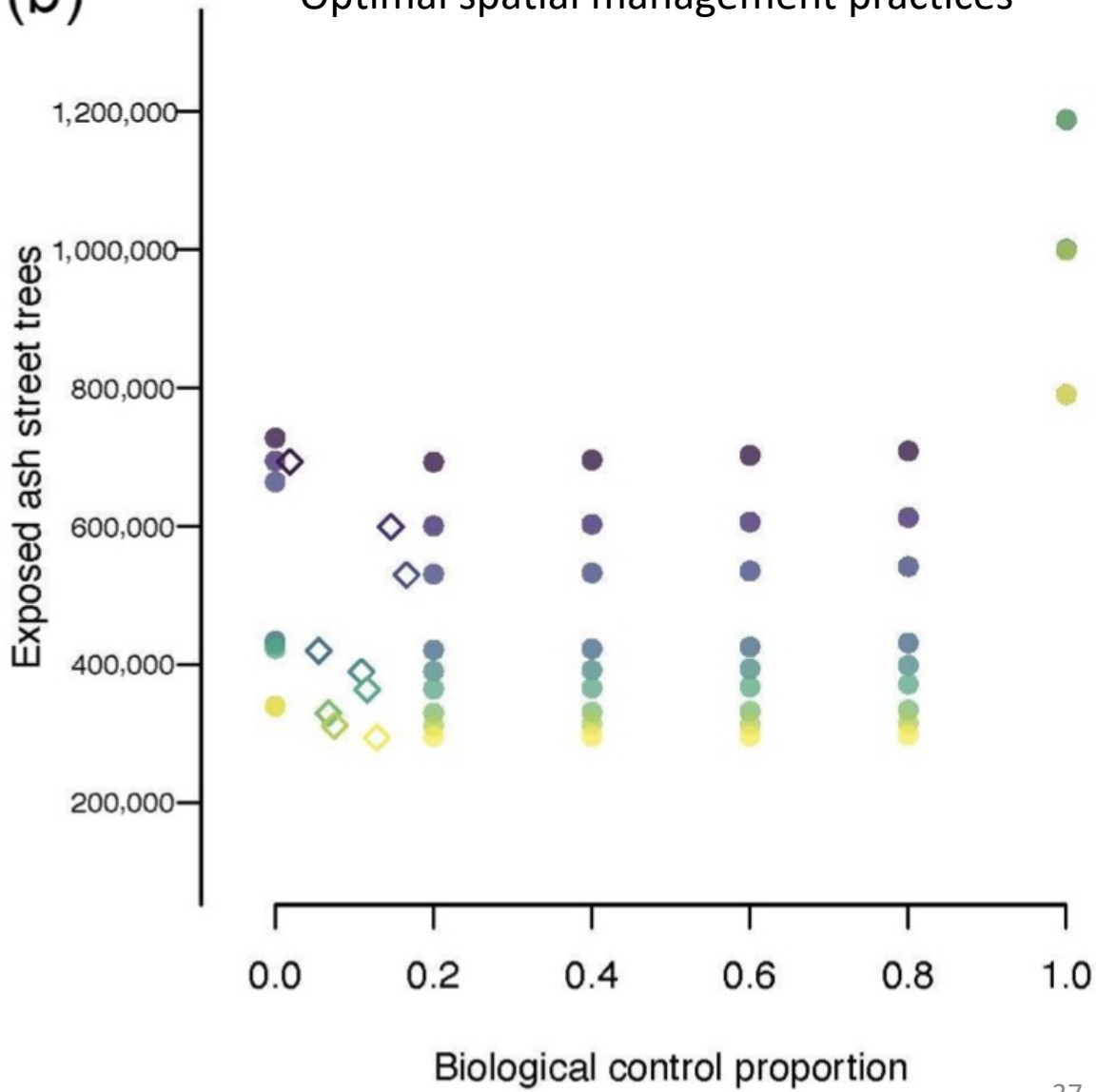




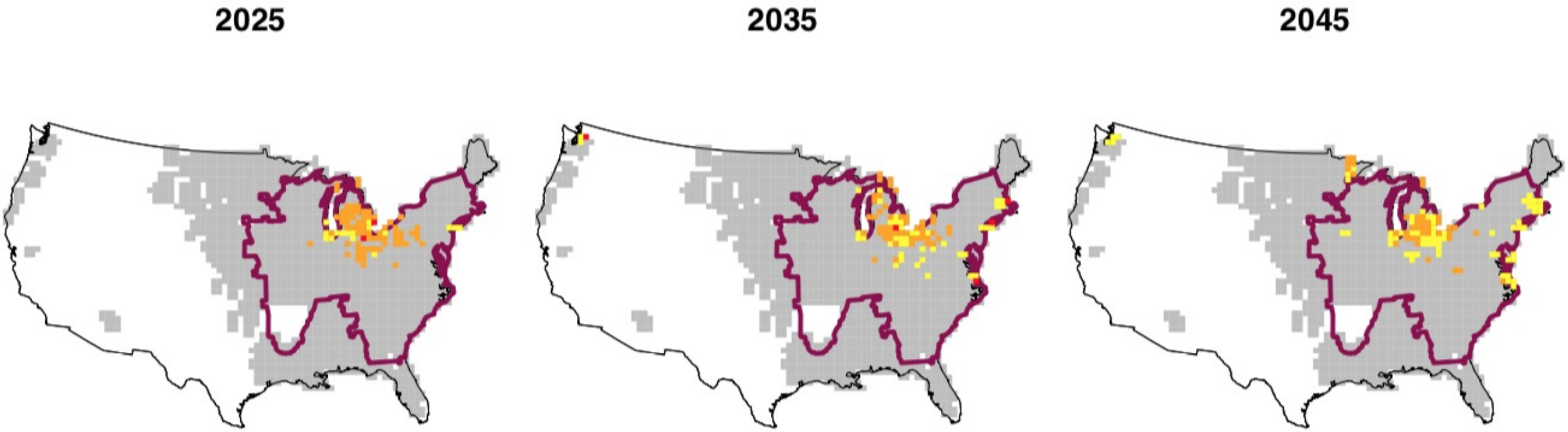
(a) Standard spatial management practices



(b) Optimal spatial management practices



Optimal spatial management practices



Example biocontrol sites:
Detroit MI, Cleveland OH, Boston MA,
New York, NY

2. Recap: Optimal EAB management

- Conventional management strategies are far from optimal
- Optimizations can lead to huge cost & conservation benefits compared to relying on rules-of-thumb

Acknowledgements

Joseph Bennett & lab, Carleton University

Eve McDonald-Madden & lab, University of Queensland

Brian Leung & lab, McGill University

Christian MacQuarrie & Denys Yemshanov, NRCan-CFS

Leigh Greenwood, Rachel Holmes & Laurel Downs - TNC

Natural Resources Canada
Ressources naturelles Canada
Canadian Forest Service
Service canadien des forêts

McGill University
Carleton University

The University of Queensland
Australia

Fonds de recherche Nature et technologies
Québec

NSERC
CRSNG

Thank you!

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