CFAES

EST. 1870

WE SUSTAIN LIFE

How does Ohio get so many non-native insects?

Samuel F. Ward

Department of Entomology

The Ohio State University

College of Food, Agricultural, and Environmental Sciences

CFAES

EST. 1870

WE SUSTAIN LIFE

How does Ohio get so many non-native insects?

forest ^

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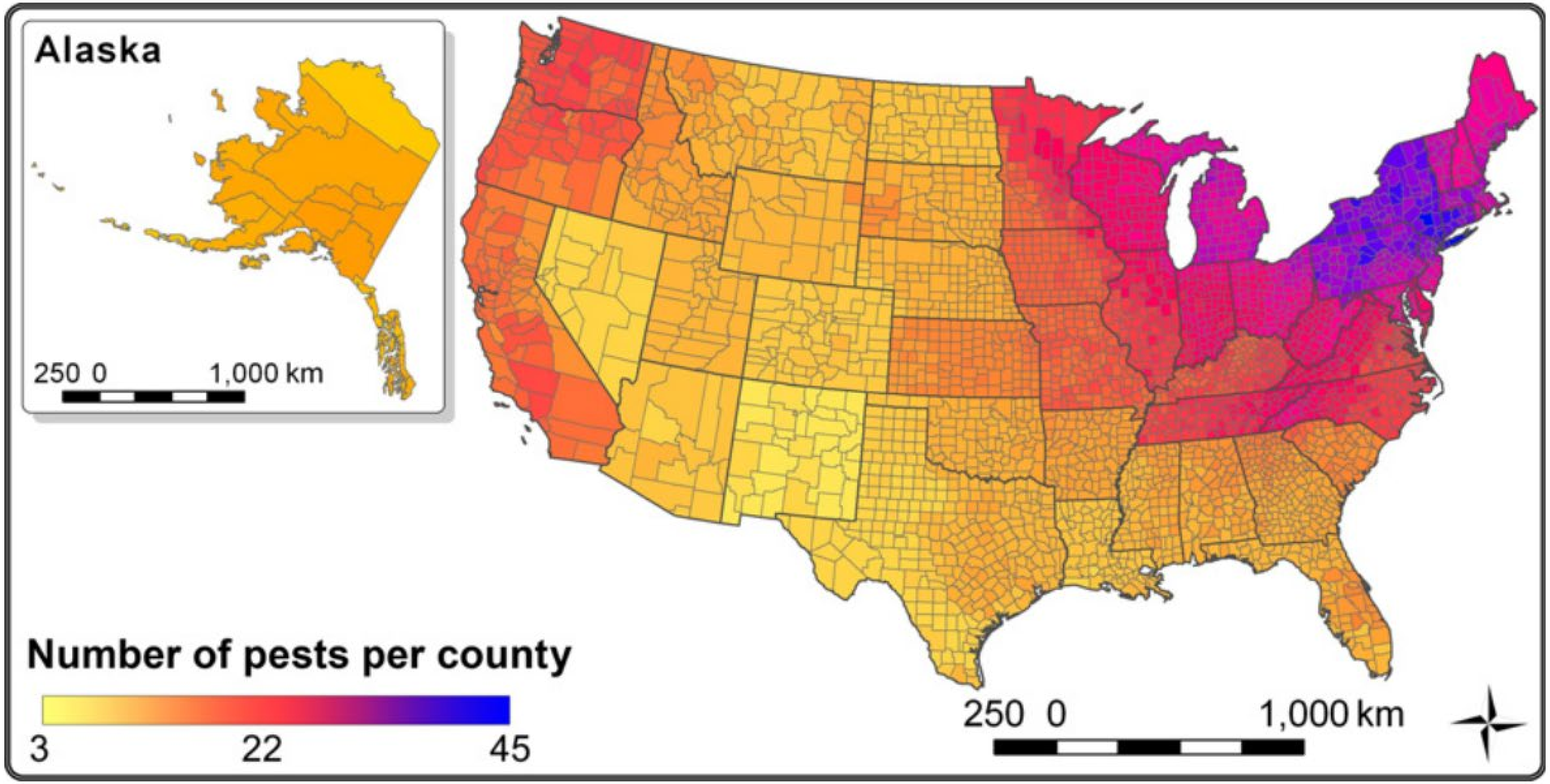

Liebhold et al. (2013) *Diversity and Distributions* (39) 14288–14293

Credit: Joe Boggs; https://bygl.osu.edu/node/2262

Elm zigzag sawfly
Larval feeding damage

Credit: Kelly Oten, NC State University

Spotted lanternfly

USDA-ARS Photo by Stephen Ausmus.

BUGWOODAPPS

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Great Lakes Early Detection Network

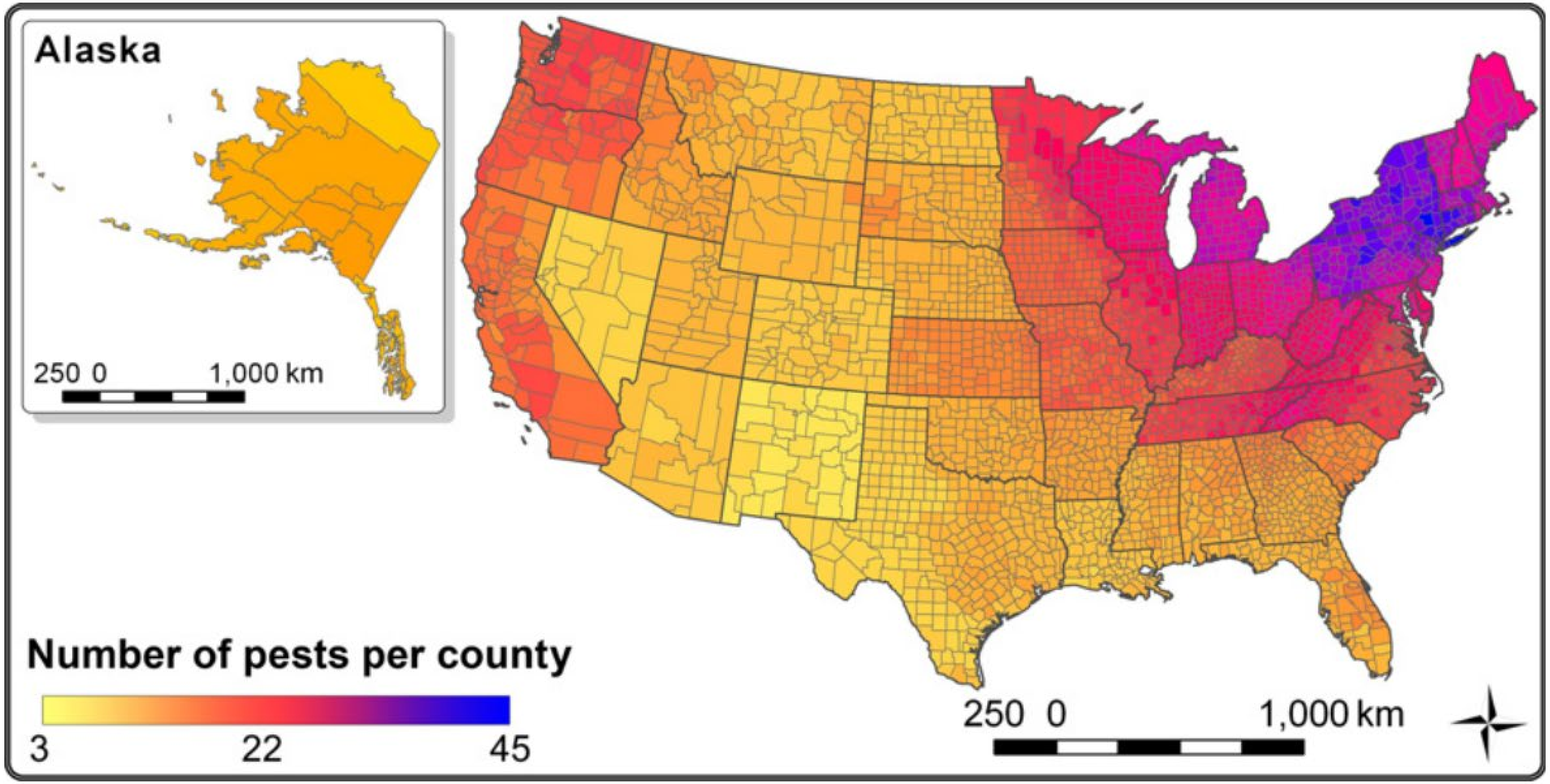
GLEDN is an invasive species early detection and warning system for the Great Lakes region developed through funding provided by the National Park Service as part of the Great Lakes Restoration Initiative

GLEDN is an online system that collects invasive species reports from casual observers, verifies these reports and integrates them with others networks. The system then uses this integrated information to send customized early detection email alerts.

Available on the App Store

ANDROID APP ON Google play

https://apps.bugwood.org/apps/gledn/



https://mapsweb.lib.purdue.edu/AFPE/

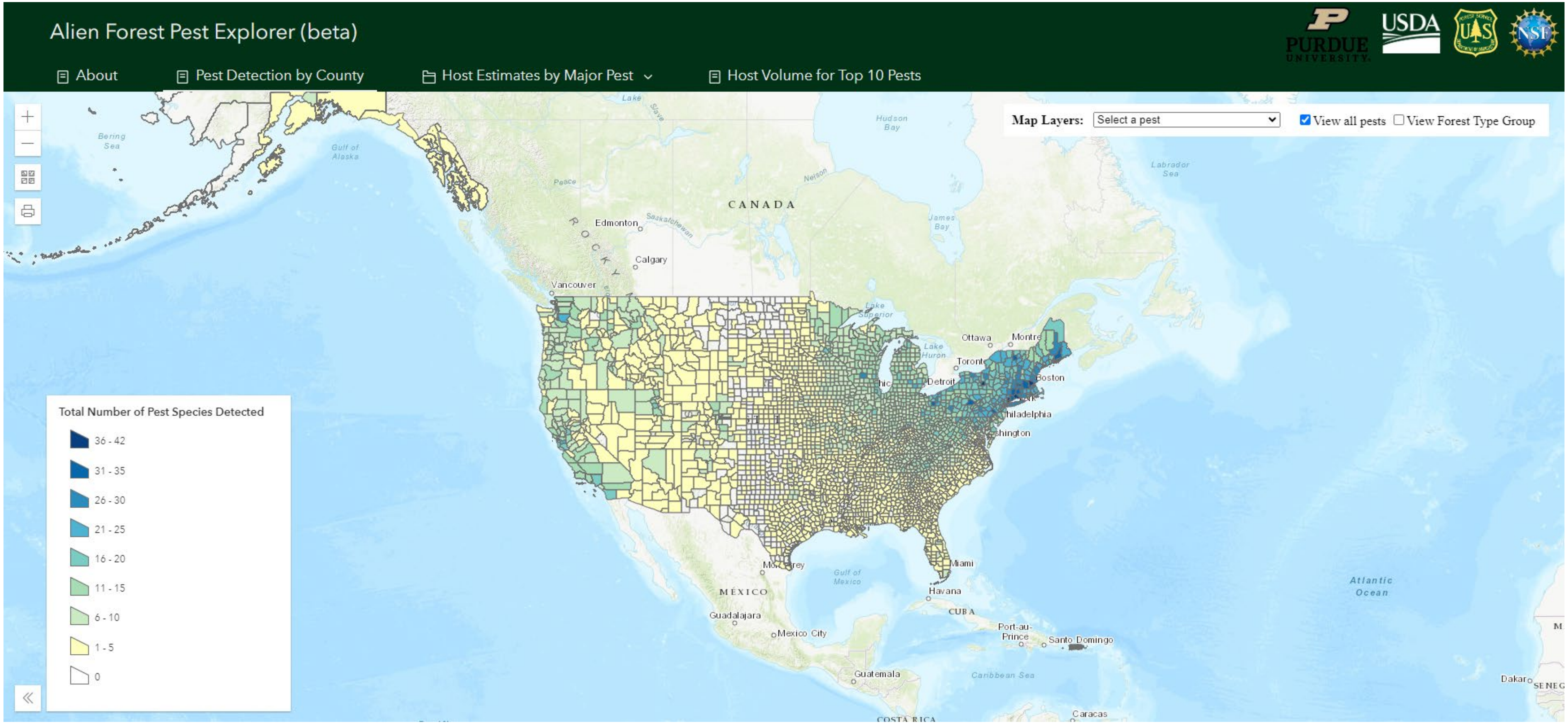
Alien Forest Pest Explorer (beta)

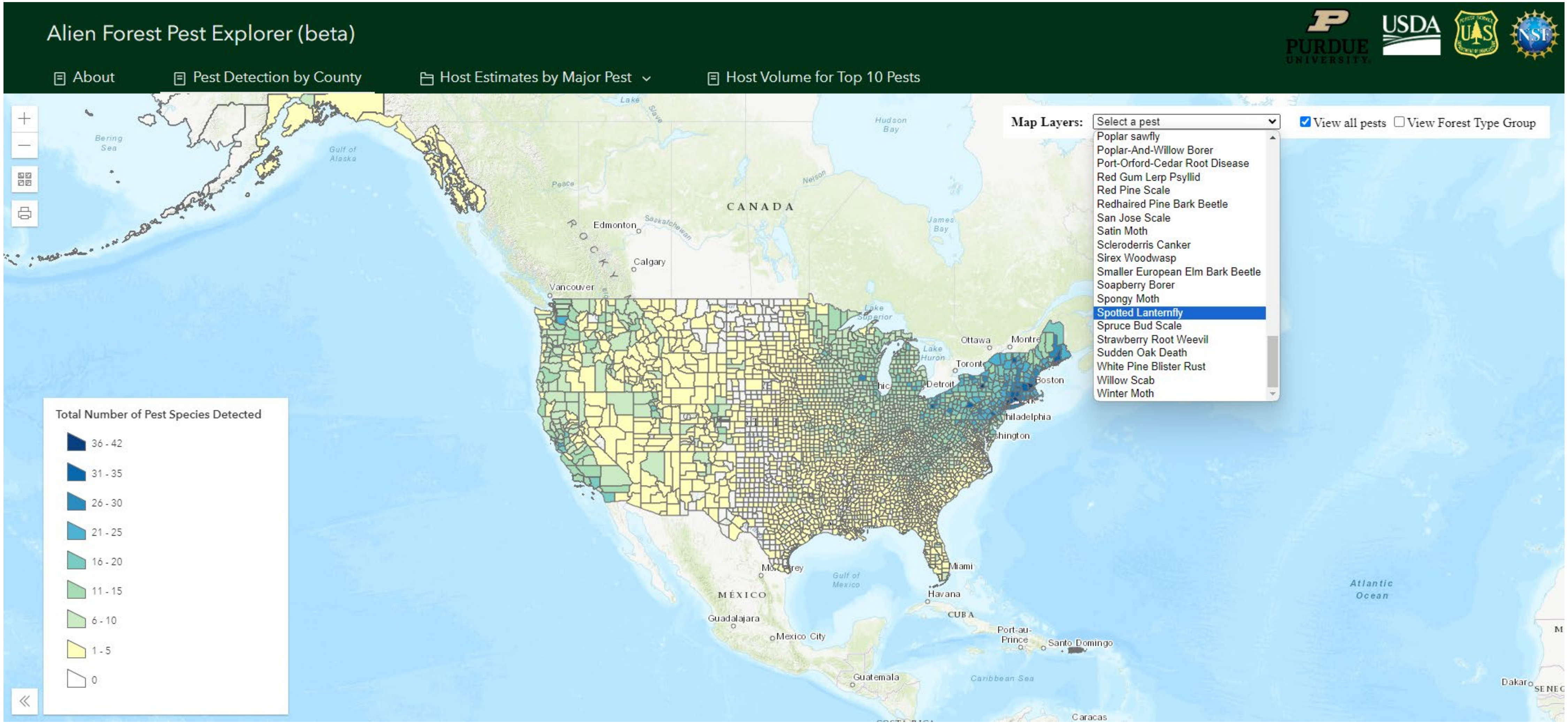
About | Pest Detection by County | Host Estimates by Major Pest | Host Volume for Top 10 Pests

The Alien Forest Pest Explorer (AFPE) is an interactive web tool which provides detailed spatial data describing pest distributions and host inventory estimates for damaging, non-indigenous forest insect and disease pathogens currently established in the United States. To date, the AFPE database includes 74 species of forest insects and 15 species of forest pathogens. This tool allows users to scale county-level data to meet local forest health research needs.

While static maps displaying pest distributions are available here, the interactive mapping tool contains collective distribution information for 89 pests, in addition to host specific estimates derived from Forest Inventory and Analysis data, including volume, and rates of growth, removals and mortality, for 15 major pest species. The host dashboards can lag when applying filters and selections in this Beta version of the AFPE. We have identified some structural changes to the online database which will facilitate faster performance in the next version.

The AFPE database is maintained as a joint effort of Purdue University, the US Forest Service Northern Research Station, the US Forest Service Forest Health Protection and the Forest Health Assessment & Applied Sciences Team partially funded by the National Science Foundation. As part of ongoing improvement and maintenance of this database, pest distribution data will be continually updated as data becomes available. Much of this information draws from


Alien Forest Pest Explorer (beta)
PURDUE UNIVERSITY
USDA
About
Pest Detection by County
Host Estimates by Major Pest
Host Volume for Top 10 Pests
Map Layers:
Select a pest
View all pests
View Forest Type Group
Total Number of Pest Species Detected
36 - 42
31 - 35
26 - 30
21 - 25
16 - 20
11 - 15
6 - 10
1 - 5
0
Bering Sea
Gulf of Alaska
Hudson Bay
Labrador Sea
CANADA
Edmonton
Calgary
Vancouver
Ottawa
Boston
Detroit
Miami
Havana
CUBA
MEXICO
Guadalajara
Mexico City
Guatemala
Gulf of Mexico
Caribbean Sea
Santo Domingo
Caracas
Atlantic Ocean
Dakar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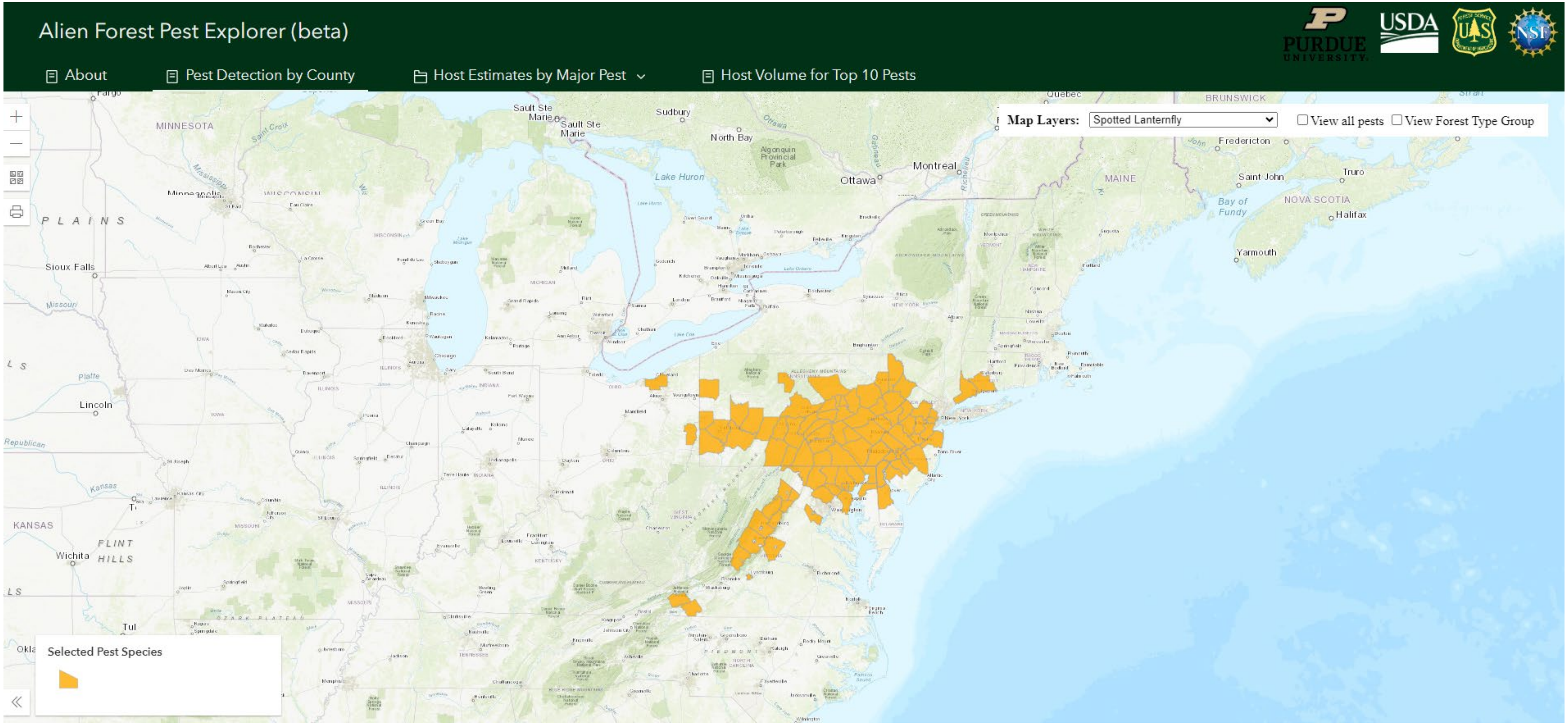
PURDUE UNIVERSITY
USDA
NSF
Map Layers:
Select a pest
View all pests
View Forest Type Group
Poplar sawfly
Poplar-And-Willow Borer
Port-Orford-Cedar Root Disease
Red Gum Lerp Psyllid
Red Pine Scale
Redhaired Pine Bark Beetle
San Jose Scale
Satin Moth
Scleroderris Canker
Sirex Woodwasp
Smaller European Elm Bark Beetle
Soapberry Borer
Spongy Moth
Spotted Lanternfly
Spruce Bud Scale
Strawberry Root Weevil
Sudden Oak Death
White Pine Blister Rust
Willow Scab
Winter Moth
Total Number of Pest Species Detected
36 - 42
31 - 35
26 - 30
21 - 25
16 - 20
11 - 15
6 - 10
1 - 5
0
CANADA
MÉXICO
Bering Sea
Gulf of Alaska
Hudson Bay
James Bay
Edmonton
Calgary
Vancouver
Ottawa
Toronto
Detroit
Boston
Miami
Havana
CUBA
Guadalajara
Mexico City
Guatemala
Port-au-Prince
Santo Domingo
Caribbean Sea
Gulf of Mexico
Atlantic Ocean
Dakar
Caracas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USDA
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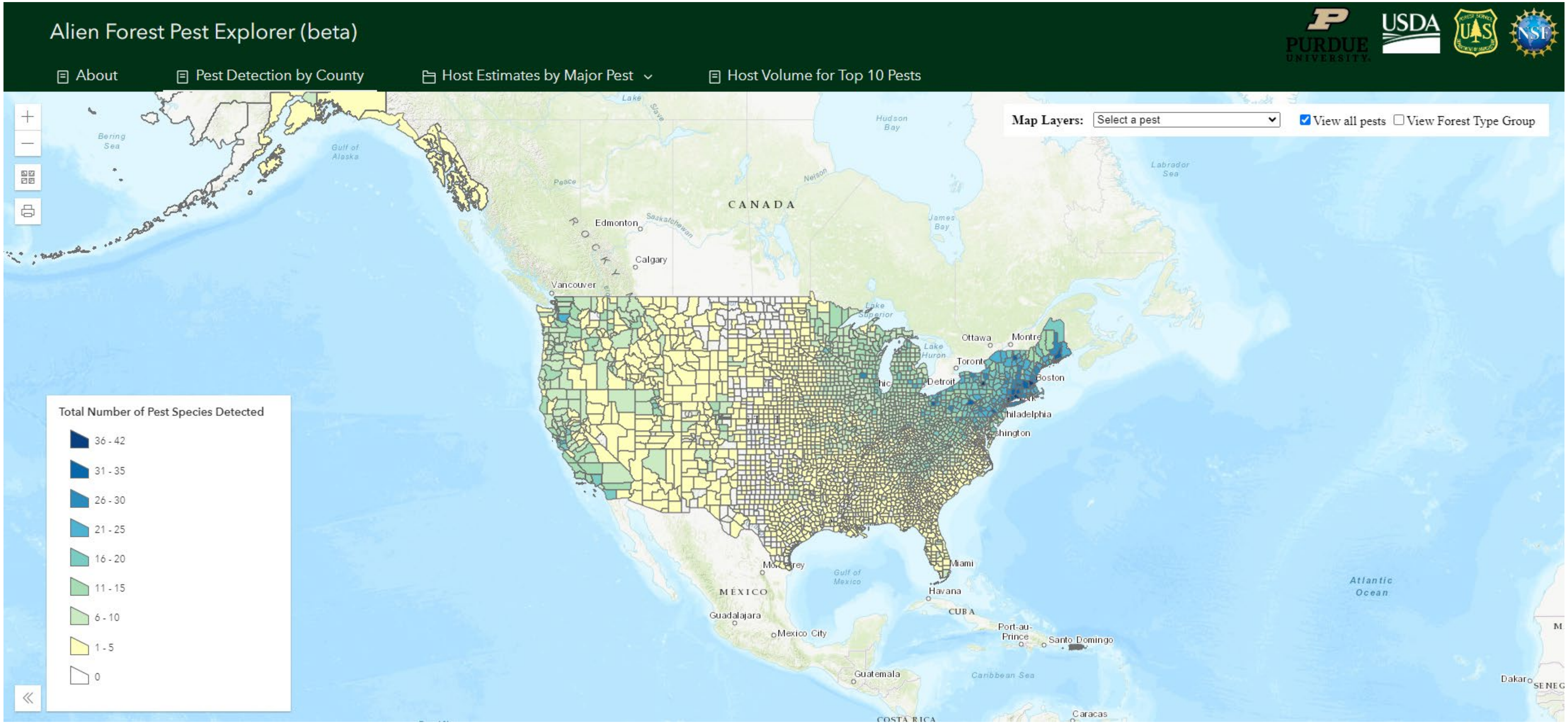
Spotted Lanternfly
View all pests
View Forest Type Group
Selected Pest Species
MINNESOTA
Sault Ste Marie
Sudbury
North Bay
Lake Huron
Ottawa
Montreal
MAINE
Fredericton
Saint John
Truro
NOVA SCOTIA
Halifax
Bay of Fundy
Yarmouth
Sioux Falls
Lincoln
KANSAS
Wichita
FLINT HILLS



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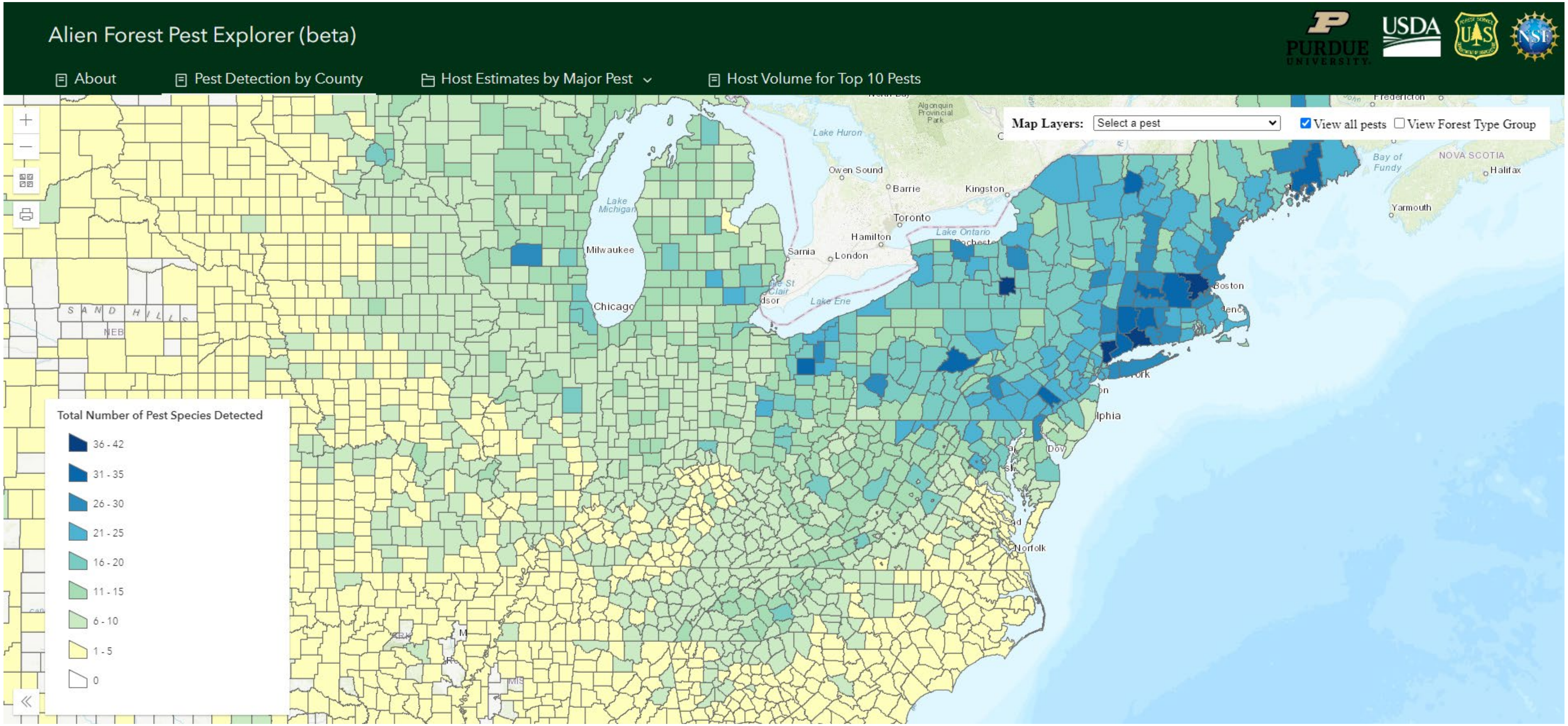
Boston
Detroit
Miami
MEXICO
Guadalajara
Mexico City
Havana
CUBA
Guatemala
Santo Domingo
Caracas
Atlantic Ocean
Gulf of Mexico
Caribbean Sea
Hudson Bay
Labrador Sea
Bering Sea
Gulf of Alaska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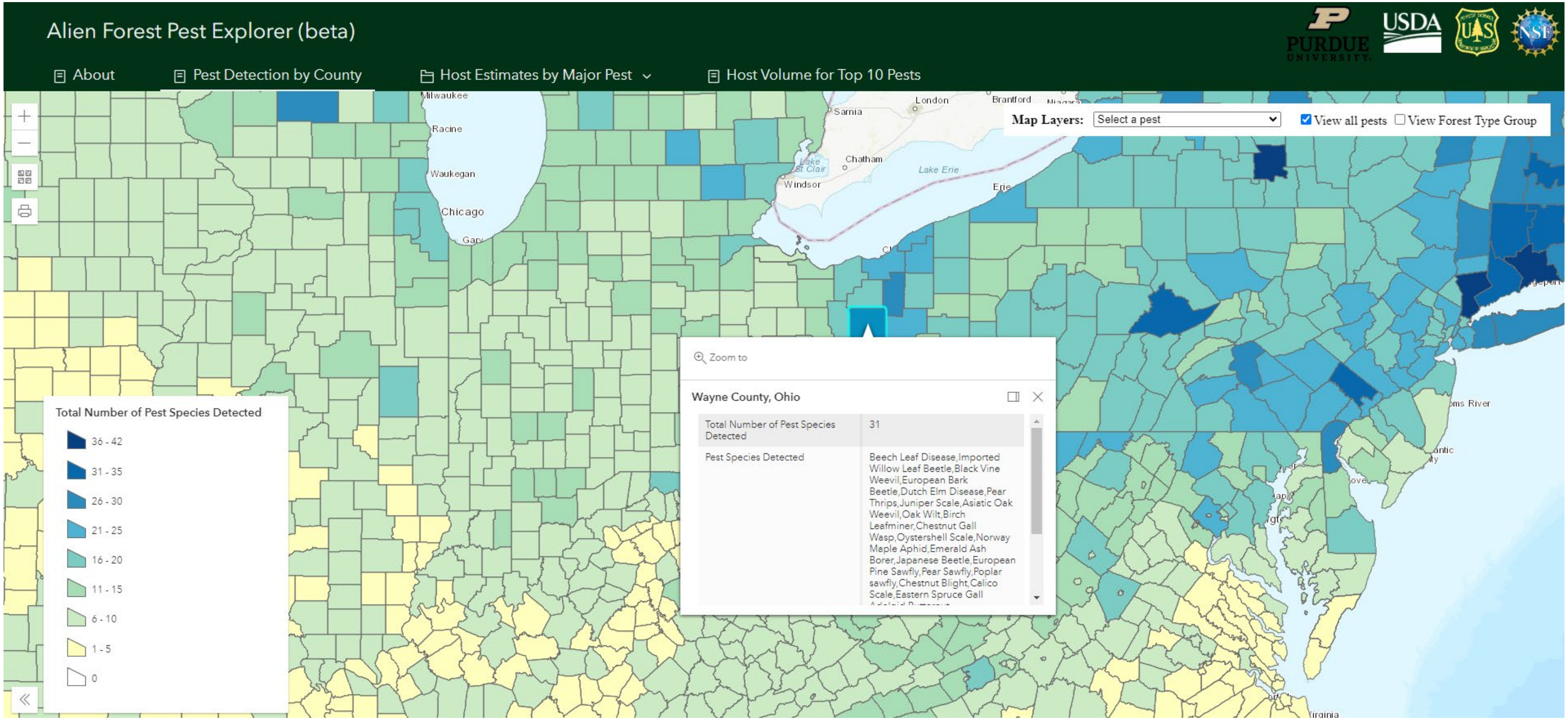
0
Lake Huron
Lake Michigan
Lake Ontario
Lake Erie
Milwaukee
Chicago
Toronto
Hamilton
London
Sarnia
Barrie
Kingston
Owen Sound
Boston
Norfolk
Halifax
Yarmouth
NOVA SCOTIA
Bay of Fundy



Alien Forest Pest Explorer (beta)
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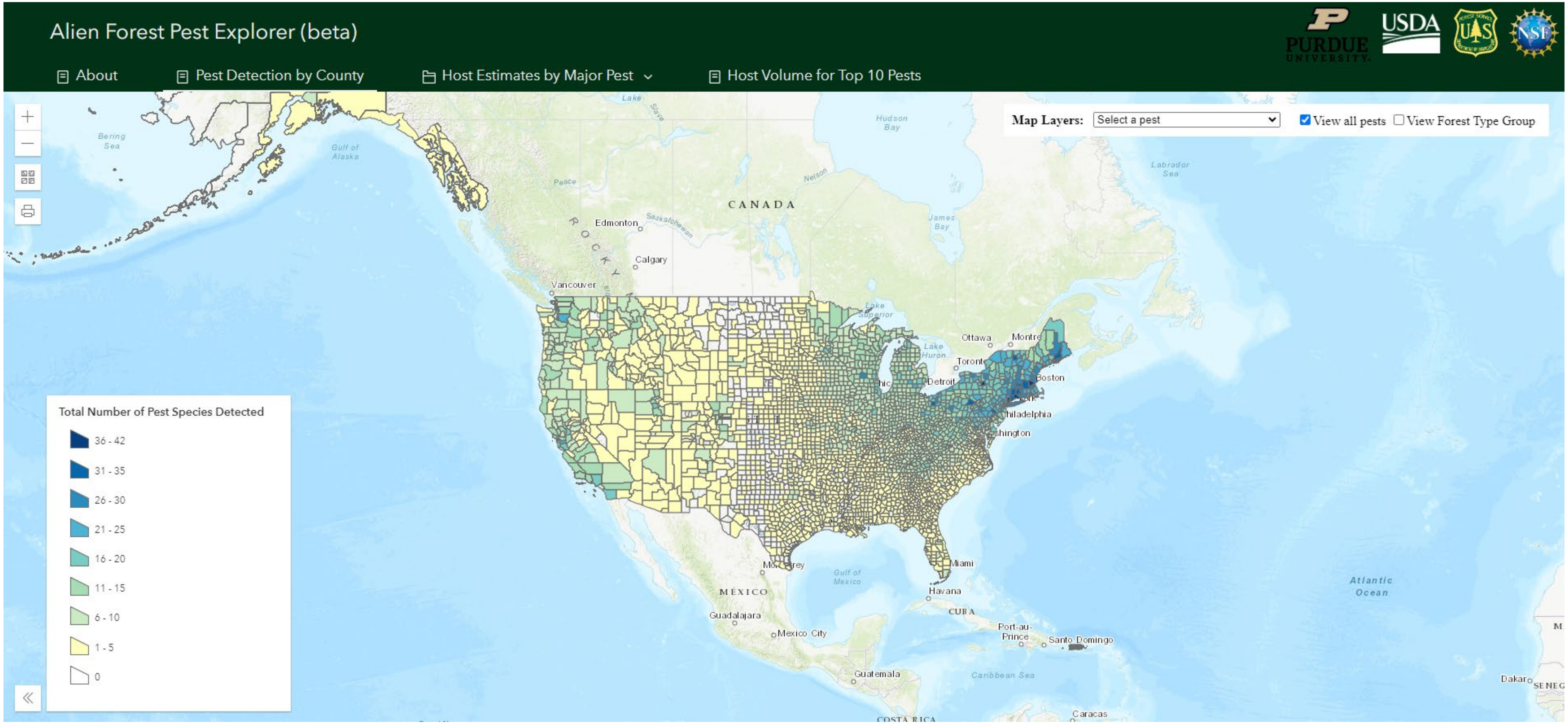
Host Volume for Top 10 Pests
Map Layers:
Select a pest
View all pests
View Forest Type Group
Milwaukee
Racine
Waukegan
Chicago
Sarnia
London
Brantford
Chatham
Windsor
Lake St Clair
Lake Erie
Erie
Zoom to
Wayne County, Ohio
Total Number of Pest Species Detected
31
Pest Species Detected
Beech Leaf Disease,Imported Willow Leaf Beetle,Black Vine Weevil,European Bark Beetle,Dutch Elm Disease,Pear Thrips,Juniper Scale,Asiatic Oak Weevil,Oak Wilt,Birch Leafminer,Chestnut Gall Wasp,Oystershell Scale,Norway Maple Aphid,Emerald Ash Borer,Japanese Beetle,European Pine Sawfly,Pear Sawfly,Poplar sawfly,Chestnut Blight,Calico Scale,Eastern Spruce Gall
Total Number of Pest Species Detected
36 - 42
31 - 35
26 - 30
21 - 25
16 - 20
11 - 15
6 - 10
1 - 5
0



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Detroit
Miami
Havana
MEXICO
Guadalajara
Mexico City
Guatemala
Atlantic Ocean
Santo Domingo
Caracas

Live plant imports: the major pathway for forest insect and pathogen invasions of the US

Andrew M Liebhold[1*], Eckehard G Brockerhoff[2], Lynn J Garrett[3], Jennifer L Parke[4], and Kerry O Britton[5]

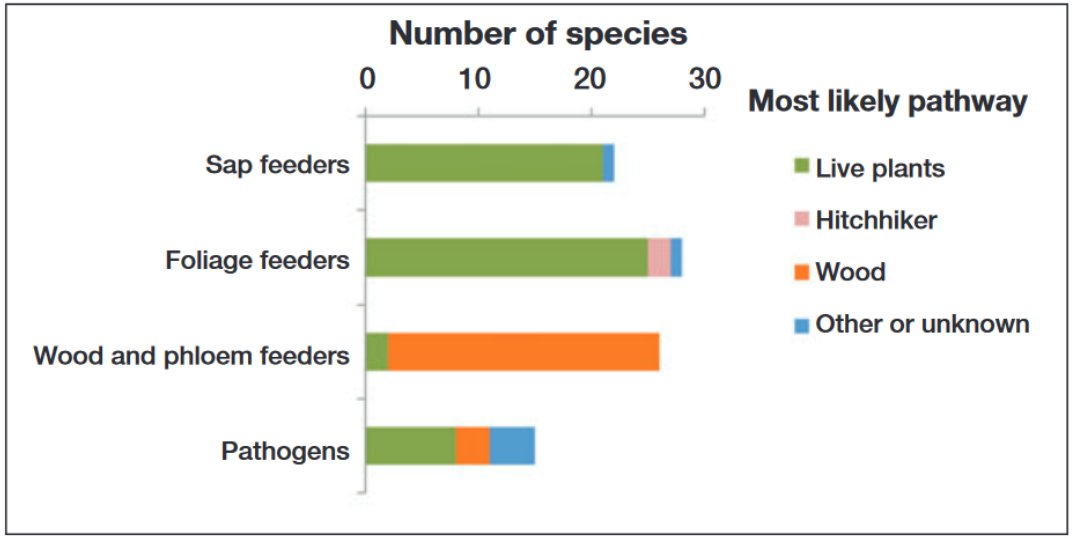


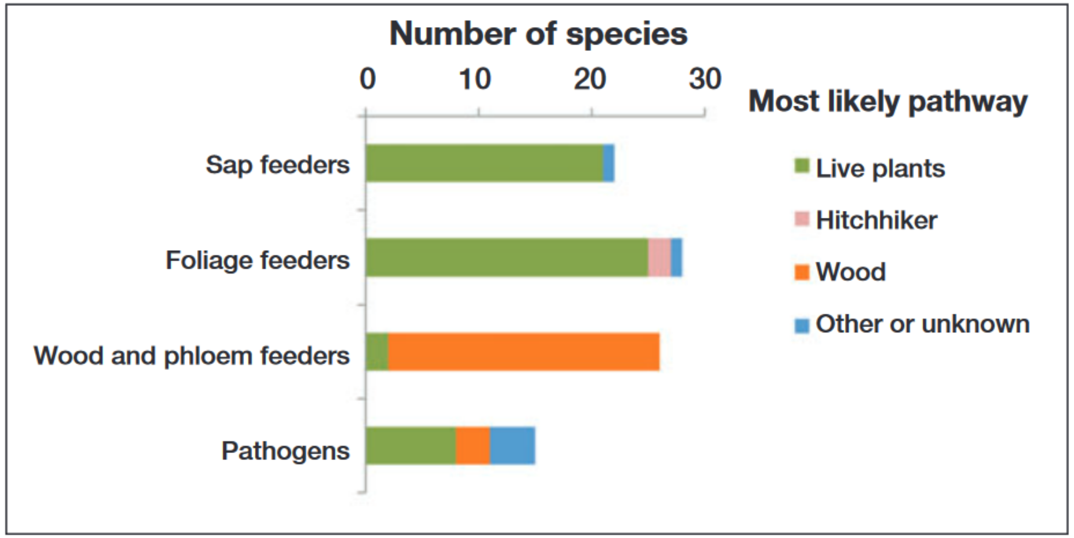
Figure 1. *Most likely pathways for forest pathogens and different insect guilds. Pathway assignment for individual species was based on published information and biology, as detailed in WebTables 1–4.*

Credit: Nathan Cima (Unsplash)

135

Live plant imports: the major pathway for forest insect and pathogen invasions of the US

Andrew M Liebhold[1*], Eckehard G Brockerhoff[2], Lynn J Garrett[3], Jennifer L Parke[4], and Kerry O Britton[5]



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Live plant imports: the major pathway for forest insect and pathogen invasions of the US

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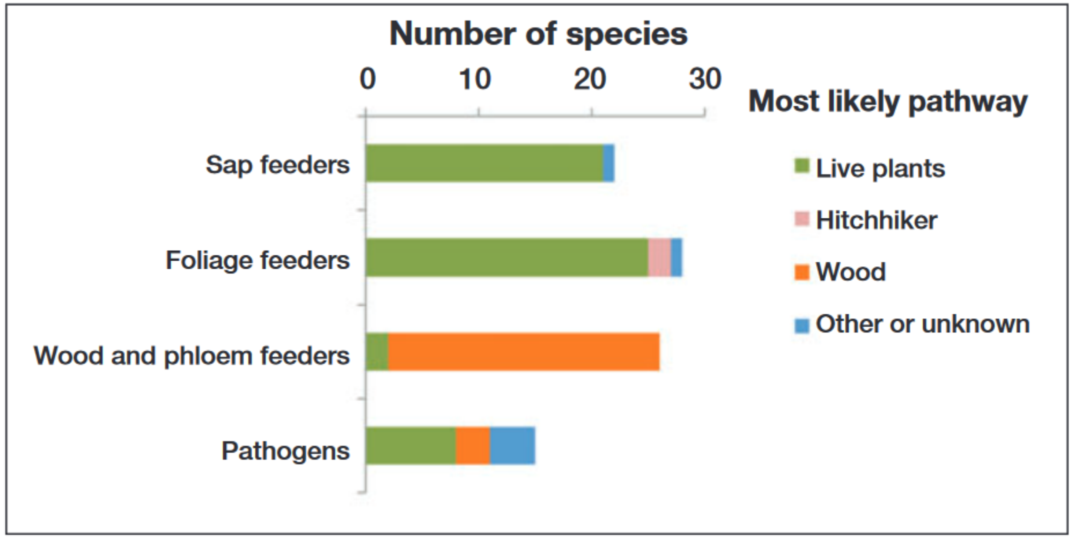

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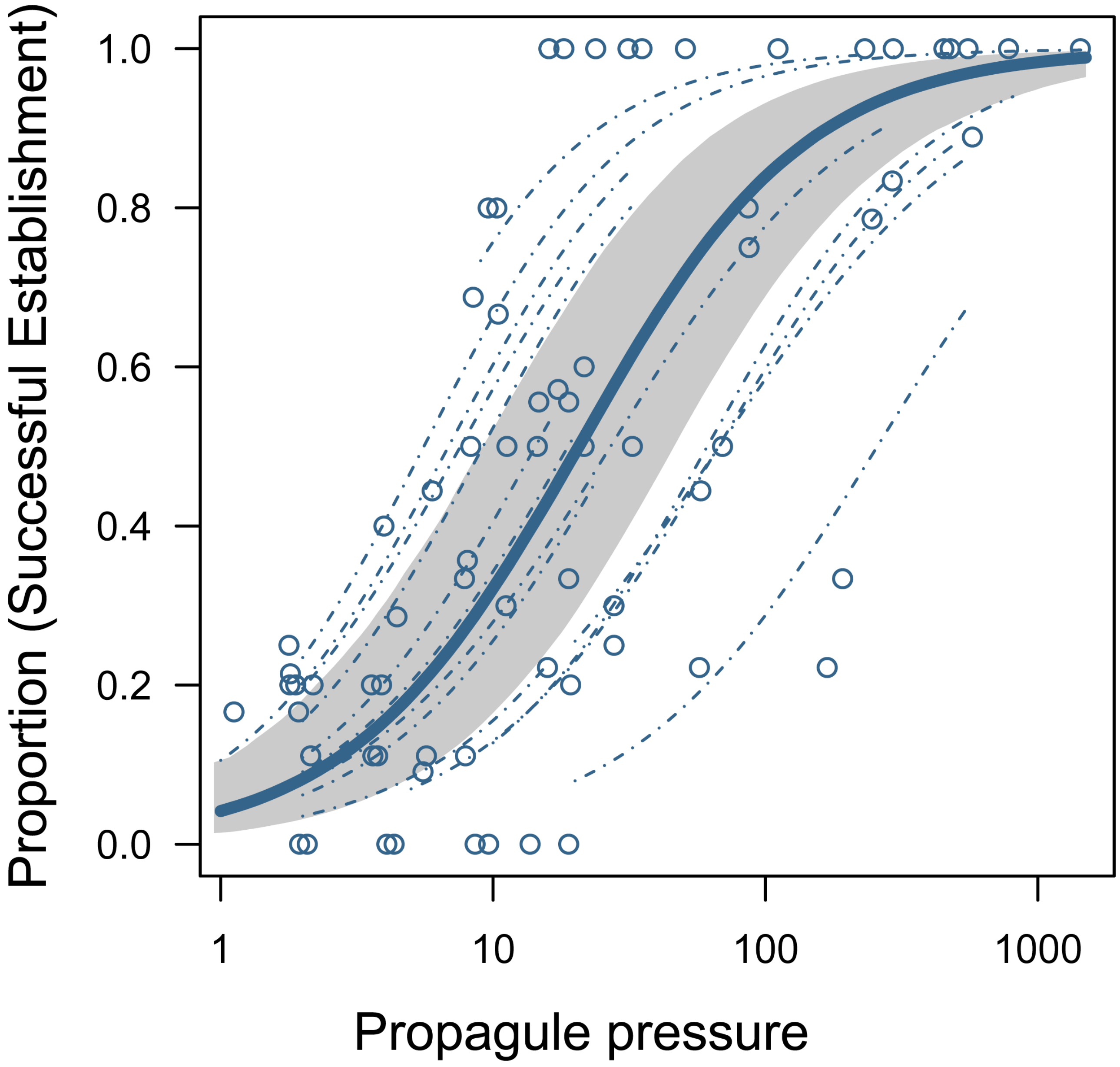
Credit: Dylan Hunter (Unsplash)



SHORT REPORTS

Dissecting the null model for biological invasions: A meta-analysis of the propagule pressure effect

Phillip Cassey[1]*, Steven Delean[1], Julie L. Lockwood[2], Jason S. Sadowski[3,4], Tim M. Blackburn[1,5,6]

1 School of Biological Sciences and the Environment Institute, The University of Adelaide, Adelaide, Australia, **2** Department of Ecology, Evolution and Natural Resources, Rutgers University, New Brunswick, New Jersey, United States of America, **3** Bodega Marine Lab, University of California at Davis, Bodega Bay, California, United States of America, **4** Department of Environmental Science and Policy, University of California at Davis, Davis, California, United States of America, **5** Department of Genetics, Evolution & Environment, Centre for Biodiversity & Environment Research, University College London, London, United Kingdom, **6** Institute of Zoology, Zoological Society of London, Regent's Park, London, United Kingdom

* phill.cassey@adelaide.edu.au

The propagules

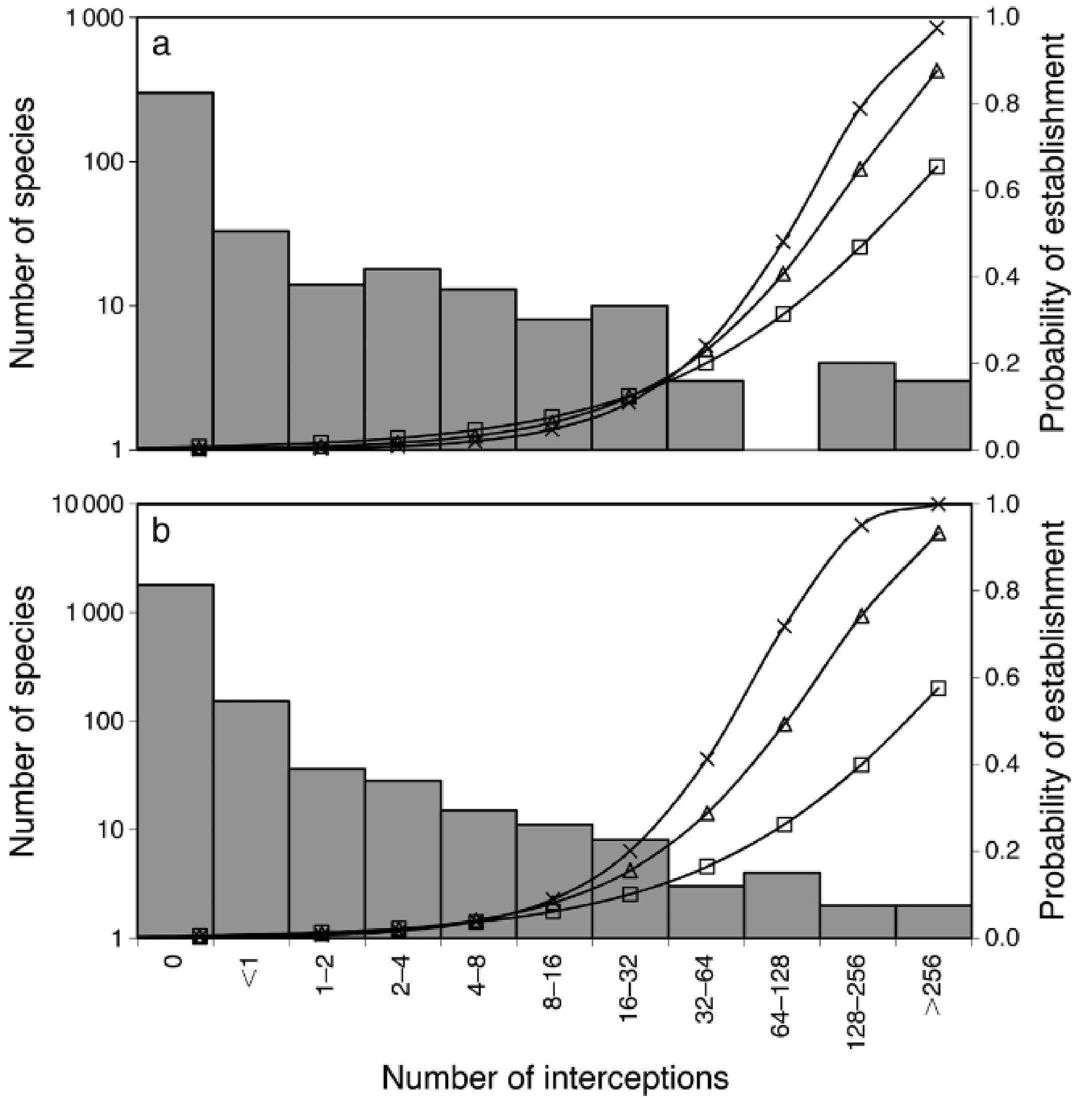
Agricultural Quarantine Inspection Monitoring (AQIM) Handbook

USDA APHIS

The caveats

- Small portion of cargo is inspected annually
- Not a true random sample
- Interceptions are reported as events, and thus can be comprised of one or multiple individuals
- Not every species that gets intercepted becomes established, and vice versa

Intercepted more often → greater chance of establishment

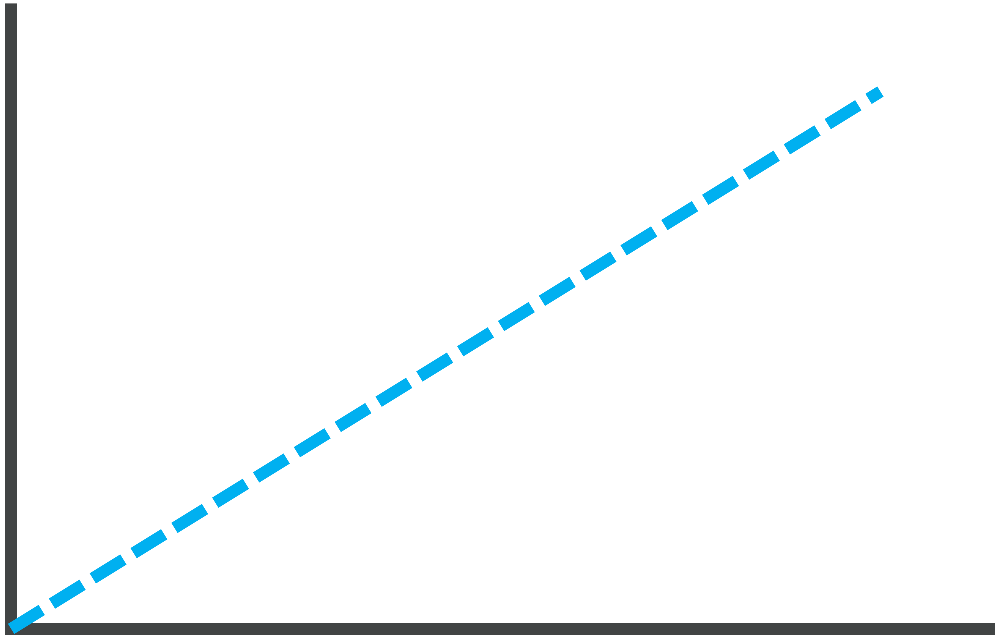


Ecology, 95(3), 2014, pp. 594–601

Predicting how altering propagule pressure changes establishment rates of biological invaders across species pools

Eckehard G. Brockerhoff,[1,6] Mark Kimberley,[2] Andrew M. Liebhold,[3] Robert A. Haack,[4] and Joseph F. Cavey[5]

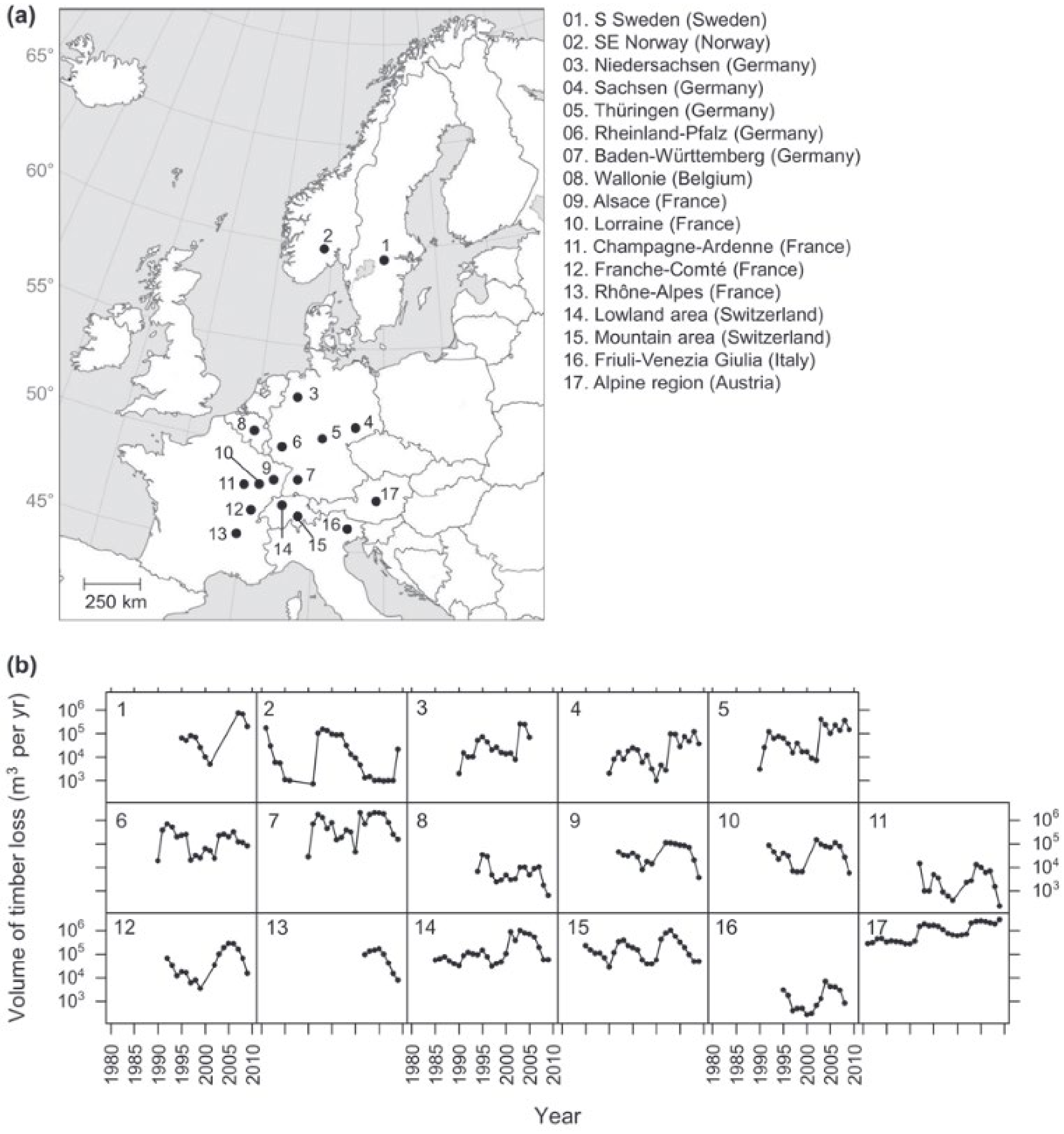
Objective: Determine if an insect's abundance in its native range corresponds to changes in arrival rates



European spruce bark beetle (*Ips typographus* L.)
Coleoptera: Curculionidae

Temel Gokturk, Artvin Forest, Bugwood.org

Ips typographus undergoes largescale outbreaks in multiple countries



Ecography 40: 1426–1435, 2017
doi: 10.1111/ecog.02769

Subject Editor: John-Arvid Grytnes. Editor-in-Chief: Miguel Araújo. Accepted 22 October 2016

Climate drivers of bark beetle outbreak dynamics in Norway spruce forests

Lorenzo Marini, Bjørn Økland, Anna Maria Jönsson, Barbara Bentz, Allan Carroll, Beat Forster, Jean-Claude Grégoire, Rainer Hurling, Louis Michel Nageleisen, Sigrid Netherer, Hans Peter Ravn, Aaron Weed and Martin Schroeder

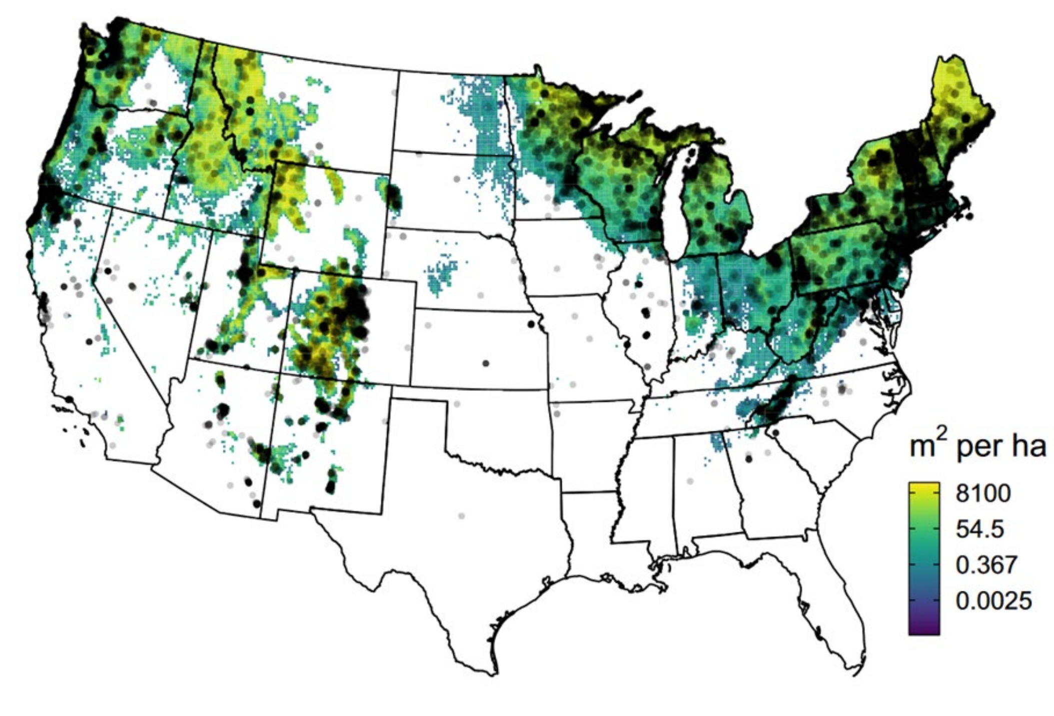
Interception frequency of exotic bark and ambrosia beetles (Coleoptera: Scolytinae) and relationship with establishment in New Zealand and worldwide[1]

Eckehard G. Brockerhoff, John Bain, Mark Kimberley, and Milos Knížek

Can. J. For. Res. 36: 289–298 (2006)

Table 1. The 35 true bark beetle species most frequently intercepted in New Zealand (N.Z.) plus less frequently intercepted species that are known to be established anywhere outside their native range, their origin and introduced range, and comparison with United States (US) interception data (N = 722 interceptions for New Zealand and 2626 interceptions for the US).

Species	Interceptions (%) N.Z.	Interceptions (%) US*	Origin†	Countries where the species has become established‡	Most common hosts
Hylurgops palliatus (Gyllenhal)	13.4	11.2	AS, EUR, NAF	US	*Pinus, Picea*
Pityogenes chalcographus (L.)	9.1	21.5	AS, EUR	Jamaica§	Conifers
Ips grandicollis (Eichhoff)	6.8	0.0‖	CAR, NAM	Australia	*Pinus*
Dryocoetes autographus (Ratzebg.)	6.2	0.8‖	AS, EUR, NAM, NAF	Brazil§	*Picea, Pinus*
Ips typographus (L.)	6.0	10.9	AS, EUR		*Picea*



Picea spp. in contiguous USA

Figure 2. Shaded area represents potential planting range.

Gilman, E. F., & Watson, D. G. (1984). *Picea abies*: Norway Spruce Fact Sheet. Southern Group of State Foresters.

forests

MDPI

Article

Are Climates in Canada and the United States Suitable for the European Spruce Bark Beetle, *Ips typographus*, and Its Fungal Associate, *Endoconidiophora polonica*?

Kishan R. Sambaraju * and Chantal Côté

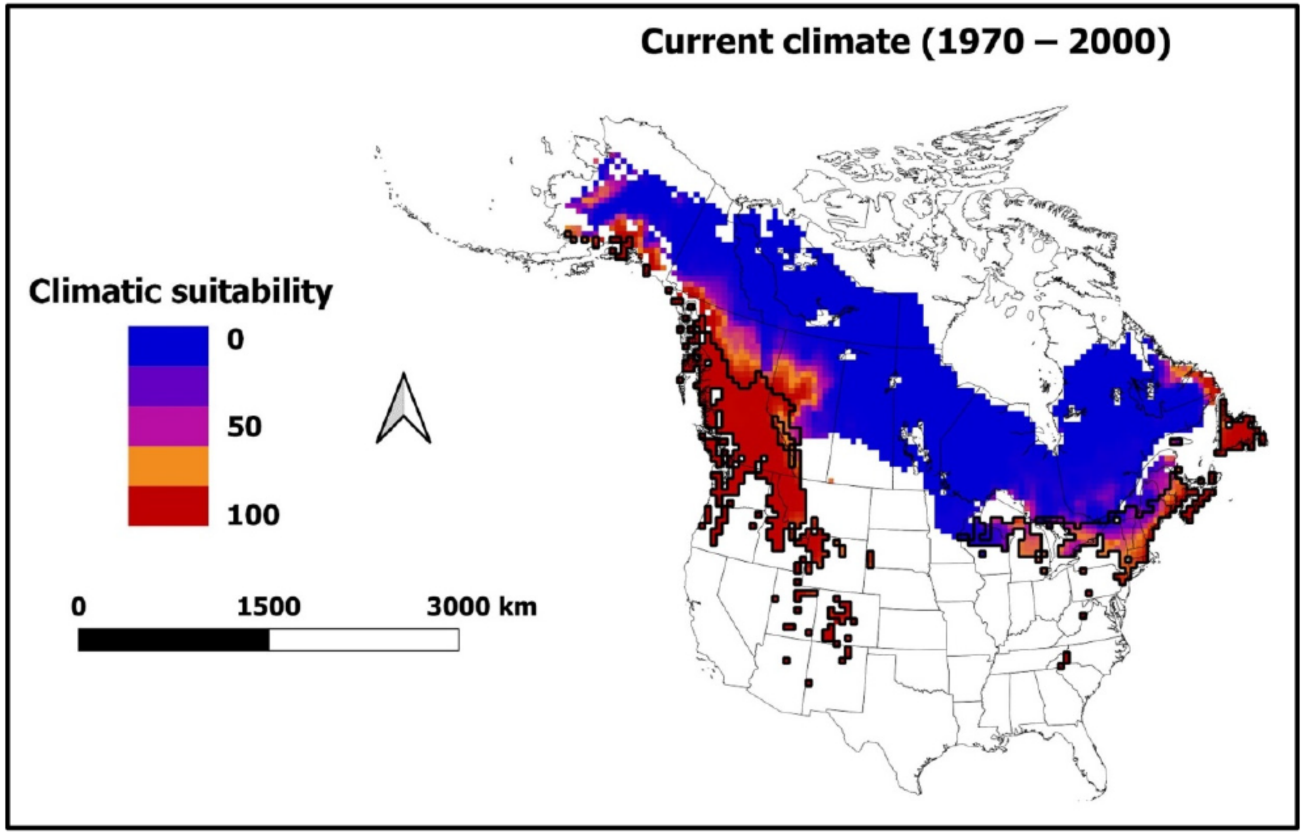
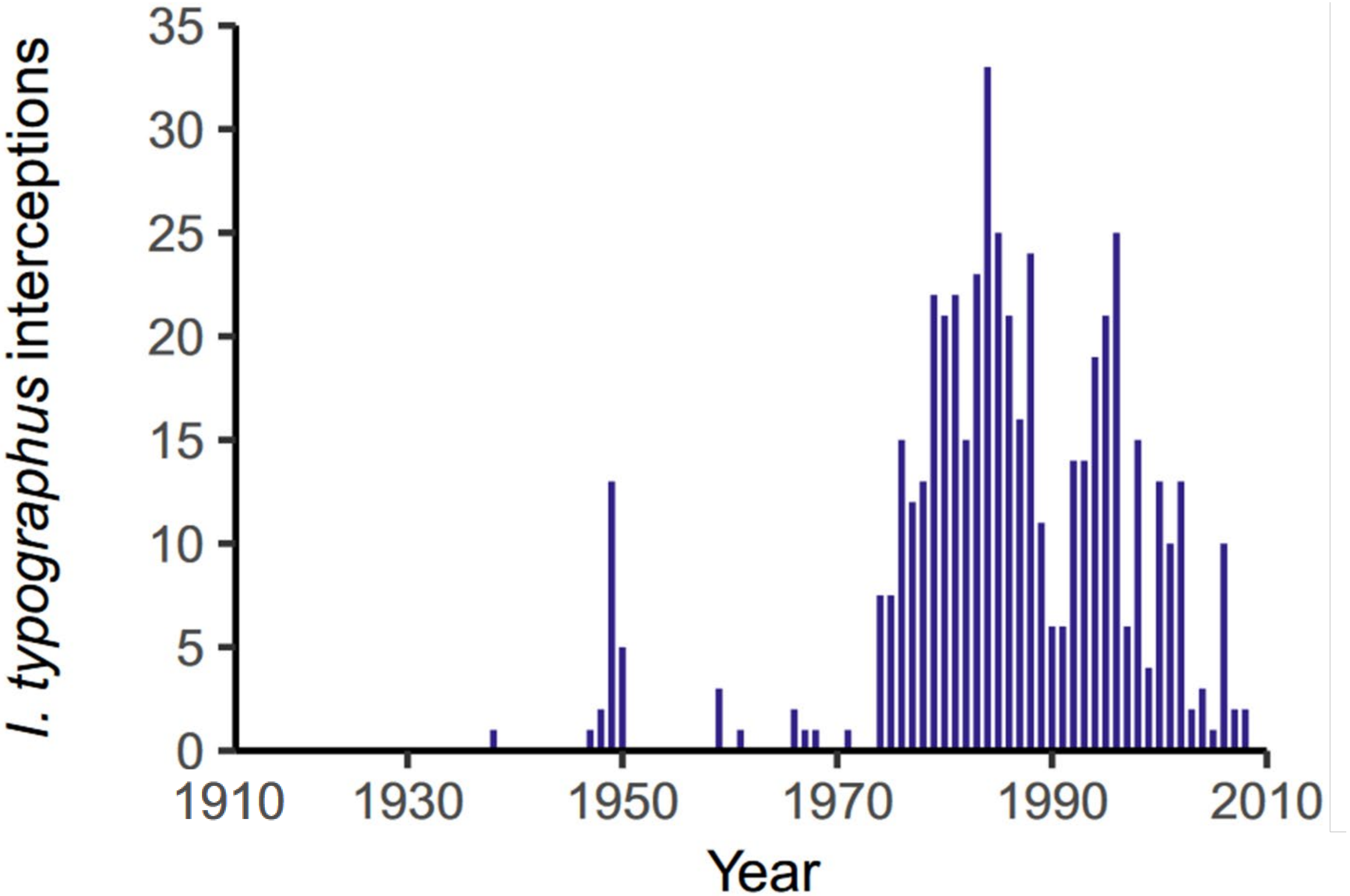
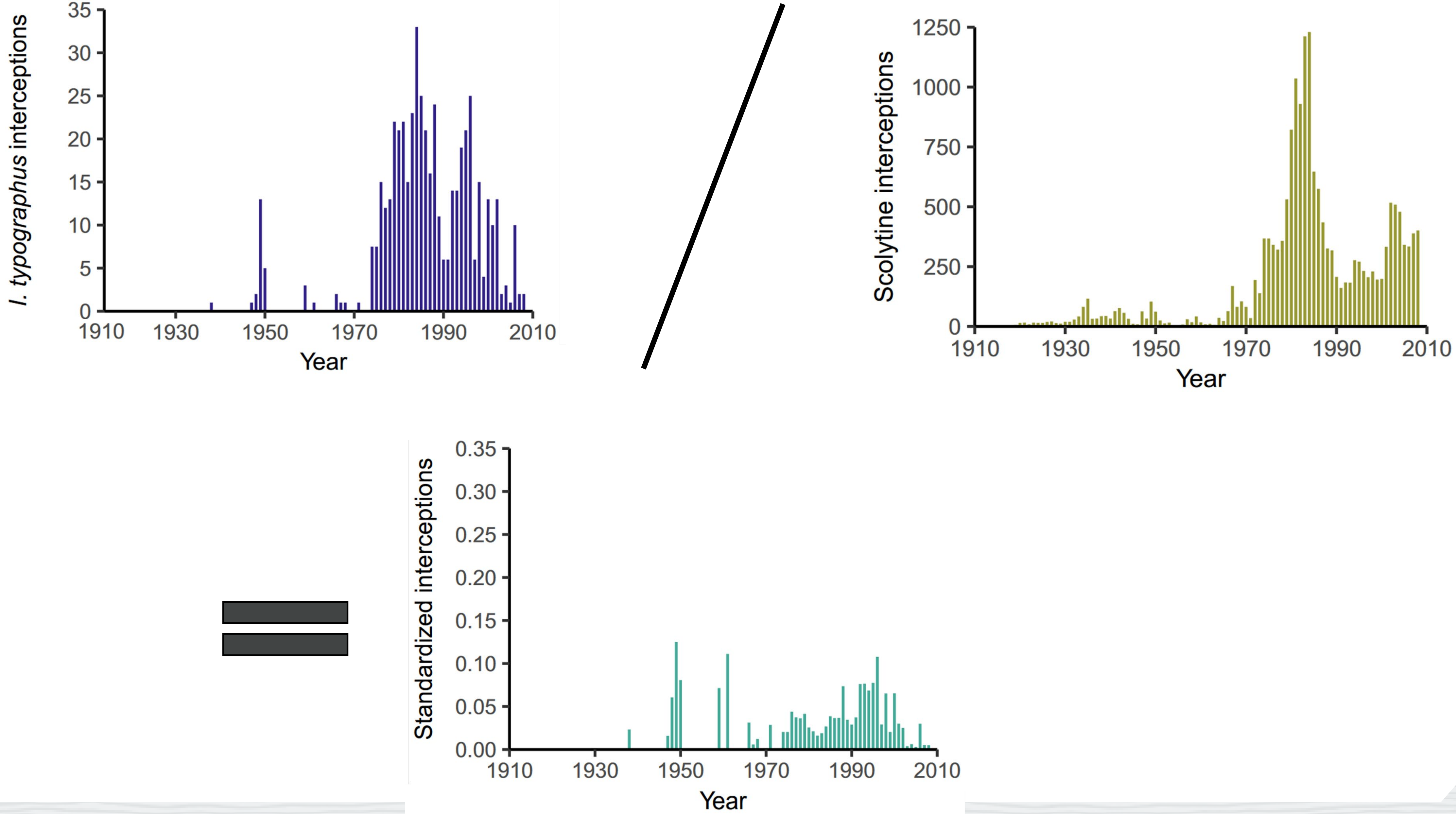


Figure 6. Climatic suitability of spruce forests in Canada and the United States for *Ips typographus* during the current period (1970–2000). Thick black line overlapping the *I. typographus* map represents climatically suitable area for *Endoconidiophora polonica*.

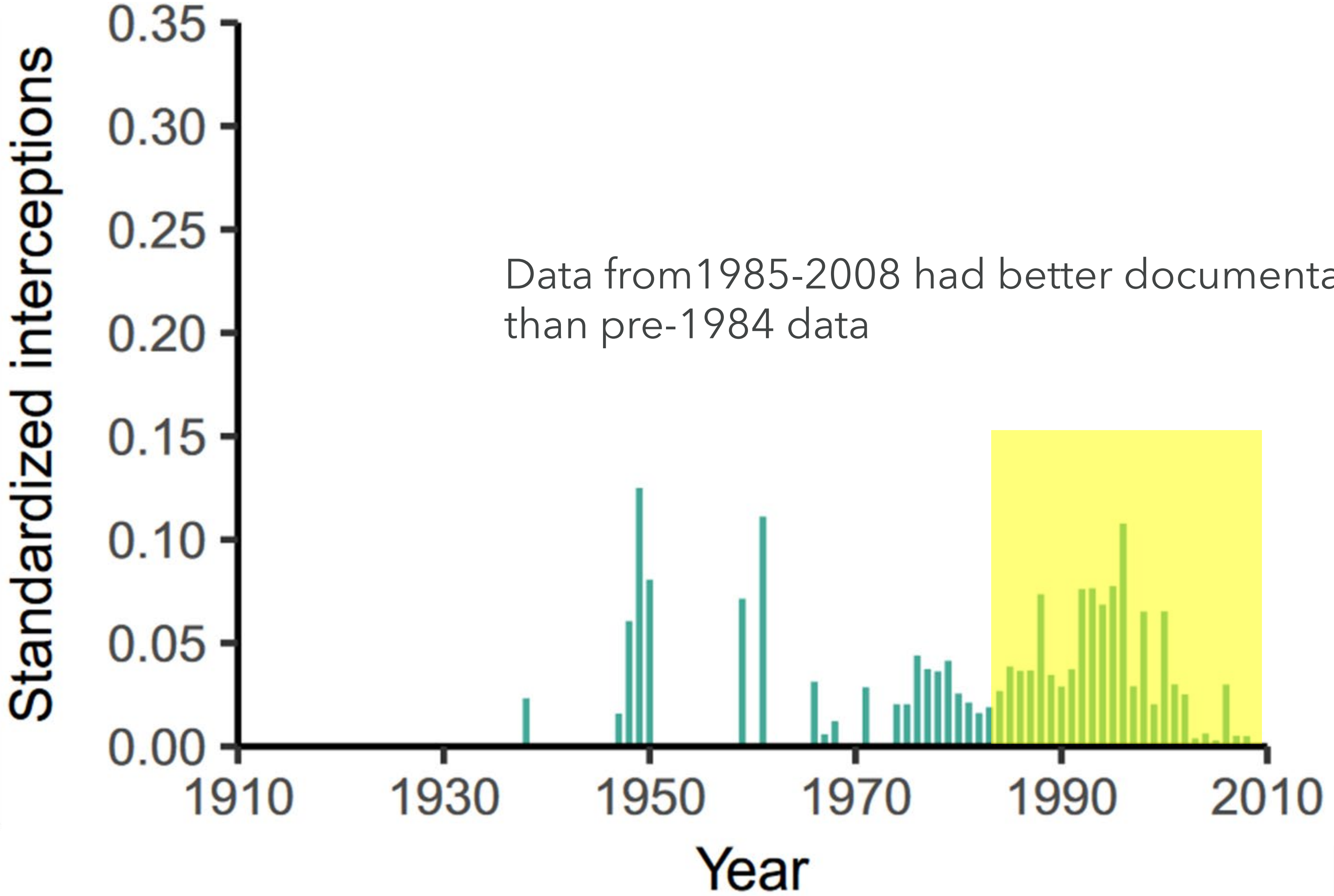


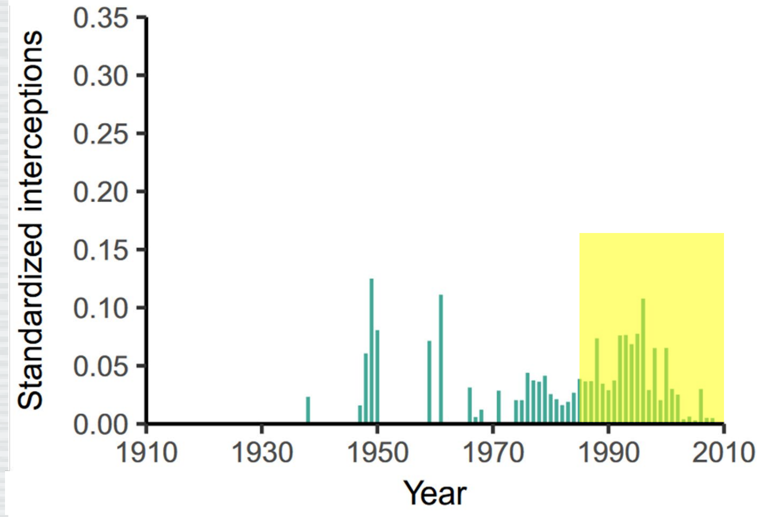
I. typographus interceptions
35
30
25
20
15
10
5
0
1910
1930
1950
1970
1990
2010
Year



I. typographus interceptions
Year
Scolytine interceptions
Year
Standardized interceptions
Year

Data from1985-2008 had better documentation than pre-1984 data





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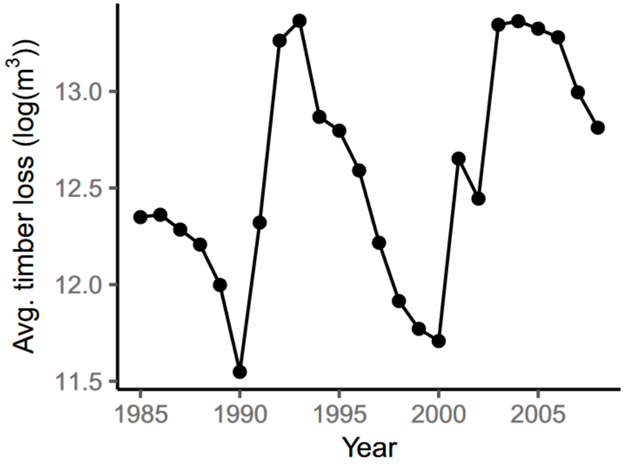

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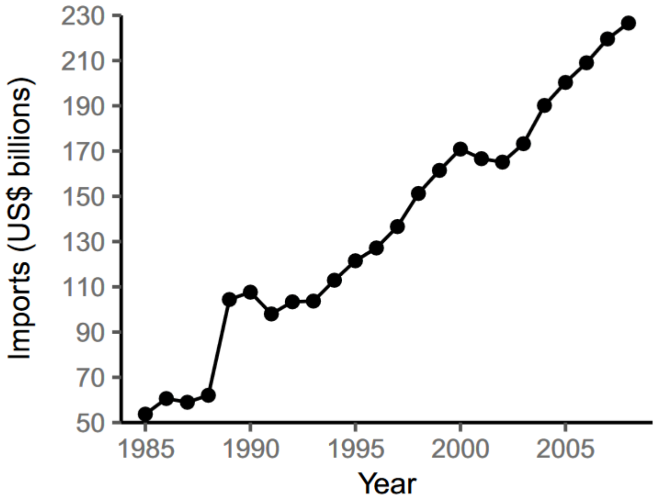

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Temel Gokturk, Artvin Forest, Bugwood.org

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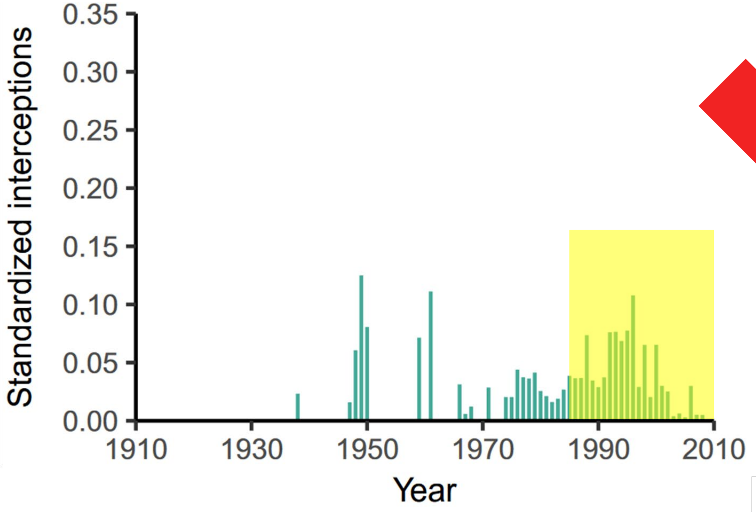
www.teralogistics.com



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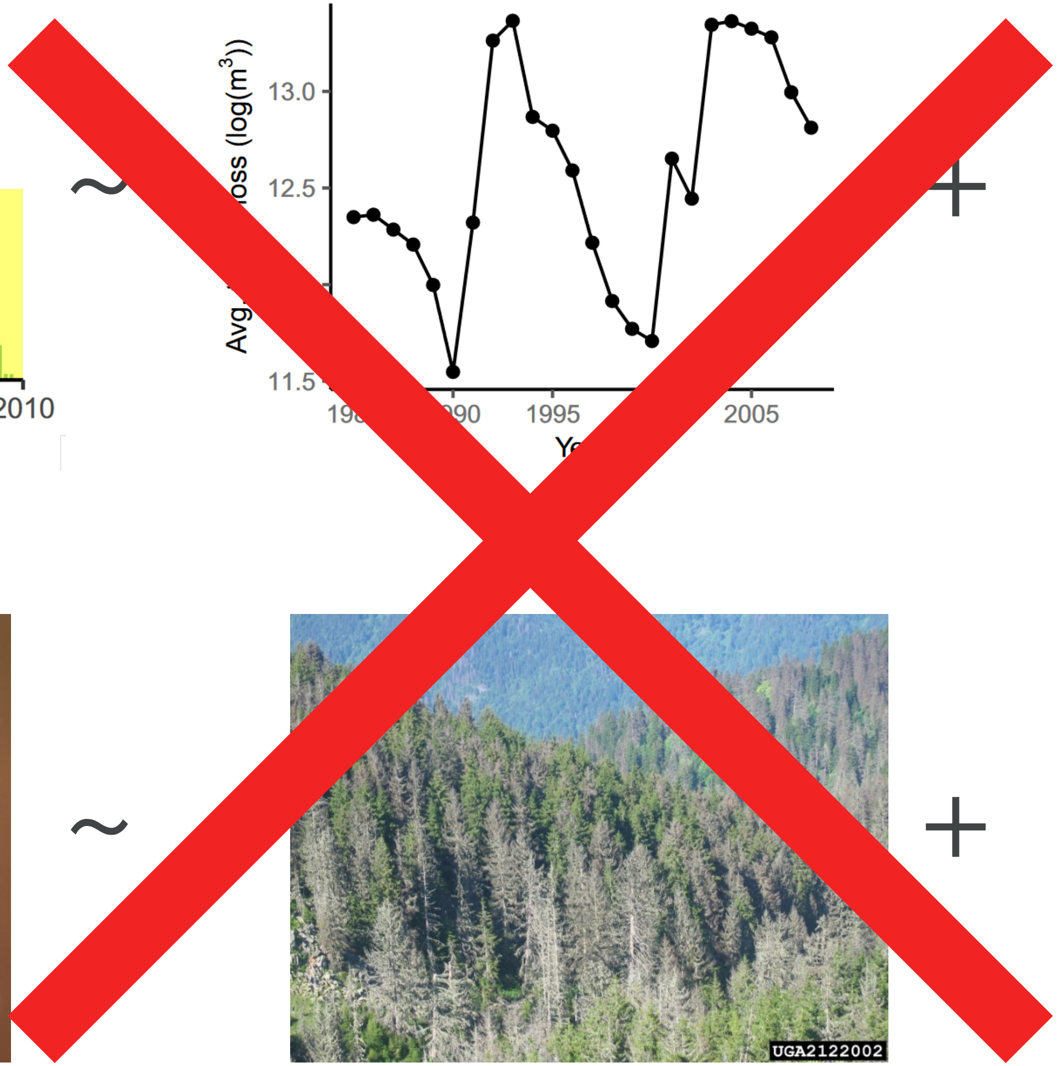

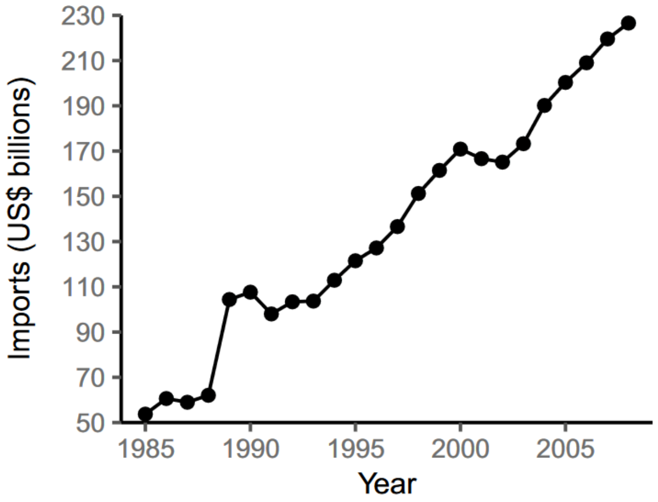

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Temel Gokturk, Artvin Forest, Bugwood.org

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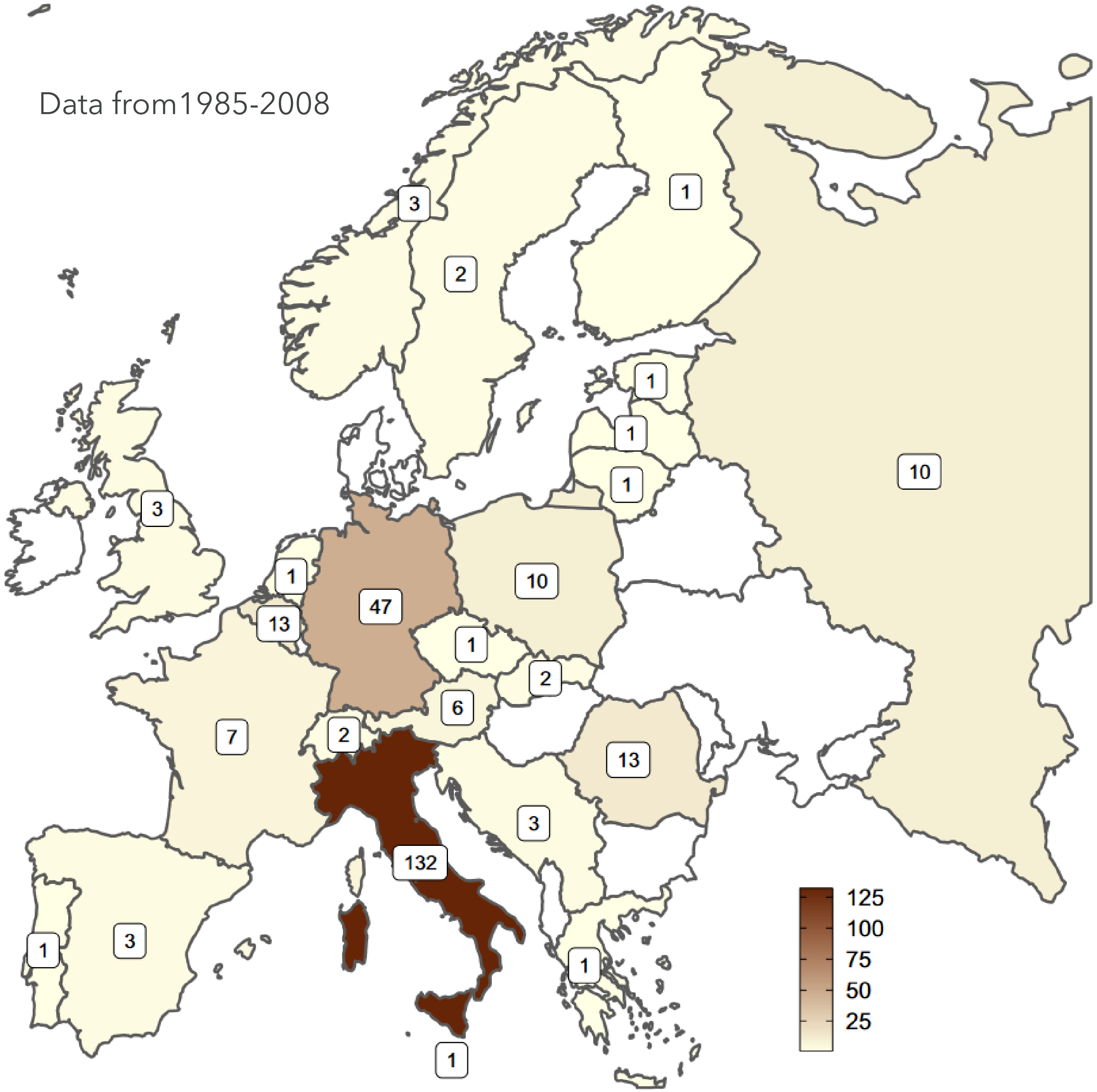
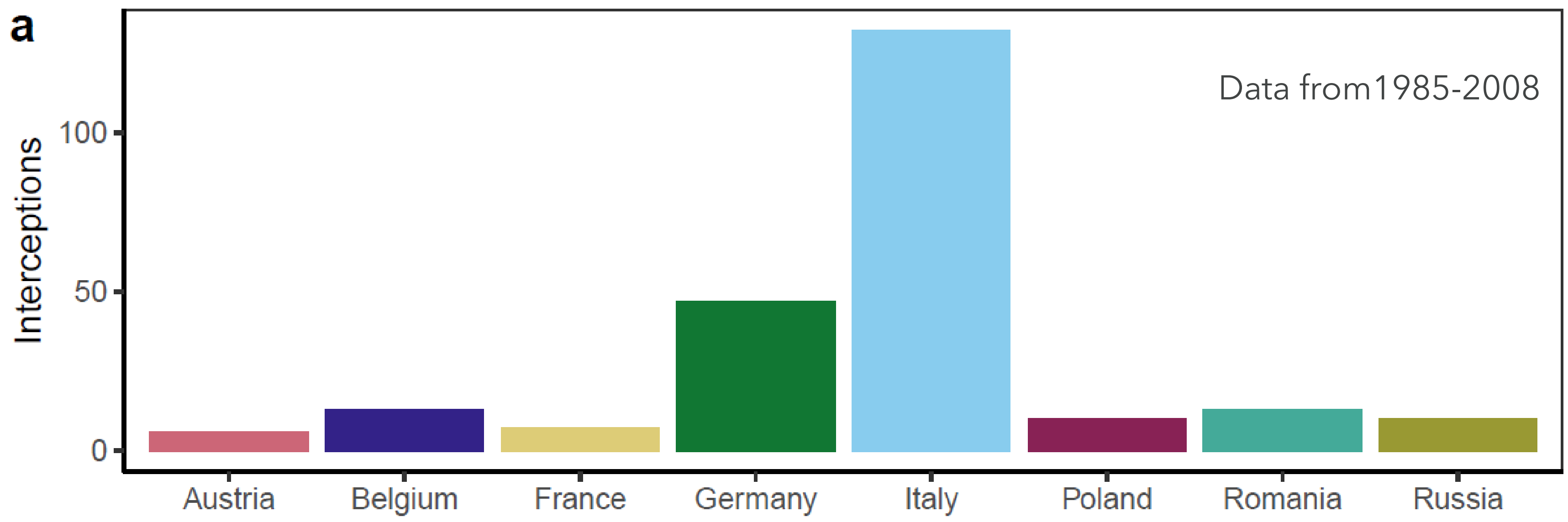

Data from1985-2008
3
2
1
1
1
1
10
3
1
47
10
13
1
2
6
7
2
13
3
132
1
3
1
1
125
100
75
50
25


a
Data from1985-2008
Interceptions
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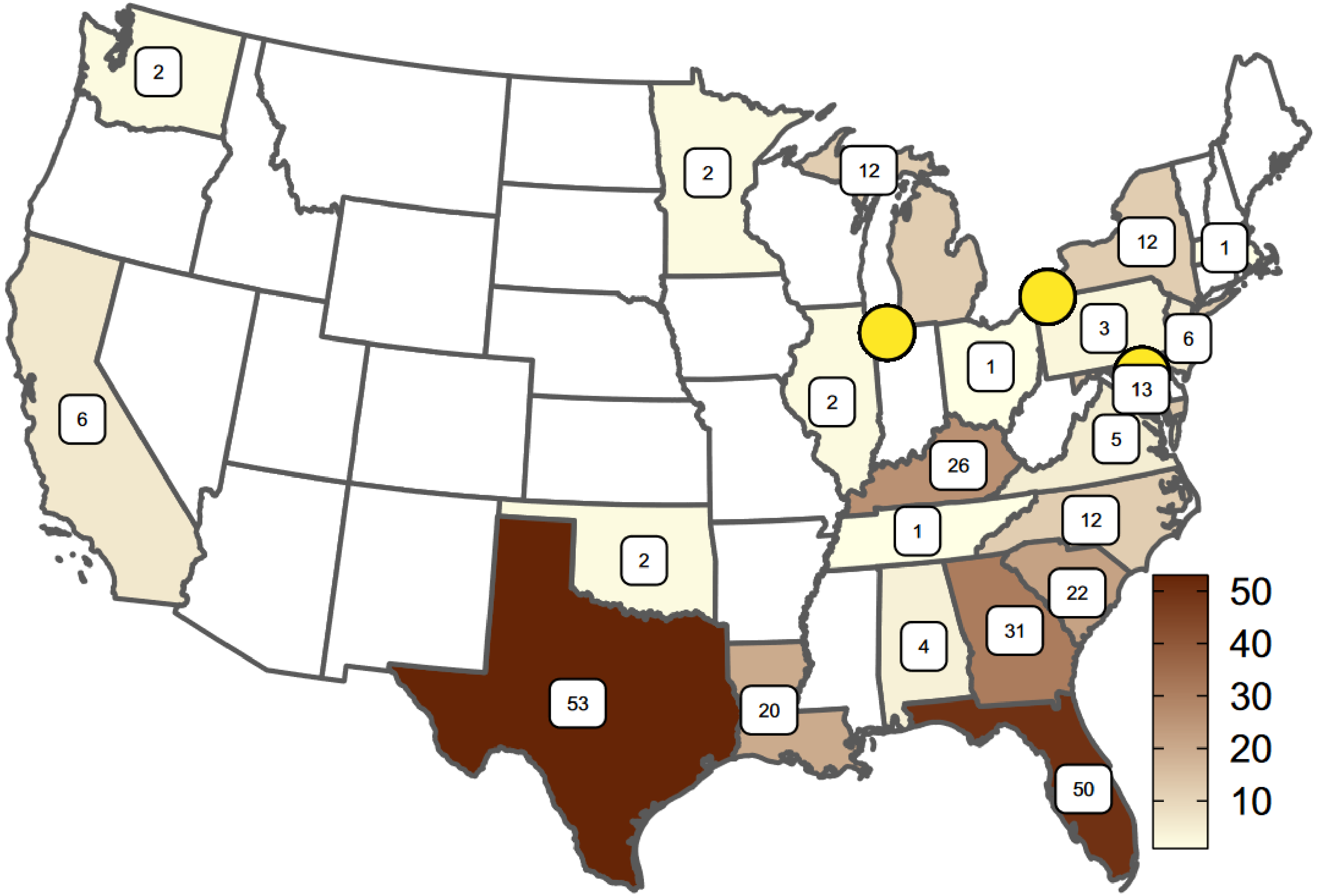
Austria
Belgium
France
Germany
Italy
Poland
Romania
Russia


2
2
12
12
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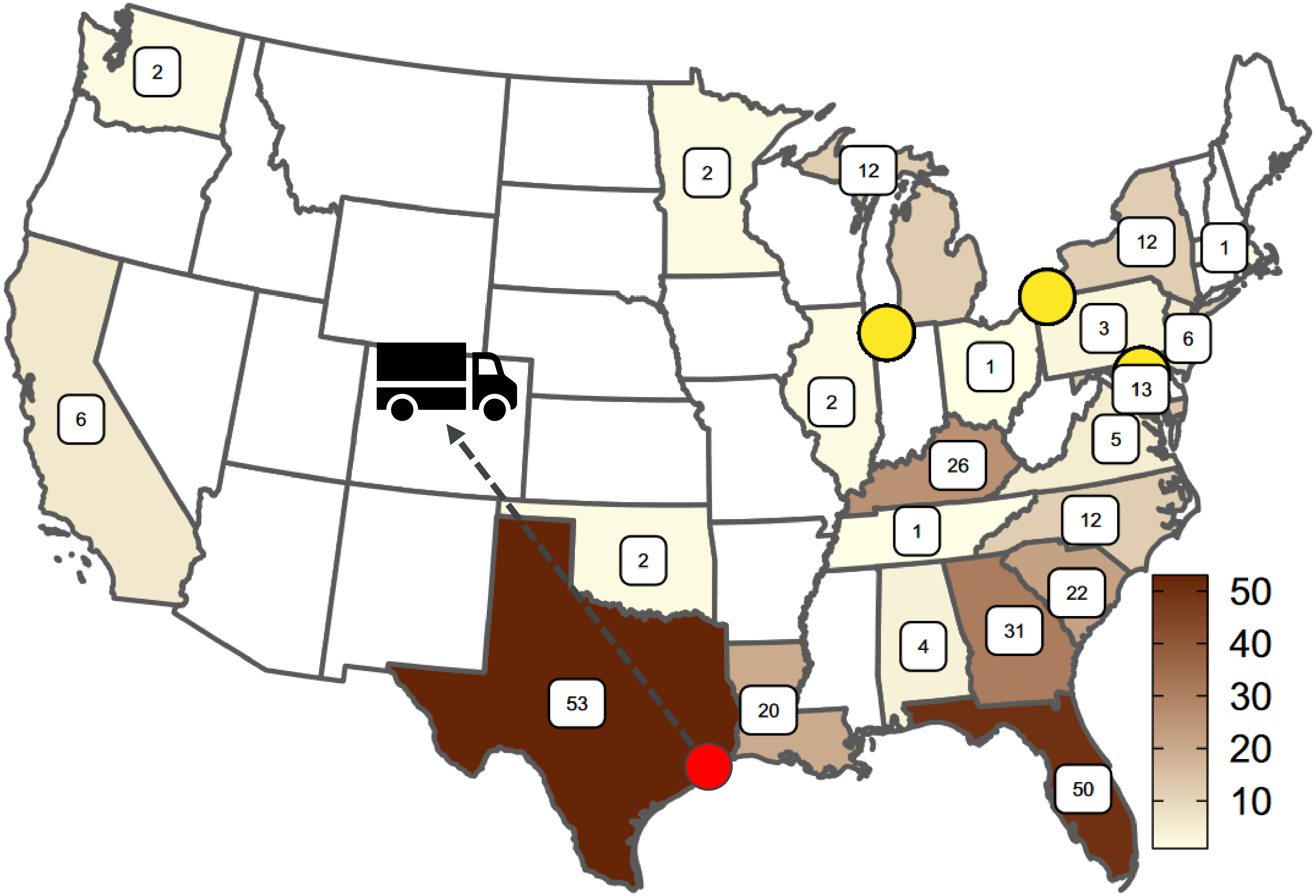
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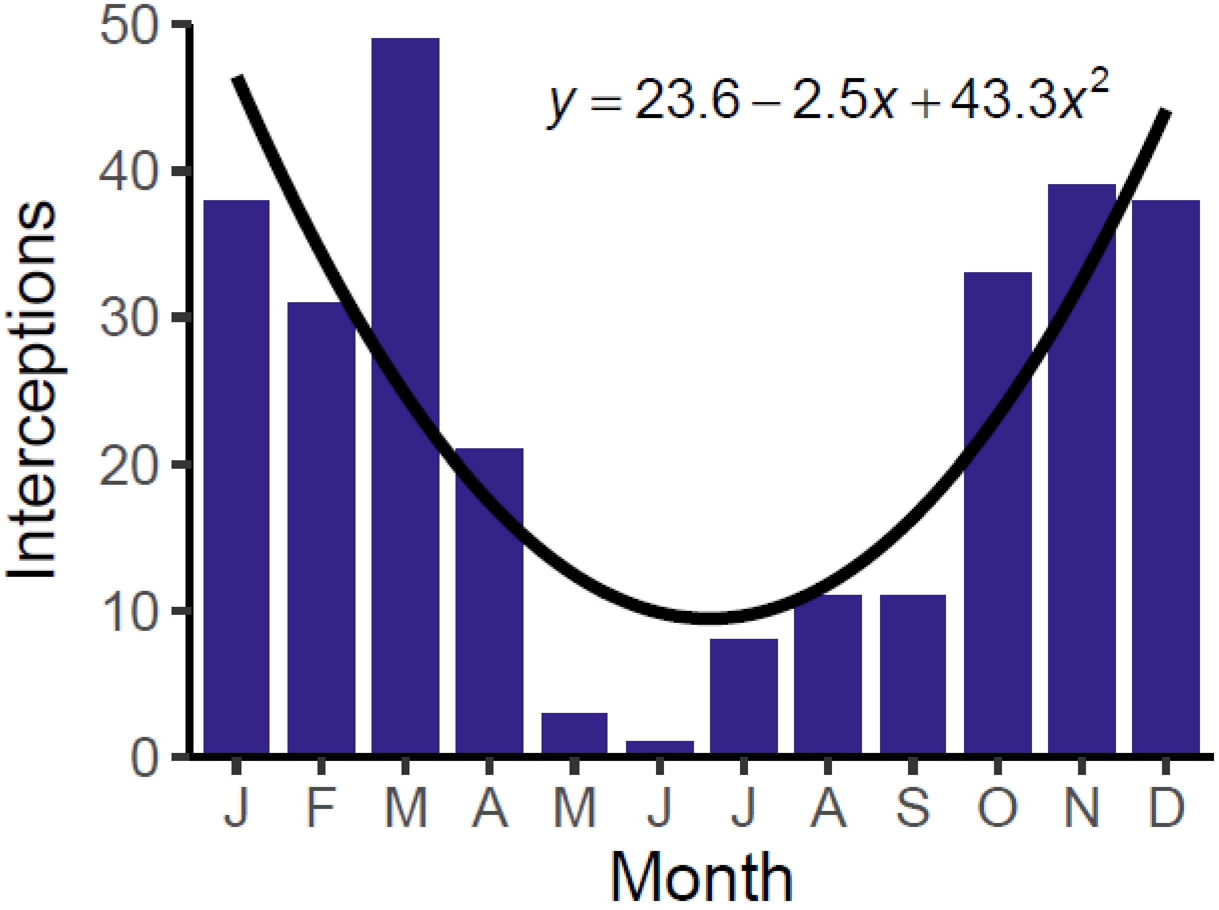
Interceptions exhibit seasonality



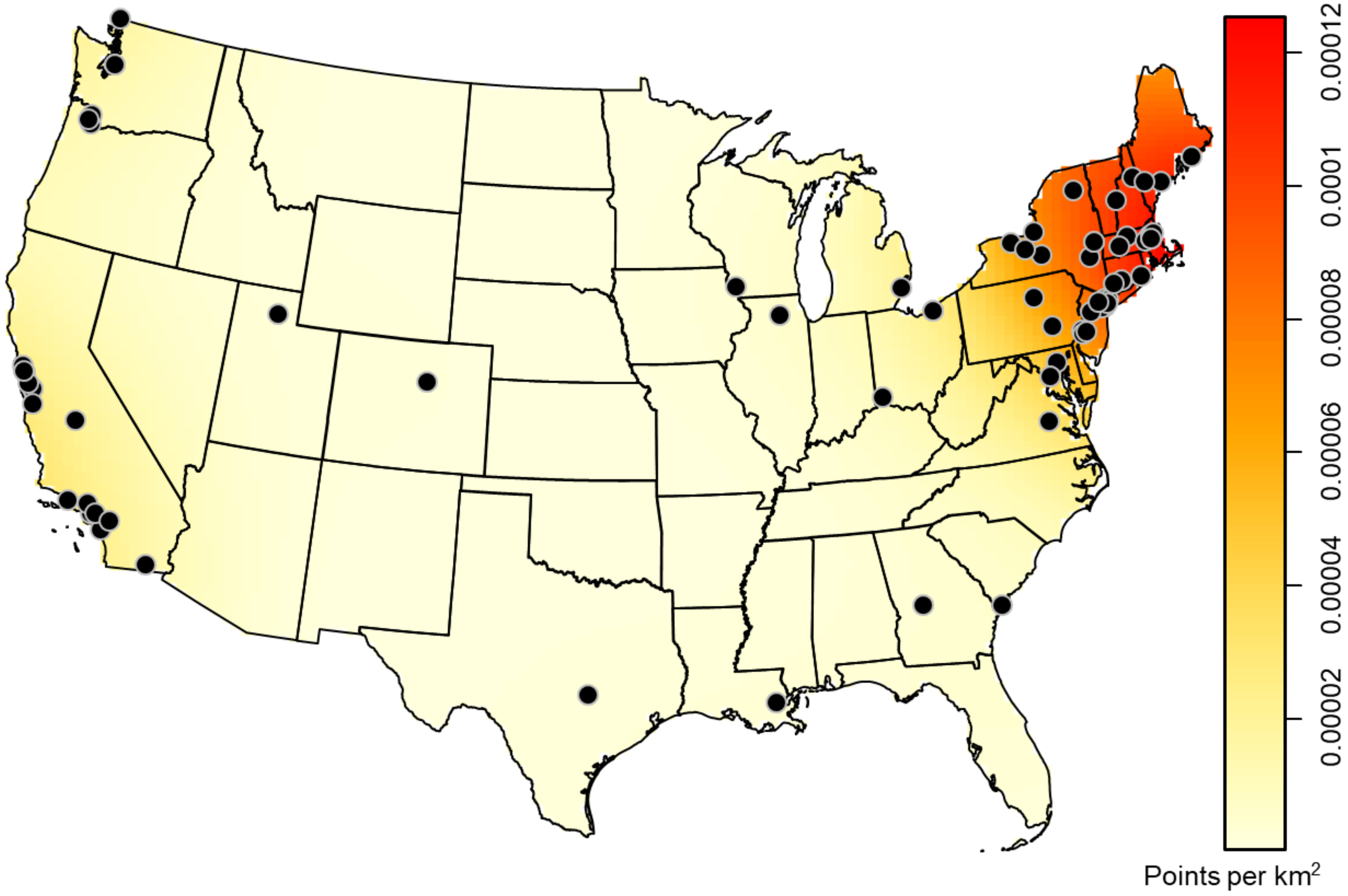
In summary…

…outbreaks and import volume do not explain variation in arrival rates of *Ips typographus*…

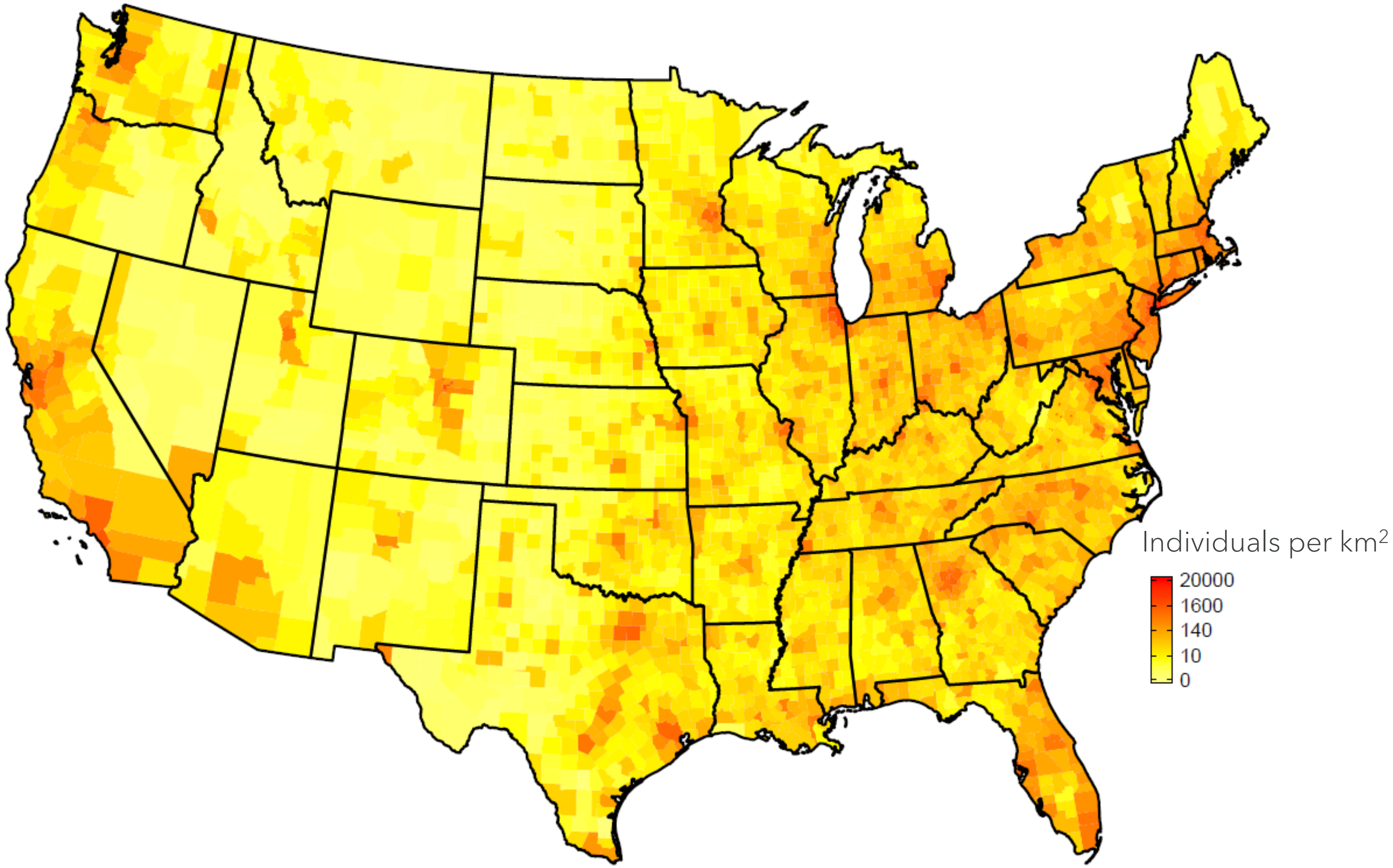
…but perhaps seasonal abundance can be an indicator of changes in biosecurity risks.

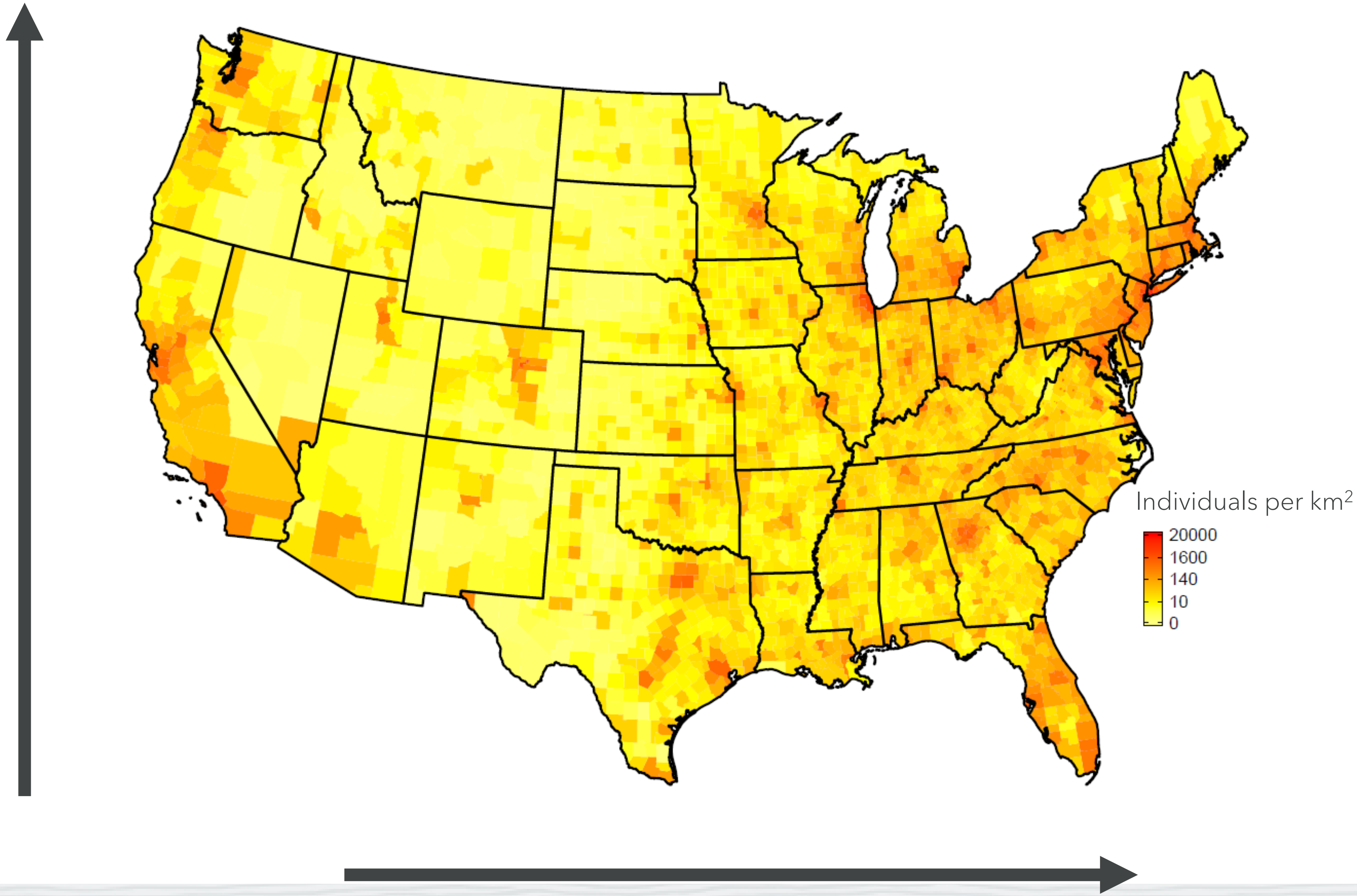
First discovery points

First discovery points



Human population density




Individuals per km2
20000
1600
140
10
0

Covariate	Estimate[a]	*SE*	$\|Z\|$[b]	*p*
Intercept	−14.12	0.39	36.39	< .0001
Population density	0.00006	0.00007	0.81	.29
Port density	0.37	0.15	2.57	.0149
Road density	0.00704	0.00081	8.68	< .0001
West–east	0.00041	0.00008	5.01	< .0001
West–east^2	10.2×10^{-7}	1.3×10^{-7}	8.00	< .0001
South–north	0.00009	0.00027	0.35	.38
South–north^2	-2.0×10^{-7}	3.5×10^{-7}	0.58	.34

Ward et al. (2019) *Global Ecology and Biogeography* (28) 1749-1762

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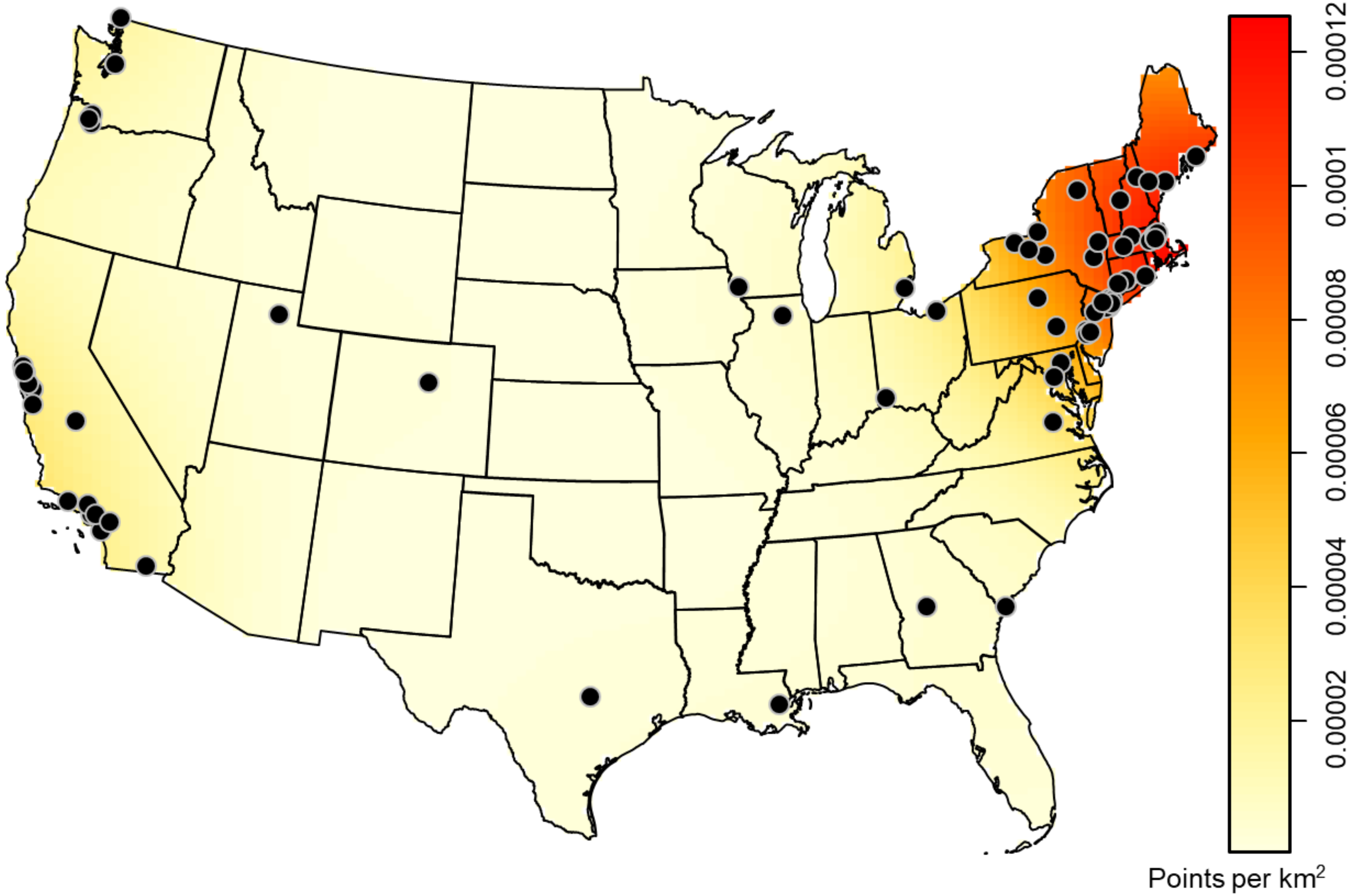
0.00012
0.0001
0.00008
0.00006
0.00004
0.00002
Points per km2

0.00012
0.0001
0.00006
0.00002
Points per km²

Covariate	Estimate[a]	*SE*	|*Z*|[b]	*p*
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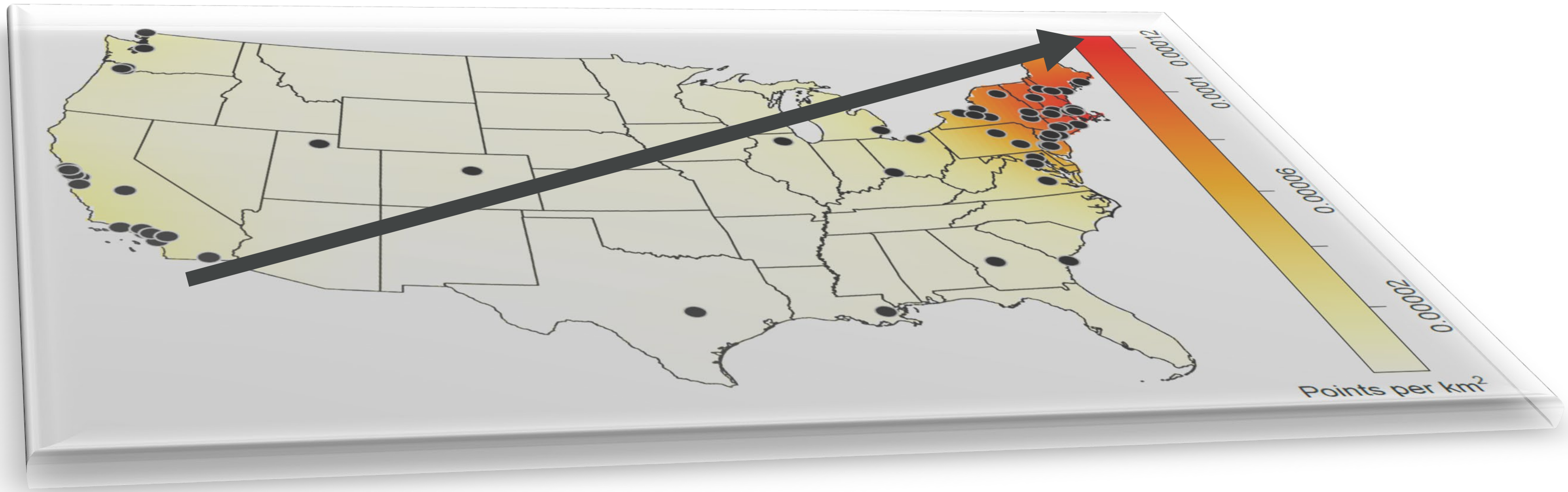

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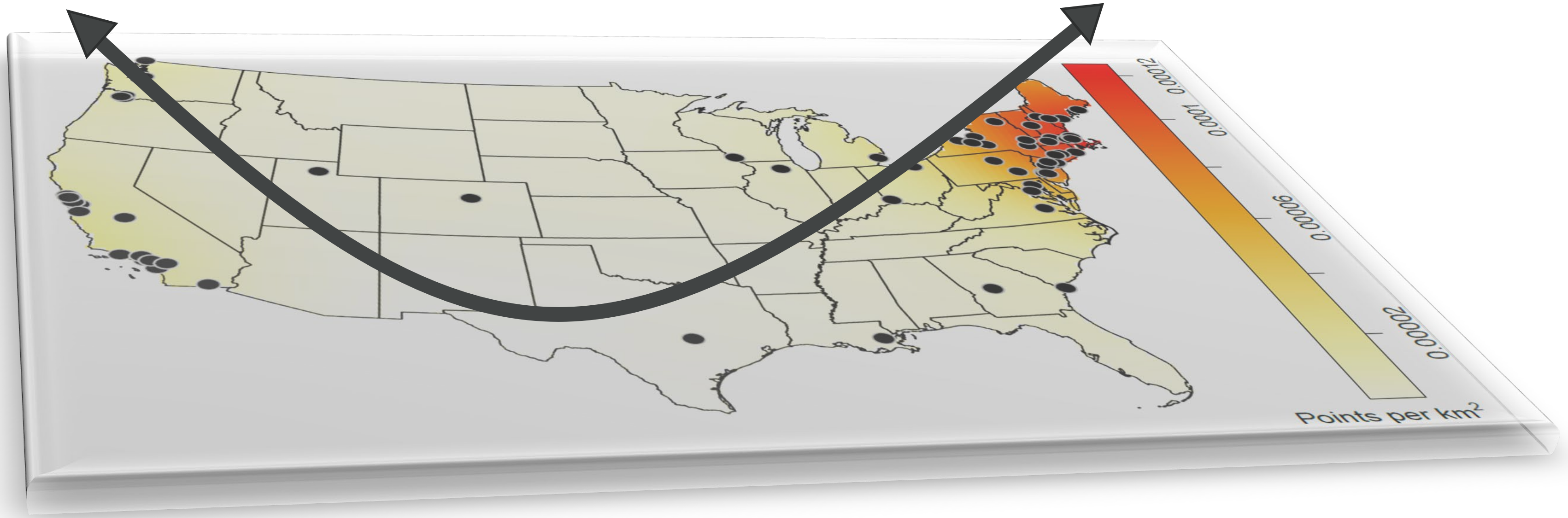
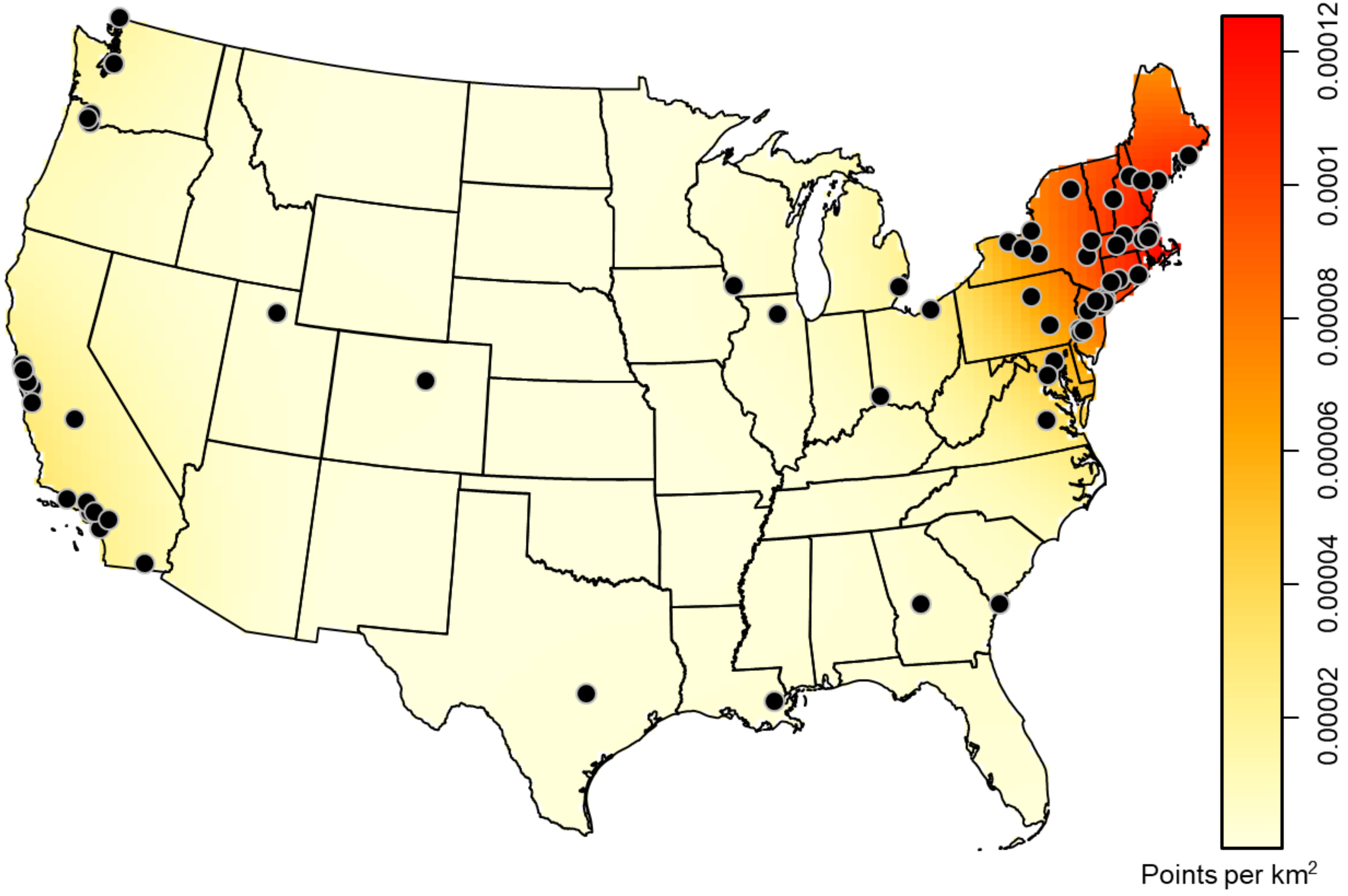
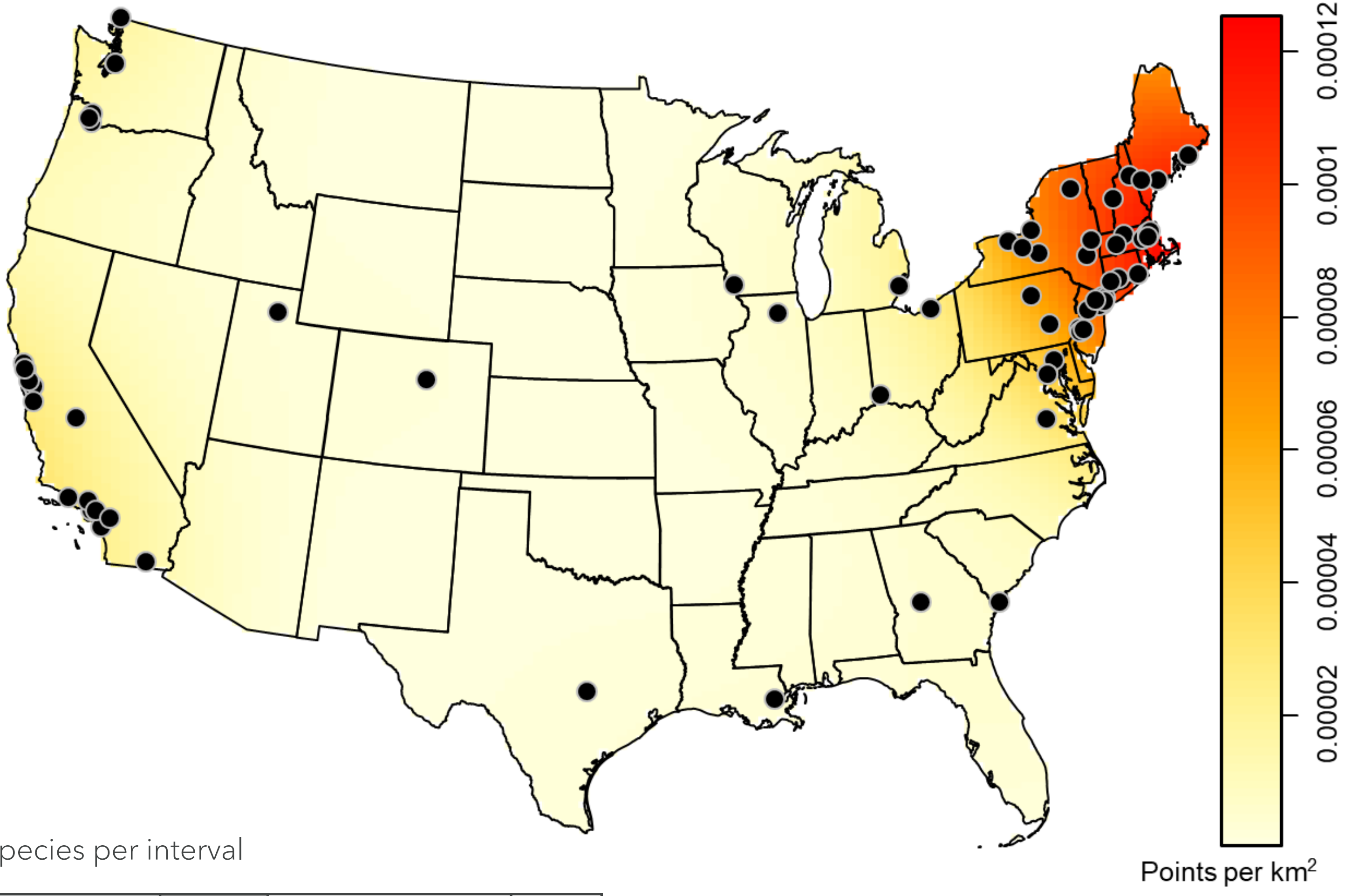
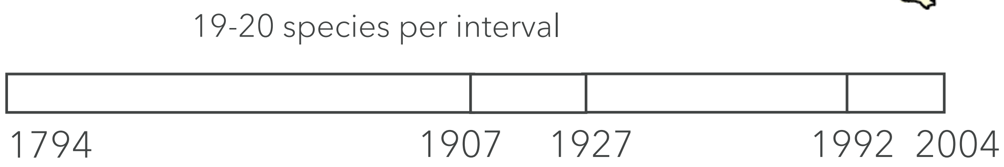


First discovery points

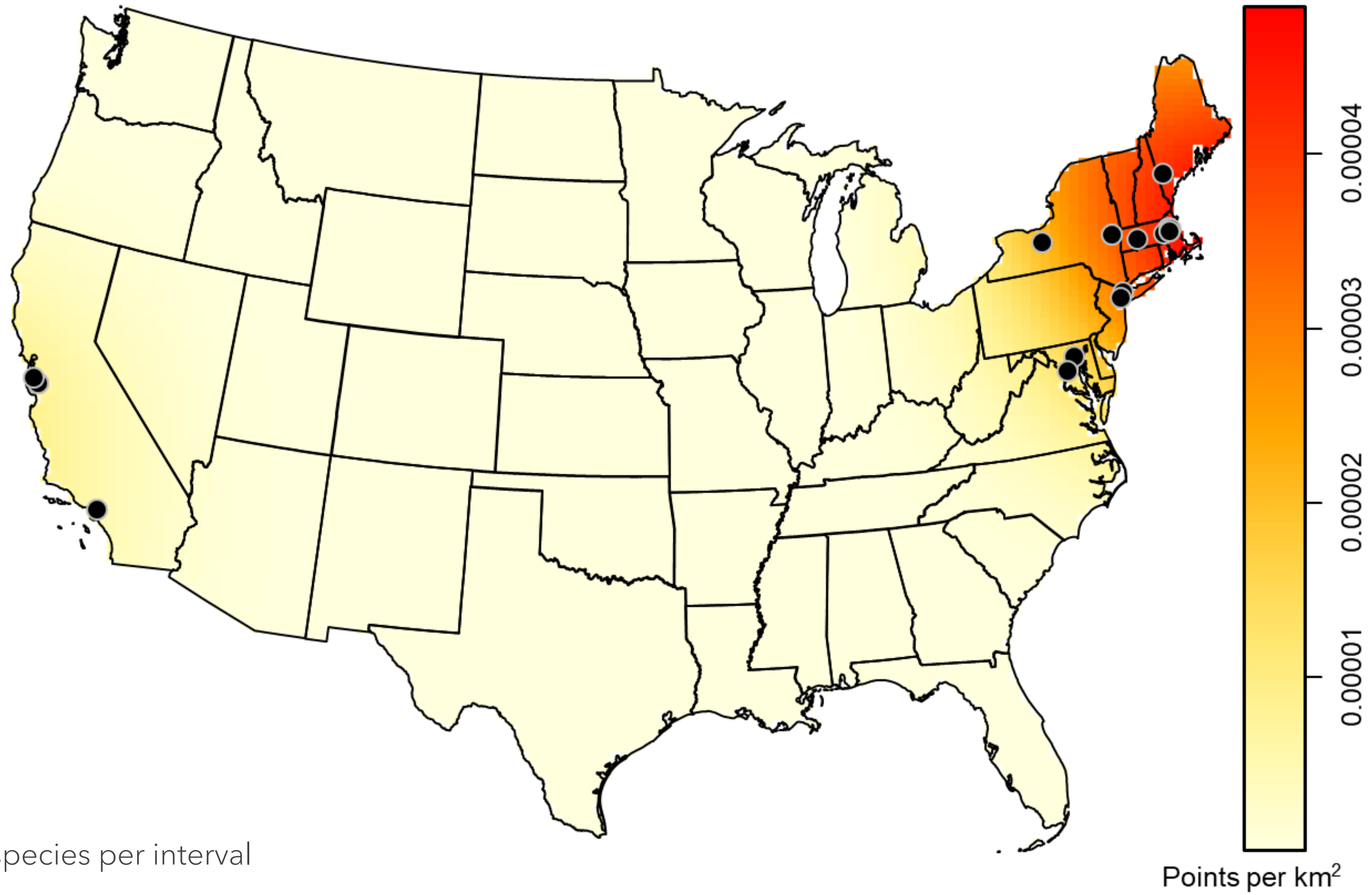


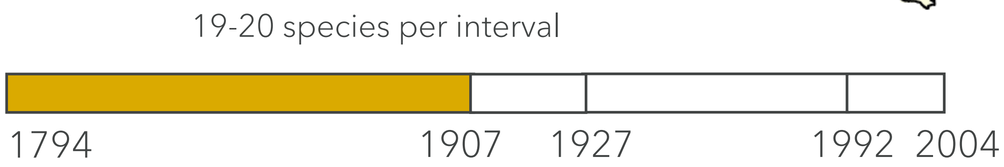
First discovery points



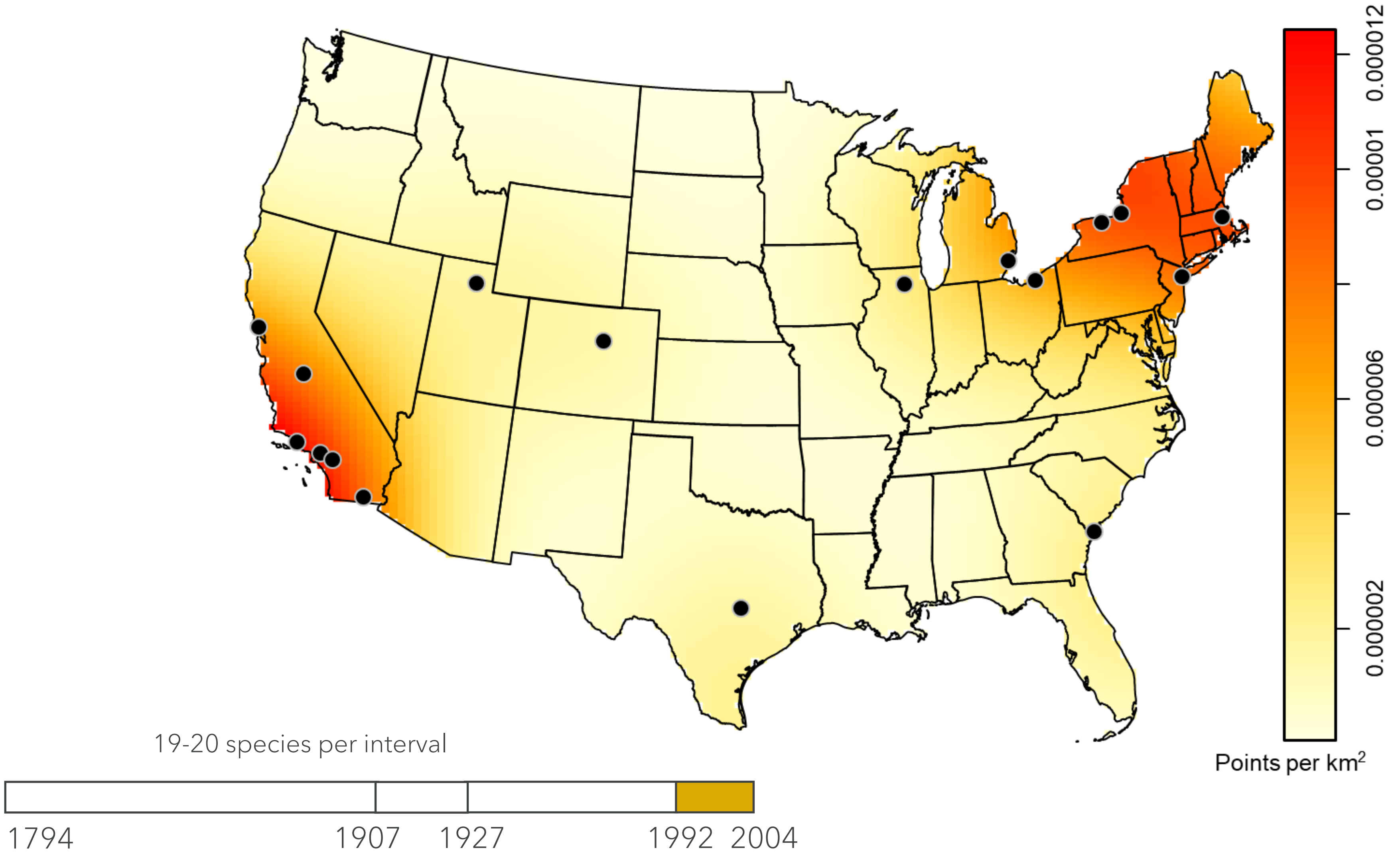


Pests introduced from 1794-1907

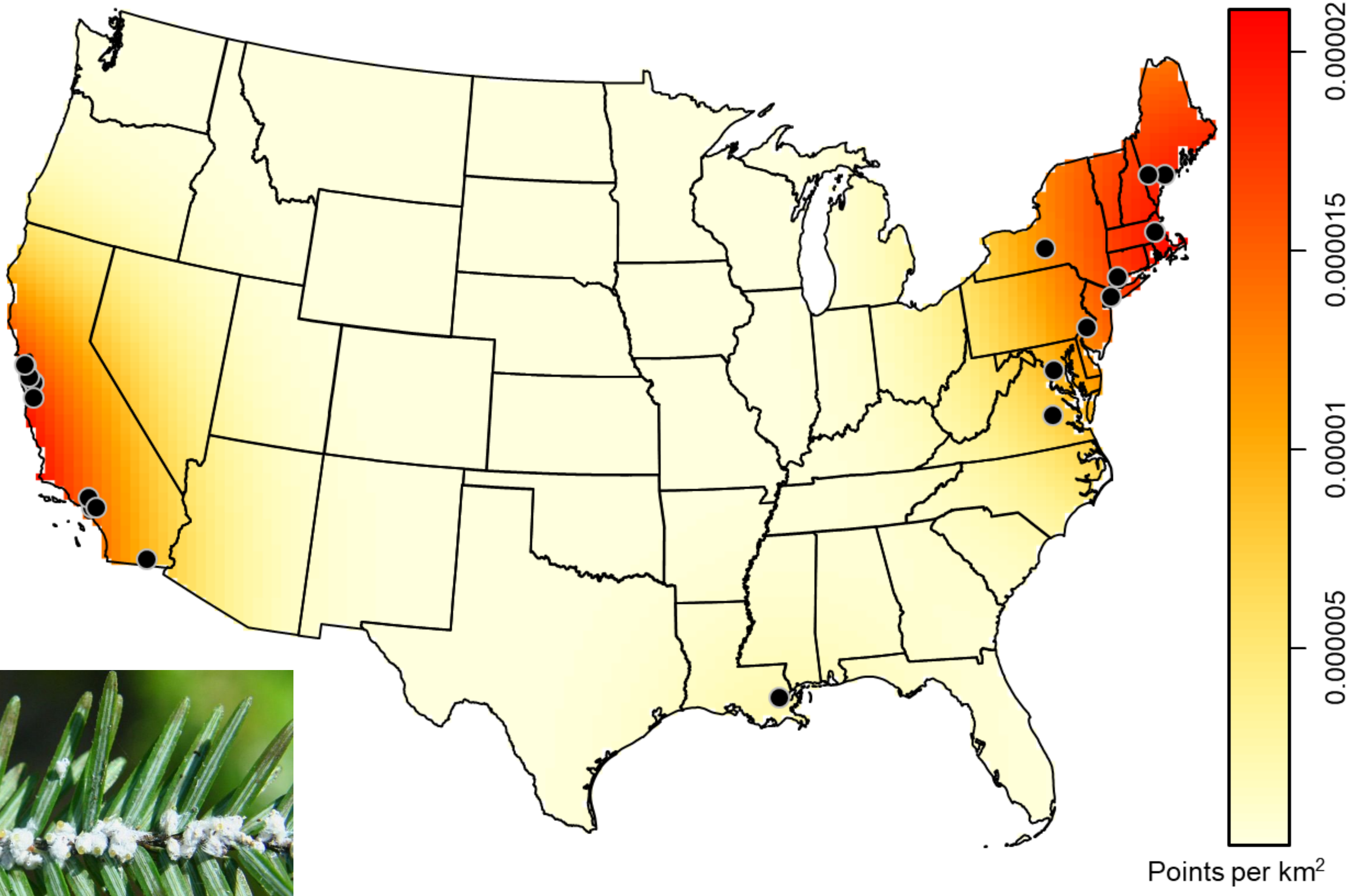




Pests introduced from 1992-2004



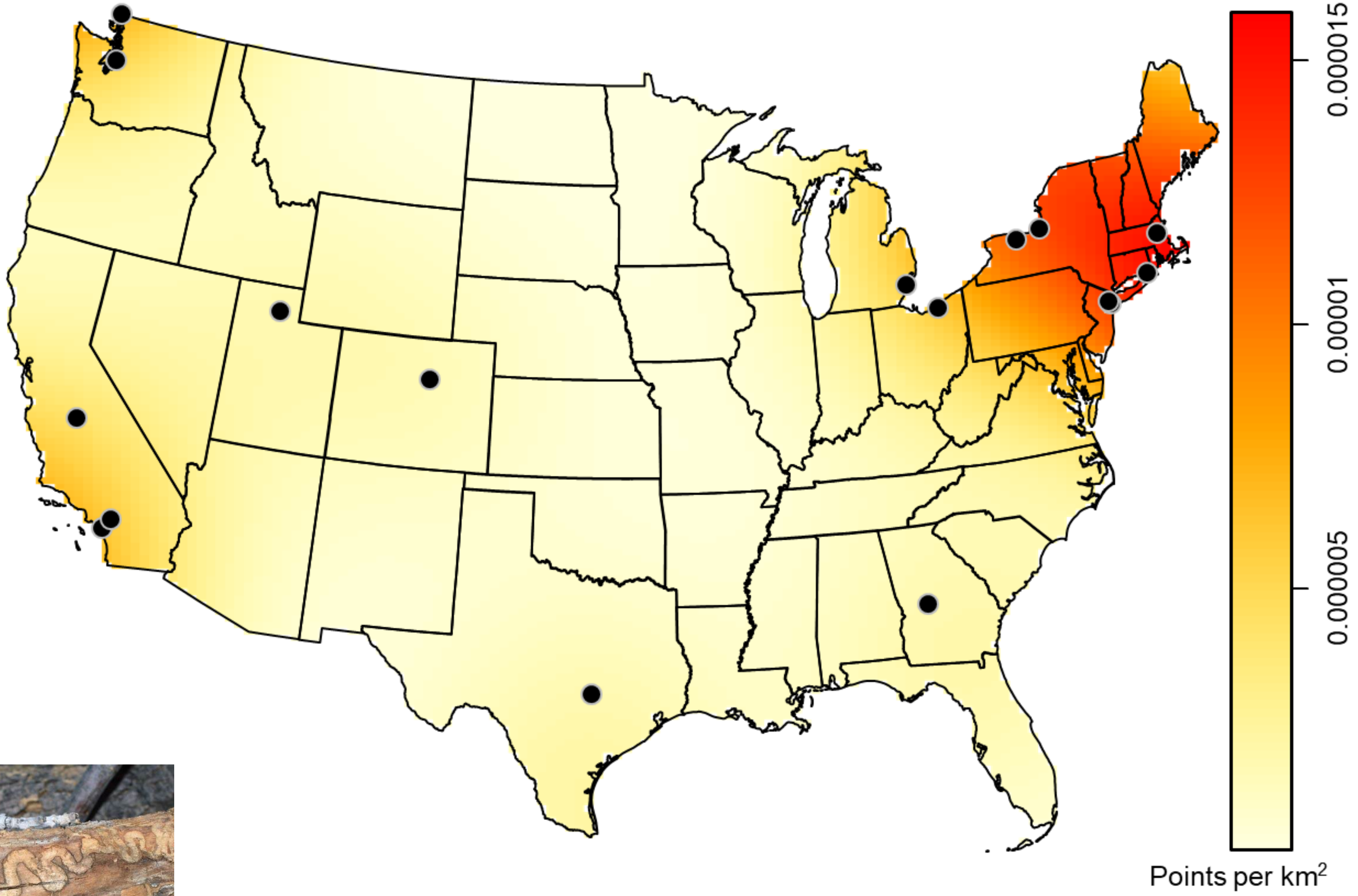
Sap-feeders



Hemlock woolly adelgid

Tom Coleman
USDA Forest Service,
Bugwood.org

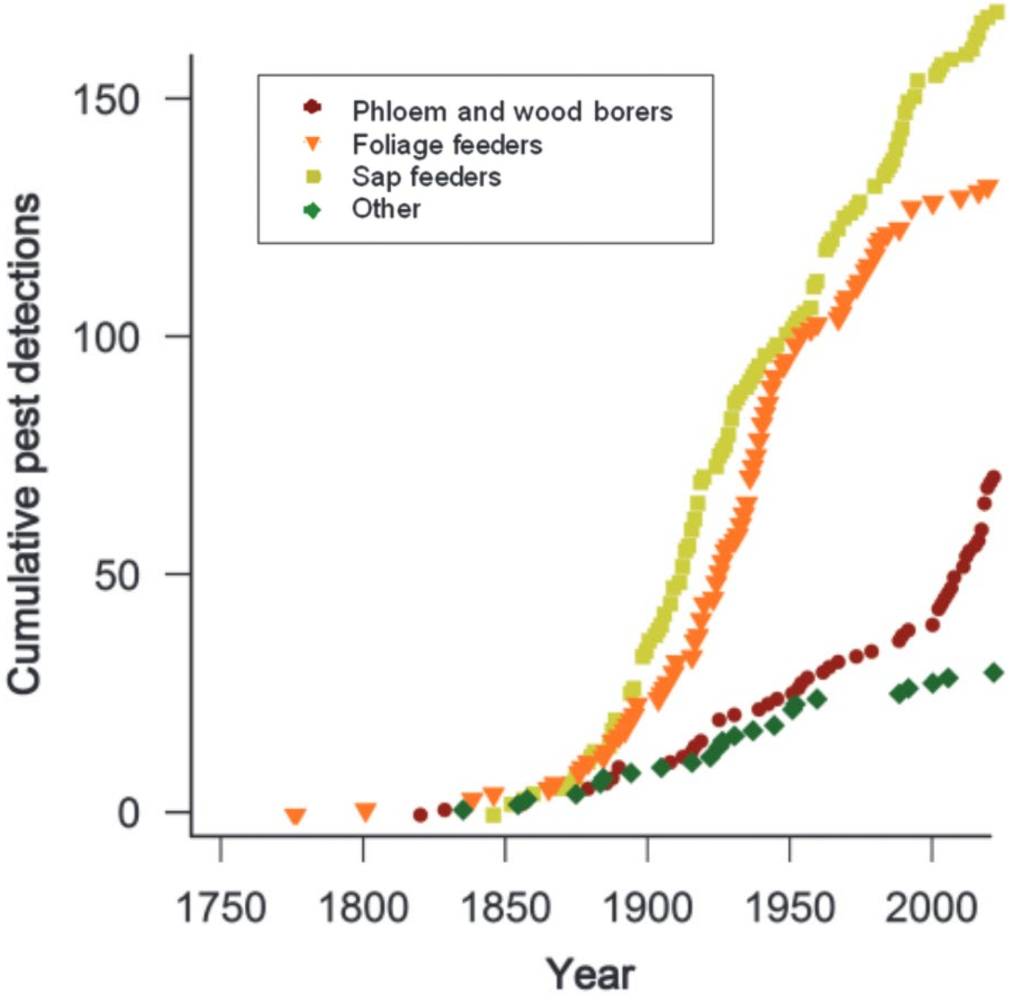
Borers



Damage from emerald ash borer

William M. Ciesla
Forest Health Management International

Rising borer invasions in the USA

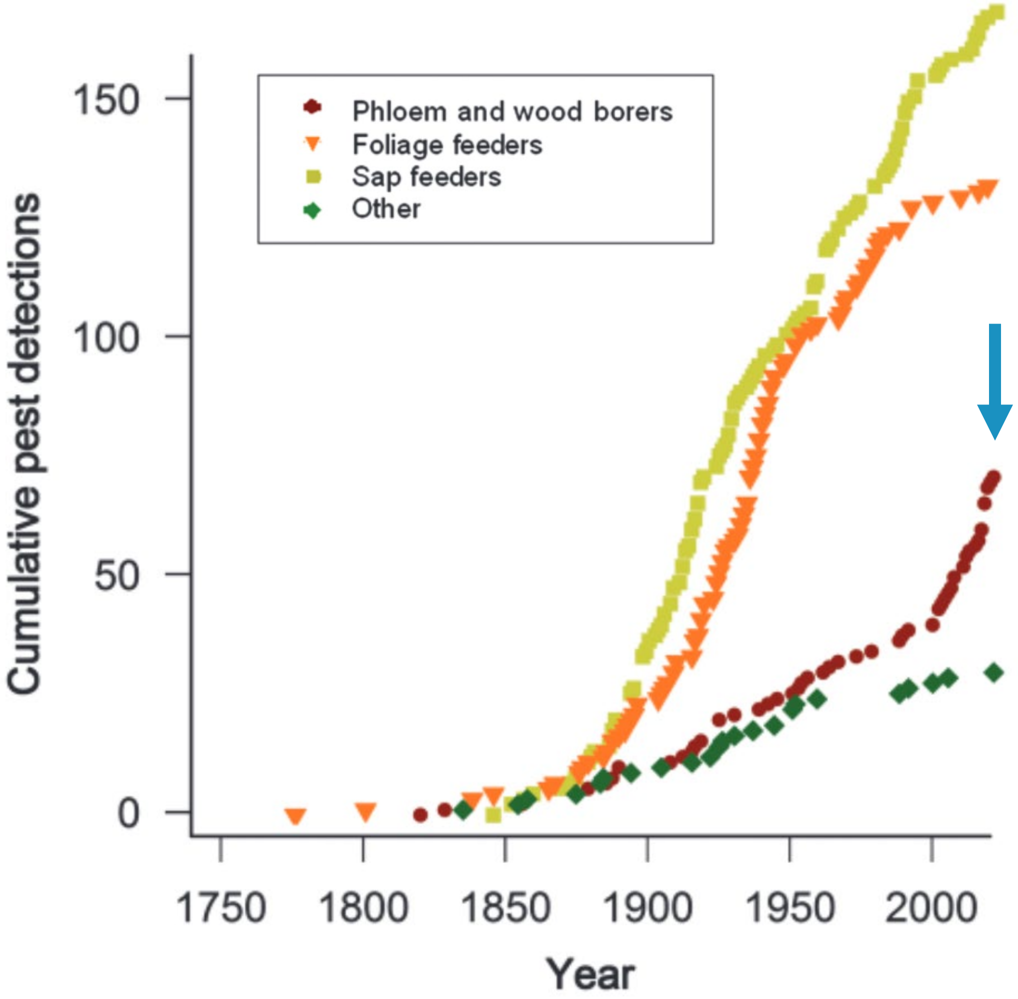


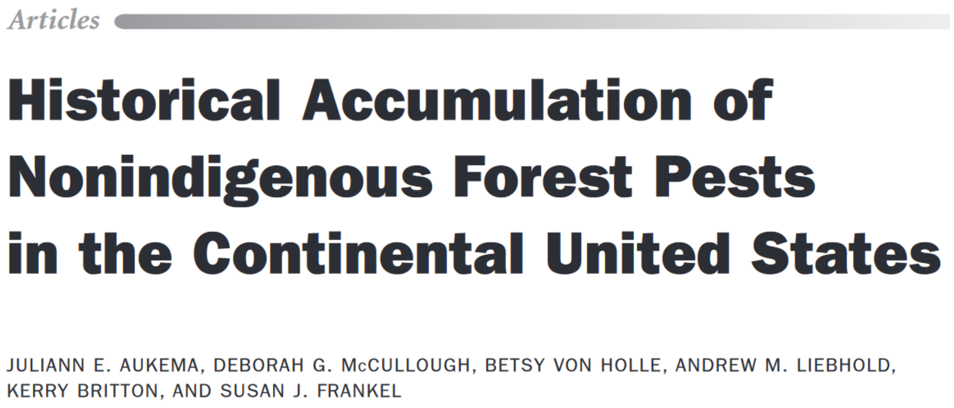
Articles

Historical Accumulation of Nonindigenous Forest Pests in the Continental United States

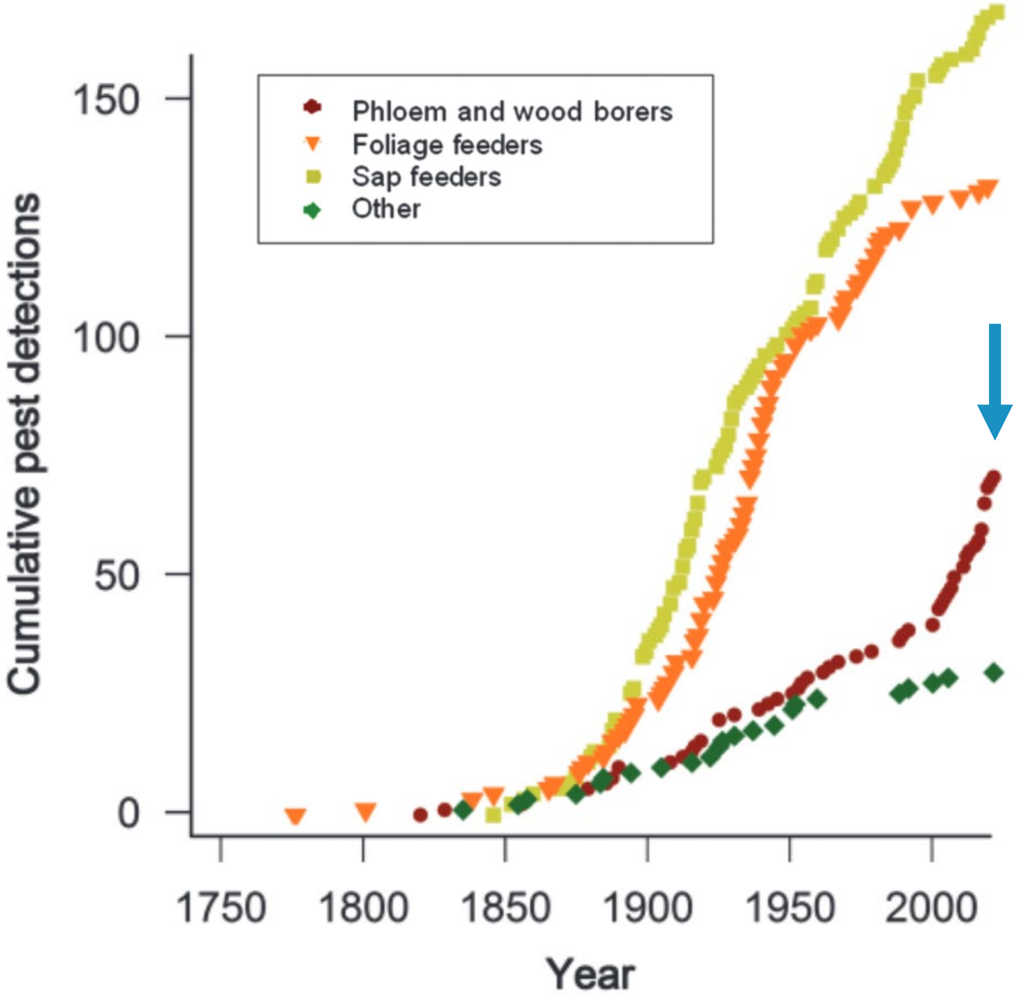
JULIANN E. AUKEMA, DEBORAH G. McCULLOUGH, BETSY VON HOLLE, ANDREW M. LIEBHOLD, KERRY BRITTON, AND SUSAN J. FRANKEL

Rising borer invasions in the USA





Rising borer invasions in the USA



Created by Atif Arshad
from Noun Project

Curculionidae: Scolytinae

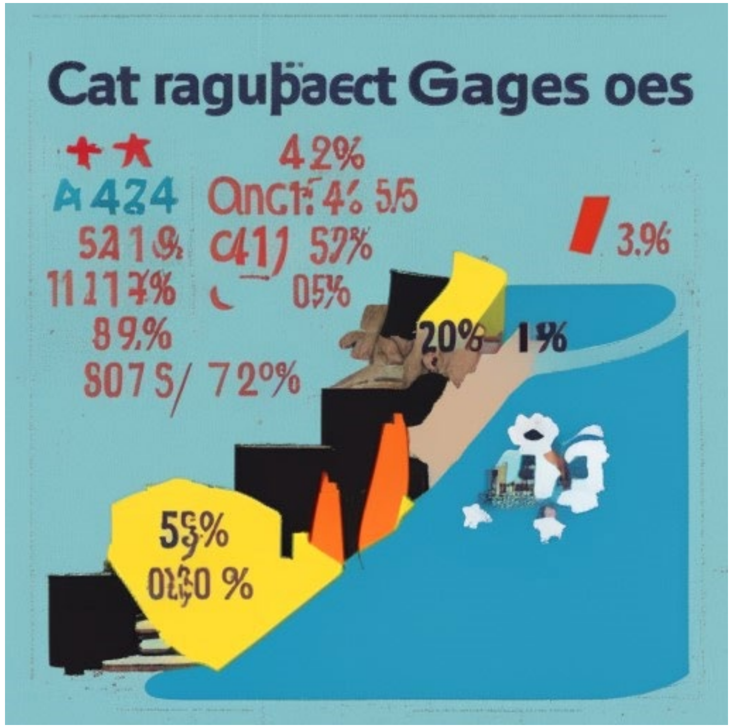
***Hypothenemus eruditus* Westwood**

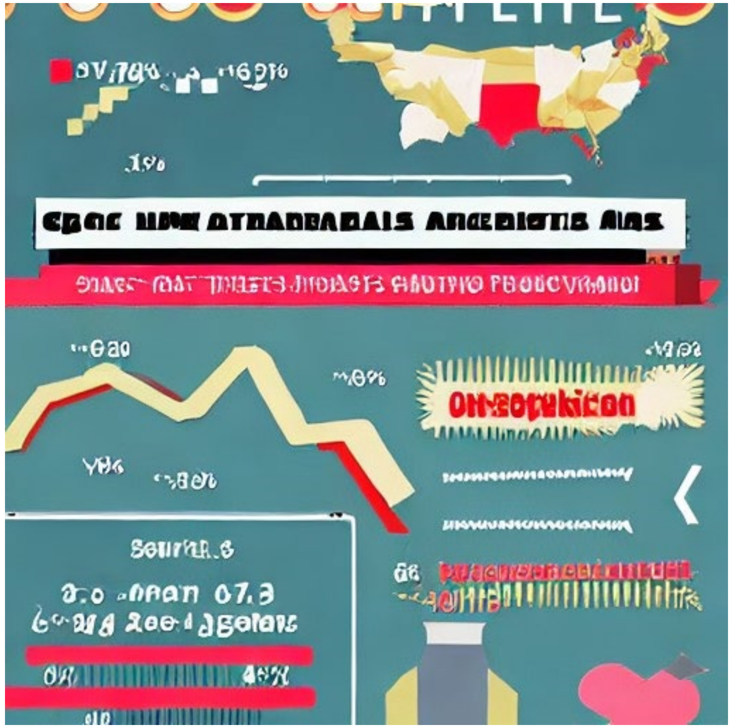
***Xylosandrus germanus* Blandford**

***Dryoxylon onoharaense* Murayama**

Photo credits: Reparto Carabinieri Biodiversità Belluno via Marchioro et al. (2022) New species and new records of exotic Scolytinae (Coleoptera, Curculionidae) in Europe. Biodiversity Data Journal 10: e93995. https://doi.org/10.3897/BDJ.10.e93995

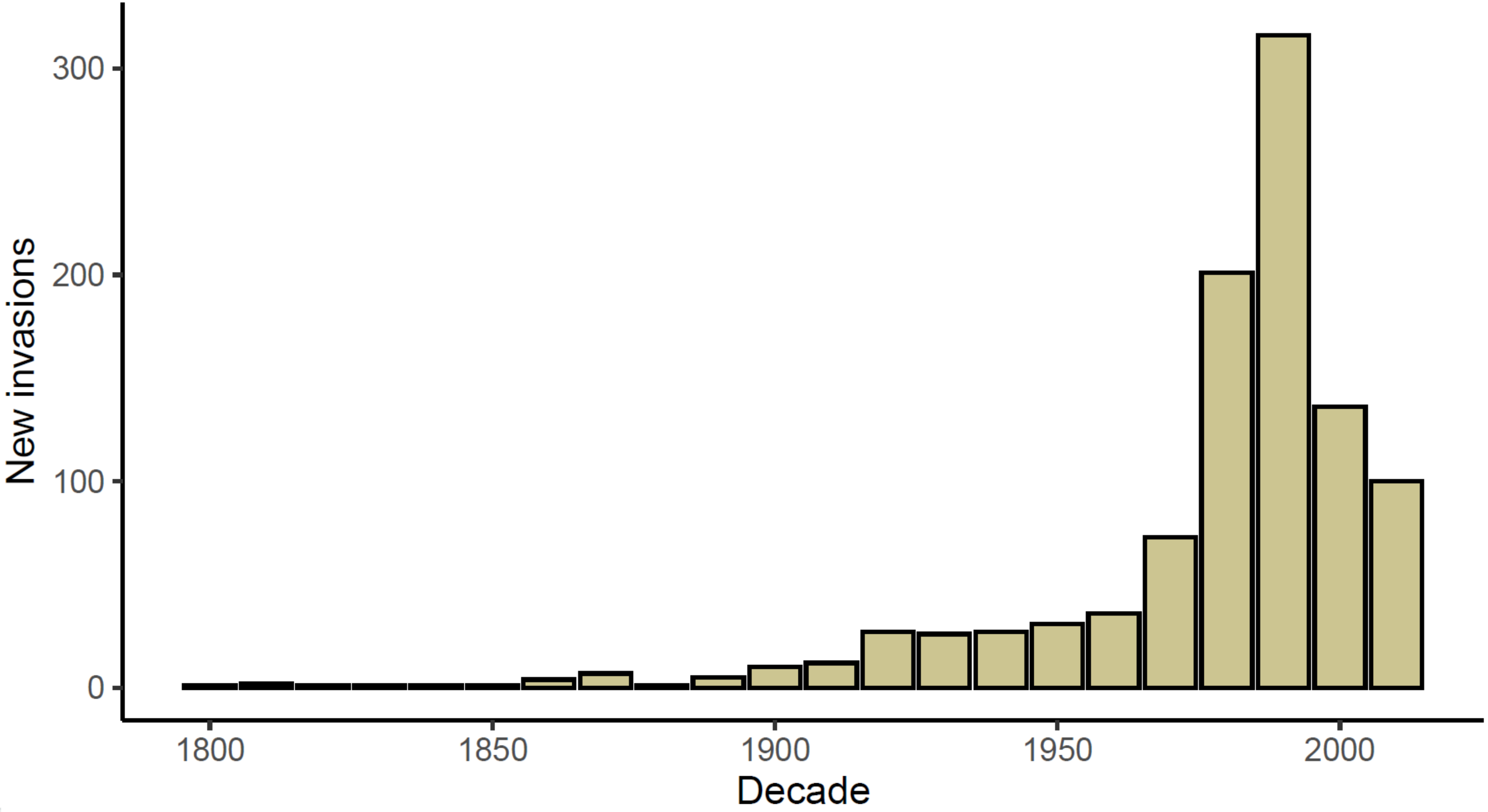
Garbage in, garbage out?...






…no, but at this stage, findings should be taken with a grain of salt.
Emmy Smith

90 species of scolytines have invaded at least one country from **1803-2020**



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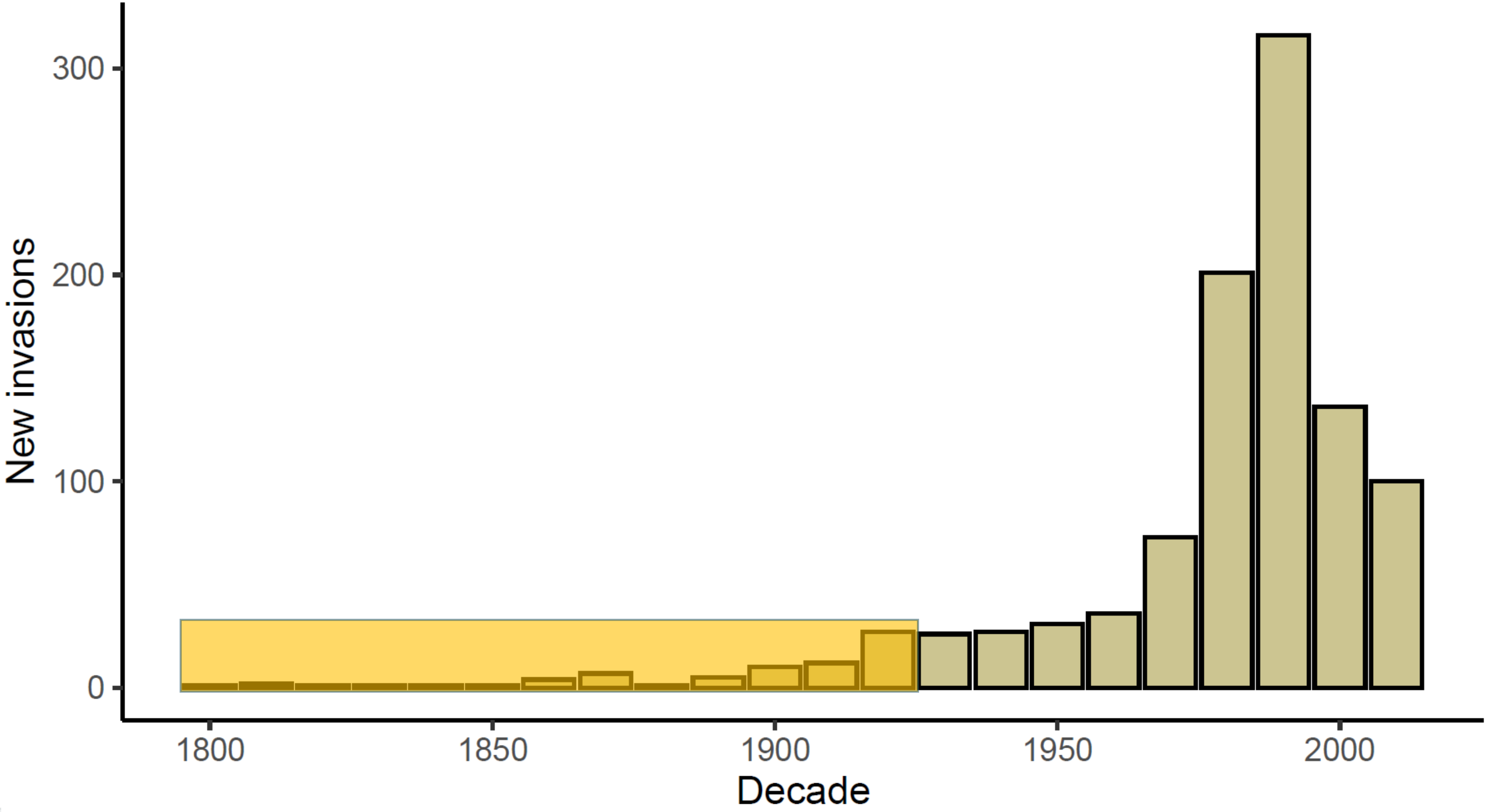

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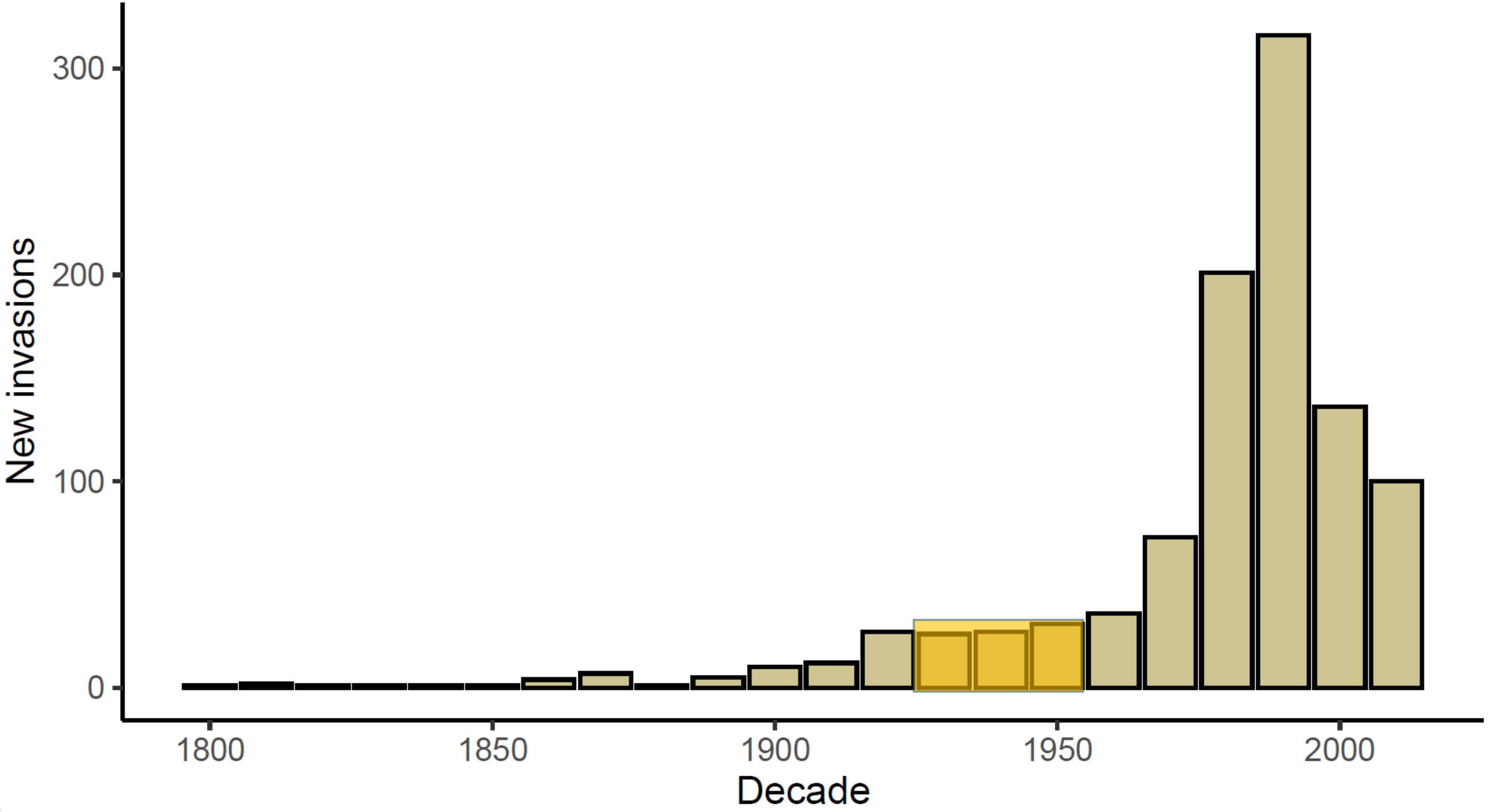

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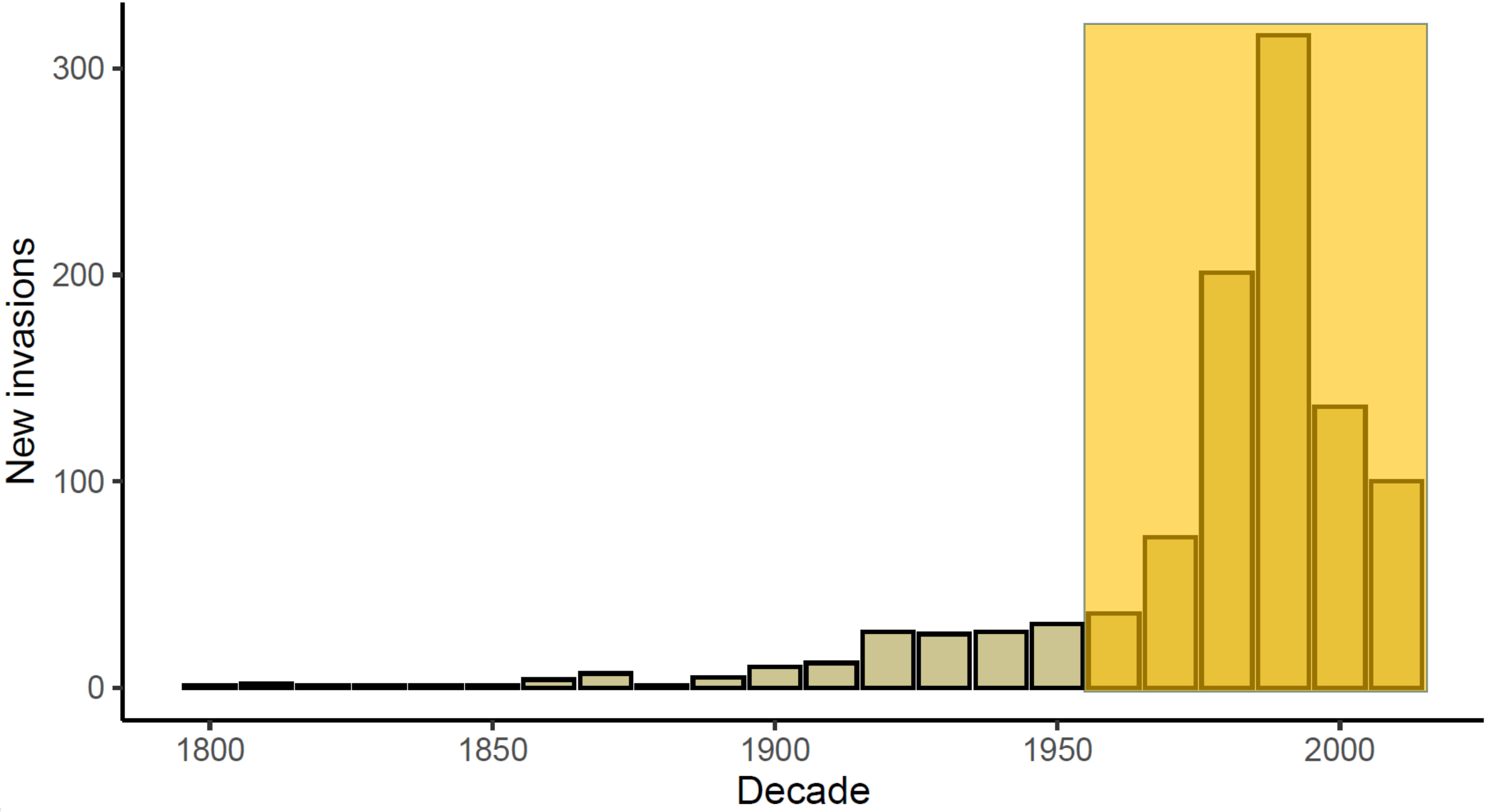

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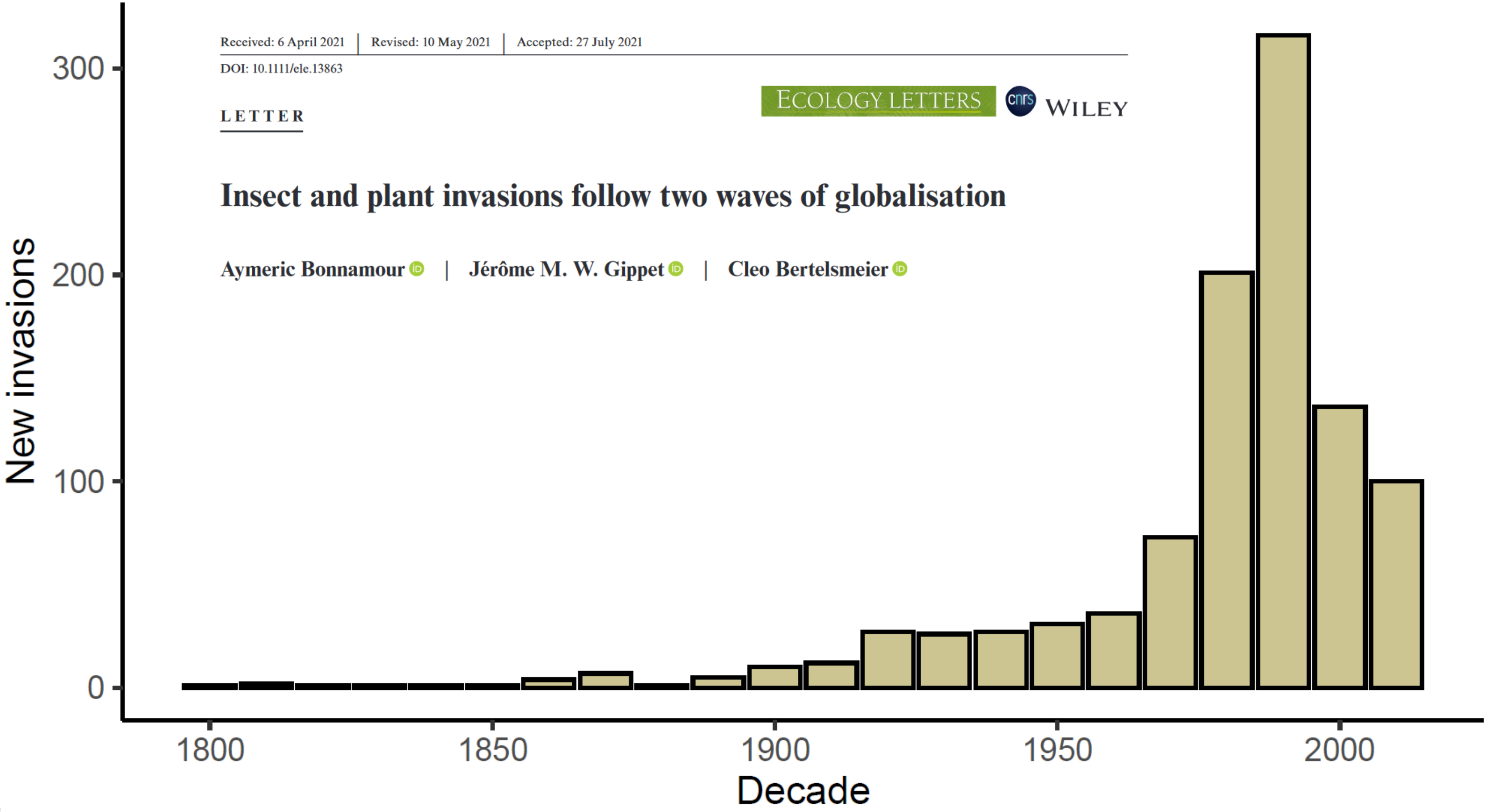

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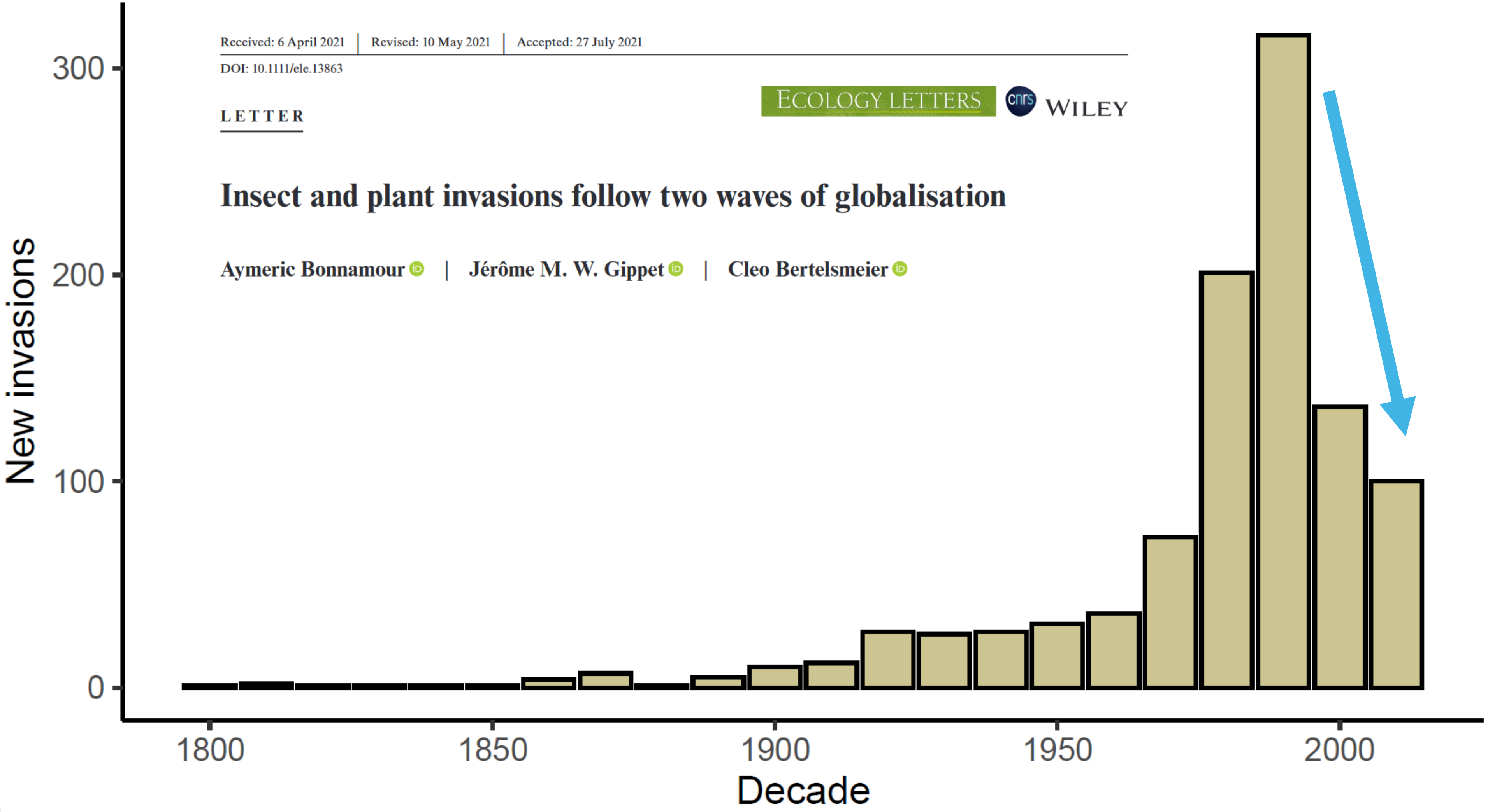

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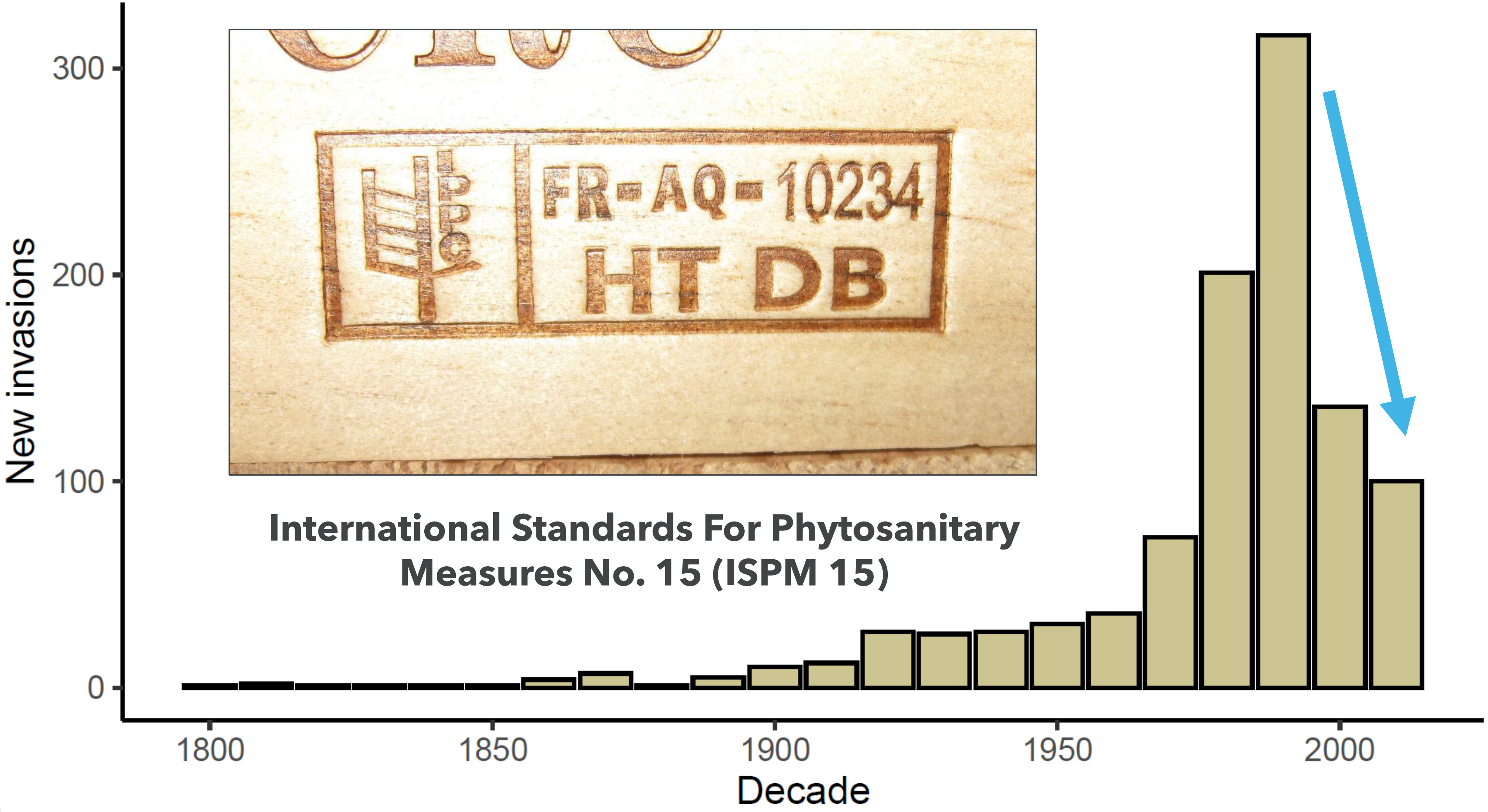
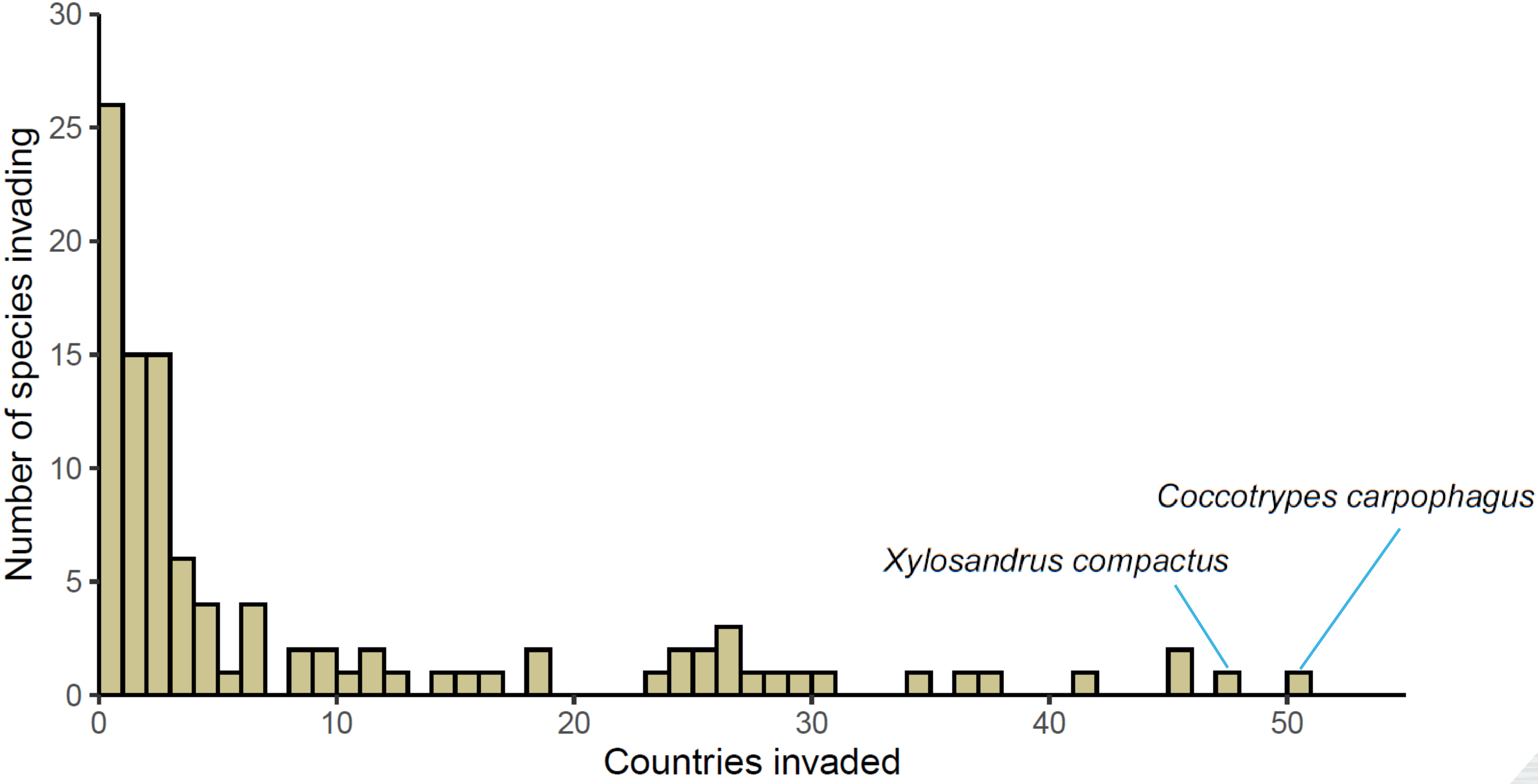
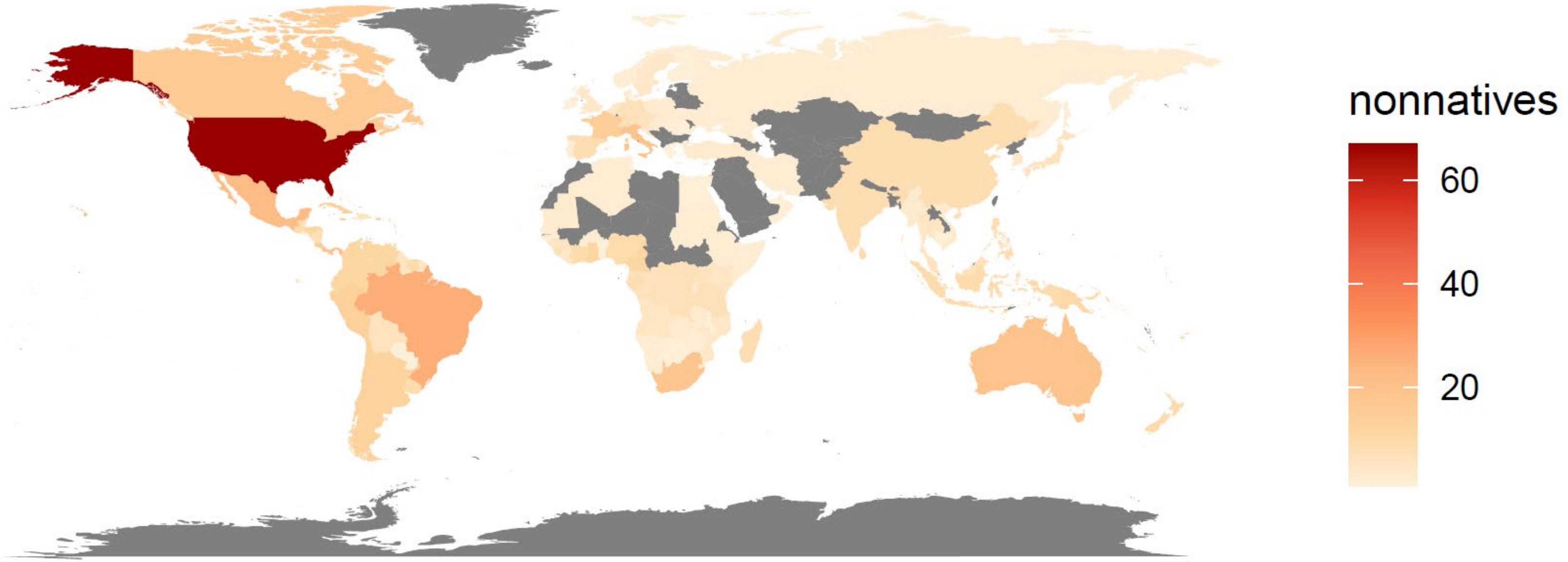


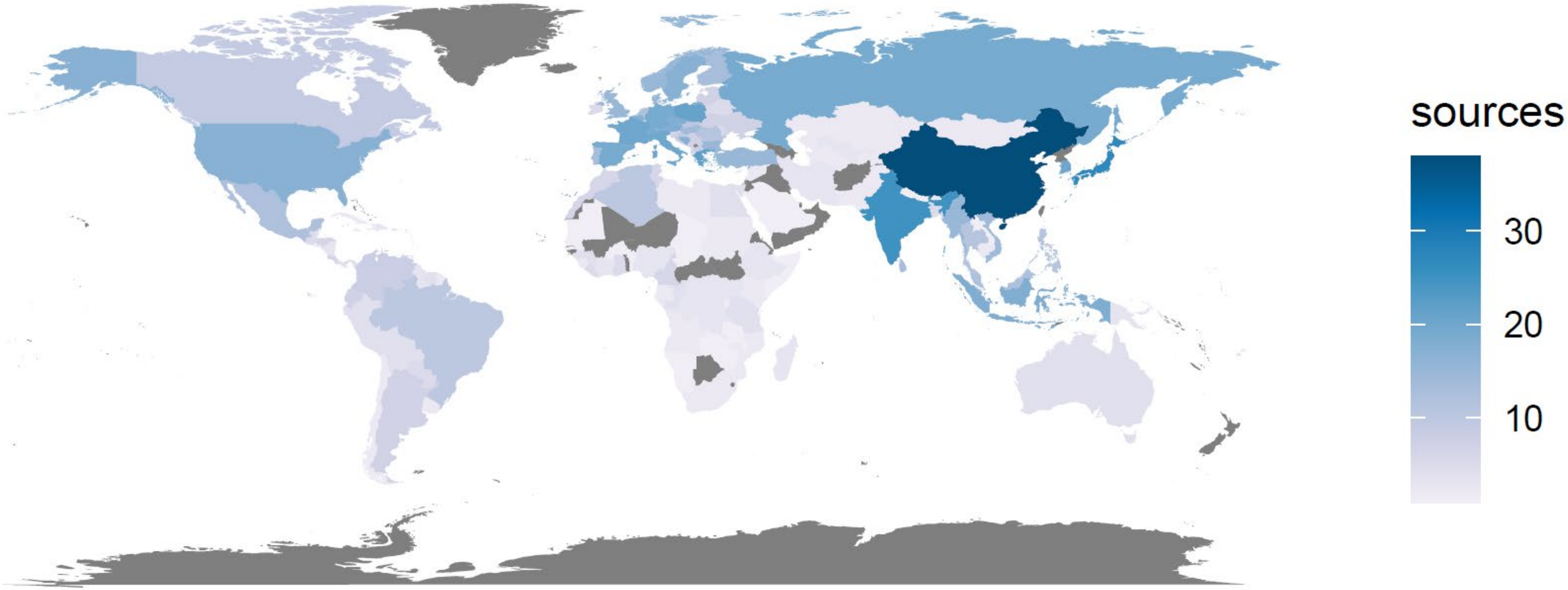
1,025 unique invasions (**143** countries)



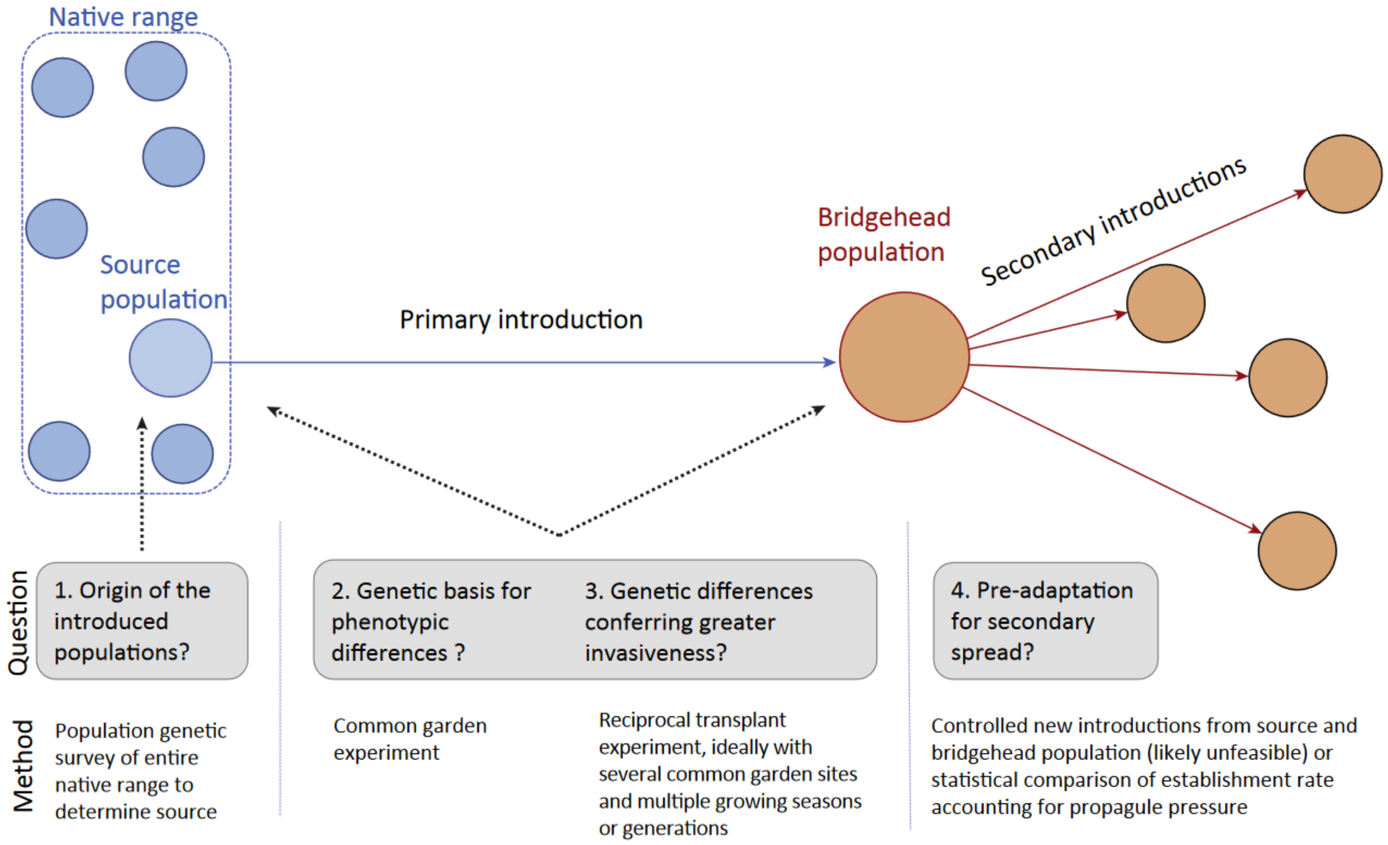
Invaded countries



Native ranges



Bridgeheads: the concept



Trends in Ecology & Evolution

Figure 1. Evidence Needed to Demonstrate That Adaptive Evolution Is an Important Driver of Secondary Introductions.

Trends in Ecology & Evolution

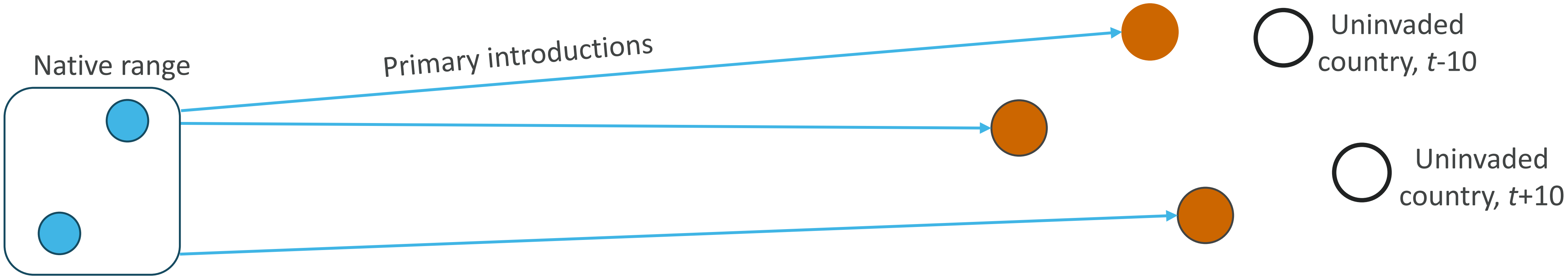
CellPress REVIEWS

Review

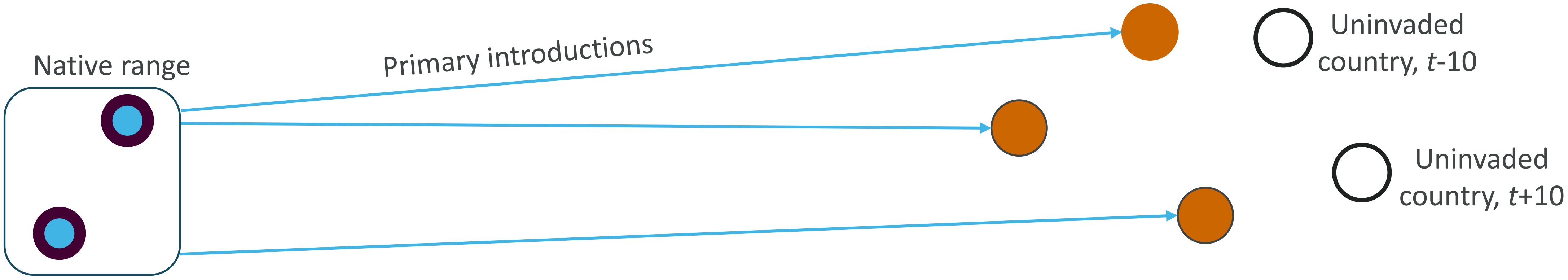
Bridgehead Effects and Role of Adaptive Evolution in Invasive Populations

Cleo Bertelsmeier[1,*] and Laurent Keller[1,*]

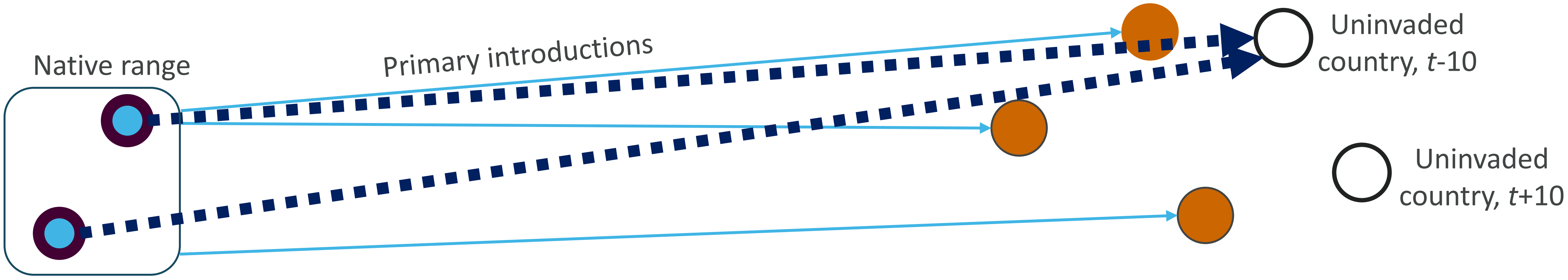
Bridgeheads: our approach



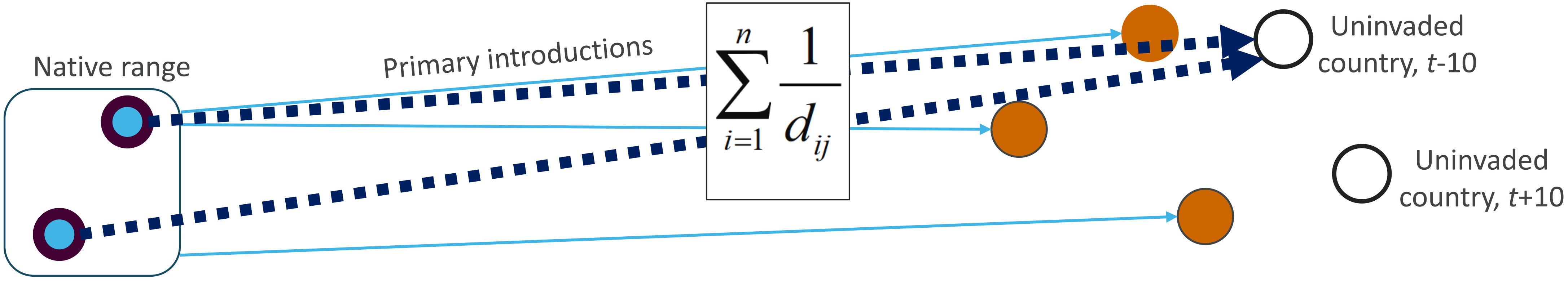
Bridgeheads: our approach



Bridgeheads: our approach

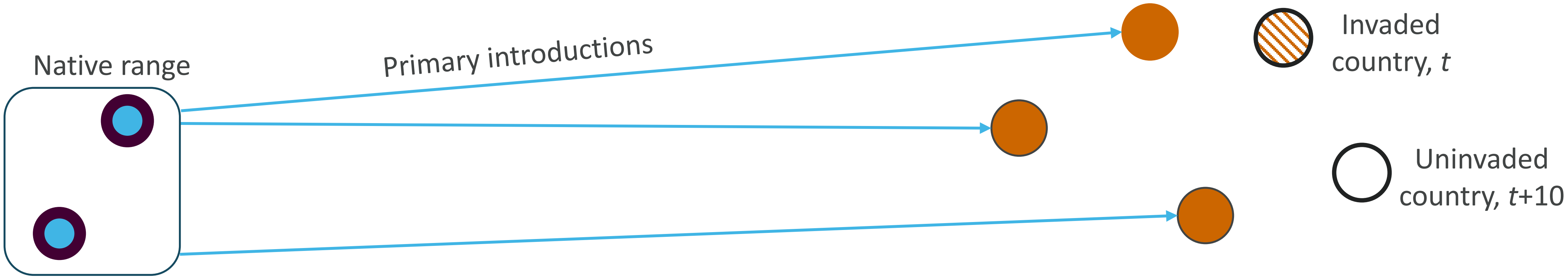


Bridgeheads: our approach

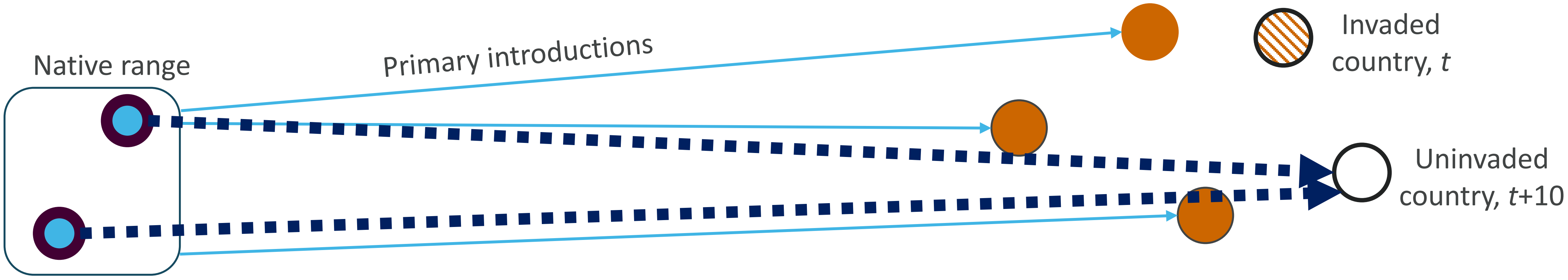


$$\sum_{i=1}^{n} \frac{1}{d_{ij}}$$

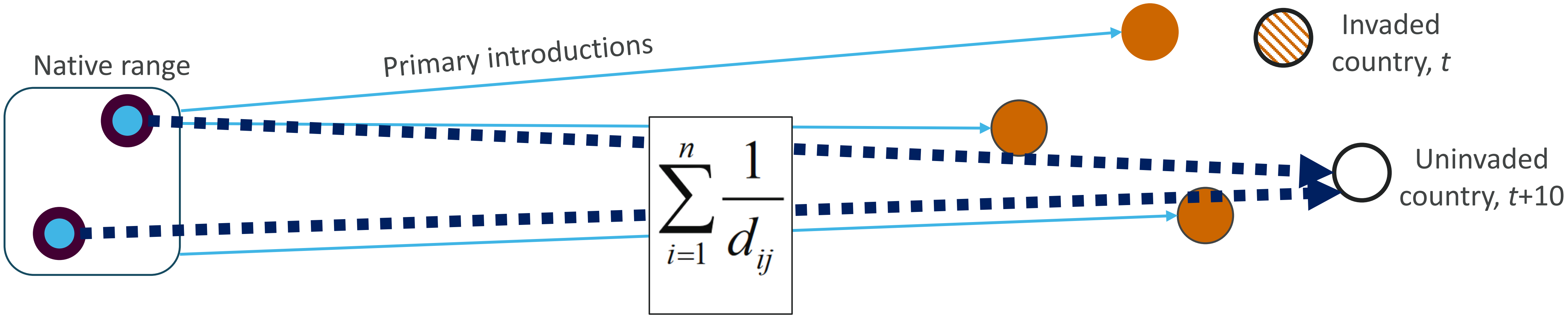
Bridgeheads: our approach



Bridgeheads: our approach



Bridgeheads: our approach



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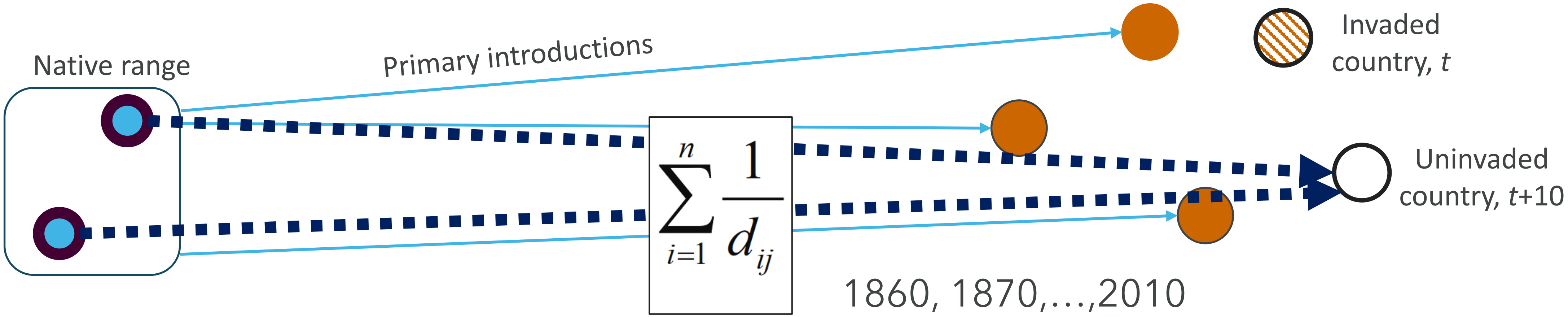

Bridgeheads: our approach

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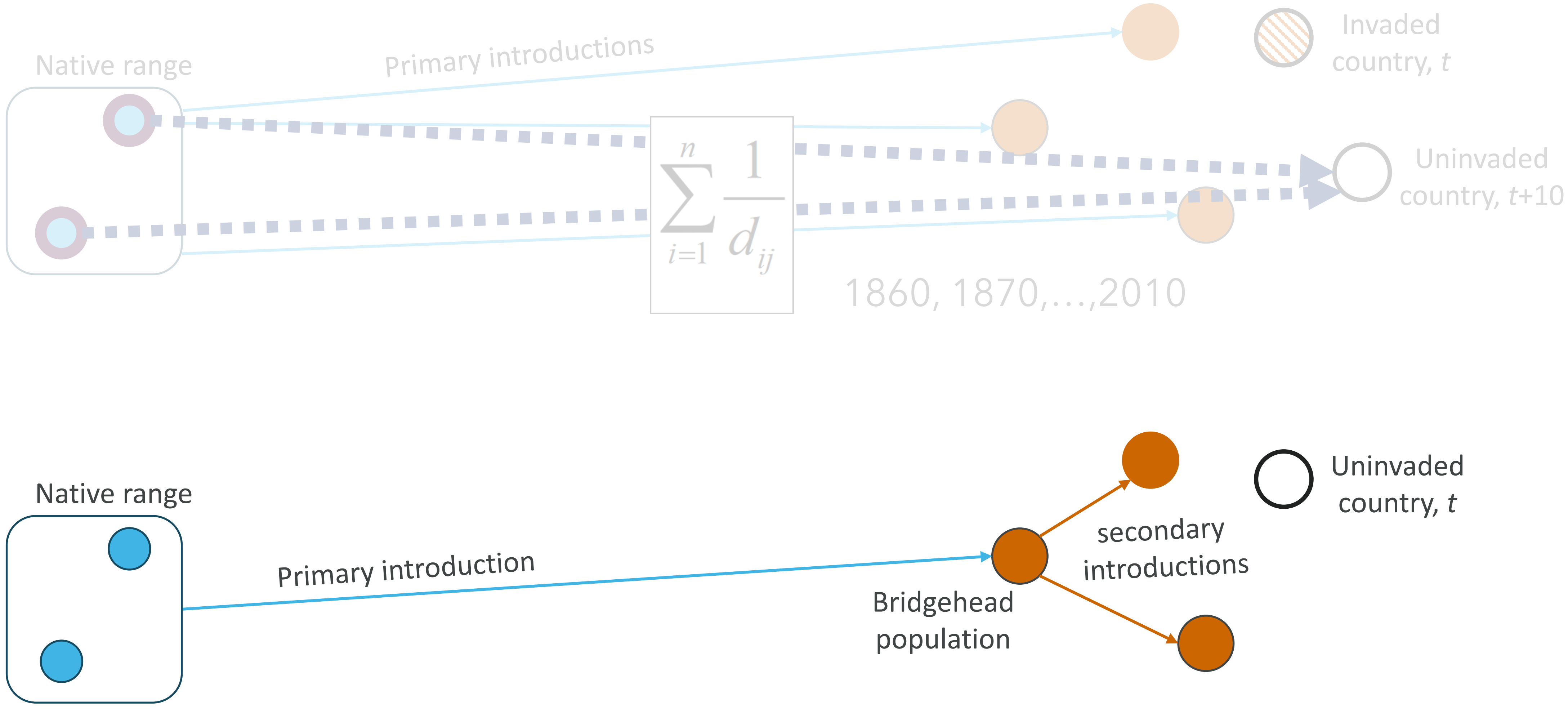
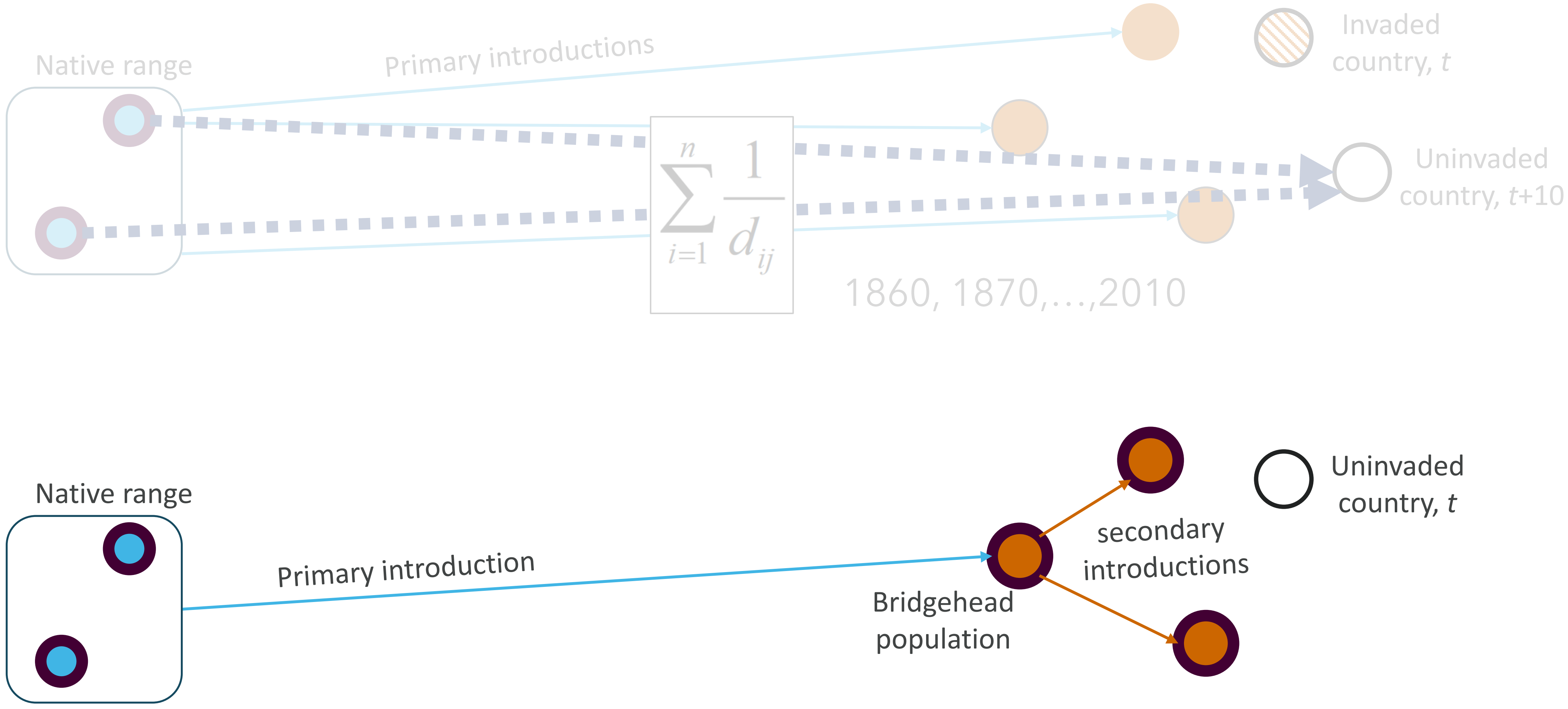


Bridgeheads: our approach



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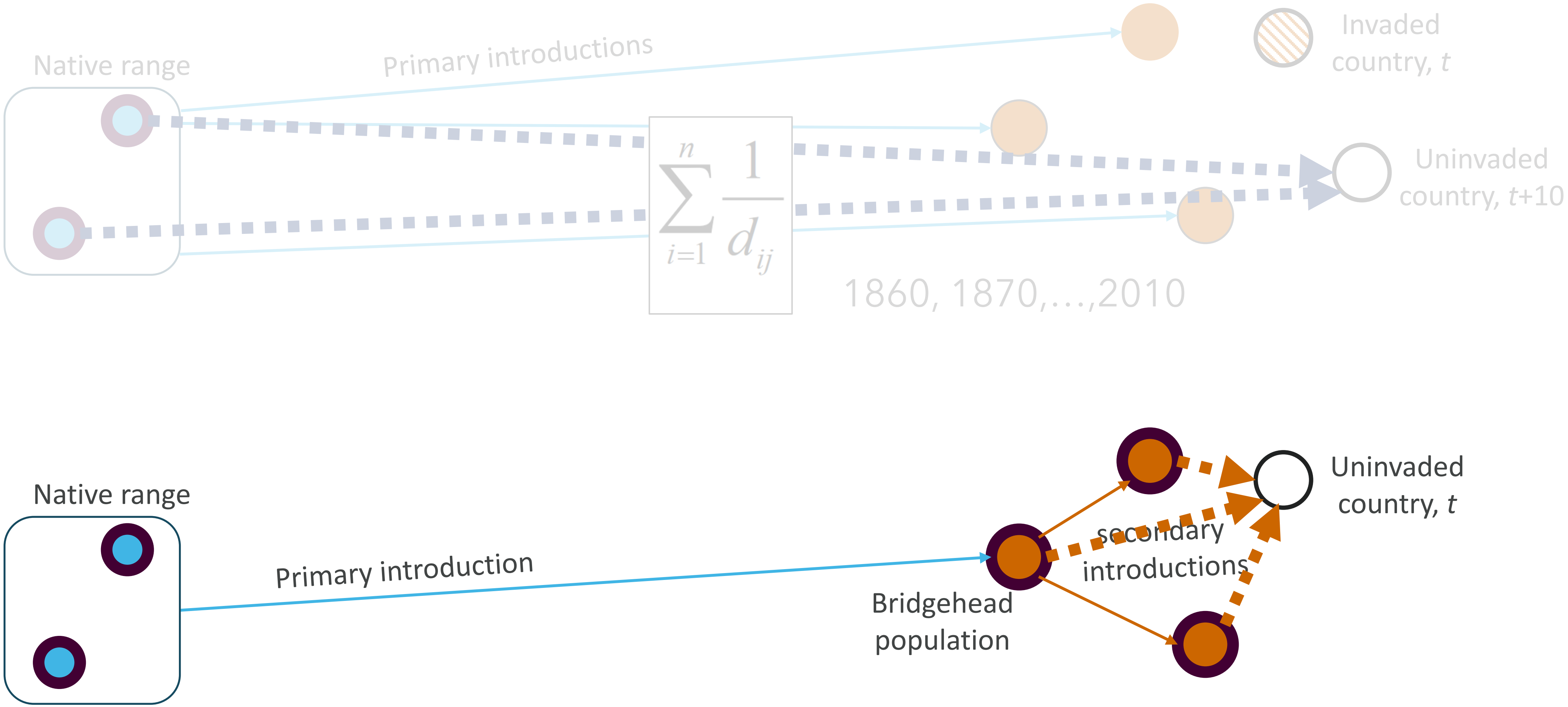

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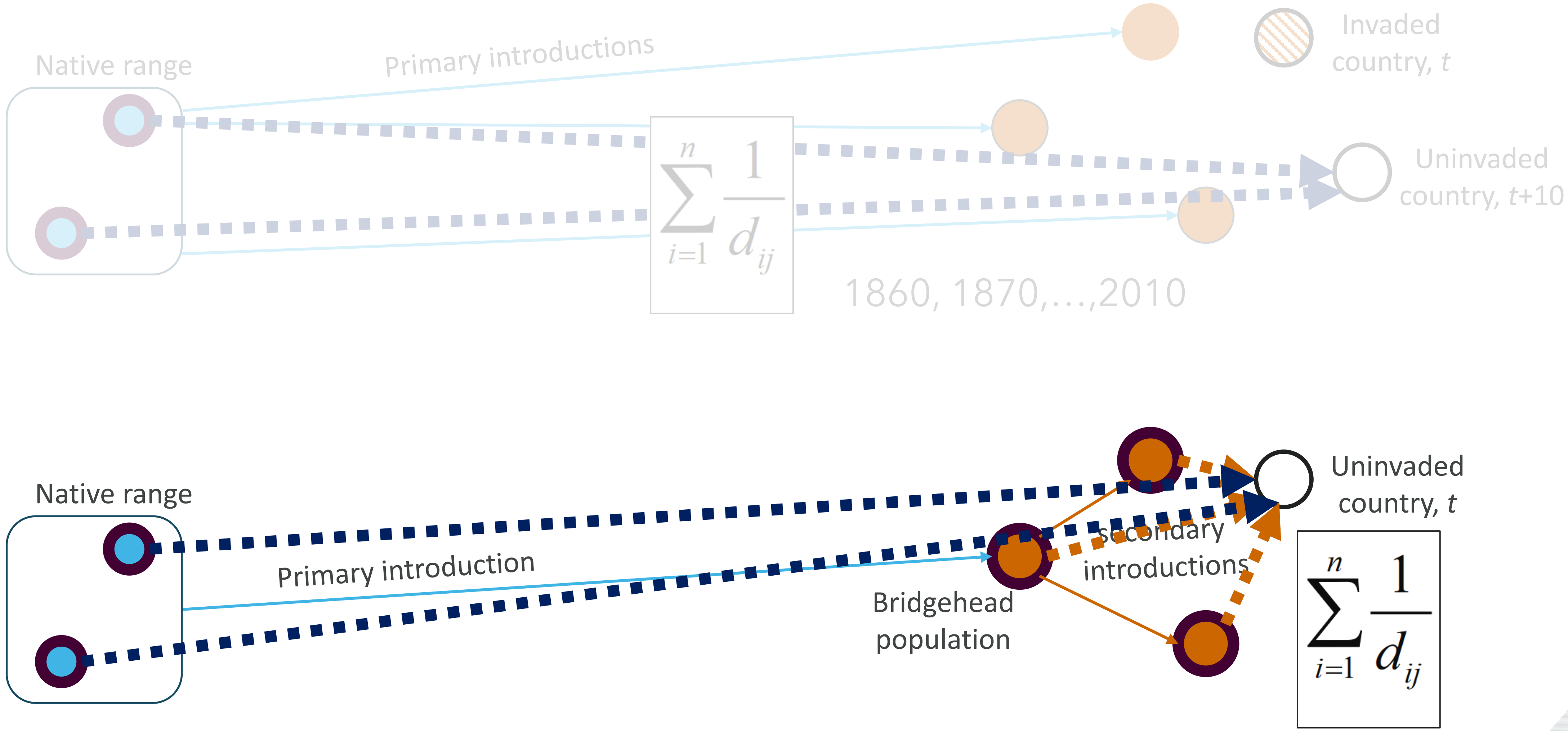
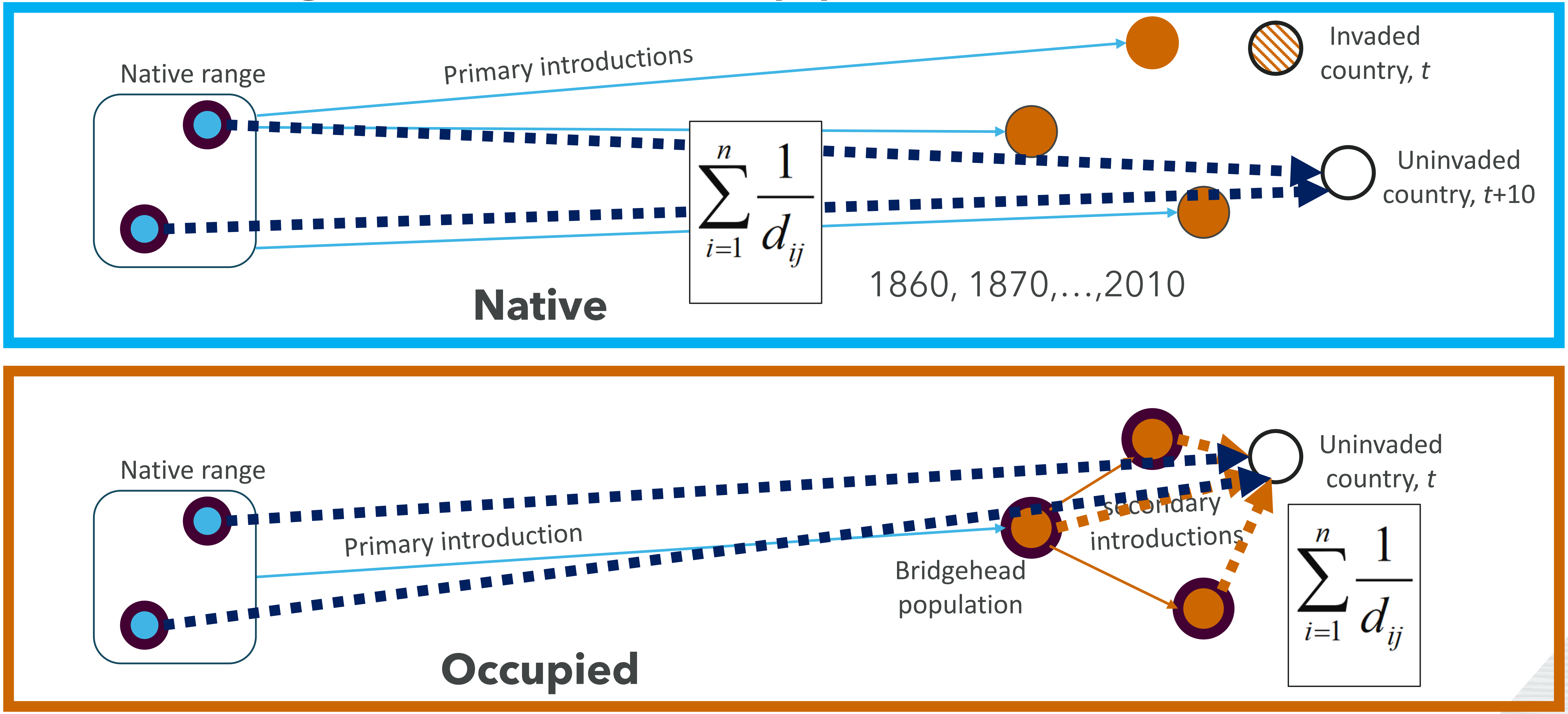
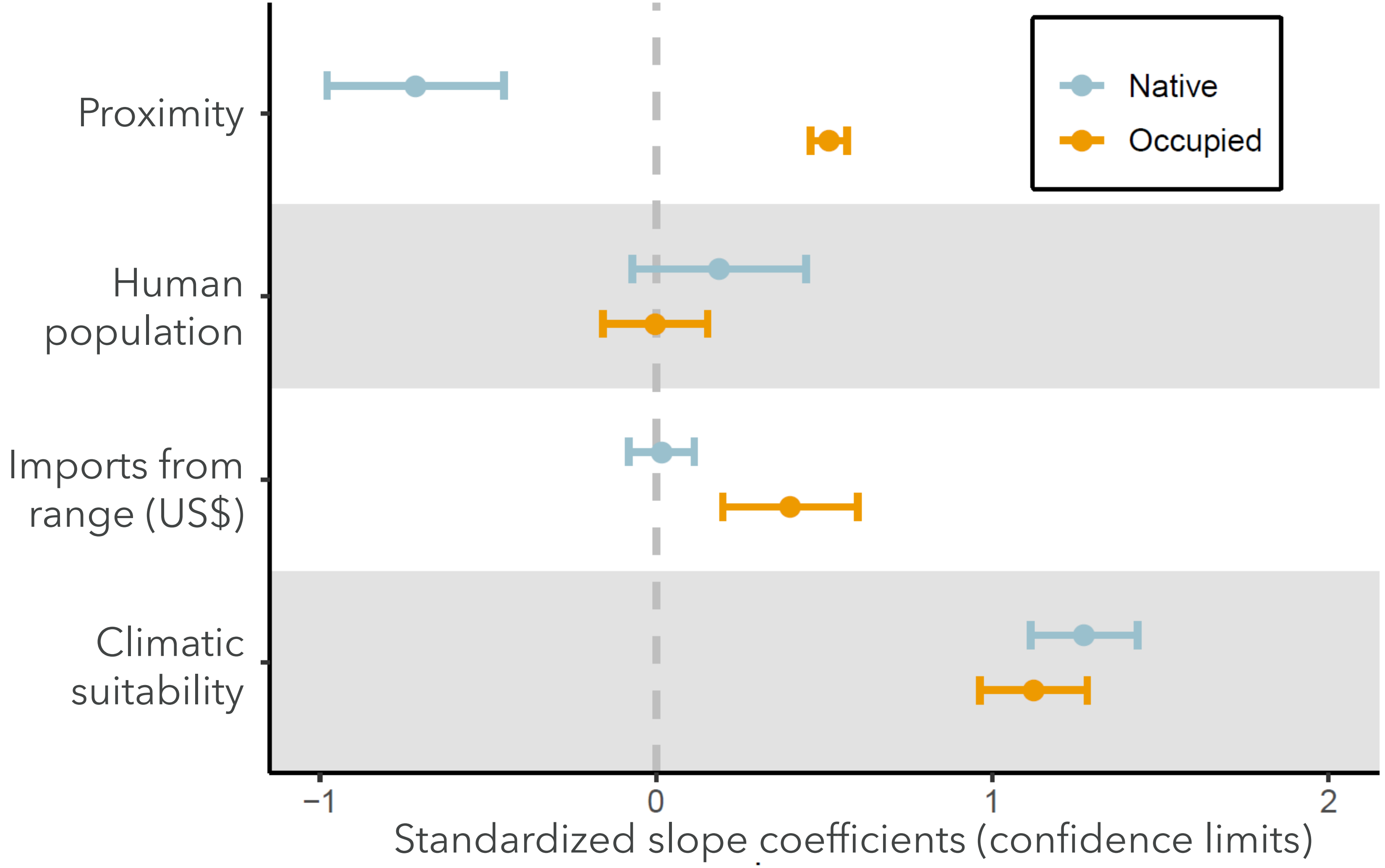


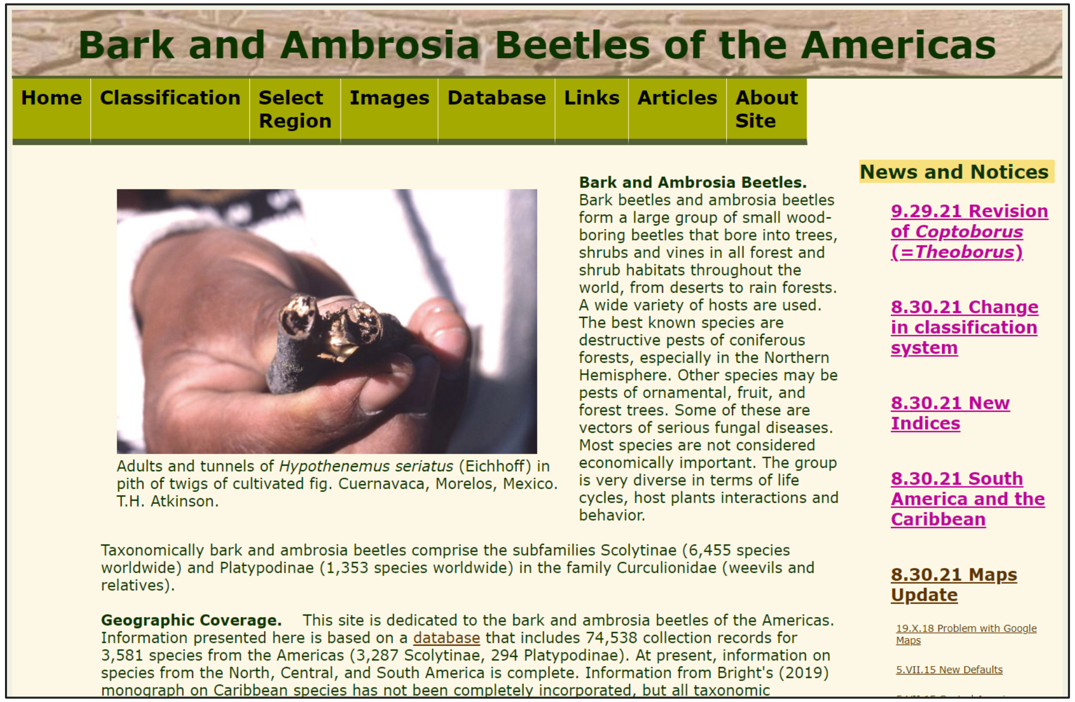
Bridgeheads: our approach



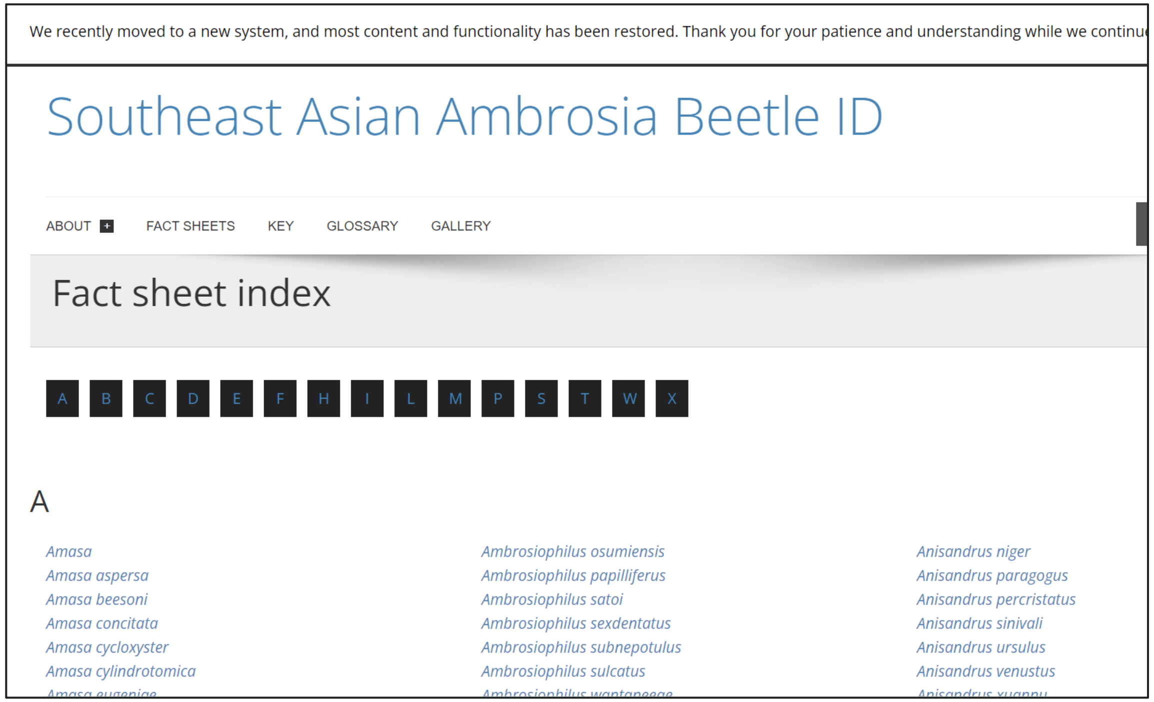
Cox proportional hazards model



Next steps



Bark and Ambrosia Beetles of the Americas
Home
Classification
Select Region
Images
Database
Links
Articles
About Site
Bark and Ambrosia Beetles.
Bark beetles and ambrosia beetles form a large group of small wood-boring beetles that bore into trees, shrubs and vines in all forest and shrub habitats throughout the world, from deserts to rain forests. A wide variety of hosts are used. The best known species are destructive pests of coniferous forests, especially in the Northern Hemisphere. Other species may be pests of ornamental, fruit, and forest trees. Some of these are vectors of serious fungal diseases. Most species are not considered economically important. The group is very diverse in terms of life cycles, host plants interactions and behavior.
Adults and tunnels of Hypothenemus seriatus (Eichhoff) in pith of twigs of cultivated fig. Cuernavaca, Morelos, Mexico. T.H. Atkinson.
Taxonomically bark and ambrosia beetles comprise the subfamilies Scolytinae (6,455 species worldwide) and Platypodinae (1,353 species worldwide) in the family Curculionidae (weevils and relatives).
Geographic Coverage. This site is dedicated to the bark and ambrosia beetles of the Americas. Information presented here is based on a database that includes 74,538 collection records for 3,581 species from the Americas (3,287 Scolytinae, 294 Platypodinae). At present, information on species from the North, Central, and South America is complete. Information from Bright's (2019) monograph on Caribbean species has not been completely incorporated, but all taxonomic
News and Notices
9.29.21 Revision of Coptoborus (=Theoborus)
8.30.21 Change in classification system
8.30.21 New Indices
8.30.21 South America and the Caribbean
8.30.21 Maps Update
19.X.18 Problem with Google Maps
5.VII.15 New Defaults



We recently moved to a new system, and most content and functionality has been restored. Thank you for your patience and understanding while we continue
Southeast Asian Ambrosia Beetle ID
ABOUT
FACT SHEETS
KEY
GLOSSARY
GALLERY
Fact sheet index
A B C D E F H I L M P S T W X
A
Amasa
Amasa aspersa
Amasa beesoni
Amasa concitata
Amasa cycloxyster
Amasa cylindrotomica
Ambrosiophilus osumiensis
Ambrosiophilus papilliferus
Ambrosiophilus satoi
Ambrosiophilus sexdentatus
Ambrosiophilus subnepotulus
Ambrosiophilus sulcatus
Anisandrus niger
Anisandrus paragogus
Anisandrus percristatus
Anisandrus sinivali
Anisandrus ursulus
Anisandrus venustus

Conclusions

So…how does Ohio get so many non-native forest insects?

Conclusions

So…how does Ohio get so many non-native forest insects?

That state up north?!

Credit: David Cappaert, Bugwood.org

Credit: Joe Boggs; https://bygl.osu.edu/node/2262

Conclusions

So…how does Ohio get so many non-native forest insects?

The (oversimplified) answer: we **import** "stuff" from countries that have (1) a **similar climate** to ours and (2) trees that are related to the **trees** *occurring* in North America.

Acknowledgments

LEAFE
LANDSCAPED ECOSYSTEM AND FOREST ENTOMOLOGY

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Czech University of Life Sciences Prague

The Ohio State University