Assessing the risks posed by goldspotted oak borer to California and beyond

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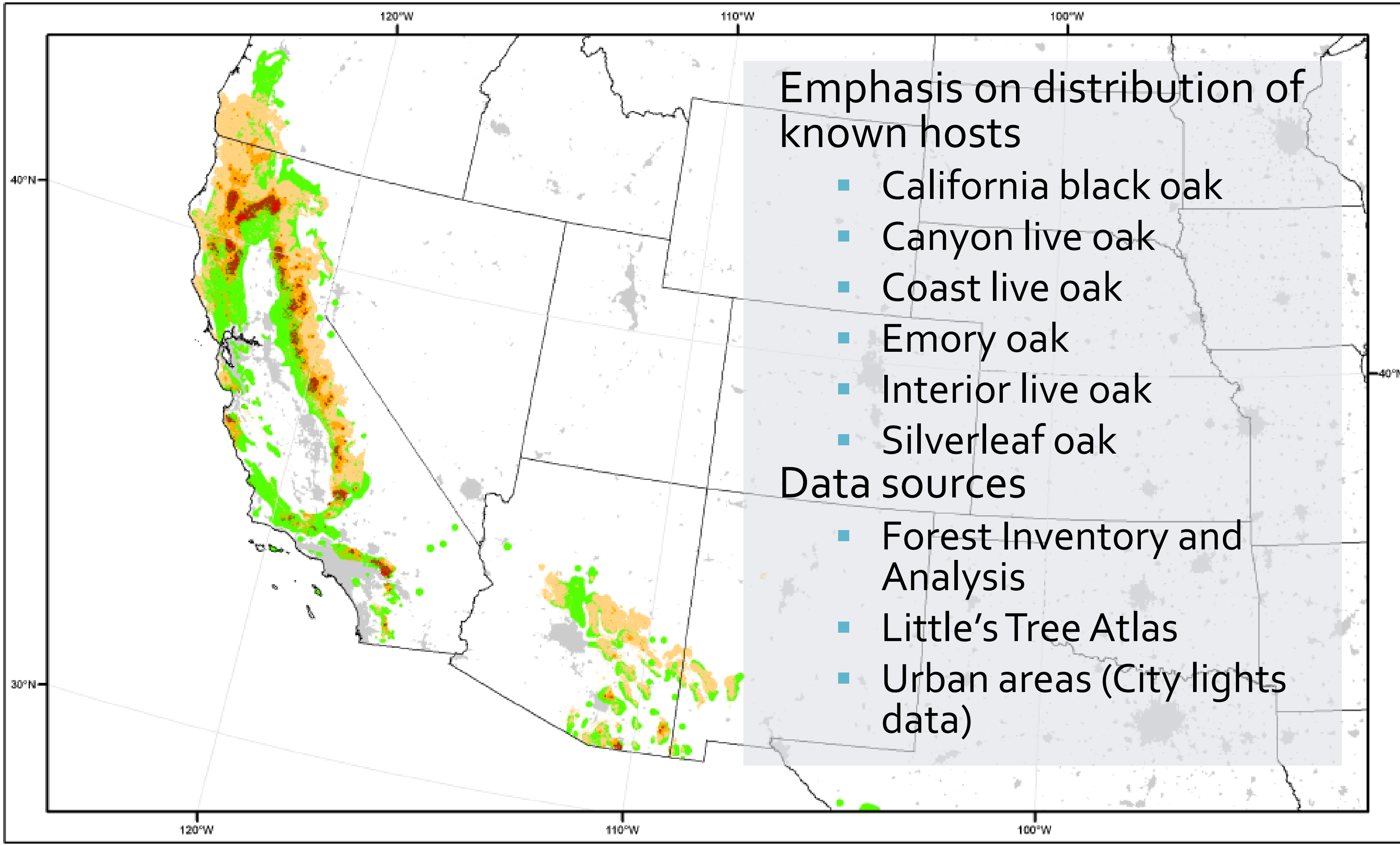
International Pest Risk Research Group, September 25-28, 2015

Agrilus auroguttatus, a domestic invasive threat to oaks in the USA

- 27,000 trees killed
- San Diego, Riverside, & Orange Counties in California

Wildland Tree Resources at Risk*

from *Agrilus coxalis* (Waterhouse) -- Goldspotted Oak Borer



Emphasis on distribution of known hosts

- California black oak
- Canyon live oak
- Coast live oak
- Emory oak
- Interior live oak
- Silverleaf oak

Data sources

- Forest Inventory and Analysis
- Little's Tree Atlas
- Urban areas (City lights data)

Wildland Tree Resources at Risk*
Trees/Acre**

- Little or No
- 0 - 25
- 26 - 50
- 51 - 90
- 91 - 750
- **Little's Oak Host****
- **Urban Areas**

* Six oak species from the Forest Inventory and Analysis program (FIA) were used: coast live, interior live, California black, Emory, canyon live, and silverleaf.

**Trees Per Acre (TPA) include all six FIA oaks with a minimum of 5" DBH.

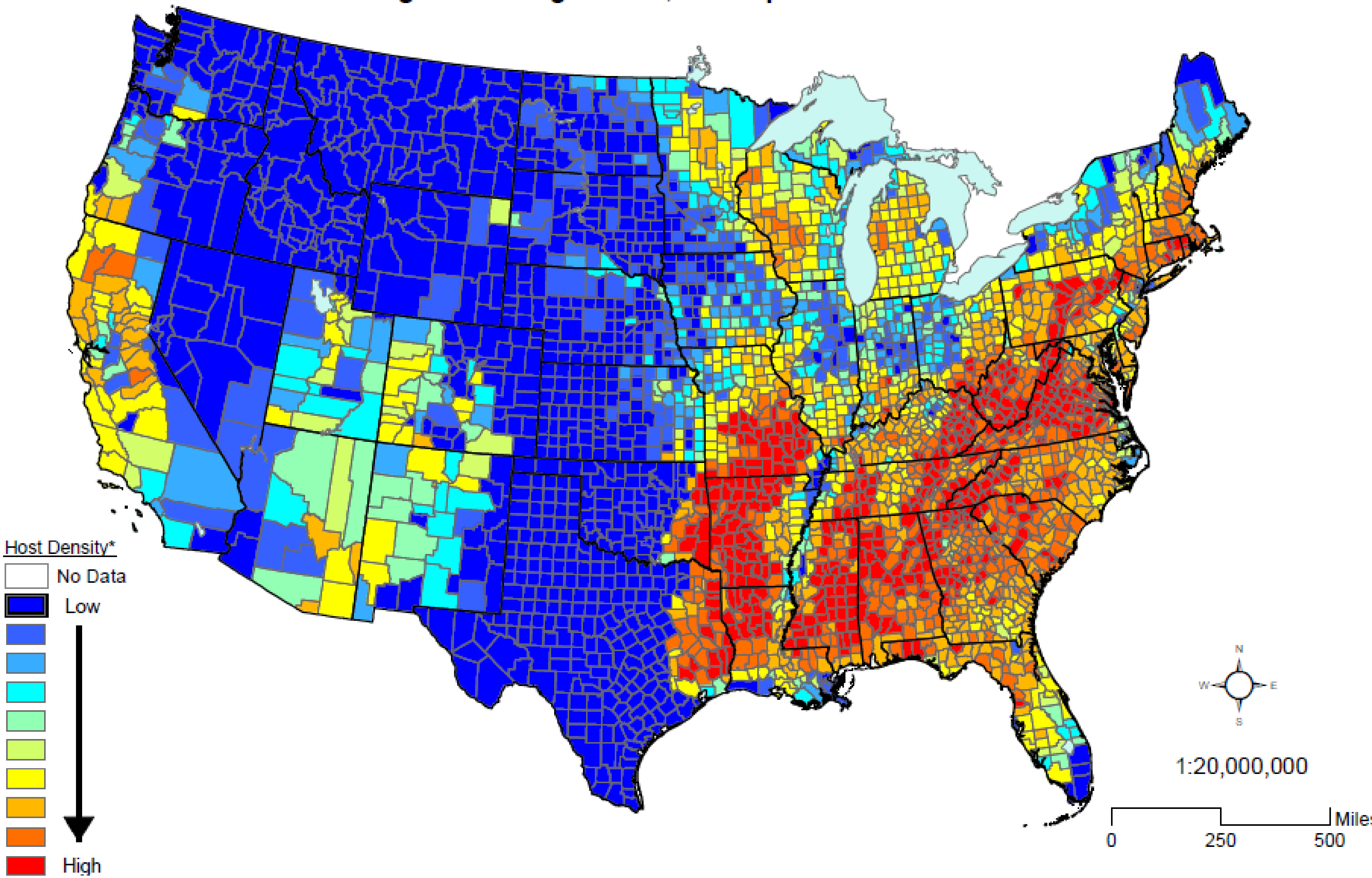
***Depicts the potential distribution (range) of all six FIA oak species. These species are at risk if present within Little's Oak Host range.

0 50 100 200 300 400 500
Kilometers

Albers Equal Area Conic Projection

Map produced by FHTET, MFT
Fort Collins, CO on 2-23-2010

Host Map
Agrilus auroguttatus, Goldspotted Oak Borer

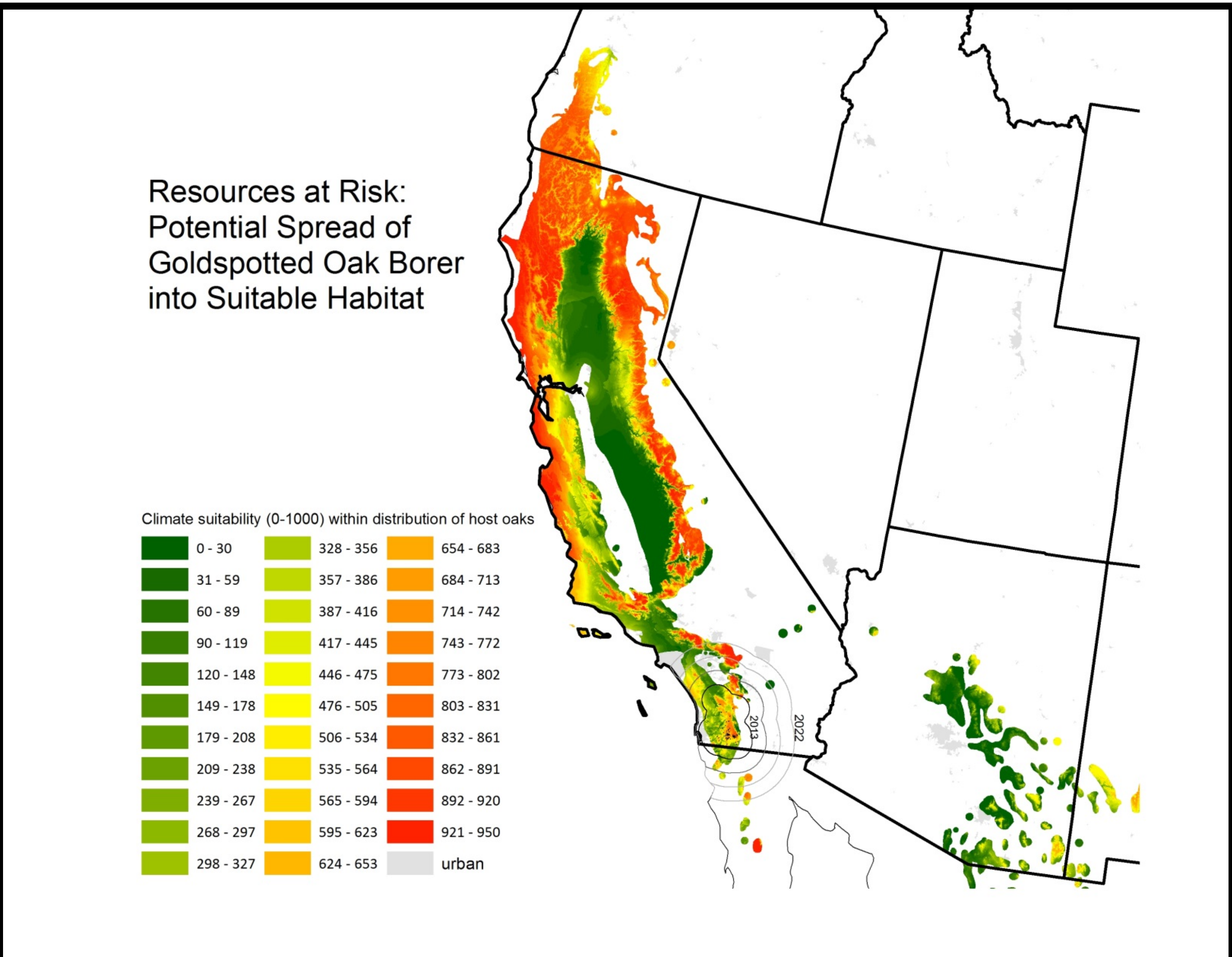


* This is a relative risk scale depicting the pest organisms host acreage intensity by county. It is possible to directly compare values between maps of the same type (e.g. Host to Host, Risk to Risk, and NAPPFAST to NAPPFAST).

The U.S. Department of Agriculture's Animal and Plant Health Inspection Service collected the data displayed for internal Agency purposes only. These data may be used by others; however, they must be used for their original intended purposes.

Source: NASS 2007; USFS FIA
North America Albers Equal Area Conic (1983)
Data contact: Dan Borchert, USDA CPHST, Raleigh
Map created: February 2012 by USDA CPHST, Raleigh

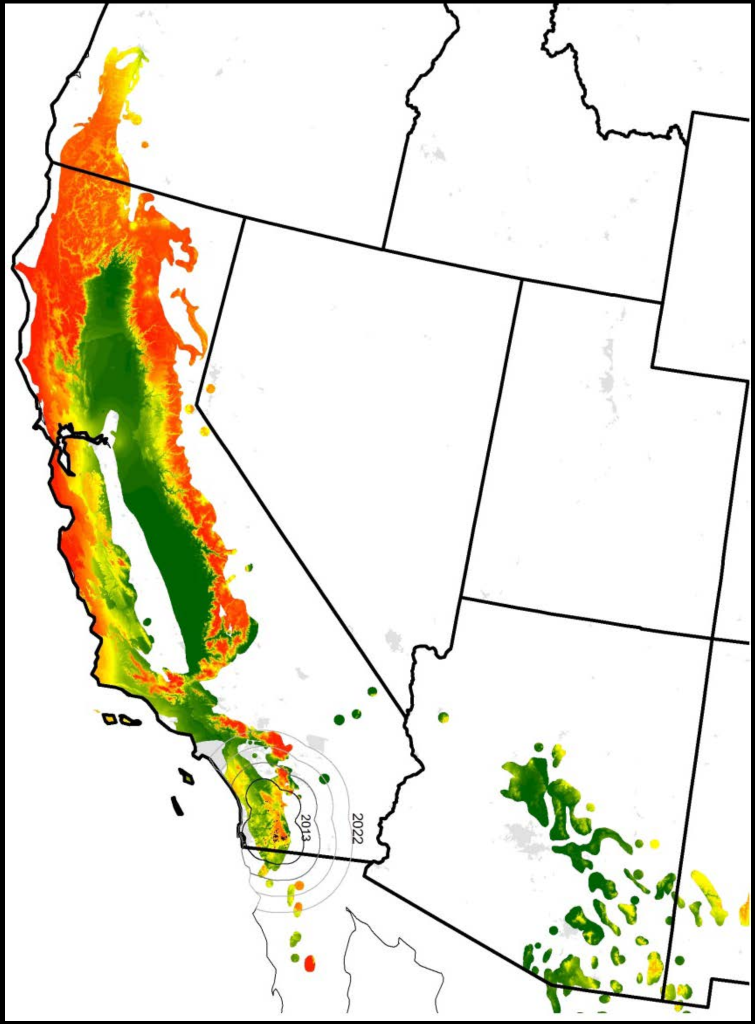
Updated risk map for goldspotted oak borer (GSOB)

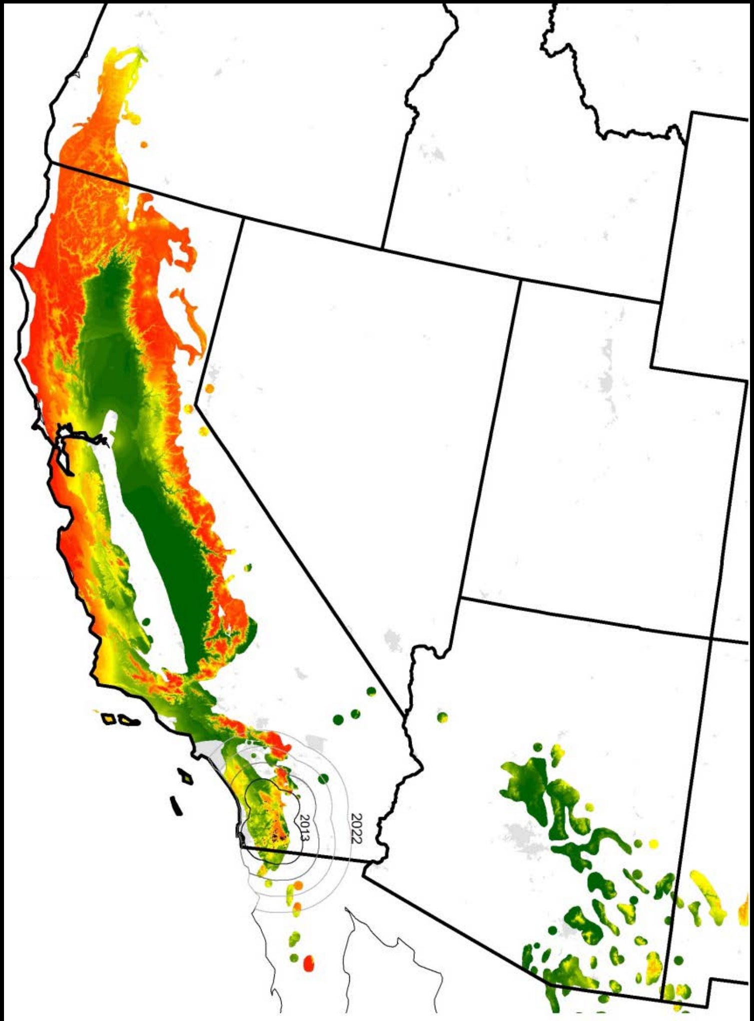


Emphasis of this map is establishment and spread

Four major components

- Suitable climate
  - Species distribution model
  - Cold tolerance measurements
- Suitable hosts
- Natural spread



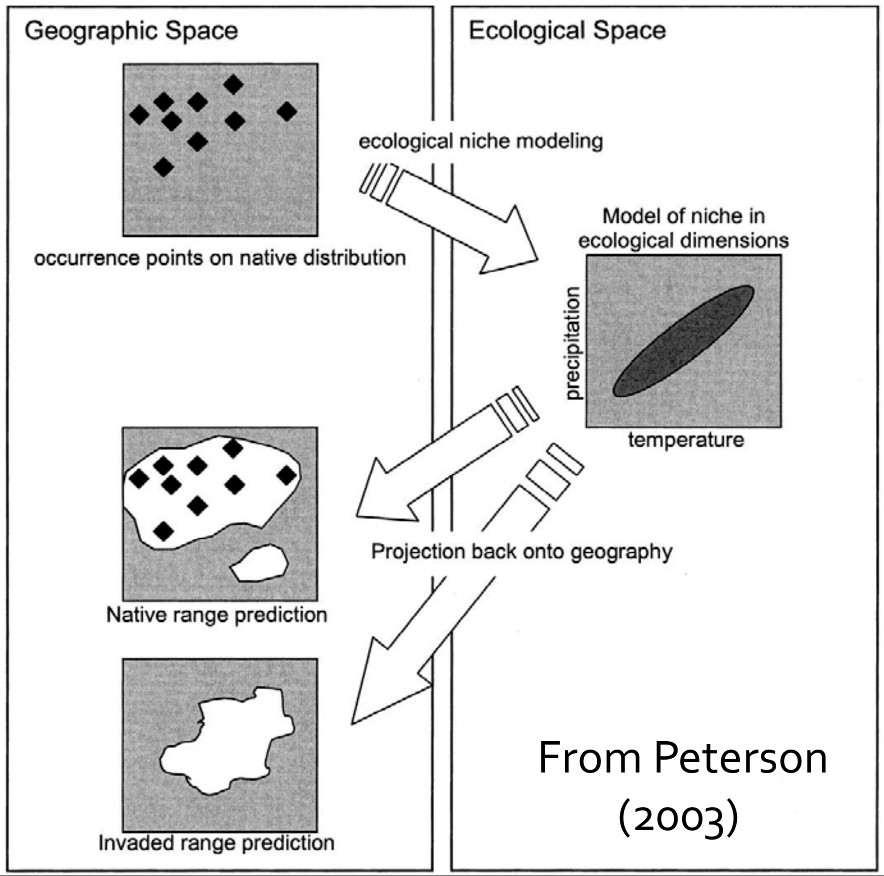


Part 1 of 4
Suitable climate: Species distribution model

-or-

Why is the risk map limited to the western United States?

Climate suitability modelling for GSOB



From Peterson (2003)

66 presence points from Coleman and Seybold (2008, 2011), Coleman et al. (2012), Haavik et al. (2014a,b)

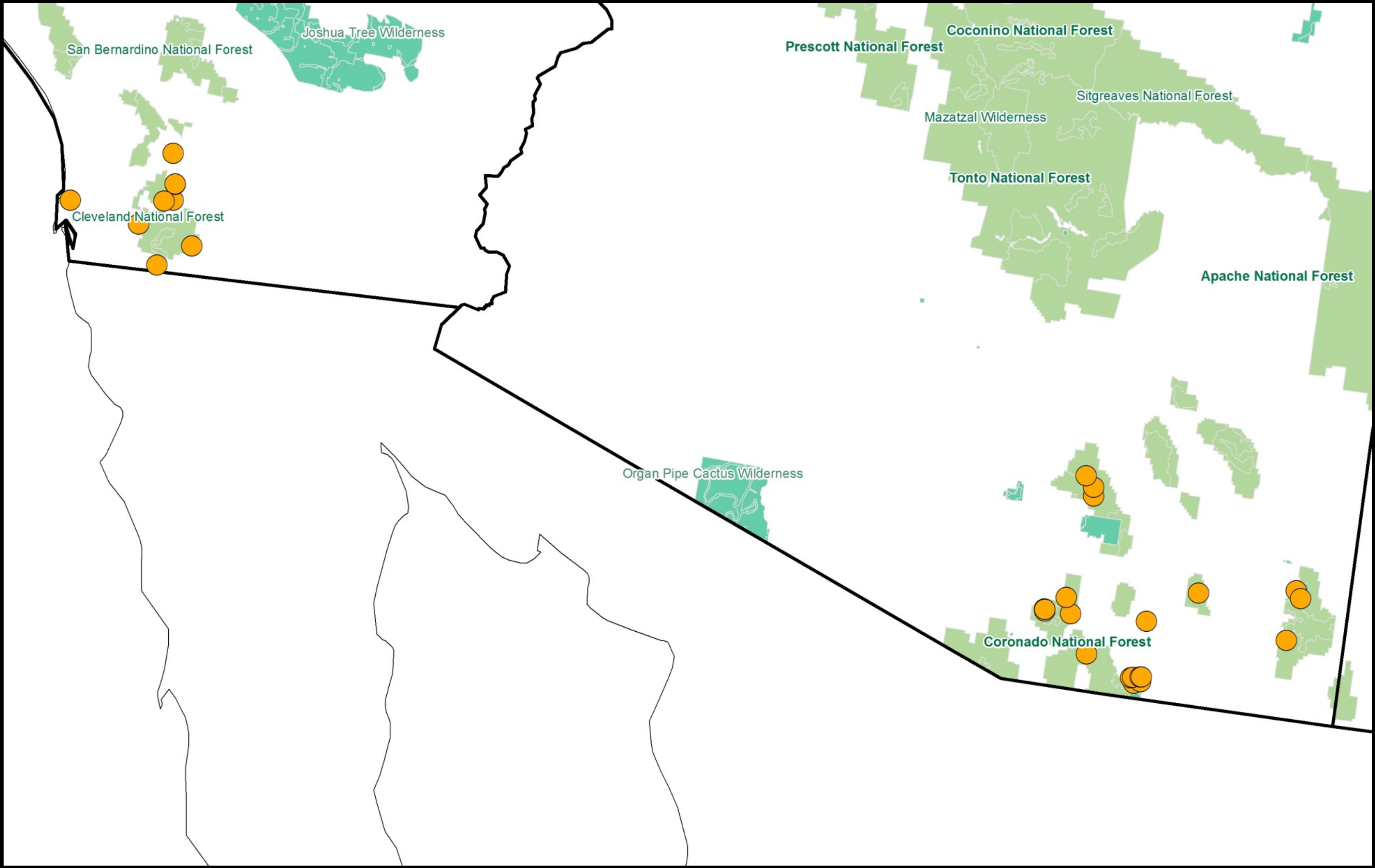
"Background" data geographically constrained.

Avoid co-linear climate predictors. (Start with 19 bioclimatic variables from WorldClim.org at 30 arc-second resolution).

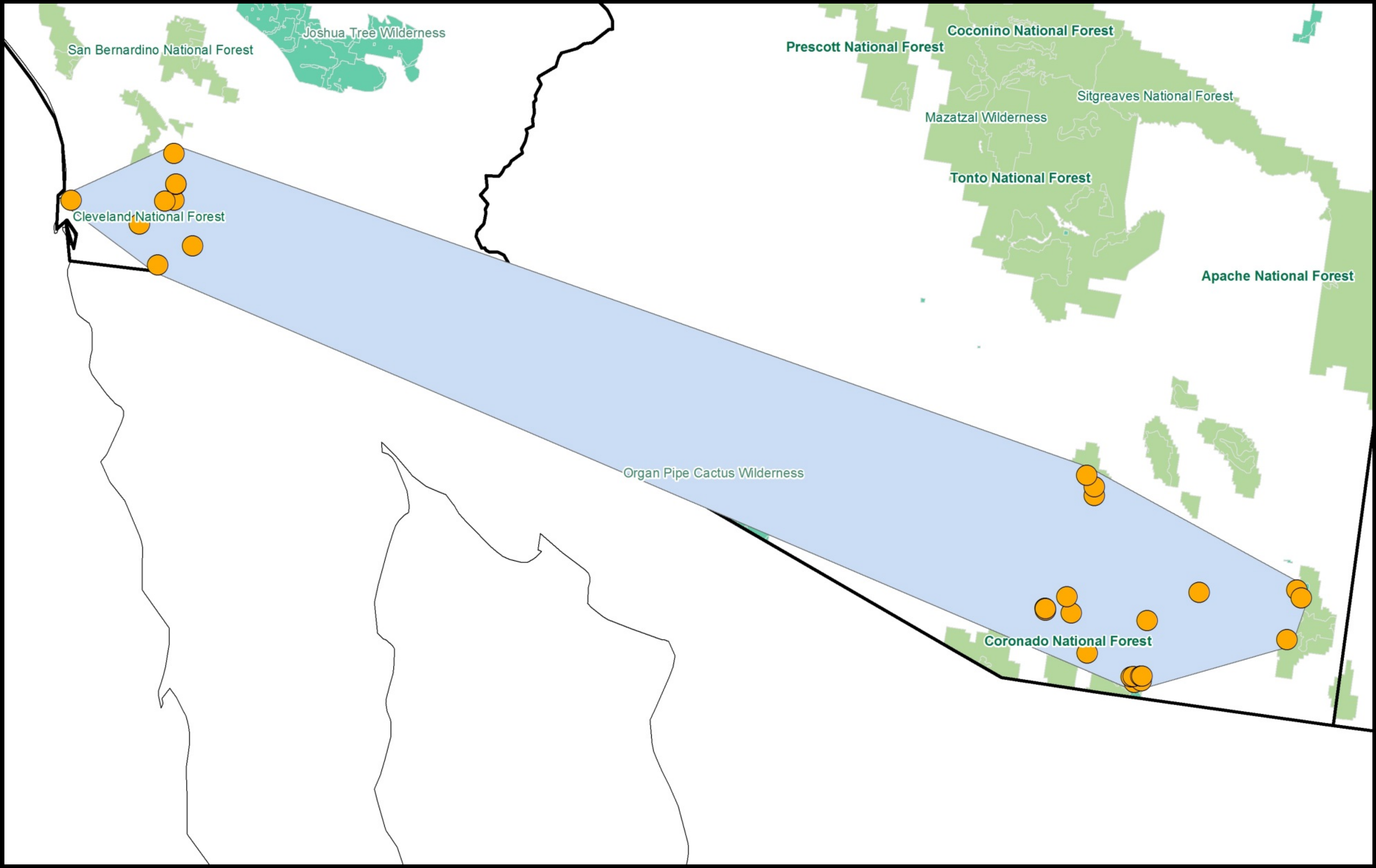
25 replicate models
13 randomly drawn presence points.

Models projected back to North America

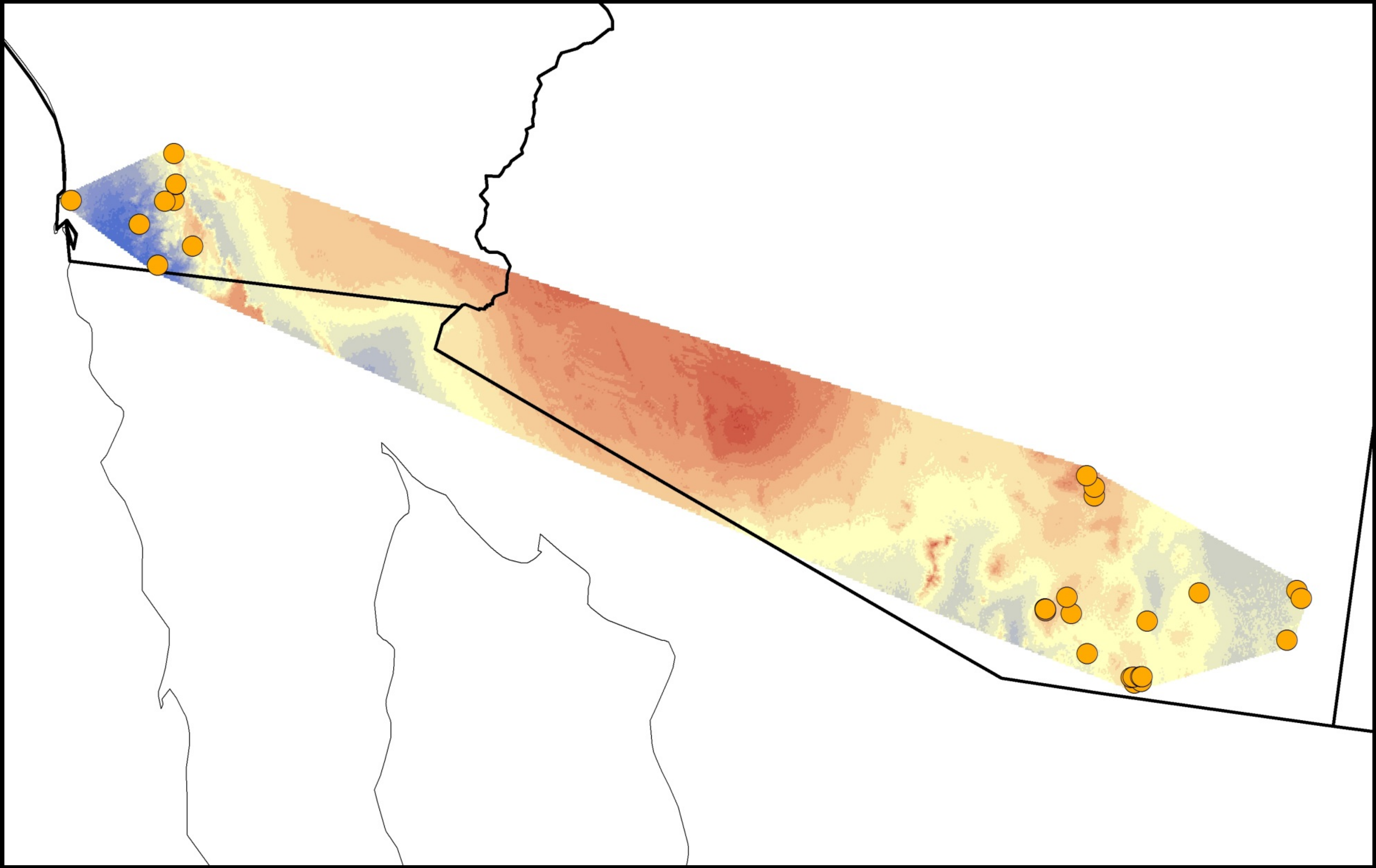
Presence points for GSOB



“Background” restricted to minimum convex polygon

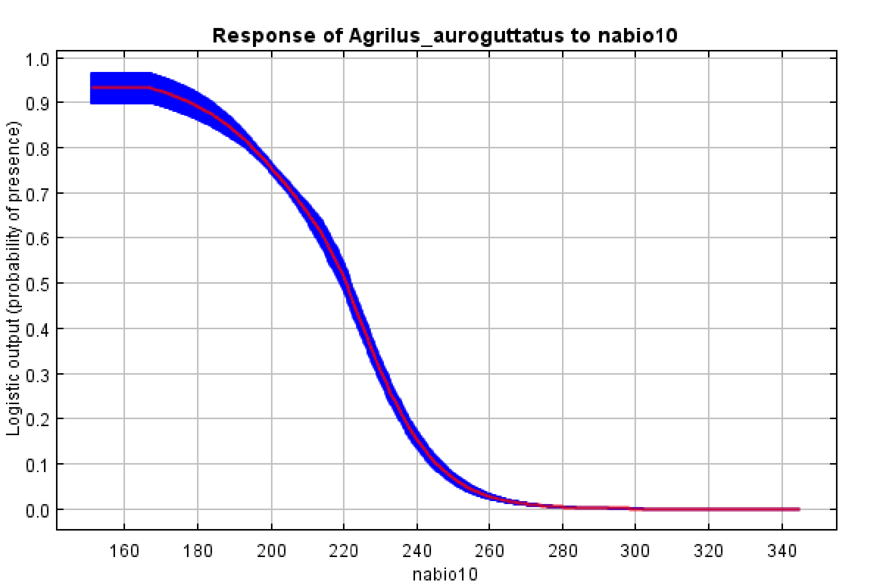


Minimum convex polygon used to trim bioclimatic datasets



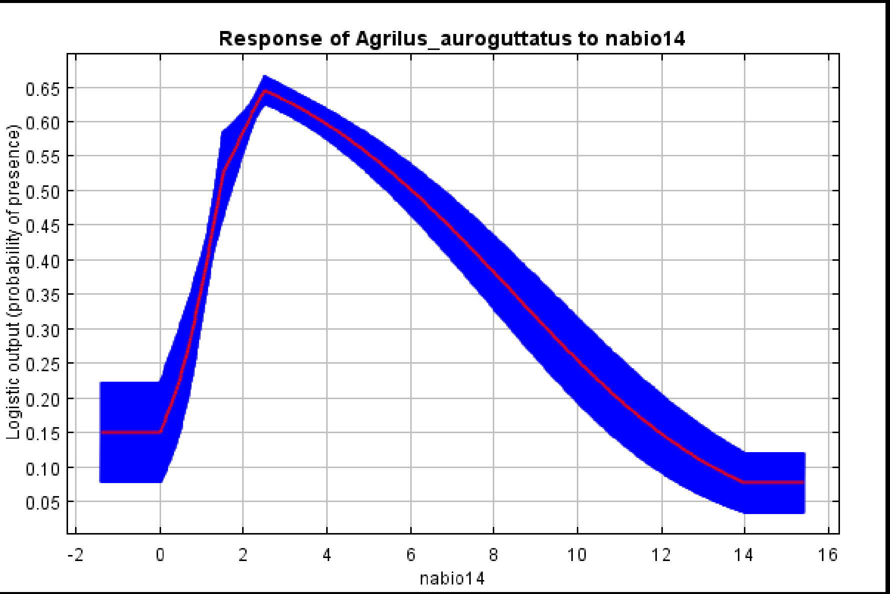
Components of final model

Mean temperature of warmest quarter



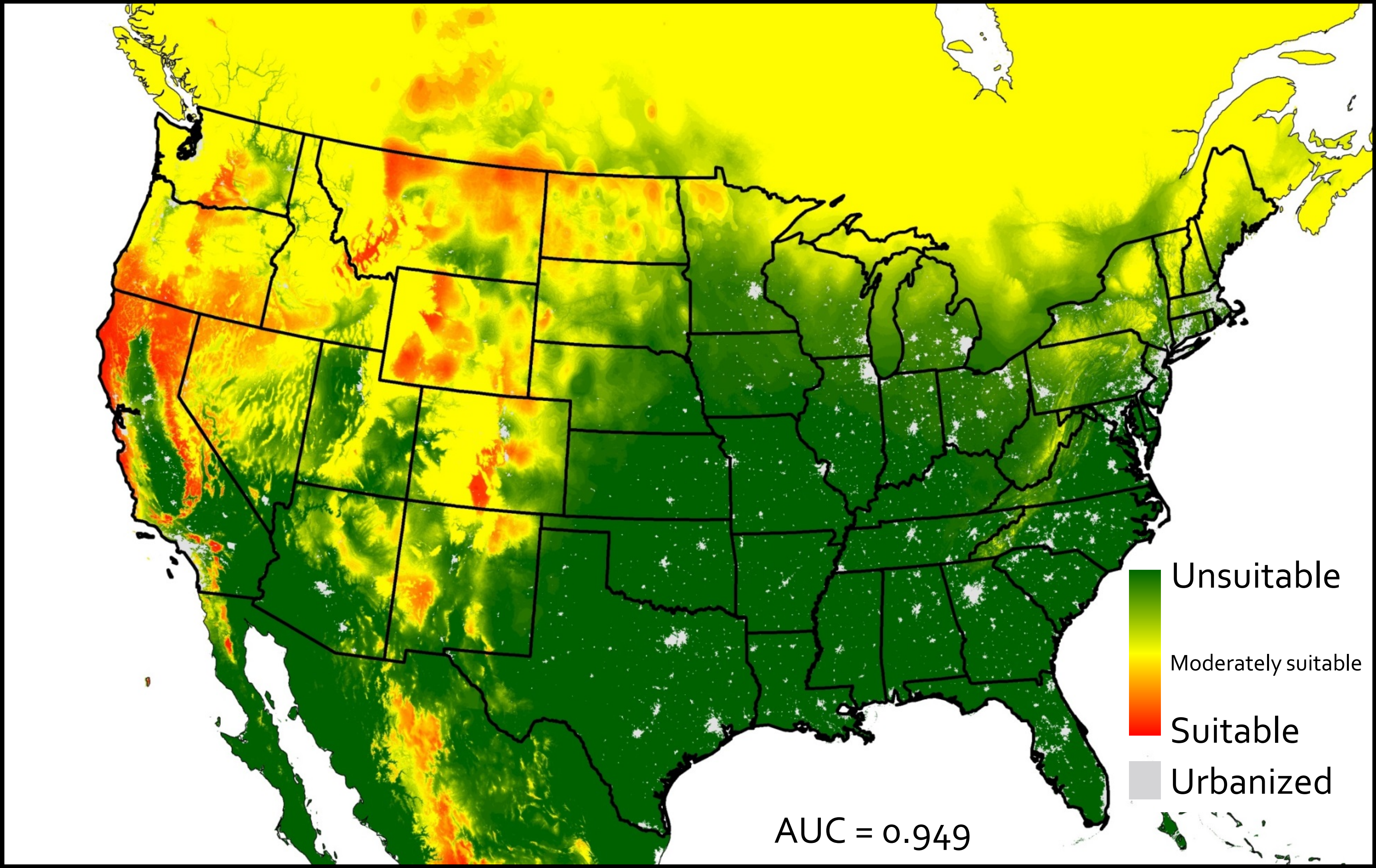
Contribution: 94.7%

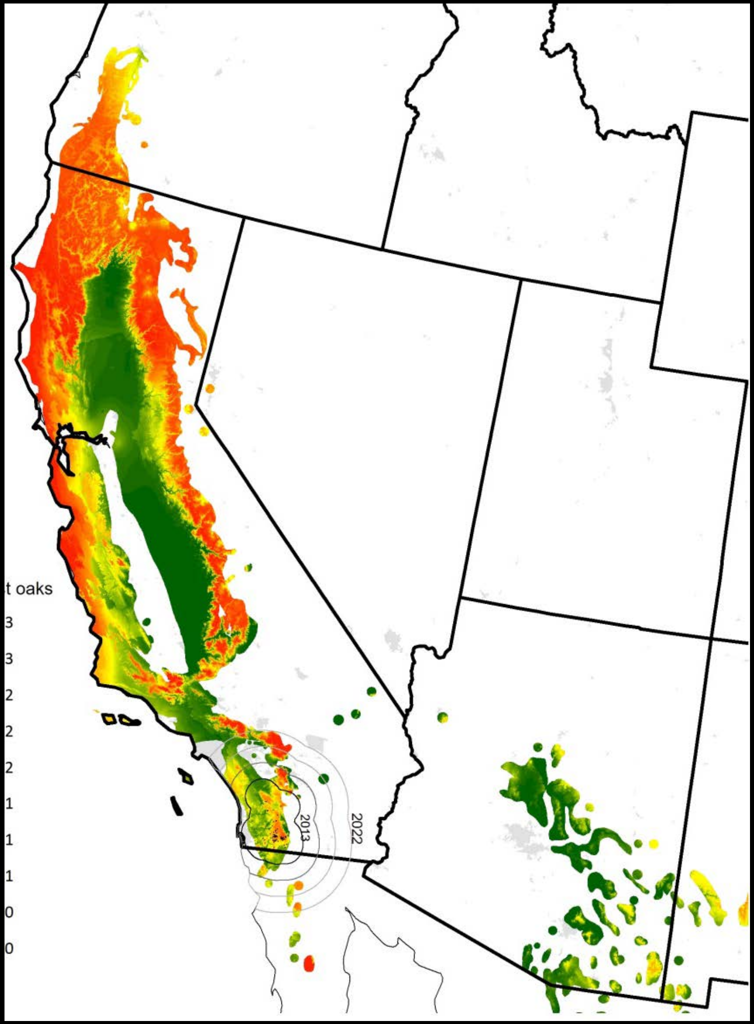
Precipitation in driest month



Contribution: 5.3%

Mean climatic suitability for GSOB





Part 2 of 4
Suitable climate: Cold tolerance measures

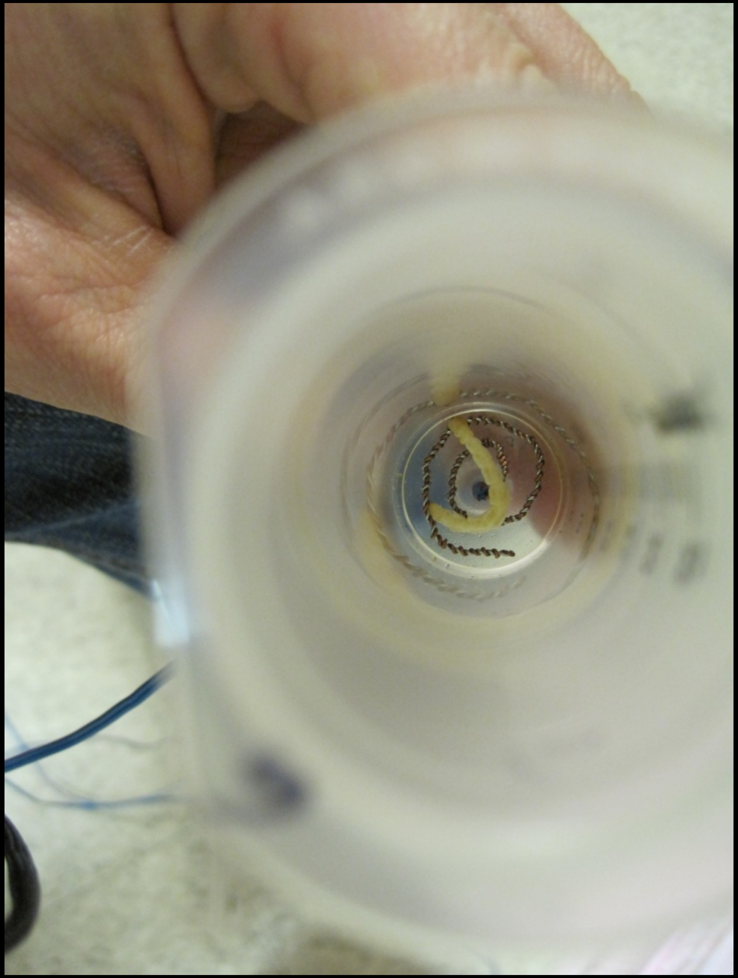
-or-

Why does the risk map emphasize the southwestern United States?

Methods for measuring supercooling point

Thanks Laurel Haavik & Tom Coleman for larvae!

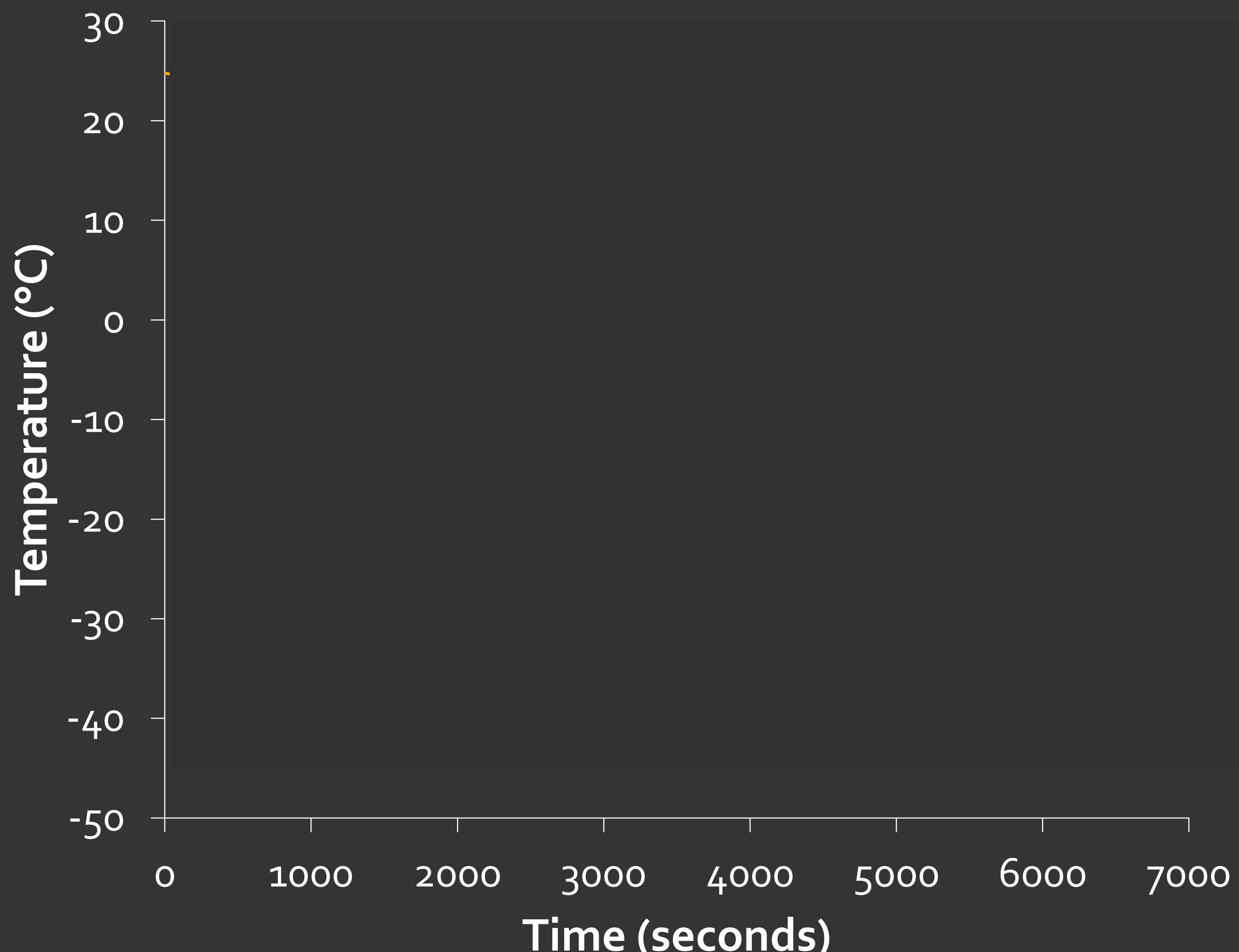
Methods for measuring supercooling point



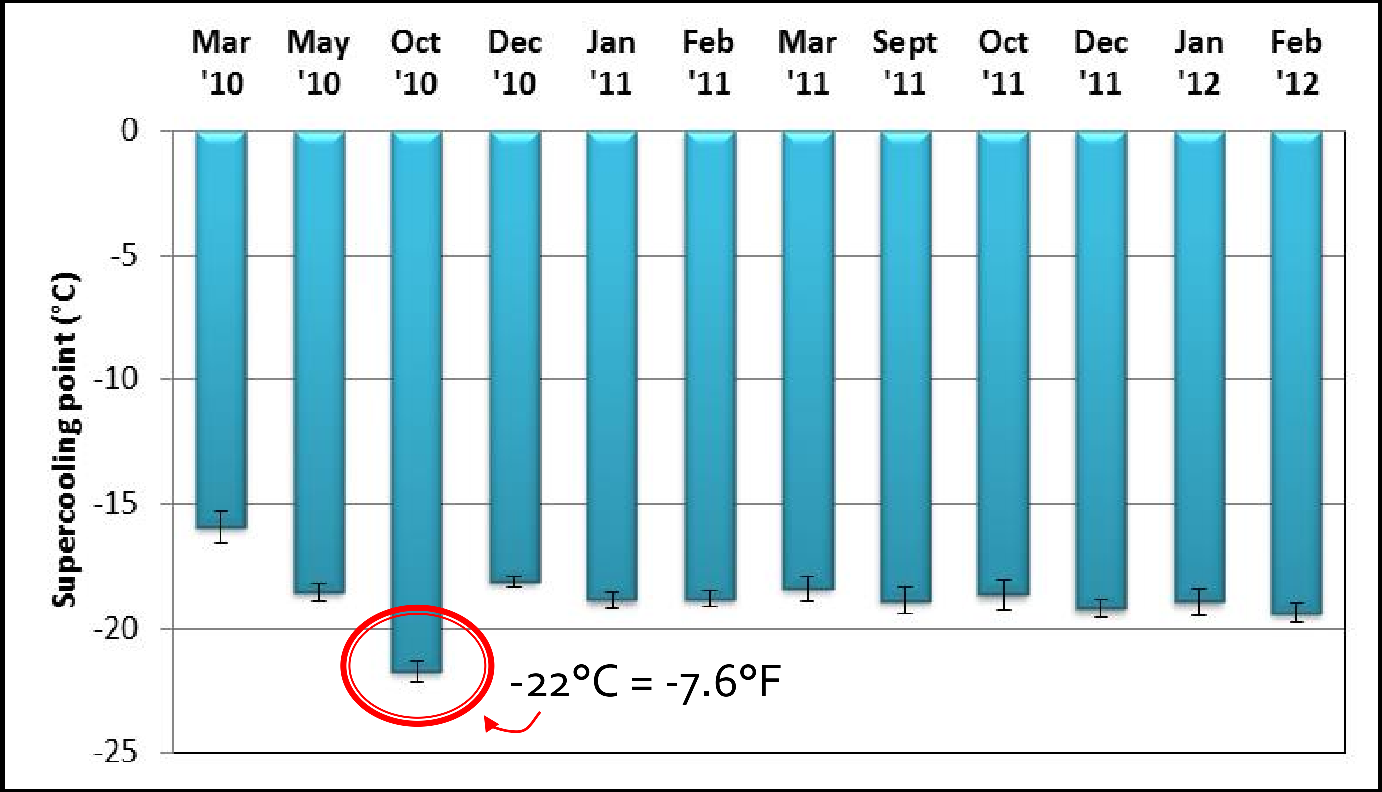
Methods for measuring supercooling point

Methods for measuring supercooling point

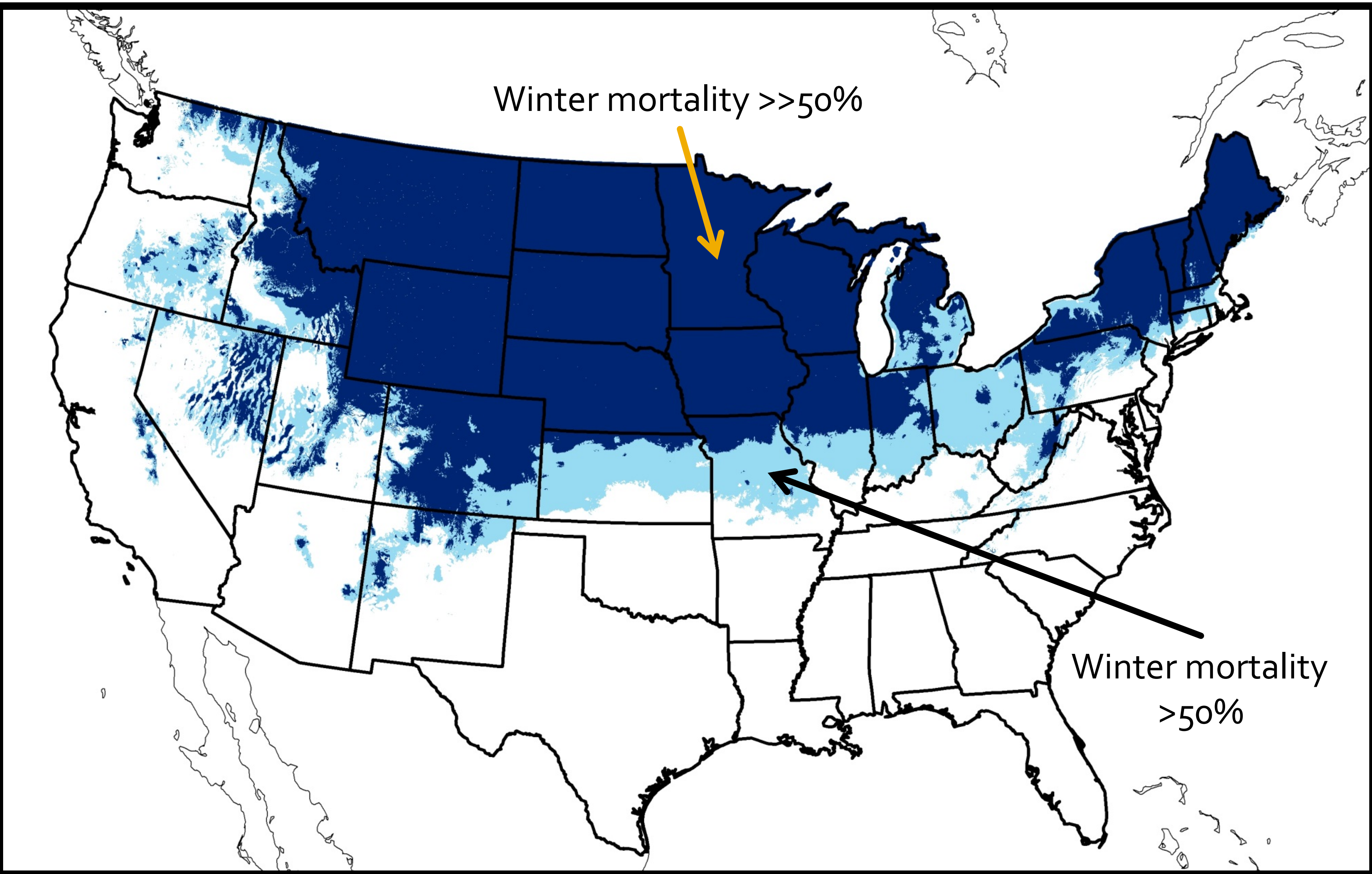
Determination of the supercooling point



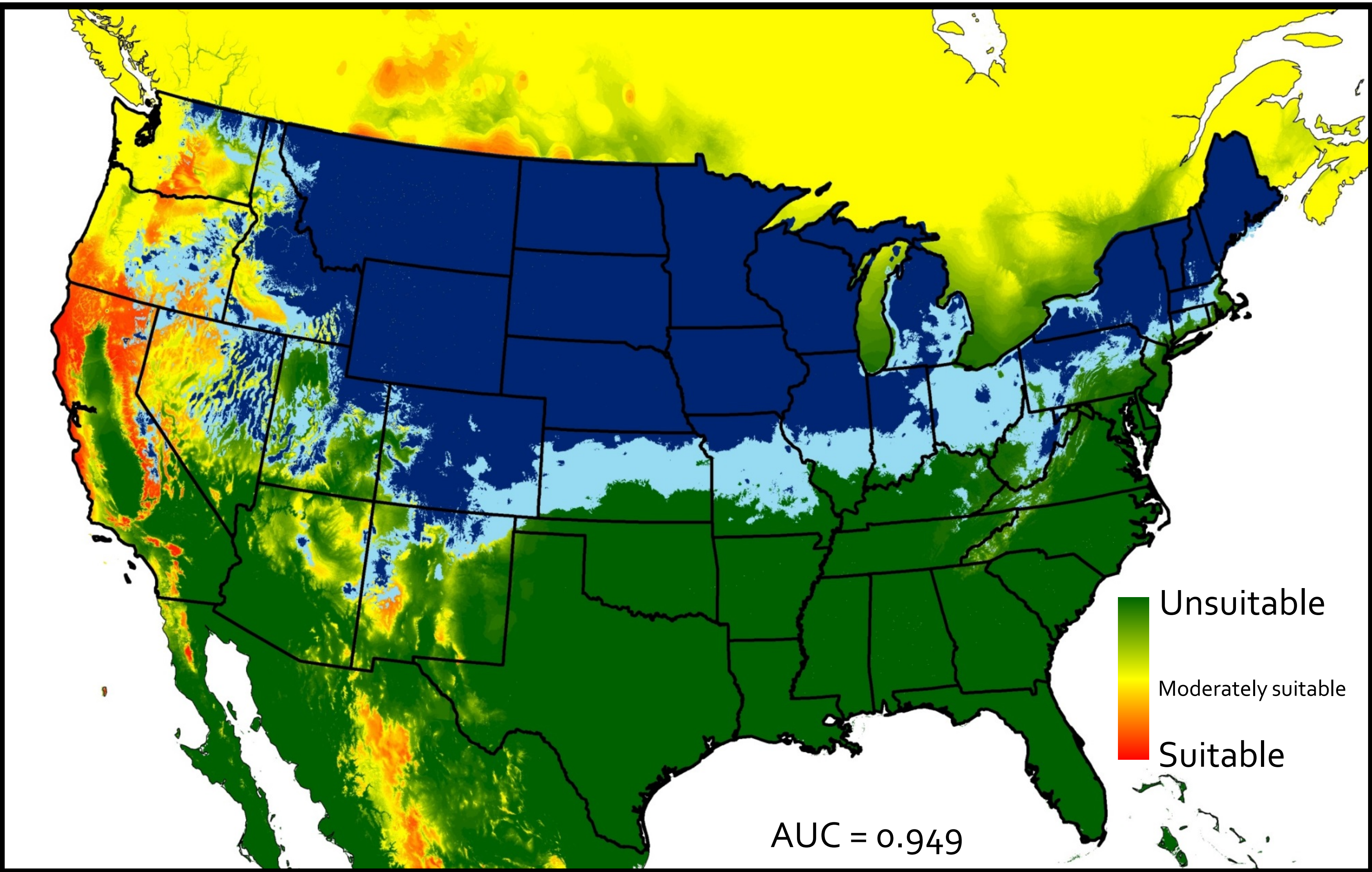
Mean (±SE) supercooling point of GSOB on different months

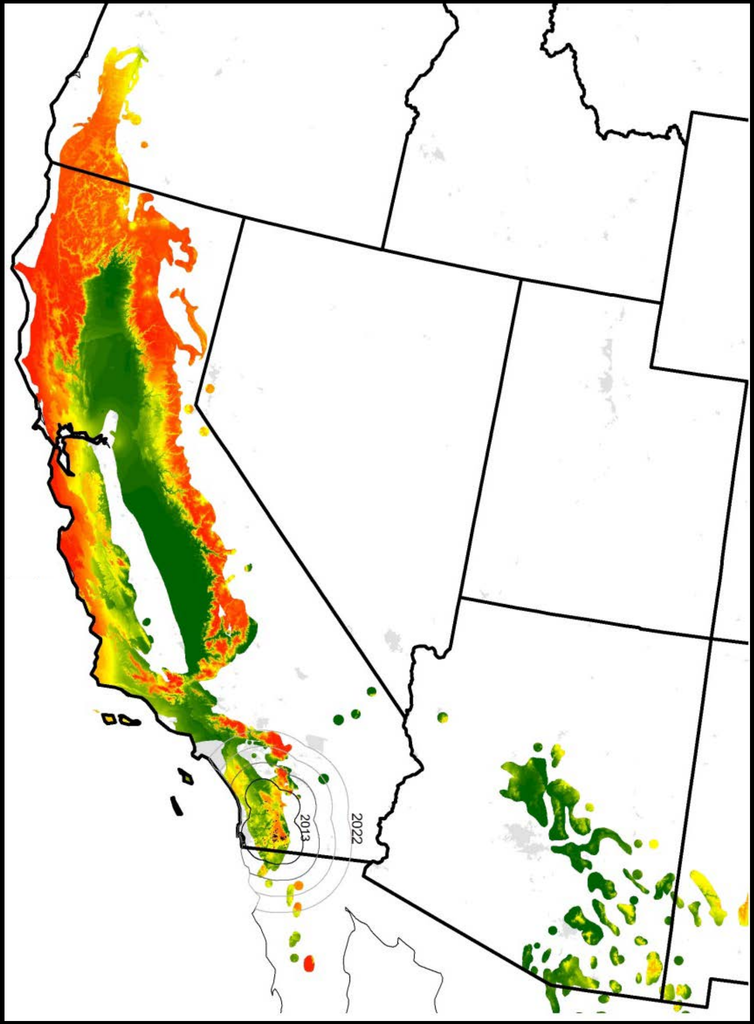


Areas of contiguous United States that are too cold for GSOB



Cold likely to exclude GSOB from central and NE United States





Part 3 of 4
Suitable hosts

-or-

Why does the risk map have patches of color surrounded by white?

Host range testing

Entomologia Experimentalis et Applicata

DOI: 10.1111/eea.12141

Suitability of native and ornamental oak species in California for *Agrilus auroguttatus*

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Key words: host range, invasive species, phloem and wood borer, Section *Lobatae*, Section *Quercus*, Coleoptera, Buprestidae, Fagaceae

Abstract

Goldspotted oak borer, *Agrilus auroguttatus* Schaeffer (Coleoptera: Buprestidae), is a new invasive species in southern California, USA. The extent of the host range of this insect is not known, but this knowledge will have a major impact on assessment of the risks that this pest poses to oaks [*Quercus* spp. (Fagaceae)]. We conducted laboratory tests to determine the potential suitability of native and ornamental oak species for larvae and adults of *A. auroguttatus*. We infested 179 cut logs (from 163 different trees) with eggs or larvae, measured neonate survival and, after 5 months, counted feeding galleries, and noted the proportion of galleries with late instars. Initial larval survival was generally high when larvae penetrated the phloem (range: 62–98% among oak species), and low by the time larvae began to feed at the phloem/xylem interface (range: 0–25% among oak species). The majority of larvae that established a visible feeding gallery survived to the fourth instar (total of 73% for all oak species). Larval galleries were established with greater frequency in red oaks (Section *Lobatae*) compared with other oaks (19 vs. 7 or 4%). All red oaks tested (*Q. agrifolia* Née, *Q. kelloggii* Newberry, and *Q. wislizeni* A. DC.) were likely suitable hosts for larvae. Larvae were apparently able to feed on some of the other oaks (*Q. chrysolepis* Leibmann, *Q. suber* L., *Q. lobata* Née, and *Q. douglasii* Hook & Arn), although it remains unclear whether these species would be preferred hosts under natural conditions. Adult longevity and fecundity varied little by species of oak foliage fed to adults. The host range of *A. auroguttatus* is likely limited by suitability of oak species for the larval rather than the adult life stage. Results support published field observations that red oaks are more suitable hosts than white oaks.

Introduction

Herbivorous insect invasions can occur inter- and intra-continentally, when a species is introduced to a new ecosystem and attacks novel plant species (e.g., Haack et al., 2002; Rabaglia & Williams, 2002; Coleman & Seybold, 2008) or attacks its co-evolved hosts growing in a non-native ecosystem (e.g., Paine et al., 1995; Carnegie & Bashford, 2012). As a result of global change, herbivorous insects may also expand their ranges, and they may encounter new host species (e.g., Ayres & Lombardero, 2000; Logan & Powell, 2001; Bentz et al., 2010). For any of the above situations, the pest's relationship with one or several host species may be known or not. Knowledge of such relationships is critical for predicting the economic and ecological impacts of these pests in new habitats. Pest risk assessments are important tools that rely on basic biological information, including an invasive insect's host range, to forecast its establishment and spread (Yemshanov et al., 2009; Venette et al., 2010).

The goldspotted oak borer, *Agrilus auroguttatus* Schaeffer (Coleoptera: Buprestidae), is a new invasive species in southern California, USA (Coleman & Seybold, 2008). *Agrilus auroguttatus* most likely arrived in southern California years before it was first detected in 2004 (Westcott, 2005), and may have been transported there from its native range in southeastern Arizona by way of infested

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No choice assays

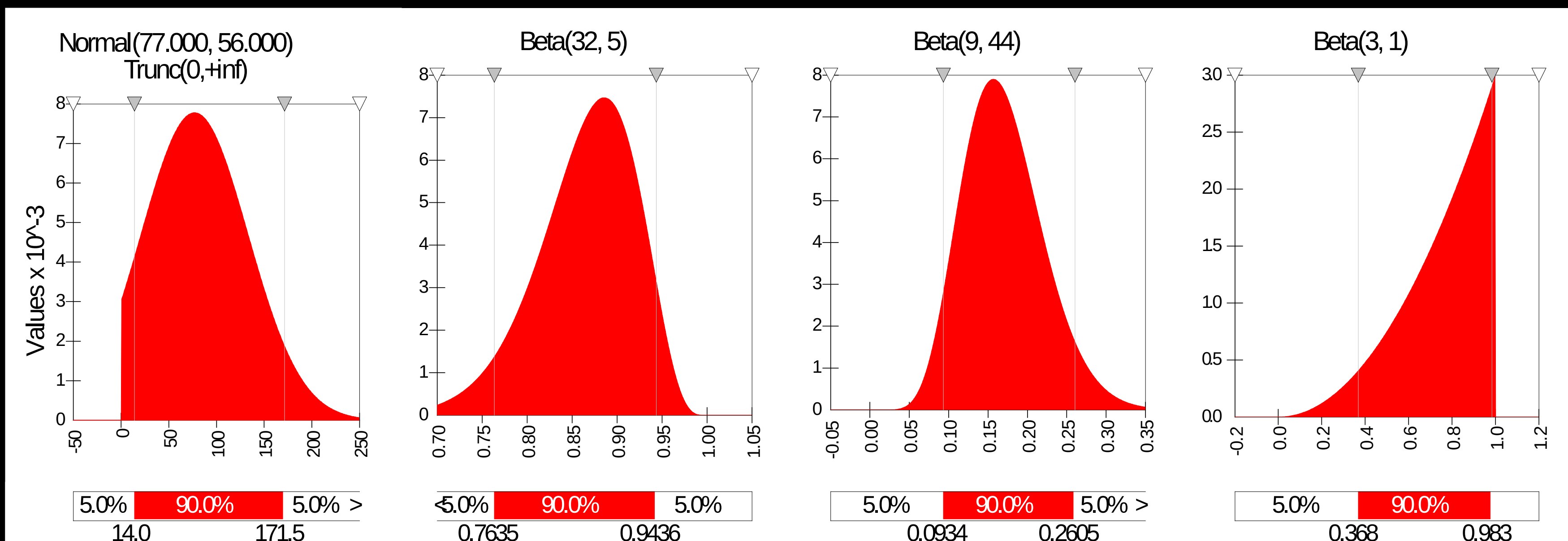
- Coastal live oak (*Quercus agrifolia*):
- California black oak (*Quercus kelloggii*): red-oak group
- Interior live oak (*Quercus wislizeni*)
- Engelmann oak (*Quercus engelmannii*): non-host
- Blue oak (*Quercus douglasii*): white-oak group
- Oregon white oak (*Quercus garryana*)
- Valley oak (*Quercus lobata*)
- Canyon live oak (*Quercus chrysolepis*): intermediate (goldencup)-group
- Cork oak (*Quercus suber*): Cerris group

Measure adult survival & fecundity.

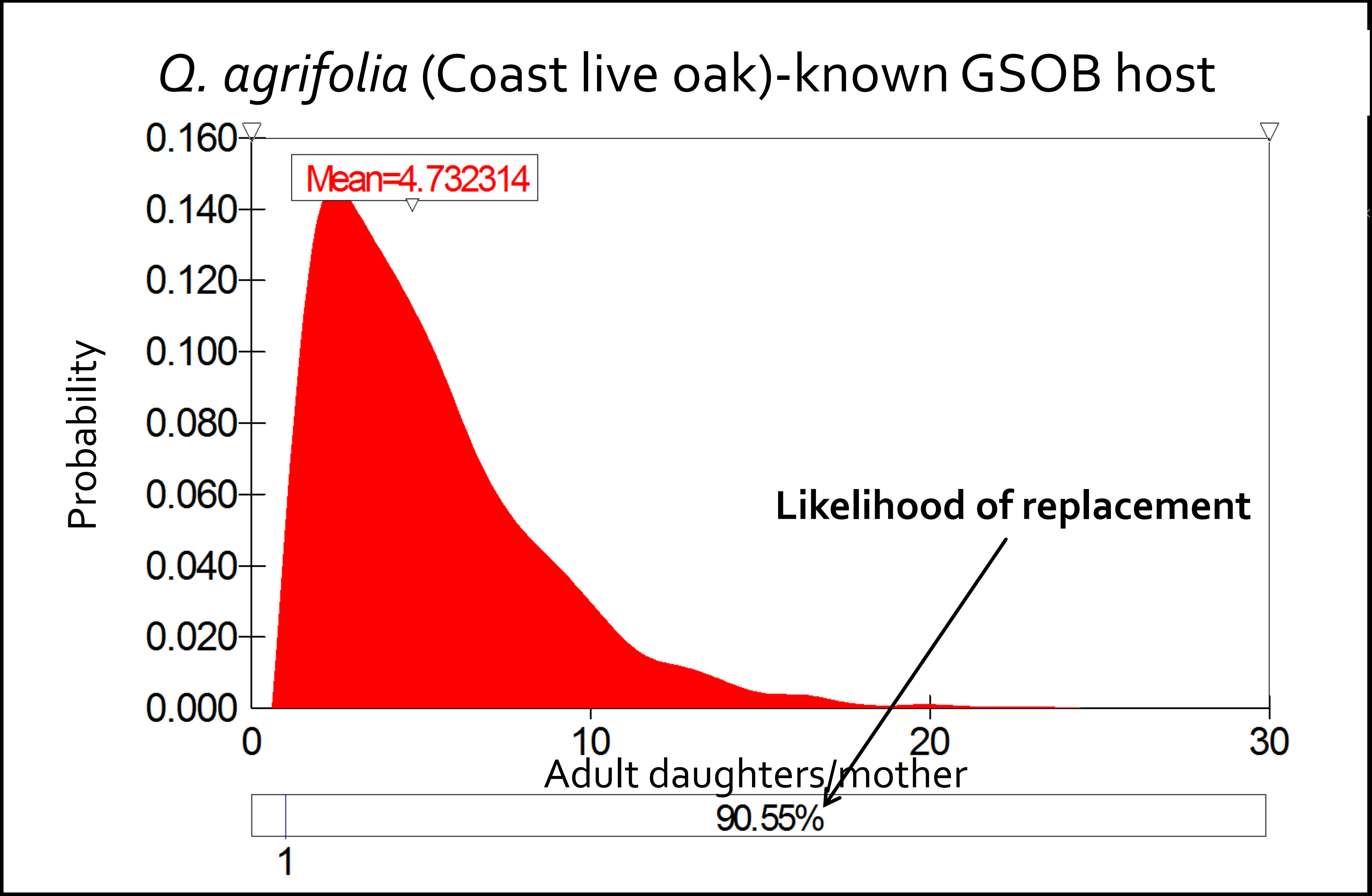
Measure survival & development of larvae put in hosts.

Monte Carlo simulation to estimate adult daughters/mother

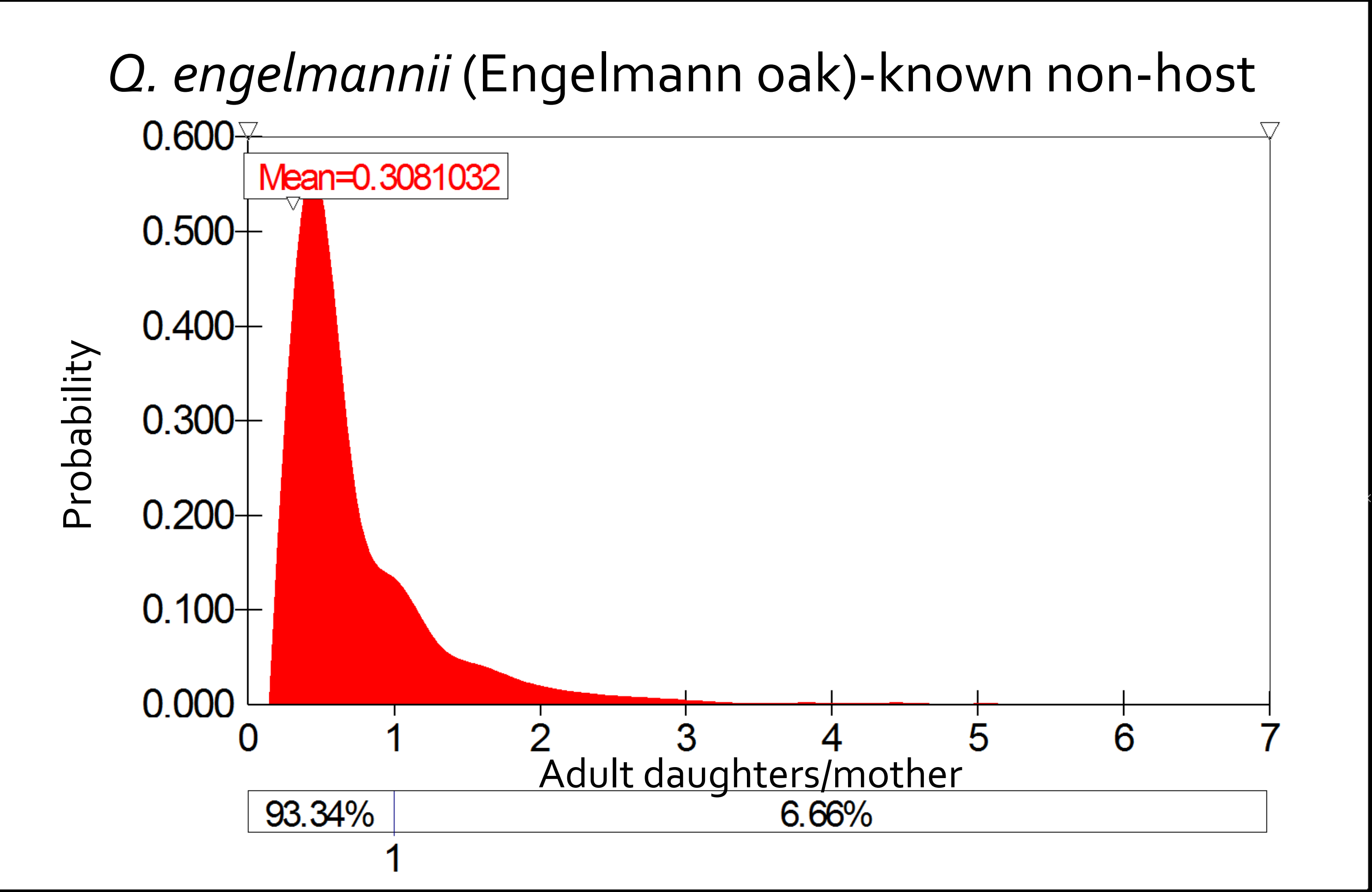
0.5 X Eggs/mother X Proportion that enter host X Proportion that form gallery X Proportion that reach 4th instar



Probability density function for number of adult daughters/mother



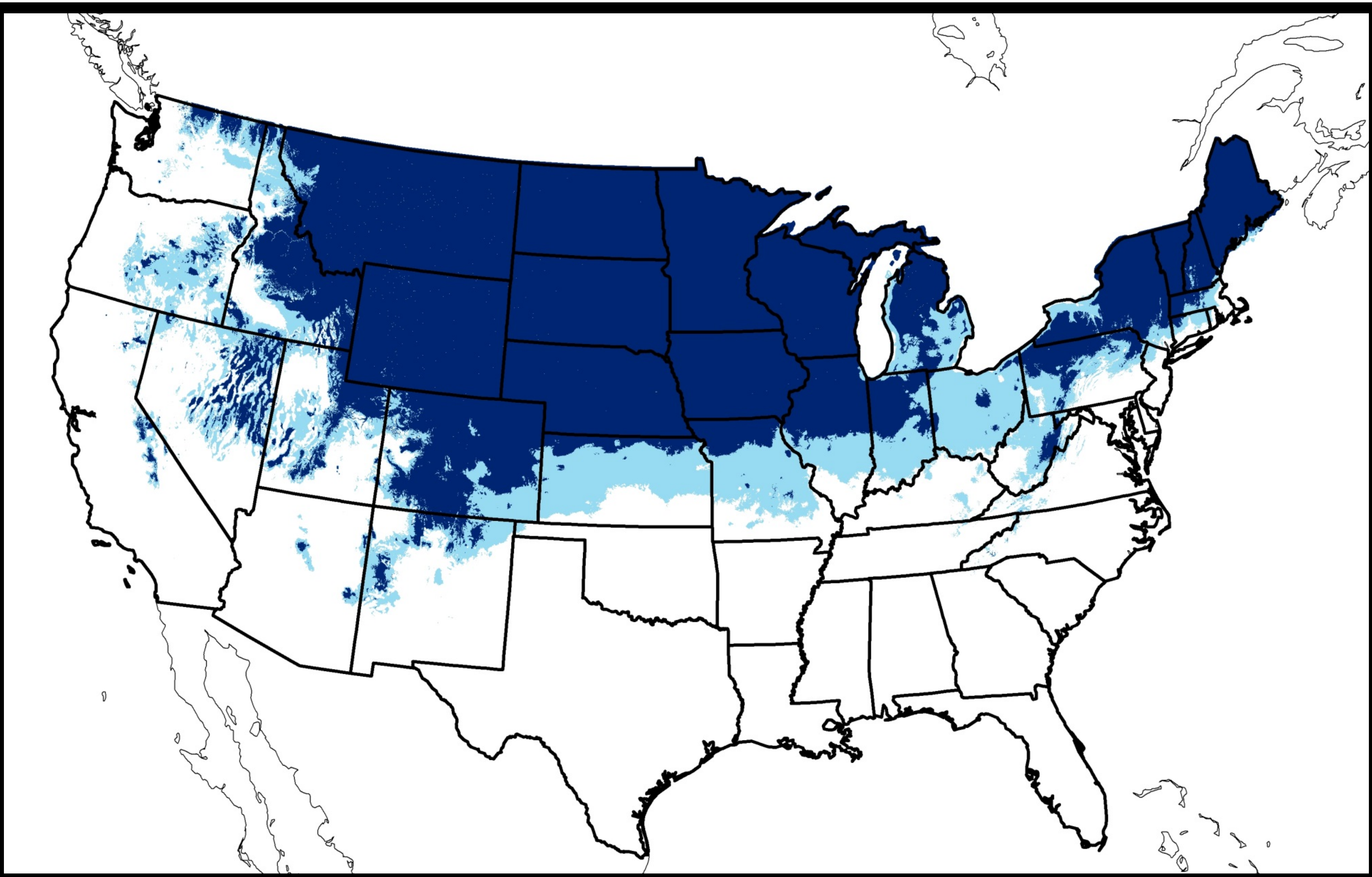
Probability density function for number of adult daughters/mother



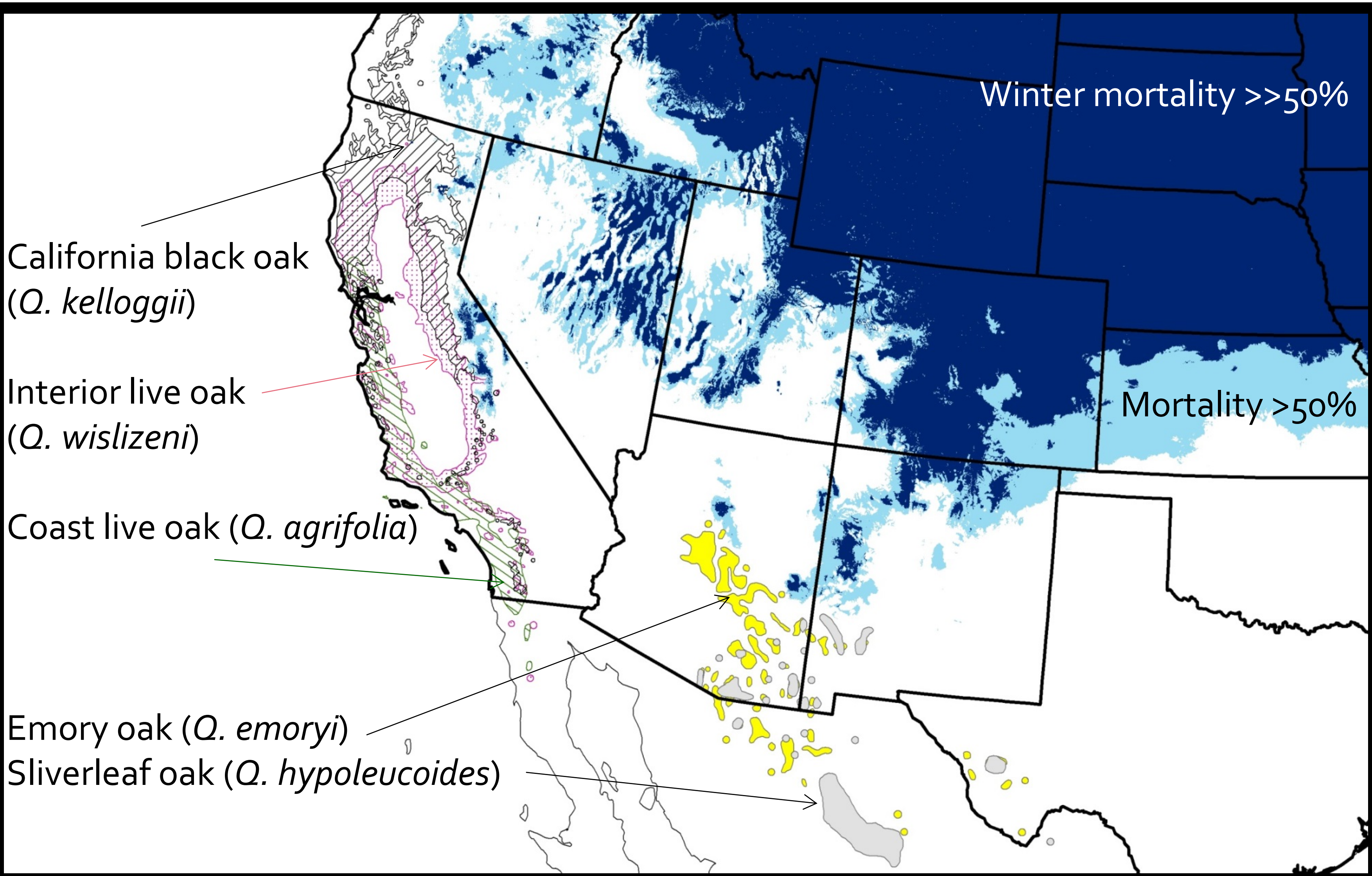
Probability of being a host

Quercus sp.	Expected adult daughters/mother	Prob. of replacement	Pre-test status
Q. wislizeni (Interior live oak)	6.48	0.996	Known host
Q. kelloggii (California black oak)	8.21	0.958	Known host
Q. lobata (Valley oak)	5.56	0.947	
Q. agrifolia (Coast live oak)	4.77	0.906	Known host
Q. suber (Cork oak)	1.96	0.579	
Q. douglasii (Blue oak)	1.58	0.487	
Q. chrysolepis (Canyon live oak)	1.16	0.342	
Q. garryana (Oregon white oak)	0.33	0.081	
Q. engelmannii (Engelmann oak)	0.31	0.067	Non-host

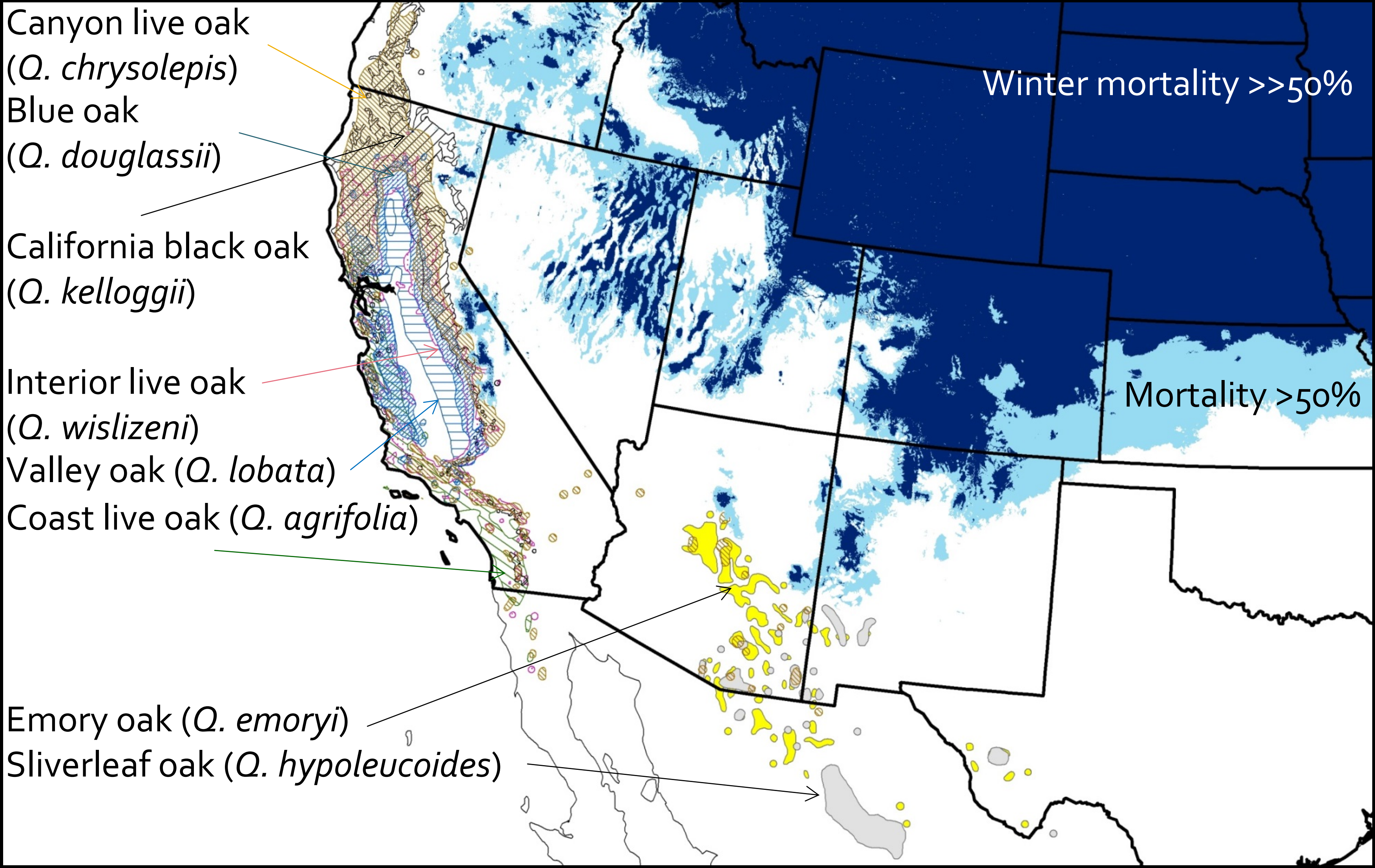
Host distribution with cold stress

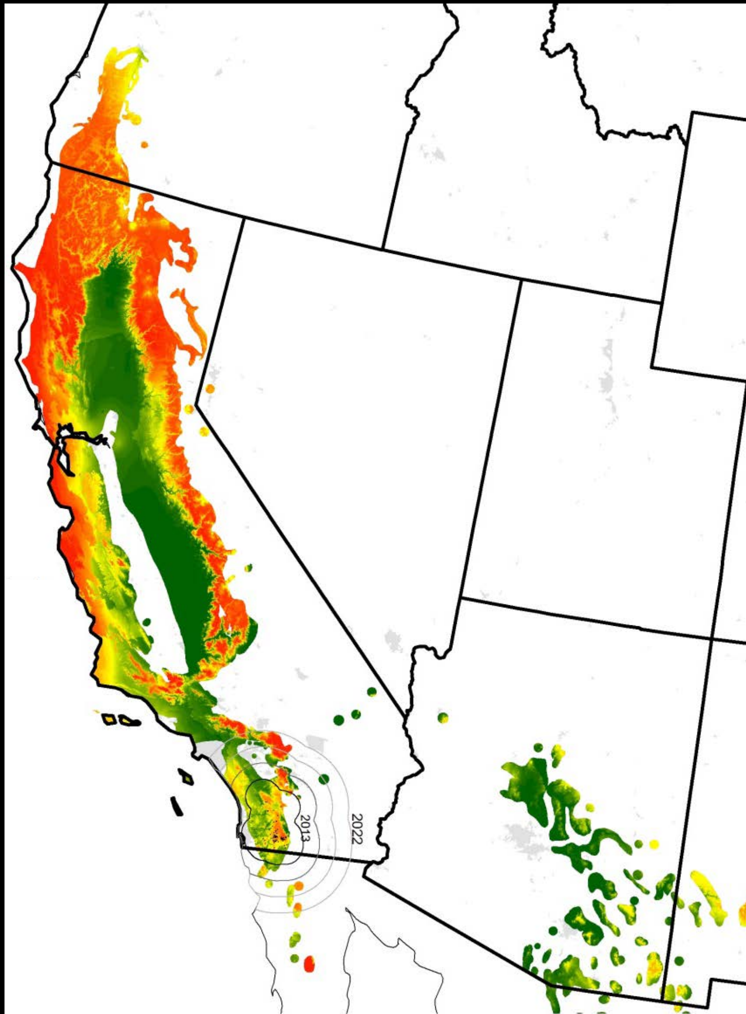


Distribution of known hosts compared with cold stress



New hosts follow similar geographic pattern



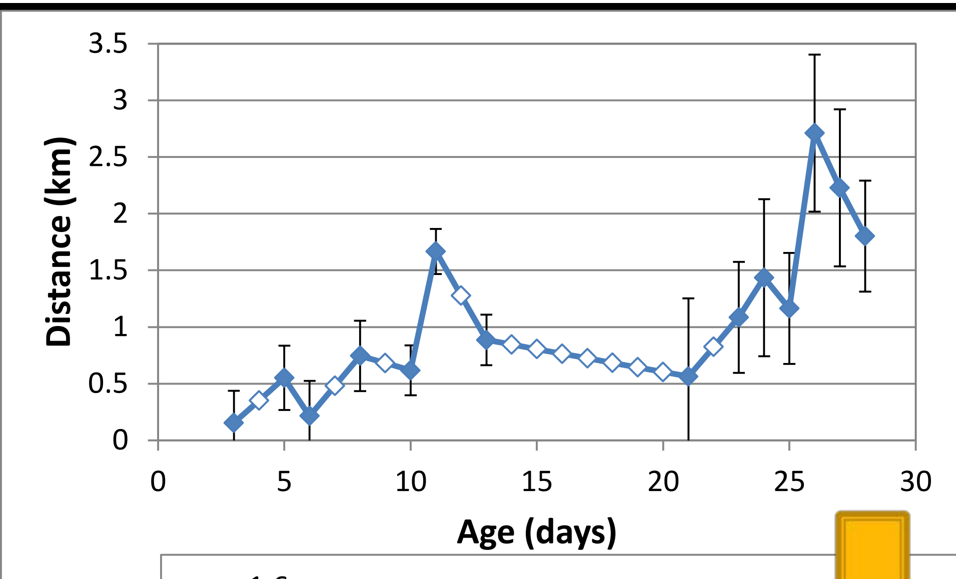


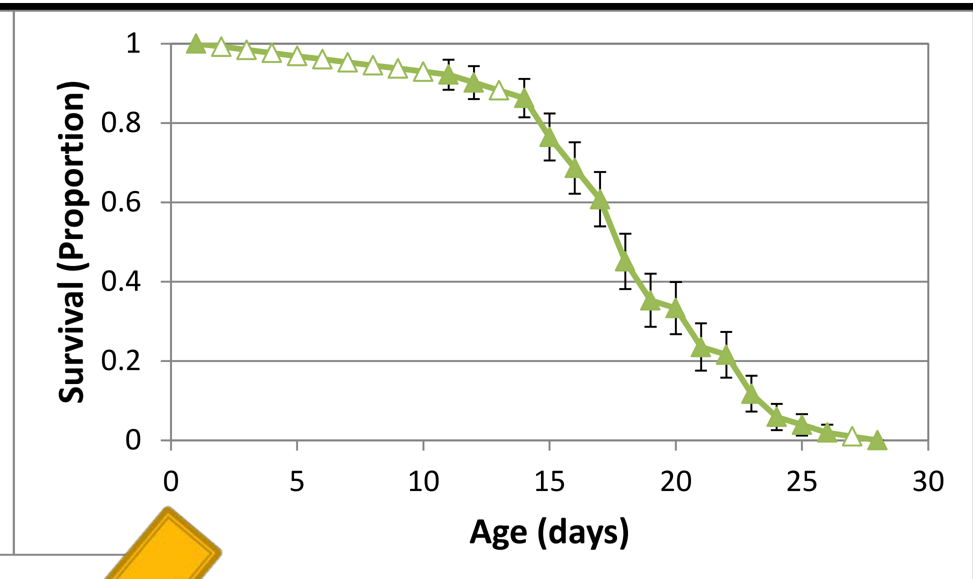
Part 4 of 4
Natural dispersal

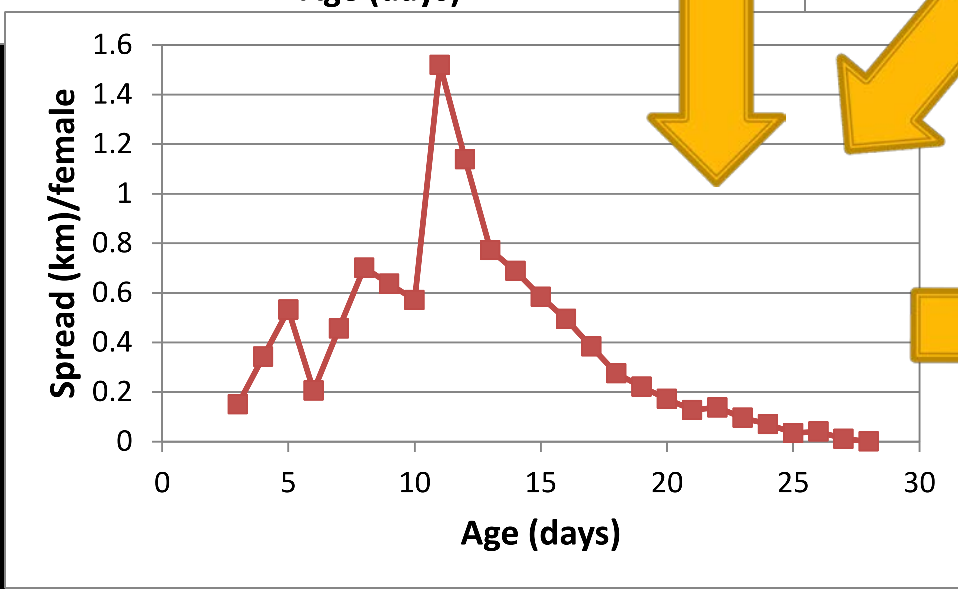
-or-

How were the spread "rings" determined?

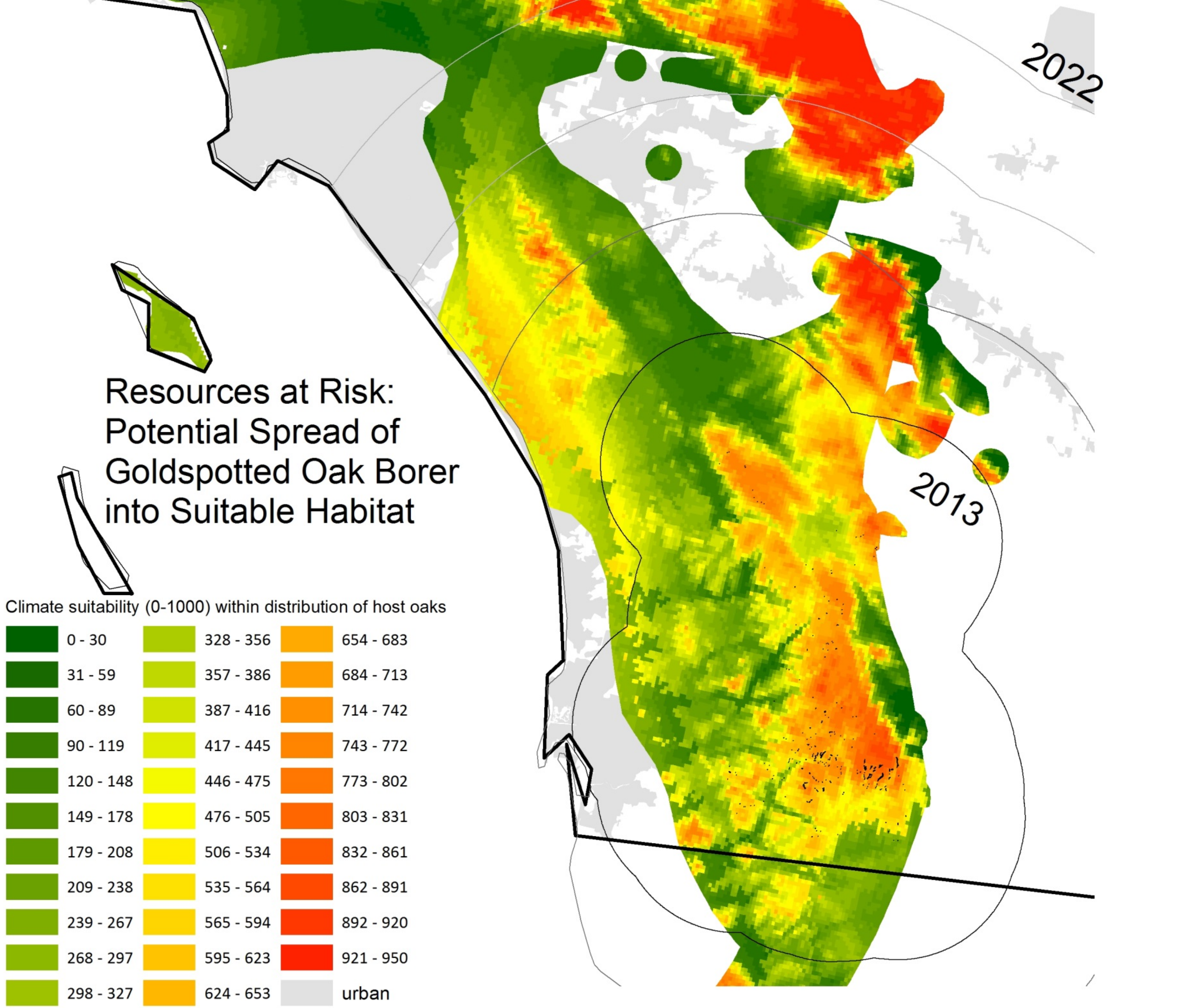
Estimated maximum displacement of a female







9.3 km/yr


2022
2013
Resources at Risk: Potential Spread of Goldspotted Oak Borer into Suitable Habitat
Climate suitability (0-1000) within distribution of host oaks
0 - 30
31 - 59
60 - 89
90 - 119
120 - 148
149 - 178
179 - 208
209 - 238
239 - 267
268 - 297
298 - 327
328 - 356
357 - 386
387 - 416
417 - 445
446 - 475
476 - 505
506 - 534
535 - 564
565 - 594
595 - 623
624 - 653
654 - 683
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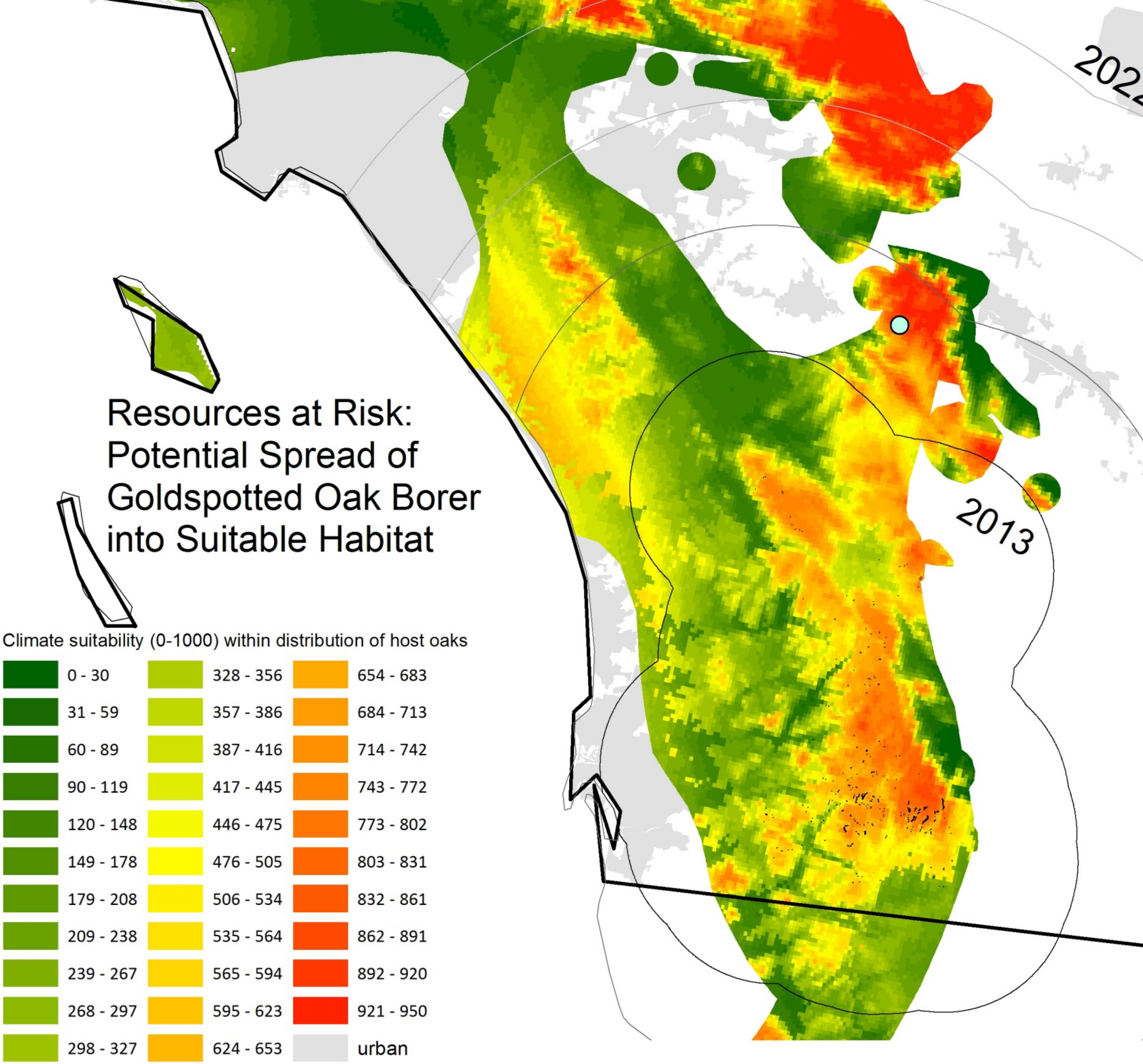
714 - 742
743 - 772
773 - 802
803 - 831
832 - 861
862 - 891
892 - 920
921 - 950
urban



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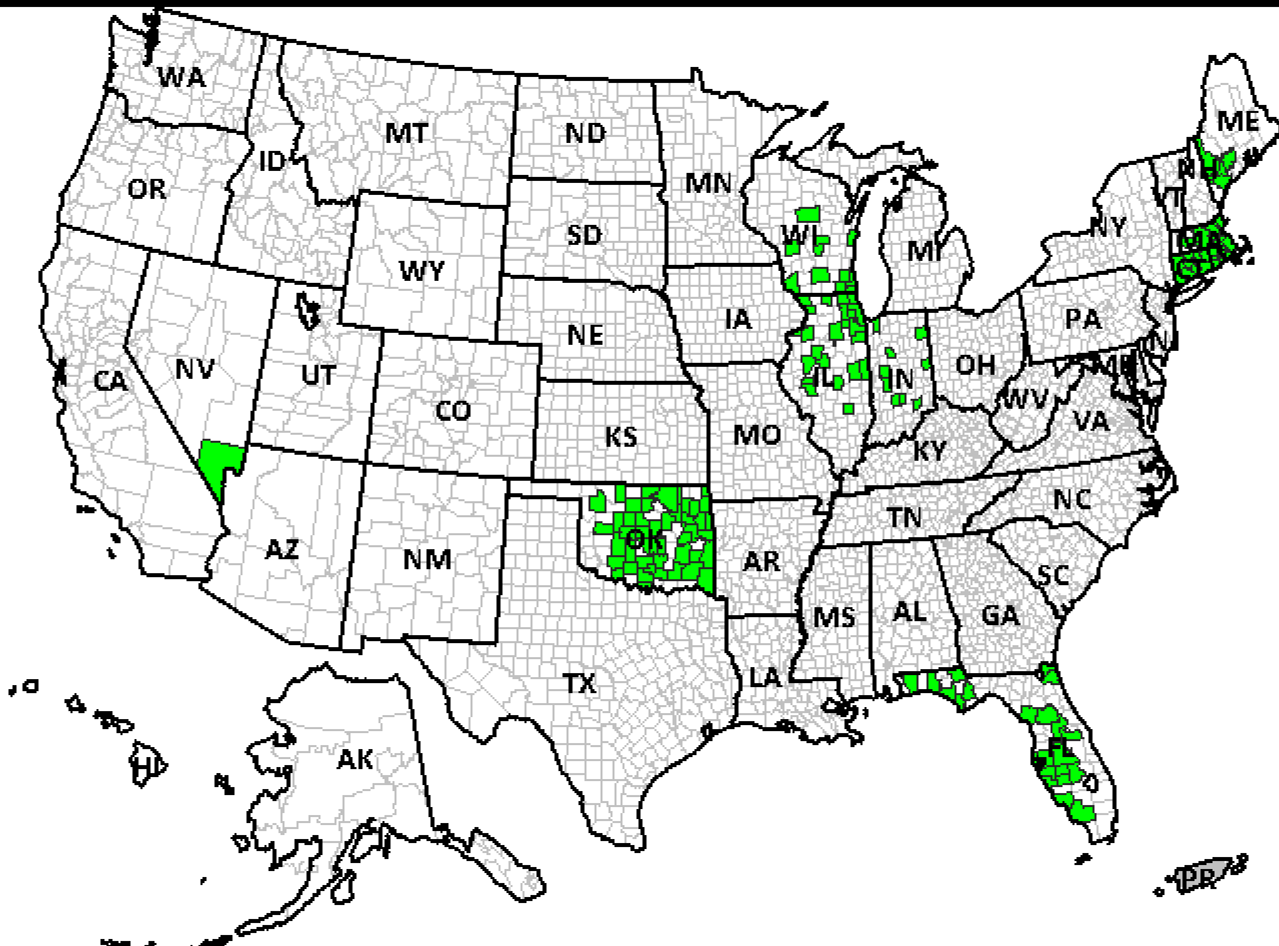
urban

Conclusions

- GSOB is likely to encounter suitable climate and hosts in much of California.
- Relatively slow natural spread and patchy habitat improve chances of management success.
- Need more research to evaluate suitability of eastern oaks.

Thank you!!!

- Special Technology Development Program (USDA Forest Service, Forest Health Protection, Region 5) for funding.
- Laurel Haavik for biological data.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