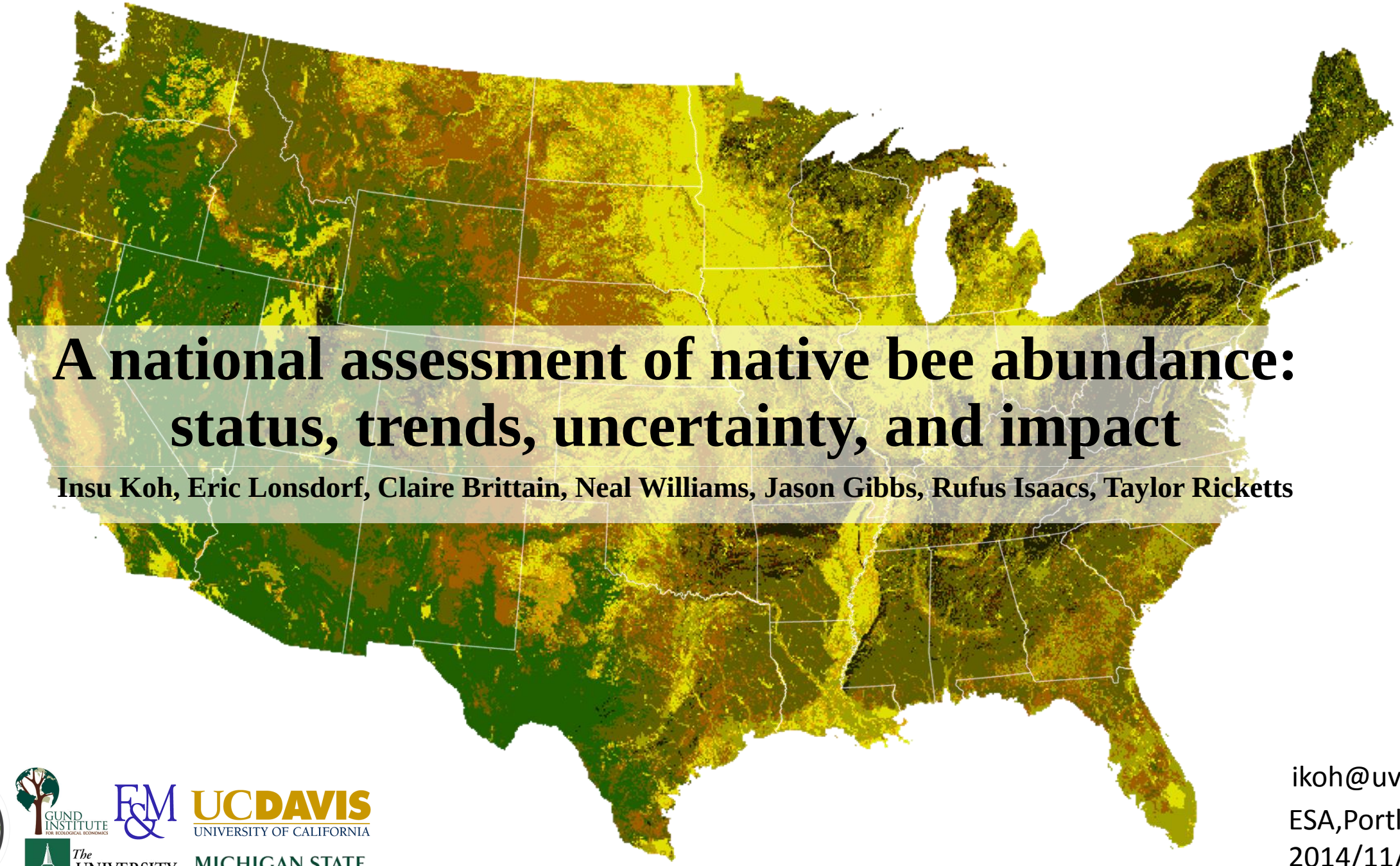

A national assessment of native bee abundance: status, trends, uncertainty, and impact

Insu Koh, Eric Lonsdorf, Claire Brittain, Neal Williams, Jason Gibbs, Rufus Isaacs, Taylor Ricketts

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ESA,Portland, OR
2014/11/18

Why native bees?

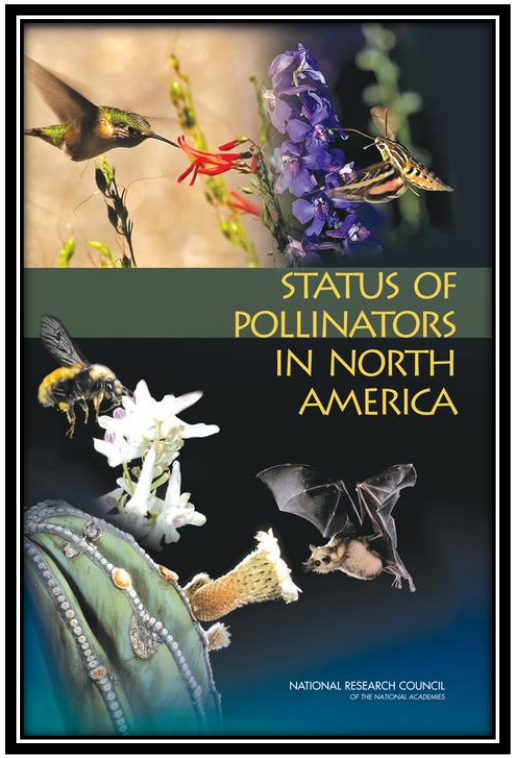
US agricultural GDP

Non-*Apis* pollinators contributed an estimated 20% of a total economic value of pollination services to crop yield in 2009[3].

- Stability[4]
- Synergy[5]

1. Lautenbach et al. 2012, *Plos One*
2. Morse & Calderone 2000, *Bee Culture*
3. Calderone 2012, *Plos One*
4. Garibaldi et al. 2011, *P Natl Acad Sci USA*
5. Brittan et al. 2013, *P. Roy. Soc B-Biol Sci*

Calling for a national assessment

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For Immediate Release

June 20, 2014

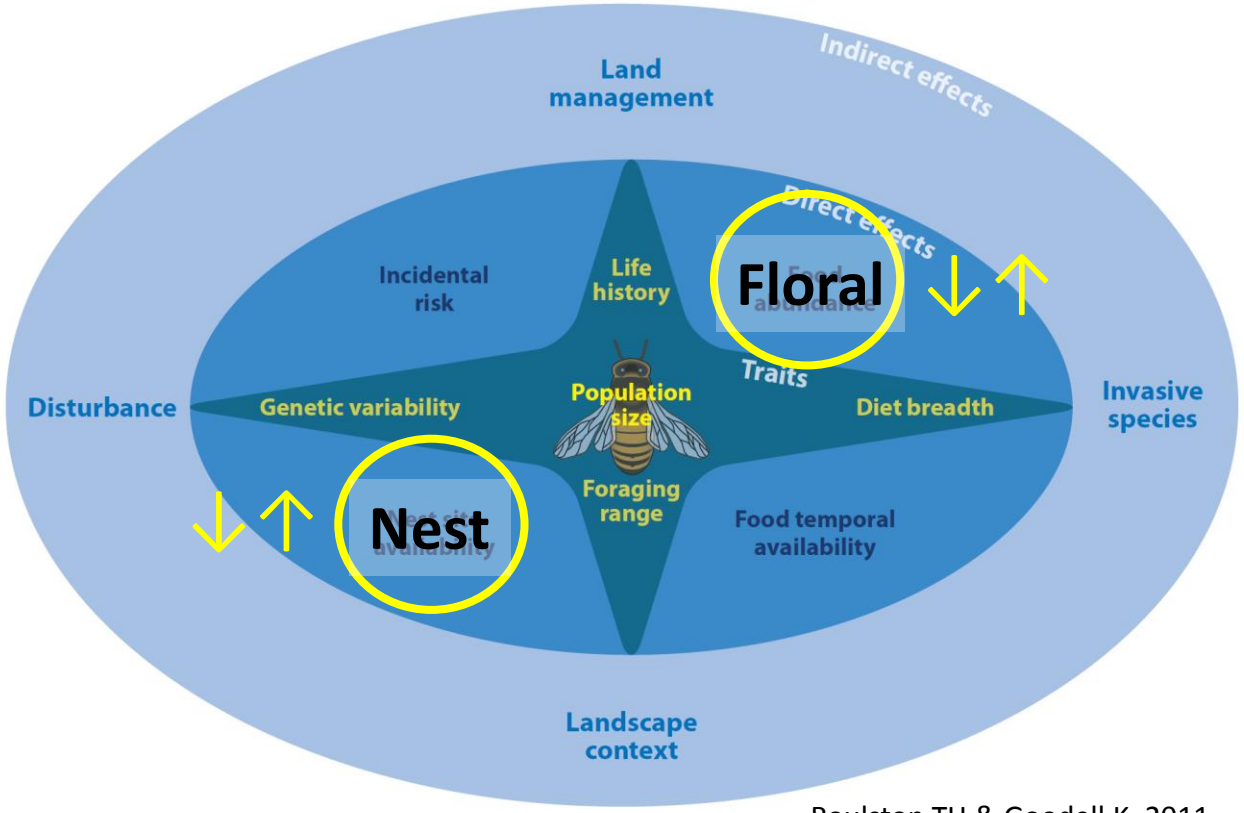
Presidential Memorandum -- Creating a Federal Strategy to Promote the Health of Honey Bees and Other Pollinators

MEMORANDUM FOR HEADS OF EXECUTIVE DEPARTMENTS AND AGENCIES

SUBJECT: Creating a Federal Strategy to Promote the Health of Honey Bees and Other Pollinators

Calling for an assessment of native pollinators, including models of **native pollinator populations and habitats** at the national level.

Habitat resources for native bees

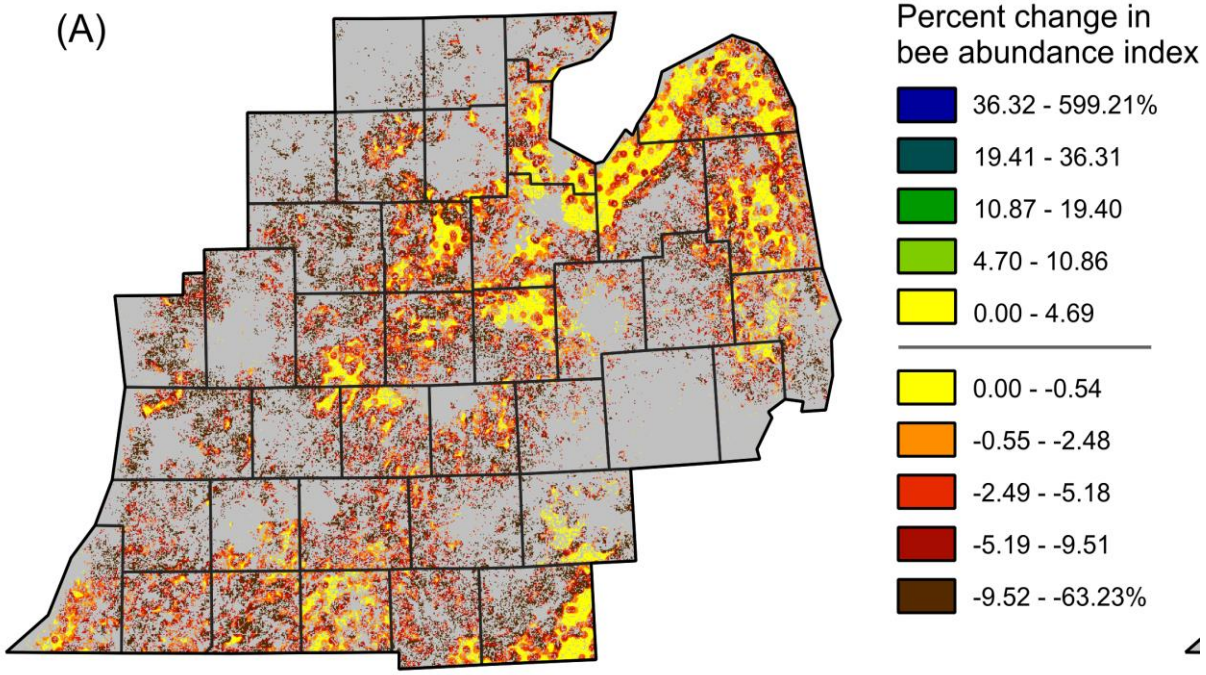


Roulston TH & Goodell K, 2011.

Annu Rev Entomol

Scenario study at state level

Perennial grasses to annual crops



Bennet et al. 2014, *Plos One*

"Land-use changes do not have a simple direction"

Research questions

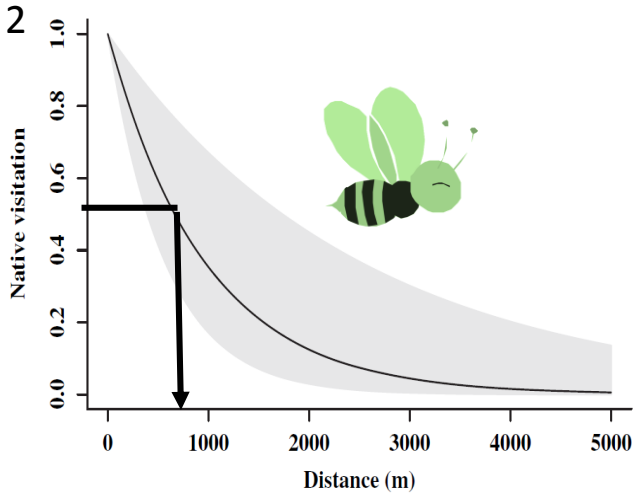
(1) What is the current status and trends of native pollinator abundance?

(2) Which areas and crops have experienced the largest change in service-provision of native bees?

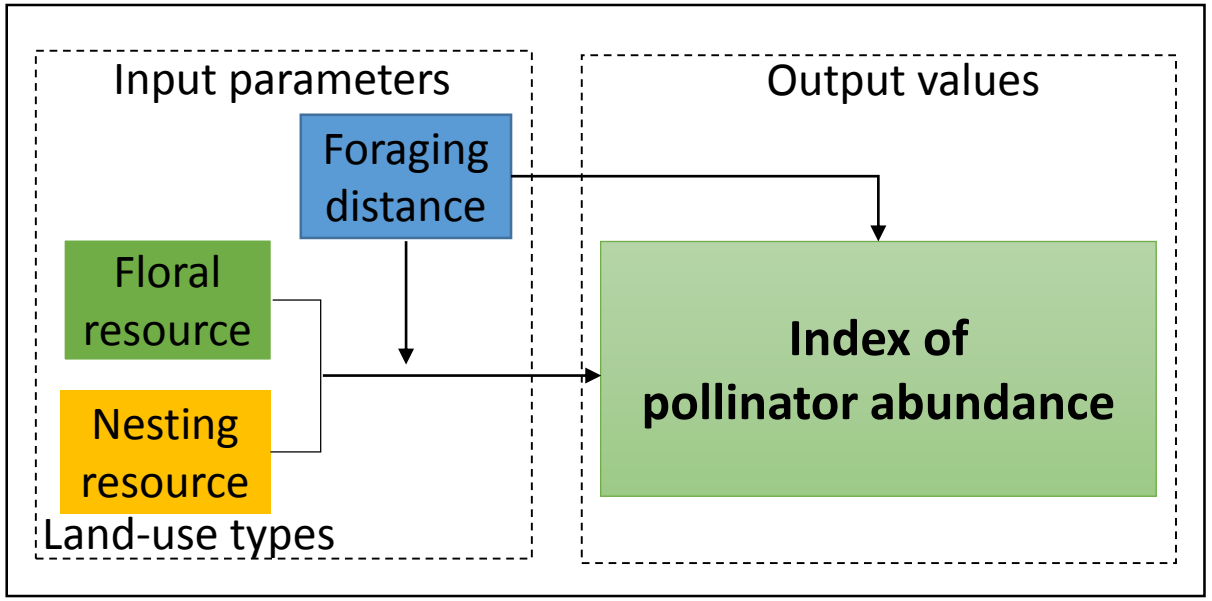
(3) How do we target conservation research effort based on uncertainty assessment?

Model

2



A crop pollination model[1]



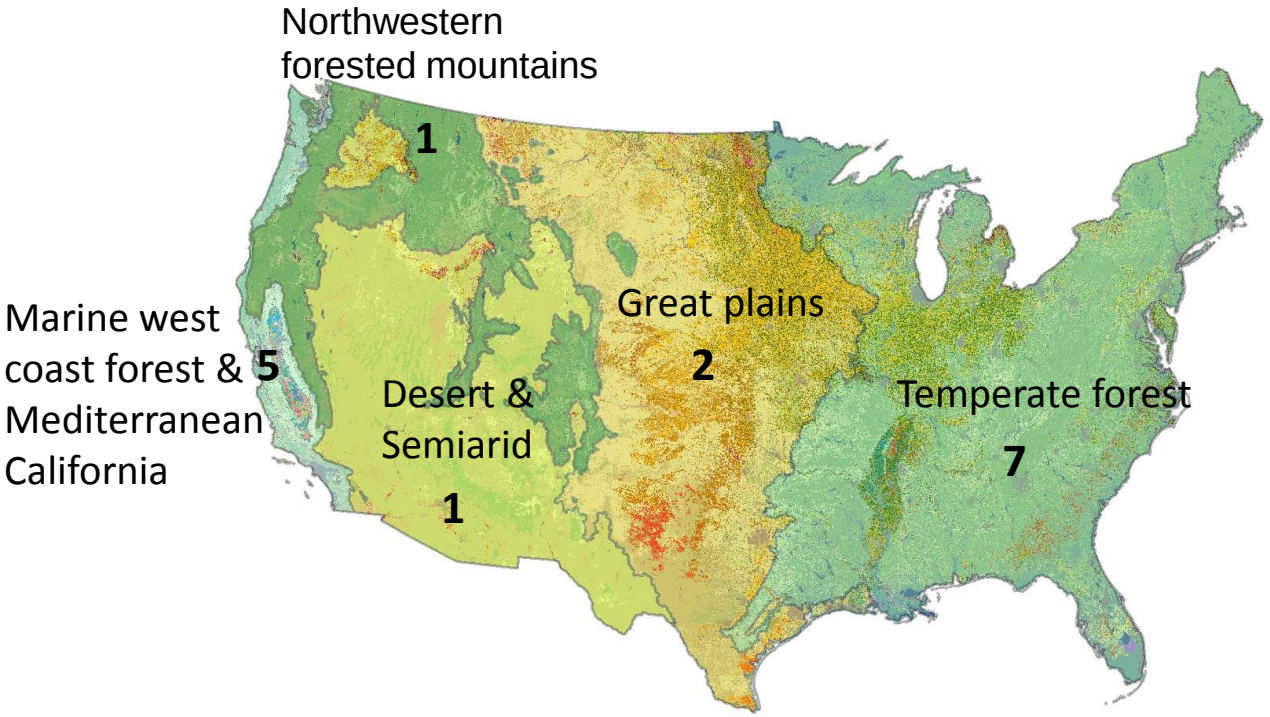
1. Lonsdorf et al. 2009. *Ann Bot*
2. Ricketts et al. 2008 *Ecol Lett*
3. Farm lug:

http://www.grimaldiandgallowayarts.com/

Export prior

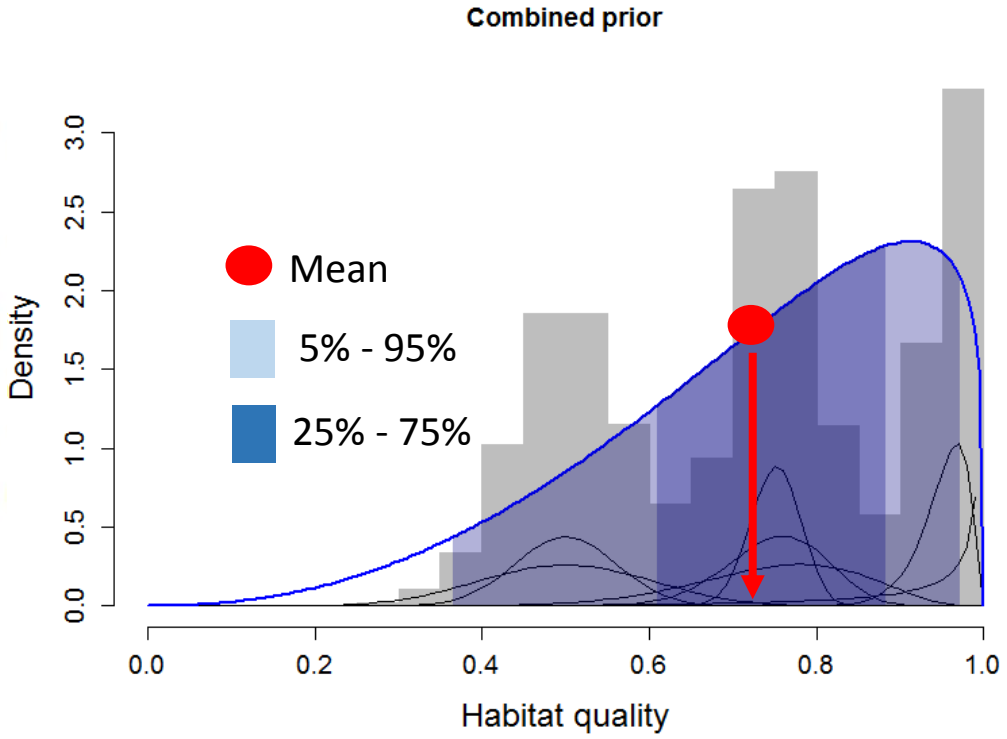
Collecting suitability value from expert survey

- Cropland Data Layer 110 land-use types from 2008 at national level:
  - 14 NLCD land-uses + 33 crop categories
- Expert opinion for major eco-regions: 16 responses



Building expert-informed priors

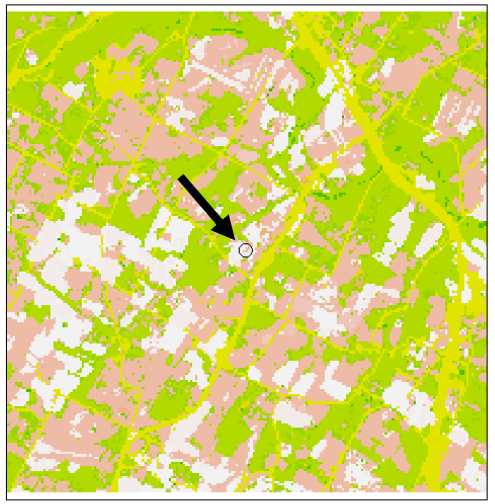
Nest suitability of 'shrubland'
for 'ground' nesters



Ground, cavity, stem, wood ➔ Average nest resource
Spring, Summer, Autumn ➔ Average floral resource

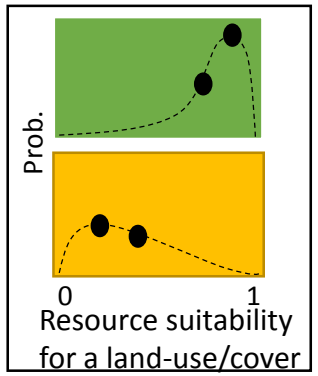
Modeling

Cropland Data Layer

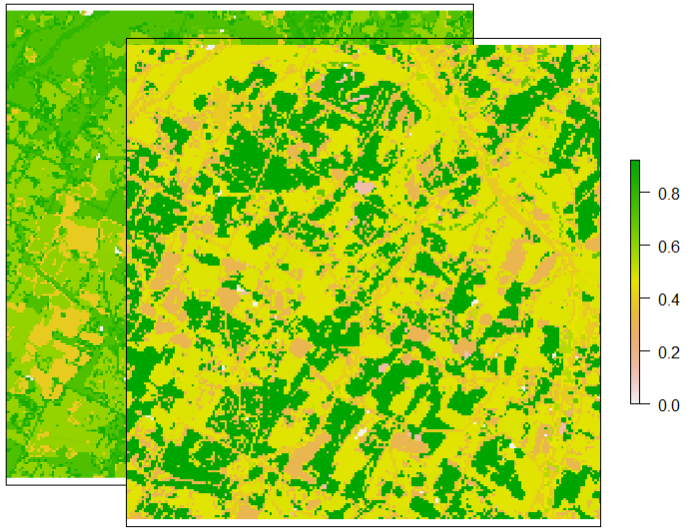


A field site in a study

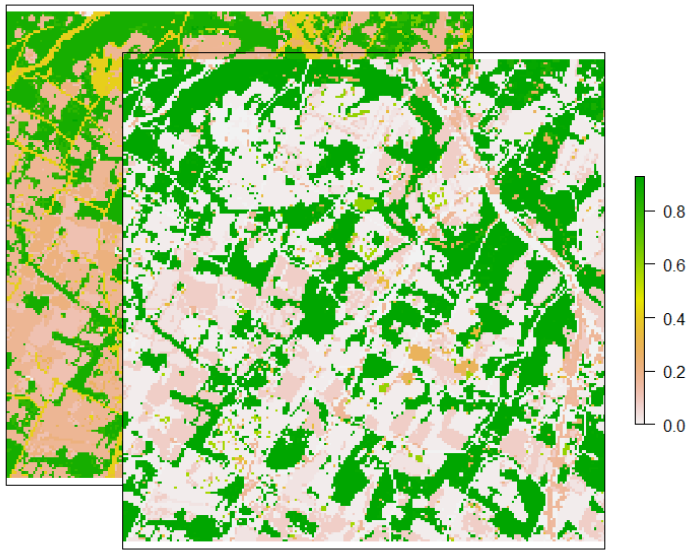
Expert-informed prior



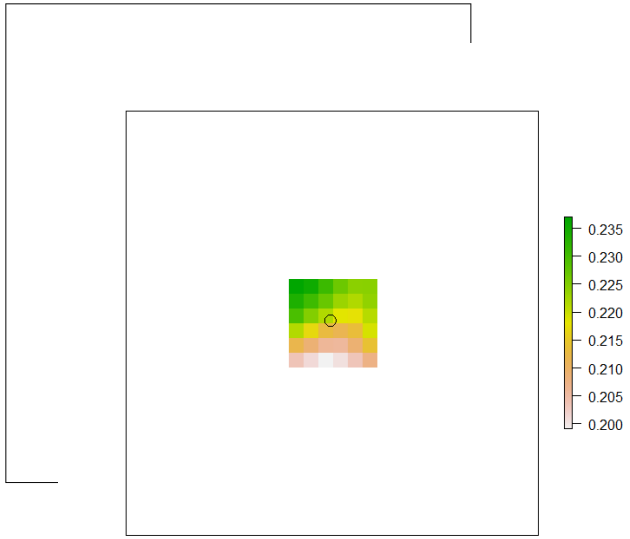
Floral resource map



Nest resource map



Index of bee abundance

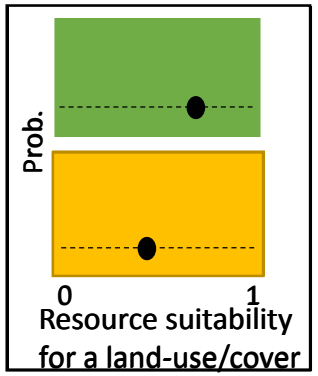


Modeling

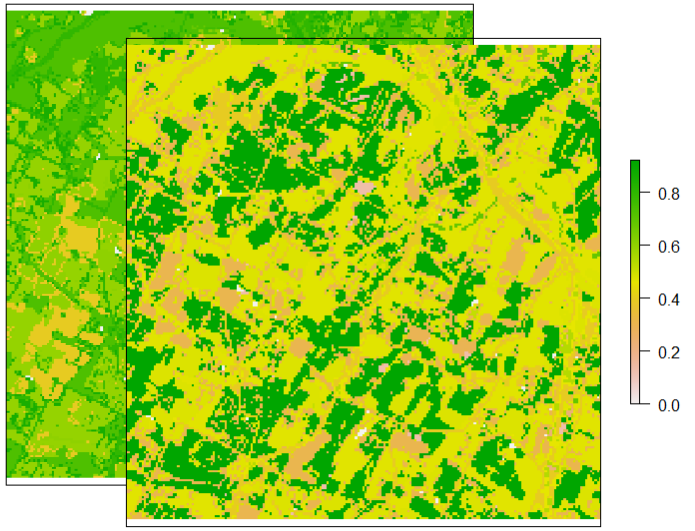
Cropland Data Layer

A field site in watermelon crop from Winfree's study

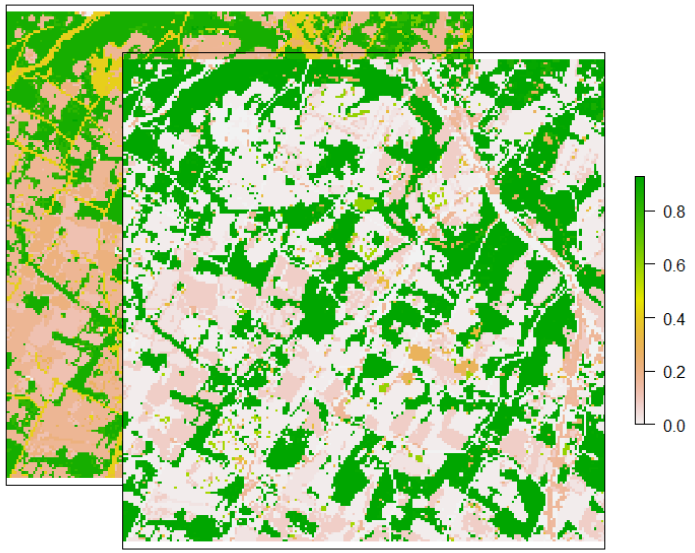
Non-informed prior



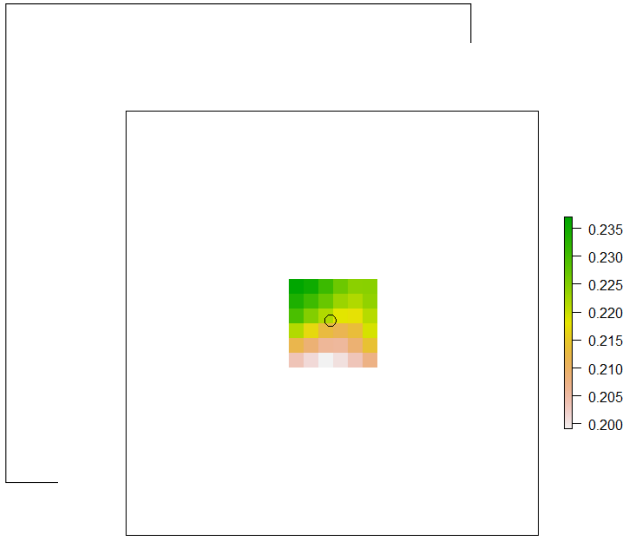
Floral resource map



Nest resource map



Index of bee abundance

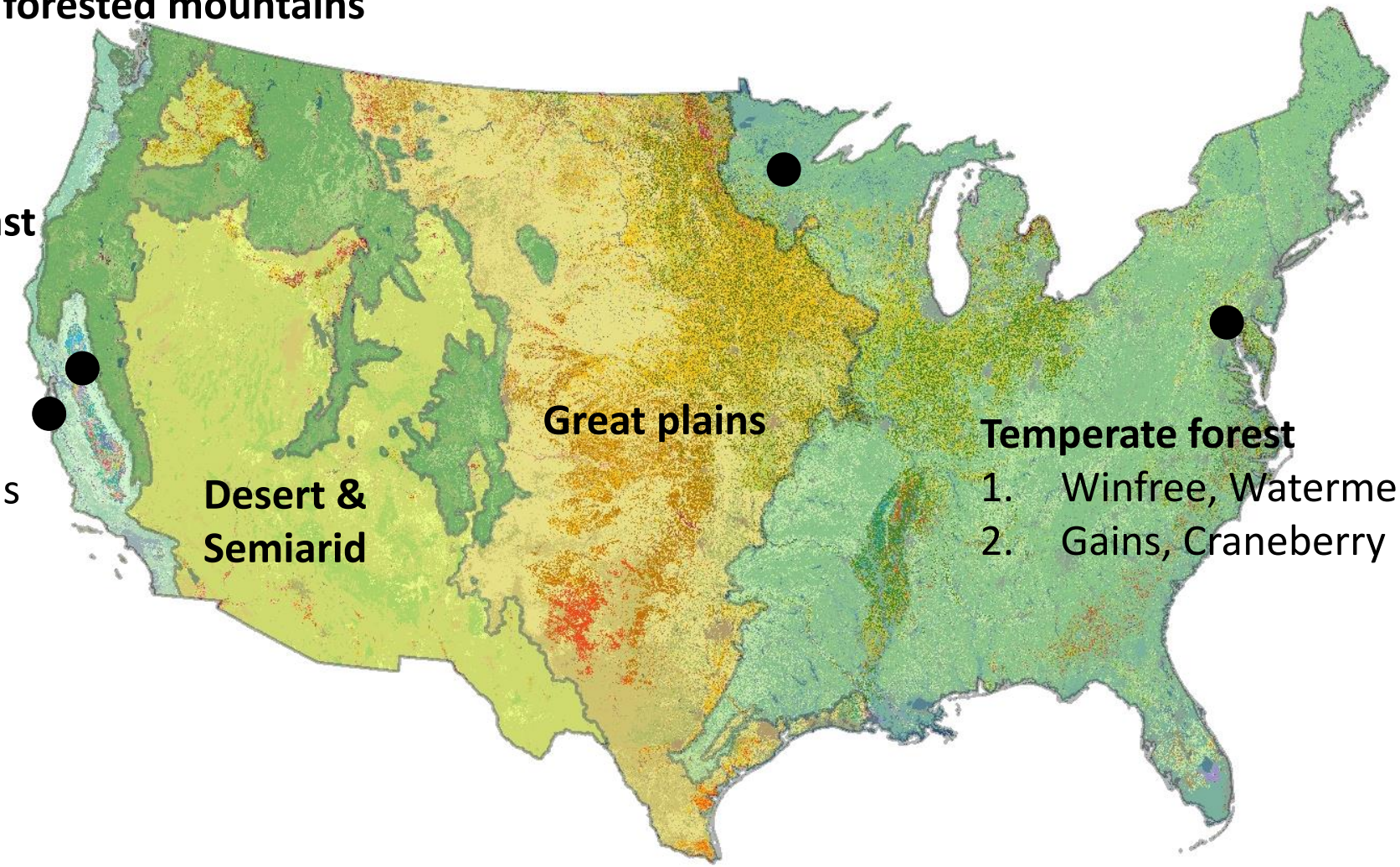


Validation data

Northwestern forested mountains

Marine west coast forest & Mediterranean California

1. Williams, Watermelons
2. Sciligo, Strawberry



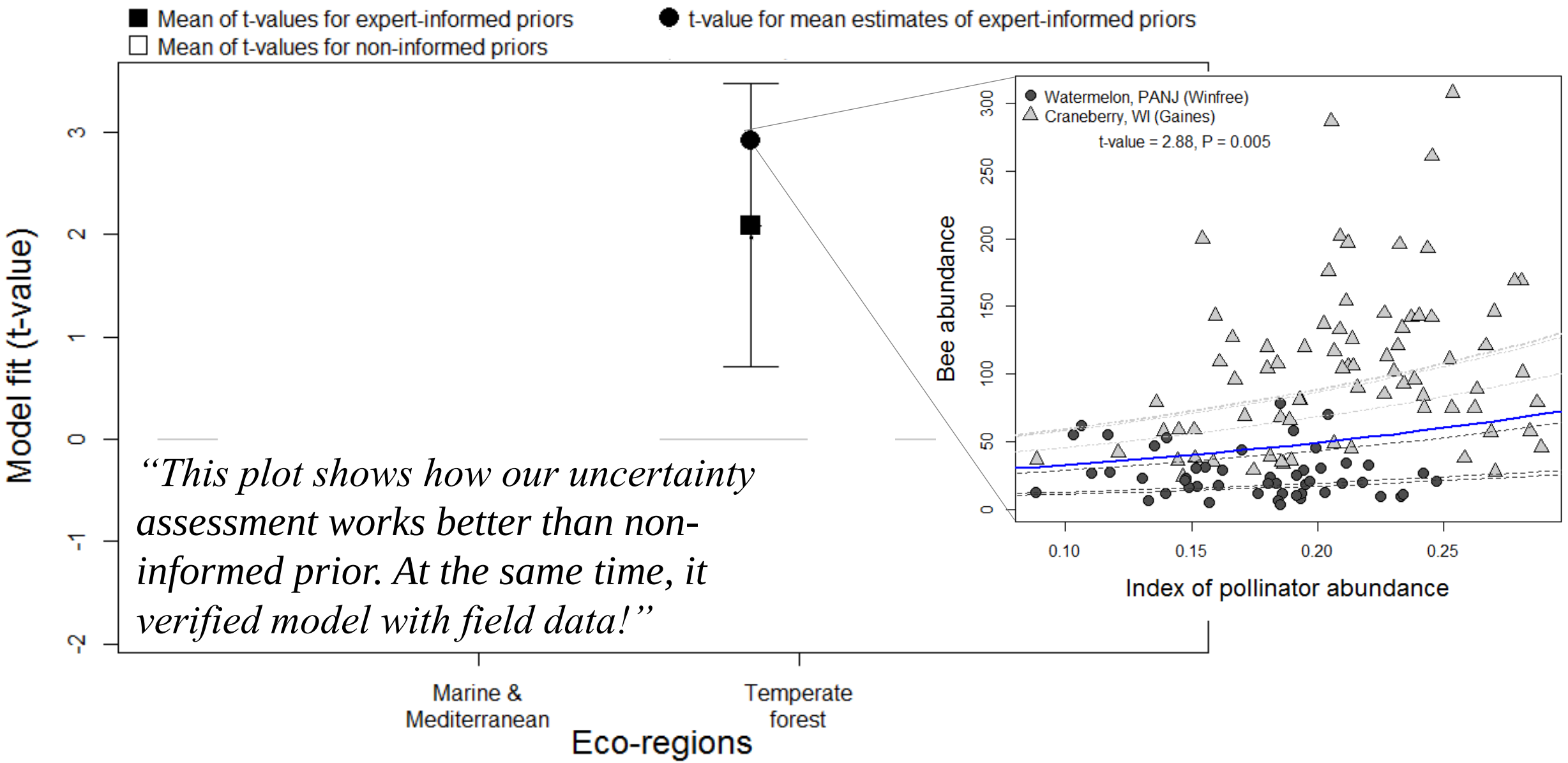
Desert & Semiarid

Great plains

Temperate forest

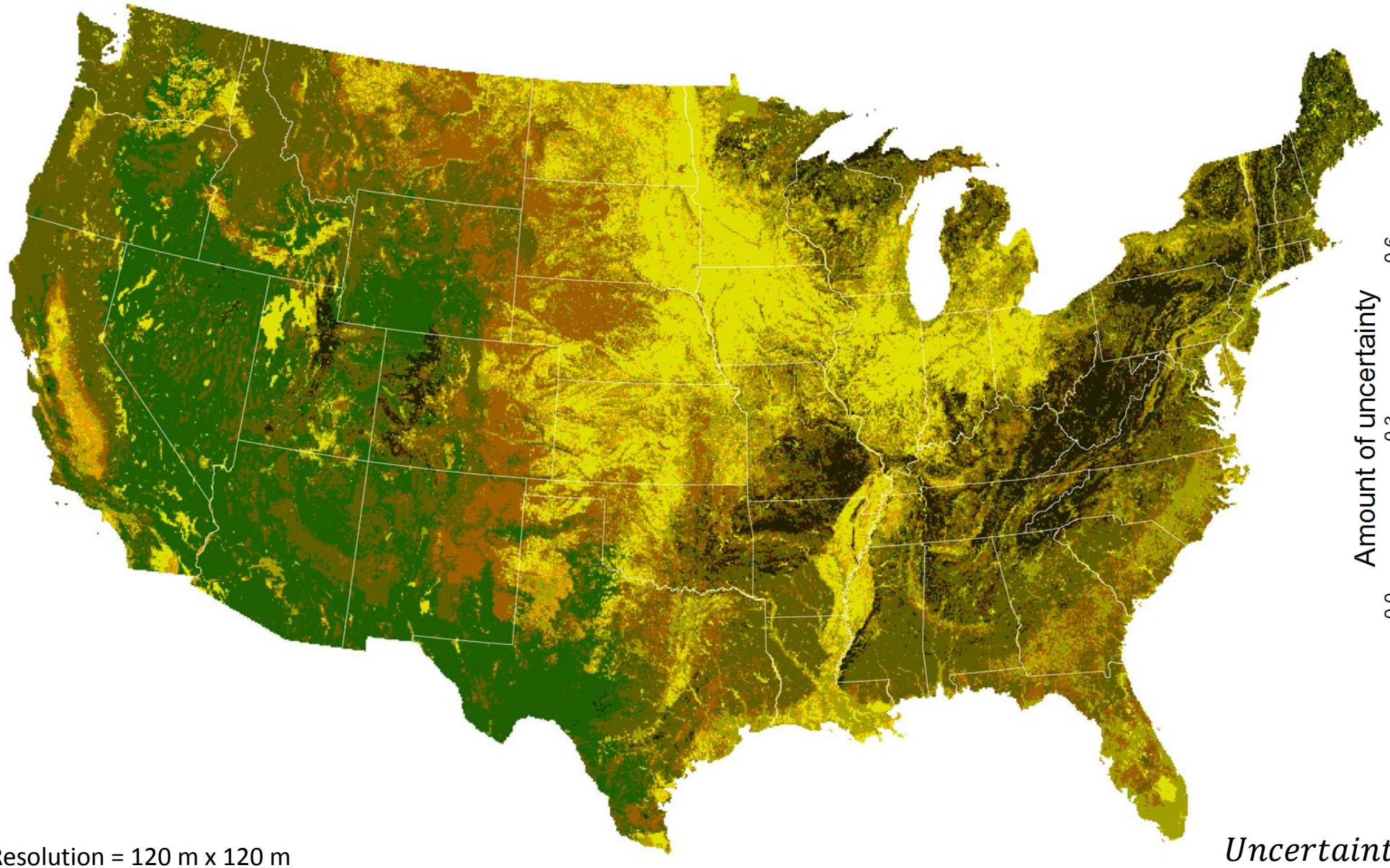
1. Winfree, Watermelon
2. Gains, Craneberry

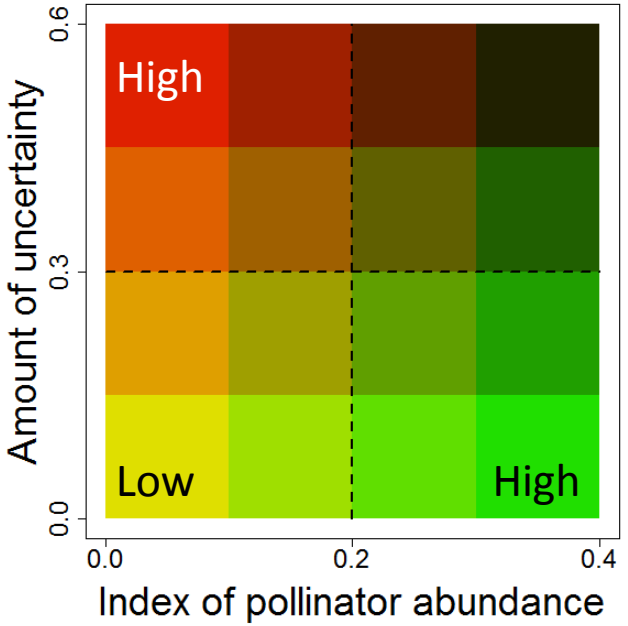
Model validation



"This plot shows how our uncertainty assessment works better than non-informed prior. At the same time, it verified model with field data!"

Status of pollinator abundance and its uncertainty in 2013

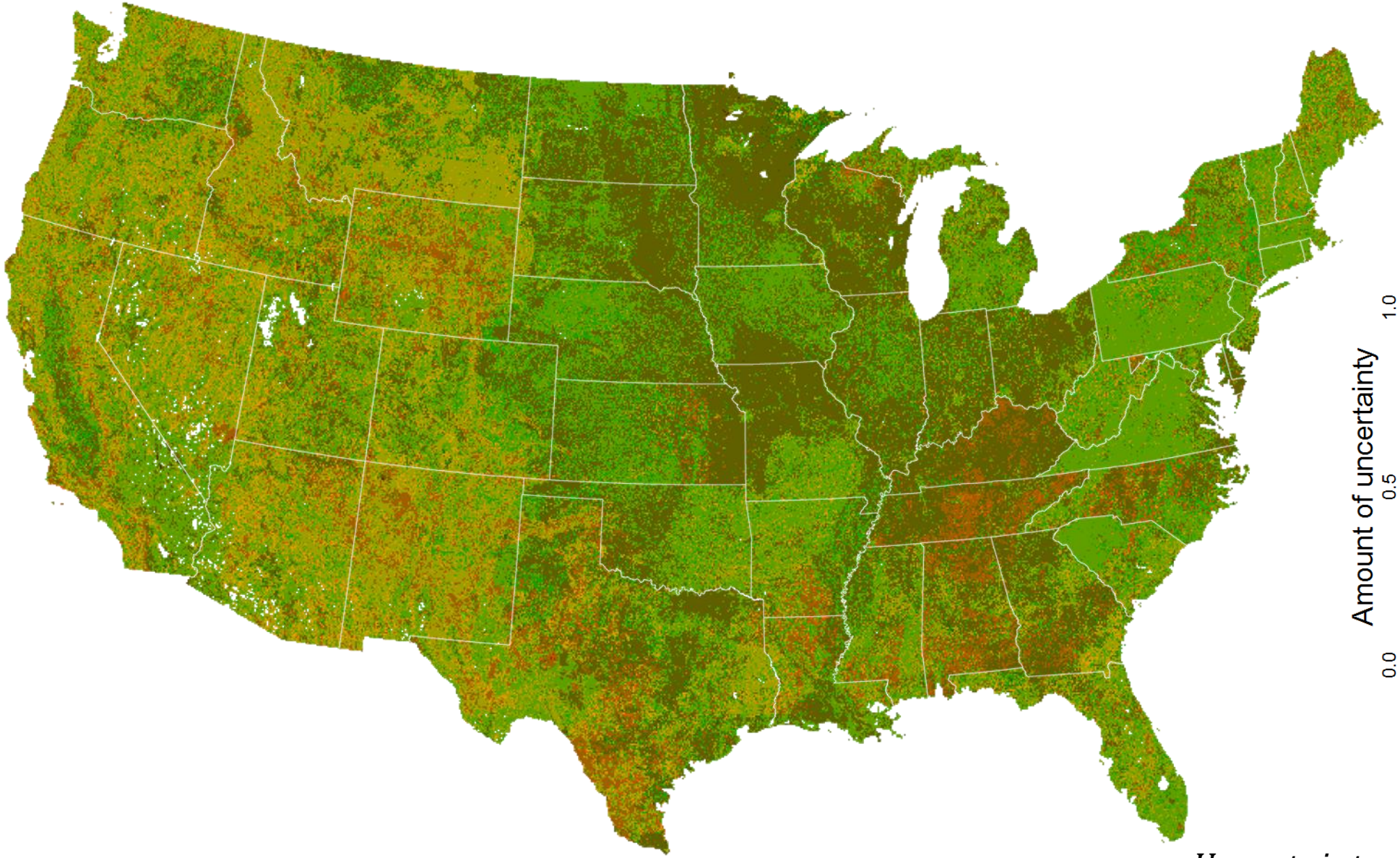


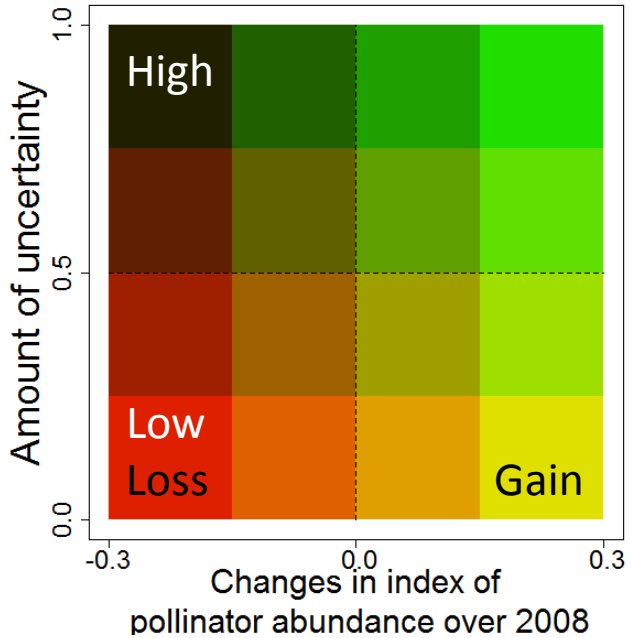


Resolution = 120 m x 120 m

$$Uncertainty = Index_{upper} - Index_{lower}$$

Pollinator abundance changes over 2008 and its uncertainty

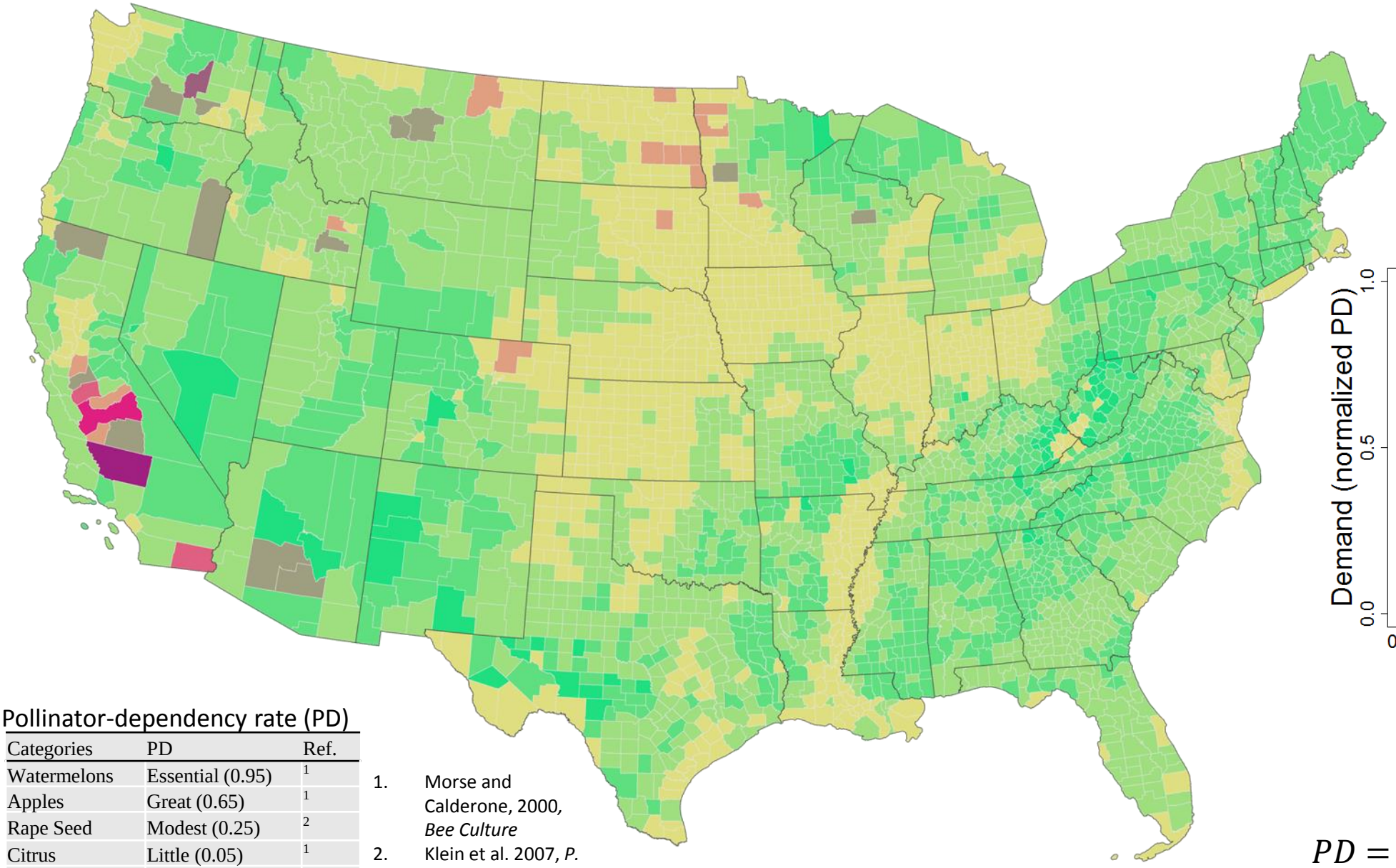


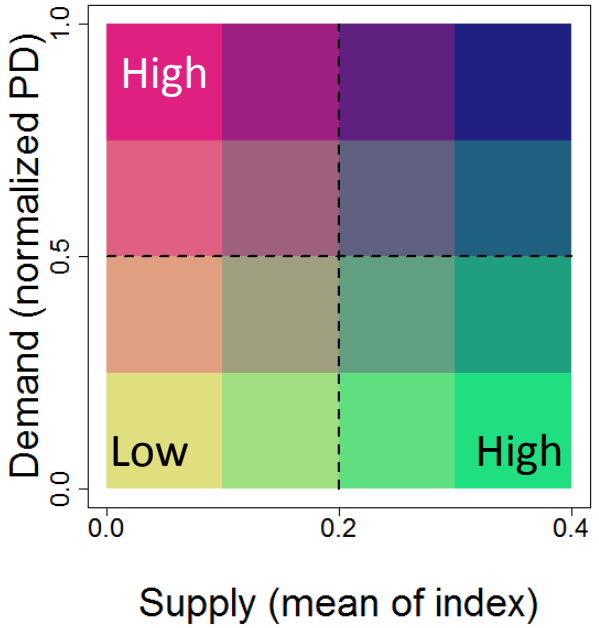


$$Uncertainty = \frac{(Max(\boldsymbol{\Delta}) - Min(\boldsymbol{\Delta}))}{|\boldsymbol{\Delta} Changes| + (Max(\boldsymbol{\Delta}) - Min(\boldsymbol{\Delta}))}$$

Resolution = 120 m x 120 m

Status of service-provision of pollinator at county level





Pollinator-dependency rate (PD)

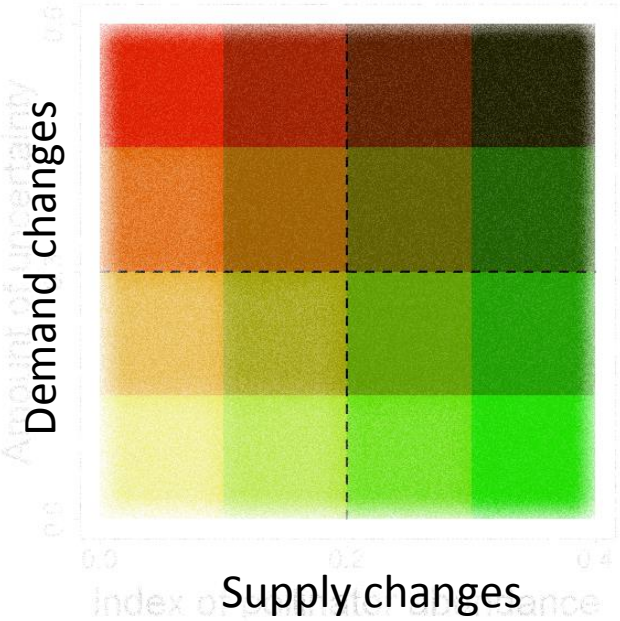
Categories	PD	Ref.
Watermelons	Essential (0.95)	1
Apples	Great (0.65)	1
Rape Seed	Modest (0.25)	2
Citrus	Little (0.05)	1
Corn	No increase	1

1. Morse and Calderone, 2000, *Bee Culture*
2. Klein et al. 2007, *P. R. Soc. B.*

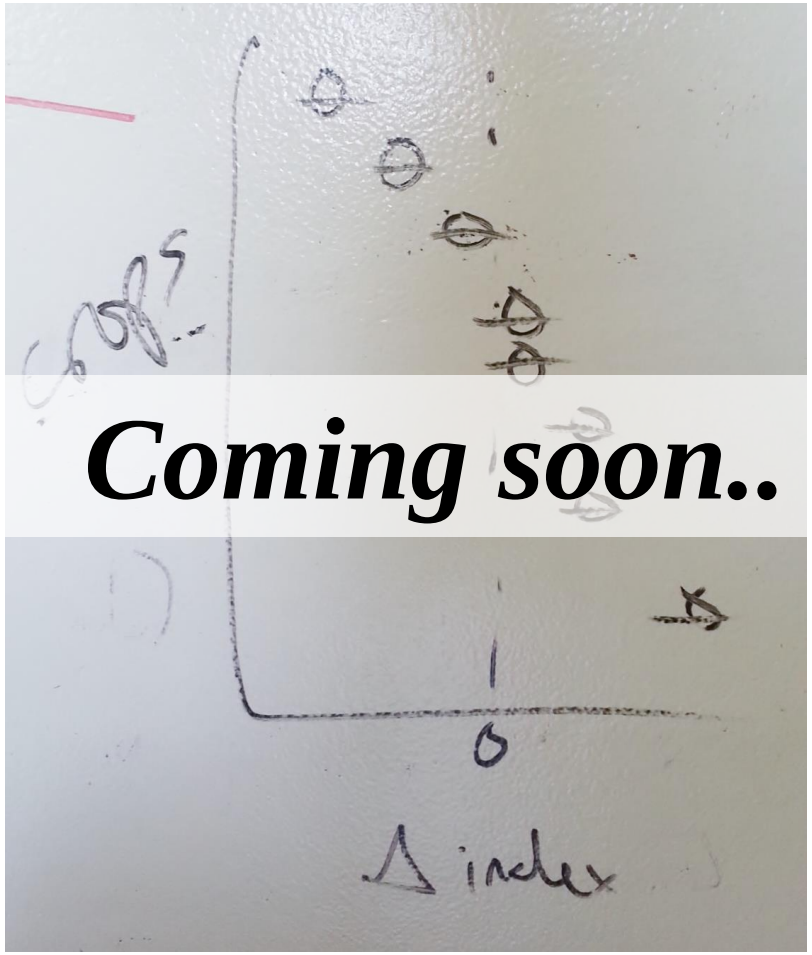
$$PD = \sum_{crop}^{n} (PD^{rate}{}_{n} * Crop_{area})$$

Changes of service-provision of pollinator at county level

Coming soon….



Changes of service-provision of pollinator at crop level

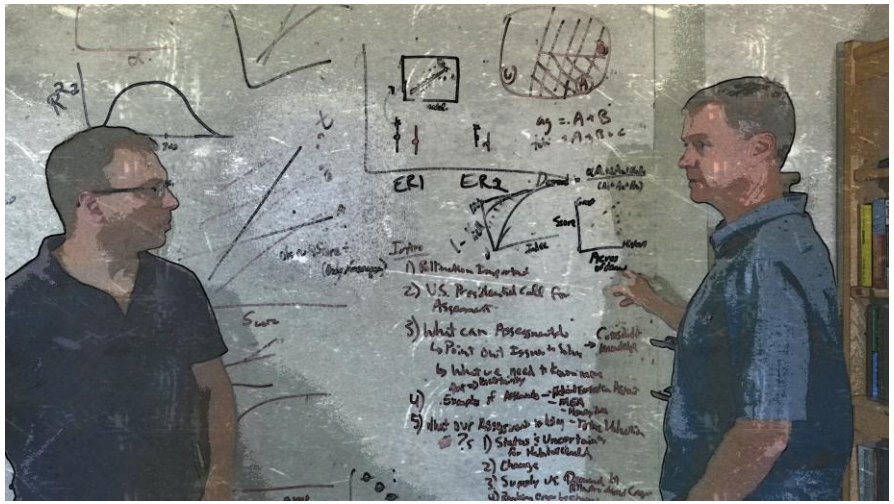


vs Uncertainty

To answer which crop has experienced the largest change in service-provision of pollinator at crop level.

Eric Lonsdorf

Taylor Ricketts



8/6/2014, Univ. Vermont

Further study

- At a national level
    - Finalizing our finding (e.g., what land-use changes caused supply shortage?)
    - Adding more validation data set across eco-regions to verify expert-informed priors
    - Suggesting conservation target.
- At a local landscape level
    - Specific parameterization for habitat suitability
    - Apply complex foraging function.

Acknowledgements

- The authors thank the 14 survey participants: Claire Brittain, James Cane, Jessa Cruz, Elaines Evans, Jason Gibbs, Kelly Gill, Jeremy Hemberger, Tina Harrison, Jennifer Hopwood, Mace Vaughan, Michael Veit, Cory Stanley-Stahr, Hillary Sardinas, and Neal Williams.
- Authors also thanks Hannah R. Gaines-Day, Claudio Gratton, Amber Sciligo, Hillary Sardinas, and Neal Williams for providing validation data set and also thanks Claire Kremen, Rachael Winfree, and Claudio Gratton who introduced us to several experts for the survey
- This research project is funded by the USDA-SCRI Program Integrated Crop Pollination grant (2012-01534).

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Thank you!