Predicting the spotted lanternfly dispersal in the United States

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NC STATE UNIVERSITY

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SAFARIS
Spatial Analytic Framework for Advanced Risk Information Systems

Outline

- Spatial Analytic Framework for Advanced Risk Information Systems
- Development of a stochastic spread model
- Case study on spotted lanternfly
- Summary

SAFARIS

Spatial Analytic Framework for Advanced Risk Information Systems

- **Funded by USDA APHIS PPQ Science & Technology**
- **SAFARIS is a framework that can rapidly integrate new data, models, and tools to support PPQ's mapping needs.**
- **Why framework?**
  - Data gathering and processing
  - Multiple models and tools
  - Multiple pests
  - Easier to collaborate

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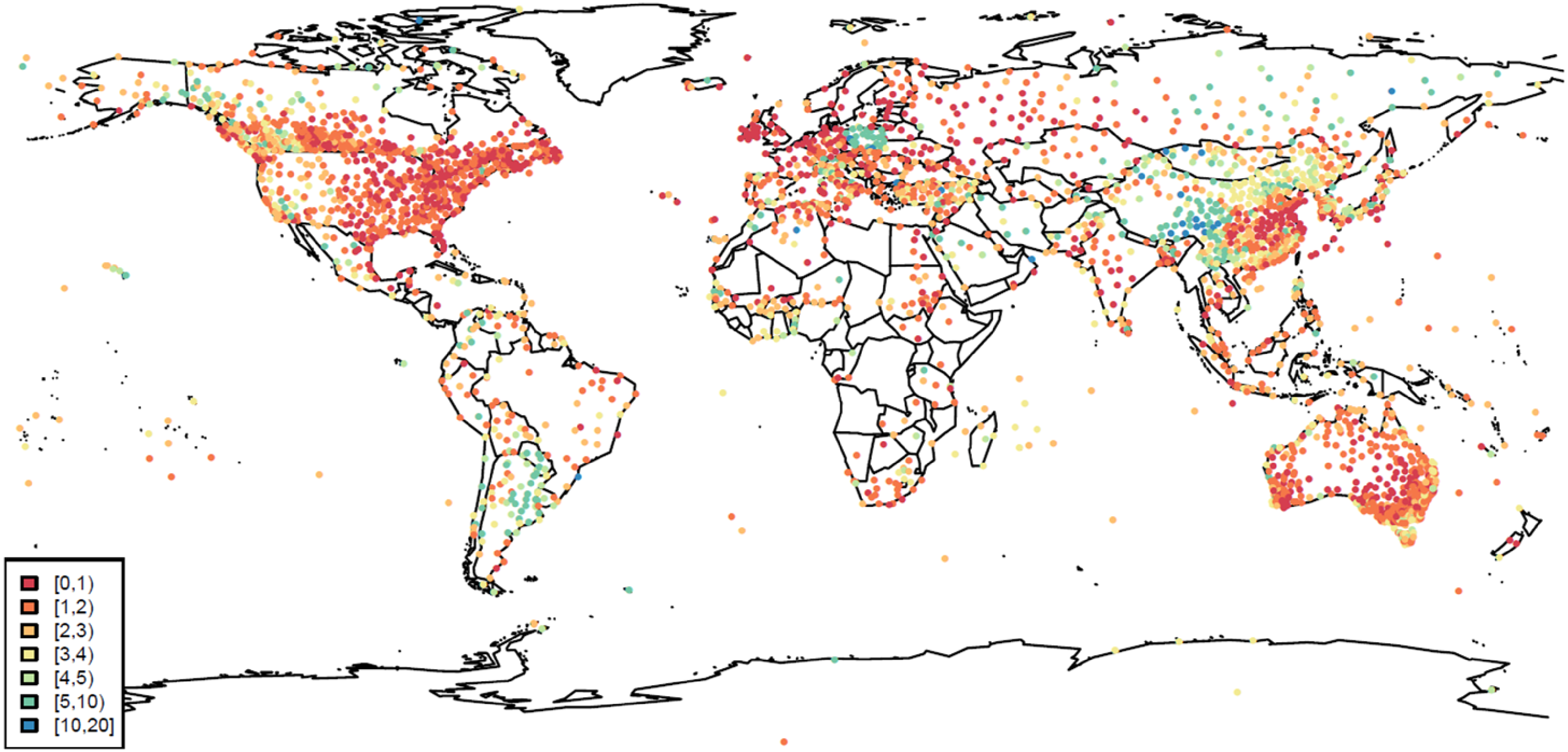
RMSE (°C) by Station: CFSR Max Temp from Month 1



SAFARIS Wind Rose Web Tool

Data is between **January 1st, 1980** and **December 31st, 2018**

Select A Windrose Timeline

Monthly Daily

Enter a Start Date:

01 / 01 / 1980

Enter a End Date:

12 / 31 / 2018

Enter a Station or Select from the map:

723060 Climatology

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Save Chart Download Data

Maximum Temperature

Grid Cell (38.59375, -121.46875)

Emissions continue to rise strongly through 2050 and plateau around 2100 (RCP 8.5)

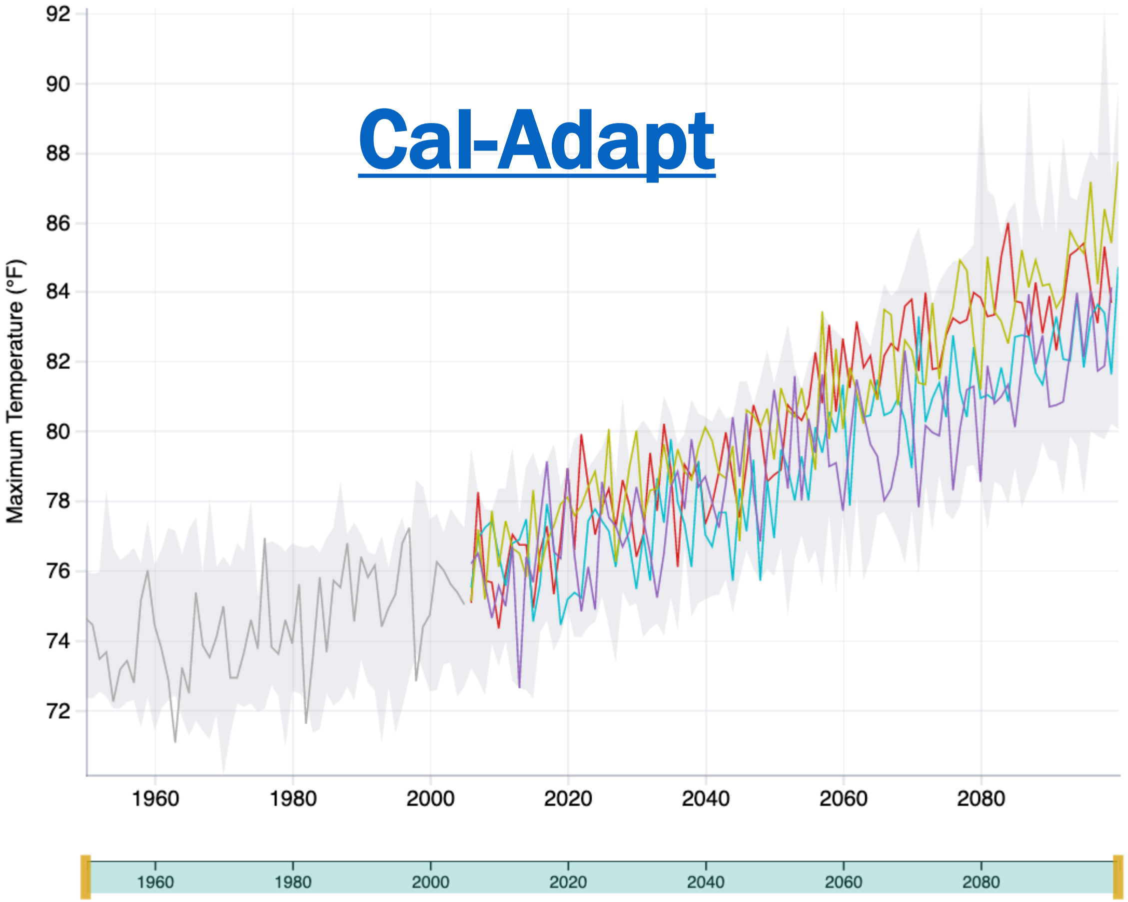
Range of annual average values from all 32 LOCA downscaled climate models

Modeled Variability Envelope

Observed Data (1950–2005)

Modeled Data (2006–2099)

- HadGEM2-ES
- CNRM-CM5
- CanESM2
- MIROC5



SCENARIOS

RCP 4.5
Emissions peak around 2040, then decline

RCP 8.5
Emissions continue to rise strongly through 2050 and plateau around 2100

QUICK STATS

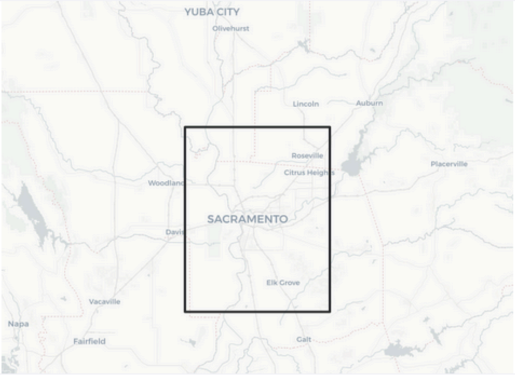
Historical Annual Mean for 1961–1990

74.2°F Observed

Modeled Projected Annual Mean for 2070–2099

82.7°F

Change Location



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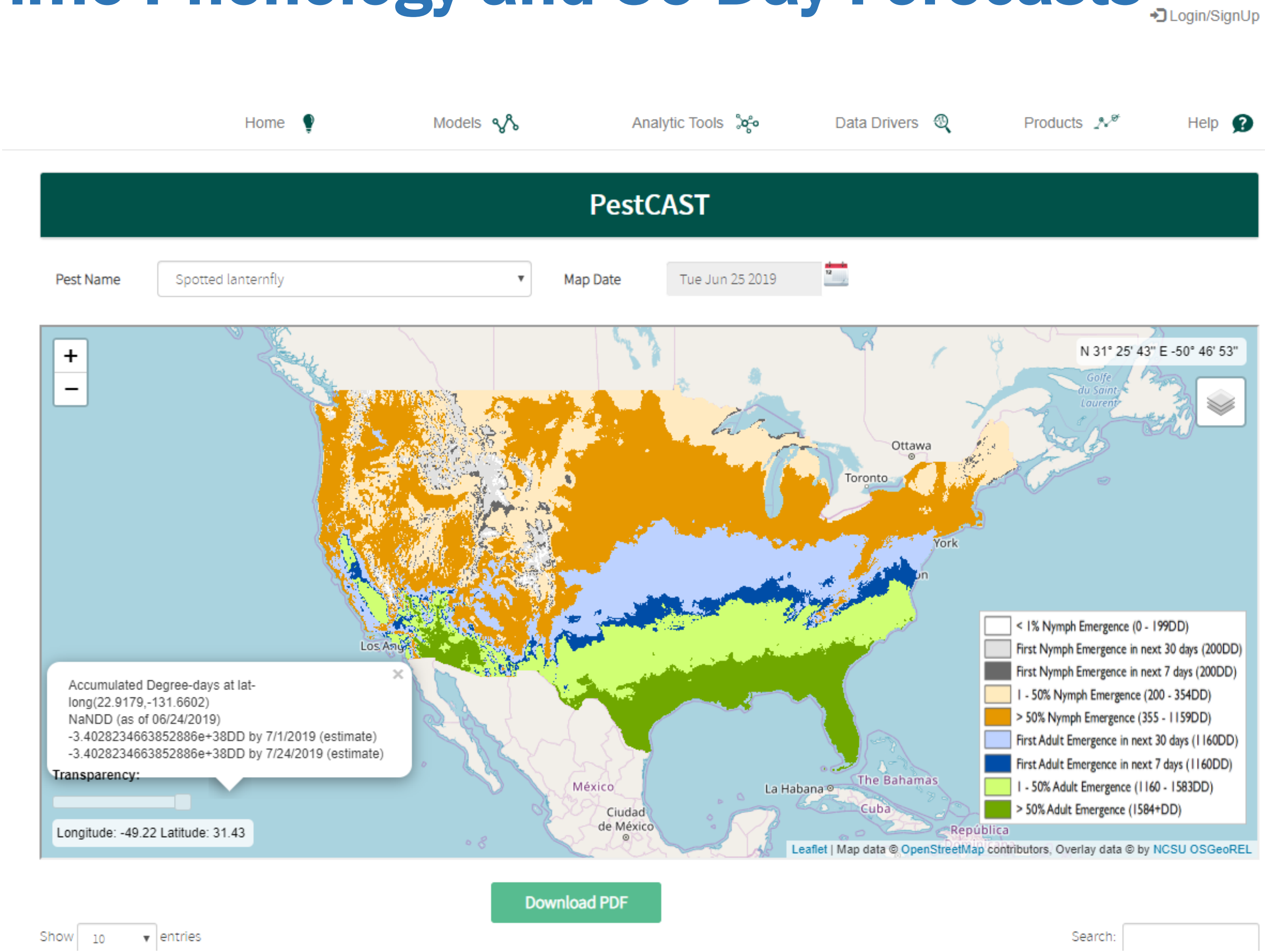
PestCAST: Near-Real Time Phenology and 30 Day Forecasts

- Connected to NOAA and other databases
- 7 day weather forecasts
- 20-year of historical data
- Web-based tool



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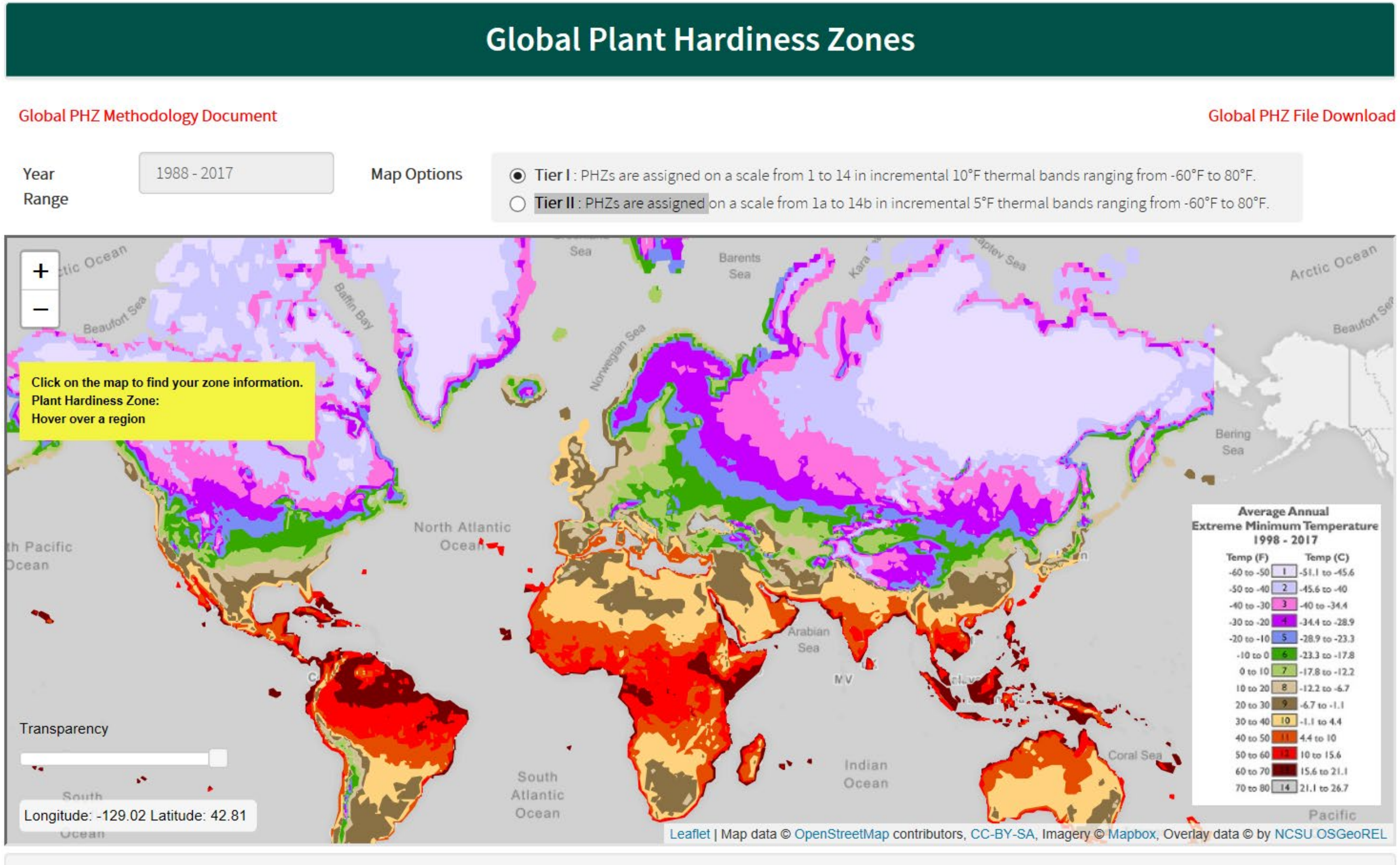
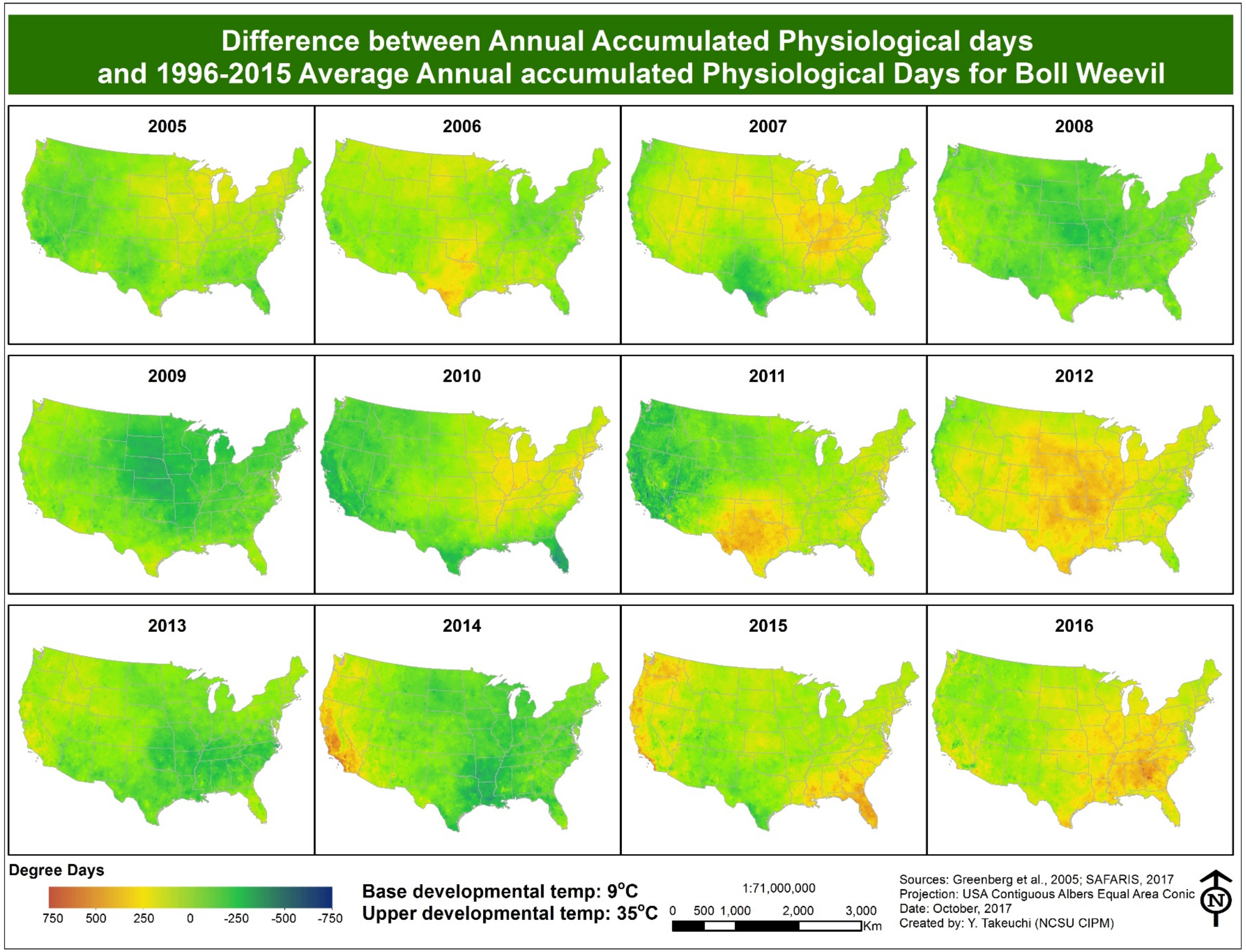
Plant Hardiness Zones



Annual Weather Variability



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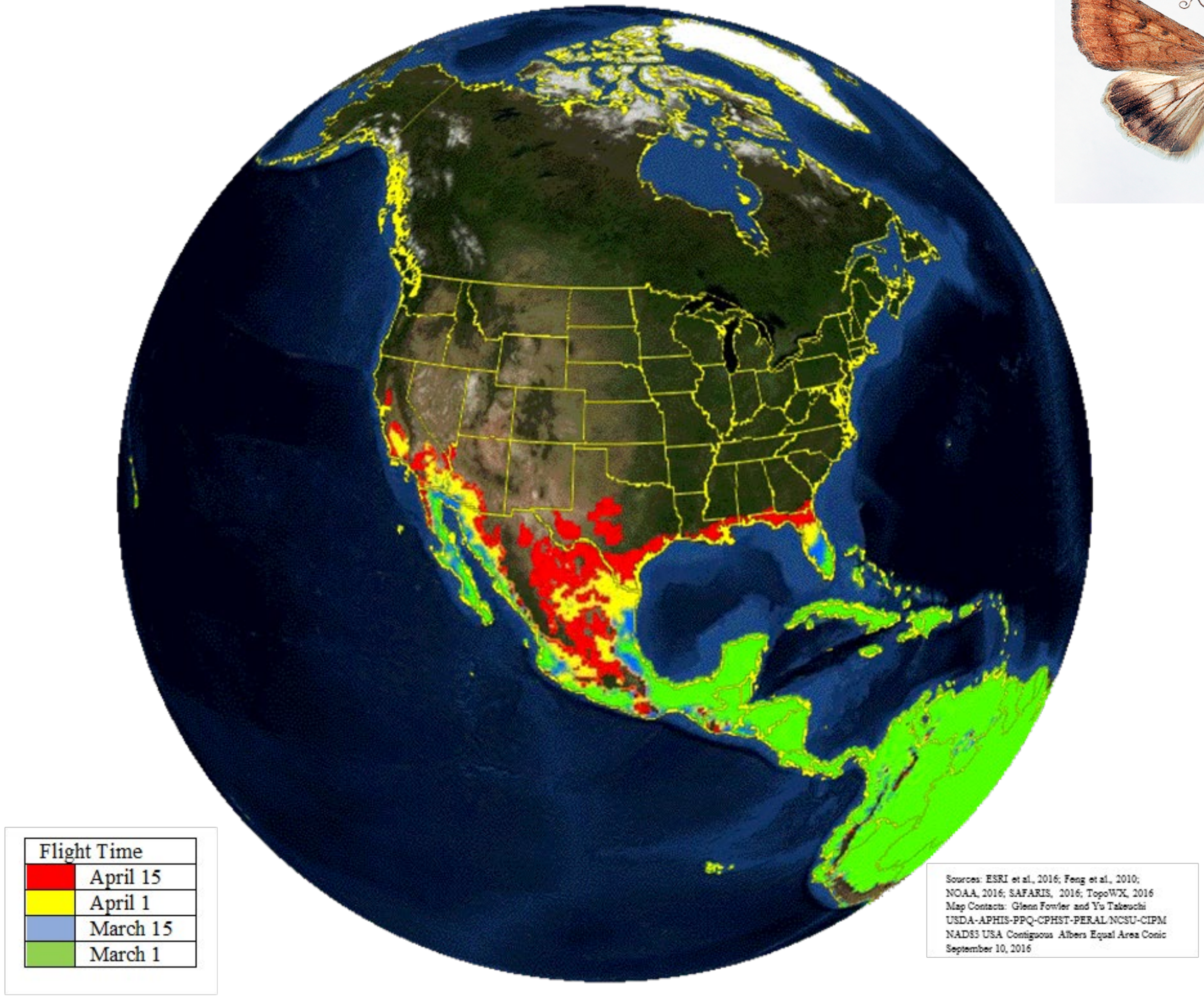
Predicted *Helicoverpa armigera*: Flight Times March 1 to April 15



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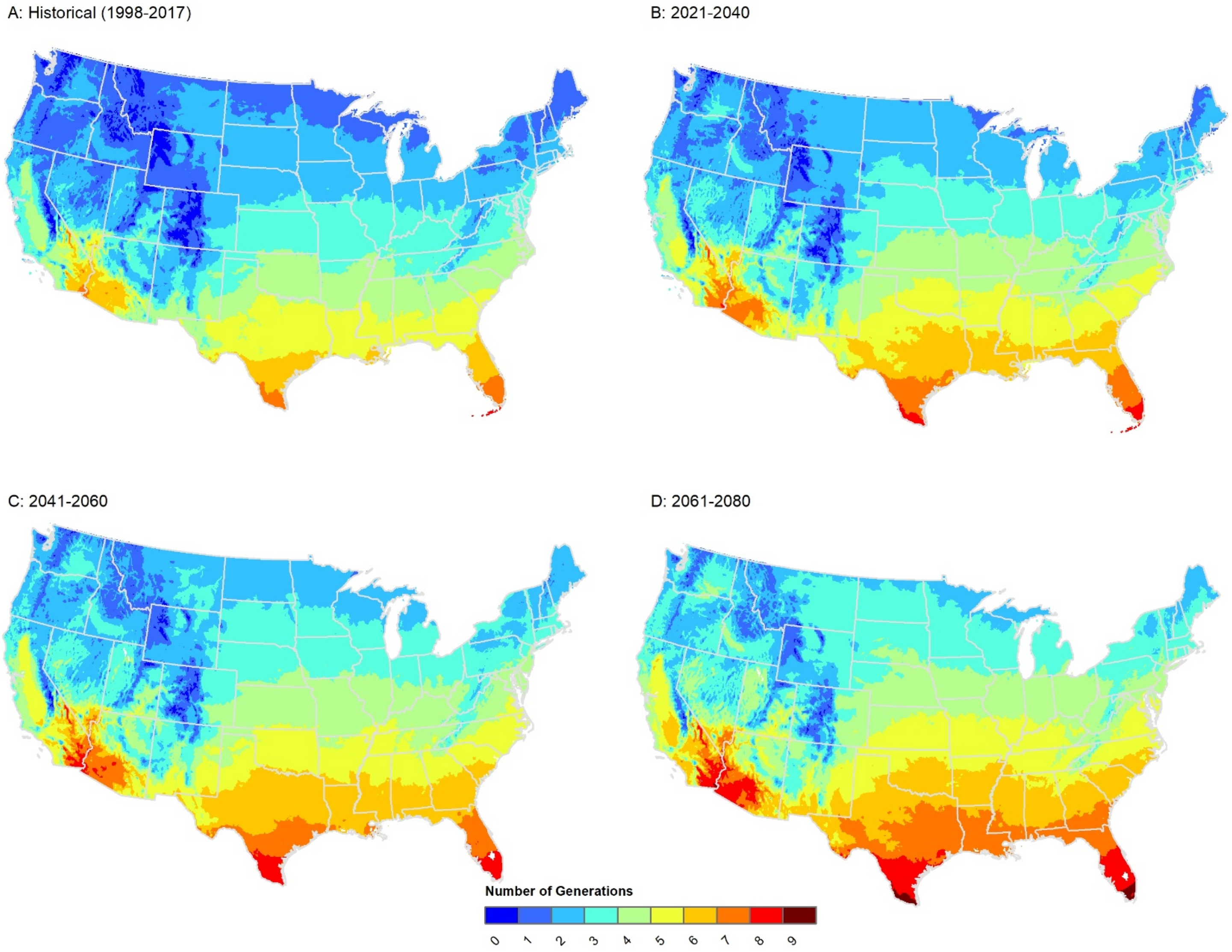
Long-term Forecast: Oriental Fruit Fly

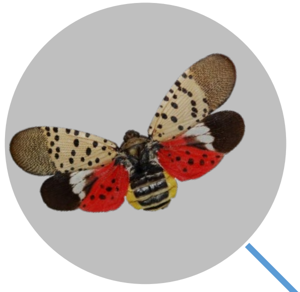
- 20 MACA downscaled GCMs
- RCP 8.5
- Southern US is expected to have 2-3 more generations in the future



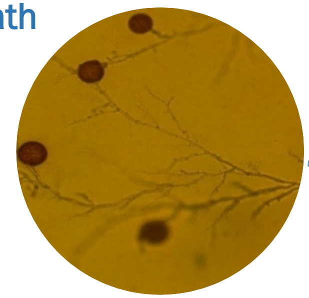
Development of a stochastic spread model

Model that could generalize to multiple pests/pathogens

Spotted Lanternfly



Sudden Oak Death



Future Pest/ Pathogen

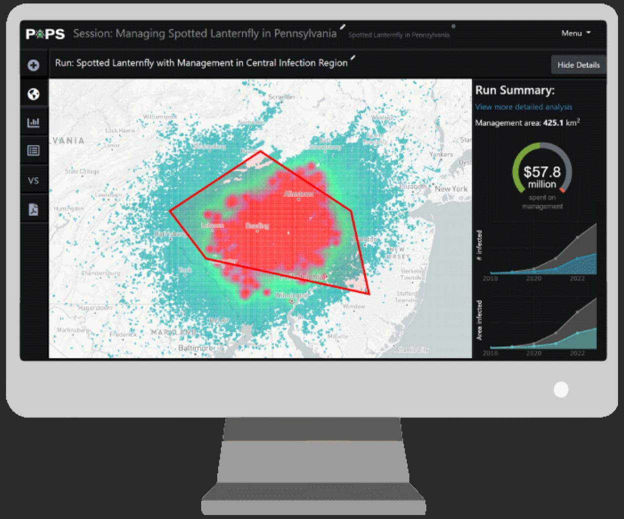
?

P●PS

a modeling framework to forecast any pest or pathogen

The **P●PS** tool suite includes:

- Data prep
- Calibration
- Validation
- Interactive Interface (In Development)



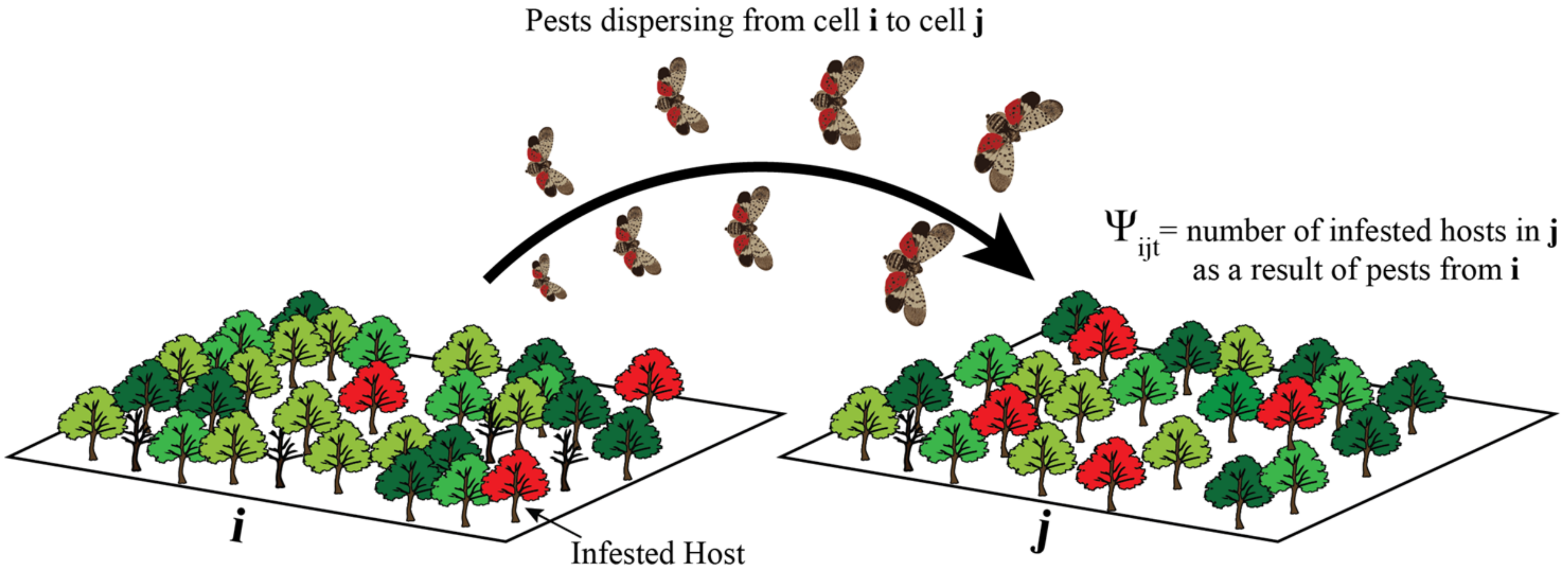
Installation instructions at popsmodel.org

Model

Number of pests moving from one location to another

Reproduction · Dispersal · Survival

$$\psi_{ijt} = \beta(X_{it}P_{it}T_{it}I_{it}) * K(d_{ij};\alpha_1,\alpha_2,\gamma)/d_{ij} * (X_{jt}P_{jt}T_{jt}S_{jt}/N_j)$$



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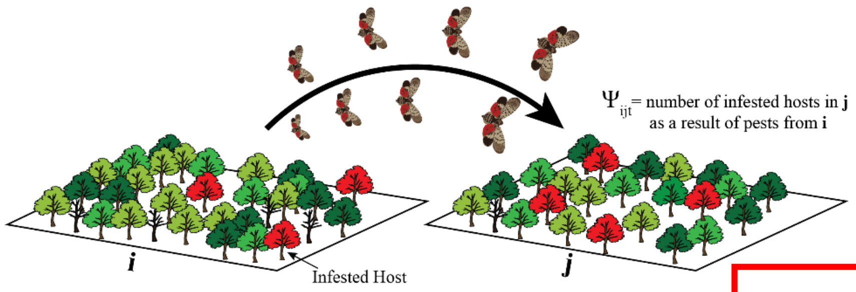
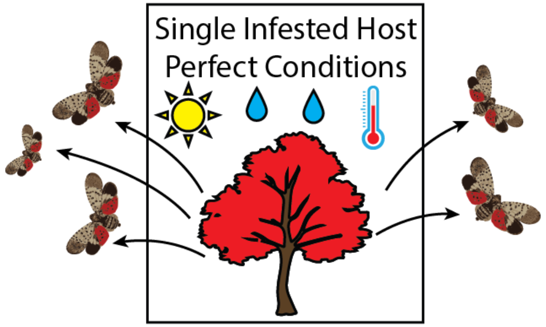
PoPS



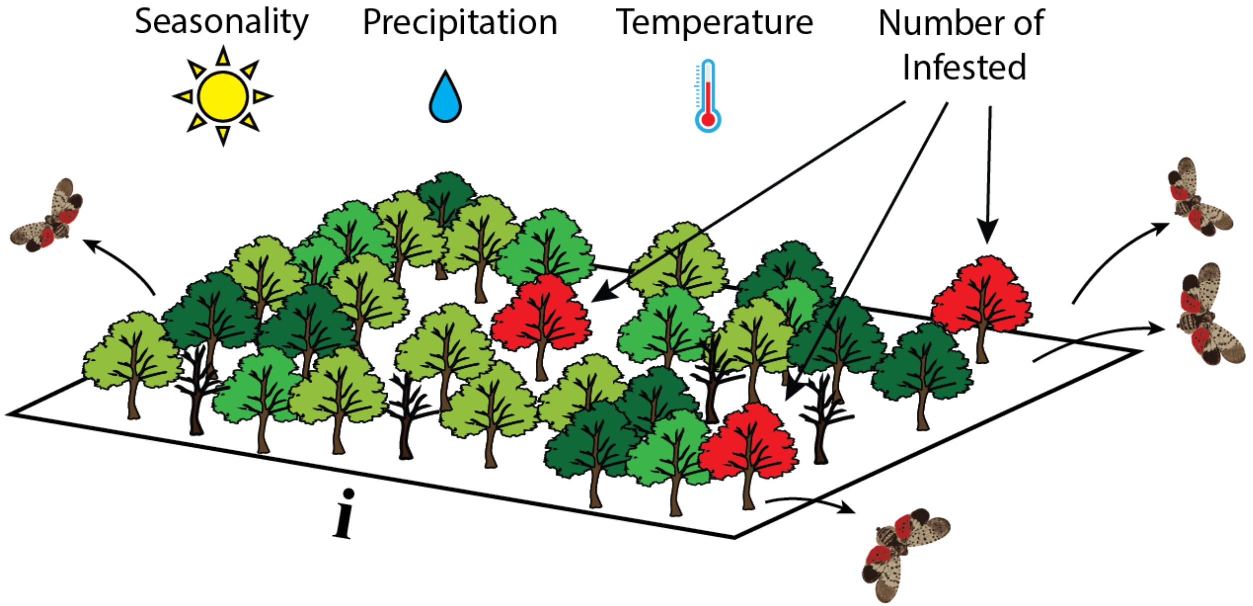
How many hosts in cell j are infested as a result of pests from cell i?

Reproduction	Dispersal	Survival

$$\psi_{ijt} = \beta(X_{it}P_{it}T_{it}I_{it}) * K(d_{ij};\alpha_1,\alpha_2,\gamma)/d_{ij} * (X_{jt}P_{jt}T_{jt}S_{jt}/N_j)$$



β = Number of Dispersing Pests



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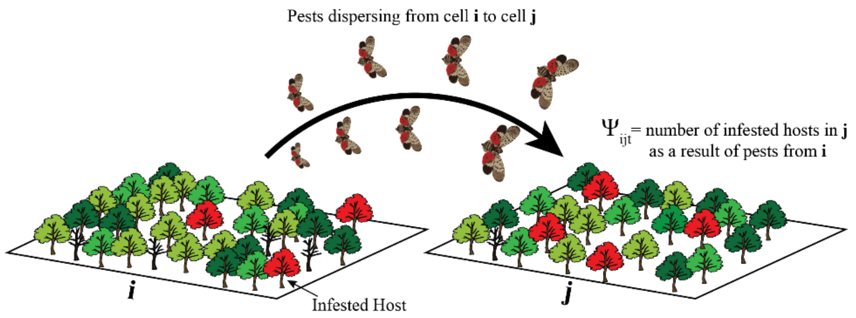
PoPS



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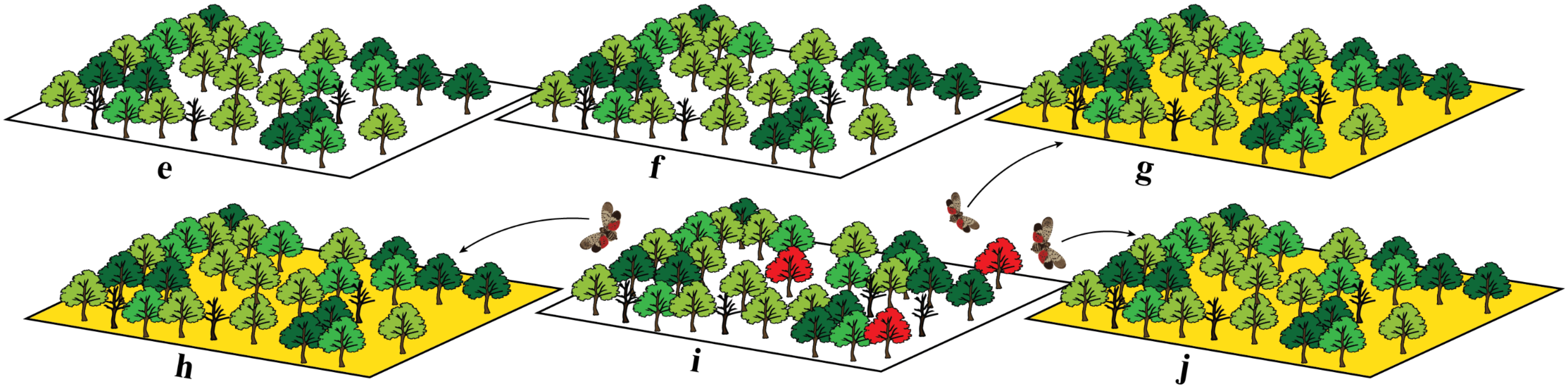
$$\psi_{ijt} = \beta(X_{it} P_{it} T_{it} I_{it}) * K(d_{ij}; \alpha_1, \alpha_2, \gamma)/d_{ij} * (X_{jt} P_{jt} T_{jt} S_{jt}/N_j)$$



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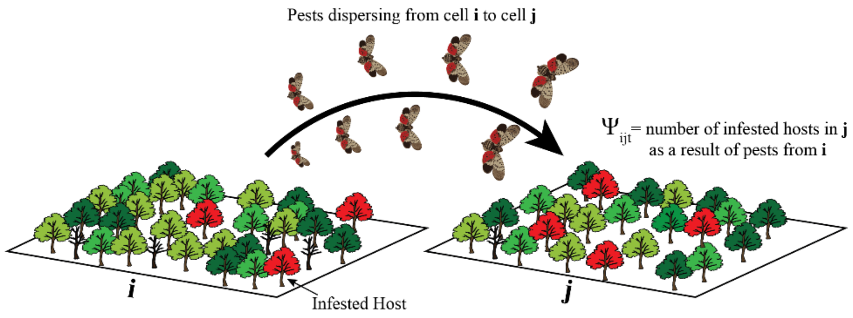
PoPS



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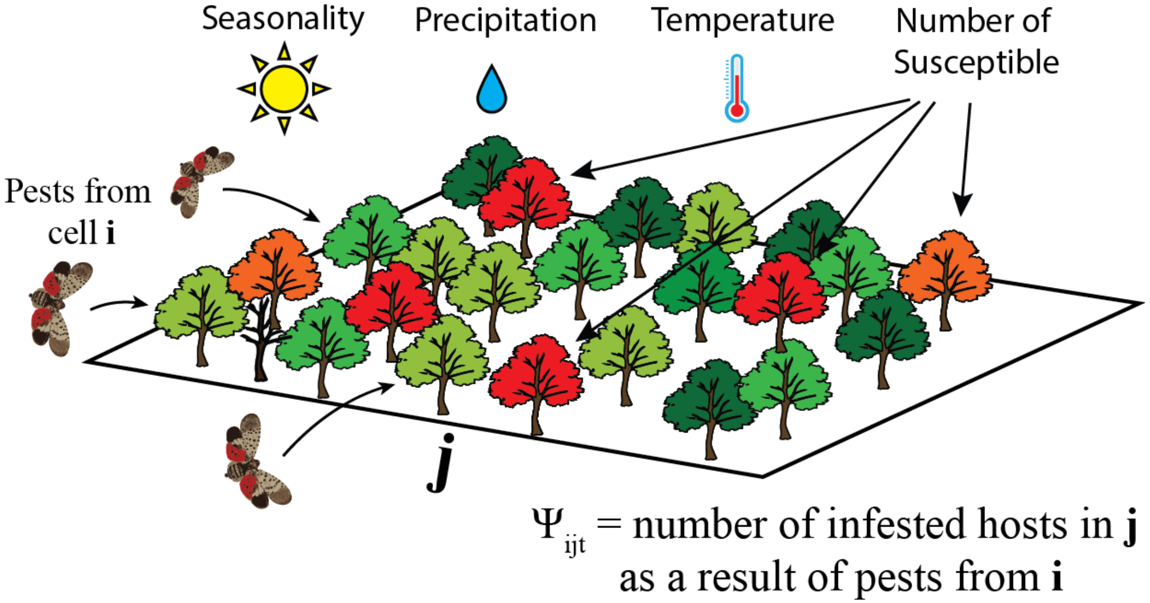
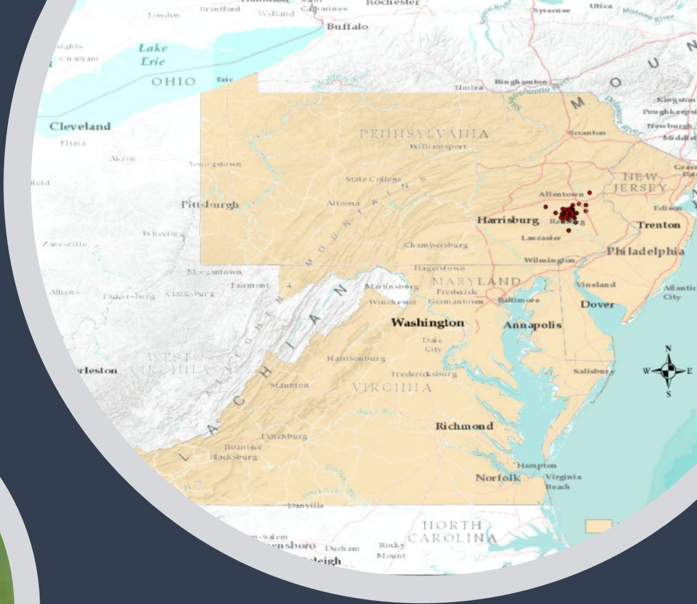
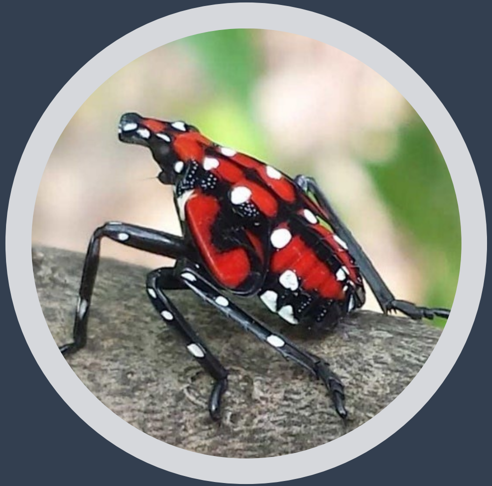


Spotted Lanternfly in Pennsylvania:



- Native range: China, Vietnam, India
- Discovered in PA in 2014
- 16 counties quarantined
- Has also been found in New Jersey, Delaware, Virginia, and Maryland.



Management effort by:

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pennsylvania DEPARTMENT OF AGRICULTURE

Sucks the sap out of branches and stems!

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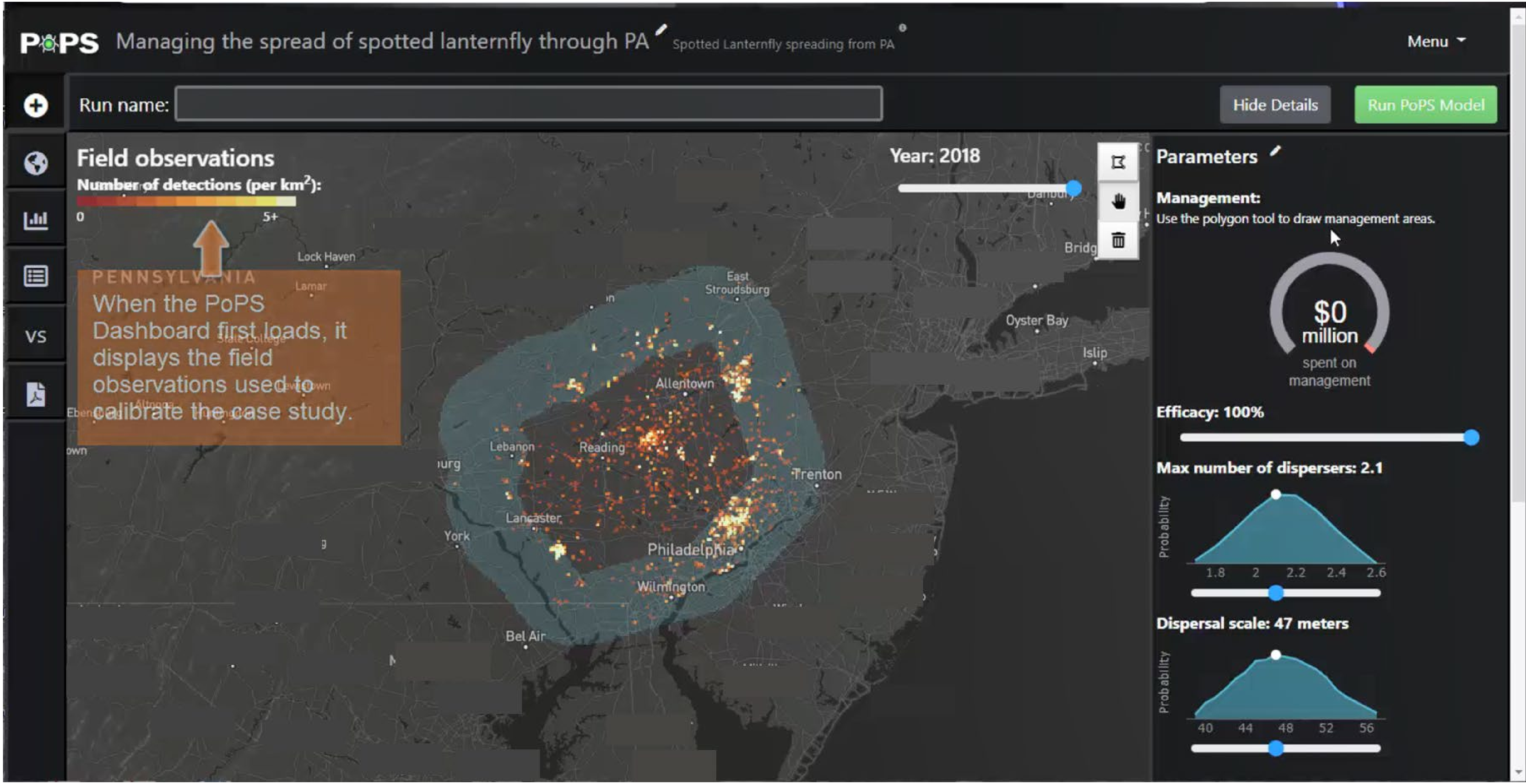
PoPS Dashboard

Parameter settings

- Years for model calibration
- Years for the model forecast
- Host information
- Weather data inputs
- Temperature requirements for SLF growth



PoPS
Managing the spread of spotted lanternfly through PA
Spotted Lanternfly spreading from PA
Menu
Run name:
Hide Details
Run PoPS Model
VS
Field observations
Number of detections (per km²):
0
5+
Year: 2018
When the PoPS Dashboard first loads, it displays the field observations used to calibrate the case study.
PENNSYLVANIA
Lock Haven
East Stroudsburg
Allentown
Reading
Lebanon
Lancaster
York
Philadelphia
Wilmington
Trenton
Bel Air
Oyster Bay
Islip
Parameters
Management:
Use the polygon tool to draw management areas.
$0 million
spent on management
Efficacy: 100%
Max number of dispersers: 2.1
Probability
1.8
2
2.2
2.4
2.6
Dispersal scale: 47 meters
Probability
40
44
48
52
56

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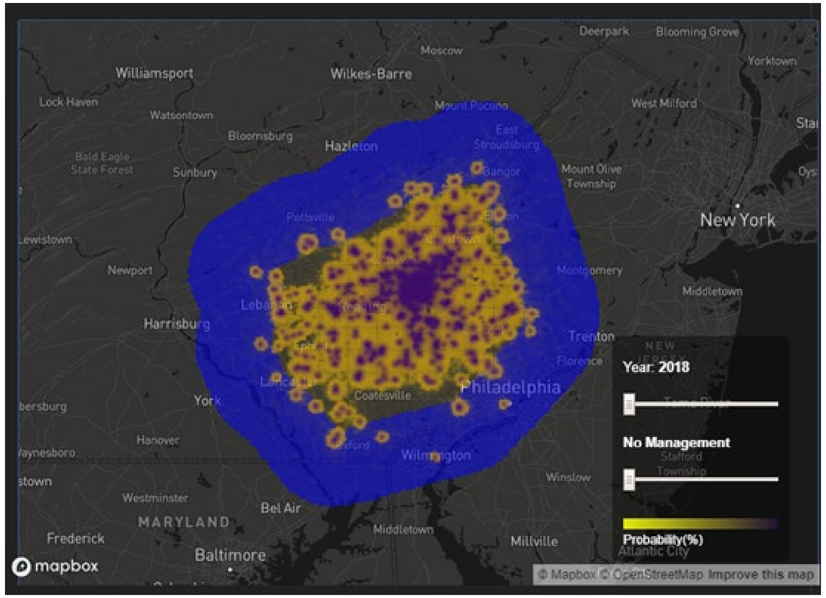
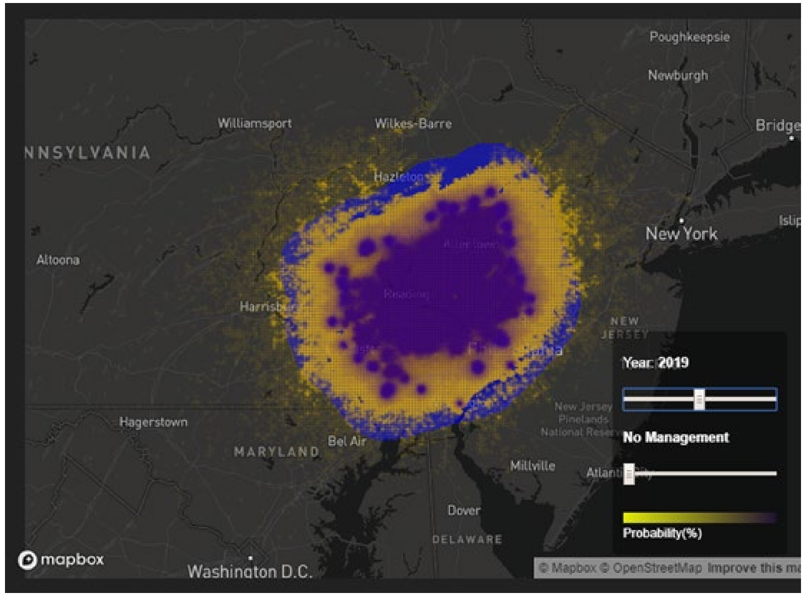
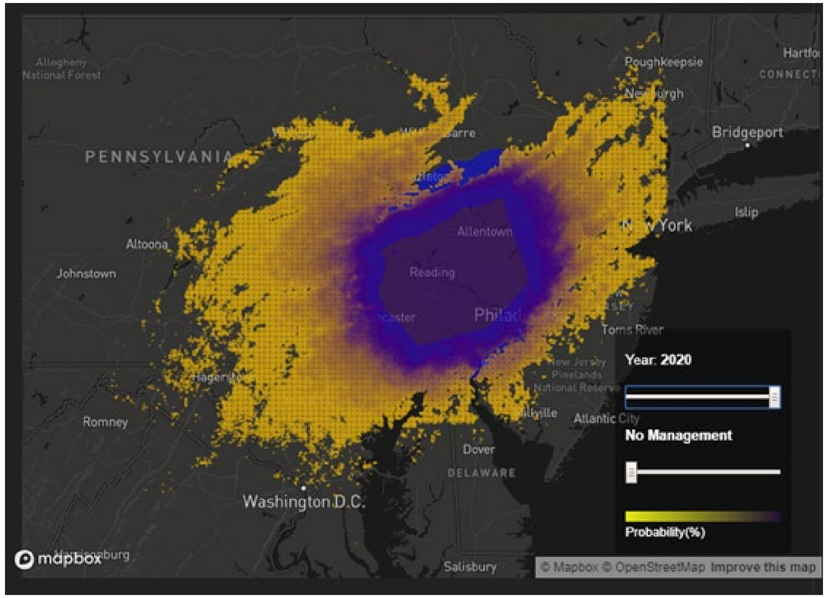
Spread Predictions



Prediction for 2018



Prediction for 2019



Prediction for 2020

Tangible Landscape

https://tangible-landscape.github.io/index.html

- Tangible freeform modeling
- Visualization
- Real-time geospatial analytics
- Participatory research

- 3D Topographic background (optional)
- Grass GIS & R
- Felt represents treatment

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POPS

PoPS – Tangible Landscape

- Real time simulation to forecast pest spread by implementing management strategies proposed on the Tangible Landscape
- Calculates economic damages and management costs
- Visualizes effectiveness of proposed management scenarios instantly
- We want to use forecasted weather data for the prediction instead of averaged weather data
- Making update on the dashboard to easily compare different scenarios

Summary and Conclusions

- The main objective SAFARIS is to create a framework to meet PPQ's predictive mapping and modeling needs with regard to informing surveys, operations and policy.
- Supporting PPQ's activities by developing new models and tools.
- Looking for new ideas to better predict pest activities at global scale in a timely manner.

Thank You

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