



United States Department of Agriculture

Animal and Plant Health Inspection Service

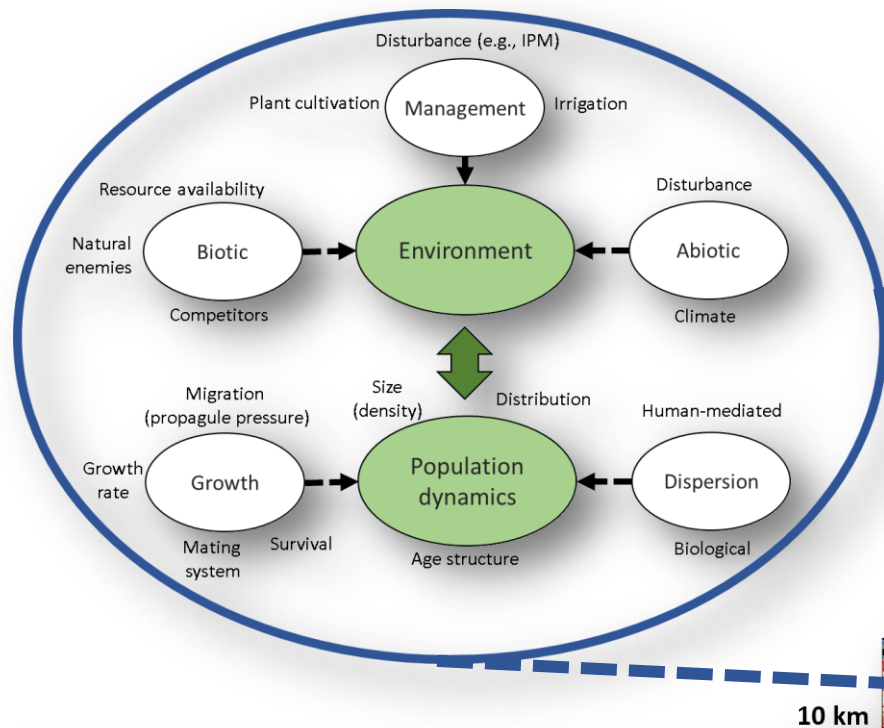
# Modelling potential introduction hotspots of exotic pests “under the radar”

Manuel Colunga

Plant Epidemiology & Risk Analysis Laboratory

Center for Plant Health Science & Technology

# Objective: to present an approach to model introduction\* hotspots of species under the radar



## Quarantine pests

- Not present in endangered area
- Of potential economic importance
- Present but not widely distributed and being officially controlled

## Species Under the Radar



Imported goods

## Entering a country undetected

- Novel pathways (new commodities, regions of origin)
- Logistics and supply chain change

10 km

10 km

# Case Study

Commodities  
associated to  
forest pests\*

From Canada,  
China, EU, and  
Mexico

Into the  
contiguous  
USA

In 2015

All transportation modes combined

Species  
Under the Radar



Photo: Chris Evans, University of Illinois, Bugwood.org

\*MINERAL PRODUCTS: Salt, sulfur, earth and stone, lime and cement plaster (HTS=25)

CERAMIC PRODUCTS: Ceramic products (HTS=69)

BASE METALS AND ARTICLES THEREOF: Iron and steel (HTS=72, 73); Copper (HTS=74); Aluminum (HTS=76); Tools, cutlery, etc. of base metal (HTS=82); Miscellaneous articles of base metal (HTS=83)

MACHINERY AND MECHANICAL APPLIANCES: Nuclear reactors, boilers, machinery etc. (HTS=84); Electric machinery, etc. (HTS=85)

# Model implementation

$$I = e \times H$$

- Transportation mode
- Country of origin
- Commodity type
- Year or month
- Volume

Country imports

State imports

10x10 km cell

Median household income

Commerce and Industry importers (No.)

Storage and warehousing area

Probability of entry

e

Forest canopy %

Host availability

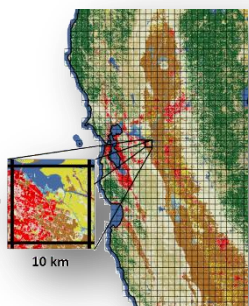
H

Introduction probability

I

Introduction hotspots

Hotspot analysis

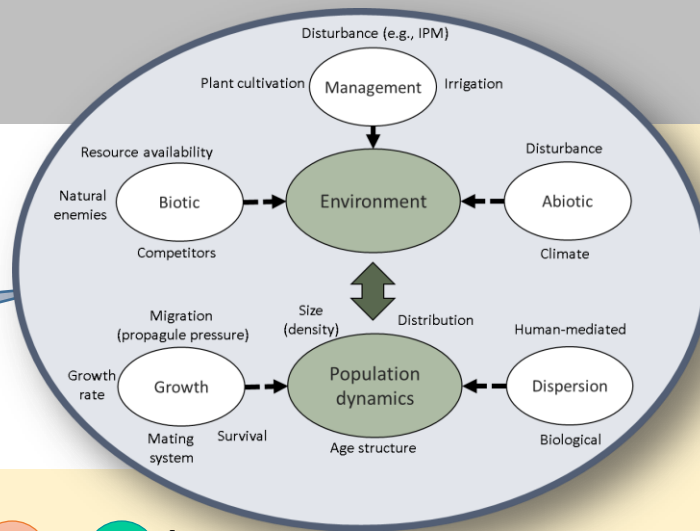


- Probability of entry to a cell is proportional to national imported volume of a commodity in a cell
- SUR assumption: Probability of entry nationwide is 1 (i.e.  $\sum \text{Cell probability of entry} = 1$ )

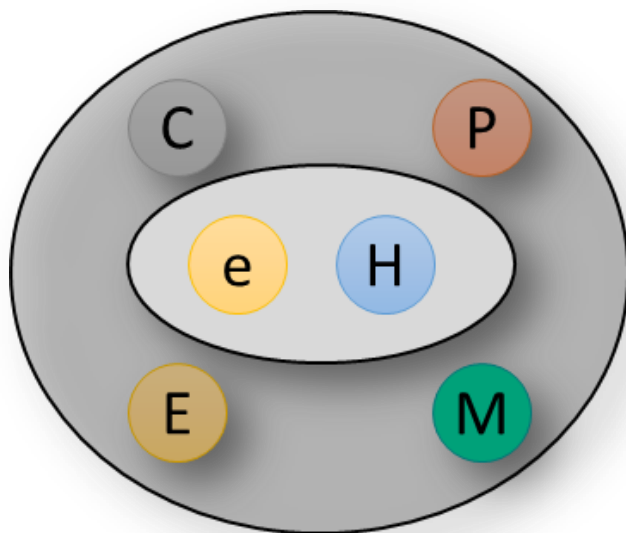
- Commodity at 2 or 4 digit HS
- Volume ~ TEU (Twenty-foot equivalent unit containers)
- Hotspot analysis (Getis-Ord  $G_i^*$  statistic)



# Getting technical



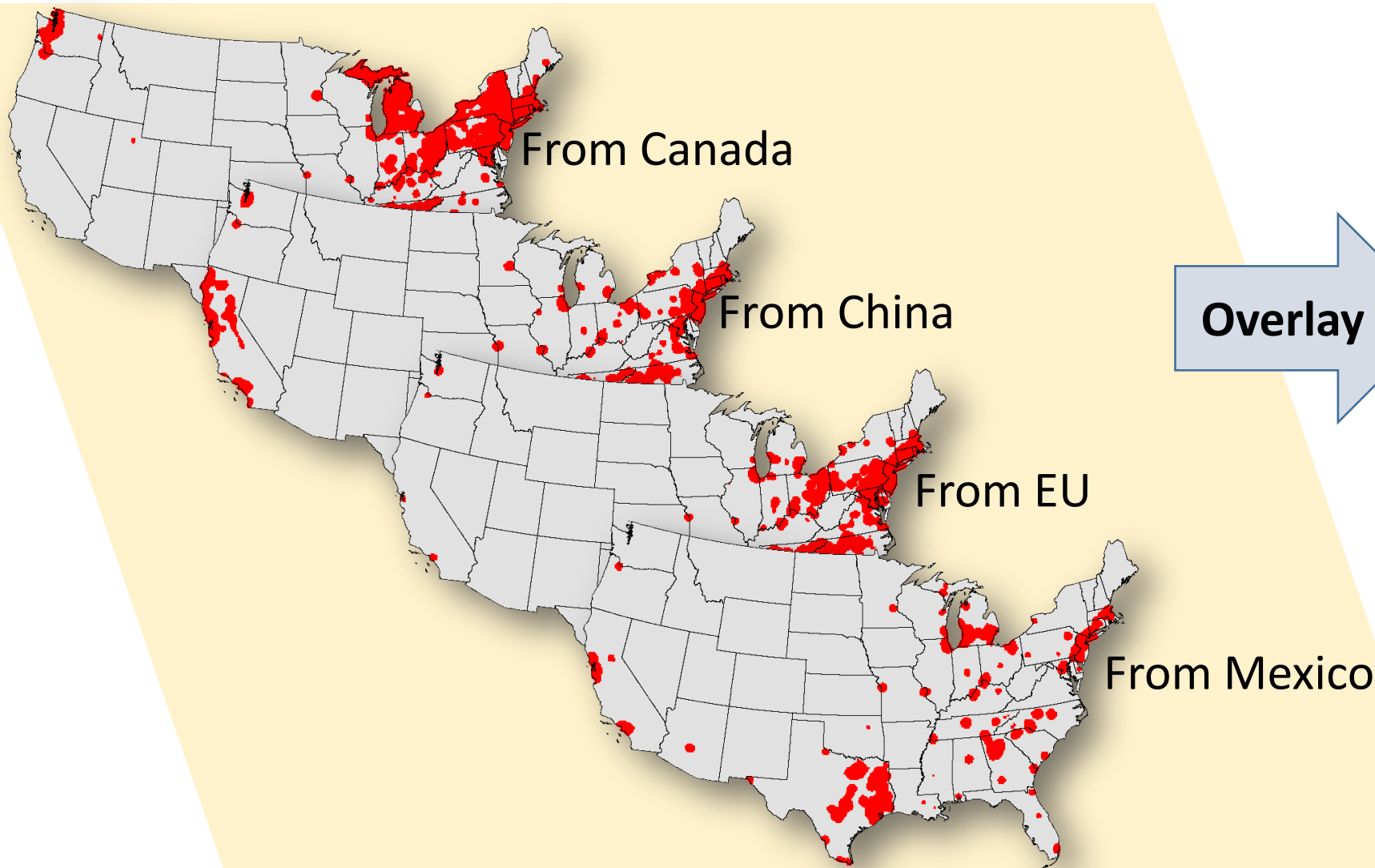
$$I = f(E, e, H, C, P, M)$$



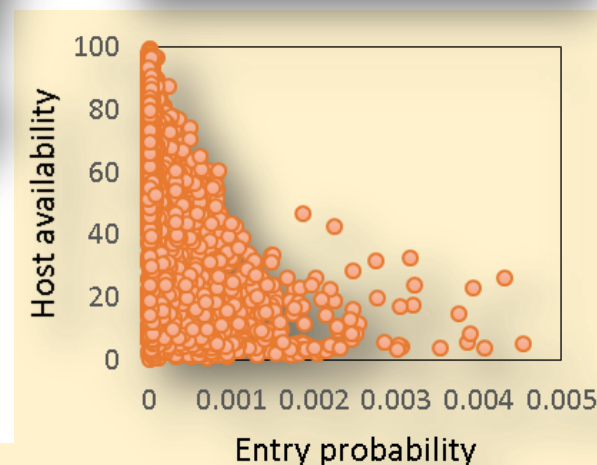
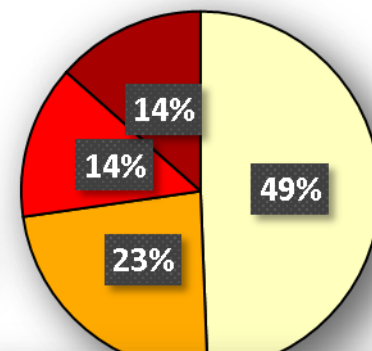
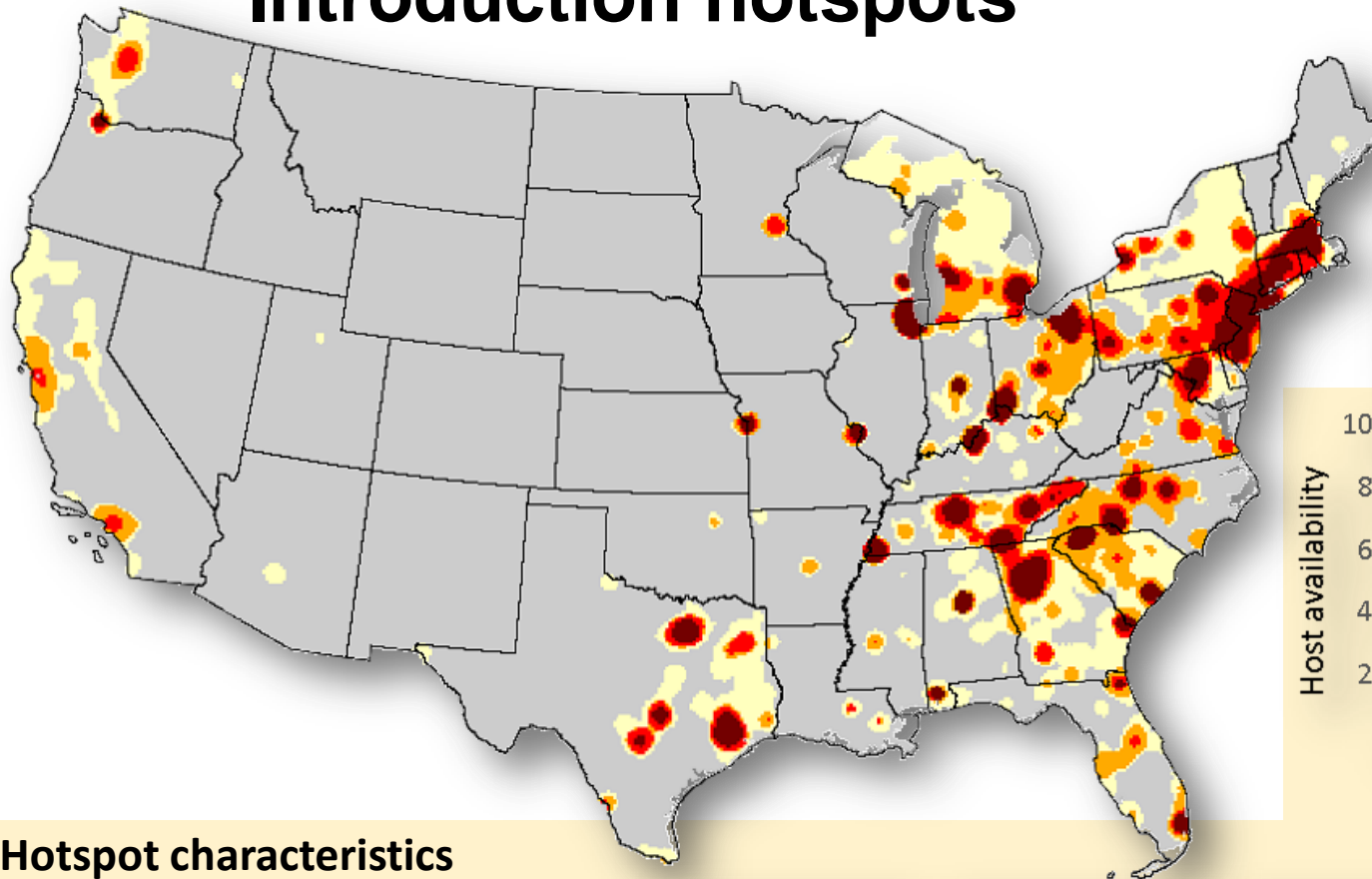
E, C, P, and M are analyzed after obtaining the introduction hotspots

- ul>
- I Likelihood of Introduction
- E Entry probability (Country)
- e Entry probability (cell)
- H Host availability
- C Climate suitability
- P Optimum propagule pressure
- M Management

# Introduction hotspots



# Introduction hotspots



## Hotspot characteristics

Origin region

**Canada**

**China**

**EU**

**Mexico**

Share (%) of total host in the country

• 19.7

• 17.6

• 18.9

• 9.0

Cumulative probability of entry

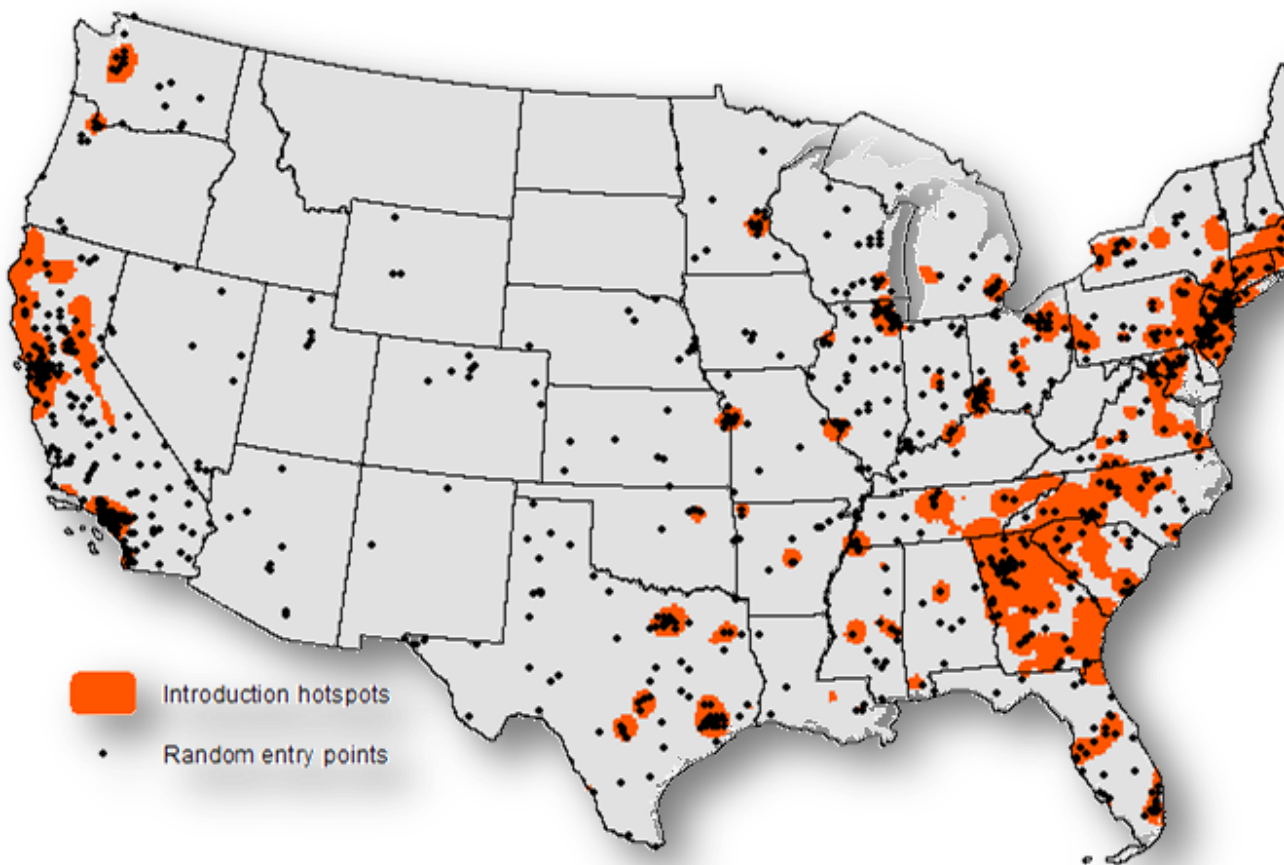
• 0.67

• 0.61

• 0.64

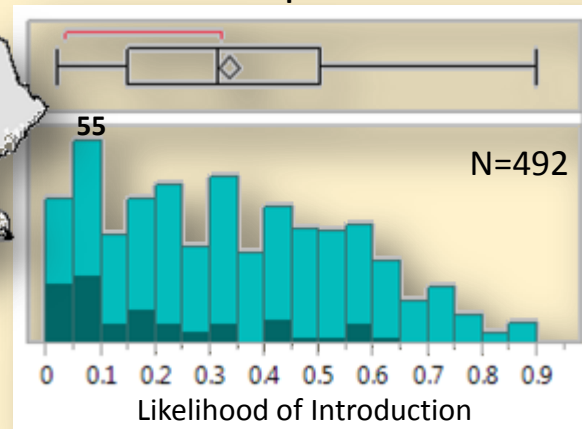
• 0.54

# Simulation

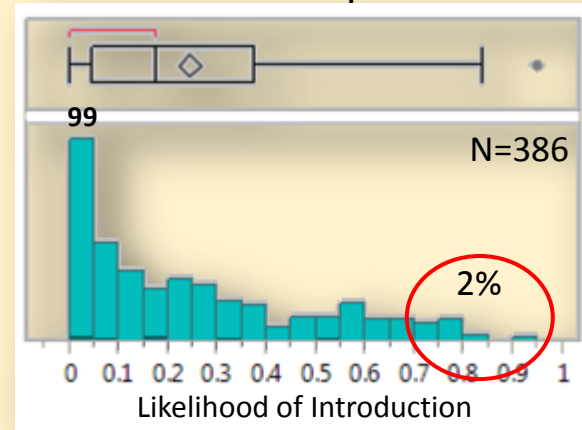


Introduction = entry x host availability

## Hotspots



## Non-hotspots



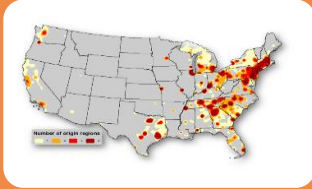
Repeated entry

Origin: China  
Year: 2015

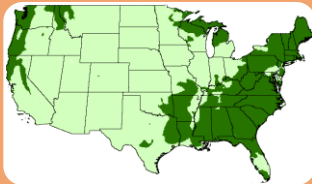
1000 random entry points using cell probability of entry



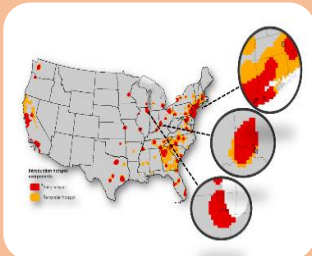
# Conclusions



The task of determining potential introduction areas for species under the radar using the above model appears promising.



Model showed potential to assist in the management of species under the radar (portfolio diversification?)



Need to develop an strategy for model validation



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END

