Evaluating the economic costs and benefits of slowing the spread of the emerald ash borer in Ohio and Michigan.

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Collaborators
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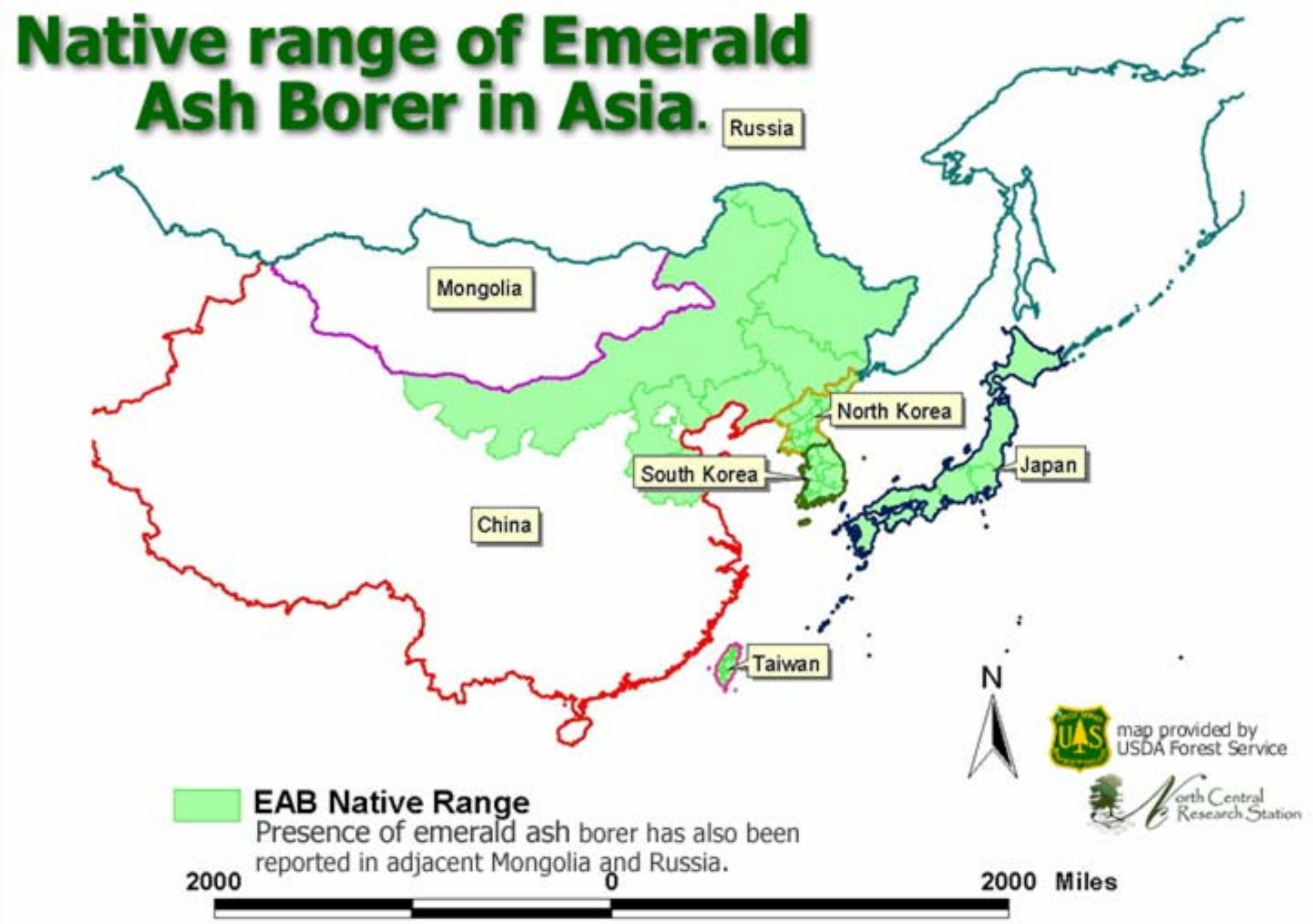
Davis Sydnor – The Ohio State University
Patrick Lawrence – University of Toledo

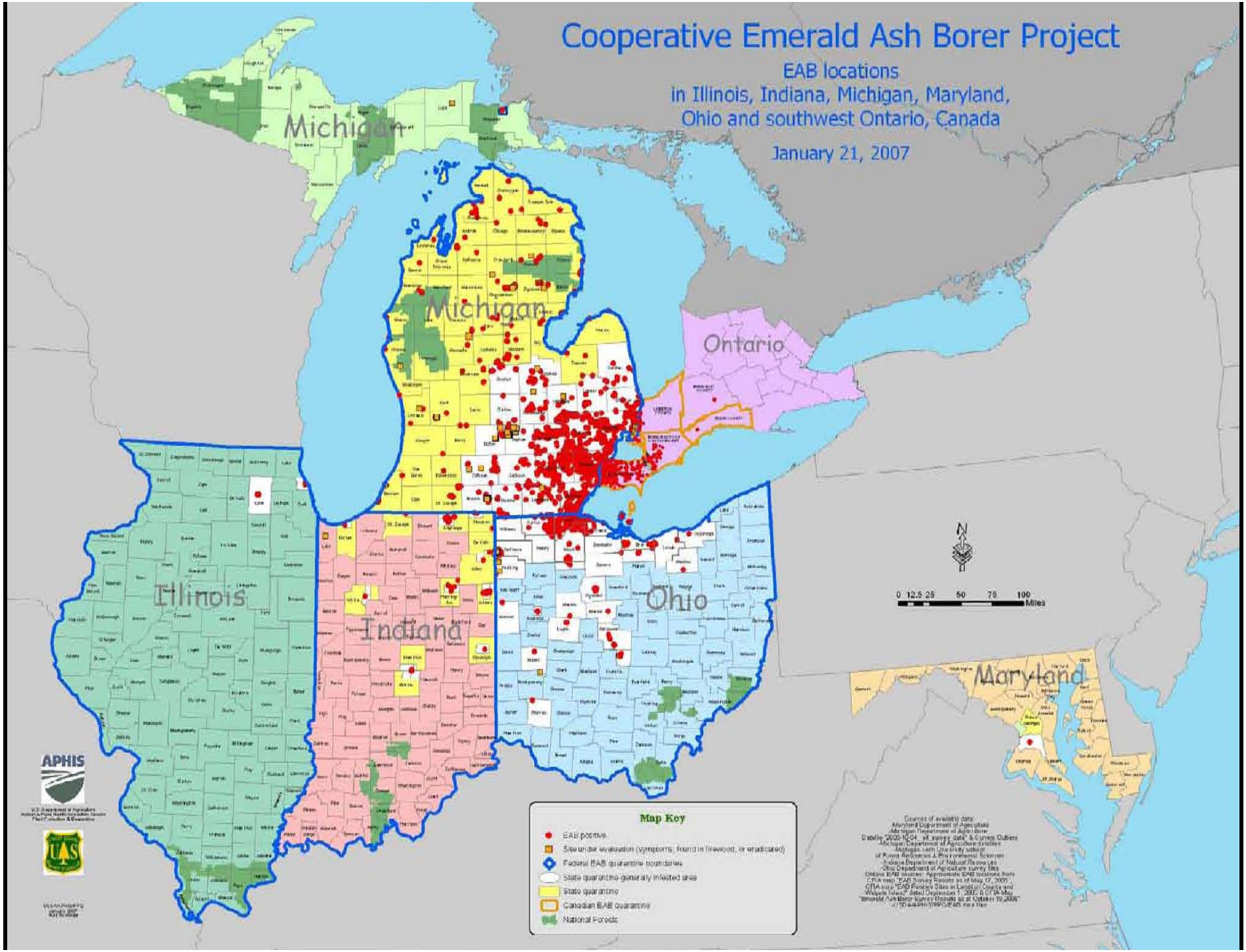
Outline

- Background on the emerald ash borer.
- Research program


Native range of Emerald Ash Borer in Asia.
Russia
Mongolia
China
North Korea
South Korea
Japan
Taiwan
N
map provided by USDA Forest Service
North Central Research Station
EAB Native Range
Presence of emerald ash borer has also been reported in adjacent Mongolia and Russia.
2000
0
2000 Miles

How did EAB arrive in North America?

- Arrived in solid wood packing material from Asia 10 -12 years ago.
- First detected in Detroit/Windsor area in July 2002.


Cooperative Emerald Ash Borer Project
EAB locations
in Illinois, Indiana, Michigan, Maryland,
Ohio and southwest Ontario, Canada
January 21, 2007
Michigan
Michigan
Ontario
Illinois
Indiana
Ohio
Maryland
N
0 12.5 25 50 75 100
Miles
APHIS
Map Key
EAB positive
Site under evaluation (symptoms, found in firewood, or eradicated)
Federal EAB quarantine boundaries
State quarantine-generally infested area
State quarantine
Canadian EAB quarantine
National Forests

Impacts

Millions of ash trees in suburban Detroit have been killed by the emerald ash borer.

Outline

- Background on the emerald ash borer.
- Research program

Evaluating the economic costs and benefits of slowing the spread of the emerald ash borer in Ohio and Michigan

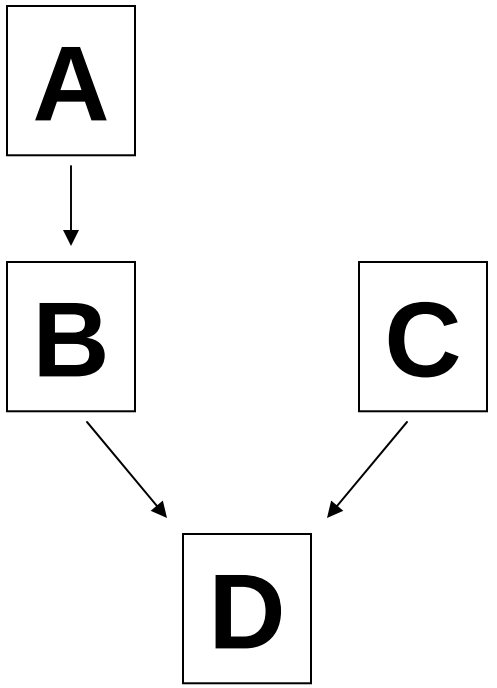
- **Objectives:**
  - **1) to provide estimates of the regional economic impact emerald ash borer will potentially inflict upon the ash forestry in Ohio and Michigan;**
  - **2) to provide policy-makers with quantitative guidance for cost-effective alternative strategies to control, prevent, or slow the spread of emerald ash borer.**

Objective 1: estimate regional economic impact emerald ash borer.

- *Estimate the current distribution of ash trees and emerald ash borer*
- *Predict the spread of emerald ash borer*
- *Estimate value of ash in spatially explicit manner*
- *Determine the regional economic consequences of emerald ash borer spread through the development of a CGE model*

Objective 1: to provide estimates of the regional economic impact of an invasive species.

- *Estimate the potential habitat - A*
- *Predict the spread - B*
- *Estimate economic impact in a spatially explicit manner - C*
- *Determine the regional economic consequences of spread through the economy - D*



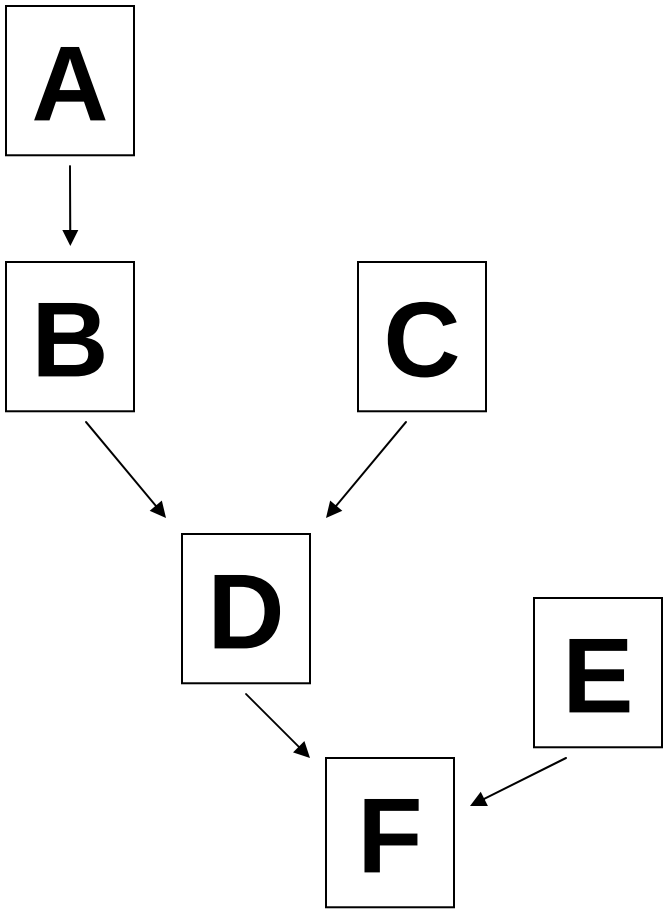
Objective 2: to provide policy-makers with quantitative guidance for cost-effective alternative strategies to control, prevent, or slow the spread of an invasive species.

- *Determine cost and effectiveness of different prevention and control strategies - E*

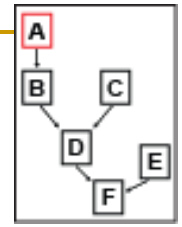
- *Integrate habitat, spread, economics and management using Stochastic Dynamic Programming - F*

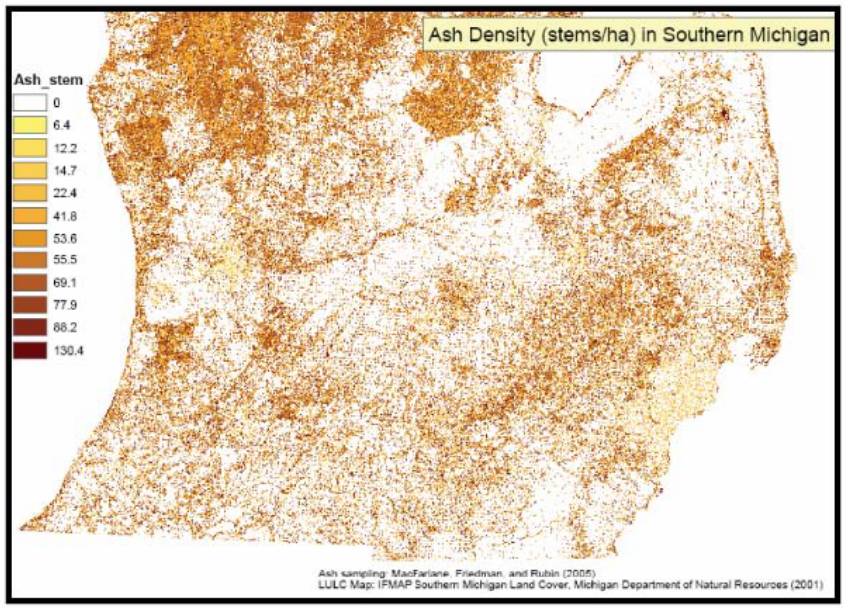
Objective 2: to provide policy-makers with quantitative guidance for cost-effective alternative strategies to control, prevent, or slow the spread of an invasive species.

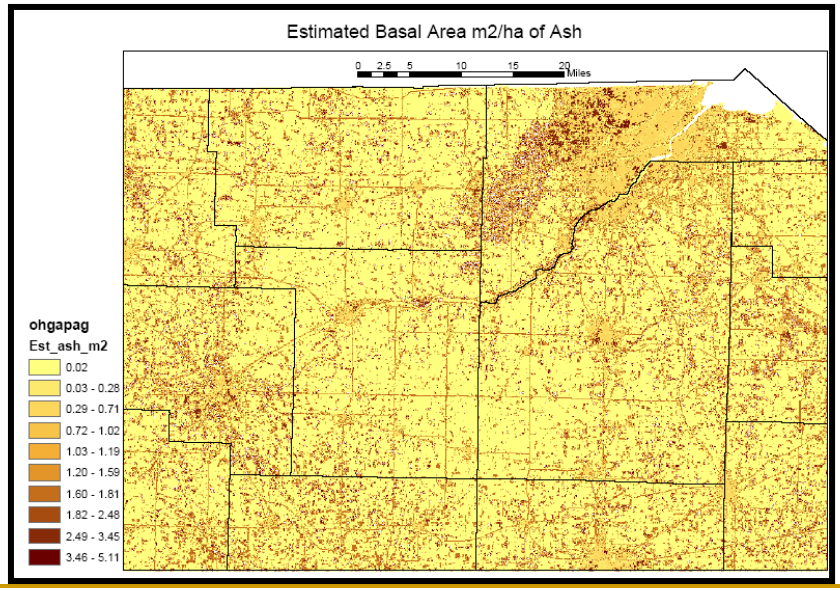
- *Determine cost and effectiveness of different prevention and control strategies - E*
- *Integrate habitat, spread, economics and management using Stochastic Dynamic Programming - F*



Estimate the current distribution of ash trees and emerald ash borer





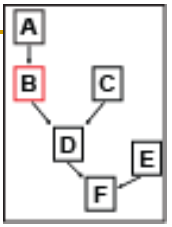


From Dr. Louis Iverson and Anatha Prasad - USFS

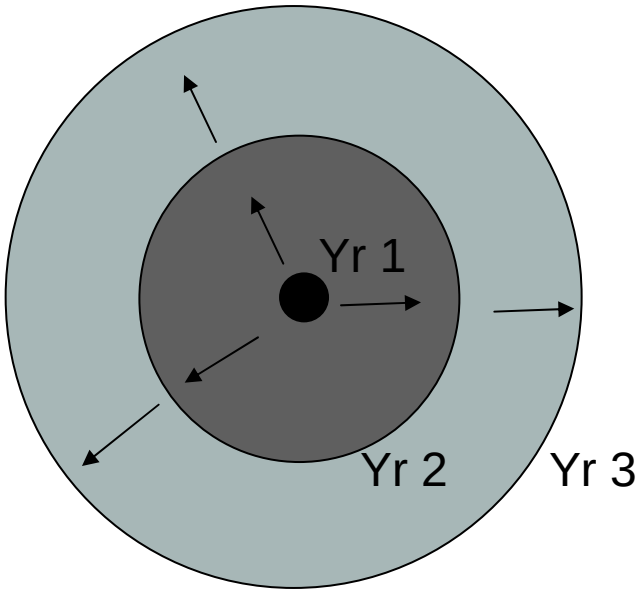
Predict the spread of emerald ash borer

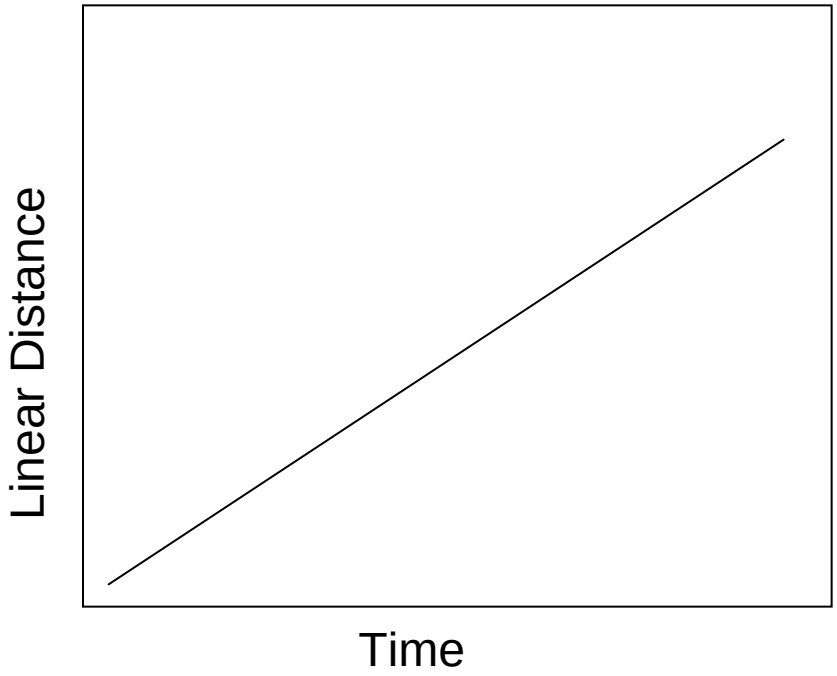
- Natural Dispersal
- Human-mediated dispersal

Modeling Dispersal

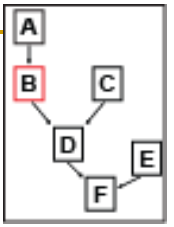


- Natural Spread

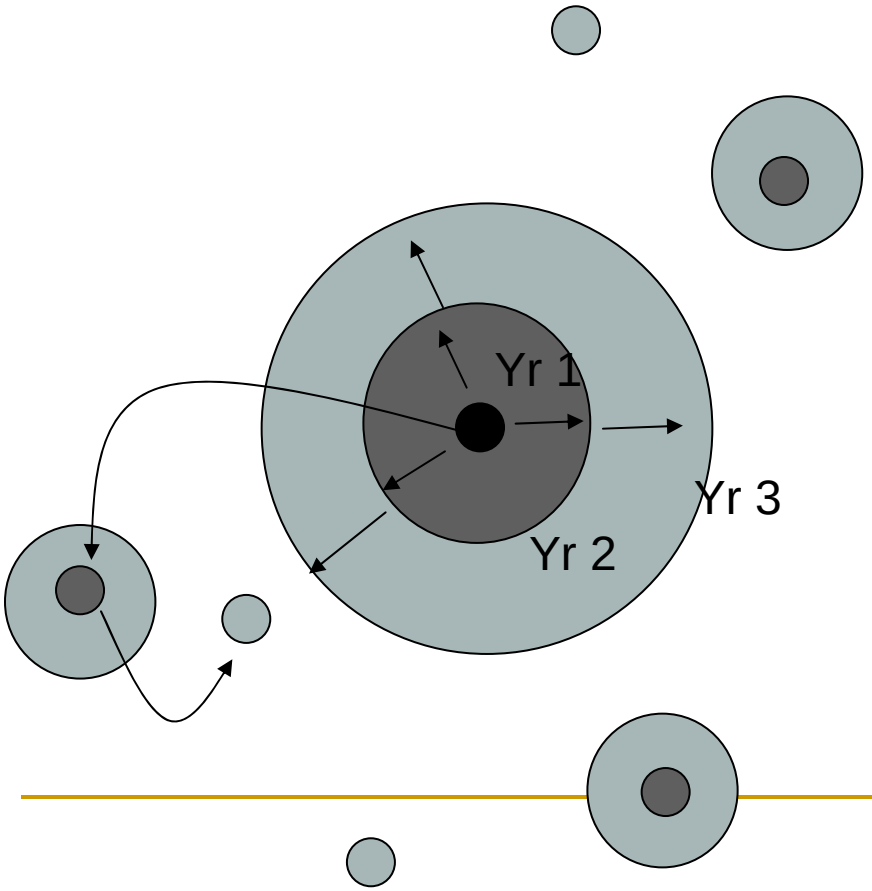


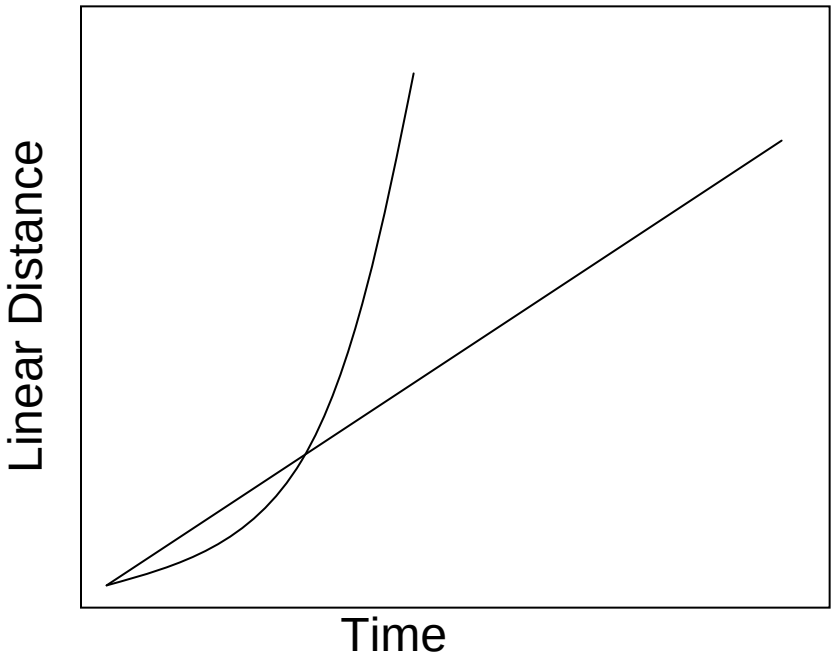


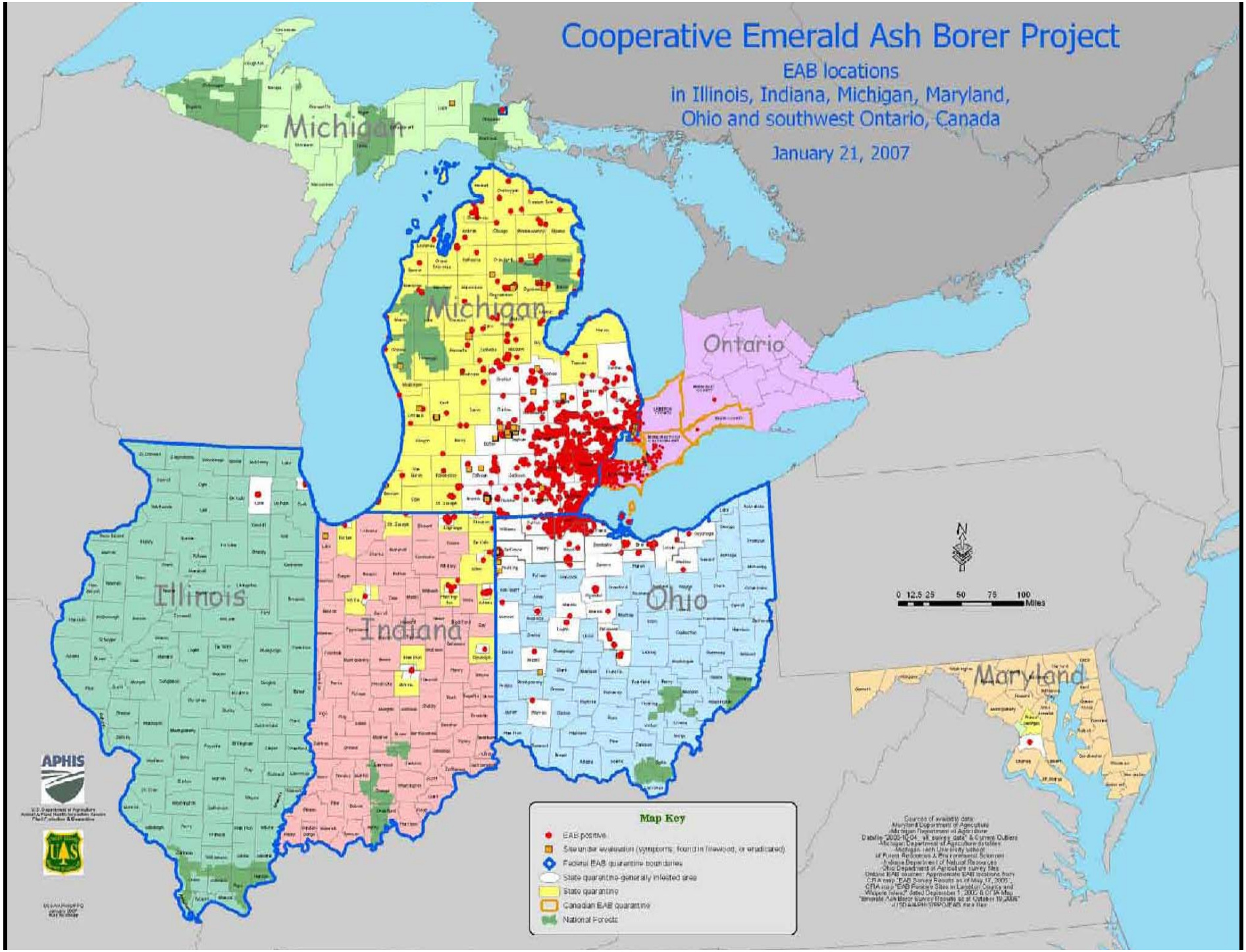
Modeling Dispersal



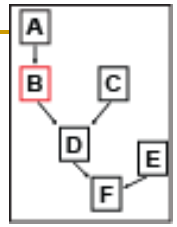
- Long-distance spread






Cooperative Emerald Ash Borer Project
EAB locations
in Illinois, Indiana, Michigan, Maryland,
Ohio and southwest Ontario, Canada
January 21, 2007
Michigan
Michigan
Ontario
Illinois
Indiana
Ohio
Maryland
N
0 12.5 25 50 75 100
Miles
APHIS
Map Key
EAB positive
Site under evaluation (symptoms, found in firewood, or eradicated)
Federal EAB quarantine boundaries
State quarantine-generally infested area
State quarantine
Canadian EAB quarantine
National Forests

Spread Model



Insect Ride Model (GIS)

Roads

Wood products

Population Density

Campgrounds

Ash Abundance Multiplier

Ash Abundance (Basal Area)

Weighted Random Seeding

Gravity Model

Maturity of Infection (EAB Abundance)

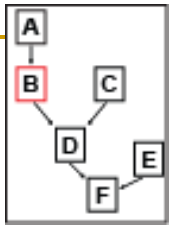
Insect Flight Model (EAB SHIFT)

Outlier Generator

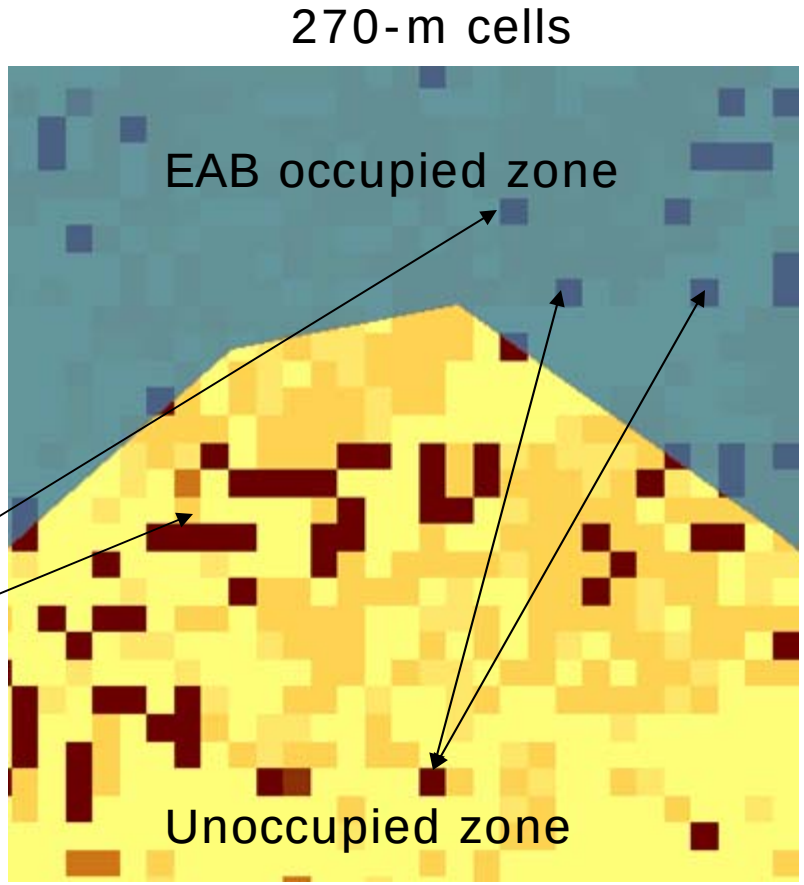
Random Seeding

Spatially Explicit Probability of Colonization

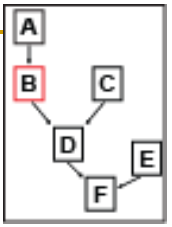
Predict the spread of emerald ash borer: Natural Dispersal



- SHIFT model for EAB spread
  (spatially explicit cell-based model)
- Calculates the **probability of colonization** of currently unoccupied cells based on **abundance of EAB**, **habitat availability of ash**, and **distance between all** cells.



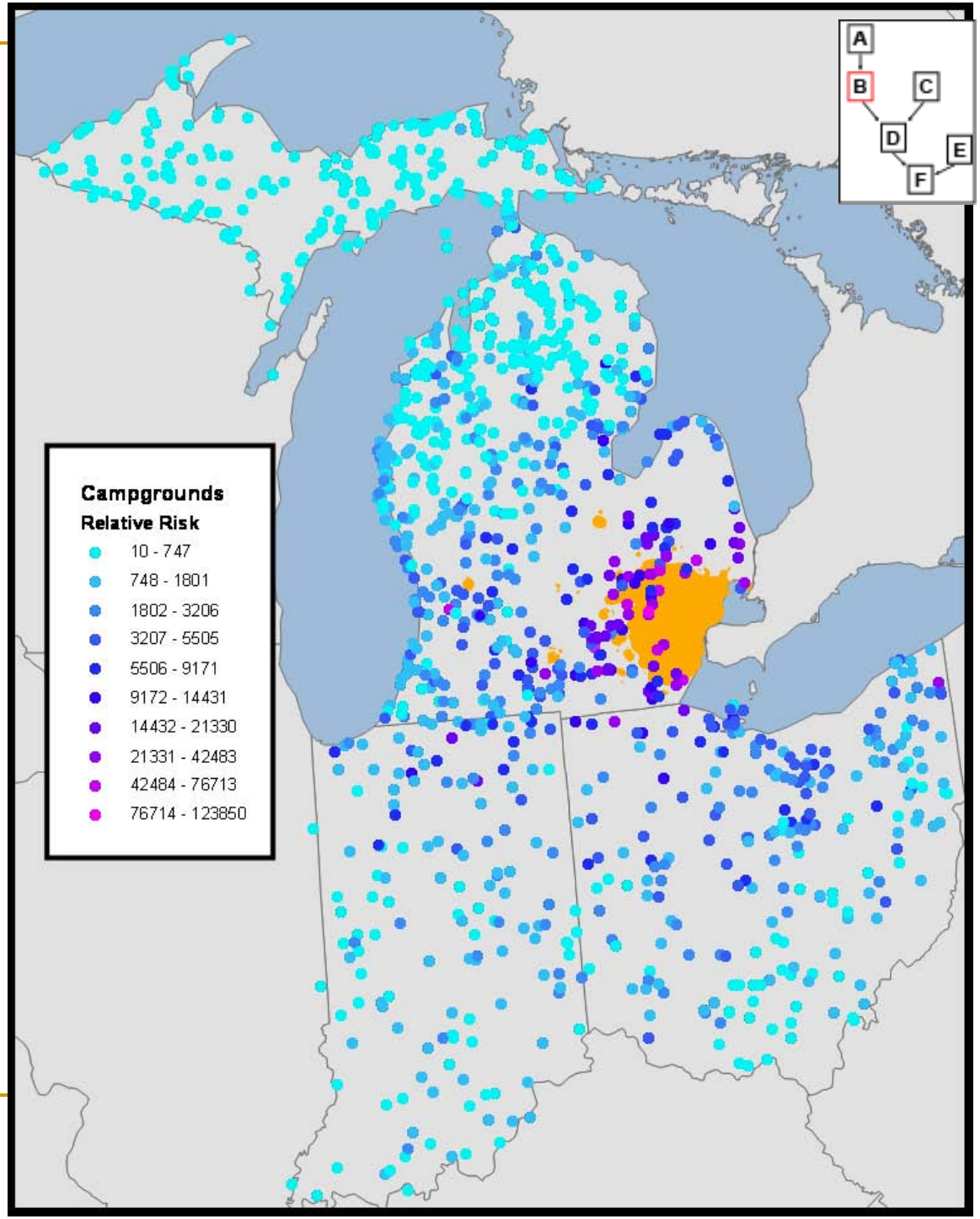
Predict the spread of emerald ash borer: Human-mediated dispersal

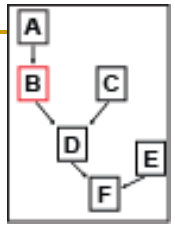


$$U_{ij} = \sum_{i=1}^{K} A_i O_i W_j D_{ij}^{-d}$$

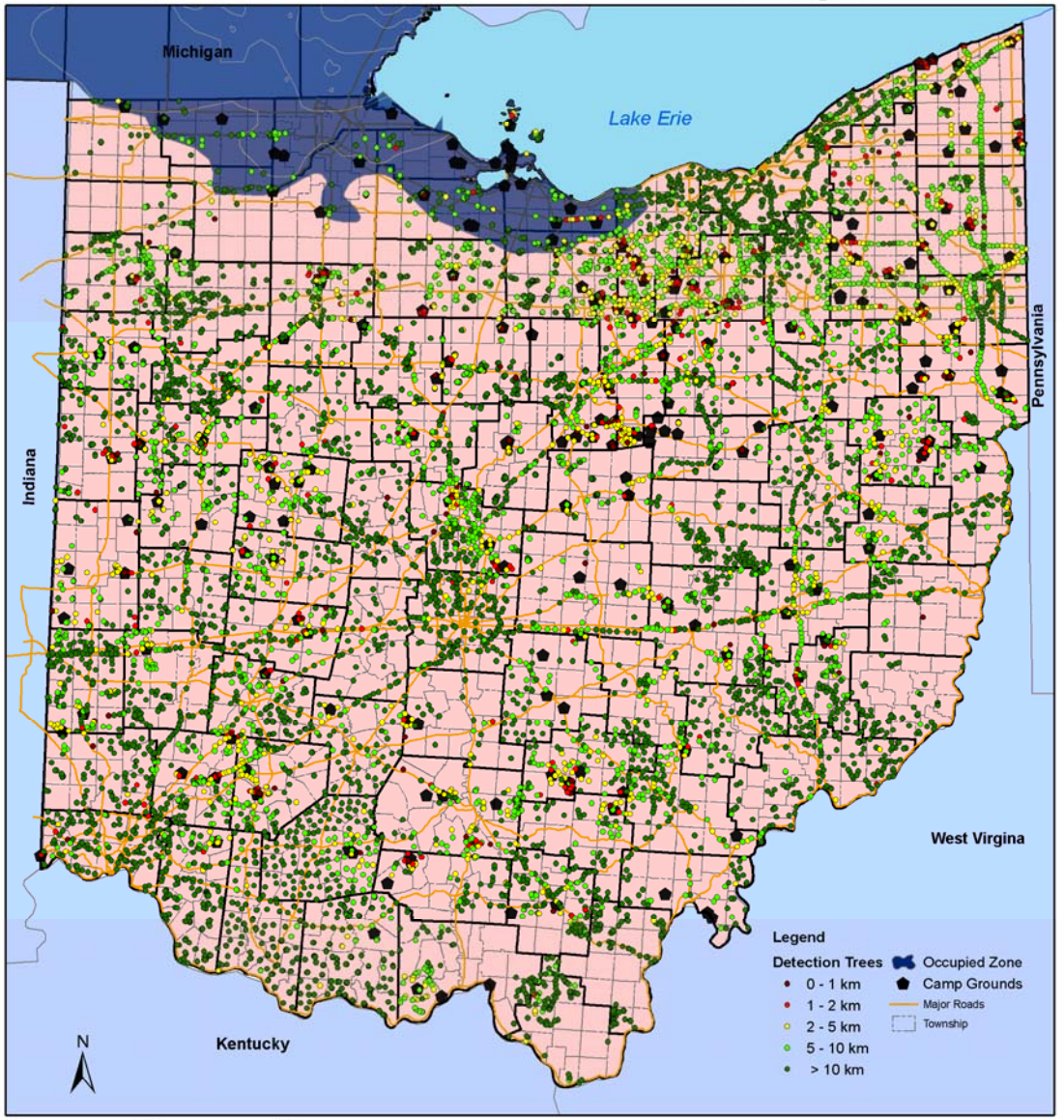
Campers with Firewood

Number of campers traveling to each campground from EAB region.





Distance of Detection Trees From Campgrounds



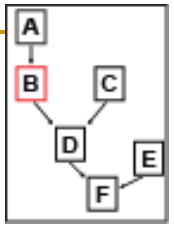
Northern Research Station
USDA Forest Service

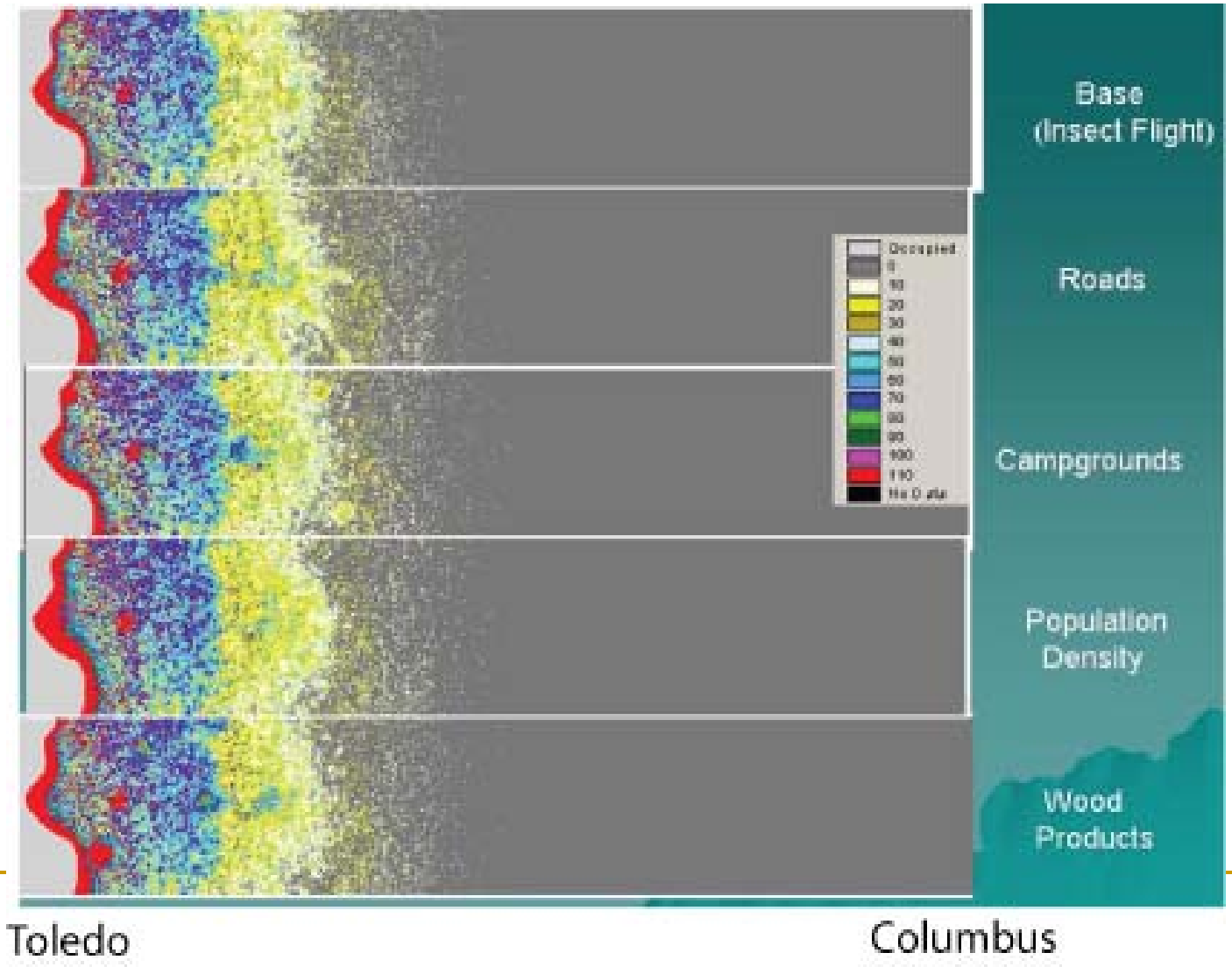
10/04/2007

Summary of Detection trees

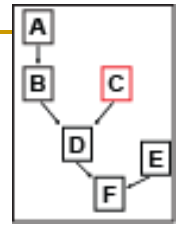
All Trees		Occupied Zone		Non-occupied Zone	
0 - 1 km:	207	0 - 1 km:	1	0 - 1 km:	206
1 - 2 km:	293	1 - 2 km:	6	1 - 2 km:	287
2 - 5 km:	1124	2 - 5 km:	39	2 - 5 km:	1085
5 - 10 km:	2411	5 - 10 km:	103	5 - 10 km:	2308
> 10 km:	4042	> 10 km:	149	> 10 km:	3893

Combined models



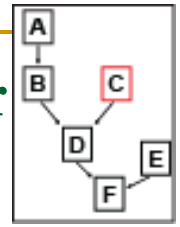


Estimate value of ash in spatially explicit manner



- Impact on Communities
- Forest products

The Potential Economic Impacts of Emerald Ash Borer (*Agrilus planipennis*) on Ohio, U.S., Communities



T. Davis Sydnor, Matthew Bumgardner, and Andrew Todd

Arboriculture & Urban Forestry 2007. 33(1):48–54.

Table 6. Potential statewide losses in millions of dollars (to the nearest million) giving mean and median values for landscape value, tree removal costs, and replacement costs[z].

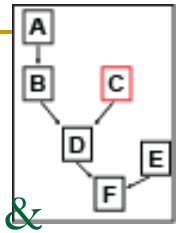
	Landscape values		Tree removal costs		Replacement costs	
	(median-based)	(mean-based)	(median-based)	(mean-based)	(median-based)	(mean-based)
Street trees	80	188	67	157	29	67
Park trees	22	292	20	261	10	126
Private trees	705	2,940	589	2,459	253	1,057
Totals	807	3,420	676	2,877	292	1,250

[z]Street, park, and private trees are given separately as are totals.

"The worst case scenario… the complete loss of Ohio's urban ash, is a staggering $7.5 billion loss for a single pest in a single state."

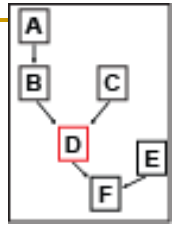
The Potential Economic Impacts of Emerald Ash Borer (*Agrilus planipennis*) on Ohio, U.S., Communities

T. Davis Sydnor, Matthew Bumgardner, and Andrew Todd Arboriculture & Urban Forestry 2007. 33(1):48–54.



- Three types of communities were determined:
  - 1. older communities without an active tree planting program;
  - 2. older communities with a tree planting program; and
  - 3. newer communities planted when ash was a popular landscape tree.

Determine the regional economic consequences with a CGE model

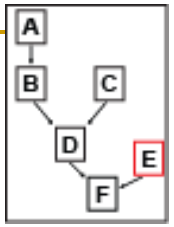


- Companies that use ash have been broken down into 10 different industries
- Rated to assess the likelihood of using ash:
  - 0 = no use, 2 - small, 4-medium, 6- high likelihood.
- Industries
  - Logging & Forest Services: 4.51
  - Wood Processing Unfinished: 4.83
  - Wood Products Finished:5.85
  - Special Wood Products: 2.10
  - Building: 2.58
  - Business Services Using Wood: 4.36
  - Transportation/Storage: 4.53
  - Wood Products Not Elsewhere Classified: 5.33
  - Furniture: 3.2
  - Consumer Wood Goods (durable/nondurable): 3.84

Objective 2: provide policy-makers with quantitative guidance for cost-effective alternative strategies to control, prevent, or slow the spread of emerald ash borer.

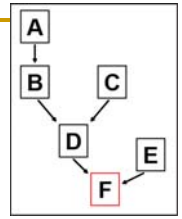
- *Determine cost and effectiveness of different prevention and control strategies*
- *Link distribution and spread models with CGE to optimize resources*

Determine cost and effectiveness of different prevention and control strategies



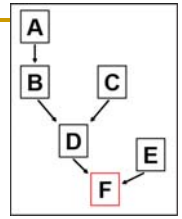
- Assess cost and effectiveness of eradication programs.
- Cost of monitoring
  - Detection tree programs in Ohio and MI.
- Education/Outreach
  - Costs? And Effectiveness?

Link distribution and spread models with CGE to optimize resources: using Real Options framework.



- Investment: "Economics defines investment as the act of incurring an immediate cost in the expectation of future rewards" (Dixit & Pindyck, 1994, p.3)
- Popular DCF method assumes reversibility, or in case of irreversibility "now or never" opportunity
- Investment rules for "real assets" can be obtained using option pricing methods developed for financial assets.
- Real option approach accounts for uncertainty, irreversibility and timing.

Link distribution and spread models with CGE to optimize resources: using Real Options framework.



- Considerations
  - *Logistic process*- density does not go to infinity
  - *Decreasing carrying capacity*- Ability to reproduce depends on availability of ash
  - *Discontinuous jump*- Control involves removing and chipping all ash trees in the vicinity of infestation
- Each period forest manager chooses whether to invest and if so to what extent (size of tree-removal area)
- Must compare benefit of waiting (option value) with cost of waiting (increased control costs)

Bottom Line

- **What is it worth to slow the spread of the emerald ash borer?**

Acknowledgements

- EAB PREISM Team:
  - Co-PIs/Collaborators
    - David Finnoff – Univ. of Wyoming
    - Louis Iverson – U.S. Forest Service
    - Davis Sydnor – Ohio State Univ.
    - Anatha Prasad – U.S. Forest Service
  - Graduate Students
    - Matt Peters - Ohio State Univ.
    - Charles B. Sims - Univ. of Wyoming
    - Shana M. McDermott - Univ. of Wyoming
    - Maria Tumeo – Univ. of Toledo
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