Forest Service
U.S. DEPARTMENT OF AGRICULTURE

Pest management and plant health care: Good practice for cities

Strategic and Technical Approaches to Tree Health Protection
UNECE Informal Network on Urban Nature

Robert G Haight, PhD
Research Forester
USDA Forest Service, Northern Research Station
St. Paul, Minnesota USA
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Outline

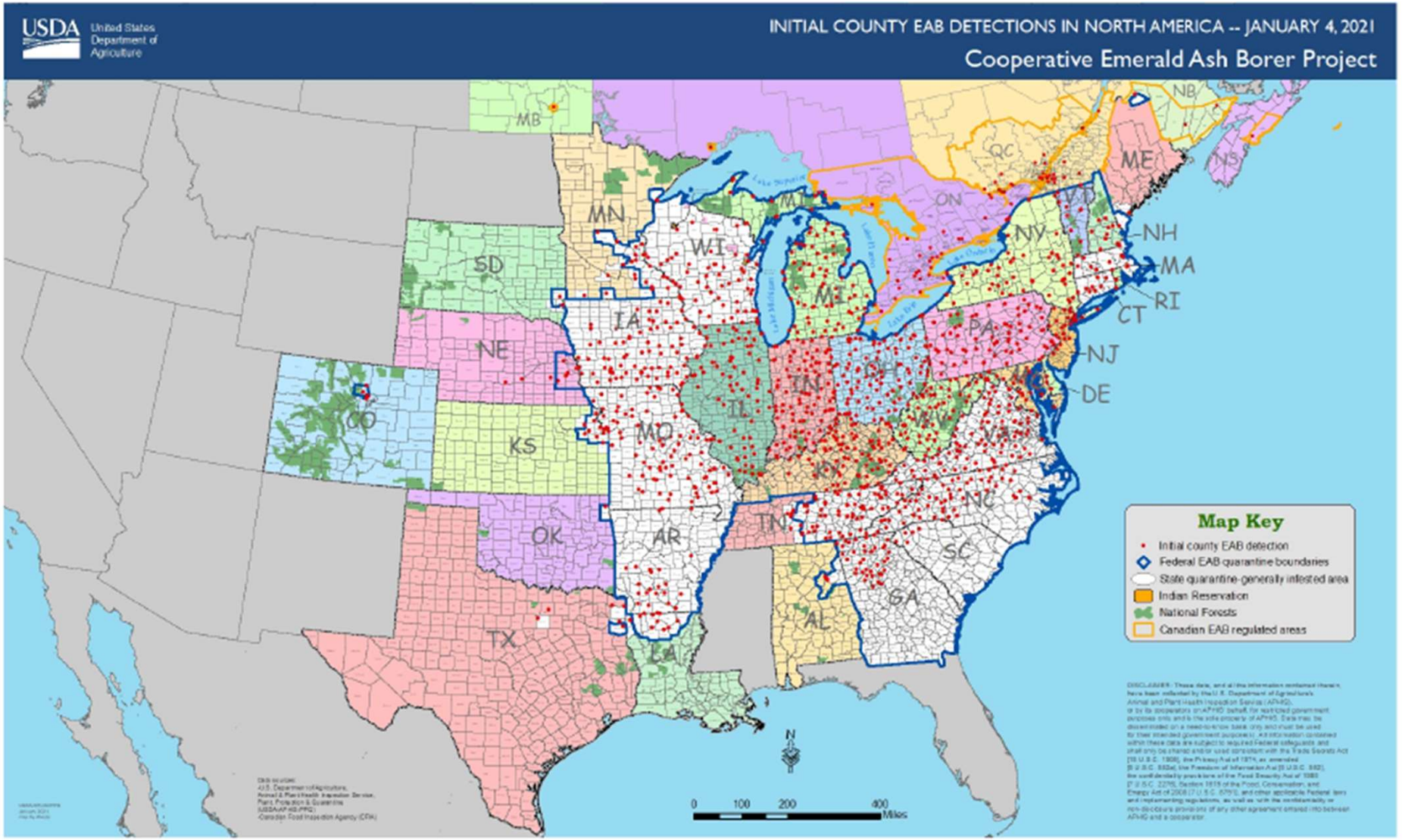
1. Emerald ash borer (EAB) infestations of urban forests in North America
2. Planning guidelines for managing EAB infestations
3. Designing tree care incentive programs for private landowners

Emerald Ash Borer: A threat to urban forests

Emerald ash borer larval galleries
(USDA Forest Service photo)

Emerald ash borer is a non-native wood boring insect (USDA Forest Service photo)

An ash tree that has not been protected with insecticide (left) versus ash trees that have been protected (right). (Courtesy photo from Jeff Hafner.)


USDA
United States Department of Agriculture
INITIAL COUNTY EAB DETECTIONS IN NORTH AMERICA -- JANUARY 4, 2021
Cooperative Emerald Ash Borer Project
MB
MN
SD
NE
CO
KS
OK
TX
IA
MO
AR
LA
WI
MI
IL
IN
KY
TN
MS
AL
GA
SC
NC
VA
WV
PA
NY
OH
ON
QC
NB
NS
ME
VT
NH
MA
RI
CT
NJ
DE
MD
Map Key
Initial county EAB detection
Federal EAB quarantine boundaries
State quarantine-generally infested area
Indian Reservation
National Forests
Canadian EAB regulated areas
N
0 100 200 400
Miles

Costs of ash removal and property value loss ($ billion)

Government	Homeowners	
Removal	Removal	Property loss
$8.5	$3.5	$3.8

Analysis

Cost of potential emerald ash borer damage in U.S. communities, 2009–2019

Kent F. Kovacs [a,*], Robert G. Haight [b], Deborah G. McCullough [c,d], Rodrigo J. Mercader [c], Nathan W. Siegert [c], Andrew M. Liebhold [e]

SLAM: SLowing Ash Mortality

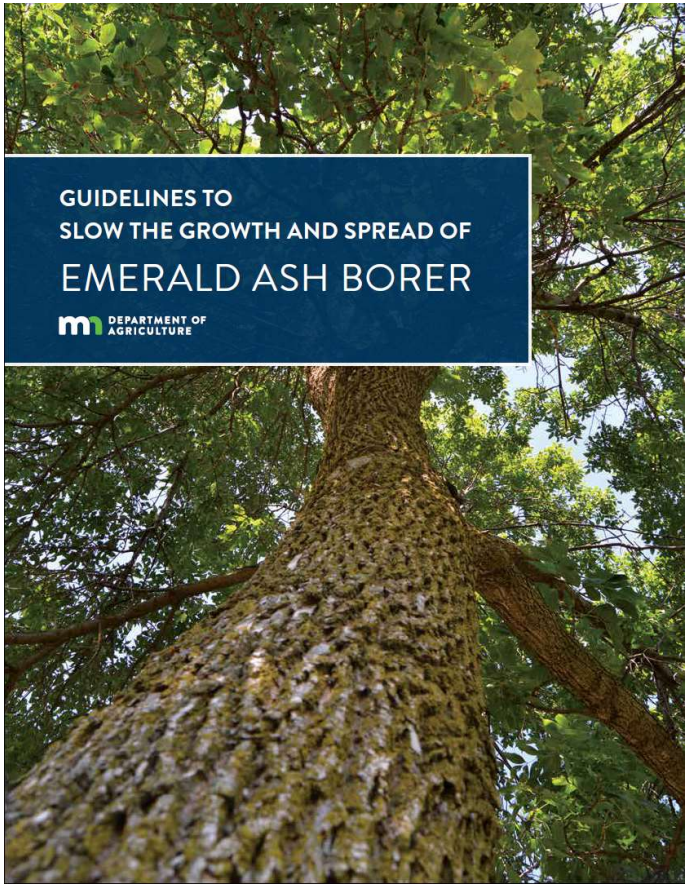
- An integrated strategy for controlling recently established, outlier EAB sites
  - Surveillance
  - Insecticide application
  - Tree removal

Photo courtesy of David Cappaert

USDA Forest Service photo by Therese Poland

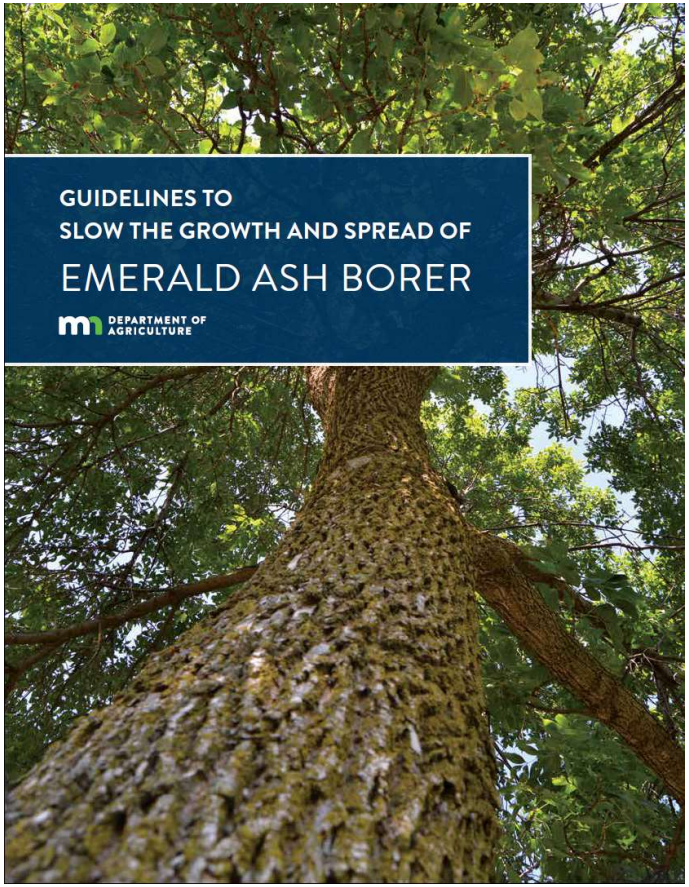
http://www.slameab.info/

EAB Management guidelines



Management objectives

- Slow the spread of EAB within a community forest
- Slow the spread of EAB to uninfested community forests throughout the state



Management tactics depend on infestation status

	Community forest infestation status		
Management tactic	**Not infested**	**Generally infested**	**Heavily infested**
Planning			
Inventory			
Monitoring			
Treatment			
Removal			
Wood utilization			
Replanting			
Biological control			

	Good time to utilize this tactic
	Getting late to utilize this tactic
	Last chance before opportunity is lost
	Not appropriate tactic at this time

Community forest management plan: Elk River, MN

Management Tactics	Elk River
Tree Inventory	All public, no private
Shade Tree Pest Ordinance	No
Yearly Monitoring	As needed basis
Disposal Site	City compost site
Ash Utilization	Mulch
Replanting	Replace every public ash tree removed
Biological Control Site	Undetermined

Management Tactics		Elk River
Insecticide Treatments	Public boulevard	Residents can treat public trees
	Public park landscape	Yes, based on tree condition
	Public Natural forest	No
	Private – not infested	Seeking grant funds for a program
	Private – lightly infested	N/A

Management guidelines and plans: Best practices

1. Employ a bi-level process: Regional guidelines for local management plans
2. Identify management objectives and tactics
3. Recommend management tactics for different levels of infestation
4. Facilitate adoption of management guidelines by community foresters

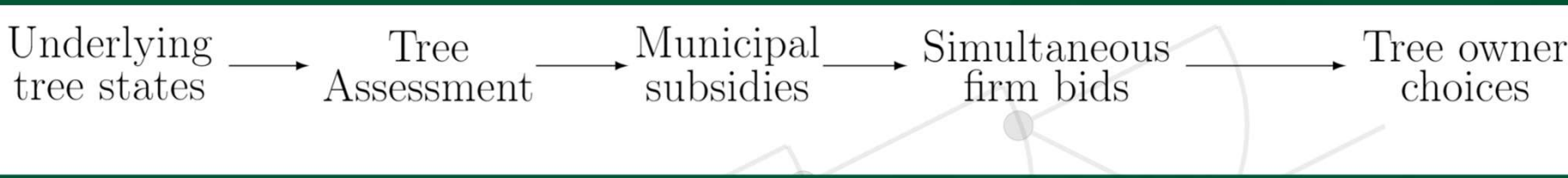
How can subsidies be optimized to align public and private incentives for EAB insecticide treatment?

Model of optimal subsidies for EAB insecticide treatment

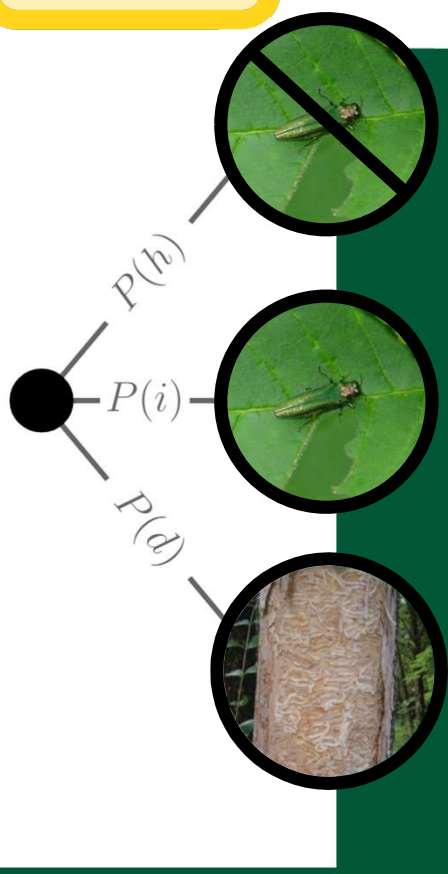
- Optimal subsidy policies for privately owned trees change as EAB spreads
  - Tree health
  - Current community state of infestation
  - Uncertainty about tree owner values

- Targeted toward privately owned trees that are unlikely to be treated

- Result in unified management across public and private land

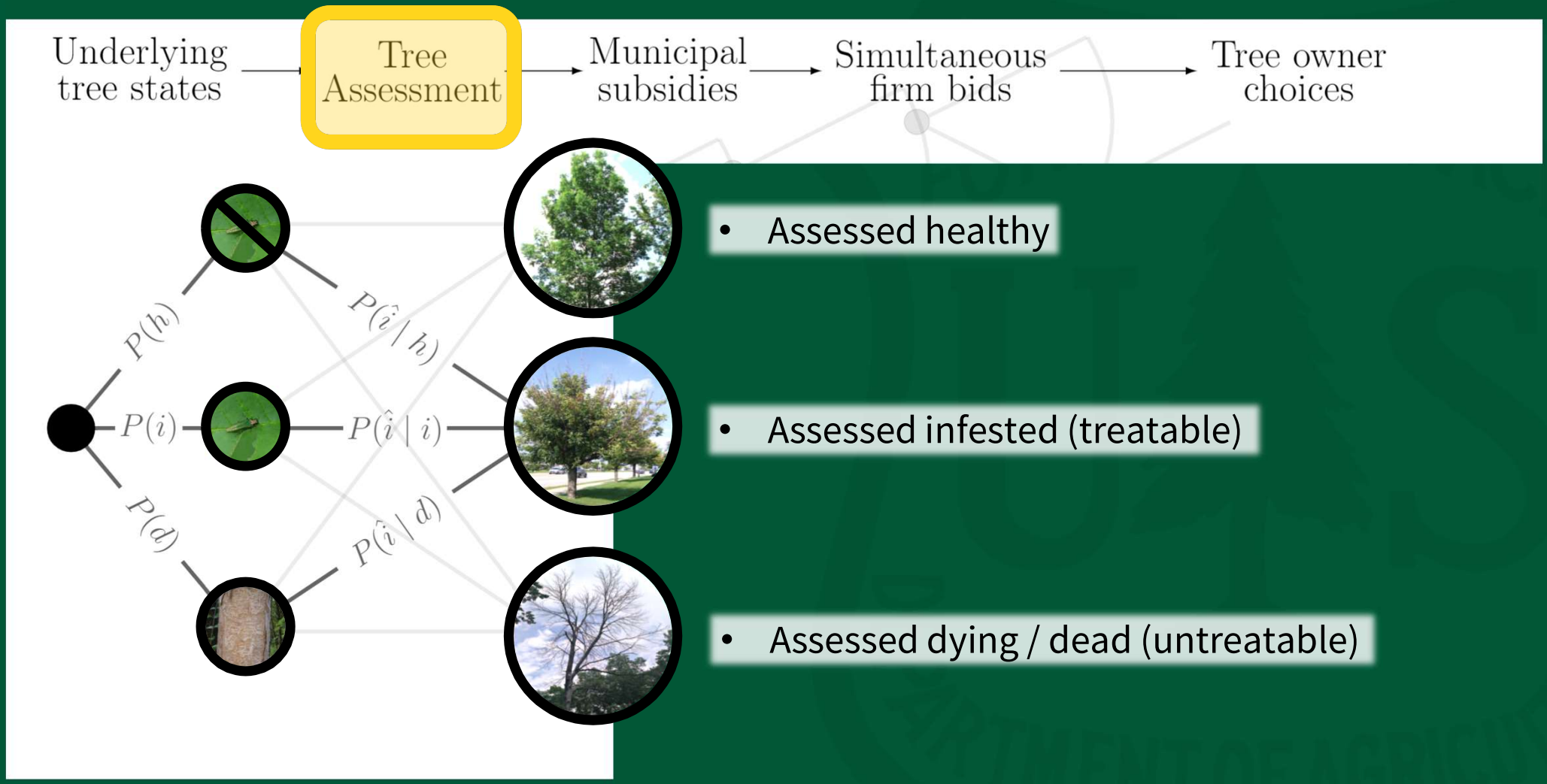

Underlying tree states
Tree Assessment
Municipal subsidies
Simultaneous firm bids
Tree owner choices

Underlying tree states → Tree Assessment → Municipal subsidies → Simultaneous firm bids → Tree owner choices



- EAB free
- Treatable EAB infestation
- Advanced EAB infestation

Pictures from: Region 9 - Emerald Ash Borer Threat Webinar Series and Knight et. al., 2014



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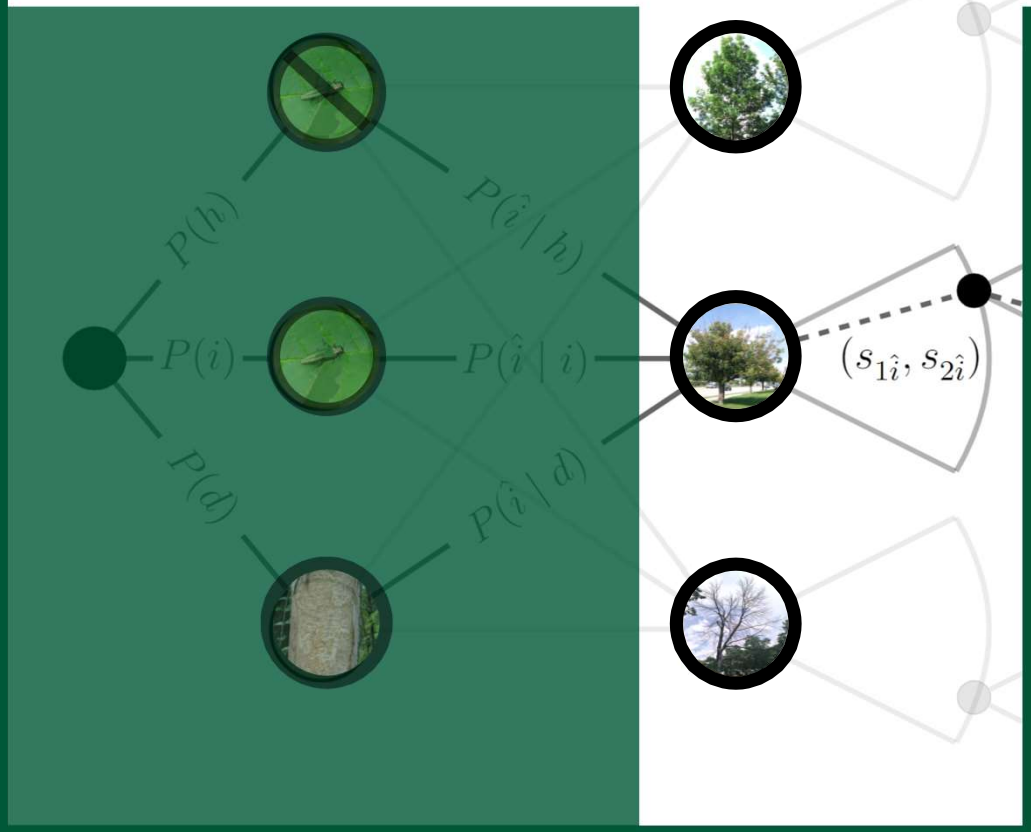
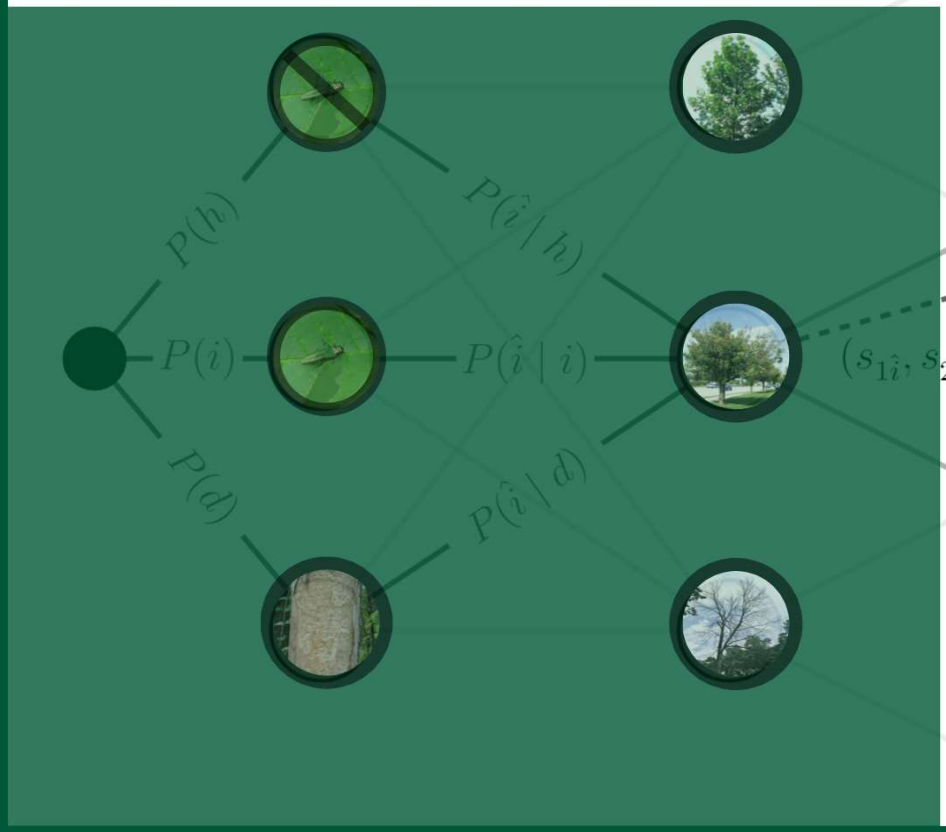
Underlying tree states → Tree Assessment → **Municipal subsidies** → Simultaneous firm bids → Tree owner choices

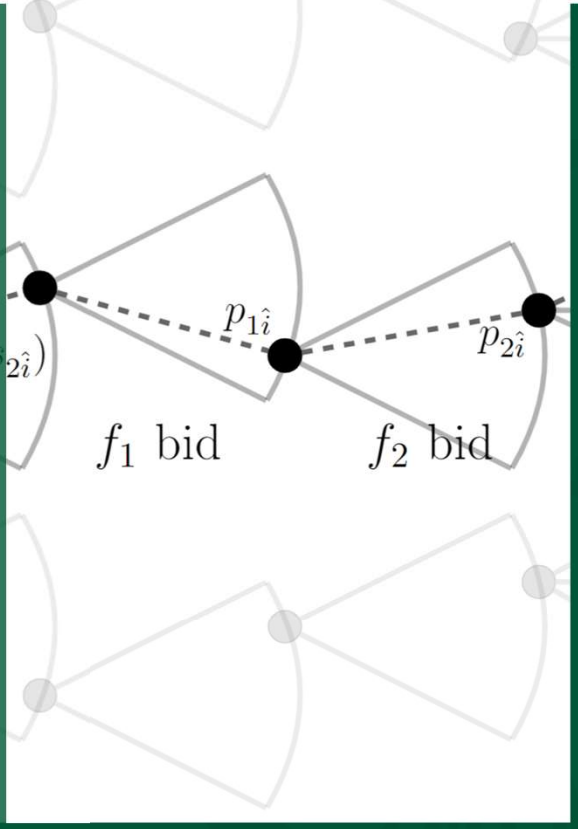


Municipality selects subsidy levels to maximize expected ecosystem service benefits from trees

Pictures from: Region 9 - Emerald Ash Borer Threat Webinar Series and Knight et. al., 2014

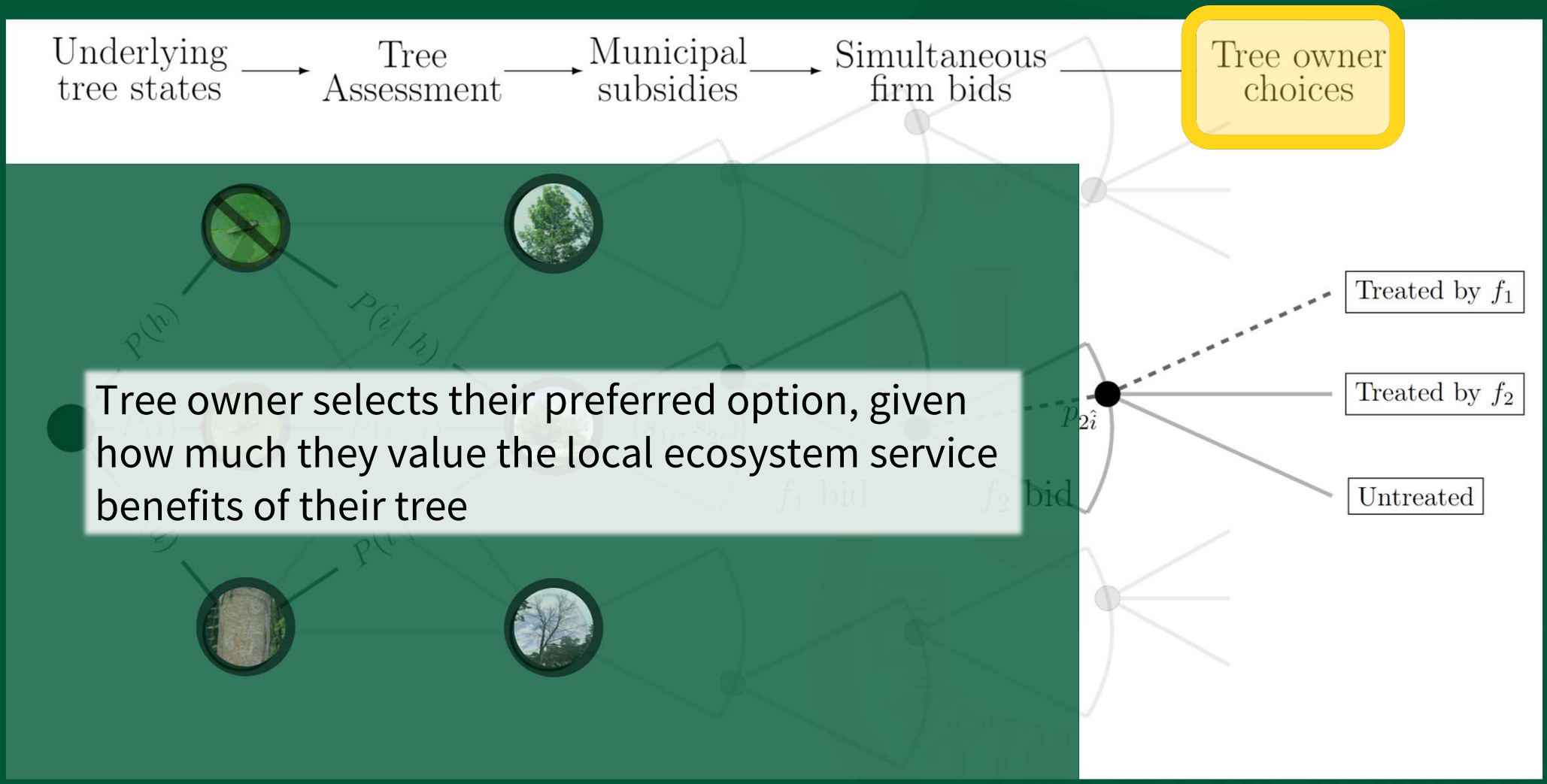
Underlying tree states → Tree Assessment → Municipal subsidies → **Simultaneous firm bids** → Tree owner choices





Firms bid competitively to maximize their profits, given subsidy levels

Pictures from: Region 9 - Emerald Ash Borer Threat Webinar Series and Knight et. al., 2014



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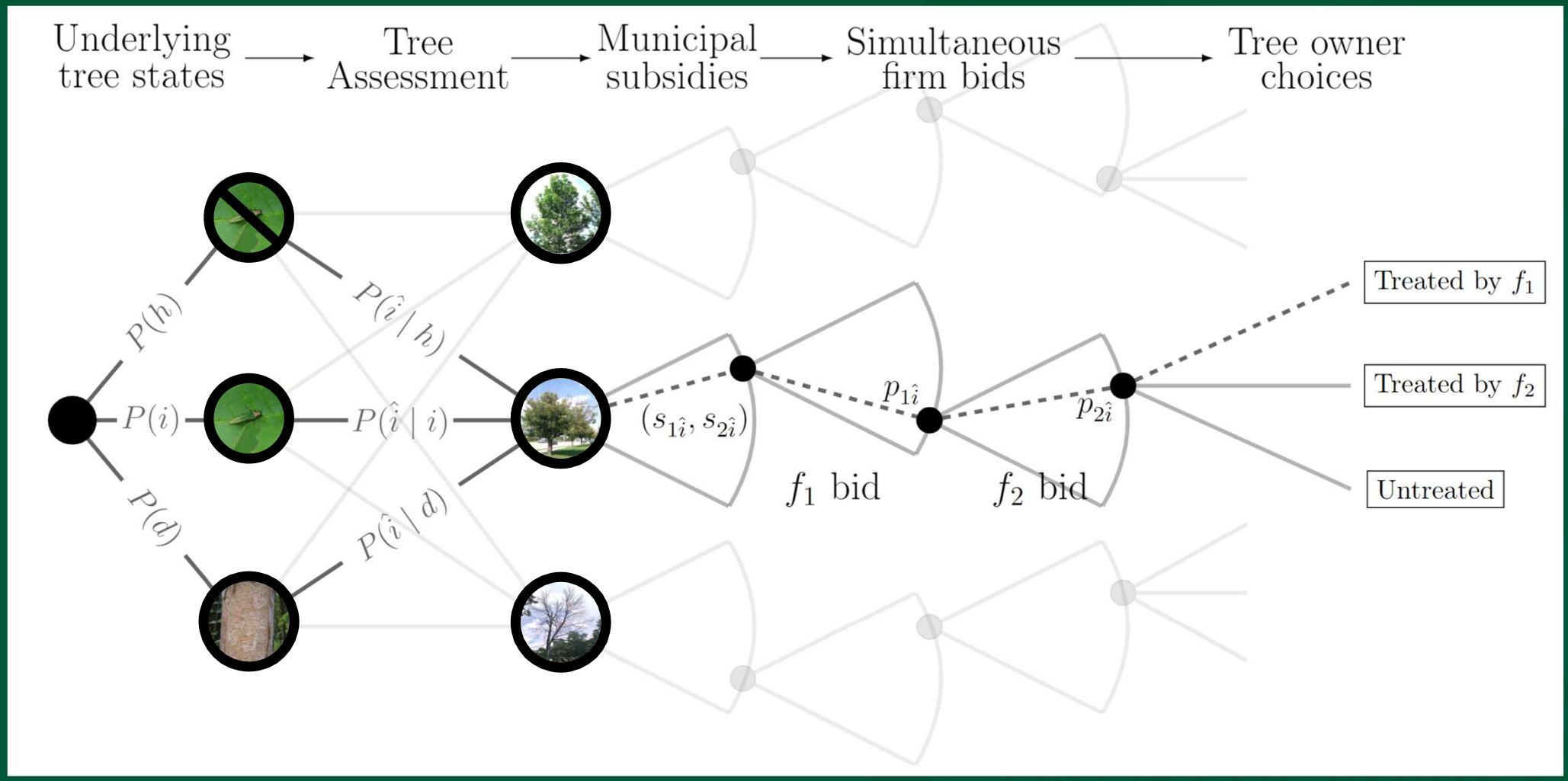


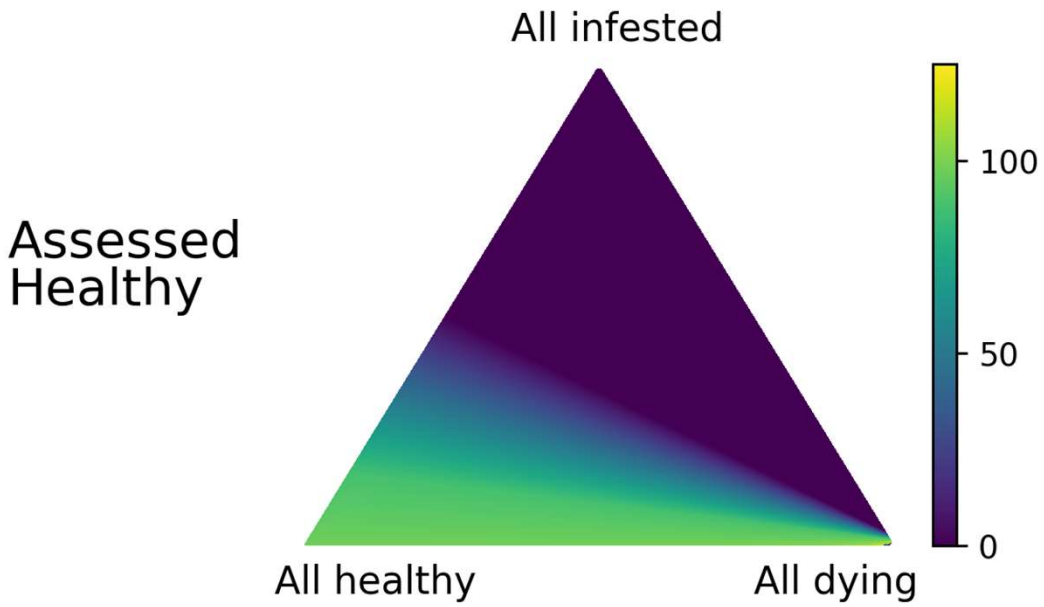
Pictures from: Region 9 - Emerald Ash Borer Threat Webinar Series and Knight et. al., 2014

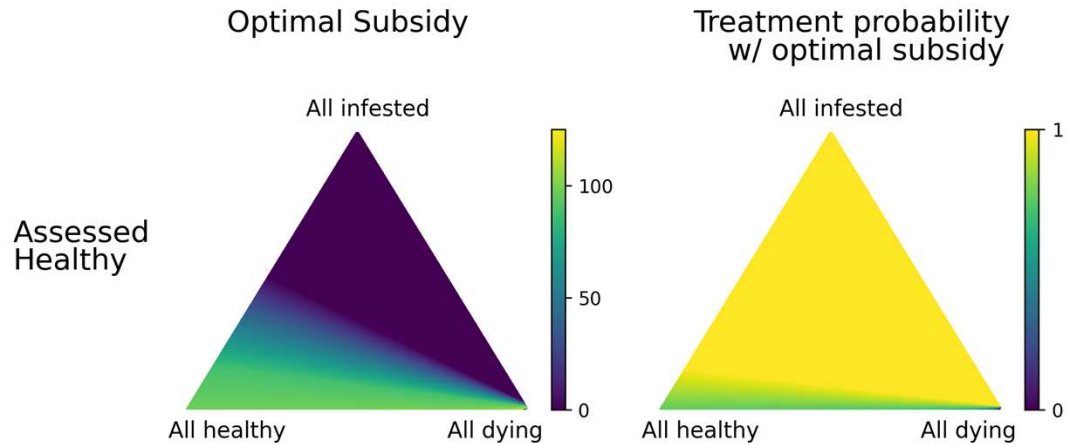
Key parameters

- Cost of administering treatment
- Community prevalence of EAB infestation
  - Surveillance data
- Accuracy of assessment
  - False positives / false negatives
- Effectiveness of insecticide treatment
  - A function of tree health
- Social and private value of saving an ash tree
  - Divergence in values expected due to cross-boundary benefits

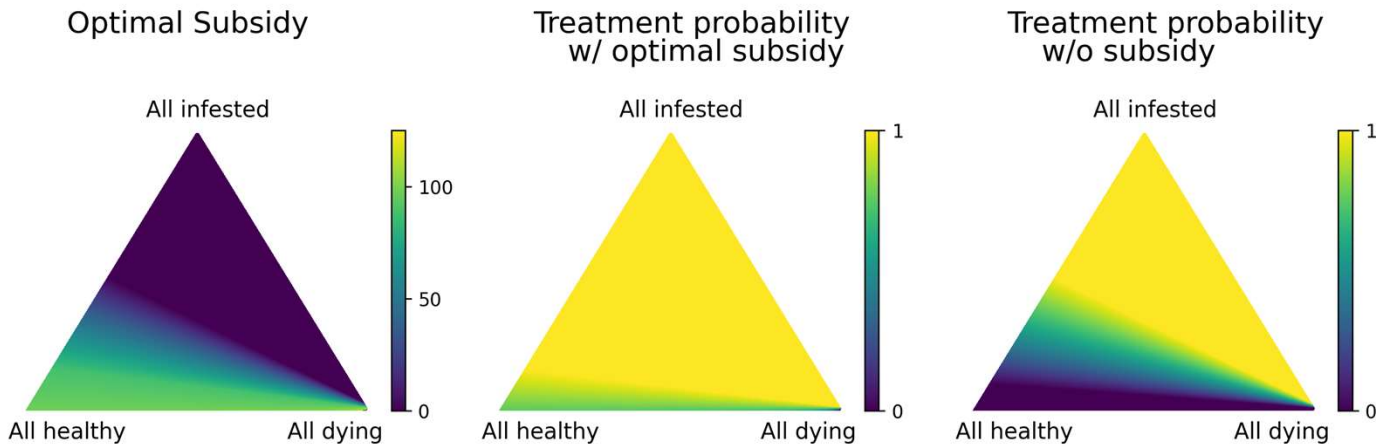
Parameter
c
$P(h)$
$P(i)$
$P(d)$
$P(\hat{h} \mid h)$
$P(\hat{i} \mid h)$
$P(\hat{d} \mid h)$
$P(\hat{h} \mid i)$
$P(\hat{i} \mid i)$
$P(\hat{d} \mid i)$
$P(\hat{h} \mid d)$
$P(\hat{i} \mid d)$
$P(\hat{d} \mid d)$
h_{th}
h_{uh}
h_{ti}
h_{ui}
h_{td}
h_{ud}
Δ_m
Δ'_m
Δ_o

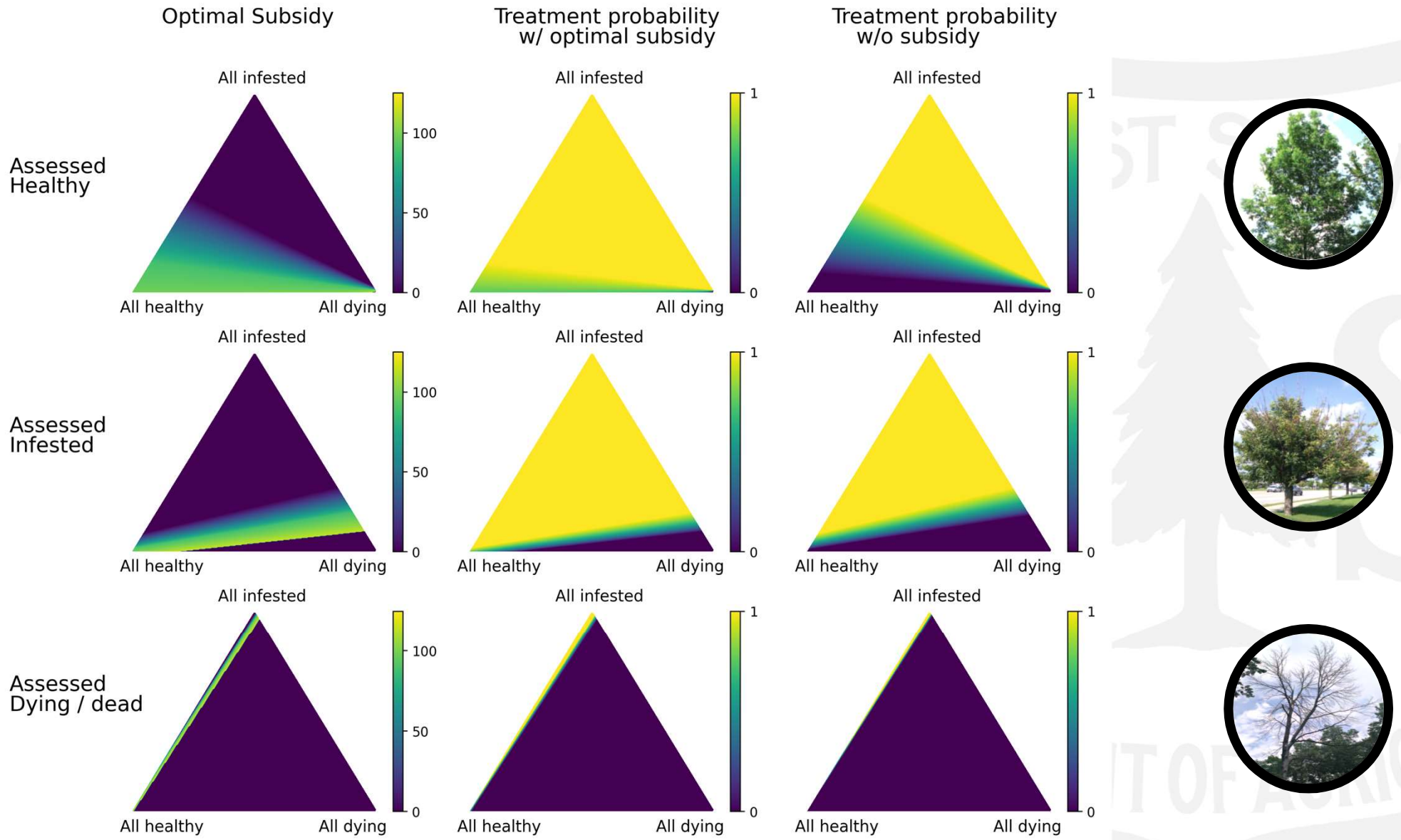
Optimal Subsidy




Optimal Subsidy
Treatment probability
w/ optimal subsidy
Assessed
Healthy
All infested
All infested
All healthy
All dying
All healthy
All dying
100
50
0
1
0

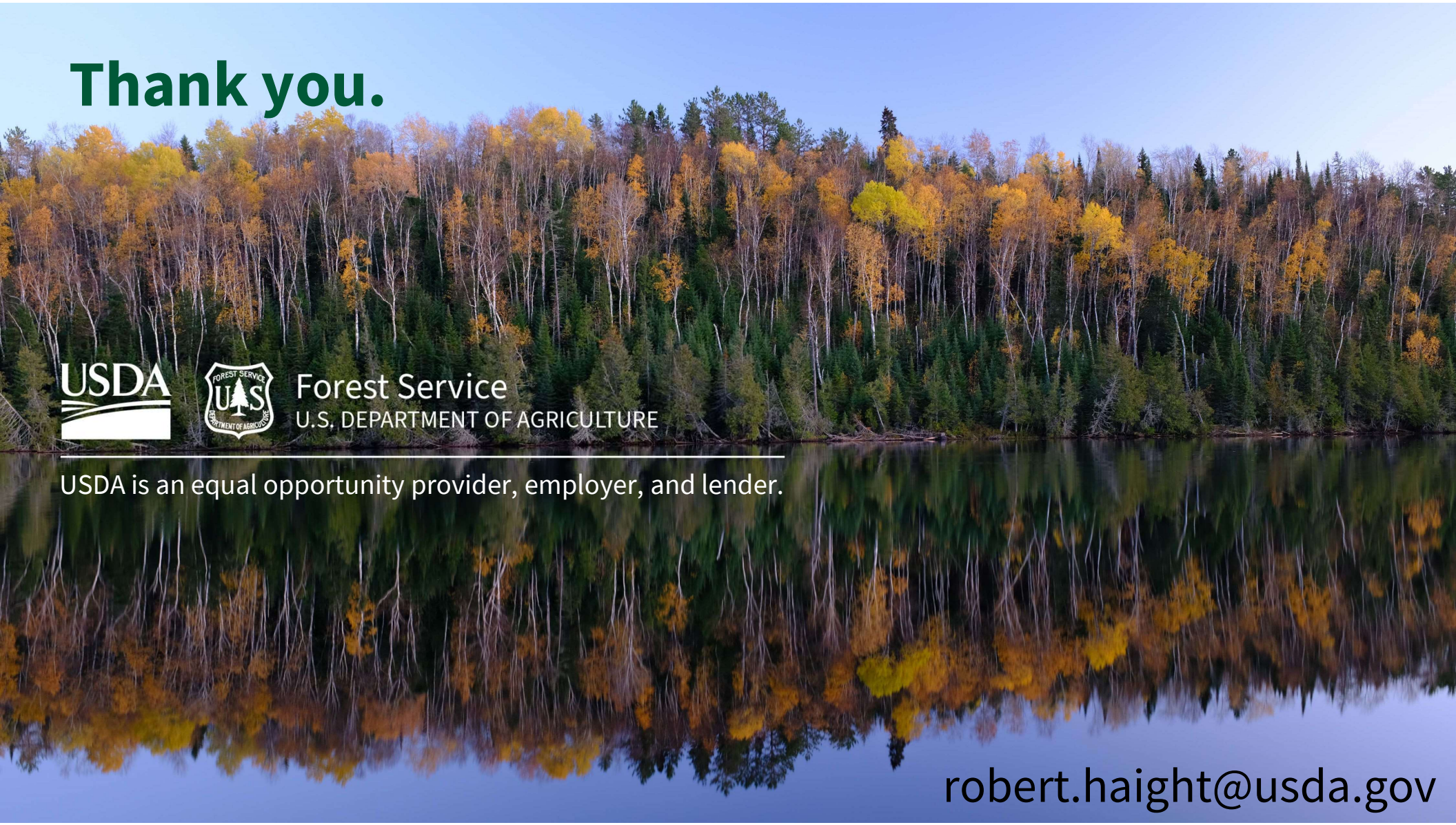
Assessed Healthy




Optimal Subsidy
Treatment probability w/ optimal subsidy
Treatment probability w/o subsidy
Assessed Healthy
Assessed Infested
Assessed Dying / dead
All infested
All healthy
All dying
100
50
0
1

Take-home messages

- Subsidies can help private landowners protect tree health
- Optimal subsidy policies are dynamic:
  - Tree health state
  - Current community state of infestation
  - Uncertainty about tree owner values
- Structure of the subsidy policy depends on the market for tree care services


Thank you.
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robert.haight@usda.gov