Recreational Firewood Transport and the Spread of Forest Pests

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Outline

- Introduction and Background
- Research Motivation
- Study 1
- Study 2
- Remarks / Recommendations

Introduction

- In recent years, widespread concern in North America regarding accidental transport of **forest pests** in **firewood**
- State and national public awareness campaigns, particularly targeted at **campers**
- National Firewood Task Force (2010)
- USDA APHIS firewood risk assessment (2011)

Images: Florida Dept of Ag and Consumer Services; New York Dept of Environmental Conservation; Iowa Dept of Natural Resources; USDA-FS, R9, Allegheny NF

Introduction: What is Firewood?

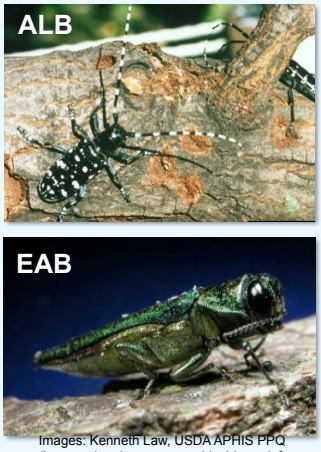
- One definition = any wood cut into a shape and size used for fuel
- Can be green, seasoned, or treated, including debarking
- Regularly transported for recreation, but also home heating
- May harbor wood borers, defoliators

Images: www.forestryforum.com; mn.gov

Introduction: Why the Attention?

- Why is there so much concern about the (recreational) firewood pathway?
- Two non-native forest insects in particular have highlighted the issue:

1. **Asian longhorned beetle (ALB)**
   - *Anoplophora glabripennis*
2. **Emerald ash borer (EAB)**
   - *Agrilus planipennis*



Images: Kenneth Law, USDA APHIS PPQ (bugwood.org); www.emeraldashborer.info

Background: ALB

- Focus on firewood issue basically started with ALB
- August 1996: detected in Brooklyn, NY
- September 1996: detected in Amityville, NY … 50 km away
- Spread when infested (maple) tree sections moved and sold as firewood (?)

Image: OK St. Univ. Entomol.

From Haack et al. (1997)

Background: ALB

- Since those initial infestations, ALB discovered elsewhere:
  - 1998: Chicago, IL
  - 1999: Queens; Manhattan (NYC)
  - 2002: Jersey City, NJ
  - 2003: Toronto, ON
  - 2007: Staten Island (NYC)
  - 2008: Worcester, MA
  - 2011: Bethel, OH / Tate Township (near Cincinnati)
- Probably not spread by firewood in these cases, but…

Images: www.cambridgema.gov; bugwood.org (PA DCNR)

Background: ALB

- …In Ohio, infestations in Monroe (Sept. 2011) and Stonelick (July 2012) Townships attributed to firewood from nearby Tate Township / Bethel

Ohio Department of Agriculture

Governor John R. Kasich • Lt. Governor Mary Taylor
Director David T. Daviela

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FOR IMMEDIATE RELEASE

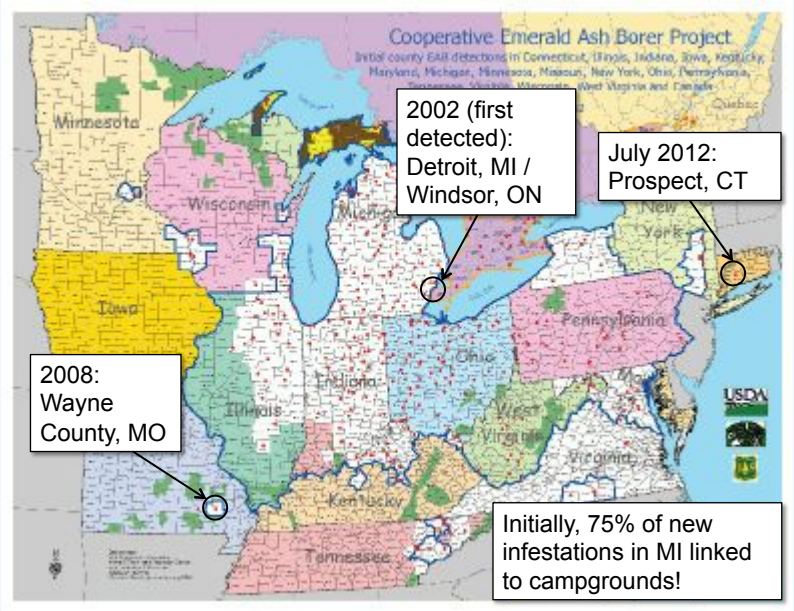
Ohio Department of Agriculture Announces New Discovery of Asian Longhorned Beetle in Clermont County
Firewood cited as source of new infestation

REYNOLDSBURG, OH (July 20, 2012) – The Ohio Department of Agriculture (ODA), in collaboration with the United States' Department of Agriculture's Animal and Plant Health Inspection Service (APHIS) today

Background: EAB

- While ALB may have started discussion about firewood, issue brought to forefront by EAB…

Images: www.invasive.org; www.ourohio.org; USDA-FS



Background: EAB

- Initial detection of EAB in Missouri serves as illustrative example
- Found at Greenville Campground, Wappapello Lake Recreation Area
  - At the time, >100 km to next closest infestation
- Believed that insect hitchhiked on load of firewood

Background: Response

- ALB, EAB, and other examples suggest firewood is an important vector
- Varied regulatory responses
  - Most states have some **restrictions regarding firewood movement**
  - Bans: Shenandoah Nat'l Park (VA) banned **all outside firewood** in 2010; Hoosier Nat'l Forest (IN) banned unauthorized firewood

Image: About.com (Debbie Hadley)

Background: Response

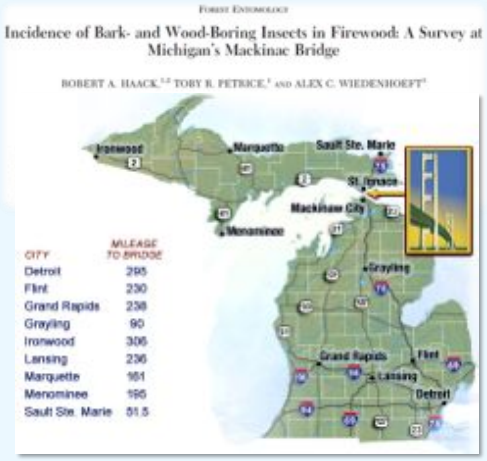
- National Firewood Task Force (NFTF)
- Recommendations (2010) focus on three primary areas of action
  - Outreach strategies
    - Multi-agency steering committee; online hub for outreach materials; consistent message about risk
  - Voluntary strategies
    - BMPs for retailers and producers; industry-run certification program; local or treated firewood at campgrounds
  - Regulatory strategies
    - USDA APHIS should promulgate interstate movement regulations; states should do so for intrastate movement

Questions for the Audience…

1. How many of you know your state's firewood policies / regulations?
2. How many of you were previously aware of the NFTF recommendations?

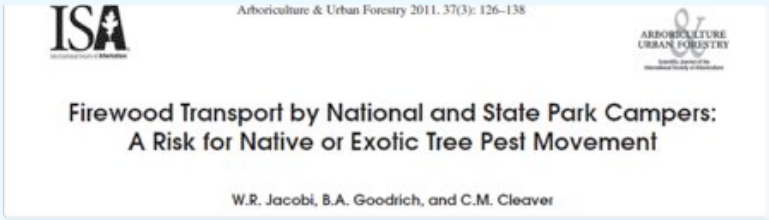
How Big Is the Threat?

- But has risk really been quantified?
  - Few published studies
- Haack et al. (2010) looked at firewood surrendered at Mackinac Bridge (MI)
  - 16% of firewood was from out of state
  - 23% infested with live wood borers



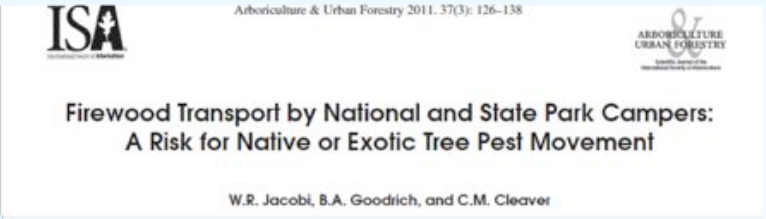
Map: www.mackinacbridge.org

How Big Is the Threat?



- Jacobi et al. (2011) reported results of camper surveys in 7 Colorado state parks, 13 National Parks (in AZ, CO, NV, UT, WY)
  - 66% of CO state park campers brought firewood, but only 4% from out-of-state
  - 60% of Nat'l Park campers brought firewood, 39% from out-of-state

How Big Is the Threat?



  - 41% out-of-state firewood from non-adjacent states
  - 53% of surveyed firewood had evidence of previous insect presence, 39% fungal infestation
- An assortment of camper surveys from other states (e.g., WI, MN, VT) tell similar stories

Question for the Audience…

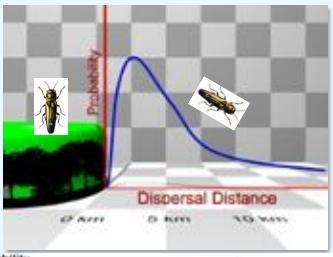
- What do you think is the main reason campers might bring firewood with them?
  a) Cost
  b) Convenience
  c) Quality (e.g., seasoning)
  d) Other

Our Research Motivation

- Unfortunately, existing data are insufficient to fully characterize risk of firewood being transported certain distances, especially long distances
- Why does this matter?
  - Long-distance dispersal greatly increases rate of spread for invasive species
  - In our research, we try to **model the spread of pests in order to forecast risk for decision makers**. These models are only useful if they include **reliable estimates of the rate and extent of long-distance dispersal events**

Study 1: "Dispersal Kernels"

- Spatial models of spread usually require a **dispersal kernel**
- Function that describes probability an organism will travel a certain distance over a given time period



3-D view of a kernel

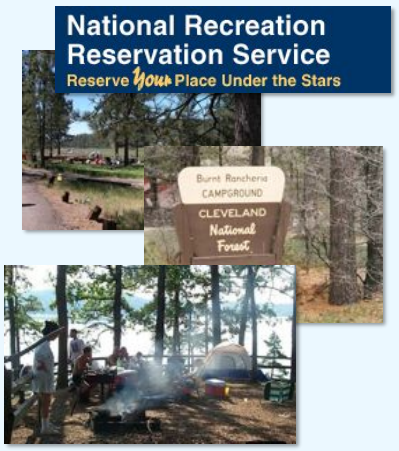
Images: www.entm.purdue.edu, sciencedirect.com, wikimedia.org

Study 1: Approach

- Goal: based on empirical data, create kernel(s) to represent firewood-facilitated dispersal in forest pest spread models
- Unfortunately, quantitative data on firewood transport and usage are lacking
- So, more general approach: explore the travel behavior of campers rather than their use of firewood
  - Then incorporate the limited information available to generally assess contribution of recreational firewood movement to the spread of forest pests in the U.S.

Study 1: Data Source

- National Recreation Reservation Service (NRRS)
  - Online reservations system for US federal camping facilities
- NRRS data for 1/2004 - 9/2009 (>5 years)
  - Approx. 7.2 million individual camper reservations
  - More than 2500 campground locations throughout U.S.



Images: NRRS; USDA-FS Cleveland NF; US Army Corps of Engineers

Study 1: Analysis

- Calculate (Euclidean) travel distances for each individual camper reservation
- Fit statistical distribution functions (curves) to these data: exponential, lognormal, etc.
  - If one fits well, can serve as dispersal kernel

Basically, something like this…

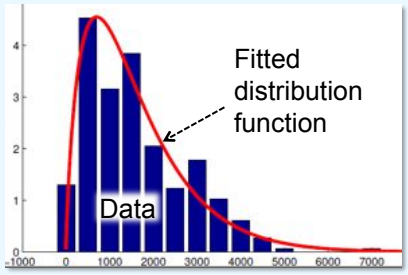
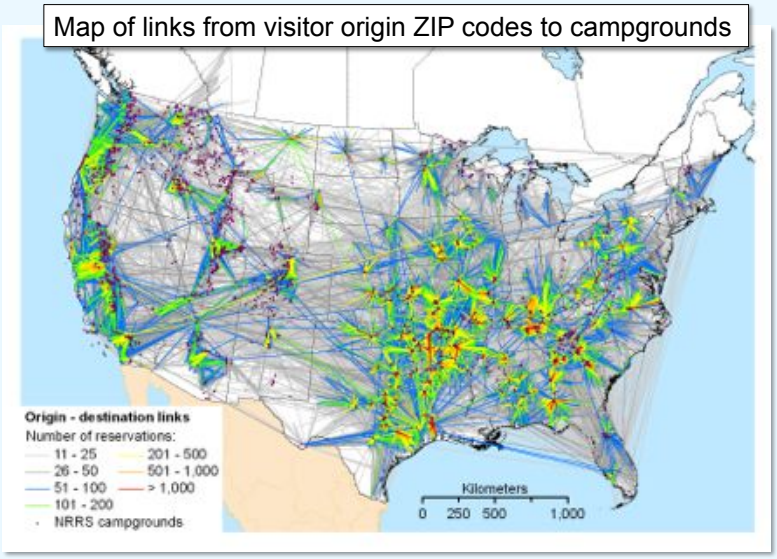
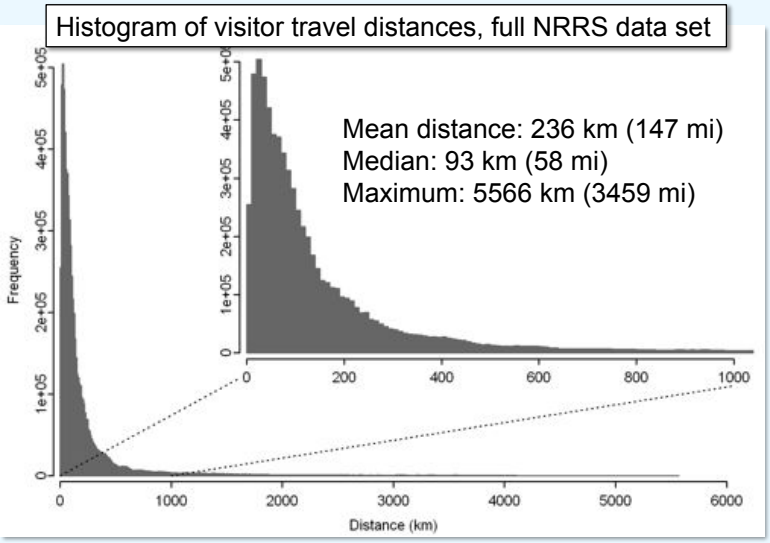


Image: janlo.de (Jan Lorenz)

Map of links from visitor origin ZIP codes to campgrounds

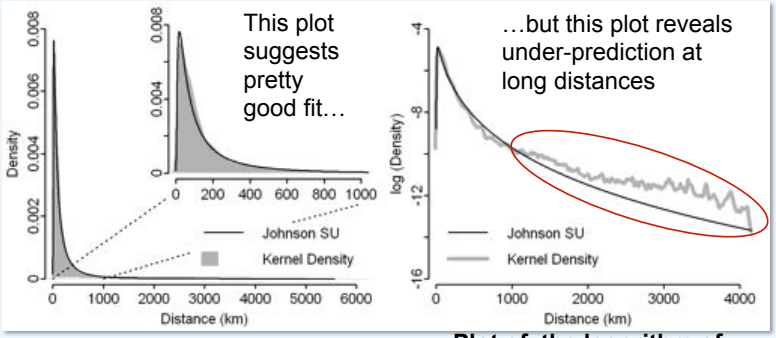


Histogram of visitor travel distances, full NRRS data set



Distribution Fitting: Full Data Set

- Best-fitting statistical distribution: unbounded Johnson (SU); lognormal distribution very similar

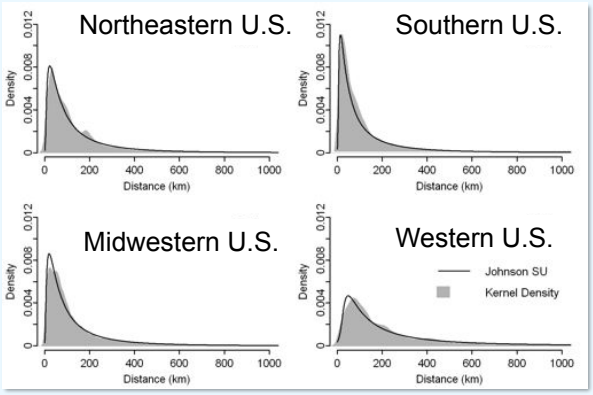


Plot of density vs. travel distance

Plot of the logarithm of density vs. travel distance

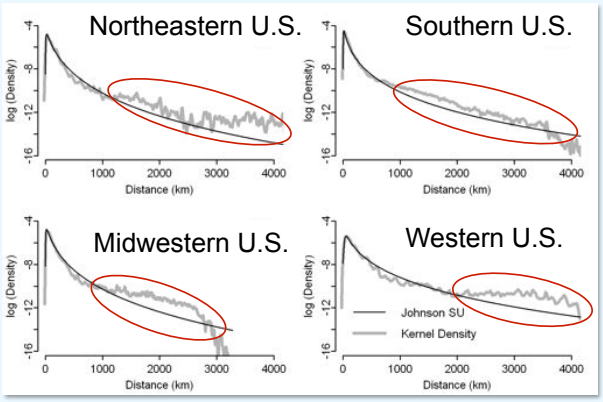
Distribution Fitting: Regional Data

- Similar story for the regions: plots of density vs. travel distance suggest good overall fit…



Distribution Fitting: Regional Data

- …but plots of log(density) vs. travel distance reveal under-prediction at longer distances

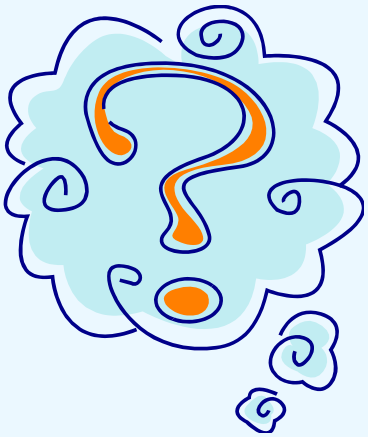


Study 1: Key Points

- Can empirically derive a distribution kernel to simulate long-distance "recreational" dispersal for use in pest spread models
  - May need to customize for specific pest problems
  - Distribution functions offer good, but not perfect, fit to data…especially at longer distances
  - Various alternatives: mixture distributions, etc.
  - In any case, better than not using real data
- Most campers don't travel too far (< 2 hrs drive), but this is enough to enhance "natural" dispersal potential of most forest pests

A Thought Exercise…

- Keep your answer to yourself for now…
- …but can you predict **what percentage of all campground visits involve the movement of infested firewood**?



Relating NRRS Data to Firewood

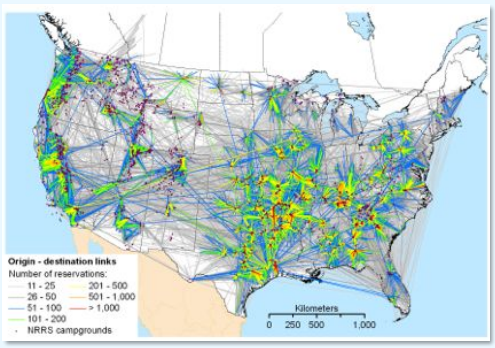
- Based on a few firewood inspections / camper surveys from across U.S. (like Jacobi et al. 2011):
  - ~30-40% of campers bring firewood from elsewhere
  - If ~20% of firewood is infested, then 6-10% of visits involve movement of infested firewood
  - Accounting for things like burning of firewood before pests can escape, seems reasonable to estimate that 3-5% of campground visits pose a risk of firewood-facilitated spread
- Even if far lower percentage, millions of campground visits per year
- Concerns about risk of pest spread due to firewood appear to be justified…**but we'll come back to this!**

Question for Audience…

- Is this estimate (3-5% of camping trips involving infested firewood) close to the prediction you made earlier?

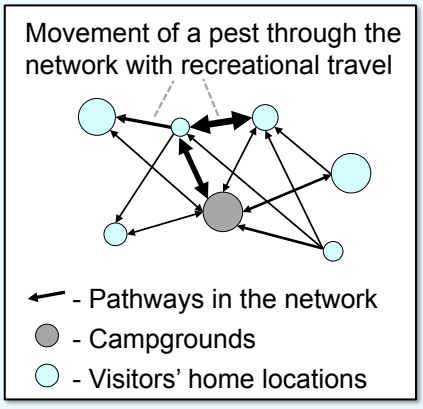
Limitation of "Kernel Approach"

- Recall map from earlier…
- Human-mediated dispersal follows **specific routes** and has a certain set of **specific destinations**
- In short, it's a **network**



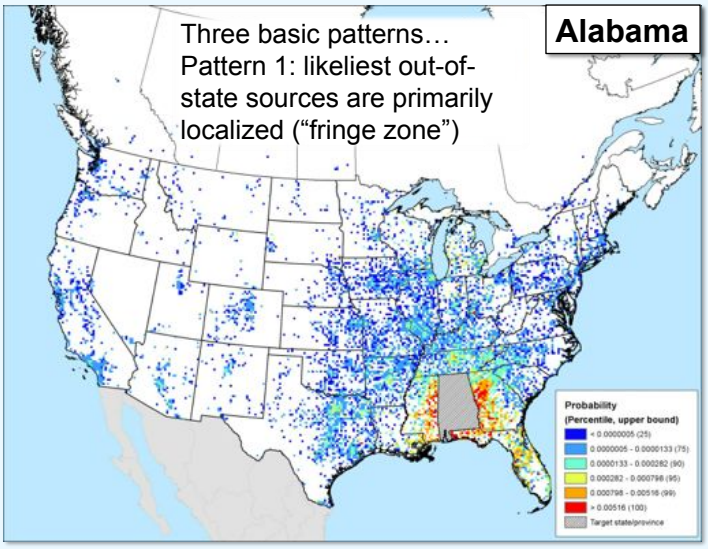
Study 2: Network-Based Approach

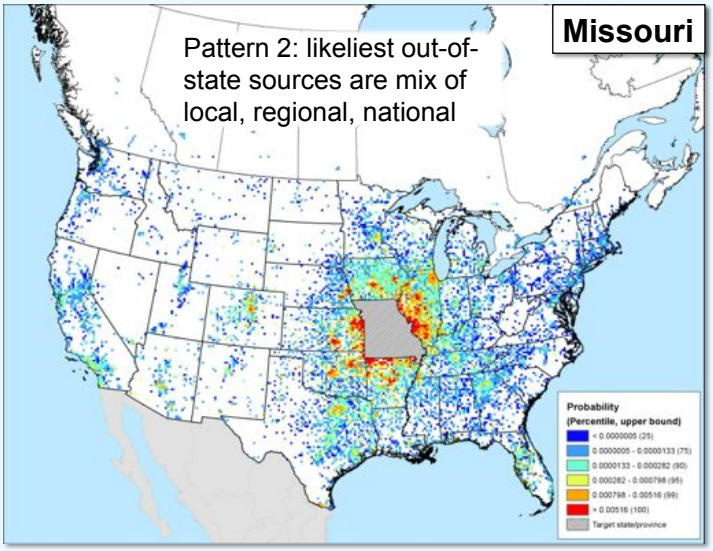
- What if we applied the NRRS data in a network setting?
  - Visitors' homes and campgrounds = two sets of networked nodes
  - Strength of pathways defined by number of campers traveling along them
- Can use this "pathway model" to identify probable origins and destinations

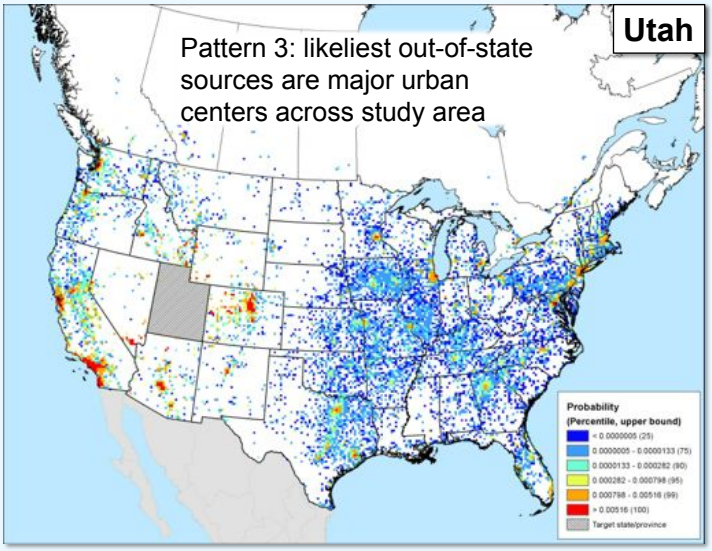


Study 2: Pathway Modeling

- Key question: How to present results?
- Much regulatory decision making takes place at state or provincial level
  - For example, implementation of firewood movement restrictions
- So, for each US state (and Canadian province), we generated a map that sums – for each 15-km map cell outside the state of interest – the probabilities for all pathways between that cell and any destination cell within the target state
  - Maps depict most likely out-of-state origin (or source) locations for the target state




Missouri
Pattern 2: likeliest out-of-state sources are mix of local, regional, national
Probability
(Percentile, upper bound)
< 0.0000005 (25)
0.0000005 - 0.0000133 (75)
0.0000133 - 0.000282 (90)
0.000282 - 0.000798 (95)
0.000798 - 0.00516 (99)
> 0.00516 (100)
Target state/province


Utah
Pattern 3: likeliest out-of-state sources are major urban centers across study area
Probability
(Percentile, upper bound)
< 0.0000005 (25)
0.0000005 - 0.0000133 (75)
0.0000133 - 0.000282 (90)
0.000282 - 0.000798 (95)
0.000798 - 0.00516 (99)
> 0.00516 (100)
Target state/province

Study 2: Key Points

- Output maps highlight key "bottleneck" locations where surveillance, awareness campaigns, etc., are most likely to be cost-effective
  - Thus, immediate applications for decision making
- It is clear that strategies / priorities should differ between regions
  - For example, in the Southern U.S., appears to be some advantage to concentrating activities in communities near state borders
  - In states with a more "national" visitation pattern, not so advantageous

But…Unanswered Questions

- We haven't truly quantified risk. Many unknowns:
  - Does proportion of campers carrying firewood change with distance? (Jacobi et al. 2011 study suggests this is true)
  - Do our studies involving federal campground data translate to state or private campgrounds?
  - Even if 3-5% of all camping trips involve infested firewood, how much of this represents a **meaningful** spread risk?
    - Chance carrying an invasive, non-native pest?
    - Populations sufficient for establishment?

So, What Next?

- We aren't quite "there" in terms of quantifying firewood risk
- However, research can still guide how or where to prioritize **public awareness / outreach** activities

Images: californiaagriculture.ucanr.org; catscorner.mlbblogs.com

Recommendations

- Engage others with a clear, simple message
  - **Don't move firewood more than 50 miles**
  - **Buy locally produced or treated firewood**
- Who needs to be engaged?
  - Boy and Girl Scouts, RV'ers, Lion's Club, park officials / campground attendants, arborists, others
  - **Targeted, local outreach** may be more effective than roadside billboards

Recommendations

- Encourage and aid development of clear firewood policies for parks, campgrounds
- Encourage “wood swap” programs
- Promote local wood sales
- Report forest pest problems!

In Closing…

- Visit this link to InterfaceSouth materials about firewood: http://www.interfacesouth.org/products/changing-roles/changing-roles-notebook/module-5-emerging-issues

QUESTIONS?
COMMENTS?

References

- Haack, R.A.; Law, K.R.; Mastro, V.C.; Ossenbruggen, H.S.; Raimo, B.J. 1997. New York's battle with the Asian longhorned beetle. Journal of Forestry 95: 11-15.
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- Jacobi, W.R.; Goodrich, B.A.; Cleaver, C.M. 2011. Firewood transport by national and state park campers: a risk for native or exotic tree pest movement. Arboriculture & Urban Forestry 37(3): 126-138.

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