Border Enforcement, Importer Behavior, and Trade-Related Invasive Species Risk

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Economic Aspects of Border Enforcement

- Stochastic negative externalities of activities with high social benefit
- protection as a weakest-link public good
- Administrative resource allocation problem
- Importers will respond to incentives, both intended and unintended

Games at the Border

- Port Shopping
  - Re-importation through Canada
  - Avoid smaller ports
- Attempt to target importer by reputation
- Importers respond by masking reputation
  - Difficult to track name changes, although “new” importers can be (are) treated with more suspicion

Research Components

1. **Theoretical Model:** Evaluates both intended and unintended importer response to different border enforcement regimes with a focus on firm-specific and port-specific attributes.
2. **Agent-Based Model (ABM):** Based on theoretical model, spatial explicit, and incorporates firm and port heterogeneity to examine welfare impacts.
3. **Econometric Analysis:** To characterize extent of port-shopping and compliance

Theoretical Model

Models firm response to border enforcement

- Firm determines through which port to ship, how much to export, and how much to treat
- Regulators determine the intensity of inspections and border treatments, and set tariffs and penalties

Results of the Theoretical Model

- Increased inspection likely to decrease the optimal level of output
- Increased inspection may increase or decrease the total point-of-origin treatment
- Increased inspection intensity may not lead to a reduction in pest risk
- Optimal inspection regime may be robust to increases in pest population
  because optimal point-of-origin treatment increases

Simulation (Agent-Based) Model

- Implemented in NetLogo software
- Incorporates the theoretical model as well as a spatially explicit damage function
- Three agents: importers, inspectors and pests
  - Importers choose pretreatment level, port, want to minimize costs
  - Inspectors choose to inspect or not, have base ability to search, choose to treat/destroy infected shipments, set fees and fines
  - Pests only have ability to establish and spread based on the damage function

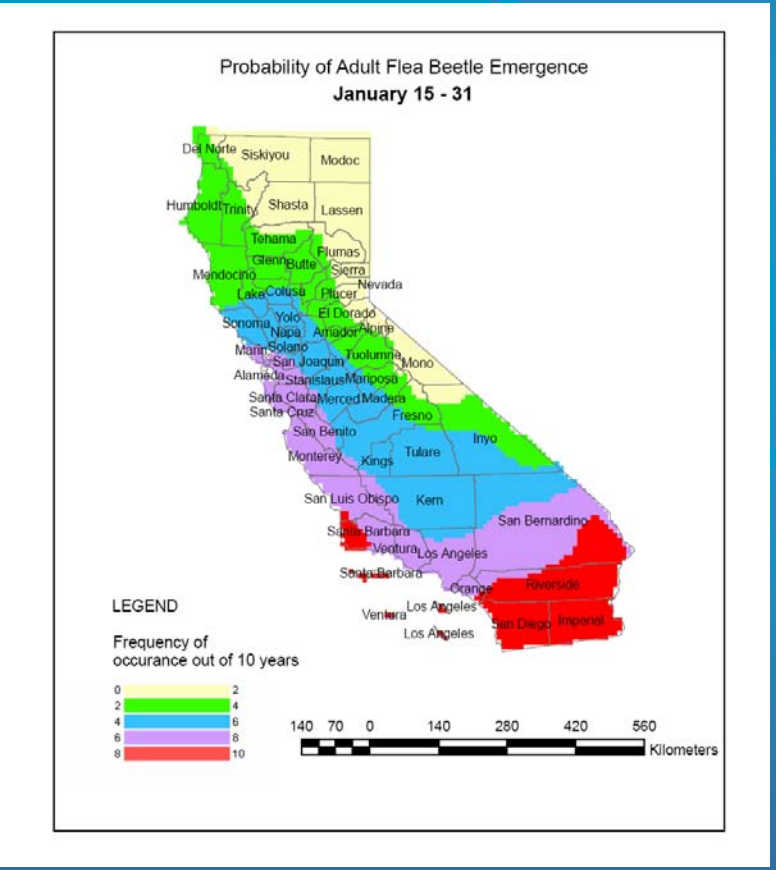
Sample Commodity, Location and Invasive Species

- Commodity: Broccoli
- Location: California
- Invasive Species: Crucifer flea beetle
  (Phyllotreta Cruciferae,Coleoptera: Chrysomelidae)

www.team.ars.usda.gov/posters/lifecycle.pdf

Spatial Damage Function Component

- Risk probability maps
  - –based on two week periods
  - –represent frequency of occurrence of the adult beetle out of 10 years
- Created using degree days model

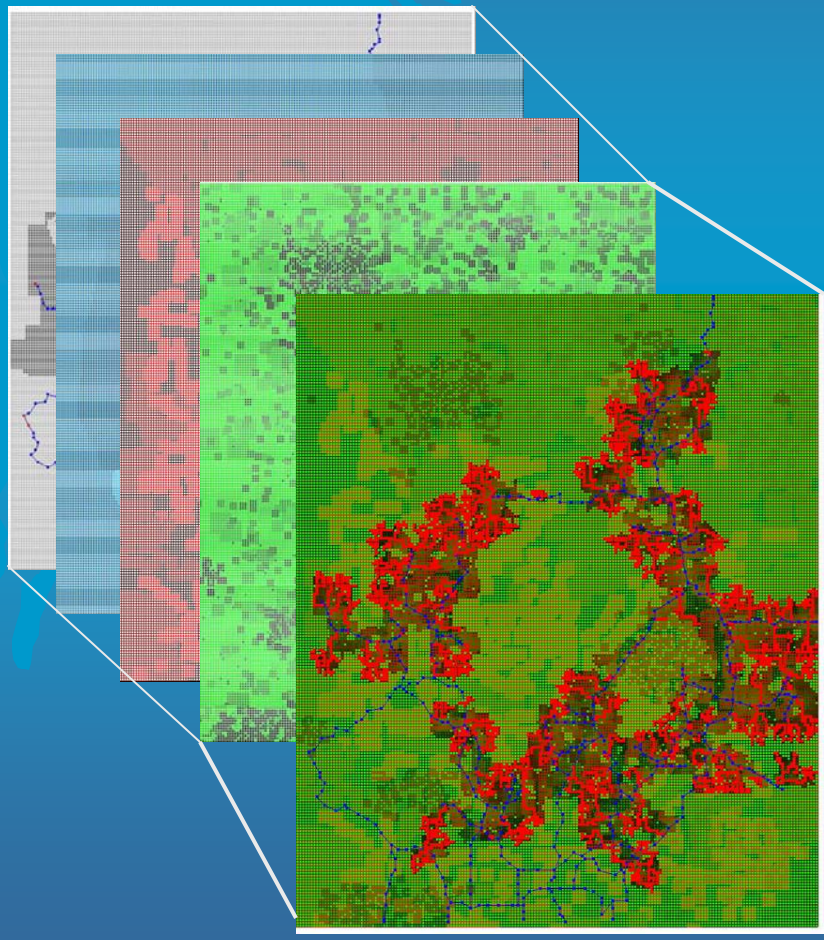


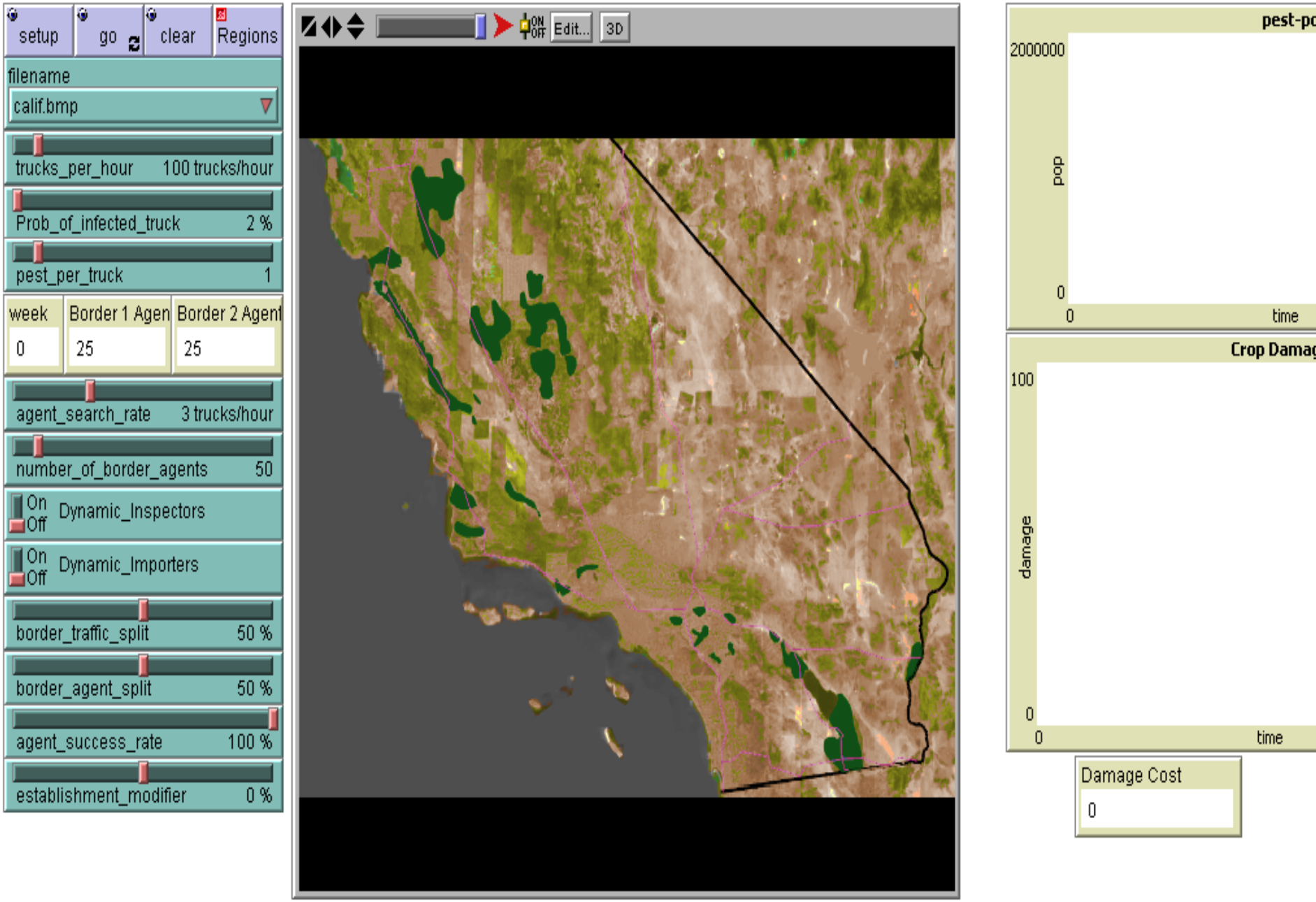
Spatially Explicit Agent Based Models

Agents
- Importers
- Regulators
- Pests, etc.

Landscape
- Roads, cities, boundaries
- Natural features
- Native animal populations
- Locations of affected industries (e.g., crops)

Dynamic
- Event sequencing
- Interaction rules
- Stochastic events

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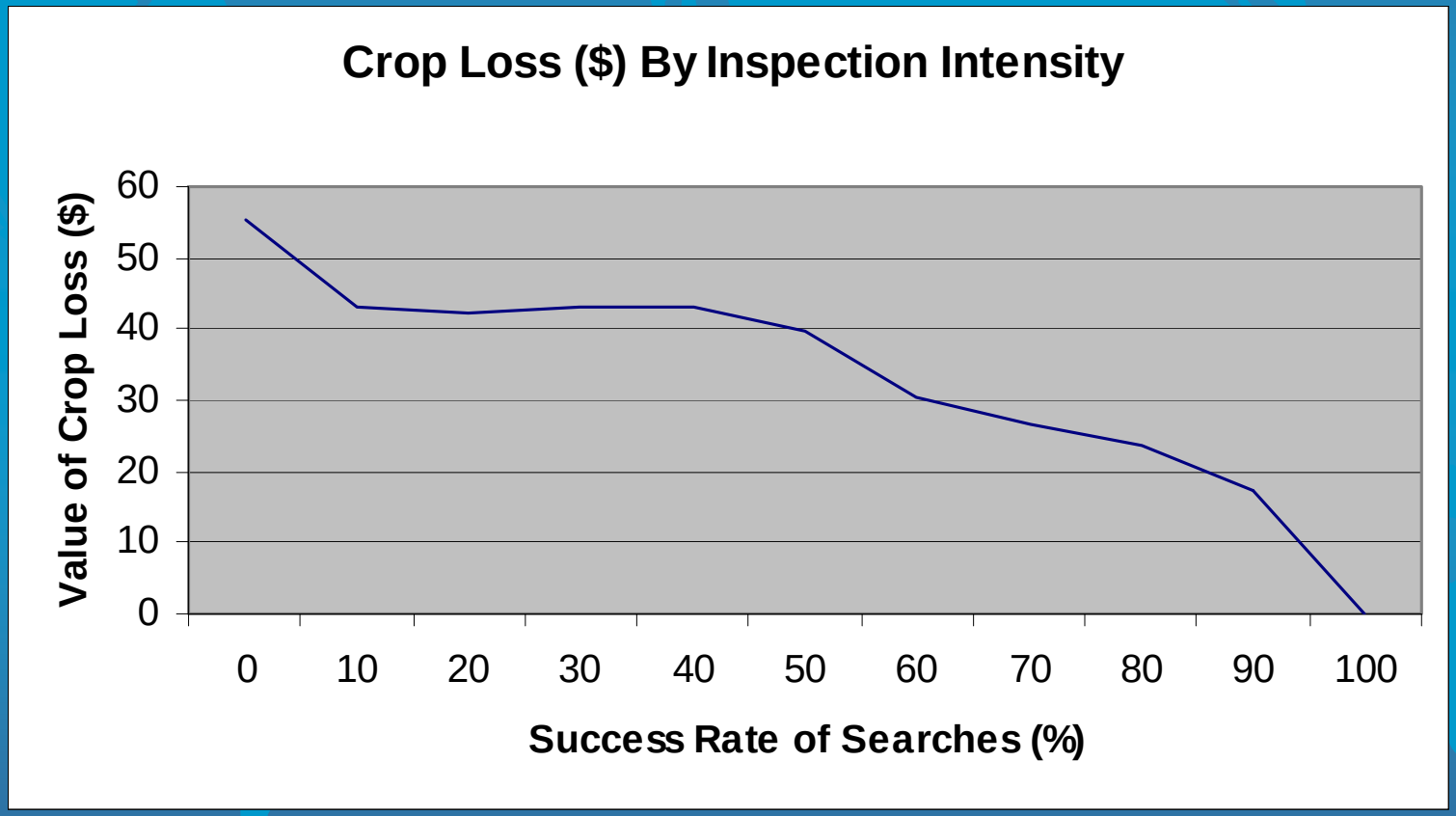
Simulation Results

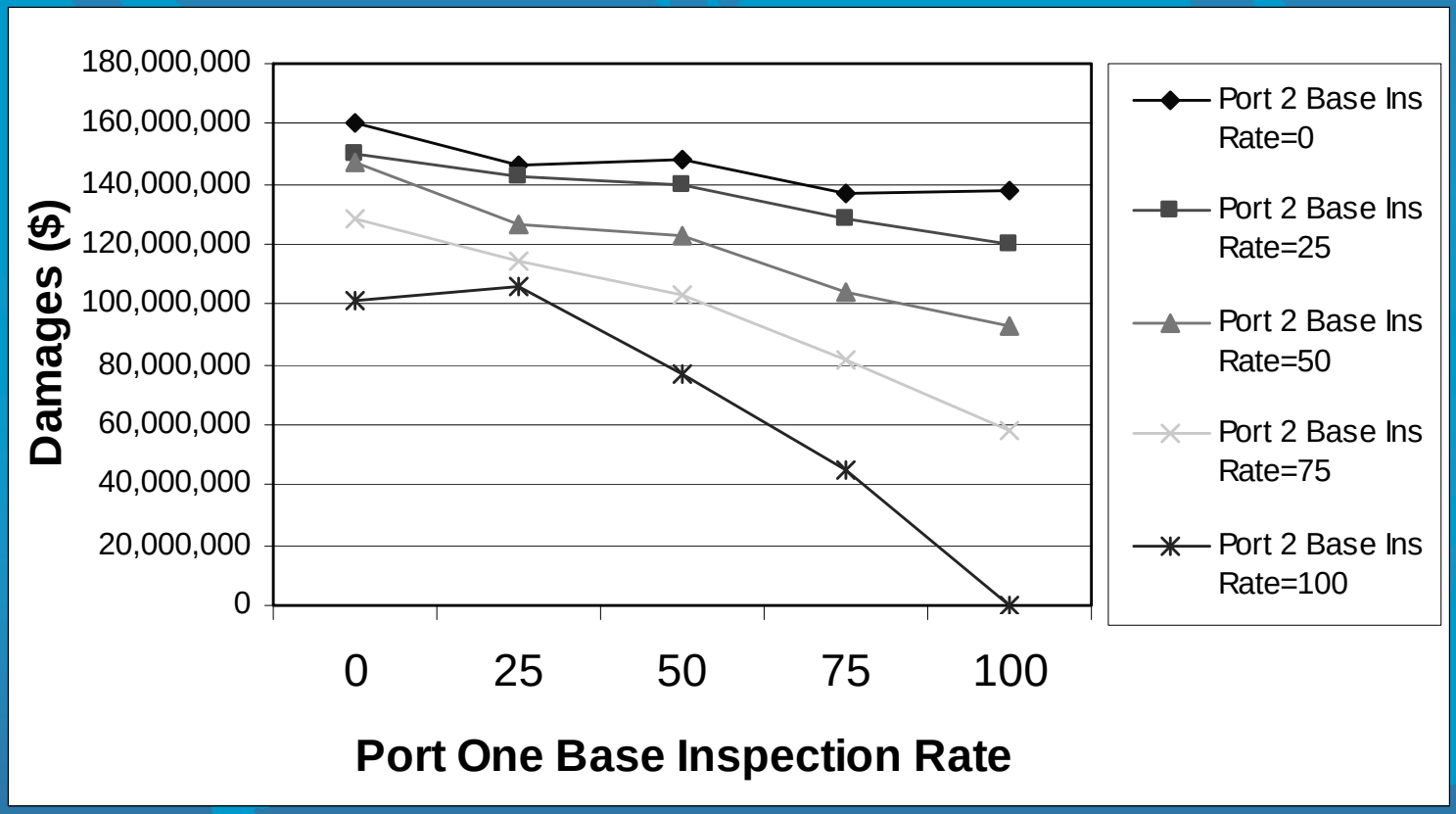
Crop Loss in Millions of Dollars From Increasing Inspection Intensity



As inspection quality increases, the total monetary loss of crops decreases.

Simulation Results

Crop Loss in Millions of Dollars From Increasing Inspection Intensity across two land ports, with heterogeneous firms



Lower damages result when we allocate resources equally across ports than when we increase inspection at one port

Some Implications of the Modeling Exercise

- Increasing inspection rates or ability to successfully inspect increases pretreatment efforts
  - Ports need to be consistent amongst each other in their rates (reduces port shopping and weakest-link)
- More pretreatment results in lower damages
- Identifying repeat violators results in lower damages

Some Implications of the Modeling Exercise

- Lower pretreatment costs (and/or increased effectiveness of pretreatment) increases pretreatment efforts and greatly decreases damages

This effect swamps impact of inspections - highlights benefits to increased cooperation!

Empirical Analysis

- (Hopefully with support from ERS!)
- Data on avoidance not available – can we measure port-shopping anyway?
- Use previous models and examine data for differences across ports and time to address four research questions:

Research Questions

- What are the effects of changes in enforcement on firm behavior across ports of entry?
- How does the response of importers of identical agricultural products differ between countries, or by shipment size (smaller versus larger importers)?
- Do firms port shop between ports in a country or instead reduce how much they ship to the country?
- How should sanctions and inspection regimes be structured to discourage an importer from choosing a more harmful deviation from the required protocol?

Challenges

- Data collection and quality inconsistencies across ports
  - e.g., paper forms, data “reconstruction” at end of shifts, varying level of knowledge and training
- Diverse focus of inspection goals
- Coordination across ports, agencies
- Sensitivity and abuse of data

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Presentations

- Sean B. Cash. “Environmental Stewardship Across the Border.” *New Leadership in U.S.-Canada Relations*, Center for Strategic and International Studies, Washington, D.C., June 27, 2006
- David Zilberman (presenting), Holly Ameden, and Sean B. Cash. “Integrating Location Theory with Risk Management for Invasive Species Management.” Workshop on the Program of Research on the Economics of Invasive Species Management, Economic Research Service, United States Department of Agriculture, Washington, D.C., October 2006.
- David Zilberman (presenting), Holly Ameden, and Sean B. Cash. “Invasive Species Management: Border Enforcement, Location Theory, and Risk.” Invited presentation, Bren School of Environmental Science and Management, University of California, Santa Barbara, November 2006.
- Sean B. Cash (presenting), D. Angele Vickers (presenting), Holly Ameden, and Sean B. Cash. “Border Enforcement and Trade-Related Invasive Species Risk.” Research on U.S. Policy Workshop, Institute for United States Policy Studies, Edmonton, Alberta, November 2006.
- David Zilberman (presenting), Holly Ameden, Sean B. Cash. “Invasive Species Management: Importers, Border Enforcement, and Risk.” Paper presented as a Selected Paper at the 2007 American Agricultural Economics Association (AAEA) Annual Meeting in Portland, Oregon, July 29 – August 1.
- D. Angele Vickers (presenting), Sean B. Cash, Holly Ameden, and David Zilberman. “An Agent-based Model of Border Enforcement for Invasive Species Management.” American Agricultural Economics Association, Western Agricultural Economics Association, and Canadian Agricultural Economic Society, Joint Annual Meeting, Portland, Oregon. July 29 – August 1, 2007.
- Sean B. Cash and Angele Vickers, expert witnesses in an inter-agency workshop sponsored by the Alberta Government: Alberta Invasive Species Risk Assessment Tool Workshop, Alberta Invasive Alien Species Working Group, Edmonton, Alberta, March 13, 2007.
- Joseph S. Mayunga. “Border Enforcement, Importers, and Trade-Related Invasive Species Risk: Spatial Damage Function Component, Sample Results.” Texas A&M, 2007.
- Sean B. Cash. Panelist participation in an Organized Symposium "On the Border: The Inspection and Regulation of Imports." 2008 AAEA & ACCI Joint Annual Meeting in Orlando, Florida, July 27-July 29.

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Modeling – Importers

- Shippers want to minimize their costs which include pretreatment efforts (e_i) transportation costs (t_{ij}) and their expected costs of fines and fees for being caught with an infected shipment ($S_j[\gamma v Qi + r(1-\gamma)Q_i + f]$)

$$c_i = e_i k_i + t_{ij} + S_j[\gamma v Qi + r(1-\gamma)Q_i + f]$$

Modeling – Inspectors

- Inspectors will be able to determine their inspection rates

  Rate of Inspection: $I_j = \rho + \theta \sum_{t=2}^{T} \frac{n_{it}}{2^t},$

  where I_i is bound between 0 and 1, n_i is a binary dummy variable (=1 if importer has been caught with a violation), and ρ is the "base" rate of inspection

Modeling - Inspectors

- Success rate of inspections:

$$S_j = \beta I_j b_i p_i$$

where: β is the base ability of inspectors

b_i indicates if bugs were originally present

p_i indicates if bugs are present after pretreatment

I_j indicates rate of inspection