The Effect of Spatial Interpolation on the Hedonic Model: a Case of Forest Pest Damages

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Introduction

- Estimate a hedonic model of the Hemlock Wooly Adelgid (HWA) infestation in central Connecticut and central Massachusetts in the northeastern U.S.

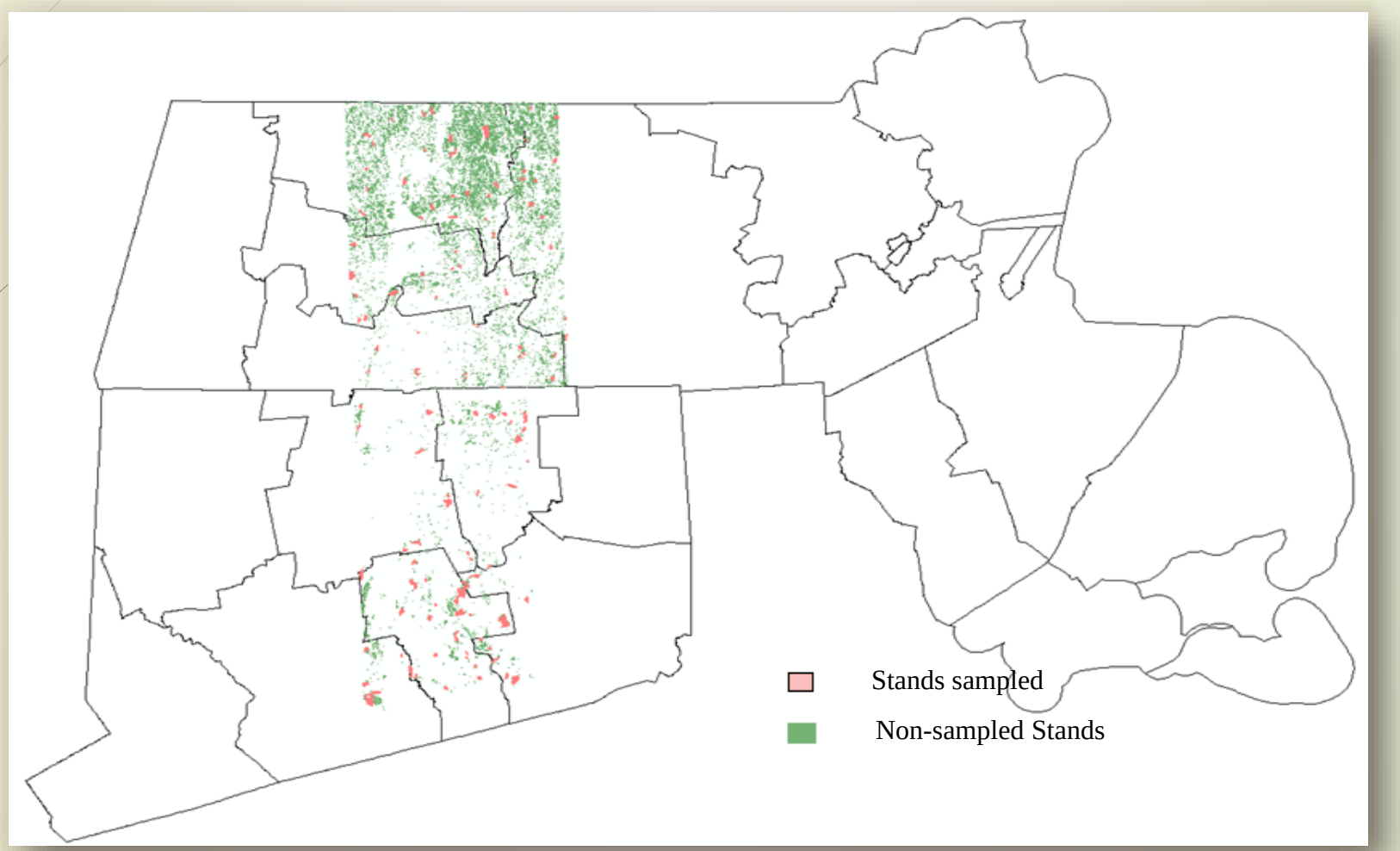
- Site-specific case studies: Hemlock Wooly Adelgid is shown to diminsh property values (Holmes et al., 2006 & 2010).

- Scale up damage data to the geographic extent of the HWA infestation and then estimate the economic model.

Motivation

- **Spatial interpolation** has only seen limited use in economic analyses:
  - air pollution (Beron et al. 2004, Anselin and Gallo 2006, Fernandez-Aviles et al. 2012)
  - water quality (Ara et al., 2006).
- While air and water pollution may be continuous in dispersal through space, Hemlock trees are clustered in discrete (lumpy) stands.
- Explore how different spatial interpolation approaches affect the performance of hedonic property value models.

Hemlock Stands in Study Area



Data

- **HWA Damage Data** for 2007, 2009 and 2011
  - Central Connecticut and Central Massachusetts (10 counties)
  - Field survey of 141 hemlock stands
  - Live basal area and Vigor

- **Aerial Photographs**: all hemlock stands (6,127 polygons) – by Harvard Forest

- **Residential Property Data**
  - House attributes and sale prices from DataQuick

- **National Land Cover Data** (2006)
  - Water, open space, high developed district, forest, agricultural land and wetland.

Spatial Interpolation

- **Interpolation Variables**
  - Live basal area (m^2/ha): diameter at basal height;
  - Vigor (1 → 0 – 25% foliar loss; 2 → 26-50% foliar loss; 3 → 51-75% foliar loss; 4 → 76 – 99% foliar loss)

- **Interpolation Methods (cross validation)**
  - IDW (Inverse Distance Weighted)
  - Kriging (Simple Kriging, ordinary Kriging, Universal Kriging)
  - Spline: (Completely Regularized Spline, Tension Spline, Thin Plate Spline, Multiquadric spline)

Model Specification

- **Traditional Hedonic Model**

$$ln\,P_{it} = Z_i\alpha + L_i\beta + lba_{it}\gamma_t + lba\_vigor_{it}\theta_t + \tau_t + \omega_j + \varepsilon_{it}$$

lba_{it} is live basal area

lba_vigor_{it} is interaction of live basal area and vigor.

- **Repeat Sale Model**

$$ln\,P_{it} - ln\,P_{it-1} = (lba_{it} - lba_{it-1})\gamma_r + (lba_{it} * vigor_{it} - lba_{it-1} * vigor_{it-1})\theta_r + \tau_t + \omega_j + \varepsilon_{it}$$

Conclusions

- Based on spatial interpolation results, HWA infestation had significant effects for 0.1km buffer.
- Two effects:
  - Ability to use site specific data for all sale properties.
  - Ability to employ repeat sales model.
- Inverse Distance and Spline are similar, Kriging differs due to scaling.
- From cross validation results, caution should be taken because of the prediction error for spatial interpolation**.**