KEL
KNOWLEDGE ENGINEERING LABORATORY

Estimating the spatial pattern and extent of hemlock mortality after HWA infestation in the Linville River Gorge via aerial imagery

Sheryl Strauch[1], Tuula Kantola[2], Maria Tchakerian[1], Robert Coulson[1] & Douglas Streett[3]

[1]Knowledge Engineering Laboratory, Dept. of Entomology, Texas A&M University, College Station, TX

[2]Dept. of Forest Sciences, University of Helsinki, Finland

[3]USDA Forest Service, SRS, Pineville, LA.

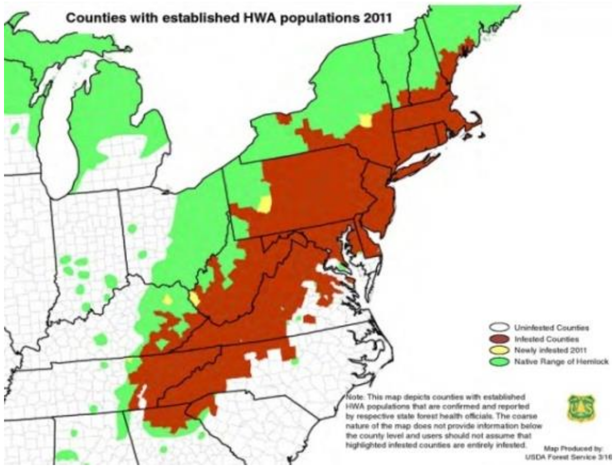
UNIVERSITY OF HELSINKI
FACULTY OF AGRICULTURE AND FORESTRY

FOREST SERVICE
U S
DEPARTMENT OF AGRICULTURE

SFIWC 2013

What's bugging us?

- Invasive species are often a significant threat to US Forests
- Severe outbreaks cause major changes in landscape structure, function, and composition
- Hemlock woolly adelgid's (HWA) rapid spread and infestation throughout eastern forests
  - Goal: to understand effects of this invasive species and obtain more data on the impact of HWA because so little known
- Data quantifying damages does not exist
- Field data is lacking
- Gaps created in forest following tree mortality
- We need more information about HWA effects!



Study Objectives

1) Estimate number and locations of dead trees in study area

2) Estimate the area covered by dead trees

3) Study the spatial pattern of dead trees

https://gustavus.edu/arboretum/treelist.php

HWA

- An invasive species causing high mortality in Eastern Hemlock

http://www.nps.gov/grsm/naturescience/hemlock-woolly-adelgid.htm

Eastern Hemlock

- Long lived and extremely shade tolerant
- Foundation species
- Habitat for a diverse of number of species
- No resistance to HWA observed

http://www.flickr.com/photos/ozark_pix/243308376/

Study Area

- The Linville River Gorge, Pisgah National Forest, North Carolina
- ~26 km^2 area
- Upper half of the Lower Linville River watershed
- Known presence of Eastern hemlock and HWA infestation
- 0.4 km^2 of shadows were excluded from analysis

Data

- 1m resolution CIR Imagery-2012
- CIR is highly useful in forest assessment
  - Actively growing plants exhibit high NIR reflectance
  - Differentiating species
  - Distinct colors for identifying live vs. dead
- 15cm resolution reference RGB aerial photo imagery-2010

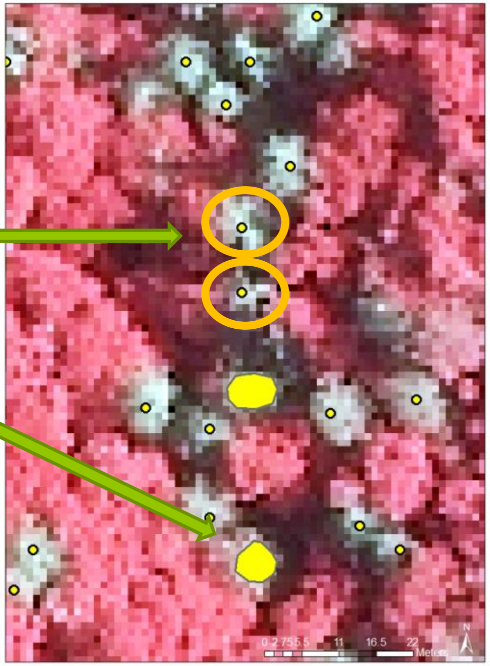
RGB

CIR

Methods: Dead Tree Identification

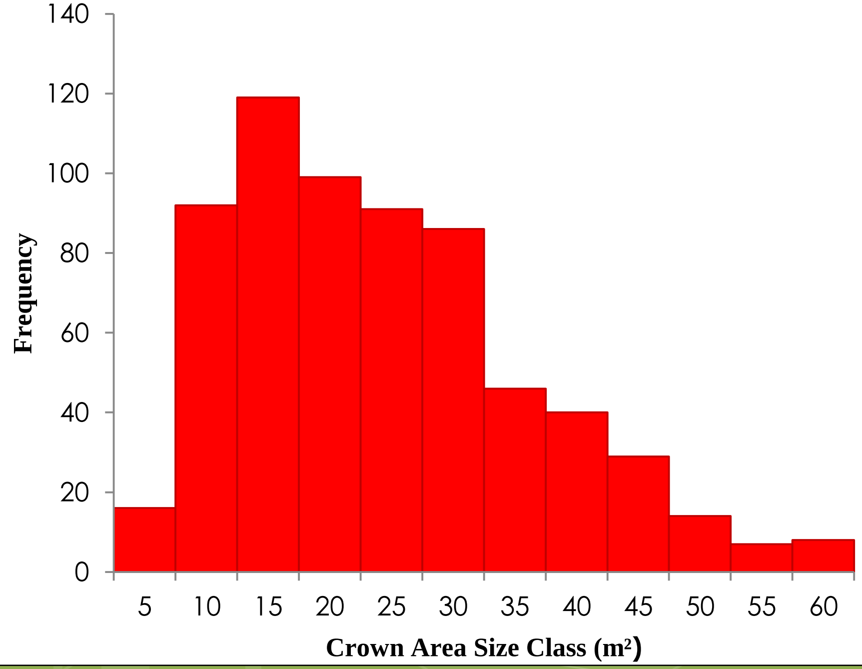
- All dead trees were located and digitized with points
- A random 10% subsample was taken and used for crown area estimation via polygon creation
- Total area covered by dead trees was estimated using distribution of crown polygon areas by entire population
- Assumed constant distribution throughout the population

Dead tree crowns



Results: Dead Tree Identification

- 6465 dead trees identified and located (assumed dead trees to be hemlocks)
- 647 tree crown areas digitized
- Crown area distribution (assumed population has same distribution throughout)
- Average dead tree crown size of 24 m^2
- Dead trees cover 0.6% of the study area



Methods: Spatial Pattern Analysis

- Grid of 1 sq. km cells
  - 36 subareas

Ripley's K function

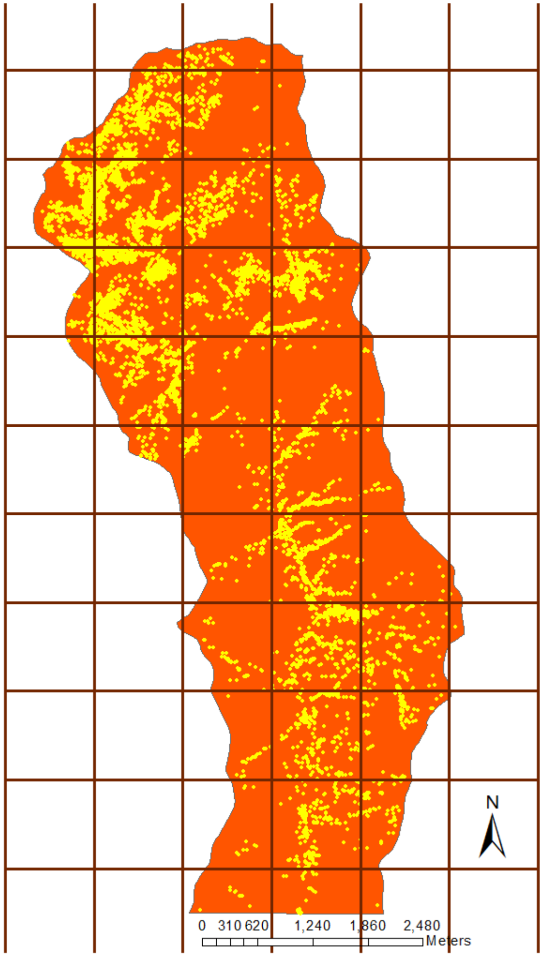
- Tests for deviation from (CSR), complete spatial randomness
- Describes spatial pattern over different spatial scales
- Null hypothesis: K function of the point pattern does not vary significantly from the homogenous Poisson process

$$\hat{K}(t) = \hat{\lambda}^{-1} \sum_{i} \sum_{j \neq i} w(l_i, l_j)^{-1} \frac{I(d_{ij} < t)}{N}$$

Linearized K function (L function)

- Easier to interpret
- Variance of all values of t in L function is almost constant

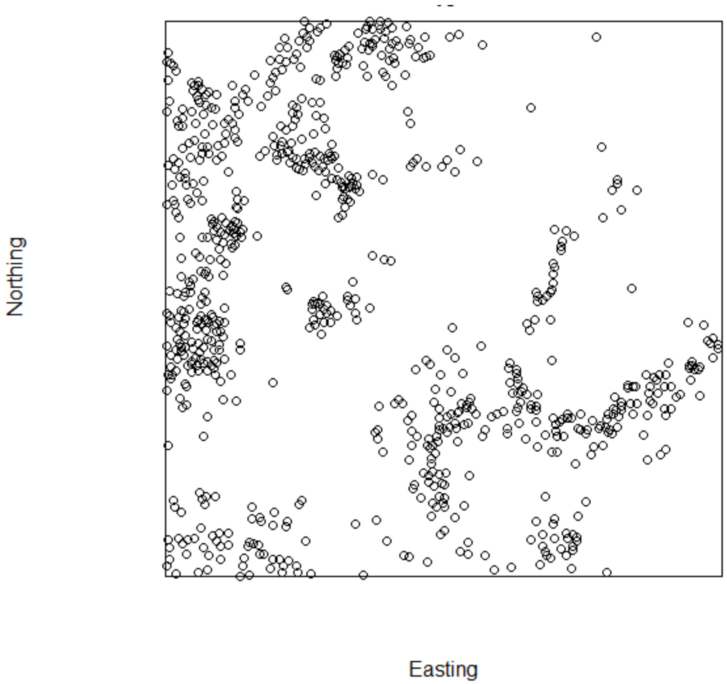
$$\hat{L}(t) = [\hat{K}(t)/\pi]^{1/2}$$

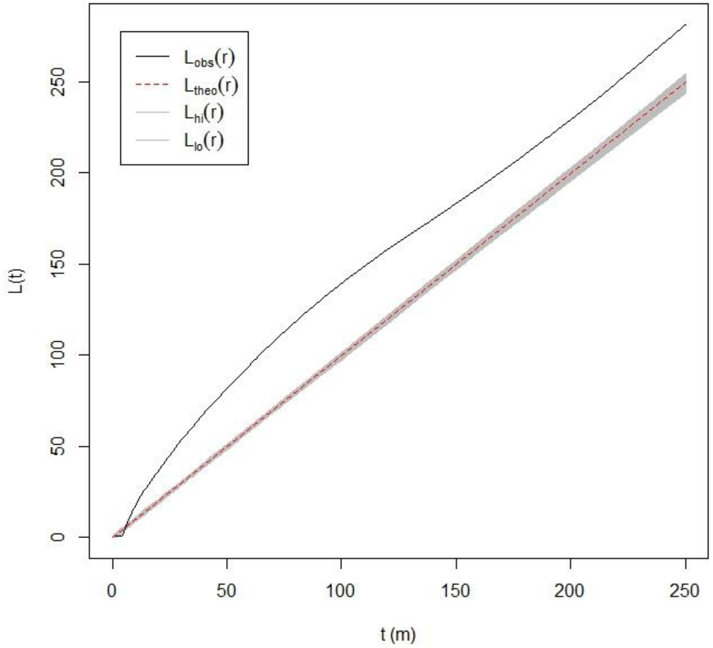


Results: Spatial Pattern

- Clustering at nearly all scales
  - L(t) = 0, pattern is random
  - L(t) > 0, pattern is clustered
  - L(t) < 0, pattern is regular

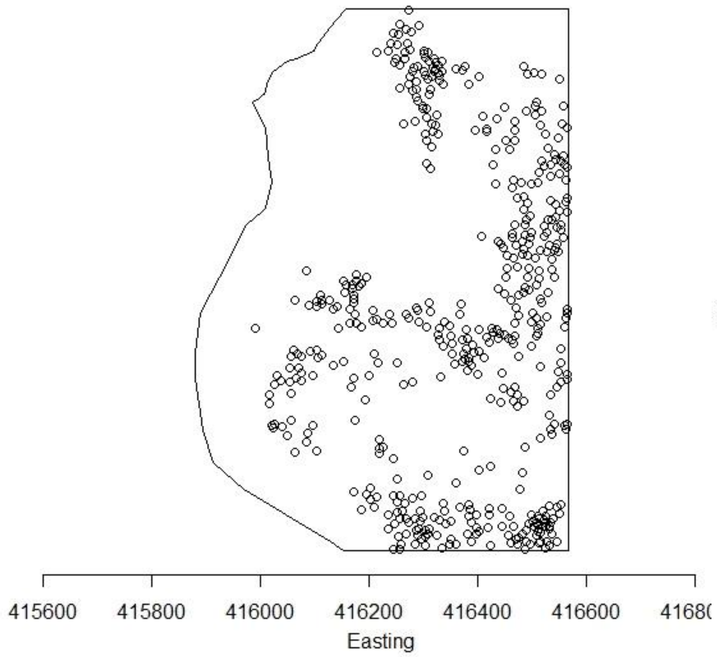
- Number of dead trees per subarea ranging 10 to 839

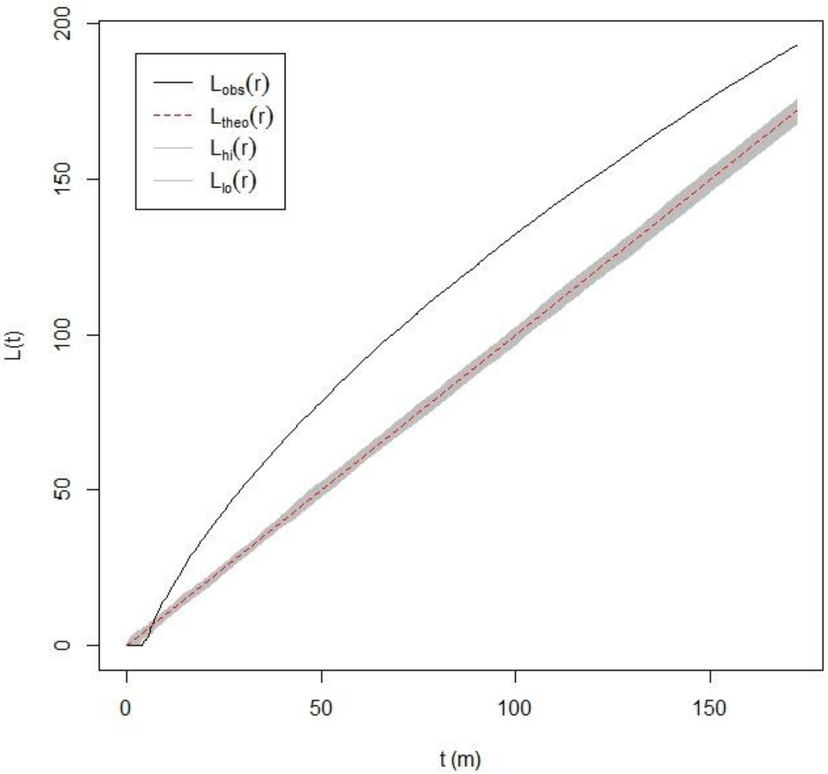




Sample size: 768

Results: Spatial Pattern





Sample size: 494

Conclusions

- Dead trees covered 0.6% of the study area
- The spatial pattern of dead trees was clustered
  - This may provide useful evidence in the future spread and mortality pattern by HWA
- Distribution skewed to the right
  - We think because of understory trees not being visible, thus not as many identified
  - No seedling or young stands present
- Results help estimate future forest gaps
  - Estimating impacts of invasive species
- Ground truth data needed to assess accuracy of visual identification of hemlocks

Questions?

http://mdmpix.com/2009/2009-10-21_003/