

Proposal Outline: Exploring the Interaction between Land Fragmentation and Hemlock Woolly Adelgid Infestations in the Great Smoky Mountains National Park

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Introduction

Land fragmentation is currently having profound effects on many ecosystems. However, the interaction of land fragmentation with disturbances such as pest/pathogen infestations is still an open area of research. One place where pest outbreaks and land fragmentation now intersect is the Great Smoky Mountains National Park (GSMNP). This park has experienced land fragmentation from logging, fire suppression, and infrastructure development, and is currently experiencing a devastating outbreak of hemlock woolly adelgid (HWA). The continued loss of hemlock stands in cove forests will result in negative consequences for the high levels of biodiversity found there.

The overall goal of this proposal is to explore how HWA outbreaks in the GSMNP correlate with land fragmentation. The objectives of this proposal are to:

- Develop a simple model of GSMNP land fragmentation for use in identifying HWA-susceptible patches
- Gather HWA infestation data from the US Forest Service (USFS) and compare this to HWA infestation sites obtained from Landsat imagery, following the method used by Bonneau (1999).¹
- Use a graph-theoretic approach to identify areas where pest occurrence is highly correlated with land fragmentation, areas important to the further spread of HWA that should be targeted for pest management by the USFS, and where HWA is likely to persist in small numbers.

Study Area

The work will be done entirely within the GSMNP. It is a good study area because of its land fragmentation history, active outbreak of HWA, and there is an abundance of ecological data collected from here.

Methods

I will use GIS to map the distribution of patches susceptible to HWA, and that have been infested by HWA both now and in the recent past. I will then use a graph-theoretic approach to assess the correlation of HWA in these patches with land fragmentation.

Data: I will use existing GSMNP land cover and HWA infestation data, provided by the USFS.

Analyses:

- Task 1: Identify all hemlock stands from the land cover data large enough to support a population of HWA.
- Task 2: Map current and past infestations of HWA using both USFS and satellite-derived data
- Task 3: Map as graph nodes each susceptible stand, with active infestations in a different color. Identify nodes that are critical to the further spread of HWA to remaining hemlock stands.

Anticipated Results

- Task 1: I anticipate having the land fragmentation model showing locations and sizes of all hemlock stands.
- Task 2: A point or polygon layer of ground-confirmed HWA infestations will be obtained from the USFS. A Landsat TM-derived polygon layer will be generated that should include these ground-confirmed HWA infestations as well as potential locations for other infestations not yet confirmed by ground observation.
- Task 3: A graph of susceptible hemlock stands will be created, and critical nodes for HWA spread will be identified. This graph will allow the generation of “what-if” scenarios of HWA spread—we can see how HWA spread will be altered by the removal (by pesticide treatment or harvest) of one or more of these critical nodes.

¹ Bonneau, L.R., Shields, K.S., Civco, D.L. 1999b. Using satellite images to classify and analyze the health of hemlock forests infested by the hemlock woolly adelgid. *Biological Invasions* 1: 255-267.