Studying Correlations Between Land Fragmentation and Pest/Pathogen Outbreaks in North Carolina

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Introduction

The ecological consequences of land fragmentation are well known, and are an ongoing topic of research. Fragmentation is often an indicator of low species diversity, more disturbance, and more edge habitat. It can also facilitate the spread of invasive species through an increase in edge habitats, while hindering the dispersal of other species between habitat patches. While the ecological consequences are considerable, the altered species compositions and patch connectivity created by land fragmentation might also have more direct economic consequences, by impacting valuable human resources such as crops or pine plantations. Few studies have been done to analyze what consequences land fragmentation might have on the persistence of pests and pathogens. Knowledge of how local outbreak risks might pertain to nearby land fragmentation can help guide simple decision-making, such as which pests and pathogens might be a problem in a particular area, what and how much pesticide to apply, or whether to apply any at all, if the farm or forest of interest is far enough away from pest sources.

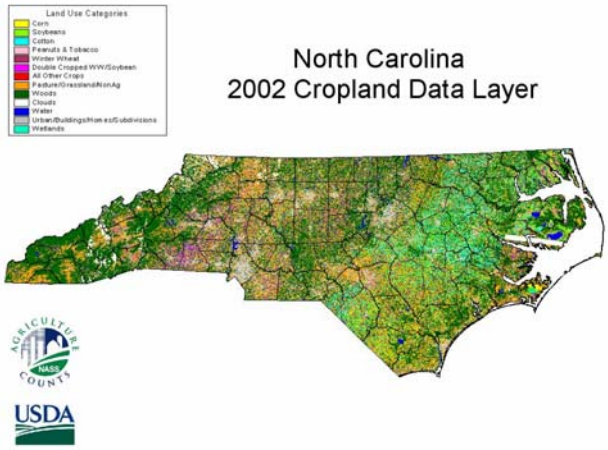
Research Question

The question this project seeks to explore is how agricultural and forest pest outbreaks correlate with land fragmentation in North Carolina. This project will consist of developing a simple model of land fragmentation and susceptibility for a small number of pest and pathogen types using ArcMap's Model Builder tool. This will allow identification of areas where pest occurrence is highly correlated with land fragmentation.

Description of Spatial and Attribute Databases Used

1. Land Cover Data: This data will be taken from the 2001 National Land Cover Dataset (NLCD 2001), available for free download from the USGS Seamless Data Server.[1] The NLCD 2001 is derived from 30x30 meter resolution Landsat TM imagery. The important land cover classes for this project will be forest (hardwood, pine, and mixed), agricultural fields, grassland, and development.

2. Crop Distribution Data: The Cropland Data Layer for North Carolina (shown at right) comes in DVD format at a cost of $50, and can be obtained within 1-2 weeks.[2] This data layer produced by the National Agricultural Statistics Service (NASS) shows the distributions of the 6 most planted crops in NC, at 30x30m resolution for compatibility with the NLCD 2001.



3. Pest/Pathogen Requirements: To determine the suitability of patches for each pest/pathogen, information about habitat requirements and host plants is required, and can be obtained from the National Agricultural Pest Information System

[1] http://seamless.usgs.gov/
[2] http://www.nass.usda.gov/research/Cropland/SARS1a.htm

(NAPIS) website. Since many of these disease agents specialize on particular crops, their potential habitat will likely be restricted to that particular crop class in the Cropland Data Layer. For forest pests/pathogens, suitable habitat will be restricted to the Pine Forest and Mixed Forest land cover classes of the NLCD 2001 dataset.

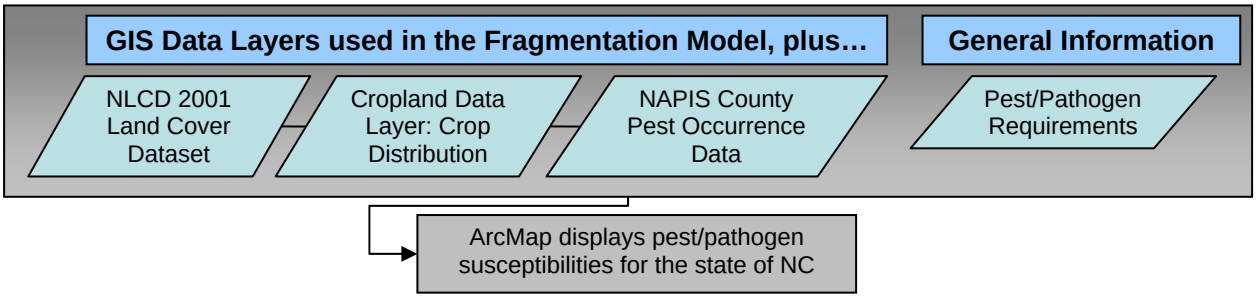
4. Pest/Pathogen Occurrence: Most of this data is also available from NAPIS for download. The agricultural pests with available distribution maps from this site are listed at right. In addition to these, this project will consider the Southern pine beetle, which is responsible for some of the largest tree losses of any insect in North Carolina.[7] Soybean rust and the soybean cyst nematode will also be considered, since these are both responsible for major soybean losses in NC, which currently produces 80% of US-grown soybeans.[8]

Pests/Pathogens with distribution maps available from NAPIS[3]:
Alfalfa weevil *Hypera postica*
Cereal leaf beetle *Oulema melanopus*
Corn rootworm, northern *Diabrotica barberi*
Corn rootworm, western *Diabrotica virgifera*
European gypsy moth *Lymantria dispar*
Sweetpotato weevil *Cylas formicarius elegantulus*

Distribution maps available elsewhere:
Southern pine beetle *Dendroctonus frontalis*[4]
Soybean rust *Phakopsora pachyrhizi* and *P. meibomiae*[5]
Soybean cyst nematode *Heterodera glycines*[6]

Methodology

1) Determine pest requirements, such as host plant types and cold tolerance, that will affect which land cover classes will support the pest. This information is available from NAPIS.
2) Obtain pest occurrence data by county. Pest occurrences on NAPIS are usually recorded at the county level, which makes this the analysis unit of choice.
3) Develop a land fragmentation model using both the NLCD 2001 dataset and the Cropland Data Layer. This model will be used to identify suitable patches of a minimum size (the default will be 1 acre; the user can change this) for pest outbreaks and pest population persistence. A 50-mile buffer will be created around the state border so that edge counties do not have different fragmentation levels than inner counties due to their edge status.
4) Use ArcMap to view patches susceptible to outbreaks, with pests displayed in different colors. These results will be generated from a fragmentation-susceptibility model created in Model Builder that combines the aforementioned data sets (see below). At all times, a state road layer and city boundary layer (available from the UNC campus network) will be displayed on top of other visible layers, to allow navigation by familiar landmarks.



[3] http://ceris.purdue.edu/napis/maps/stsurvey.html
[4] http://www.dfr.state.nc.us/health/health_spb.htm and http://www.barkbeetles.org/spb/index.HTML
[5] http://ceris.purdue.edu/napis/pests/asbr/
[6] http://www.ces.ncsu.edu/depts/pp/notes/Soybean/soy001/img_smap.htm
[7] http://www.fs.fed.us/foresthealth/risk_maps/risk_maps.html
[8] http://www.wisc.edu/ncra/impstate-NCERA137.doc