Modeling the impacts of communication among nonindustrial private forest owners on forested landscapes

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The Big Question

How will forested landscapes change in the next 50-100 years given changes in:

1. Ownership turnover
2. Parcelization
3. Policy changes (e.g., to preserve biodiversity, carbon sequestration, increase production of biofuels)

(Landscape change = forest cover, age, patchiness)

Extent of NIPF ownership

- Non-Industrial Private Forest
  - Individuals, families, groups, small companies
  - "Small-scale forestry", "family forests"
- 56% of US forests owned privately
  - 62% of it is NIPF
- Many state and federal programs aimed at NIPF for improving management
- Only ~5% of NIPF owners have a written management plan filed with state agency
  - Most programs require a plan

NIPF-targeted policies

- Originally: timber production
  - Vermont: Use Value Appraisal program
  - Indiana: Classified Forest
  - Michigan: Commercial Forests
- ~1980's: biodiversity protection, wildlife habitat
  - Forest Stewardship Program
  - Wildlife Habitat Incentive Program
- ~2000's: Carbon sequestration
  - Oregon: new funding for Forest Resource Trust
  - Michigan: Forest Carbon Offset and Trading Program
  - Appalachian Carbon Partnership
- Now: Bioenergy?

Literature Review

NIPF CHARACTERISTICS AND BEHAVIORS

NIPF owner trends

- Older owners more likely to manage, harvest, live on or near forest

- Younger owners (especially inheritors) live far away, do not intentionally manage

- Owners with more education are more likely to manage (including harvest)
  - (some disagreement)

- Younger, urban owners more likely to manage for wildlife/nature than timber
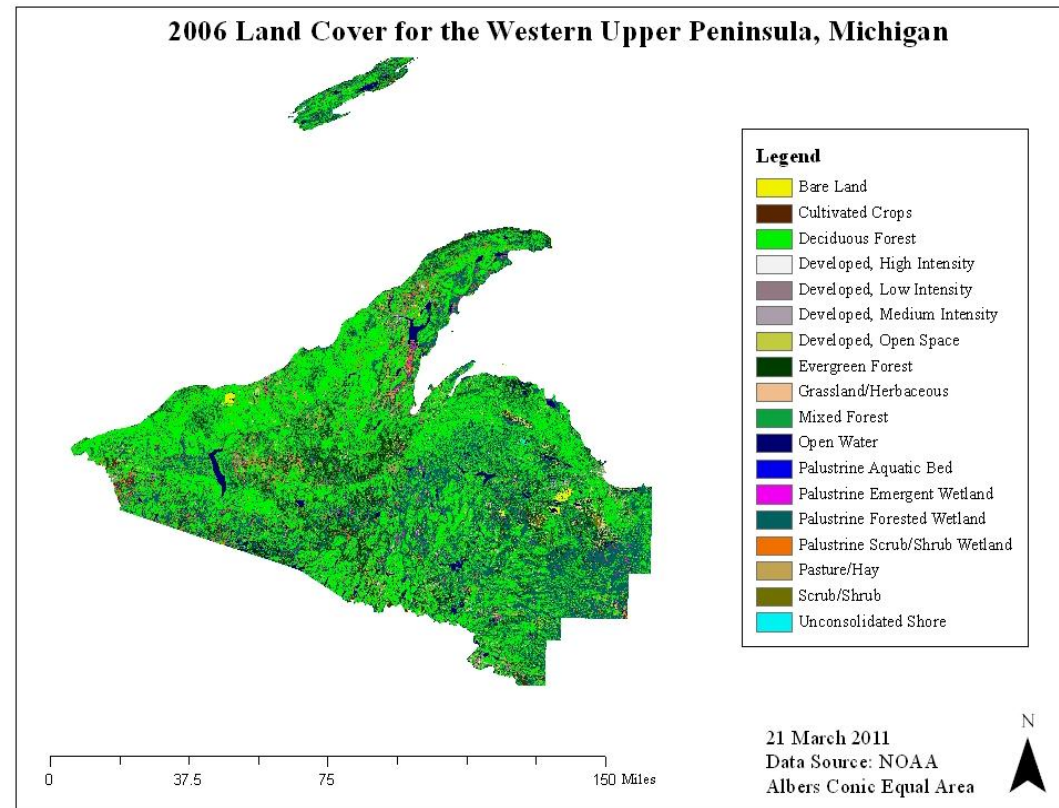
NIPF owner information flows

- Topic
  - Timber production
  - Wildlife habitat
  - Carbon sequestration, Bioenergy (new)
- Source
  - Professionals (agency, industry)
  - Peers, relatives, friends
- Method
  - Hierarchical (forester-led classes, handbooks and mailings)
  - Peer-to-Peer workshops*

Direct vs. Indirect influence?

*Ma, Kittredge, Catanzaro. (2011/online) *Small-scale Forestry*

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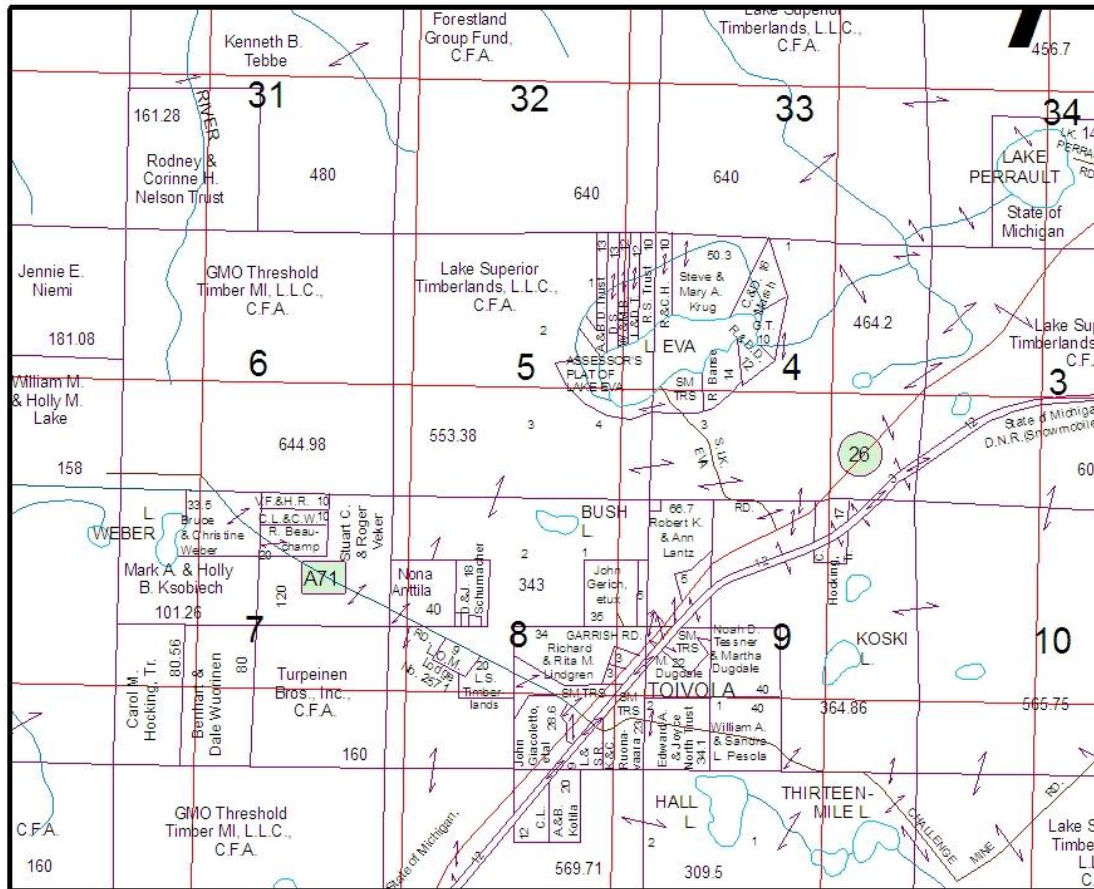Create the Future

Modeling Case Study #1

WESTERN UPPER PENINSULA OF MICHIGAN

NIPF in the Upper Peninsula (UP), MI

- About 30,000 NIPF owners in the western UP
- About 80% forested
  - Rebounded from massive deforestation ±1880's
- Houghton County:
  - NIPF control ~30%
  - Public ~35%
  - Corporate ~35%

2006 Land Cover for the Western Upper Peninsula, Michigan

Legend
- Bare Land
- Cultivated Crops
- Deciduous Forest
- Developed, High Intensity
- Developed, Low Intensity
- Developed, Medium Intensity
- Developed, Open Space
- Evergreen Forest
- Grassland/Herbaceous
- Mixed Forest
- Open Water
- Palustrine Aquatic Bed
- Palustrine Emergent Wetland
- Palustrine Forested Wetland
- Palustrine Scrub/Shrub Wetland
- Pasture/Hay
- Scrub/Shrub
- Unconsolidated Shore

0   37.5   75   150 Miles

21 March 2011
Data Source: NOAA
Albers Conic Equal Area

N

Ownership patterns

- Increasing ownership turnover
  - Older to younger owners
  - Timber companies to:
    - Investment companies (TIMOs)
    - NIPF
    - Increased parcelization

Java Agent-based model using MASON libraries

- Developed at George Mason University and available to public
  - http://cs.gmu.edu/~eclab/projects/mason/
- MASON (Multi-Agent Simulator Of Neighborhoods) provides a set of Java libraries for multi-agent simulation models
  - GeoMASON extension provides networking support with GIS

NIPF model base

- Base layer:
  - US Census block data for population characteristics
    - Age
    - Education
  - ~~GIS layer of parcel boundaries~~
    - (when we get access to server cluster)

- In each time step, a parcel is:
  - Not harvested
  - Selectively harvested
  - Clear cut
- Harvest not possible unless forest > 40 years old

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Houghton Co.

PRELIMINARY RUN: SENSITIVITY TESTING

NIPF model parameters

- Likelihood owner harvests in next time step:
  - Owner age, ~~education,~~ absenteeism, ~~inheritance v. purchase,~~ communication with neighbors
  - Age of forest

- Growth after harvest depending on forests in surrounding parcels
  - Average stand age
  - Selective or clear-cut
    - Clear-cuts take 40 years to be eligible for a new harvest
    - Selective harvests eligible in next time step (although probability decreased)

Model assumptions: Owner characteristics

- From National Woodland Owner Survey, Literature reviews

  – Increase age: selective > clear-cut

  – ~~Increase education: selective > clear-cut~~

  – Absentee owner: clear-cut > selective

  Selective cut also proxy for "management"

Model assumptions: Information flow

- Communication: increased probability that parcel will be harvested similar to neighboring parcels
 - Selective vs. clear-cut
  - Stand age at which harvest occurs

Preliminary Results

- 500 runs per parameter set, 100 timesteps

- Mean forest age decreases when owner age increases in influence
  - Older owners selectively harvest, Young owners clearcut

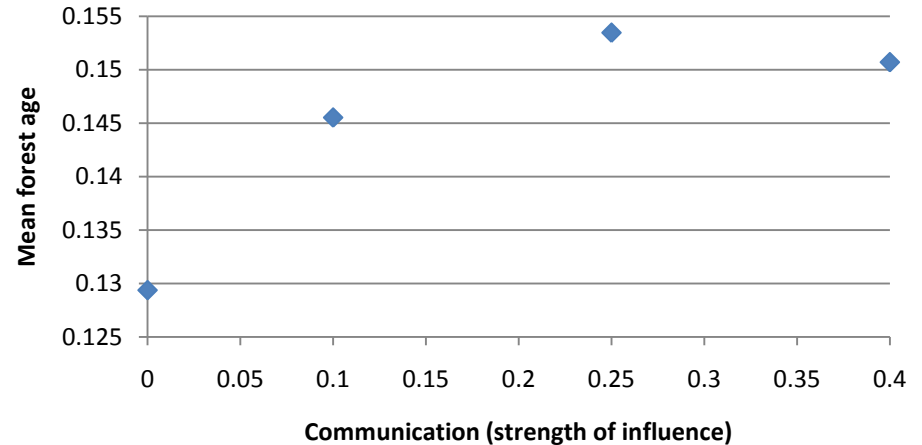- Absenteeism and Communication more influenced by other parameters
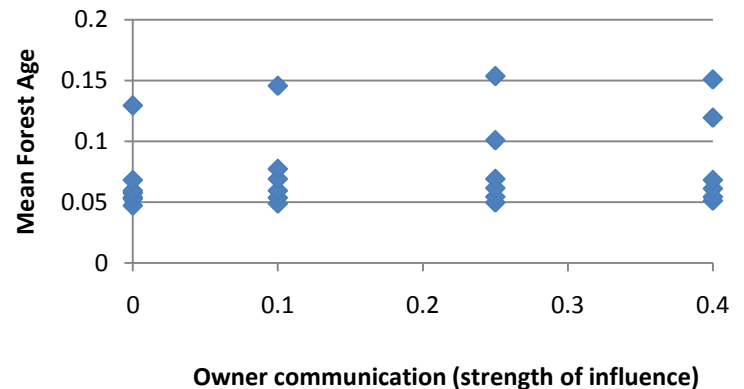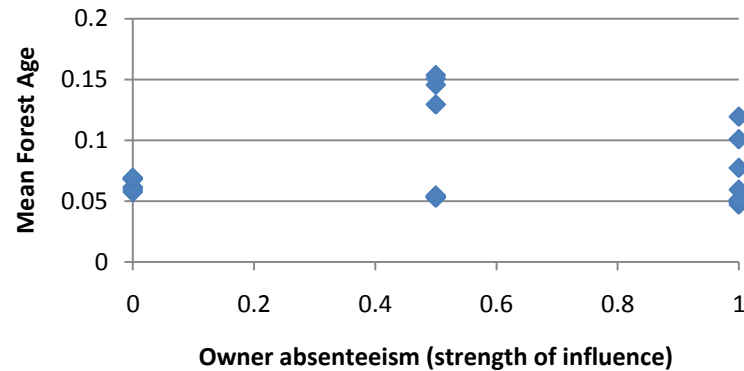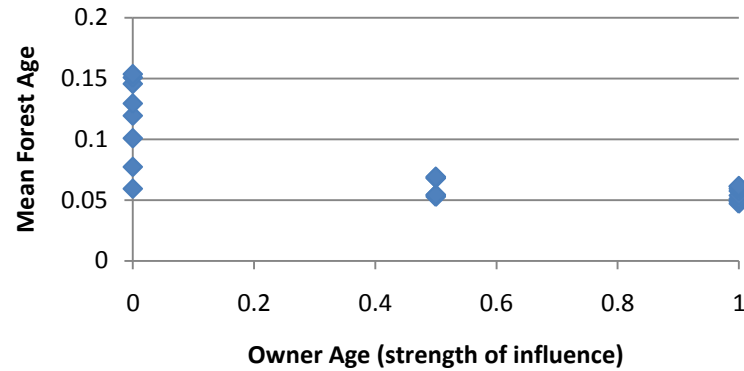
- Lowest mean forest age when age and absentee influence highest, communication zero.

- Highest mean forest age when age has no influence, absenteeism is moderate and communication is highest
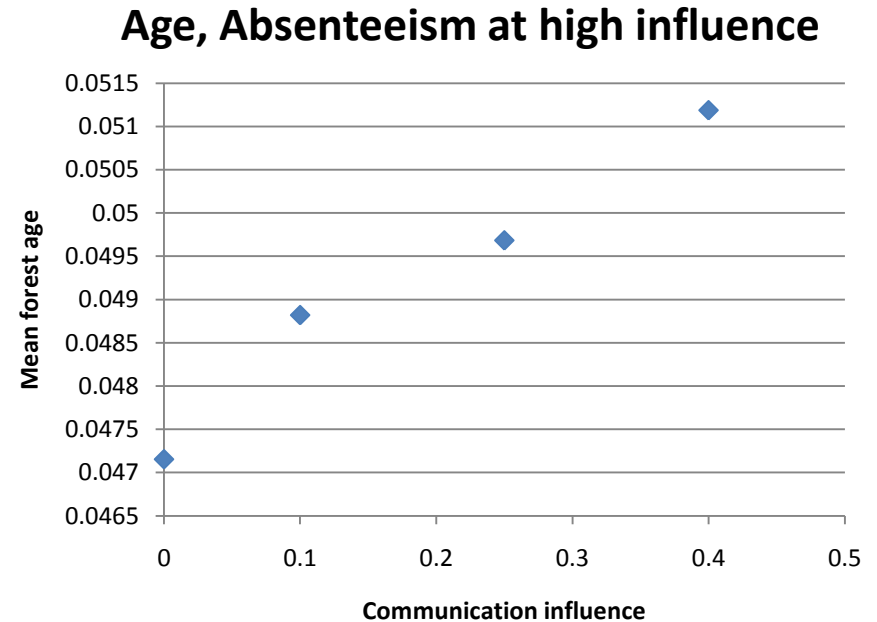
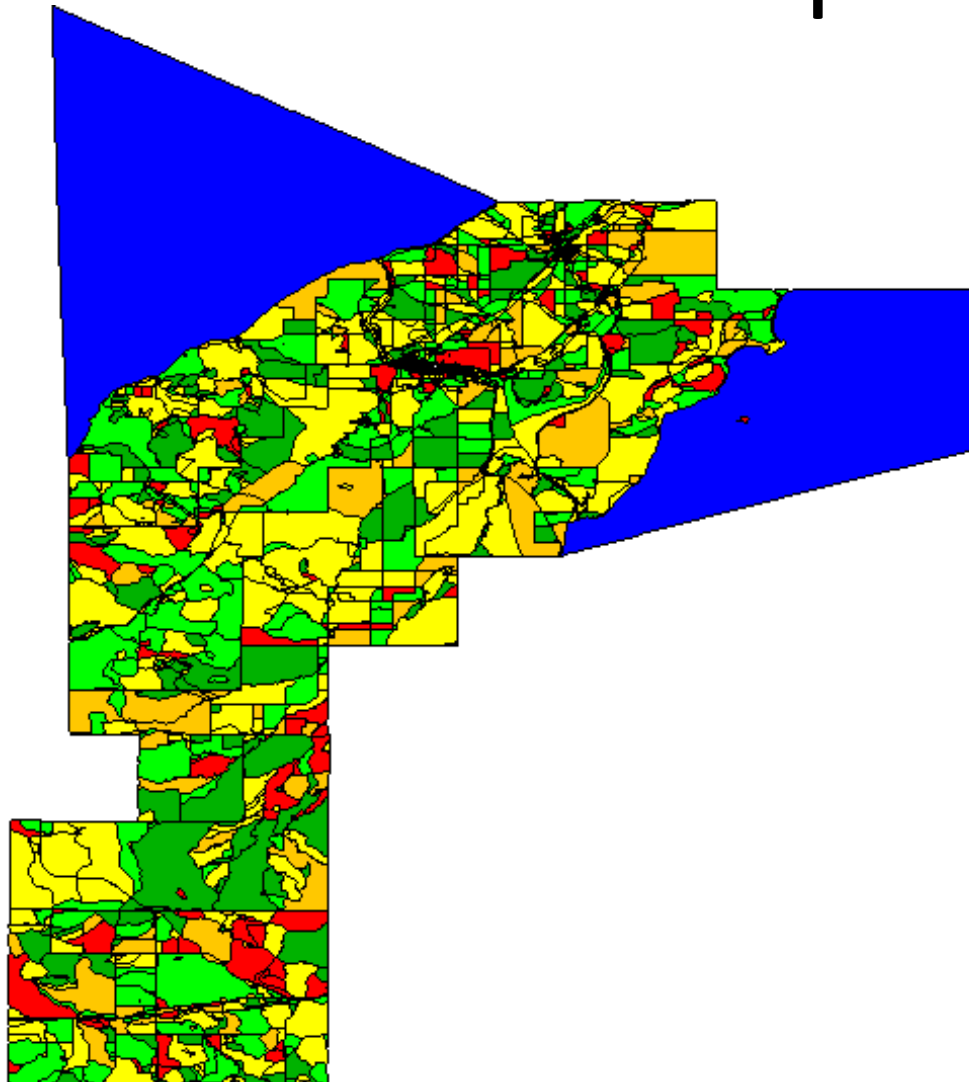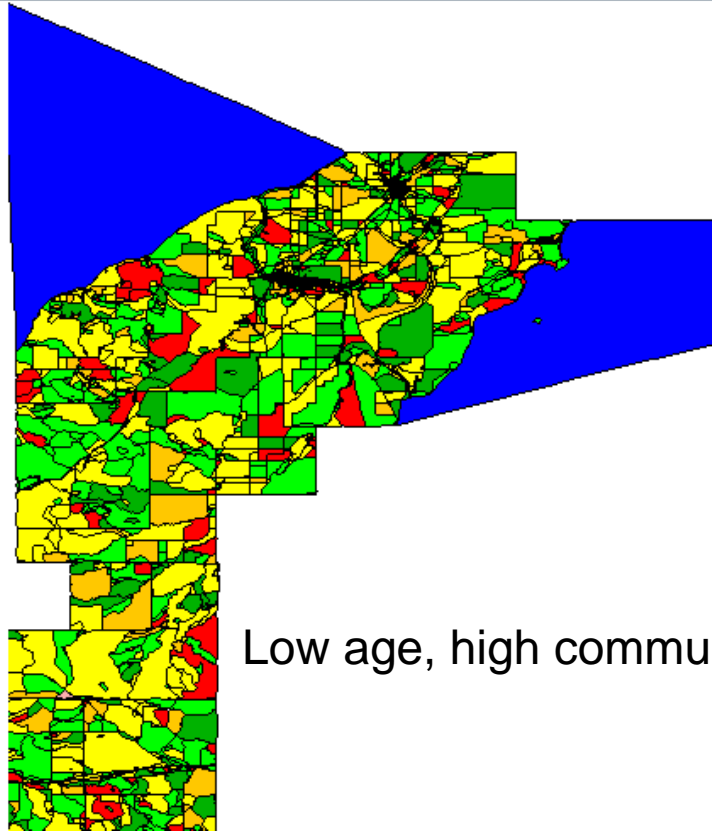**Age and Absenteeism = 1.0**
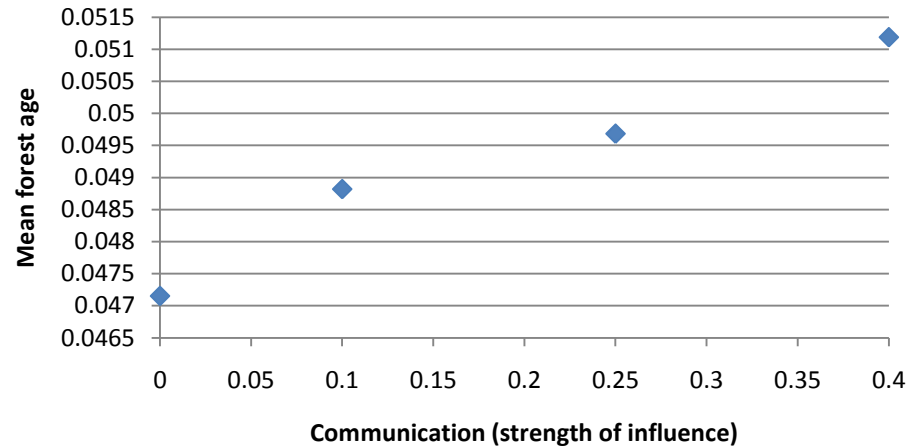
Age = 0, Absenteeism = 0.5

Communication

- Increased communication increases mean forest age
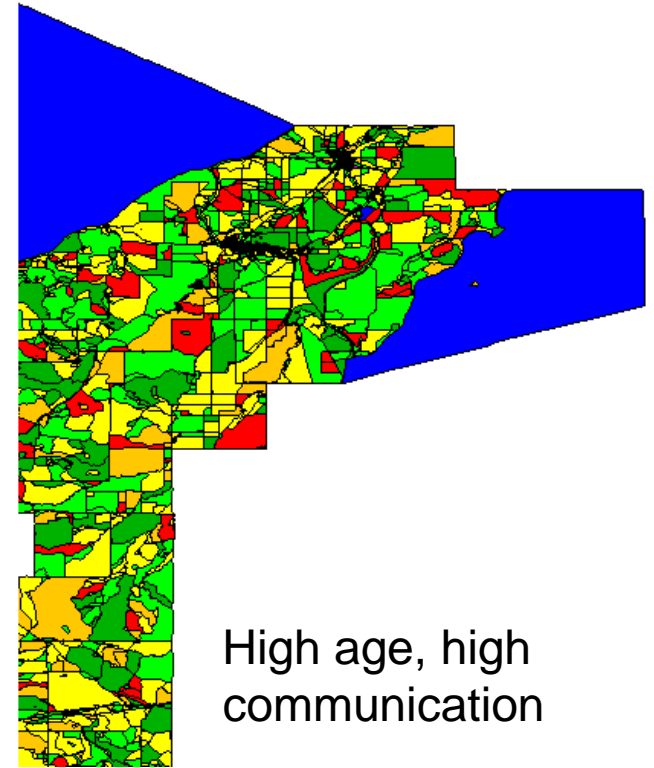 - Can ameliorate influence of age and absenteeism to some extent

Age, Absenteeism at high influence

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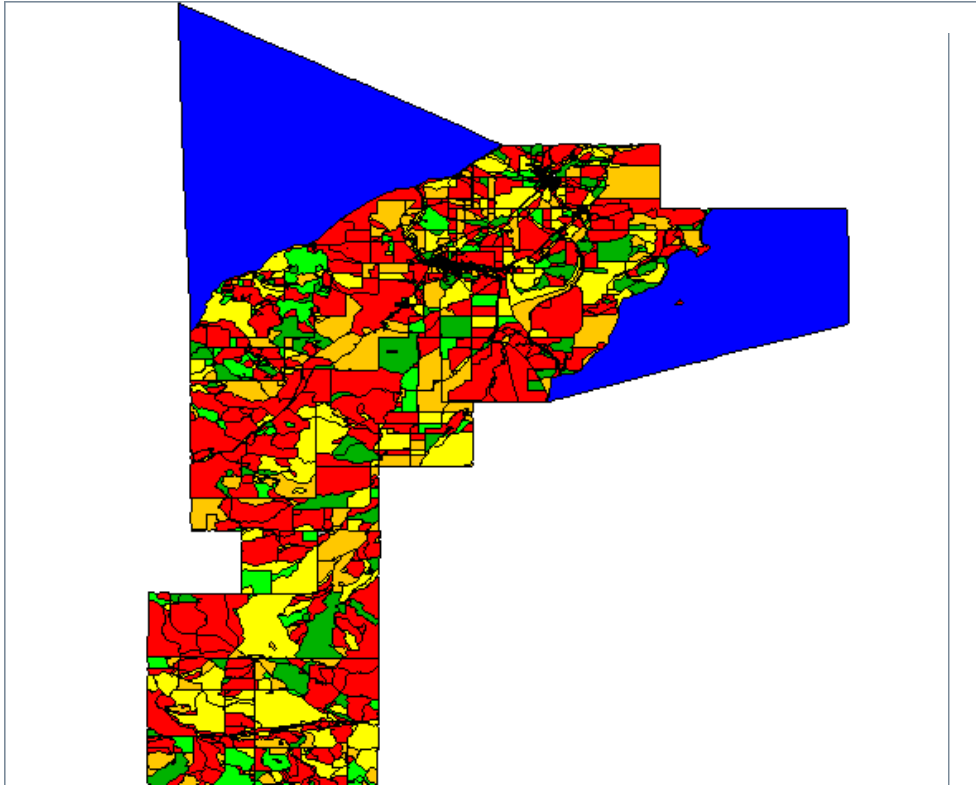Create the Future

Initial Base Map

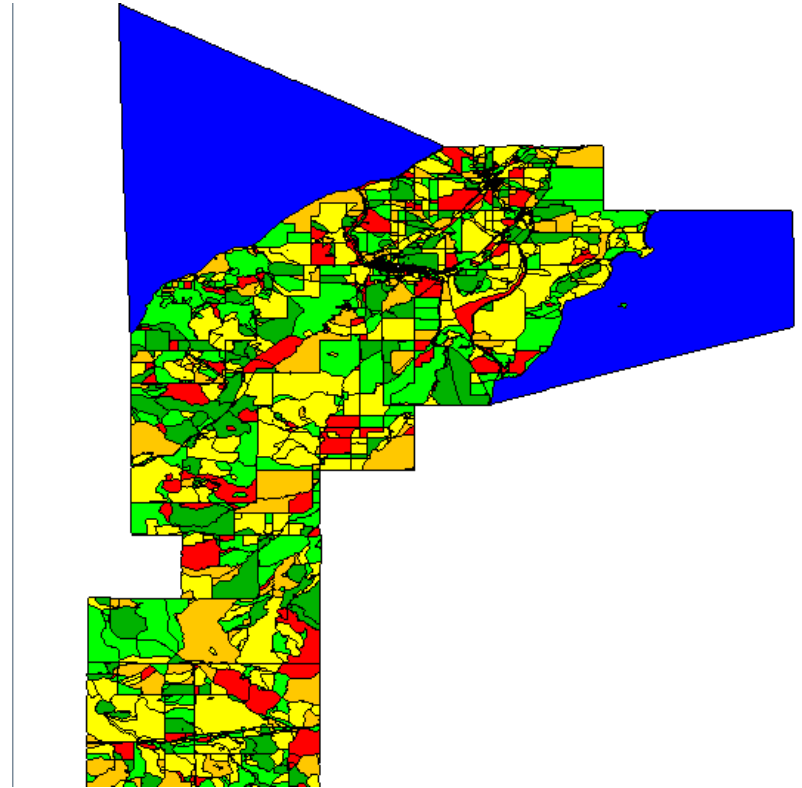# Patchiness

Low age, high communication

High age, high communication
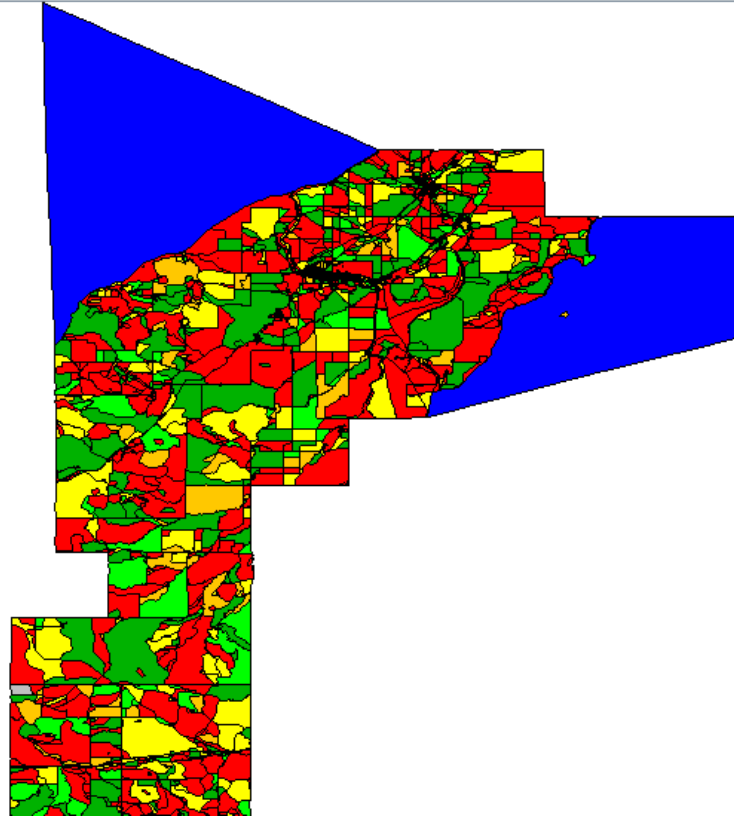
Patchiness

Low Communication,
High Absenteeism

High Communication,
High Absenteeism

Patchiness

High Age, High Absenteeism

Conclusions (Model sensitivity)

- Absenteeism and communication ameliorate each other's influence
  - Higher absenteeism decreases influence of neighbors, while communication increases it
- The influence of age on forest age is weakly influenced by absenteeism and communication
  - Clearcutting by young owners drives forest age lower

- Increasing the influence of absenteeism increases patchiness
  - Especially when age also has high influence
    - Absentee owners form blocks of old forests
    - Younger owners form block of clearcuts
  - Higher communication can break up patches

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Houghton Co. and Roane Co.

COMPARATIVE MODELS

Table 1. Characteristics of NIPF owners in Michigan and Tennessee based on responses to the National Woodland Owner Survey (data from http://www.fia.fs.fed.us/nwos/). Percentages based on number of owners.

Characteristic	Michigan (n = 424 respondents)	Tennessee (n = 531 respondents)
Forest part of primary residence	71% yes	72% yes
Forest part of secondary residence	19% yes	8% yes
Size		
1-9 acres	53%	65%
10-49 acres	37%	25%
50-99 acres	6%	6%
100-499 acres	4%	4%
Management plan?	3% yes	1% yes
Future intentions*		
No plan, no or minimal activity	104%	102%
Harvest timber	9%	14%
Harvest firewood, nontimber products	34%	17%
Sell, transfer, subdivide, or buy more land	22%	21%
Convert to/from forest	4%	2%
Other, no answer, unknown	9%	13%
Other management activities**		
Tree planting	28%	8%
Public and private recreation	54%	24%

Trusted information sources

- MI
  - NWOS
    - Foresters: 20% federal, 41% state, 22% industry/private
    - 18% other forest owners
  - West et al. 1988
    - Foresters: 27.6% federal and state, 24.2% private
    - 11.1% friends and neighbors (peer NIPF owners)
- TN
  - NWOS
    - Foresters: 12% federal, 51% state, 31% private
    - 7% other forest owners

Peer influence: 18-38%

- Schubert thesis:
  - 32% directly influenced by NIPF neighbors
  - 38% indirectly influenced
  - 21% influenced both ways
  - (Long term owners more likely to be influenced than short-term owners)
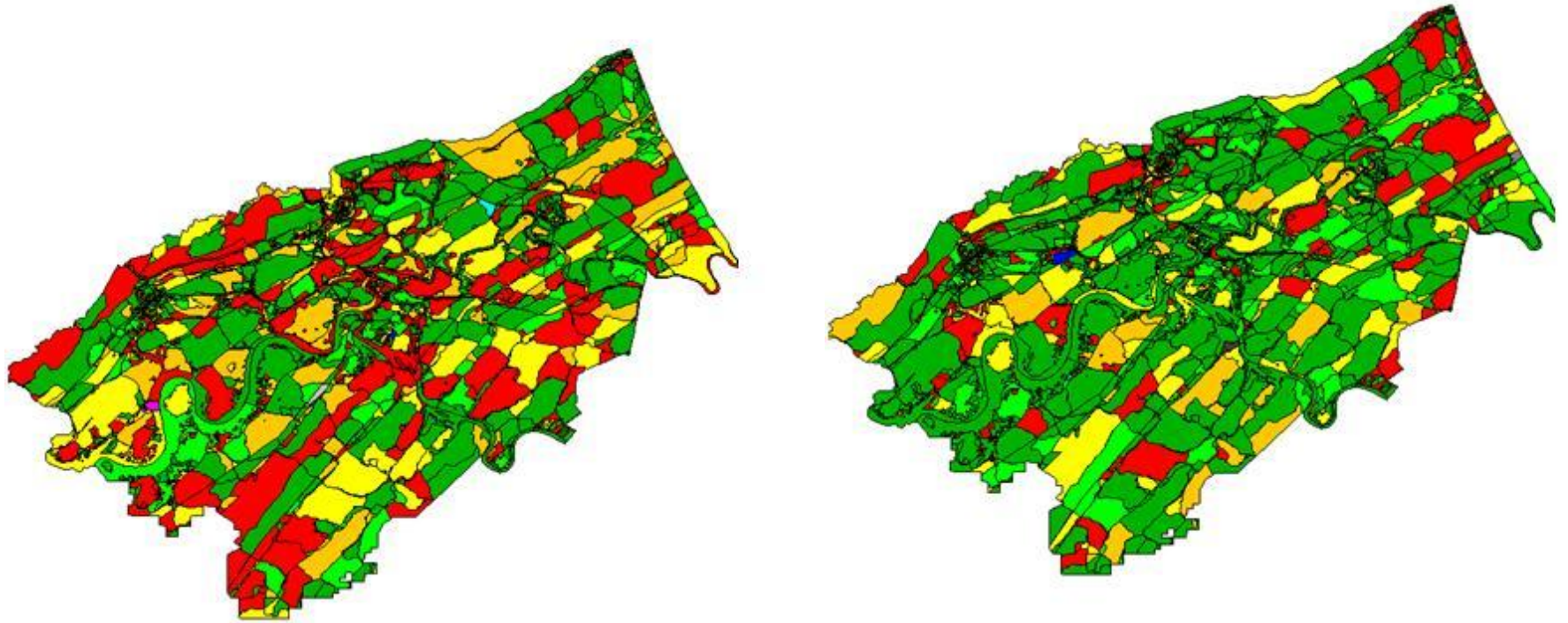
Model differences

- Roane Co.:
  - Less communication among neighbors
  - Fewer absentee owners
  - Higher probability of timber harvest
- Houghton Co.:
  - More communication among neighbors
  - More absentee owners
  - Lower probability of timber harvest (across all age groups)
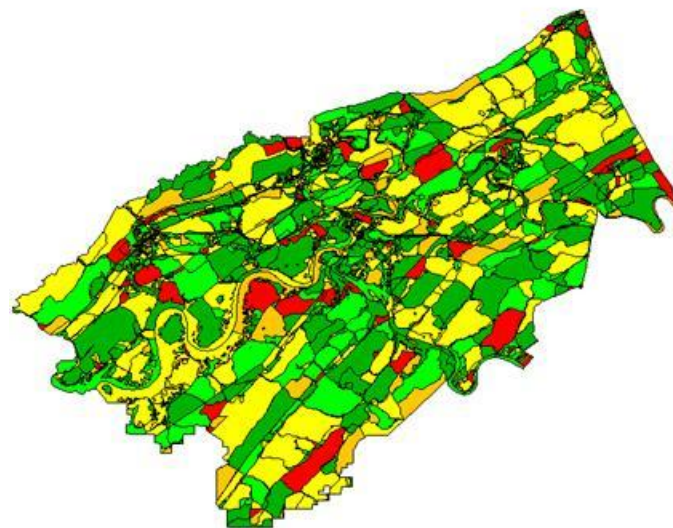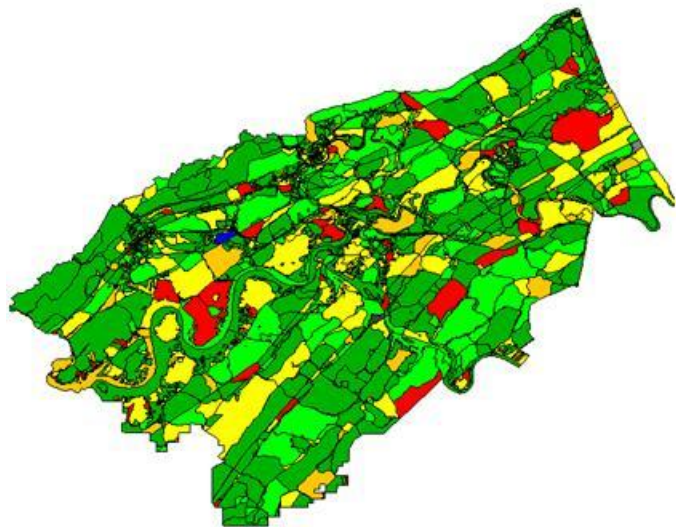
Initial runs

ROANE COUNTY

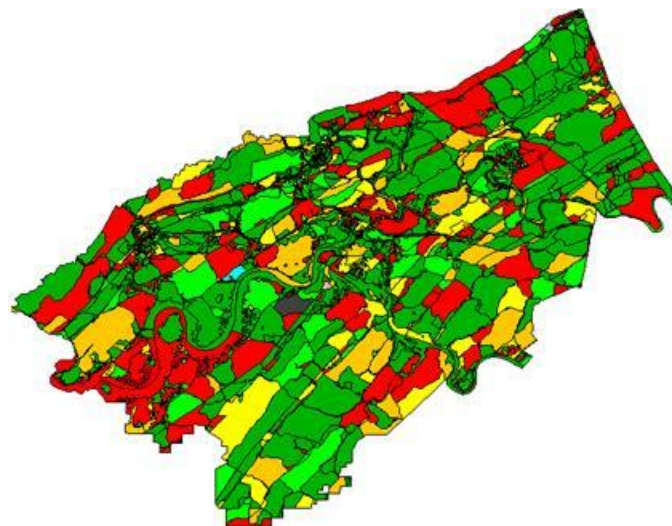# Roane Co. initial maps
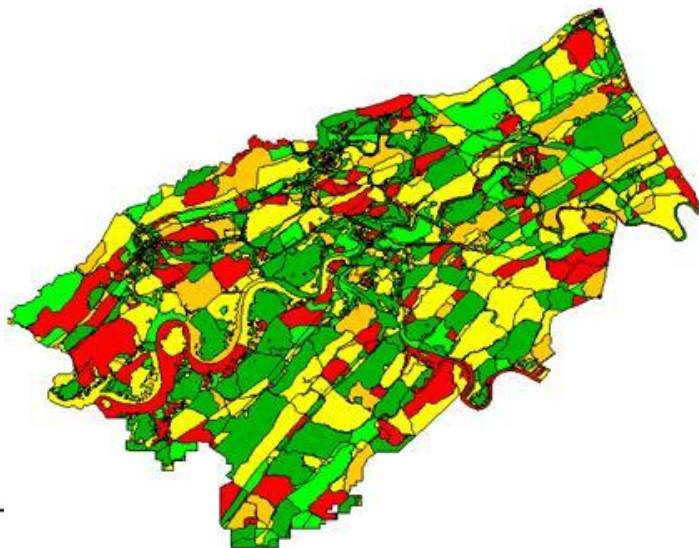# (US Census blocks)

Low Communication

High Communication

Low Harvest

High Harvest

Conclusions: Houghton Co. vs Roane Co.

- Forest Age:
  - High harvest probability does not necessarily result in low mean forest age
  - Young, resident owners decrease mean forest age
  - Communication among owners can increase forest age (counteracts absentee owners)

- Clustering/Patchiness
  - More absentee owners, more patchiness
  - Communication can increase clustering in some cases (high harvest probability, high communication, low absenteeism… Roane Co.)

Current work

- Calculate annual ownership turnover and parcelization rates from plat books
  - Add feature to model to include parcelization
- Verify model results
  - Compare with land cover change (remote sensing, forest inventory)
- Use model to forecast potential landscape impacts of policies and programs
  - Other parameters (e.g., probability of enrollment in programs)

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Future work

- Expand model to 8 counties in western UP
- Compare northern and southern NIPF landscapes
  - Differences in forests (diversity, biomass)
  - Differences in owner behaviors, management
- Add more detail on information flow for specific owners
  - "Opinion leaders" have disproportionate influence
    - Long time owners, private foresters
  - Women much less informed about management options, neighboring parcel activity
    - Lidestav and Ekström (2000) *Scand J For Res*

Questions?

Photo Courtesy Michigan Tech Archives