

Forest Trends in the Mid-Atlantic States: Prospective Impacts Due To Climate change

We Do Not Know What the Impacts of Climate Change Will Be

We Do Know the Systems, Drivers, Stressors, and Services

We Should Be Able to Examine Prospective Impacts

Caution: Impacts are Non-Linear with Multiple Interactions

Complexity is High Because for Every Action, There is Another

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Climate Change in the Mid-Atlantic States: an Interagency Workshop

Cambridge, MD, March 23-24, 2010

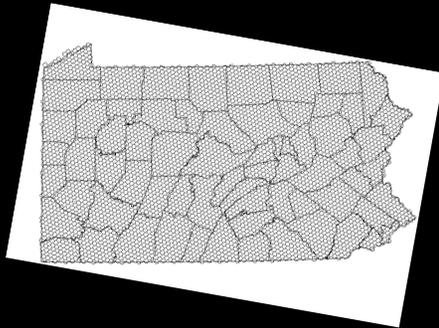


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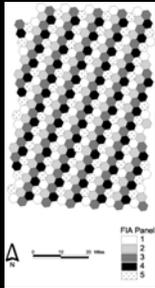
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Methods



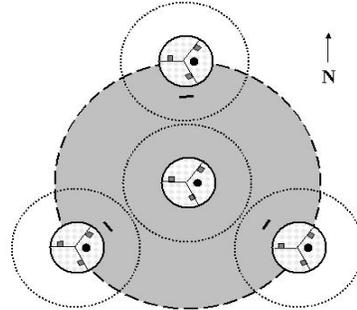
Phase 2



Phase 3



Phase 2/Phase 3 Plot Design



○ Subplot	24.0 ft (7.32 m) radius
● Microplot	6.8 ft (2.07 m) radius
○ Annular plot	58.9 ft (17.95 m) radius
○ Lichens plot	120.0 ft (36.60 m) radius
■ Vegetation plot	1.0 m ² area
— Soil Sampling	(point sample)
— Down Woody Debris	24.0 ft (7.32 m) transects



Phase 2

Tree species
Tree Diameters
Tree Heights
Tree Damage
Forest Type
Stand Size...
And more...

Phase 3

CWD
VEG
Crowns
Soils
Lichens
Ozone Damage
And more...



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Climate Change Impacts Literature Review

Temperature: higher minimums, more erratic fluctuations in precipitation

Moisture: wetter at higher latitudes and drier at middle latitudes

Tree Fitness: susceptibility increases, health decreases, insect impacts, disease impacts, ...

Species Migration: northward migration, extirpation of some species, migration barriers, ...

Wildlife: changes in habitat similar to forests, increase in herbivores (e.g. mild winters), ...

Wood Products: increased harvest (maturity and increased productivity)

Other: coarse woody debris increases , plant damage increases, old growth suffers,

(Malmshiemer et. al. 2008), Irland 2001, Iverson and Prasad 2002, Logan et. al. 2003, Matgem and Stephenson 2007



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Organizing Our Thoughts

Systems: mixed oak, northern hardwoods, spruce-fir, etc..

Drivers: temperature, moisture, fire, soil, catastrophic weather, ...

Stressors: anthropogenic impacts, disease, insects, invasive plants, herbivory, ...

Services: wood, recreation, clean water, clean air, wildlife, soil productivity, flood control, climate stabilization, aesthetics, non-traditional products, biodiversity, ...

(Dave Cleaves, USDA Forest Service, National Climate Change Advisor)

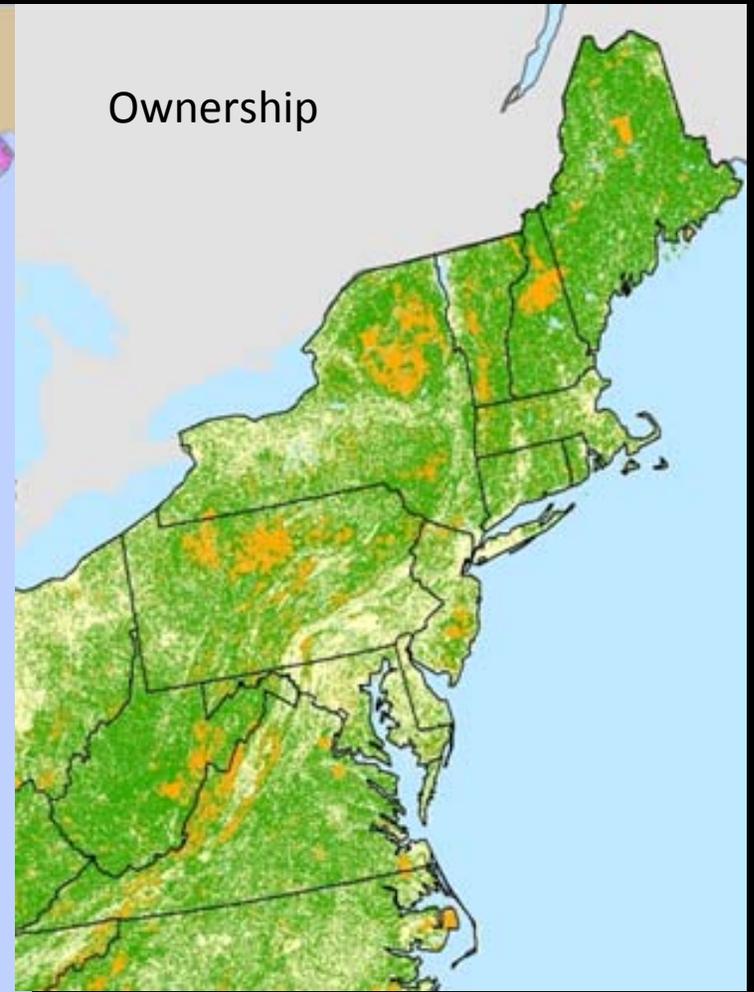
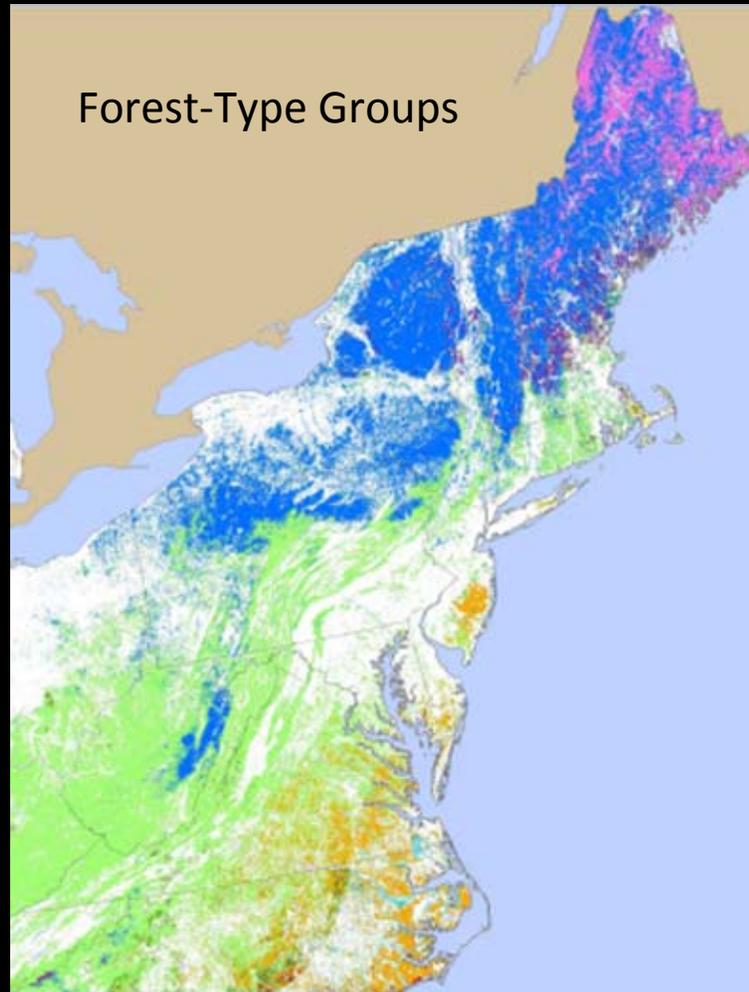
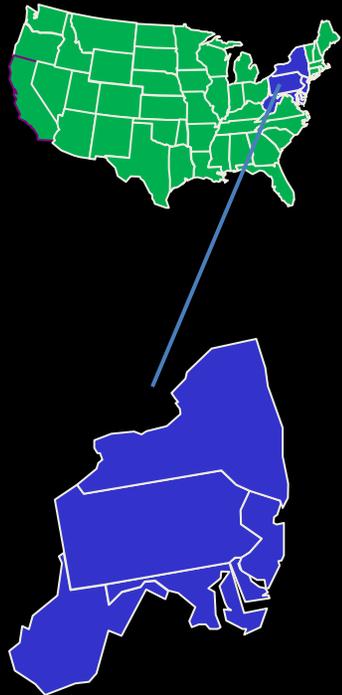


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Mid-Atlantic Forest Systems



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Drivers

Climate variables: temperature, moisture, solar radiation, ...

Anthropogenic Impacts: development (forest loss), parcelization, fragmentation, ...

Other: soil, fire regimes, ...

Climate change: drought, intense precipitation, catastrophic events (wind), fire, ...

(Malmshemer et. al. 2008)



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Stressors

Forest are Maturing: reaching economic maturity, growth is slowing, mortality is increasing,...

Structure is Changing: increases in stand size, partial harvests remove preferred species, understory vegetation diversity, ...

Composition is Changing: fewer oaks, more red maple and black birch, ash extirpation, ...

Tree diseases: chestnut blight, Dutch elm disease, beech bark disease, ...

Regeneration is Lacking: herbivory, lack of native tree seedlings, competing vegetation, ...

Other: acid rain (soil calcium deficiency), ozone, many small woodland owners, ...



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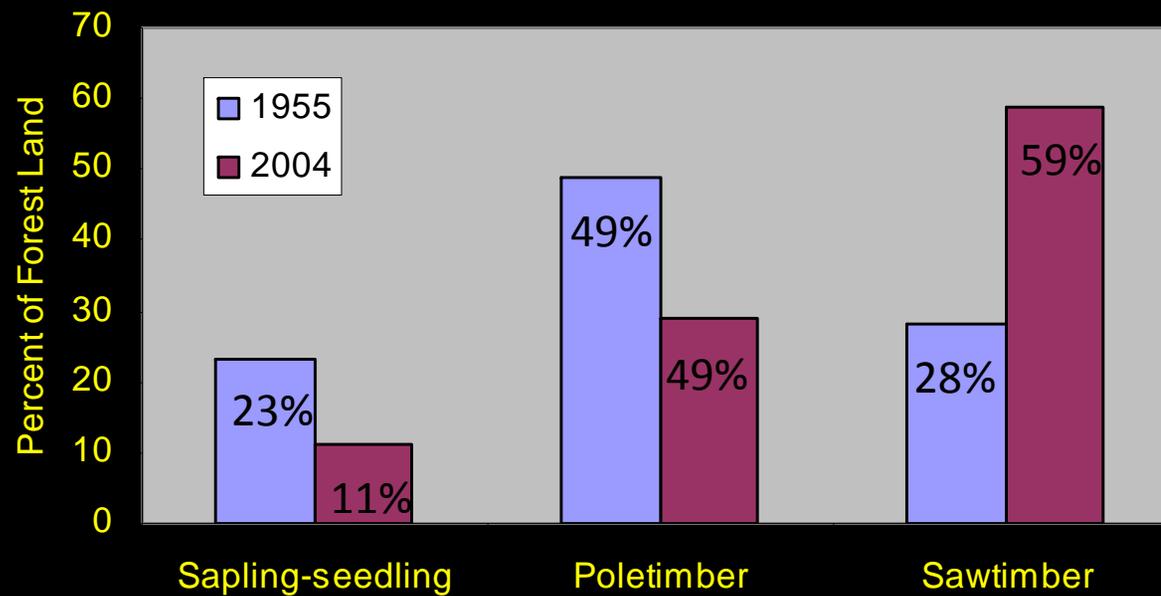
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Stressors

Forests are Maturing and Structure is Changing

Distribution of Forest Land by Stand-size Class, PA



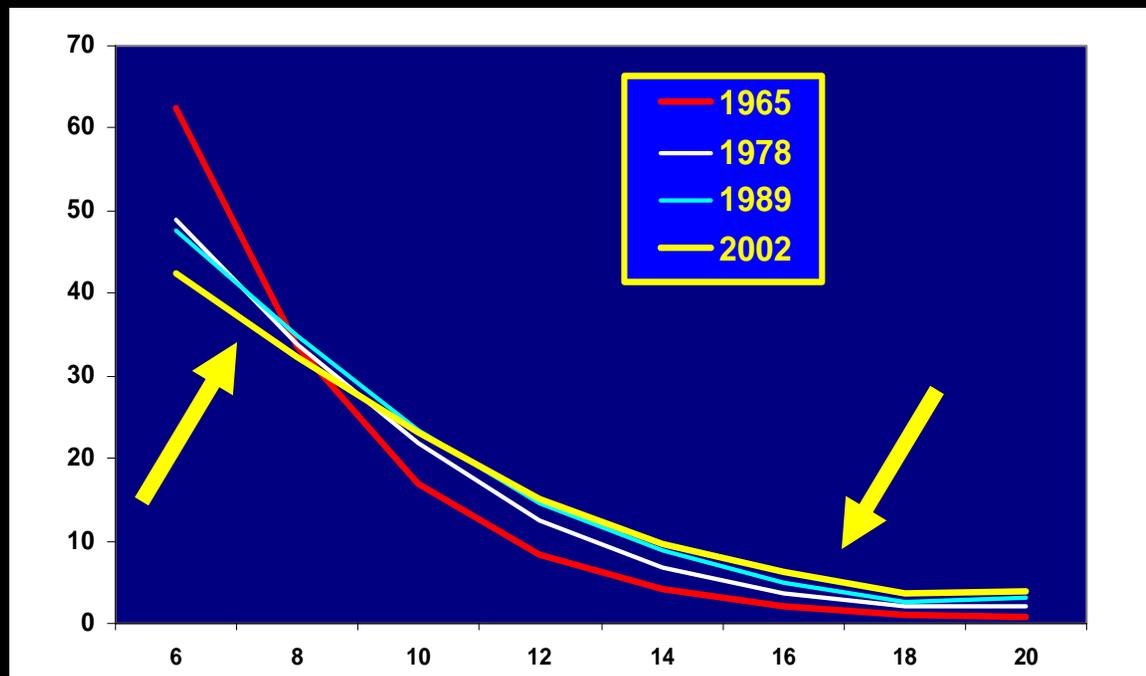
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Stressors

Forests are Maturing and Structure is Changing

Number of Growing-Stock Trees Per Acre, PA



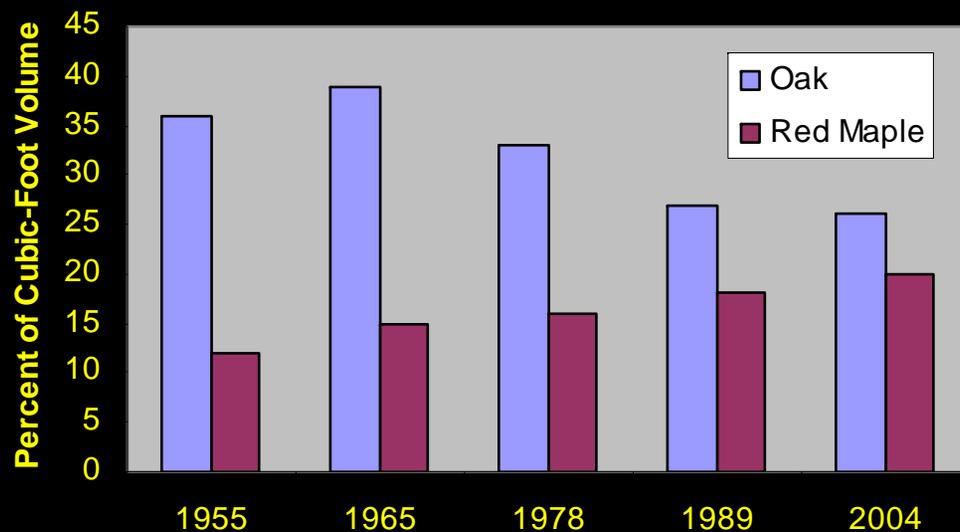
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Stressors

Composition is Changing

Oak is Decreasing and Red Maple is Increasing, PA



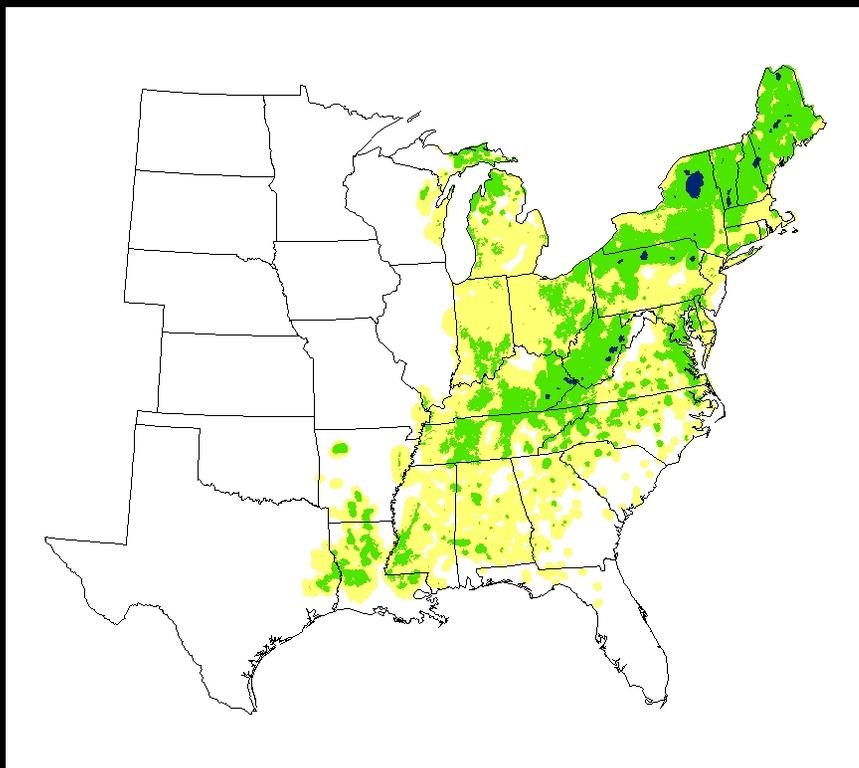
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Stressors

Tree Diseases

Beech Bark Disease



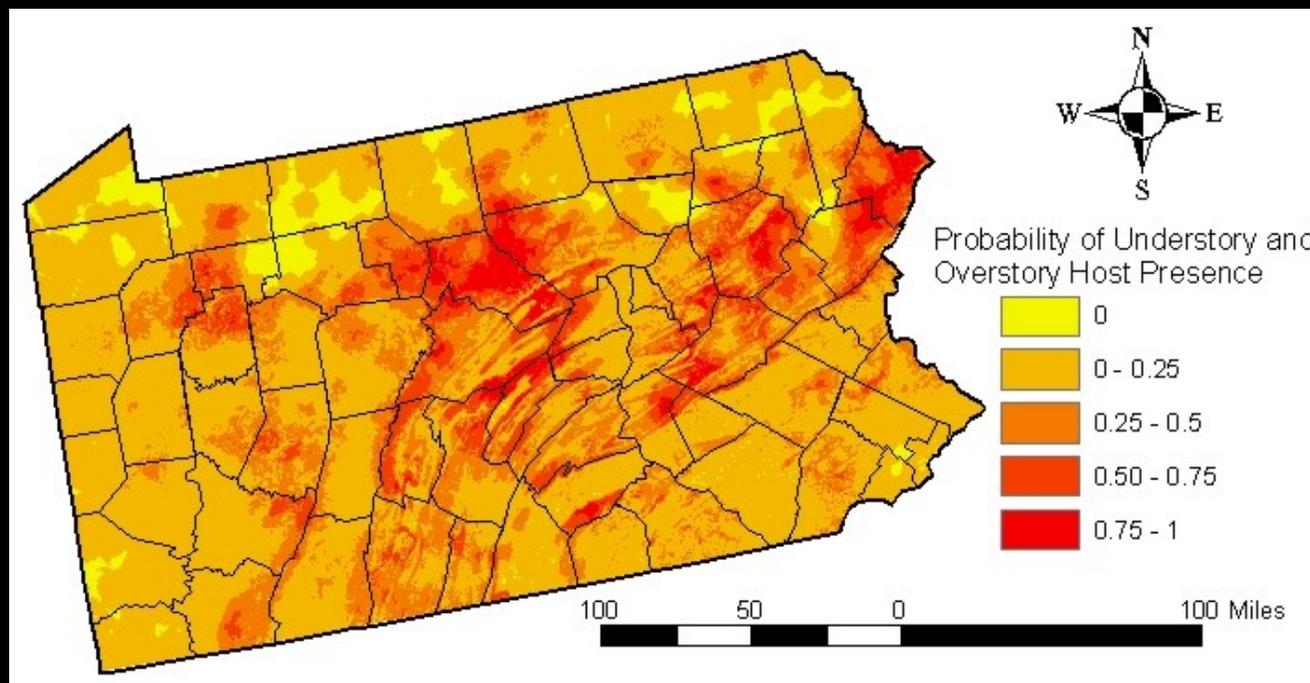
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Stressors

Tree Diseases

Sudden Oak Death



Stressors

Regeneration is Lacking



Regeneration is Lacking and Options Are Expensive



Climate Change Impacts Compound Ambient Stressors

Anthropogenic Impacts: development (forest loss), parcelization, fragmentation, ...

Invasive Plants and Pests: improved conditions for expansion of invasive plants, pests, ...

Species Migration: northward migration, extirpation of some species, migration barriers, ...

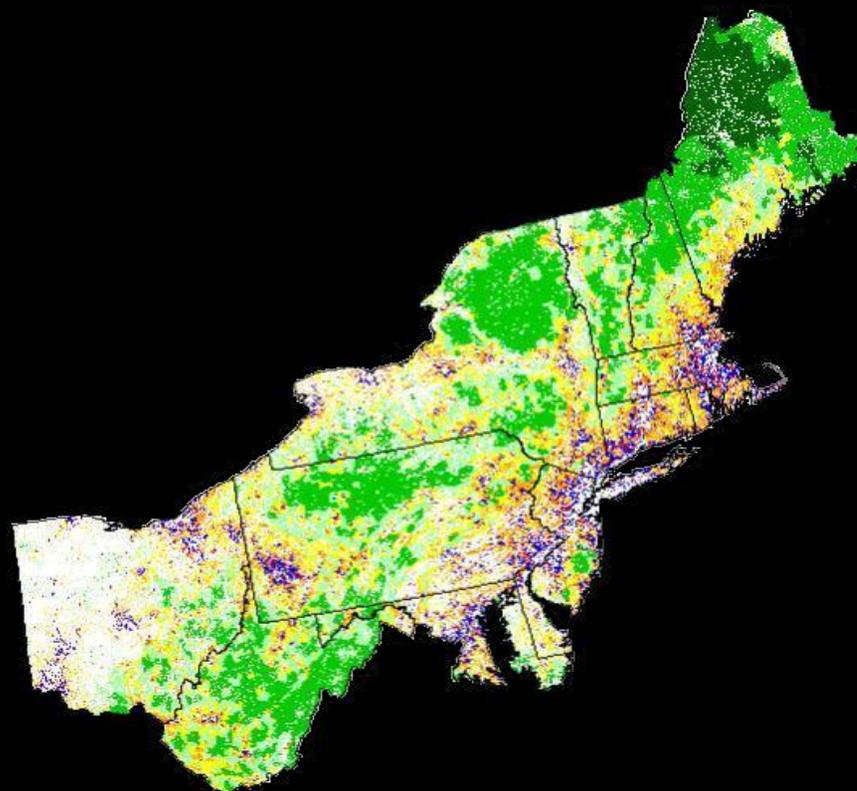
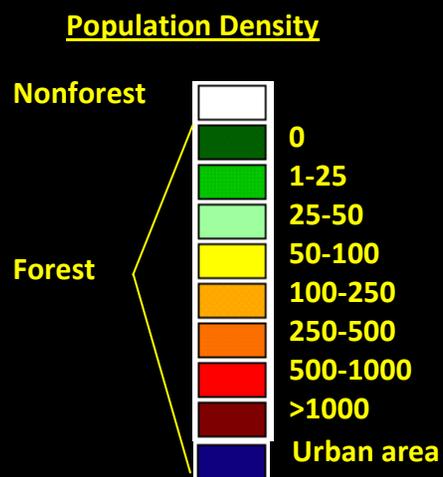


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Anthropogenic Impacts

Urbanization: increasing population and housing density, roads, industrial corridors, ...



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Anthropogenic Impacts

Parcelization: subdivision of large single-owner tracts into smaller multiple-owner tracts

Fragmentation: reductions in forest-tract size, loss of interior forest, increased edge, ...



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Anthropogenic Impacts



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Anthropogenic Impacts

Parcelization



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Fragmentation



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Anthropogenic Impacts

Fragmentation

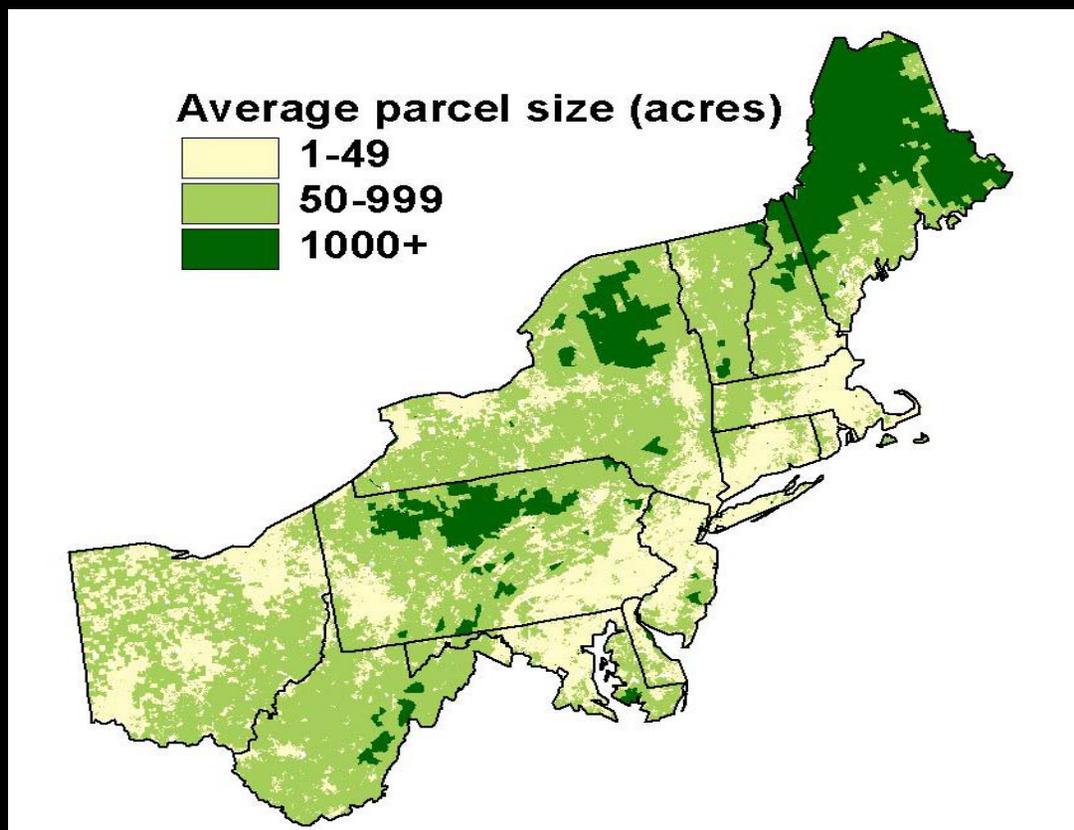


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Anthropogenic Impacts

Parcelization: subdivision of single-owner tracts into multiple-owner tracts



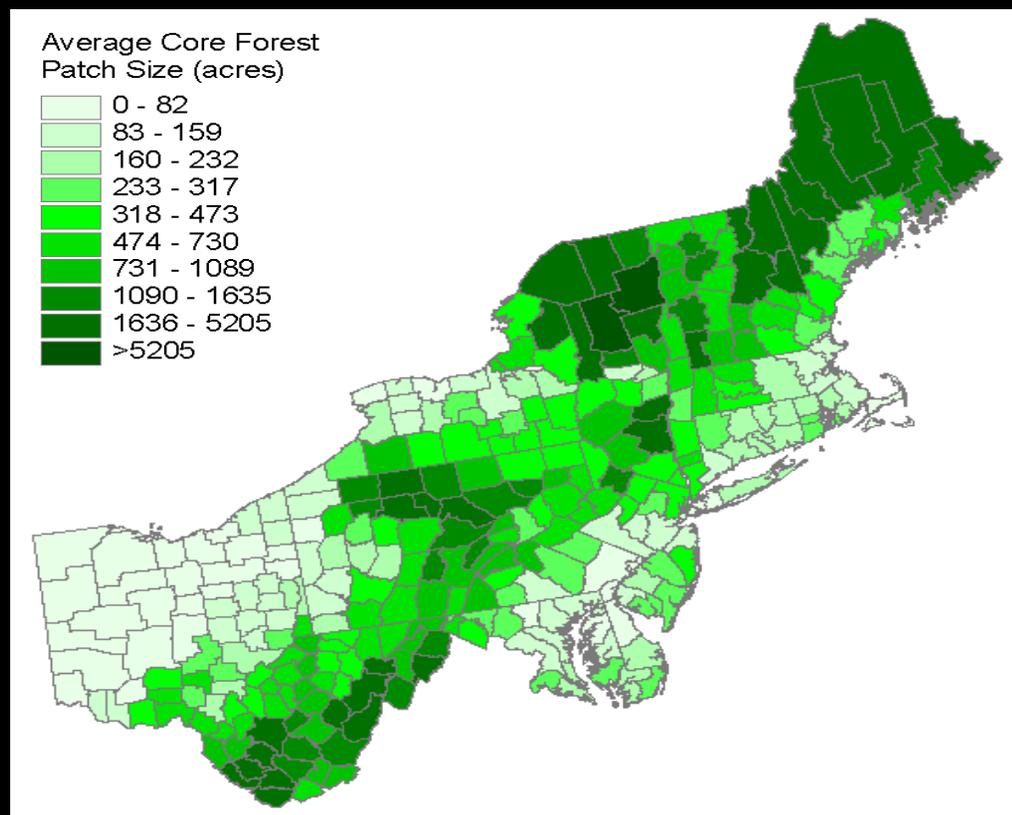
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Anthropogenic Impacts

Fragmentation: reductions in forest-tract size, loss of interior forest, increased edge, ...



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Invasive Plants



Mile-a-Minute Weed



Oriental Bittersweet



Giant Knotweed

- Vines (8)
- Fiveleaf akebia
 - Porcelain-berry
 - Oriental bittersweet
 - English ivy
 - Japanese honeysuckle
 - Mile-a-minute vine
 - Kudzu
 - Common periwinkle

- Shrubs (19)
- Japanese barberry
 - European barberry
 - Russian olive
 - Autumn olive
 - Winged Euonymous
 - Border privet
 - Common privet
 - Bell's honeysuckle
 - Amur honeysuckle
 - Morrow's honeysuckle
 - Standish honeysuckle
 - Tartarian honeysuckle
 - Common buckthorn
 - Glossy buckthorn
 - Multiflora rose
 - Wineberry
 - Japanese spiraea
 - Linden viburnam
 - Guelder rose

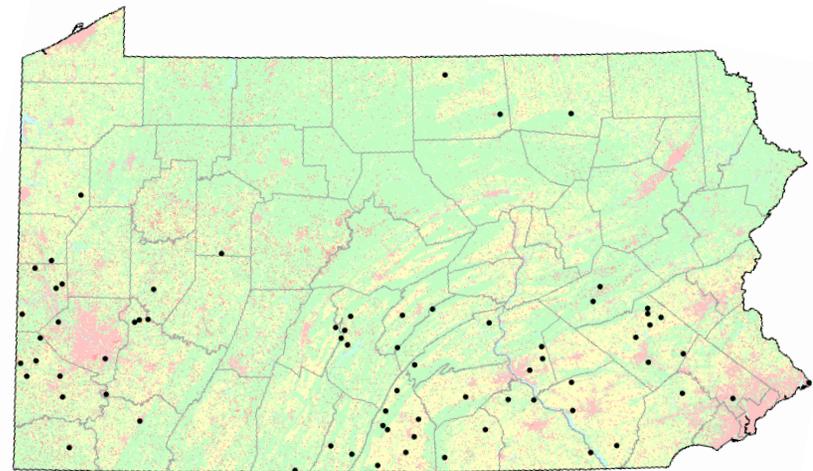
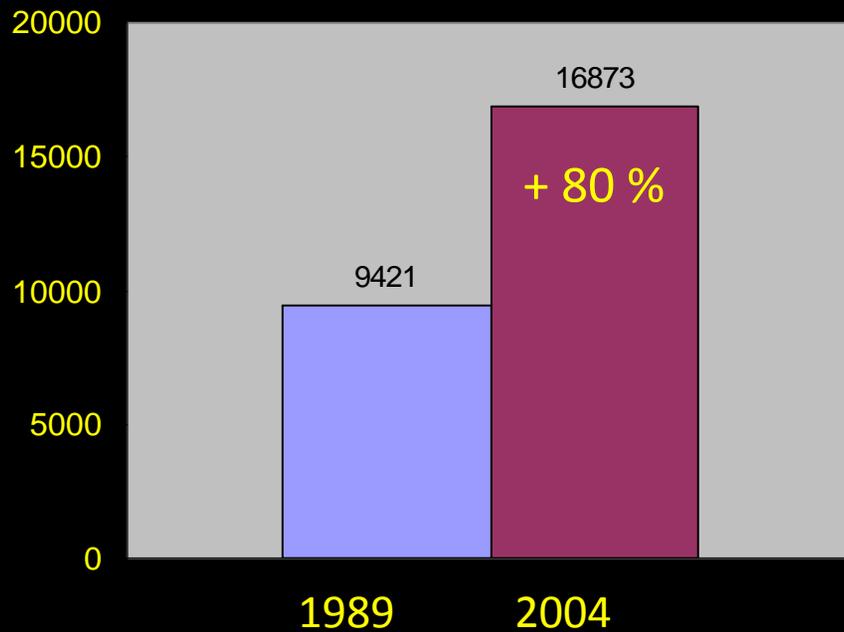


- Forbes and Grasses (12)
- Garlic mustard
 - Spotted knapweed
 - Canada thistle
 - Bull thistle
 - Crown-vetch
 - Giant hogweed
 - Purple loosestrife
 - Japanese stilt grass
 - Reed canary grass
 - Common reed
 - Japanese knotweed
 - Giant knotweed



Invasive Plants

There are now enough trees to occupy every acre of Pennsylvania's forest



Distribution of Samples with Tree-of-Heaven



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Invasive Plants

Alien Pests are Here and More are on the Way

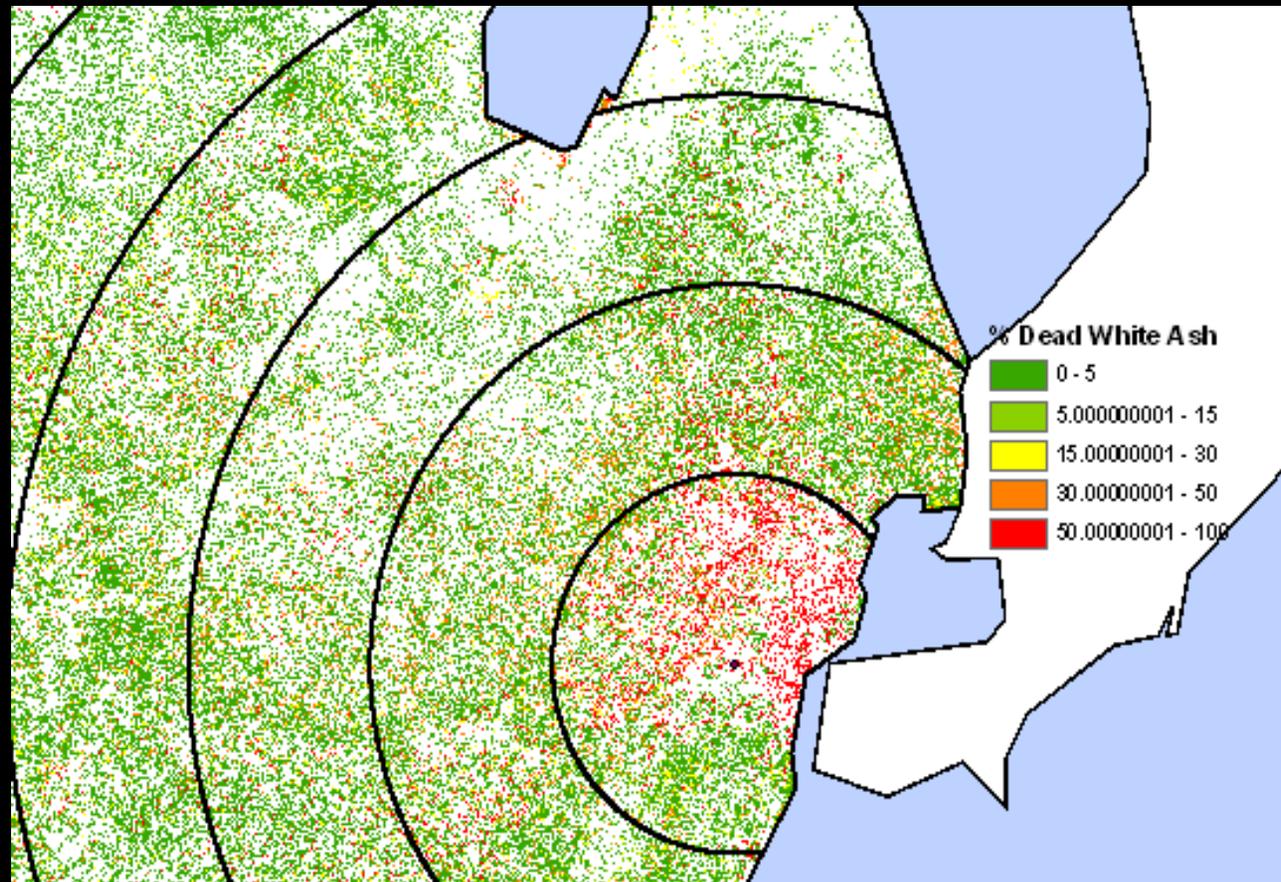


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Emerald Ash Borer



Percent Standing Dead White Ash – Southern Michigan



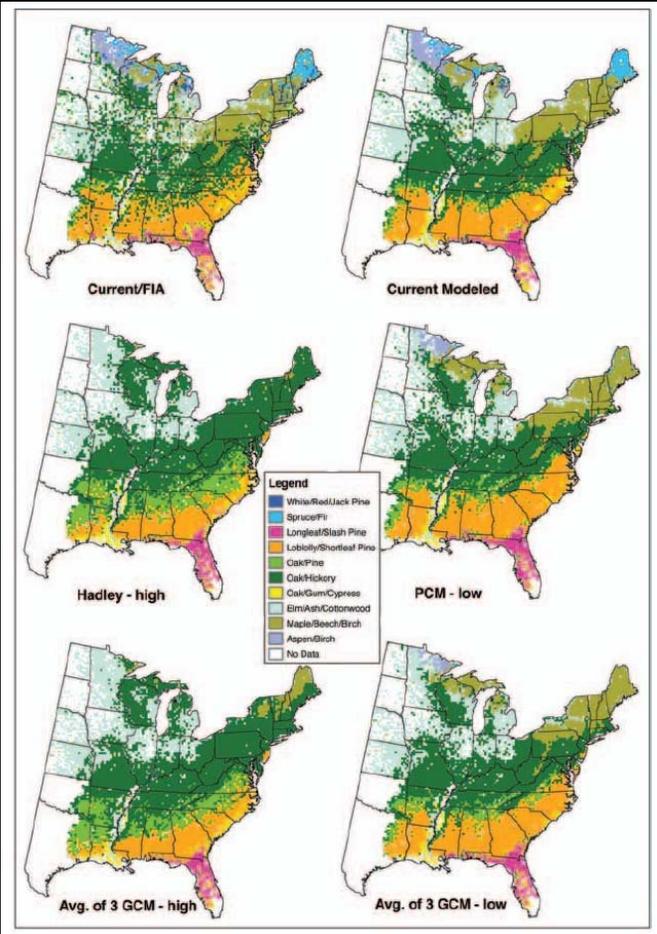
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Species Migration Forest-Type Group

Prasad, Iverson, and Mathews, 2009



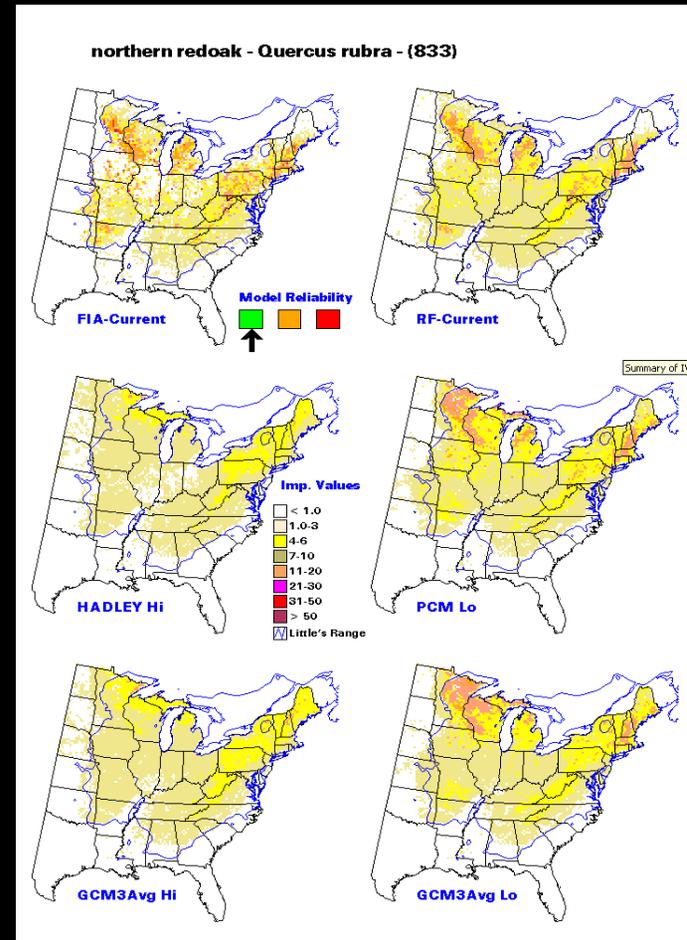
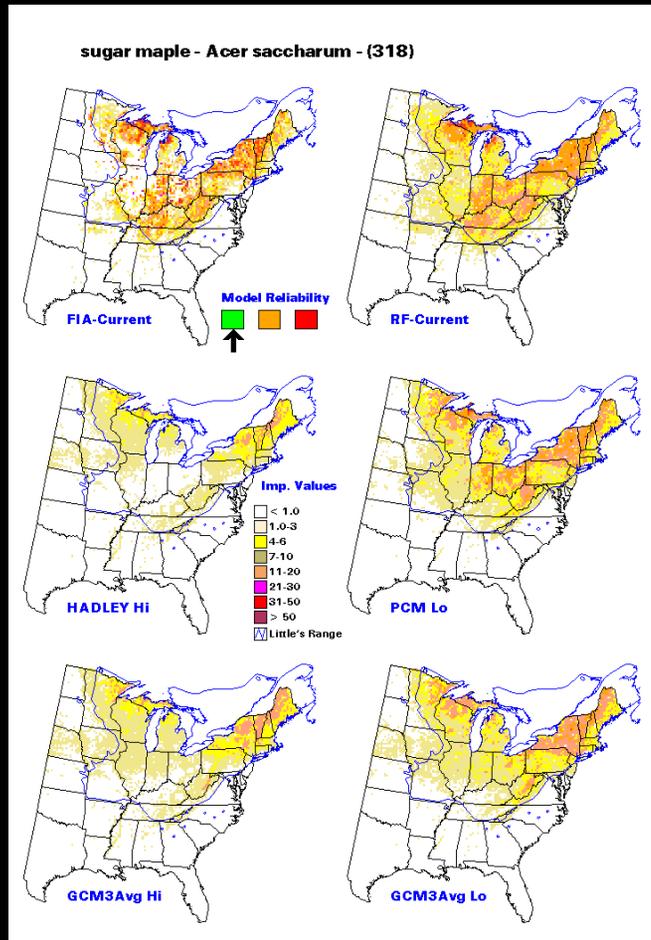
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Species Migration

Prasad, Iverson, and Mathews, 2009



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Summary of Prospective Impacts

Climate Change:

Warmer, Drier, Precipitation Fluctuations,...

Composition and Structure:

Decrease in area of old growth

Decrease in native species (oak vs. red maple)

Invasive Plants and Pests:

Increase in non-native invasive plants

Increase in non-native insects and diseases

Forest Regeneration:

Decrease in favorable regeneration

Increase in native invasive plants (fern)

Increased herbivory (mild winters)

Species Migration:

Spruce-fir becomes very rare

Northern Hardwood retreats to north

Mixed Oak advances north

Native species extirpation (Ash)



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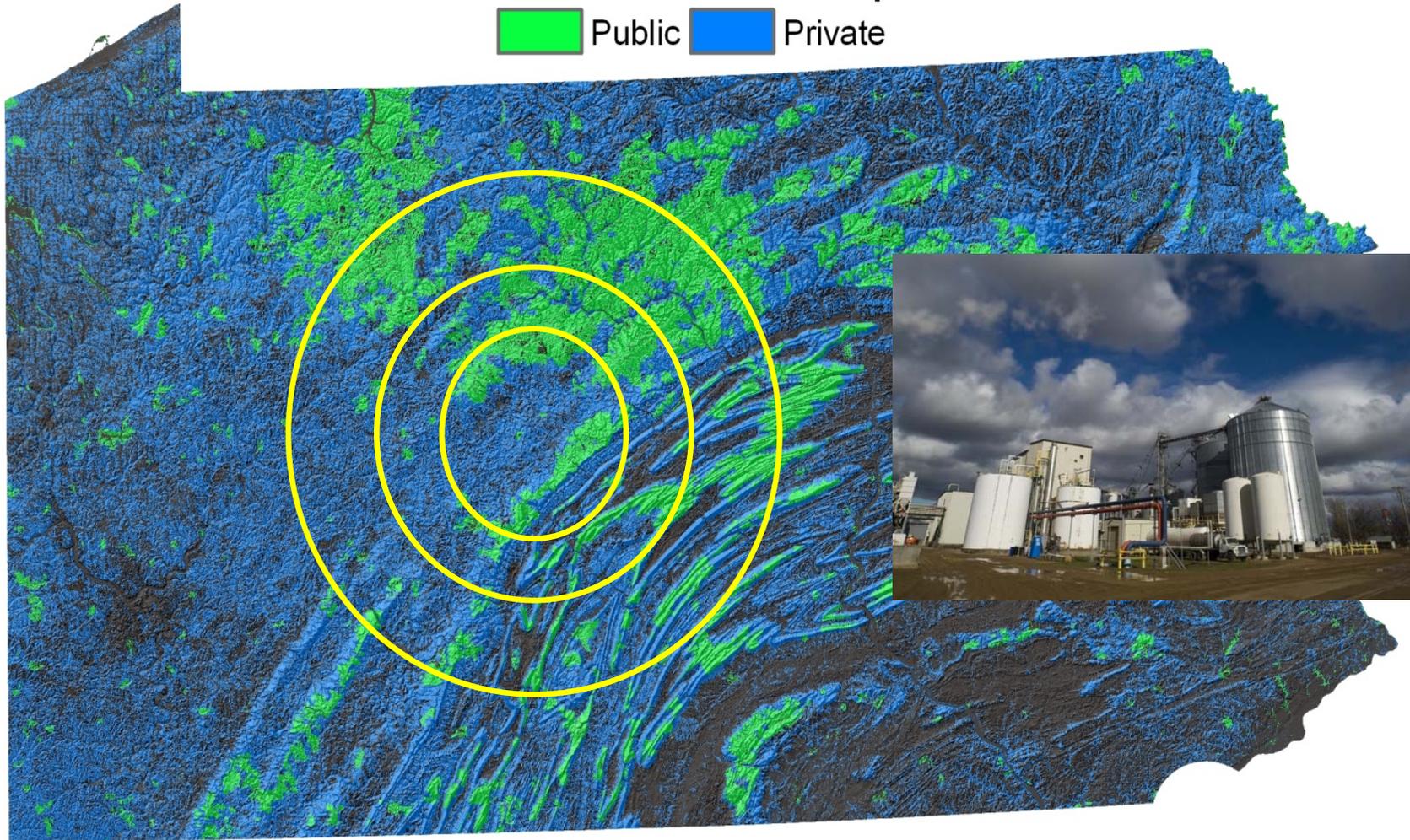
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History of Wood Energy in Pennsylvania

Forest Land Ownership

 Public  Private



0 50
Miles

