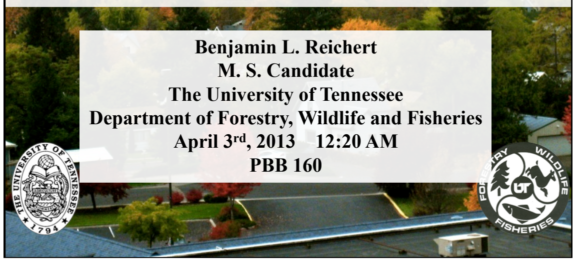
Investigating the effects of urbanization on residual forest dynamics in Knox and Hamilton Counties, Tennessee



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PBB 160

Outline

- Introduction
- Justification for Research
- Research Objectives
- Proposed Methods
  - Plot generation
  - Plot establishment
  - Data collection
  - Statistical analyses

Photo: Rich Maxey

Introduction

- Natural forest ecosystem process
  - Nutrient cycling
  - Organic matter decomposition
  - Cycling of water
- Biotic ecosystem process
  - Photosynthesis
  - Succession

Introduction

- Urbanization
  - The conversion of rural land for urban use is referred to as urbanization

Introduction

- Land use / Land cover change
  - function of land in relation to the activities allowed
  - the physical and biological cover over the surface of land, including water, vegetation, bare soil, and/ or artificial structures
- Urban residual forest
  - Small woodlots in the middle of developments
  - Backyard trees

Introduction

- Urbanization
  - The process by which large numbers of people become permanently concentrated in relatively small areas, forming cities

Introduction

- Urban sprawl
  - The process by which cities grow or by which societies become more urban
  - Cause forest fragmentation
    - Leaving residual forest patches with in urban areas

Justification for Research

- Various non-FIA inventories have been done in the past, mainly on street trees of cities. Inventories of residual forest found in residential areas (i.e. backyard trees, small woodlots in the middle of developments, or patches of residual forest lands) are limited

(Riemann, 2003; Cumming et al., 2006; Nowak et al., 2011)

Justification for Research

- Soil microbial communities play a key role in nutrient cycling
- The associated plant–soil interactions provide important feedbacks that regulate ecosystem processes
- Recent studies suggest that microbial composition and function can fundamentally alter soil decomposition processes; independent of environmental drivers such as water content or soil temperature

(Zinke, 1962; France et al., 1989; Pallant and Riha, 1990; Porazinska et al., 2003; Binkley and Menyailo, 2005; Kulmatiski et al., 2008)
(Balser and Firestone,2005; Zogg et al.,1997)

Research Objectives

- Adapt tree inventory techniques for "non-forested areas" as proposed by USDA Forest Inventory Analysis (FIA) to residential areas in Knox Co. and Hamilton Co., Tennessee.
- Establish baseline information of vegetation diversity, percent tree canopy and soil conditions in Knox Co. and Hamilton Co., Tennessee.
- Investigate the effects of tree species diversity on soil microbial biomass in urban forest soils in Knox Co. and Hamilton Co., Tennessee.

Objective 1: Adapt tree inventory techniques for "non-forested areas" as proposed by USDA Forest Inventory Analysis (FIA) to residential areas in Knox Co. and Hamilton Co., Tennessee

Methods: Urban plot generation

- Random Sampling
  - Geographic Coordinate System (GIS)
- Microsoft Excel
- Goggle Earth
  - KML file
- KGIS Maps
- Landowner Letter

Objective 1: Adapt tree inventory techniques for "non-forested areas" as proposed by USDA Forest Inventory Analysis (FIA) to residential areas in Knox Co. and Hamilton Co., Tennessee

Methods: Urban plot generation

- Random Sampling
  - Within ArcGIS 10.0 a boundary box was placed on top of the state of Tennessee
  - Two x, y coordinates were established
    - x_1, y_1 at the northeastern point
    - x_2, y_2 at the southwestern point
  - Coordinates exported to excel

Objective 1: Adapt tree inventory techniques for "non-forested areas" as proposed by USDA Forest Inventory Analysis (FIA) to residential areas in Knox Co. and Hamilton Co., Tennessee

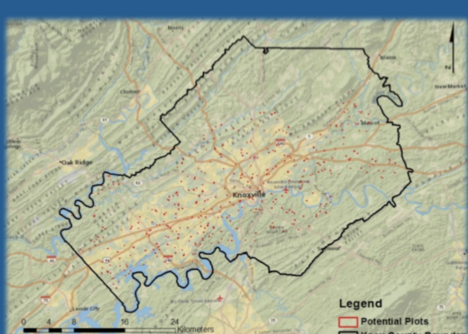
Methods: Urban plot generation

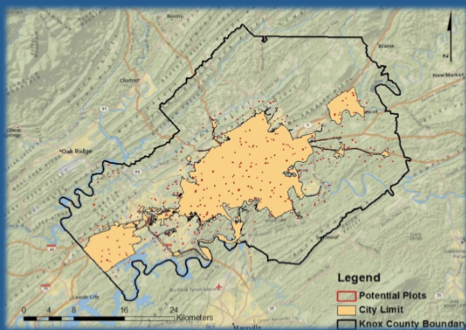
- Microsoft Excel
  - Difference between x_1 and x_2 / y_1 and y_2 was calculated
    [Rand ()*differences + x2]
  - 78,000 tenth–acre potential sampling points state wide
  - 2,918 tenth-acre potential sampling points (*Sites were selected based on population (>50K) with counties)
    - Knox
    - Hamilton
  - Potential sampling points the coveted to KML format for Google Earth

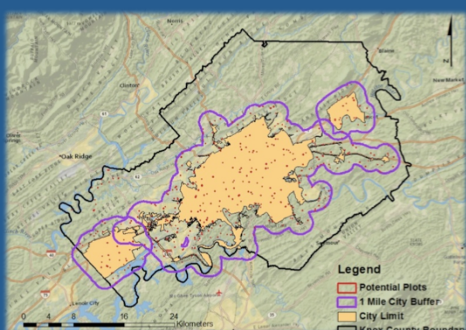
Objective 1: Adapt tree inventory techniques for "non-forested areas" as proposed by USDA Forest Inventory Analysis (FIA) to residential areas in Knox Co. and Hamilton Co., Tennessee

Methods: Urban plot generation

- Google Earth (Knox County)
  - 423 tenth-acre potential sampling points
  - Plots acceptance guidelines
    - 100 ft. buffer zone
    - ≥ 1 acre forested or open field (no agriculture)
    - Points that fell on tops of buildings, in water, and on impervious cover
    - Residual points only







Objective 1: Adapt tree inventory techniques for "non-forested areas" as proposed by USDA Forest Inventory Analysis (FIA) to residential areas in Knox Co. and Hamilton Co., Tennessee

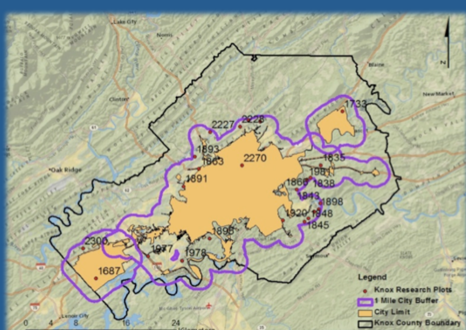
Methods: Urban plot generation

- KGIS Maps
  - 180 potential sampling points
  - Identify potential sample plot information
    - Property owner
    - Address
    - Approximate land area

Objective 1: Adapt tree inventory techniques for “non-forested areas” as proposed by USDA Forest Inventory Analysis (FIA) to residential areas in Knox Co. and Hamilton Co., Tennessee

Methods: Urban plot generation

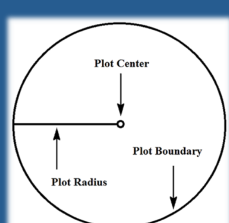
- Landowner Letters
  - Develop research letter for mailing to potential property owners for field study
  - 1) letters were distributed with information about the study at each residence, 2) a follow-up phone call to the owner(s), and 3) upon receiving permission from an owner, meeting with them and conducting the inventory
  - Secure field study plots for research
    - 28 confirmed plots



Objective 2: Establish baseline information of vegetation diversity, percent tree canopy and soil conditions in Knox Co. and Hamilton Co., Tennessee.

Methods: Forest data collection

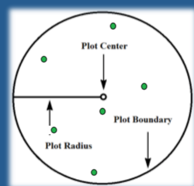
- Location verification (GPS)
- General site characteristics
- Aspect (azimuth)
- Understory vegetation
- Percent canopy cover
  - 5% classes ranging from 0% to 100%
- Tree species
  - DBH
    - ≥ 2.54 centimeters (1.00 inches)



Objective 2: Establish baseline information of vegetation diversity, percent tree canopy and soil conditions in Knox Co. and Hamilton Co., Tennessee.

Methods: Soil collection

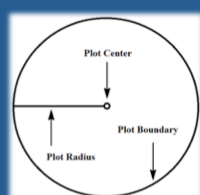
- 28 tenth-acre plots
- Sample intensity
  - 6 randomly collected samples
  - Depth of 30 cm
  - Combined into one composite sample
- Sample frequency
  - Winter
  - Spring
  - Summer
  - Fall



Objective 2: Establish baseline information of vegetation diversity, percent tree canopy and soil conditions in Knox Co. and Hamilton Co., Tennessee.

Methods: Soil data collection

- 28 tenth-acre plots
  - Soil temperature
  - Soil bulk density



Objective 2: Establish baseline information of vegetation diversity, percent tree canopy and soil conditions in Knox Co. and Hamilton Co., Tennessee.

Methods: Lab data analyses

- Gravimetric soil moisture content
- Cation exchange capacity (CEC)
- pH
- Chloroform direct extraction
  - Microbial biomass Carbon
  - Microbial biomass Nitrogen
- Total elemental concentration (ActLabs)
- Total C (TC) (ActLabs)
- Total known N (TKN) (ActLabs)

Methods: Statistical analyses

- Excel calculations
  - Diameter distribution
  - Basal area (BA)
  - Trees per acre (TPA)
- Shannon Diversity Index
- Correlation coefficient
  - With in plots and between plots
- Principal component analysis (PCA)
  - Reveal factors that explain the greatest amount of variation in the abundance of the vegetation sampled
- Correlation coefficient
  - With in soil samples and between soil samples
- Principal component analysis (PCA)
  - Reveal factors that explain the greatest amount of variation in the abundance of the soil microbial biomass sampled

Objective 3: Investigate the effects of tree species diversity on soil microbial biomass in urban forest soils in Knox Co. and Hamilton Co., Tennessee

Methods: Statistical analyses

- ANOVA to investigate differences in the tree specie effects on each plot variable across all aspect/degree of residential plot combinations
- Regression methods to relate the abundance tree species, soil microbial biomass, to nutrient concentrations or conditions
- PCA to reveal factors that explain the greatest amount of variation in the abundance of the vegetation sampled, soil microbial biomass, and elemental concentration

References

Images Cited
- Title page image: http//spokaneurbanforest.org
- Image 2: http//ag.tennessee.edu
- Image 3: http//tnsos.org
- Image 4: http//landtechco.com
- Image 5: Thomas Turnbull 02.15.2013
- Image 6: Thomas Turnbull 02.15.2013

Literature cited
- Balser, T.C., Firestone, M.K., 2005. Linking microbial community composition and soil processes in a California annual grassland and mixed-conifer forest. Biogeochemistry 73, 395–415.
- Binkley, D., Menyailo, O., 2005. Tree species effects on soils: implications for global change. Springer, NATO Science Series IV: Earth and Environmental Science vol. 55.
- Cumming, A.B., Forester, Twardus, D.B., Smith, W.D., 2006. National Forest Health Monitoring: Program Maryland and Massachusetts Street Tree Monitoring Pilot Projects. Gen. Tech. Rep. NA-FR-01-06. Newton Square, PA: U.S. Department of Agriculture Forest Service, Northeastern Research Station and Northeastern Area State and Private Forestry.
- France, E.A., Binkley, D., Valentine, D., 1989. Soil chemistry changes after 27 years under four tree species in southern Ontario. Can. J. For. Res. 19, 1648–1650.

References

Literature cited

- Kulmatiski, A., Beard, K.H., Stevens, J.R., Cobbold, S.M., 2008. Plant–soil feed backs: a meta-analytical review. Ecol. Lett. 11, 980–992.
- McDonald, R., Motzkin, G., Bank, M., Kittedge, D., Burk, J., Foster, D., 2006. Forest harvesting and land-use conversion over two decades in Massachusetts. Forest Ecology and Management, 227:31-41.
- Nowak, D.J., Cumming, A.B., Twardus, D., Hoehn, R. E. III, Oswalt, C.M., Brandeis, J.T. 2011. Urban forests of Tennessee, 2009. Gen. Tech. Rep. SRS–149. Asheville, NC: U.S. Department of Agriculture Forest Service, Southern Research Station.
- Pallant, E., Riha, S.J., 1990. Surface soil acidification under red pine and Norway spruce. Soil Sci. Soc. Am. J. 54, 1124–1130.
- Porazinska, D.L., Bardgett, R.D., Blaauw, M.B., Hunt, H.W., Parsons, A.N., Seastedt, T.R., Wall, D.H., 2003. Relationships at the aboveground–belowground inter-face: plants, soil biota, and soil processes. Ecol. Monogr. 73, 377–395.
- Riemann, R., 2003. Pilot Inventory of FIA Plots Traditionally Called 'nonforest'. General Technical Report NE-312. Newton Square, PA: U.S. Department of Agriculture Forest Service, Northeastern Research Station.
- Zinke, P.J., 1962. Pattern of influence of individual forest trees on soil properties. Ecology 43, 130–133.
- Zogg, G.P., Zak, D.R., Ringelberg, D.B., Macdonald, N.W., Pregitzer, K.S., White, D.C., 1997. Compositional andfunctional shifts in microbial communities due to soil warming. Soil Sci. Soc. Am. J. 61, 475–481.

Thank you

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Questions?