Proceedings

EMERGING ISSUES ALONG URBAN/RURAL INTERFACES: LINKING SCIENCE AND SOCIETY

March 13-16, 2005
Hilton Atlanta
Atlanta, Georgia

Edited by:
David N. Laband

Conference Co-sponsors:

Center for Forest Sustainability: A Peak of Excellence at Auburn University

National Science Foundation

USDA Forest Service, Southern Center for Wildland-Urban Interface Research and Information

School of Forestry & Wildlife Sciences, Auburn University
Forest Policy Center, Auburn University
Plum Creek Foundation
Georgia Pacific
Smurfit-Stone
Weyerhaeuser Company Foundation
Inter-American Institute for Global Change Research
Temple-Inland
The Pinchot Institute
Ecological Society of America
Auburn University Environmental Institute
International Union of Forestry Research Organizations
American Water Resources Association

August 2005
Acknowledgements

The papers included in this Proceedings volume were presented March 13-16, 2005 in Atlanta, Georgia at a conference titled, “Emerging Issues Along Urban-Rural Interfaces: Linking Science and Society.” This conference was the brain-child of B. Graeme Lockaby, Director of Auburn University’s Center for Forest Sustainability, which was established in 2000 and is one of 6 Peaks of Excellence at Auburn University.

The conference attracted 250 attendees, from 20 countries. Including the 5 keynote speakers, there were 198 presenters, representing a wide spectrum of academic disciplines and perspectives. All presentations at the conference are represented here, in the form of a paper or an abstract. This information also is available at: www.sfws.auburn.edu/urbanruralinterfaces/. I would like to take this opportunity to thank all contributors to the conference for helping to make it a truly exceptional event for everyone who attended.

The planning of the conference required (and benefited greatly from) the contributions of many individuals, especially members of the Steering Committee: Jack Feminella, Upton Hatch, Graeme Lockaby, Ed Loewenstein, John Schelhas, and Larry Teeter. Our conference planner, Lisa Ditchkoff, provided simply superb professional service both before and during the conference. Lisa was responsible for many aspects of the behind-the-scenes organization that were vital to the smooth running of the conference. Our keynote speakers, Joseph Chamie, David Wear, Jack Liu, Peter Groffman, and Clifford Duke, attracted widespread praise from the conference attendees. They merit special thanks for contributing their expertise and perspectives so generously, with such good humor. Thanks to Erik Schilling, Maksym Polyakov, Ram Pandit, Indrijit Majumdar, and Shaun Tanger from the School of Forestry & Wildlife Sciences at Auburn University and my wife, Anne, for their help as conference facilitators.

On behalf of Graeme Lockaby and The Center for Forest Sustainability, I want to extend my heartfelt appreciation to all of the conference co-sponsors. The National Science Foundation provided financial support for a large number of students who otherwise simply would not have been able to attend. These students not only were an extremely valuable part of our conference, they are the future of interdisciplinary approaches to understanding and resolving complex urban/rural interface issues. Major sponsorship and continuous encouragement was provided by the Southern Center for Wildland-Urban Interface Research and Information. Other co-sponsors include the School of Forestry & Wildlife Sciences at Auburn University, Auburn University’s Forest Policy Center, the Weyerhaeuser Company Foundation, the Plum Creek Foundation, Georgia Pacific, Smurfit-Stone, the Inter-American Institute for Global Change Research, Temple-Inland, the Pinchot Institute, the Ecological Society of America, Auburn University’s Environmental Institute, the International Union of Forestry Research Organizations, and the American Water Resources Association. The generosity and encouragement of these organizations was instrumental to the success of our conference and the publication of this Proceedings volume.

David N. Laband
Center for Forest Sustainability
Auburn University
Introduction

The following papers and abstracts represent the tangible outputs from an international conference on natural resource issues at the urban / rural interface that was held in Atlanta during March, 2005. The reasons for holding the conference were threefold. Given the immense potential for degradation of natural resources by urban sprawl at local, regional, and global scales, an urgent need exists to (1) identify the most critical facets of the urban sprawl phenomenon and (2) design new research approaches with the capability to embrace the very complex nature of urban / rural interactions. Finally, it was obvious that any progress toward needs (1) and (2) was heavily dependent on success with (3), i.e. bringing together representatives of the many disciplines involved with urban sprawl issues.

Approximately 250 participants from Africa, Asia, Australia, Europe, and North and South America gathered to share views on these general objectives. Both the papers and abstracts bear testimony to the highly multidisciplinary nature of the conference as well as the wide range of issues associated with urbanization. Consequently, a very broad geographic and disciplinary array of perspectives and expertise was made available for attendee consumption. The resulting atmosphere drove an enthusiastic interchange of information and ideas and generated many requests to develop a biennial sequence of similar meetings.

To that end, planning has begun for a second conference to be held in spring, 2007. We look forward to designing that conference and, with your help and that of others, maintaining the momentum of Atlanta, 2005 toward finding compatible ground among urban expansion, natural resources, and the quality of human life.

B. Graeme Lockaby
Director, Auburn University Center for Forest Sustainability
Table of Contents

Acknowledgements 2

Introduction - - B. Graeme Lockaby 3

Defining the Interface 17

Defining the Urban/Rural Interface of the South Carolina Piedmont Using a GIS-Based Model - - Lawrence R. Gering, T. Stephen Eddins, and Mary Webb Marek 18


Landscapes, Land-Use Change, and Ecosystem Integrity 28

From Agricultural to Urbanised Landscapes: Reflections of Technological, Social and Ecological Transitions in the Wet Tropics of North Queensland - - Iris Bohnet 29

Understanding Rural Character at the Urban/Rural Interface - - Jenna H. Tilt 36


Landscape Fragmentation Measurement for Ecological Exurban Development - - Chien-Chi Chiang and Donna L. Erickson 46

Future Visions for Urbanizing Tropical Landscapes - - Iris Bohnet 53

Dynamic Models of Land Use Change in Northeastern USA - - Mary L. Tyrrell, Myrna H. P. Hall and R. Neil Sampson 61

Landuse Change Determinants in Alabama - - Indrajit Majumdar, Maksym Polyakov and Larry Teeter 66

Birmingham-to-Atlanta: Returning Longleaf Pine and Fire to Where it Belongs - - John S. Kush and John McGuire 70

Urbanization: Forest Structure, Fragmentation, and Private Forestry 75

Effects of Urbanization on Forest Biodiversity in Alabama - - Maksym Polyakov, Lawrence Teeter and Indrajit Majumdar 76

Changes in Land Use, Forest Fragmentation, and Policy Responses - - Ralph J. Alig, David J. Lewis, and Jennifer J. Swenson 79

Land Ownership Parcelization, Urban Sprawl and Timberland Value - - Yi Pan and Yaoqi Zhang 83

The Impact of Urbanization on Timberland Use by Ownership - - Rao V. Nagubadi and Daowei Zhang 88

Non-Native Plants in the Understory of Riparian Forests Across a Land Use Gradient in the Southeastern U.S. - - Nancy J. Loewenstein and Edward F. Loewenstein 94
Environmental Knowledge

Wildland-Urban Interface Professional Development Program - - Martha C. Monroe, L. Annie Hermansen-Baez and Lauren W. McDonell

Potentials for Increased Farm Profits and Non-Farmer Awareness of Agriculture: An Assessment of Consumer Interests in Agricultural and Nature Tourism - - Kristin Reynolds and Desmond Jolly

Assessing Visitor Awareness of Invasive Species and Attitudes Toward Control Options - - Melissa L. Baker, Mae A. Davenport and John W. Groninger

4-H Wildlife Stewards: Bringing Urban and Rural Oregon Together - One School at a Time - - Maureen Hosty and Maggie Livesay

Species Conservation and Management

Central Cascades Habitat Conservation Plan Implementation: Keeping Promises for Adaptive Management - - Bernice L. Smith

Using GIS to Rank Forest Restoration Potential: Integrating Core Area, Edge Density and Bird Habitat Criteria in the Kaskaskia River Watershed - - Jean C. Mangun, Michael D. Gaskins, Andrew D. Carver, Karl W.J. Williard and James J. Zaczesk

Human Dispersion and Species Fragility: A Country-Level Comparative Analysis - - Ram Pandit and David N. Laband

Brij Mandal, India: Minimum Operating Plants Diversity from the Social Perspective - - Nurmira Jamangulova

The Impact of Hunting and Fishing on Species Fragility: Evidence From NatureServe's 'At-Risk' Species - - David N. Laband and Michael Nieswiadomy

Wildlife Management on Urban-Rural Interfaces: Cooperation and Conflict Between Science and Society - - Daniel J. Decker, Heidi E. Kretser, Meredith L. Gore, Kirsten M. Leong, and William F. Siemer

A Social Hangout or an Appetizing Food Source: Glaucous gull (Larus hyperboreus) Abundance at the Barrow Landfill - - Rebecca Nemecc, Henry Horn, and Nora Rojek

Peri-Urban Agriculture

Agricultural Viability at the Urban Fringe - - Adesoji Adelaja, Kevin Sullivan, and Mary Beth Lake

Agriculture and Territorial Changes in Peri-Urban Zones in Central Mexico - - Héctor Avila-Sánchez

Chemical Use Reductions in Urban Fringe Agriculture - - Adesoji Adelaja, Kevin Sullivan, and Ramu Govindsamy

Urban Sprawl Towards Eden Gardens - - Isabel Maria Madaleno
<table>
<thead>
<tr>
<th>Title</th>
<th>Authors</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>A Livelihood Strategy for the Urban Poor: Enhancing the Productivity of Urban Food Supply among Low-Income Households in African Cities</td>
<td>Lola Lawrence</td>
<td>180</td>
</tr>
<tr>
<td>Fire</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Would I Stay or Would I Go? Exploring Stated Wildfire Evacuation Behavior</td>
<td>Nejem Raheem and Robert P. Berrens</td>
<td>181</td>
</tr>
<tr>
<td>Community Advisor: Firewise</td>
<td>Richard Reitz</td>
<td>191</td>
</tr>
<tr>
<td>Soil and Water Quality</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Impact of Land Use on Fecal Coliform Levels in Surface Waters of Fairfax County, VA</td>
<td>Judith Buchino</td>
<td>196</td>
</tr>
<tr>
<td>Evaluation of the Physical-Chemical Properties of Forest Soils Under Different Management Regimes</td>
<td>Olena Polyakova</td>
<td>208</td>
</tr>
<tr>
<td>Impacts of Urbanization on Nitrate Export in Two Northern Virginia Watersheds</td>
<td>Ryan Albert, Laura Vacherlon, and R. Chris Jones</td>
<td>214</td>
</tr>
<tr>
<td>Economics and Urban Sprawl</td>
<td></td>
<td></td>
</tr>
<tr>
<td>A Spatial-Temporal Modeling of Residential Property Values at the Urban-Rural Interface</td>
<td>Huiyan Lin, Molly Espey, Kangshou Lu, and Zhe Zhang</td>
<td>225</td>
</tr>
<tr>
<td>A Spatially-Explicit Approach to Economic Impact Assessment Modeling: Applications in the Rural/Urban Interface</td>
<td>Richard G. Thurau, Andrew D. Carver, and John G. Lee</td>
<td>226</td>
</tr>
<tr>
<td>Spatial Dependency and Heterogeneity of Housing Density in Tennessee’s Six Metropolitan Statistical Areas</td>
<td>Seong-Hoon Cho, Christopher D. Clark, William M. Park, and Alexander Young</td>
<td>231</td>
</tr>
<tr>
<td>Complex Connections: The role of non-timber forest products in urban and rural livelihoods in Nicaragua</td>
<td>Laura Shillington, Jeffrey K. McCrary, and A. L. Hammett</td>
<td>238</td>
</tr>
<tr>
<td>Urban Forests and Forestry</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Public Conceptions of and Attitudes towards Urban Forestry in Alabama</td>
<td>Yaoqi Zhang, Anwar Hussain, and Neil Letson</td>
<td>250</td>
</tr>
<tr>
<td></td>
<td></td>
<td>256</td>
</tr>
<tr>
<td></td>
<td></td>
<td>257</td>
</tr>
<tr>
<td></td>
<td></td>
<td>261</td>
</tr>
</tbody>
</table>
Estate Thomas Experimental Forest, U.S. Virgin Islands: An Urban Forest in the Middle of St. Croix - - Peter L. Weaver


The Hidden Forests of the Amazon: Issues Surrounding the Protection and Use of Urban Forests in Belem, Brazil - - Brenda Baletti

Stakeholder Preferences Among Various Forest Management Regimes at the Wildland-Urban Interface - - Randall P. Rawls, John M. Lhotka, Edward F. Loewenstein, Joshua M. McDaniel, and Matthew F. Smidt

Animal Logging Applications in Urban Forestry - - Suraj P. Shrestha

Hazards and Human Health

Hazards and Society in the Peri-Urban Interface - - Abdullah Adam-Bradford

Spent CCA Treated Wood From Residential Decks Can be a Resource for Reuse and Recycling, Bob Smity, Phil Araman, David Bailey, and Matt Winn

Do Sprawling Counties in Georgia Adversely Affect Health? A Focus on Obesity and Cancer - - Inas Rashad and Michael Eriksen

Vulnerability and Adaptation to Climate Change in Central Peruvian Andes Cities - - Alejandra G. Martínez and Ken Takahashi

Community Planning and Perspectives

The Role of GIS in Facilitating Public Participation in Planning for Urban Growth in Kiama, New South Wales, Australia - - Emma McIntyre

A New Generation of Public/Private Partnerships for Tropical Forest Conservation: Case Study of the Former Naval Base in the Urbanizing Panama Canal Region - - Andrew D. Carver, Nestor J. Correa, Gerald P. Bauer, Peter L. Weaver, Jean C. Mangun, and Pedro M. Gascón

Leadership Structures in Regional Economic Development Partnerships: Charisma, Conflict, and Competition - - Jeffrey Sachse

An Investigation of Community Stakeholders’ Perspectives on Non-Native and Invasive Plants - - Molly Braddock and Mae A. Davenport

Urban Form and Efficiency

Urban Form, Urban Efficiency, and Rural Ecology - - William Code

Abstracts of Additional Papers Presented at the Conference

The New International Population Order [Keynote Address] - - Joseph Chamie

Forest Sustainability along Rural Urban Interfaces [Keynote Address] - - David N. Wear

The Bio-Geo-Socio-Chemistry of Urban Watersheds [Keynote Address] - Peter Groffman

Blurring the Boundaries: The Urban-Rural Interface and the Need for Cultural Change in Ecology, Planning, and Management [Keynote Address] - Clifford S. Duke

Defining the Interface

Defining the Interface: What is it? Where is it? - Wayne Zipperer

Canyon Frags and the City: The Nature of Nature in San Diego -- Alicia Cox

Fire

Development and Assessment of a Fire Model for Forest Park, Portland, Oregon - David Kuhn

The Front Range Fuels Treatment Partnership - A Multi-Agency Response to a Growing Problem - Robert Sturtevant and Katherine Timm

Collective Action to Reduce Risk of Catastrophic Wildfire in the WUI: Theory & Evidence - Evan Mercer and Toddi Steelman

Restoring Community Spirit After Wildfire: An Example - Alix Rogstad

Interface Fire Mitigation - Delores D. Funk


Urban Sprawl

A Comparison of Housing Growth Hotspots in the Midwestern and Northeastern U.S. from 1940-2000 - Christopher A. Lepczyk, Roger B. Hammer, Volker C. Radeloff, and Susan I. Stewart

Emerging Exurbia: A Comparative Analysis of Exurban Settlement Patterns Across the U.S. - Jill Clark, Elena Irwin, and Ron McChesney


Large-Scale Land Transformations in China Estimated with Satellite Data: Urbanization and its Potential Consequences - Hanqin Tian, Mingliang Liu, Jiyuan Liu, Siqing Chen, Shufen Pan, Wei Ren, and Dafang Zhuang

Four Legs Good, Two Legs Bad? Re-Examining the Ecology of Rural Residential Growth - Peter A. Walker (with Sarah J. Marvin and Patrick T. Hurley)
Urbanization and Forest Structure

Analyzing Tree Cover in South Carolina's Rapidly Urbanizing I-85 Corridor - - Christopher Post, Donald Ham, Patricia Layton, Donald Lipscomb, and David Nowak

Riparian Forest Diversity and Structure Along an Urbanization Gradient in West Georgia, USA - - Michele L. Burton and Lisa J. Samuelson

The Changing Social Fabric of Private Forest Landscapes in Missouri - - Bernard J. Lewis and K. Julie Richter

Human Health Issues


The Relationship of Forest Fragmentation to Lyme Disease in Rapidly Urbanizing Maryland - - Laura Jackson and Elizabeth Hilborn

Fragile Population Segments in Georgia, USA - - Frank H. Millard

Water Quality and Watershed Management

Identification of Lands Important for Protecting Water Quality and Watershed Integrity in the Chesapeake Bay Watershed - - Albert Todd, Stephanie Painton-Orndorff, and Carin Bisland

Lot Size Regulations and Water Quality Protection: The Case for Large Lots in Rural Areas - - Eric Olson and Paul McGinley


Gait Transition: A Promising New Approach for Establishing Culvert Water Velocity Guidelines - - Alison Jane Johnson

An Economic Analysis of Costs of Bioretention Cells and Stormwater Ponds - - Ritu Sharma, Scott R. Templeton, Charles Privette, John C. Hayes and William F. Hunt

The Etowah Habitat Conservation Plan: Watershed Planning Along an Urban/Rural Interface - - Laurie Fowler, Bud Freeman, and Curt Gervich

Comparison of Watershed Planning Strategies for the Lake Sunapee Protective Association - - Laura M. Weit

The Baldwin County Wetland Conservation Plan: Development and Implementation - - Cara Stallman and Ken McIlwain
<table>
<thead>
<tr>
<th>Title</th>
<th>Author(s)</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agroforestry Solutions for Integrated Watershed Management</td>
<td>Greg Ruark</td>
<td></td>
</tr>
<tr>
<td><strong>Land Conservation</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sierra Nevada</td>
<td></td>
<td></td>
</tr>
<tr>
<td>An Integrated Analysis of Private Land Conservation Initiatives in</td>
<td>George Wallace, Katherine King and Tawnya Ernst</td>
<td>346</td>
</tr>
<tr>
<td>Larimer County, Colorado: An Overview of Programs and Benefits</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Space</td>
<td>Bell and Erin R. Buteau</td>
<td></td>
</tr>
<tr>
<td>National Survey of County Open Space Protection Efforts</td>
<td>Karen Mumford and Margaret Myszewski</td>
<td>347</td>
</tr>
<tr>
<td>Urban &quot;Green&quot; Developments and Natural Resource Conservation: Can we</td>
<td>Mark Hostetler and Kara Youngentob</td>
<td>348</td>
</tr>
<tr>
<td>Truly Create Sustainable Communities?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>The Big &quot;Green&quot; Chill: An Assessment of the Recently Announced</td>
<td>Richard W. Hall</td>
<td>349</td>
</tr>
<tr>
<td>Crackdown on Conservation Easements by the IRS</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Spatial Aspects and Issues</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Examining Linkages Between Urban Spatial Patterns and Ecological and</td>
<td>Matthew Beaty, Andrew Huggett, Amy Griffin, and Michael Doherty</td>
<td>349</td>
</tr>
<tr>
<td>Social Processes in Sydney</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Characterization of Land Use and Land Cover Changes at the Urban-Rural</td>
<td>Hangin Tian, Shufen Pan, Chi Zhang, Guangsheng Chen, Siqing Chen, Hua</td>
<td>350</td>
</tr>
<tr>
<td>Interface of West Georgia by Using a Time Series of Satellite Imagery</td>
<td>Chen, and Mingliang Liu</td>
<td></td>
</tr>
<tr>
<td>A GIS-Based Approach to Assessing Development Impacts on Private</td>
<td>Susan M. Stein, Ronald E. McRoberts, Mark D. Nelson, David M. Theobald,</td>
<td>350</td>
</tr>
<tr>
<td>Forests</td>
<td>Mike Eley, and Mike Dechter</td>
<td></td>
</tr>
<tr>
<td>Land-Use and Marine Spatial Planning in Hong Kong and Southern China</td>
<td>Kerrie L. MacPherson</td>
<td>351</td>
</tr>
<tr>
<td>Explaining the Spatial Distribution of Second Homes: An Integrated</td>
<td>Ryan Bidwell, Michelle Kondo, Rebecca Rivera and Stan Rullman</td>
<td>351</td>
</tr>
<tr>
<td>Approach</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Ecosystem Integrity</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A New Scorecard Method for Rapid Assessment of the Sustainability of</td>
<td>S. L. Madson and D. Markewitz</td>
<td>352</td>
</tr>
<tr>
<td>Ecosystem Functions Within Urban and Rural Forest Stands</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Urbanization and Forest Dynamics</td>
<td>C.E. Tripler, M. M. Carreiro and C. D. Canham</td>
<td>352</td>
</tr>
<tr>
<td>Ecosystem Integrity Versus Urban Growth in the Southeast: Connecting</td>
<td>Rick Durbrow, Cory Berish, and John Richardson</td>
<td>353</td>
</tr>
<tr>
<td>the Dots to Support Quality of Life</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Urban Forests and Forestry

Development of Urban Forestry in China - Chunjiang Liu, Yaoqi Zhang, Xiaohui Shen, Pisheng Zhou and Jun Zhao

Demand for Residentially Located Trees in the Southeastern U.S. - Tymur Sydor, David Newman and Mike Bowker

Effect of Canopy Cover on the Volume of Rain Throughfall - Jeff Cochran, Shirley E. Clark, and Melinda M. Lalor

Environmental Knowledge

Agency Protocols for Wildlife Information Transfer: The Challenges and Opportunities of Serving an Urban Population - Kieran J. Lindsey

Birds, Bugs, and Dangerous Animals: Children's Acquisition of Environmental Knowledge in the Sonoran Desert - Colleen M. O'Brien

Connecting Local Environmental Knowledge and Land Use Practices: A Human Ecosystem Approach to Urbanization in West Georgia - Josh McDaniel and Kelly Alley

Rapid Identification of Biological Elements in the Urban/Rural Interface - Don Hamilton, Ed Brown, Julian Beckwith, David Barber and Sherri Clark

Species Diversity and Wildlife Issues

Biodiversity and its Health in Urbanizing Landscapes - W. Douglas Robinson

Effects of Land-Use Intensity on Bird Communities in Puerto Rico - Marcela Suarez-Rubio and John R. Thomlinson

Densities of Neotropical Migrant Songbirds Along a Southeastern U.S. Urban-Rural Gradient - Jeff A. Stratford and W. Douglas Robinson

Animal Behavior in Urban Ecosystems: Modifications Due to Human-Induced Stress - Sarah T. Saalfeld and Stephen S. Ditchkoff

A Different Urban Gradient: Human Socioeconomic Predictors of Avian Diversity - Paige Warren, Ann Kinzig, and Chris Martin

Addressing the Problem of Urban Moose-Related Vehicular Collisions in Prince George, British Columbia - Roy V. Rea

Nutritive Quality of Native, Warm-Season Grasses Exposed to Tropospheric Ozone - John S. Lewis, Stephen S. Ditchkoff, John Lin, Russell B. Muntifering, and Arthur H. Chappelka

Conservation of the Avifuana of the Juan Fernandez Islands, Chile - Erin Hagen, Peter Hodum and Michelle Wainstein

Planning Housing Developments for Biodiversity Conservation - Roarke Donnelly and John M. Marzluff
Managing Disease in Elk on the National Elk Refuge: Competing Claims and Common Goals - - Mark Neff


Analysis of Deer-Vehicle Crashes (DVCs) in Alabama: A Wildlife Management Perspective - - James B. Armstrong and Anwar Hussain

Urban Growth Boundaries

Constructing Greenbelt to Contain Urban Sprawl - Its Success and Failure in Beijing, China - - Jun Yang and Joe McBride

Redefining the Boundaries of Metro Manila, Philippines: The Handicap of "Legalistic" Boundaries in an Ever-Changing Rural/Urban Interface - - Maria Aileen Leah G. Gazman and Jude Anthony N. Estiva

The Costs and Benefits of Urban Containment: The Case of Seoul's Greenbelt Policy - - David N. Bengston and Youn Yeo-Chang,

Community and Regional Planning

Connecting on the Urban-Rural Margins: How One Community Used Public Dialogue and Collaboration to Create a Plan for Responsible Development - - Patrick McNamara

Conditions for Sustainable Community Forests: Evidence From 17 Village Groves in Korea - - Inae Kim and Yeo-Chang Youn

Community-Based Landscape Assessment in Western Interface Areas - - Tamara Shapiro

Preliminary Findings of a Stakeholder Analysis for the Black Warrior and Cahaba Watersheds - - J. Patrick Carter-North

Grassroots Solution to Urban Tensions - - Robert G. Hoyt and Katrina Jones

Community-Based Water Quality Programs in Prince William County, Virginia - - David D. Close, Gregory K. Eaton, and Patricia M. Reilly

Changing Land Use and the Environment


Urbanization as a Driver of Distant, Rural Land-Use and Land-Cover Change: Environmental Dependency in Chihuahua, Mexico - - Nate Currit

Farmland and Rural Residents


American Idle: The Effects of Urbanization on Farmland and Farm Structure in the United States - - Eric B. Jensen and Douglas Jackson-Smith

Fundamental Long-Term Changes in Alabama Agriculture - - Claude E. Boyd and Mike Polioudakis

Soils and Nutrient Cycling


Urban Pressure and Soil Degradation in the Rural-Urban Interface: How Sustainable is the Soil in the Kano Close-settled Zone, Nigeria? - - Roy Maconachie

Urbanization, Private Forestry and Forest Fragmentation

The Impact of Urbanization on Forest Ownership Dynamics in the Northeastern United States - - Brett J. Butler

Cost Analysis of Mechanical Thinning Treatments in Small Stands at the Wildland Urban Interface - - Bruno Folegatti, Mathew Smidt, and Ed Loewenstein


Impacts and Social Transformations Generated by Forest Plantations: Studies on Three Rural Towns - - Matias Carambula Pareja

Modeling the Causes and Consequences of Forest Fragmentation in the Raleigh-Durham Area - - Robert McDonald

Modeling Forest Change and Its Ecological Consequences in the Southern Cumberland Plateau - - Robert Gottfried, Douglass Williams, Matthew Lane, Christopher Butler, Derek Lemoine and Kevin Willis
Social and Political Aspects

The Effects of Social Networks in Natural Resource Product Development, Marketing and Distribution in Rural Vermont - - Curt Gervich

Urban-Peri-Urban/Rural Interface: Food Quality Assurances - A Study of Harvana and Uttar Pradesh - 2 States of India - - Neela Mukherjee and Meera Jayaswal

No Land Under Our Feet: Urbanisation, Land, and the Poor in Peri-Urban Kumasi, Ghana - - Daniel K.B. Inkoom

Celebrating Rural Traditions in Increasingly Urban Contexts: Fiestas and Kitchenspaces in the House-Lot Garden in Central Mexico - - Maria Elisa Christie

Federally Managed Public Lands and Issues of Environmental Justice - - Uttiyo Raychaudhuri and Michael A. Tarrant

Ethics and Ecology on the Urban Frontier - - Robert Kirkman

The Rural-Urban Split and the Course of Democracy in Africa - - John Murungi

Saigon's Edge: Conflicts Between Ideal Representation and the Social Organization of Space on Ho Chi Minh City's Rural-Urban Fringe - - Erik Harms

Case Studies

Urban-rural Interface Issues in a Predominantly Rural State: Some Experiences from Arkansas - - Sayeed R. Mehmood and Philip A. Tappe

Regional Convergence Toward Sustainability in Northeastern Ohio - - Joe Konen, Ben Stinner, Bill Grunkemeyer and Myra Moss

Place and Rural Change: A Case Study of a 'Restructuring' Community in the City's Countryside - - Jeffrey R. Masuda and Theresa D. Garvin

Rural and Urban in the Brazilian Amazon and the "Fate of the Forest" - - Alvaro O. D'Antona, Andrea D. Siqueira, and Leah K. VanWey

Urban Form and Design

Do Certain Features Attract Certain People to a New Urban Community? - - Neil Wieloch

A Trans-Disciplinary Research Approach Providing a Platform for Improved Urban Design, Quality of Life and Biodiverse Urban Ecosystems - - C.T. Eason, J. Dixon and M. van Roon

Urban Regeneration in the Pacific Northwest: Portland's Pearl District Comes of Age - - Barbara Cates

Inspiration From the Landscape: Creativity Meets the Challenge of the Urban/Rural Interface - - John Peine
**Economic Aspects**

Black Belt Housing Rehabilitation - - *Patrick Kennealy* 383

The Nature and Impacts of Tourism in the Urban Coastal Zone - - *Yehuda Klein, Jeffrey Osleeb and Lee Hachadoorian* 384

Sustaining Forestland In Urbanizing Areas - - *Robert E. Bardon and Mark Megalos* 384

Storm Surge Forecasting for New York Harbor - - *Frank Buoniauto* 385

**Poster Abstracts**

The Transformation in Irrigated Land in the Spanish Valley of the Ebro: The Case of the Rioja Region - - *Mohamed Amir Bouzaida* 387

Zion Lodge Landscape: Holding On to the Past and Preparing for the Future - - *Rick Heflebower and Lisa Ogden* 387


Honey, What's for Dinner? An Exploration of the Effects of Garden Plants on the Pollination and Reproductive Success of Native Wildflowers - - *Khrystina N. Smyth, Tiffany M. Knight, and Jonathan M. Chase* 388

Housing Growth over Time: The Influence of Human Settlement on the Landscape - - *Roger B. Hammer, Susan I. Stewart, Christopher A. Lepczyk, and Volker C. Radeloff* 389


Effects of Landscape Context and Recreational Use on Carnivores in Regional Protected Areas - - *Sarah E. Reed* 390

An Analysis of Social and Economic Aspects of Suburban Subdivision Development - - *Troy Bowman, Jan Thompson, Joe Colletti and Lois Morton* 390

Urbanization and Infectious Disease Risk in Wild Songbirds - - *Catherine A. Bradley and Sonia M. Altizer* 391

Support for and Opposition to Stricter Environmental Regulations - - *Rooney Elizabeth Patterson* 391

Wetlands from the Literary, Biological, Mathematic and Economic Perspectives - - *P.R. Fernandes, M.E. Bellanca, M.R. Bacon, C.A. West, and J.F. Logue* 392

A Study to Evaluate the Impact of Urbanization on Local Air Quality: Differences Seen in Large Urban, Small Urban and Rural Ozone - - *Kari L. Maxwell-Meier and Michael E. Chang* 392

Regional Vulnerability Analysis of Air Toxics Impacts on Ecological Resources and Human Health in EPA Region 4 - - *Latoya Miller* 393

Urban Rural Interface Conference Proceedings
Species Composition and Quality of Forests in Preserved, Managed, and Developed Areas Near Cedar Rapids, Iowa - - Michael E. Gerken, Jan R. Thompson, and Cathy M. Mabry


The Effect of Impervious Surface Area and Forested Riparian Buffer Width on Stream Salamanders in Wake County, NC. - - Jennifer Miller

Agrarian Landscapes in Transition: a Timeline of the Salt River Valley of Central Arizona Utilizing a Socioecological Systems Approach - - Steven Kent Metzger

Rural-Urban Food Flows: Key Issues and Themes for sub-Saharan Africa - - Kenneth Lynch

The Center for Forest Sustainability’s WEST GEORGIA PROJECT:

Uncertainty in Estimation of Impervious Surface Based on Multi-Scale Remote Sensing Data: Scale Effect - - Shufen Pan, Hanqin Tian, Siqing Chen and Guangsheng Chen

Development of a GIS-based Integrated Information System (GIIS) for Interdisciplinary Research at Urban-rural Interface - - Shufen Pan and Hanqin Tian

Redbreast Sunfishes and Rip-Rap: Does Stream Fish Diet Change in Response to Increased Watershed Urbanization? - - Nathan W. Tubbs, Brian S. Helms, and Jack W. Feminella

Effects of Forest Regrowth and Urbanization on Ecosystem Carbon Storage in a Rural-Urban Gradient in the Southeast US - - Chi Zhang, Hanqin Tian, Shufen Pan, Graeme Lockaby, Erik B. Schilling, and John Stanturf

Sediment and Hydrologic Relationships Along an Urban-Rural Gradient in the Lower Piedmont - - Jon E. Schoonover, B. Graeme Lockaby, and Brian S. Helms

Urbanization Effects on Forest Health in the Vicinity of Columbus, Georgia - - Diane M. Styers and Arthur H. Chappelka

Alterations of Floodplain Ecosystem Processes as a Result of Chinese Privet (Ligustrum sinense Lour.) Invasion Across an Urban Gradient - - Eve F. Brantley, Jennifer D. Mitchell, and B. Graeme Lockaby

Evaluating Hydrology and Stream Biotic Integrity Across a Gradient of Urbanization - - Brian Helms, Jon Schoonover, and Jack Feminella
Defining the Interface
Defining The Urban / Rural Interface Of The South Carolina Piedmont Using A Gis-Based Model

Lawrence R. Gering¹, T. Stephen Eddins² and Mary Webb Marek³
¹Dept of Forestry & Natural Resources, Clemson University, ²American Forest Management, Inc., ³USDA Natural Resources Conservation Service.

Abstract
A GIS-based model for defining the urban/rural interface for the Piedmont Region of South Carolina (Anderson, Greenville, Oconee, Pickens and Spartanburg Counties) was developed. Classified Landsat Thematic Mapper data provided a description of the current landcover and landuse of the study area. Data from the 2000 Census were used to obtain information on social and cultural attributes such as housing density. These datasets were layered in a GIS environment and a model was developed to assign Census blockgroups within the study area to one of five discrete categories (rural, partly rural, urban/rural interface, partly urban and urban). The model accounted for 93.31% of the study area. Groundtruthing, using field plots located with GPS technology, was used to verify the results and contingency tables were developed. This procedure created a snapshot view of current interface zones and provides a foundation for developing a dynamic model designed to predict future change.

Introduction
The continuing growth of America’s cities has created a zone where people reside who desire both rural and urban attributes. This zone is often referred to as the urban/rural interface. In theory, the urban/rural interface may offer the natural setting of a rural area along with opportunities and activities associated with an urban area. As people relocate into this area because of its existing characteristics it often begins to develop traits similar to a more urbanized landscape. Many questions and problems have arisen concerning the urban/rural interface. Wildfire is a main problem that is associated with this region, but this study was not concerned with the fire aspect of the interface. The primary objective of this study was to develop a process to identify and to spatially determine the location of the urban/rural interface zones in the study area.

This study reports the results of a recently completed project (Eddins 2004) and is the continuation of two previous projects (Gering et al. 2000 and Marek 2001). The study area was enlarged to five counties and a newer version of geographic information system (GIS) software, ArcGIS version 8.3, was available to create the model. Validation of the model in the previous studies was based on a subjective procedure that was difficult to replicate and may have included human biases which could not be quantified. Newer, more quantitative, methods of ground truthing were applied to this study so that the validation procedure is less subjective.

Methods
The five counties that make up the Piedmont region of South Carolina are Anderson, Greenville, Oconee, Pickens, and Spartanburg (Figure 1). ArcGIS was used to pool all of the digital data sets together and determine the different discrete categories of identification for this study region. Block group shapefiles and housing density data were downloaded from the U.S. Census Bureau website. Landsat Thematic Mapper data were downloaded from the University of South Carolina’s GIS website. Satellite imagery data were available as previously classified landcover data. Auxiliary data such as topographic maps, road systems and municipal boundaries were downloaded from the South Carolina Department of Natural Resources (SCDNR) GIS Data Clearinghouse.

Marek (2001) determined the best results for defining the urban/rural interface were achieved by combining landcover data with housing density data which was calculated by dividing the number of housing units per block group by the area (square kilometers) of the block group. The block groups could then be queried to determine the housing density value. The block groups for each county were separated into one of five categories for the project (Marek 2001, Eddins 2004). These categories were urban, partly urban, urban/rural interface, partly rural, and rural and the range of housing density values for each category were:
<table>
<thead>
<tr>
<th>Category</th>
<th>Query</th>
</tr>
</thead>
<tbody>
<tr>
<td>Urban</td>
<td>density ≥ 71 units/km²</td>
</tr>
<tr>
<td>Partly Urban</td>
<td>46 units/km² ≤ density ≤ 70 units/km²</td>
</tr>
<tr>
<td>Urban/Rural Interface</td>
<td>18 units/km² ≤ density ≤ 45 units/km²</td>
</tr>
<tr>
<td>Partly Rural</td>
<td>5 units/km² ≤ density ≤ 17 units/km²</td>
</tr>
<tr>
<td>Rural</td>
<td>density ≤ 4 units/km²</td>
</tr>
</tbody>
</table>

The GIS layer, containing block groups classified into one of the five categories, was combined with the landcover layer based on the classified Landsat imagery. The two layers were then compared to see if the classifications were compatible. This was done by looking at the urban/rural category based on housing density and the landcover classification based on the satellite imagery. If both agreed (for example, a given block group might be classified as urban on both layers), the block group was assigned to that category. If there was a disagreement between the two classifications, the block group was assigned to the “undefined category”. 93% of the study area was assigned to one of the five urban/rural categories and 7% of the area was undefined (Figure 2).

The areas classified as urban and partly urban, as expected, were always located in and adjacent to the cities and larger towns. Areas classified as rural or partly rural occurred in the more remote locations of the study area. The urban/rural interface regions occurred in the “in between areas”. Generally, these interface zones occurred on the outskirts of towns and cities and were often concentrated along major highways. Areas that were classified as undefined were characterized by one of two problems. The first problem was when Census data for a given block group were missing. The second was when the satellite imagery had a classification that was suspicious, such as having a block group identified as “urban” in the middle of a rural landscape. It was beyond the scope of this project to investigate problems within the datasets being used.

**Model Verification**

The strength and validity of the model can be determined by comparing the predicted category with actual ground observations. This means that ground observations in the study area were taken and compared to the corresponding category locations that were predicted in the GIS environment for the same location. Ground verification of the model was conducted by collecting GPS positions in the field (Eddins 2004). These positions were created in the office as waypoints. A random point generator script was used to create the 100 points that covered the study area. Fifty points were concentrated in the interface region, 15 each in the partly rural and partly urban, and 10 each in the rural and urban regions. These points were combined into a single dataset and the category that each fell into was undisclosed to prevent a bias based on prior knowledge. Once this was completed a method of collecting these waypoints had to be determined. The waypoints were added to the road layer in the GIS to make it easier to find the points in the field.

At each waypoint an optical rangefinder was used to determine the number of houses within a radius of 178.41 meters, which is equivalent to an area of 100,000 square meters. Each house that fell within the boundary was tallied and the number of houses was multiplied by an expansion factor of 10 to get the housing density (number of houses per square kilometer) for the point. Once the housing density for each point was determined, the appropriate urban/rural category was identified. The range of housing densities for each category was the same as used to create the GIS model. This was repeated for each of the 100 verification points.

Contingency tables for each county and for the entire study area were used to compare the areas defined in the model and the verification points conducted in the field. These tables evaluated each of the five urban/rural categories. Table 1 shows the comparison of the model to ground truthing for the entire study area. In this comparison, 48 out of 50 points were in agreement for the interface region. This table also shows that 6 out of 10 urban points, 10 out of 15 partly urban points, 12 out of 15 partly rural points, and 9 out of 10 rural points were in agreement. Partial agreement for this study occurs when a waypoint was marked in the field as different from the model, but only one region different either way. With this definition in place, only 2 out of the 100 points were not in total or partial agreement.

**Results And Conclusions**

The first objective of this project was to define the urban/rural interface in the Piedmont region of South Carolina. Along with this interface, four more categories were defined. These other categories were urban, partly urban, rural and partly rural. The second objective was to develop a process of predicting the urban/rural interface using ArcGIS version 8.3. A raster-based method, combining Census data and landcover data, was used to complete this objective.
The basic concept was to first select the Census block group that met the criteria for housing density for each of the five categories. Once these block groups were selected, they were compared to the corresponding land classification from the Landsat data. The areas that were selected in both of these processes were assigned to the appropriate urban/rural category (rural, for example). This process was repeated for each of the five urban/rural categories for each of the five counties. Once this was completed, 93% of the study area had been assigned to one of the five categories (Figure 2).

The undefined areas (7% of the study area) occurred where the classified satellite imagery did not match the corresponding housing density. An example of this situation was a very large waste-water treatment facility within a city boundary. This area was identified as a unique Census block group with a housing density value of zero. Undefined areas also occurred for block groups that had missing housing data.

The final objective was to improve the method of ground validation from a subjective method that may have contained biases to a method that was repeatable, with major aspects of bias removed. This repeatable method of validation was achieved by creating random points across the study area. Prior knowledge of the urban/rural category attached to these random points was hidden before the fieldwork was conducted. This process resulted in a total or partial agreement of 98% between the category defined by the GIS model and the category determined by groundtruthing (eddins 2004).

### Table 1

Contingency table showing predicted category points compared to actual ground validation points for the Piedmont of South Carolina

<table>
<thead>
<tr>
<th>Determined By Ground Truthing</th>
<th>Predicted by Model</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Urban</td>
<td>Partly Urban</td>
<td>Interface</td>
<td>Partly Rural</td>
<td>Rural</td>
<td></td>
</tr>
<tr>
<td>Urban</td>
<td>6</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>6</td>
</tr>
<tr>
<td>Partly Urban</td>
<td>2</td>
<td>10</td>
<td>1</td>
<td></td>
<td></td>
<td>13</td>
</tr>
<tr>
<td>Interface</td>
<td>1</td>
<td>5</td>
<td>48</td>
<td>1</td>
<td></td>
<td>55</td>
</tr>
<tr>
<td>Partly Rural</td>
<td>1</td>
<td>1</td>
<td>12</td>
<td>1</td>
<td></td>
<td>15</td>
</tr>
<tr>
<td>Rural</td>
<td></td>
<td></td>
<td>2</td>
<td>9</td>
<td></td>
<td>11</td>
</tr>
<tr>
<td>Total</td>
<td>10</td>
<td>15</td>
<td>50</td>
<td>15</td>
<td>10</td>
<td>100</td>
</tr>
</tbody>
</table>

### Literature Cited


Marek, Mary Webb. 2001. A model for defining and predicting the urban-wildland interface for the Piedmont of South Carolina. MS Thesis; Department of Forest Resources, Clemson University; Clemson, SC. 99p.


Figure 1 – Five-county study area in the Piedmont Region of South Carolina.

Figure 2 – Urban / rural classifications for the Piedmont of South Carolina
Rural Urban Interaction in the Developing World: Focusing on Flows

Kenneth Lynch
Centre for Earth & Environmental Sciences Research, Kingston University

Abstract
This paper sets out to re-unite urban and rural areas in the study of development processes across the developing world. It will discuss briefly past approaches to development and to rural-urban relations, arguing that there is a need to re-connect these two spaces in a profound way. For example, both theoretical and empirical approaches to development studies are often based on the premise that there is a clear distinction between the urban and the rural. However, this distinction has also been challenged. There is research on ‘rural’ activities in ‘urban’ spaces, urban activities in rural spaces, and changes taking place on the interface between urban and rural spaces and on the increasing interdependence between these two realms. This paper makes a case for bringing these themes together.

Introduction
Some of the earliest work on the interaction between city and country in the developing world focused on spatial models that may be pessimistic (Friedman, 1966), or optimistic (Vance, 1970). These influential theories primarily focus on settlement hierarchies, suggesting an urban focus, however, they are used to theorise about rural urban interaction. Lipton (1977) made considerable impact on development studies later, presenting a thesis of the ways in which urban-based industrialisation policies can have an adverse impact on the development of rural areas. Lipton's ideas of urban bias were hotly debated, but more recently, the question of the distinction between urban and rural development is being questioned. This question has been particularly strong in the field of demography and migration studies. The impact of the economic crises of the 1980s has also prompted research on the differentials between cities and the rural areas. Continued urban growth has prompted concerns about the environmental impacts on the countryside. These disparate critiques have begun to coalesce into a stronger basis body of research in recent years.

Linking Urban and Rural Areas
There is therefore a wide range of research and theory which has relevance for the question of interactions between urban and rural areas. This is proposed within a broader context of research trends that appear to be moving away from the study of the physical interface between urban and rural, to conceiving of the relationships between them as more important. This is the case in recent approaches to the peri-urban interface where rural and urban come into contact (Tacoli, 1998a). In the physical space where the urban and the rural meet there is an emerging consensus that the physical location of these linkages is less important than the way they are constructed and structured (McGranahan & Satterthwaite, 2002; Iaquinta & Drescher, 2001). Major international organisations are moving in a similar way in a realisation that practically as well as theoretically the urban and the rural need to be considered alongside each other (see Table 1). The justification for this is usually usually based on the idea that it encourages a consideration flows of goods, people and ideas across the interface between cities and the countryside.

This focus on flows and linkages is about the links between the areas rather than the structures or processes that separate them. This provides more useful and more powerful analysis of the relationship between city and countryside. Many of these linkages are developed in more detail elsewhere (Lynch, 2004).

The rapid population growth of Third World cities gives rise to concerns about the changing nature of the relationship between urban and rural. For example, the UNCHS (1999) estimated that the world’s urban population is likely to grow to over 50 per cent of the total world population in 2007, an increase on the 30 per cent in 1950. It indicates that the future challenges of the world will involve an increasingly urban-based population. Previous concerns about urban rural relations in the developing world have focused on rapidly growing cities and have tended to characterised many of the cross boundary flows as unidirectional. A focus on flows presents the possibility of considering each of the flows as working in either direction. Under certain conditions one-way flows may dominate or the emphasis may change over time or from one context to the next. For example rural-to-urban migration is often the focus of urban-rural migration in the
developing world. However, some studies have found that even in sub-Saharan Africa, a region affected more than most by rapid urban growth, there is evidence that migration can be in both directions and that the net migration flows can reverse as happened in many African countries during the economic hardships of the 1980s when people abandoned the cities because of the high cost of living and low income earning opportunities (Potts, 1997).

Much of the basis of research that examines population in relation to the rural-urban interface relates to the migration of people across the rural-urban interface. In turn much of this research focuses on rural-to-urban migration. To some extent this is understandable, since net migration flows tend to be in this direction. However, there are questions about some of the research that has been carried out. For example Feldman (1999) argued that previous approaches to the study of rural-urban migration were flawed. These problems included:-

- They focused on seasonal or temporary migration, rather than on permanent migrants.
- They tended to focus on individuals rather than on households, thus focusing on migration as an outcome resulting from rural or urban change, rather than as a process.
- There was a lack of research on the impacts out-migration, such as the loss of agricultural labour capacity, the impact on rural infrastructural needs and the impacts of the increased incomes on consumption or investment.

The result is an assumption that the remaining rural population is primarily dependent on remittances from urban migrants. This assumption has meant that non-farm employment and micro-industries in rural areas have received little research attention until relatively recently (see for example Potts, 1997 and Rigg, 1998). Only recently has it been possible to examine the highly varied demographic profiles of migrants and their complex decision-making processes (Chant (1998) on gender; de Haan (1999) on livelihoods). In particular, research which focuses on the social networks of migrants has provided powerful analyses of migration processes which are linked to more complex understandings of informal sector activities, slum and squatter communities, rural communities and the flows of people, capital and ideas through the social networks: ‘What kinds of continuity and discontinuity shape information and resource flows between (migration) sites? What kind of kin and familial networks facilitate and hinder

Table 1. International Activities Focusing on Rural Urban Links.

*Source: Adapted from Lynch (2004).*

<table>
<thead>
<tr>
<th>Organisation</th>
<th>Activity</th>
<th>weblinks</th>
</tr>
</thead>
<tbody>
<tr>
<td>IIED</td>
<td>Urban-Rural Linkages research</td>
<td><a href="http://www.iied.org/rural_urban/index.html">http://www.iied.org/rural_urban/index.html</a></td>
</tr>
<tr>
<td>OECD Club du Sahel</td>
<td>Research on regional integration &amp; the local economic development (ECOLOC)</td>
<td><a href="http://isur.iep.free.fr/docoursisur/PDM/data/html_/home.html">http://isur.iep.free.fr/docoursisur/PDM/data/html_/home.html</a></td>
</tr>
<tr>
<td>FAO Food into Cities</td>
<td>Food links research, publications and policy recommendations</td>
<td><a href="http://www.fao.org/ag/ags/agsm/SADA/SADAE-5_.HTM">http://www.fao.org/ag/ags/agsm/SADA/SADAE-5_.HTM</a></td>
</tr>
</tbody>
</table>

Urban Rural Interface Conference Proceedings
Mobility? (Feldman, 1999; p.6; see also Lynch, 2004).

Many major world developments have been linked to the relations between urban and rural realms. For example, on coming to power in 1949, the revolutionary Chinese government was made up of politicians largely from peasant backgrounds and with peasant support, but it took control of a country already struggling to cope with the demands of its many large cities. By 1950 Shanghai was already estimated to be 5.3 million, Beijing, 3.9 million and Tianjin 2.4 million (UN, 2001) and the urban population accounted for 57.7 million or 10.6 per cent of the total (Knight & Song, 2000). Some of the earliest government actions were to control marketing of agricultural goods and to ration of urban food consumption, and to control the movement of people – especially rural-urban migration. The level of land scarcity experienced by rural dwellers convinced the Chinese government that urban-based heavy industrialisation was the only way the country would be able to support its population which was 541 million in 1952. However, by 1964, the urban population had grown to 129.3 million, or 18.4 per cent. The government decided that there was a need to further control population and to create employment for the urban population.

External hostility of global powers meant that foreign investment was unlikely, the government pursued a policy that the State Purchase and Marketing Co-operative’s main function was to ‘extract as much of the harvest as possible from the peasants’ (Knight & Song, 2000; p. 11). The Co-operative also supplied agricultural inputs and the State also controlled the banking. The state therefore mediated all rural-urban flows of goods and capital, other than household remittances. This was compounded by the agricultural tax which amounted to approximately 30 per cent of farm proceeds (Knight & Song, 2000). The Chinese government therefore funded its policy of exploiting rural areas, Hodder (2000) argues that inevitably rural agricultural sectors and urban industrial sectors play strategic roles in each other’s development. He identifies six key reasons for these close links between the two sectors:-

1. Agriculture depends on manufactured goods for both the transformation of agriculture (such as machinery and inputs) and for consumer as agricultural incomes rise (such as radios and bicycles).
2. As agriculture incorporates more technology it releases capital and labour which moves into the urban industrial sector.
3. Agriculture provides raw materials for some industries, such as tobacco, cotton and sisal.
4. Agriculture for export can earn foreign exchange which is important for purchasing items which are vital to industrial processes, including petroleum, chemicals and imported technology.
5. The balance in incomes, prices and taxation between the urban and the rural areas. For example, high food prices provide rewards to farmers and incentives to increase production, but may mean high prices in urban areas and can lead to poverty and unrest. Taxation in the agricultural sector can raise revenues to finance public expenditure, but this may act as a disincentive to farmers, particularly if the expenditure is urban- or industrial focused.
6. In rapidly urbanising countries agriculture produces strategically important food for the growing number of urban residents in order to ensure food security at prices that are affordable. (after Hodder, 2000; 80-82)

These six reasons explain the key interdependencies between rural and urban areas. In China, relatively small settlements are not counted as urban. However, the cities include extended metropolitan areas in their definitions of the city – or city-region. While such data allow for monitoring demographic changes in countries across time – for example comparing rates of urban growth from one census to the next - this argument about the differences of definition suggests that comparisons between countries are problematic to say the least. Rigg (1998) cautions against ‘pigeon-holing’ when it comes to definitions of what is ‘urban ‘ and what is ‘rural’. For example, he argues that to separate people into urban or rural categories is problematic. He outlines three main difficulties associated with such categorisation.

Registration records often do not detect changes in residence. For various reasons it may be undesirable for recent in-migrants to be registered as urban dwellers. Rigg gives examples of under-reporting of urban residence particularly in relation to the controversies this can pose during elections when the definition of the area can have implications for the number of political representatives or the authority into which the representatives are elected (for further discussion of this see Lynch, 2004).
Allocating people to discrete categories such as ‘urban’ or ‘rural’ assumes that these categories accurately reflect their realities. Rigg’s own empirical research in Thailand, among others, has demonstrated the significance of fluid, fragmented and multi-location households to survival strategies. This results in households straddling and moving across the rural-urban interface. Thus categorisation of them as one or the other makes no sense. In addition there is the problem of defining the boundaries of urban places which is usually based on some arbitrary definition.

Rigg argues that many Asian urban residents do not consider the cities and towns they live in as ‘home’. This is because they ultimately intend to return to their rural origins. He argues that this brings the issue of identities of the individuals into focus. ‘Home’ and ‘place’ are therefore ambiguous and shifting notions, involving multiple identities that can be embodied simultaneously.

A final concern that could be added to Rigg’s three points above relates to the blurring of the actual geographical definition of the rural-urban divide. This is particularly the case where cities are physically expanding rapidly and extending their physical limits and their influence outwards into the rural areas. Adding to the difficulty of definition, we find that different sizes of settlement are defined as ‘urban’ by different countries.

In another example, Afsar (1999) reports that Bangladesh, the world’s ninth largest country by population, experienced urban population growth of 6 per cent per annum between 1970 and 1996 and the proportion of the population living in urban areas grew from 7.4 per cent to 20 per cent of the country. However, she points out that the designation of new urban areas accounted for 8 per cent of urban growth from 1961 to 1974 and this increased to about one-third between 1974 and 1981. The result is that the progression from rural to urban or vice versa is very unclear and varies from one country to another. The fact that such enormous populations as China and Bangladesh, are re-allocated arbitrarily from rural to urban areas raises questions about the validity of globally aggregated data on urban growth rates and urbanisation. Hardoy et al (2001) suggest that it is best not to consider the proportion of urban and rural populations in terms of precise percentages because of the difficulty of enumerating, but rather in terms of a range.

Researchers have also presented arguments for the separate definition of high density rural areas that can occur under a particular set of characteristics. For example McGee (1991) describes a kind of high density rural area he calls desakota, suggesting it is the result of the metropolitan urban area extending its economy and influence into the surrounding rural areas producing an intense mixture of agricultural and non-agricultural activities. Examples include areas around Jakarta, Manila and Bangkok. Mortimore (1998) carried out research in what he called the ‘close settled zone’ around Kano in northern Nigeria, a densely settled area that is extensive, but has maintained its rural nature. Qadeer (2000) argues that it is important to consider such high density rural areas, what he calls a ‘ruralopolis’, because many have population densities of more than 400 persons per square kilometre, which is the threshold used by some countries as a minimum for defining an urban area. Qadeer (2000) examines examples of ruralopolises comprising most of Bangladesh, and parts of India and Pakistan. He also mentions the South Yangtze Valley in China, the Mekong Delta in Vietnam, and the lower Nile Valley in Egypt. He concludes that ruralopolis is an alternative route to urbanisation, bringing about similar social transformations and spatial reorganisation in a rural setting, and “the future form of human habitat in large parts of Asia and Africa in the 21st Century” (Qadeer, 2000; p.1601).

Such settlement patterns are problematic when trying to fit them into the traditional context. However, Potter et al (2004) argue that geographies of development are about relationships between people, environment and places in different locations and at a variety of scales. The nature of the interaction between city and countryside is at the heart of this focus. The relationships, by implication, involve geographies of groups and individuals. A households location (whether city or countryside) has a bearing on its livelihood assets and opportunities. The interaction between urban and rural is initiated in an attempt to take advantage of the differentials or complementarities between the two areas. The differential may be in the form of income and cost of living, supply and demand or security and hazard. Potter et el (2004) go on to argue that the “nature and relative significance of these relationships changing constantly, both through time and space, and are themselves determined to a large extent by complex movements and flows of people, commodities, finance, ideas and information” (Potter et al, 2004; p. 319).

The nature of the relation between town and countryside could be dynamic, where:
a large number of urban centers (sic.) that will have strong economic ties based on exchanges of labor (sic.), goods and services with their surrounding rural areas. A network of local economic areas will emerge - unheard of thirty years ago -, and just beginning in countries like Nigeria. These "market watersheds" will cut across national borders in ways that will encourage economic growth (Club du Sahel, 1994).

De Haan (2000) argues that because the implications of migration can be negative as well as positive, the outcome depends on the social relations between the migrants and those affected. It is important therefore that governments are sensitive to the informal institutions that structure and facilitate migration processes. It is these institutions that are the key to how migrants’ decisions can support livelihoods. This may well be a part explanation for the incredible growth of cellular telephones in sub-Saharan Africa and in a number of low income countries throughout the world (Lynch, 2004). The importance of social networks provides a demand for technology to ensure those networks are connected.

Conclusions
Some brief concluding points that arise from this discussion.

- Whether it is credit provision or food supply, the urban-rural relationship has an impact in both the urban and the rural area that could be either positive or negative.
- Until recently the only research that has given significant coverage to rural-urban relationships in the developing world is that on migration.
- Recent developments in among development organisations suggest a growing interest in the practical potential of promoting rural-urban interaction.
- There is now a need to better understand the relations between the cities and the countryside.
- Rural-urban relations can be mutually exploitative, but they also provide potential for mutually beneficial links.

List of References


Landscapes, Land-Use Change, and Ecosystem Integrity
From Production to Urbanised Landscapes: Reflections of Technological, Social and Ecological Transitions in the Wet Tropics of Far North Queensland

Iris Bohnet, CSRIO Sustainable Ecosystems

Abstract
Innovation in sugarcane farming – the dominant crop grown in the Wet Tropics – not only led to changes in land management but also to changes in the pattern of farming and farming values. This paper tells the complex story of interacting technological, social and ecological change in the Wet Tropics. New farming methods and greater awareness of environmental issues led to shifts in farmers’ attitudes and to a redefinition of the relationship between agriculture and landscape. The analysis of qualitative interviews with farmers in the Mossman coastal landscape illustrates how attitudes to land use and the occupancy of rural land is changing. The shift from cutting sugarcane by hand to mechanical harvesting triggered landscape change in areas that were too small or too steep for mechanical harvesting, providing opportunities for alternative land uses. Green cane harvesting and trash blanket retention, a further innovation in sugarcane management, helped to increase regrowth tree cover significantly, as the risk of escaping cane fires burning bordering hill vegetation was greatly reduced. In retrospect, these changes and their side-effects have been welcomed by farmers as many expressed a strong environmental ethic. However, concerns about possible future change were also expressed: most traditional specialised cane growers are worried about the declining sugar price and the implications for their farm survival. The emerging lifestyle and hobby farmers are concerned about preserving their quality of life and preventing the ecological impacts of further urban growth. The implications of this differentiation of the stakeholder community for future landscape development in the Wet Tropics are explored.

Key words: landscape change, landscape history, sugarcane farming, qualitative interviews, social profiles, Wet Tropics of North Queensland

The Wet Tropics of Far North Queensland
The Wet Tropics bioregion stretches over 500 km along the Queensland coast between Townsville and Cooktown and forms a belt of approximately 50 km (Figure 1). The area is estimated to be 140 million years old and the oldest living tropical rainforest on earth. Aboriginal people lived on their tribal lands – rainforests, riverine and coastal environments – for millennia and derived their subsistence from access to a wide and varied range of resources (Anderson, 1984). Although some aboriginal people still continue to live and occupy their tribal land, much has changed since European colonisation. For example, Kuku-Yalanju people used to live in the Far North of the Wet Tropics, but are now concentrated in two small towns (Hill et al., 2000).

In 1770, Captain Cook passed the Wet Tropics coastline heading north when his ship, the Endeavour, struck the Great Barrier Reef and was stranded at Cooktown for repairs (Aughton, 2002). However, it took another century before the Palmer River Gold Rush in 1873 led to extensive clearing of forest for settlement and infrastructure (Bolton, 1972). Soon after the discovery of further goldfields in the Hodgkinson River in 1876, the ‘Bump Track’ was blazed and became the lifeline to the port facilities of Port Douglas for a vast territory where mines, farms, stations and townships were being hewn out of the bush (Kuhn, 2001). At the same time, the Mossman district was opened to selection of land under the Crown Lands Alienation Act of 1876 in 1877. The purpose of this Act was to encourage settlement and agricultural development. The result was permanent European occupation and until recently, extensive clearing of rainforest and drainage of coastal wetlands. Local residents report that “when we first came here, we were made to clear the land… that was progress” and a requirement to freehold land.

In 1988, the Wet Tropics bioregion was recognised for its exceptional environmental values and some 900 000 ha (48%) of the bioregion was granted World Heritage Status (Figure 1). The major vegetation type of the World Heritage Area is rainforest. The bioregion occupies about 1% of Queensland (Goosem et al., 1999), yet provides about 10% of the gross values of agricultural production in the state and about 22% of tourism activities (Natural Resource Management Board, 2002). The Great Barrier Reef, also under World Heritage status since 1981, borders the Wet Tropics. This unique setting – where two World Heritage Areas meet – attracts millions of visitors each year (McDonald and Lane, 2000).
**History of the Mossman coastal landscape since European settlement**

The Mossman coastal landscape is located in the northern part of the bioregion and is fully surrounded by World Heritage Areas (Figure 1). Mossman is the agricultural and administrative hub in the area. After successful European occupation, the first sugar mill was erected in Mossman in 1883. However, only the second attempt to establish a sugar mill in Mossman was successful after tick fever appeared in cattle herds and farmers turned to growing sugarcane again. The same mill, which commenced receiving and crushing sugar in 1897, still exists and operates today. To ensure the success of the local sugar mill over time, as much land as possible was required to be assigned to produce sugarcane. By 1927, Mossman counted 148 cane growers. The sugar industry expanded its production area over the following decades. High sugar prices returned in the early 1960s, and again in the early 70s, triggered further expansions (Kerr, 1995). Hillslopes and the surrounding mountains provided a natural boundary and limitation for further expansion, which led to the drainage of coastal wetlands. Cutting increasing amounts of sugarcane by hand was the industry’s biggest problem, as there seemed to be no way to get the crop to the mill without canecutters. Attempts to find an alternative begun even before Mossman Mill started crushing, but it took until the early 1960s until mechanical harvesting was introduced. In 1961, two machines cut about 15 000 tons of sugarcane on 36 farms, a lot less than anticipated (Kerr, 1995). For efficient operation, long rows are required and many paddocks close to hills and following creek valleys were too small or too steep. These areas consequently became available for other land uses such as rural residential development. Also during the 1960s, degradation of hillslope vegetation adjacent to cane fields became a matter of public concern (Hoare, 1989; Phillips, 1990). Following a coastal investigation, the Queensland Government recommended action to prevent fire degradation of hillslope vegetation in 1976 (Pak-Poy & Associates, 1976). A further major change, also in the harvest of cane, was green cane harvesting and trash blanket retention which helped preventing hillslope degradation. This practice was steadily adopted in Mossman during the 1980s, however, primarily to save cultivation costs. Eliminating the risk of escaping cane fires, which until then frequently burned adjacent hill vegetation, was a welcomed side-effect. This technological innovation consequently increased regrowth tree cover significantly, particularly on hills bordering sugarcane paddocks (Figure 2).

Technological changes in sugarcane farming and their environmental and social consequences, the listing of the two World Heritage Areas in the 1980s, and increasing attractiveness of coastal landscapes as lifestyle destinations have resulted in increased interest in the Mossman area as the only place in the world where two World Heritage Areas meet. The development of a successful international tourism industry in the area, with its base in Port Douglas, has pushed land prices up and the demand for further urban and rural residential development is creating pressures to subdivide agricultural land for residential purposes. At the same time, sugarcane farmers in the area are undergoing significant economic difficulties of a dimension that has led some farmers to sell sugarcane paddocks for urban and rural residential subdivisions. The viability of the local sugar mill is under threat due to the low sugarcane price and a reduction of sugarcane being put through the mill system. Consequently, the local sugar mill operates with financial support of the growers today and it is uncertain how long these growers are willing to support their sugar mill. Therefore, despite the fact that the Mossman coastal landscape is still dominated by sugarcane paddocks today, the future of this landscape is highly uncertain. This landscape is therefore an ideal place to study the effects of cumulative change – technological, social, cultural and ecological – that are transforming many landscapes along the Queensland coast.

**Interviews and landscape assessments**

Given that the primary objective of this research was to carry out a detailed study of the causes and consequences of landscape change and their implications for future landscape developments, I decided to focus on a small sample of farmers and land managers located in the Mossman coastal landscape, who occupy, use and manage land. The choice to carry out interviews with farmers and land managers was based on the idea that (1) farmers and land managers can provide a ‘rich story’ about the history of their farms, changes introduced in land use and management practices, the drivers of change, and that (2) the accumulation of a range of stories offers a patchwork that allows the analyst to create a comprehensive picture of how the Mossman coastal landscape developed over time to its current state. It was also assumed that the interviewees could provide some important hints about the future of their farms and the potential for the development of the Mossman coastal landscape as a whole. Taking a qualitative approach, the interviews were semi-structured and took up to three hours’ duration. The interviews were retrospective and prospective in
scope and followed some common themes discussed in each interview:

- personal background of the interviewee and history of farm;
- recent trajectory of land use and management change, focusing on the drivers of change;
- economics (including on-farm and off-farm income); and
- future goals and aspirations, focusing particularly on potential change in use and management practices and the drivers of change (e.g. susceptibility to policies and market trends).

In total, 19 interviews were carried out with a wide range of farmers and land managers using a snowball technique. The purpose of this selection was to learn about as many different farm and occupancy situations as possible. The aim was not to extrapolate from a representative sample but to explore through a micro-sociological case study analysis the defining features, motivations, and held assumptions of the land managers involved (Yin, 1994). In most cases, the interview was carried out with the farmer who was also the business principal of the farm and therefore able to talk about all aspects of the farm. In some cases, particularly were more than one generation was living on the farm, the interview was carried out with father and son or the whole family. These interviews proved to be very useful in providing some of the family dynamics, with respondents expressing their views on past and future land use and management.

To underpin the information gathered in the interviews, landscape assessments of the land managed by the respondent interviewees was undertaken in addition to each interview. These were always carried out together with the farmer – the business principal – of the farm. Verbal information provided in the interview such as information on land management practices or introduced changes could be viewed in the ‘real’ landscape and in its spatial context. Restoration projects, for example, were commonly proudly presented by the farmers. These assessments also provided the opportunity to clarify the meaning of what was said during the interview through illustrations in the landscape.

Both, the interviews and landscape assessments were analysed with the qualitative software package ATLAS.ti (Muhr, 1997). The interviews were treated as text documents and the data gathered in the landscape assessments (annotated maps, notes and photographs) were treated as images. Text and images were coded and common linkages identified. Links between codes, known as nodes, were used to assist in identifying underlying relationships and common patterns in the data.

Social profiles
The aim of social profiling is “to understand the patterns, the recurrences, the plausible whys” (Miles and Huberman, 1994, p. 69) of the relationships being studied. For example, Paquette and Domon (1999, 2001) studied agricultural trajectories and trends in rural landscape development in Southern Quebec which resulted in agricultural and sociodemographic profiles. In this study, analysis of the qualitative data allowed classification of different strategies that farmers/land holders have followed over time to successfully manage their farm. These strategies were found to be closely related to distinct groups of farmers/land managers. Five different groups could be distinguished:

- traditional specialised sugarcane farmers
- traditional mixed farmers
- early diversifiers
- lifestyle farmers
- hobby farmers.

In the following section the five different groups identified are being described in more detail.

Traditional specialised sugarcane farmers
It is often the 3rd or 4th generation who is farming sugarcane on the original home farm today. These farmers have specialised in sugarcane farming and generally bought or leased additional land/farms to increase their production area and subsequently the farm income. For many traditional sugarcane farming families this has been a popular farm ‘survival’ strategy until a few years ago. Diversification efforts until now largely remained outside the agricultural sphere. Investment in properties, businesses, and the stock market is common amongst some sugarcane growers; while others work elsewhere to supplement their farm income. More recently, some of these farmers have sold farm assets, for example a sugarcane paddock for urban development, to supplement their income or to get out of debt. Farm based diversification has not appealed much to these farmers in the past; they are only slowly looking at farm based diversification options. However, many sugarcane farmers have planted rainforest timber trees in steep terrain, in gullies and along rivers and creeks without losing any production land. Others have decided to establish wetlands on unproductive ground and now enjoy the multiple benefits, such as
recreational opportunities and aesthetic and biodiversity values, provided by those areas.

**Traditional mixed farmers**

Traditional mixed farmers are farming sugarcane and cattle often in the 3rd or 4th generation. Acquisition of land also appears to have been common amongst these farmers to increase production and income. In the recent past, however, these farmers have frequently leased additional farms whereas before, when the price of sugarcane was ‘good’, further land or small farms were purchased to increase the production area. Traditional mixed farmers have been looking for farm based diversification options for some time; some have already set up farm forestry blocks, others are going to establish small orchards. Some farmers have, similar to the traditional specialised sugarcane farmers, planted trees and/or created wetlands and enjoy the benefits provided by those areas. It appears that this group of farmers has fewer assets outside agriculture when compared with the traditional specialised sugarcane farmers.

**Early diversifiers**

Contrasting to the traditional specialised sugarcane growers, some sugarcane growers diversified into other crops such as tropical fruit and flowers and/or farm-based enterprises such as farm stays in the early 1980s. Reasons for diversification vary greatly between individual farmers. Obviously these farmers could have acquired additional land to expand their existing enterprise or find work outside the farm to supplement the farm income. Indeed, the options are diverse, and every personal farming situation is unique. A common view early diversifiers share is their perception that agricultural land along the Mossman coast is limited and therefore rather expensive. It appears that to them purchasing extra land to increase the production area was not an appealing option for future development. Interestingly, these farmers are still being able to provide, at least one successor, the opportunity to stay on the farm and to continue the farm business. Also, early diversifiers provide significant local employment opportunities.

**Lifestyle farmers**

In addition to the cane growing community, there are two further distinct groups of farmers. One of these groups identified themselves as ‘lifestyle farmers’. They have chosen to become farmers either because they had been attracted to the area and searched for opportunities to make a living that fitted their personal aspirations and long term goals or they had gained specific knowledge of tropical crops they wanted to grow and chose the Mossman coast because of its environmental conditions. Lifestyle farmers grow tropical fruit crops, exotic flowers, and may also have other farm-based enterprises such as farm stays or similar. Some have given up their professional jobs and have chosen to take a different approach to working and living. They are environmentally minded and either farm organically or avoid using chemicals on their farm. In addition some are trying to become more self-sufficient by growing their own vegetables. Farm succession is less of an issue for these farmers compared to cane growing farmers as they decided to farm as their personal lifestyle choice. Lifestyle farmers also provide some local employment. They typically live on rural residential blocks or small farms.

**Hobby farmers**

‘Hobby farmers’ have moved to the area mainly because of its unique location, appreciating the exceptional environmental values similar to lifestyle farmers. However, they earn their main income outside their farm, but enjoy the rural lifestyle, including working on their properties in their free time. Rainforest timber trees and tropical fruit are grown on some of these properties to provide some farm based income in the future, or horses are kept to manage the pastures and to pay for ongoing land management. At present some hobby farmers work rather hard on their properties and spend money on the land, which they earn elsewhere. For some, the hobby farm is intended to provide some retirement income whereas for others the development of the hobby farm into a lifestyle farm is highly desirable. Similarly to the lifestyle farmers, they occupy rural residential blocks of varying size.

**Transition from a production to an urbanised landscape**

A short summary of change in the Mossman coastal landscape

The establishment of a sugar industry in Mossman and innovation in sugarcane farming has led to widespread change in land use and management. Land of reduced agricultural production value was subdivided and provided opportunities for new ways of developing and occupying land. This land is mainly occupied by lifestyle and hobby farmers today who moved to the area since the late 1970s. They add diversity to the landscape through their varied land use and management practices as well as adding to the diversity in the people living there. They have brought with them new ideas and values. Those values are primarily related to the natural
environment – clean air, fresh water, a unique setting with mountain and ocean views – and to quality of life. Increased recognition of environmental values and programs under the Natural Heritage Trust (NHT), which were set up by the Australian Government in 1997 to help restore and conserve Australia’s environment and natural resources, enabled traditional specialised sugarcane and mixed farmers to integrate trees and wetlands on their commercial farm businesses without losing any productive land. These trees and wetlands often serve multiple functions, which are appreciated by the farmers themselves but also by the wider community. One of the traditional specialised sugarcane farmers pointed out: “it’s really a pretty area … and there is lots of fishing … the family spends quite a bit of time down there, going there to have a look and see what’s happening.” Their own shift in values and recognition of the environmental and social values and services provided by the landscape has left the traditional specialised sugarcane and mixed farmers wondering about the implications for their farm survival, particularly at times when the price for sugarcane is declining. Lifestyle and hobby farmers are becoming more and more concerned about preserving their quality of life and preventing the ecological impacts of further urban and rural residential growth.

Future prospects
Looking at the landscape of the Mossman coast does not reveal the full extent of the transition. Nothing in the landscape tells about the uncertain situation of the traditional specialised sugarcane farmers in the district, who provide large open spaces and give the area a rural feel. Many of these farmers expressed doubts that their children would be able to continue to farm the land and keep these remaining open spaces undivided. They also expressed doubts that there would be another crop they could grow at this scale if the local sugar industry would collapse. These farms comprise the largest area of the landscape, which means that the future of many parcels (in total about 10 000 ha) is highly uncertain. As land values are extremely high, it is unlikely that local farmers would be able to afford such land to expand their farm businesses. It is far more likely that new people, who bring with them their own ideas and values, will be purchasing sugarcane farms and/or sugarcane land, as lifestyle and hobby farmers have done since the late 1970s. However, many locals question the ideas and values of potential new entrants as property and land speculation has been driving the market for some time. Many locals, and in particular lifestyle and hobby farmers, fear that the rural feel and social ambience, the very motives that brought them to the area, will deteriorate with further rural residential and urban developments. Much of the land currently used for sugar production could be sold by their owners under separate titles. This means that farmers are able to sell parcels of land, which are currently part of their farm, without applying for subdivisions. The local planning scheme (Douglas Shire Council, 2004), despite protecting good agricultural land according to Queensland State Planning Policy 1/92, is not able to prevent this development. The question remains as to how much further these developments can take place until a threshold is reached, and the current multifunctional landscape which still retains its rural feel will lose it. For example, local produce can be purchased at road side stalls, and tropical fruit wine is sold directly from the producer and the costumer can hear first hand how the wine has been made and might even the able to get to see the fruit at the tree from which the wine was made. It is feared that in the future, newcomers to the area may only retain manicured gardens contributing to further change towards a potentially less diverse and slowly urbanising landscape. When this threshold might be reached is a question to be answered in a ‘landscape futures study’. Such a study is urgently needed, as the local council has already reported to be under pressure from the tourism sector to retain the rural character of the area because of fears that if the landscape undergoes significant changes international and national visitor numbers may drop (Douglas Shire Council, 2005, pers. comm.).

Implications for future landscape development
Analysis of the qualitative data illustrates how closely related agricultural and landscape change is to the personal histories and values of the people who occupy, use and manage land. The data analysis also illustrates how cumulative change created a milieu that attracted new people to move to the area. However, the incoming lifestyle and hobby farmers use their land in a variety of ways that challenges a simplistic understanding of rural-residential developments as synonymous with suburban sprawl. Converted sugarcane paddocks to tropical fruit orchards, flower farms, rainforest timber lots, and horse paddocks retain a high degree of agricultural use and rural feel. Another noticeable transition found on lifestyle and hobby farms assessed in this study was increased regrowth tree cover. It appears that in future the feeling of openness in the Mossman coastal landscape is under threat. Forty percent (10 000 ha) of the Mossman area is currently used for
sugarcane production. The traditional specialised cane farmers interviewed almost universally indicated that they intend to sell some titles of their farm to others for development. Common reasons for those farmers were to finance their retirement or to reduce their debts. The question that needs to be asked now is how to balance the environmental, social, cultural and economic needs of the increasing stakeholder community and retain a diverse landscape with a rural feel.

Looking at the extent of change that occurred in the landscape, it is evident that the farming/land holding community has also changed quite dramatically. The diversity of people managing the Mossman coastal landscape today is reflected in the different land uses and management practices. As these people carry out land use and management practices according to their individual goals, aspirations and needs land use and management issues become more complex. Based on this analysis, I suggest that future land use and planning policies need to be based on social, cultural and ecological interconnections and that future policies need to be tailored to address the needs of the different stakeholder groups. This will be the key for uptake of, for example, voluntary policy measures, such as schemes under the National Heritage Trust. However, the anticipated changes of such schemes and their intended as well as their unintended side-effects should be studied and analysed first to avoid any future surprises.

References
Figure 1: Wet Tropics bioregion, World Heritage Areas, and the Mossman coastal landscape (case study area).

Figure 2: The adoption of green cane harvesting led to regrowth of secondary rainforest. The images above show Mt Beaufort (hill behind Mossman mill) in 1968 and 2003. Please note the difference in vegetation cover.
Understanding Rural Character at the Urban/Rural Interface

Jenna H. Tilt, College of Forest Resources, University of Washington

Introduction

Understanding the precise meaning of “rural,” let alone “rural character,” is difficult. Heyer (1990: 1) compares looking for rural character to looking for pornography: “it’s very difficult to define, but you know it when you see it.” Despite this ambiguity of what rural and rural character entails, rural character has become a battle call for urban and rural residents alike. As more and more rural areas are seeing unprecedented growth and change, there has been movement to protect rural character. Sonoma County, California, Loudoun County, Virginia, and Fulton County, Georgia are just a few counties across the US that are adopting planning measures—usually large lot zoning densities and design guidelines in an effort to protect rural character. Washington State, where this study takes place, also tries to protect rural character through its Growth Management Act (Sonoma County, 1989; Loudoun County, 2001; Fulton County, 2001; Enger, 1994).

Density and design guidelines, however, may ignore the underlying factors of rural character that are important to rural, and possibly urban, residents. By implementing an innovative community visioning process, planners may become more aware of what aspects of rural character are more important in the abstract sense (what it represents) and what aspects are more important in the visual sense. As illustrated in this paper, rural character does not necessarily depend upon what density or layout pattern is present in a rural area, but rather on cognitive and visual perceptions that create a sense of community, a particular livelihood, and do not illicit feelings of change or development. To more accurately protect and preserve rural character a new approach in community visioning is necessary. This paper does not set out to find a definitive definition of rural character and all it does or does not entail; rather this study uses visual and cognitive methodology to assess how different groups of people perceive rural character.

Past studies have looked at only the visual or cognitive side of rural character. Visually oriented studies have included visual preference surveys that usually are incorporated into design guidelines (Arendt et al., 1994; Jutla, 1997; Krohn, 1993; Nelessen, 1994; Nelessen, 1989; Ryan, 2002; Sullivan, 1996; Tucker, 1991). Conceptual studies have included ethnographies regarding sense of community or conflicts between long-term and recent residents as rural areas grow (Dubbink, 1984; Fichen, 1991; Hibbard and Davis, 1986; Willits and Luloff, 1995).

This study will incorporate both the visual and cognitive methodological approaches to create a new and innovative way to discern perceptions of rural character that may be used in an enhanced community visioning processes and to develop a fuller picture of rural character, especially regarding the relationship between rural character and zoning and design guidelines. Study participants came from four distinct groups—long-term residents, short-term residents, planners who implement rural character policies, and urban recreationists who travel to rural areas for leisure. However, this paper will primarily discuss results for the entire study population together rather than looking at differences between groups.

The study took place in 2001 in two rural towns, Snoqualmie and Roslyn, Washington, along the urban/rural gradient (the I-90 corridor) outside of Seattle, Washington. The two towns were chosen because Snoqualmie had recently seen more urban growth in the form of a large-scale master planned community. Snoqualmie is located within commuting distance from Seattle. Roslyn, on the other hand, was still quite small, although at the time was in a heated battle over the potential development of a large resort nearby. That resort has since been approved.

Methods and Results

Several research methodologies were employed to understand how rural character is perceived both visually and conceptually. These methods included a photo-questionnaire (Kaplan and Kaplan, 1989) to gather visual data; Conceptual Content Cognitive Mapping (3CM) (Austin, 1994; Kearney and Kaplan, 1997) to gather conceptual data; and open-ended
Urban Rural Interface Conference Proceedings

Cognitive perceptions of rural character were explored using the 3CM methodology. The 3CM method works from the premise that each individual possesses knowledge structures regarding different issues (Kearney and Kaplan, 1997). 3CM is a card-sorting technique that allows the researcher to access a knowledge structure regarding a certain issue—in this case, rural character. This technique prompts respondents to list concepts important to a certain issue and elicits the organization and rating of items (Kearney and Kaplan 1997; Kearney et al., 1999). Participants were asked to “brainstorm” any concepts they could think of—positive or negative—regarding rural character. Once the participant mentioned all the concepts he/she could think of, he/she then grouped concepts together by theme and sub-theme that made the most sense to him/her and labeled each group.

The cognitive “maps” generated by the 3CM process were analyzed by employing a content analysis. Concepts mentioned three or more times by any one participant group (i.e. new and old residents, planners or urban recreationalists) were included in the content analysis and grouped together by sub-themes and theme based on the original map structures by the authors. The 3CM analysis generated forty-one concepts. Table 1 illustrates the ten main themes created through the content analysis of these concepts and the individual concepts included in that theme. The themes generated through the 3CM exercise widen the perspective of rural character beyond the visual form. Six out of the ten themes were not visual in nature and instead tapped into the more intangible and conceptual aspects of rural character.

The photo-questionnaire in this study included two distinct sets of color photos: 1) photos of residential scenes from an aerial “bird’s eye view” (referred to as “aerial” scenes in this paper) and 2) scenes taken from a ground level “roadside” perspective (referred to as “residential” scenes). Participants were asked to rate the scenes for rural character (rather than the more traditional rating for preference) on a 1-to-5 Likert scale with “5” indicating the highest rural character. Both the residential and aerial photo sets included scenes of high, medium and low density development. After rating the photos in each photo set for rural character, participants were asked to explain why they rated a small sample of scenes the way that they did. These scenes included a range of densities and were representative of the larger photo sets.

A Principal Component Factor analysis (Varimax, Kaiser Normalization rotation) was used to help reduce the data from the photo-questionnaire into manageable and coherent factors to identify the underlying dimensions of participants’ perceptions of rural character. The criteria for identifying factors were eigen values greater than 1.0 and at least two scenes loading at a level .45 or above. Scenes that loaded on multiple factors were disregarded. Cronbach’s reliability test was run on each factor and alpha levels of .6 or greater were considered coherent. A new variable was created for each factor, with participants’ ratings reflecting the average rating for scenes comprising the factor. Three factors were found in residential photos and similar factors were found in the aerial photos (Figure 1). Factor one, the highest rated factor, represents scenes that had an open feel, few structures and mountains in the background. Factor two represents scenes that have older, historic looking homes in medium to high density neighborhoods. Factor three represents scenes that have newer structures with landscaped yards, large driveways and garages.

Discussion

What is interesting with the photo-questionnaire factor analysis results is that density was not a determining factor in how scenes were rated (Figure 2). Scenes were rated more for a presence or absence of a “planned” or “suburbia” look. Comments associated with the suburbia or planned scenes included: “anywhere USA” “no character” “suburb look on streets and manicure yards” and “suburban lifestyle.”

On the conceptual side, the issue of density was also apparent. The 3CM themes, Low density vs. Isolated (Table 1) showed that all participants conceptualized part of rural character as being “small town” or “low population” or low density.” However, rural residents
did not conceptualize the pattern of that small town as being “isolated” or having large lots. This is an interesting finding in light of the fact that many towns are trying to protect notions of rural character through a variety of density designations. Three other themes played heavily into explaining rural character beyond density and pattern of development. These themes were: 1) perception of community, 2) perception of livelihood, and 3) perception of change as a threat to rural character.

“Community” was a concept mentioned by virtually all participants in this study. However, the 3CM process revealed that rural residents have ownership over very specific and numerous concepts related to community in contrast to the ubiquitous “sense of community” concept mentioned by the non-resident participants. Knowing and helping neighbors and caring for one another were just a few concepts that detailed what community meant to residents (see Abstract Community Theme Table 1). In addition, residential scenes low in density generated negative concepts regarding community, such as: “isolated,” “but no community,” and “transplant lifestyle.” Although it is difficult to determine the extent to which sense of community influenced rural character ratings, it is clear that the concept looms large in peoples’ conceptual idea of rural character and should not be ignored when considering planning and development in rural areas.

Livelihood
Livelihood and economy were concepts also generated through the 3CM process by all participants. Many of these concepts dealt with the hard economic realities of living in a rural environment. On one hand, concepts in the No Economy theme (see Table 1), take the more traditional viewpoint that rural areas, especially those tied to natural resource industries, are slowly dying from lack of jobs and income. Other concepts in the Too Much Economy theme (Table 1) pointed to participants’ views of “outsiders” who profited from the bubble economy of the 1990s and were moving to rural areas in large numbers during that time. Both of these themes relate to the larger question of what livelihoods inhibit or enhance rural character. The concept of livelihood also played an important role in explaining rural character ratings of the photo-questionnaire. Scenes illustrating farms or what looked like agricultural lands were rated highest in rural character for both aerial and residential scenes. Comments associated with these scenes included: “working landscape”, “traditional uses”, “natural resource link” and “agriculture and community.” In contrast, many participants also mentioned livelihood when commenting about scenes that were given a low rural character rating with comments such as: “not enough room to maintain a rural lifestyle,” and “no connection to the land.”

Perceptions of Change as a Threat to Rural Character
The 3CM exercise revealed that Snoqualmie residents focused on the physical change, since they were able to perceive these ideas after having just experienced growth and change (see Change Theme Table 1). Meanwhile, Roslyn residents focused on Agents of Change, such as GMA rules, the beauty of the area that makes it susceptible to development since these were concepts that Roslyn was at the time experiencing (see Agents of Change Theme Table 1). Differences existed between Snoqualmie and Roslyn on several visual factors rating for rural character. Snoqualmie residents still saw themselves living in a rural town though they had seen large growth and development in recent years with a new master planned community. These residents showed a higher preference towards scenes that were more “suburban” in look because they identified their own town of Snoqualmie as a “rural place” even though its physical characteristics had changed. Whereas Roslyn residents who had not seen this level of development perceive these “suburban” scenes as having little rural character.

Though Snoqualmie residents were more acceptable of scenes that had a more developed, suburban look; some scenes were seen negatively by all participants. In particular, the scene below (Figure 3) illustrates that “change as a threat to rural character” is clearly a salient notion held by most participants. Each group rated this scene quite low and the comments--
“buildings designed to be rural, but could be in the city,” “made to look rural,” “looks fake,” “over-pretentious”--associated with this scene suggests that design guidelines tailored to “blend in” with rural character can backfire and be seen as an indicator of change of a rural area.

Conclusions
Density is not the only thing that directs cognitive and visual perceptions of rural character. A Sense of community, how one makes a living in a rural area and uses their property, and the antithesis of rural character (i.e. change and development) also play important cognitive and visual roles in perceptions of rural character. Because rural character means so many things beyond a certain pattern of growth, planners should be wary of using the term “rural character” in policy. If rural character to the planner is only a proxy to allow for large lot density zoning to create a buffer between more urban areas and natural resource lands, then rural towns and residents may feel confused when policy measures to “protect rural character” do not address livelihoods or communities.

However, these towns, as in the case of Snoqualmie in this study, are not frozen in time and do change their perceptions of rural character as growth and development occurs in their towns. Neither trying to thwart all growth nor allowing unfettered growth in rural towns is an appropriate strategy to protect rural character. In the case of Snoqualmie, the physical form of the new buildings mattered less than the feeling of community that still existed in the town. That is not to say that physical visual form doesn’t matter as in the case of the “fake rural” shop in Figure 3. My recommendation is to allow for flexible design guidelines that try to incorporate the eclectic feeling and sense of community of rural towns.

One should not implement any recommendations from this study without first examining the rural town. The most significant message of this study is that, although their may be common themes of rural character in different rural towns, knowing what perceptions are important both cognitively and visually is vital before implementing policies that may affect the pattern of growth or design of the rural community. This study illustrates a quick and easy way to retrieve cognitive and visual data that could be incorporated in a community visioning process.

References


<table>
<thead>
<tr>
<th>MAJOR THEMES</th>
<th>CONCEPTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Description of the area</td>
<td>Open space, natural features, forestry, agriculture, living off the land, old buildings, local schools, local businesses, not generic looking</td>
</tr>
<tr>
<td>Experiencing the area</td>
<td>Low traffic/pedestrian friendly, safe, peace and quiet, slow pace access to nature, outdoor recreation</td>
</tr>
<tr>
<td>Physical Change</td>
<td>Development, transportation improvement, population growth, loss of nature</td>
</tr>
<tr>
<td>Agents of Change</td>
<td>Growth management, desirability of the area, resorts, tourism</td>
</tr>
<tr>
<td>Physical Community</td>
<td>Community center (grange, church, town hall etc.)</td>
</tr>
<tr>
<td>Abstract Community</td>
<td>Sense of community, history, know neighbors, care for neighbors, generations</td>
</tr>
<tr>
<td>Too Much Economy</td>
<td>Booming economy (relative wealth of west side, large influx of money, etc.)</td>
</tr>
<tr>
<td>No Economy</td>
<td>No financial base (not being able to make a living, lack of industry, etc.)</td>
</tr>
<tr>
<td>Low Density</td>
<td>Small population (small town, not populated, etc.)</td>
</tr>
<tr>
<td>Isolated</td>
<td>Isolated (separate from population centers, off the interstate, large lots)</td>
</tr>
</tbody>
</table>

Table 1. Major Themes and concepts within those themes
Of looks, laws and lawns: How human aesthetic preferences influence landscape management, public policies and urban ecosystems

Loren B. Byrne, The Pennsylvania State University

Introduction
Throughout history, humans have transformed and managed landscapes for many reasons including agriculture, natural resource extraction and inhabitation. The contemporary extent and impact of human landscape modification is now so great that the Earth may be described as “human-dominated” (Vitousek et al. 1997). Among ecologists, the increasing recognition that human activities have important environmental consequences has spurred interest in integrating humans into ecological theories and research. The central question of such interdisciplinary research is: How do human sociocultural systems interact with ecological systems to determine environmental patterns and processes (e.g., biodiversity, nutrient cycles) (Pickett et al. 2001)?

Sociocultural and ecological systems interact most strongly in urbanized landscapes where human activities are the dominant drivers of ecological patterns and processes. Although historically neglected as a subject of scientific inquiry, a growing number of ecologists have begun to study the ecology of urban ecosystems (Pickett et al. 2001). However, incorporating sociocultural variables into basic and applied ecological science remains a major challenge for ecologists because of, among other reasons, disciplinary divides in research and training. Such hurdles may be overcome in many ways but especially by developing new interdisciplinary frameworks about the influences of humans on ecological systems. In particular, the influence of aesthetic preferences on ecological patterns and processes has not been widely explored.

In urban ecosystems, humans affect ecological patterns and processes through the design, creation and management of unique habitats such as buildings, landfills and parking lots. However, the most familiar human-created habitat is the lawn, composed of closely mown grasses and herbaceous vegetation. Lawns comprise up to 60% of urban residential areas (Kaye et al. 2004) and cover upwards of 30 million acres across the United States (Bormann et al. 2001). Although ubiquitous, lawns have been the subject of precious few studies both from sociocultural and ecological perspectives.

Synthesizing existing knowledge on sociocultural and ecological aspects of lawns is the main objective of this paper with the hopes that it will provide a springboard for future discussion and research.

My central thesis is that aesthetic preferences influence urban landscape (especially, lawn) management, which in turn has ecological consequences. Although lawns may be managed in a variety of ways for many purposes, the focus of this paper is the idealized lawn found around homes and in institutional landscapes and parks. The idealized lawn is evenly mown, contains one grass species without weeds or diseases, and is green all year round. Discussion of my thesis is developed on a conceptual framework (Fig. 1) and will highlight linkages among 1) the sociocultural variables that have given rise to the idealized lawn aesthetic (Fig. 1a, b, c), 2) the influence of this aesthetic on public policies and lawn management (Fig. 1d, e) and 3) the ecological consequences of idealized lawn management (Fig. 1f). I will conclude by proposing that the dominant preference for the idealized lawn aesthetic could be modified by incorporating ecological knowledge into lawn management preferences and practices (Fig. 1g).

History of the lawn aesthetic
Lawns are a human construct in both concept and physical form. The nearest relatives of lawns are grazed grasslands or pastures. However, the idealized lawn differs from its non-human managed cousins in many respects. Its maintenance requires extensive inputs of money, time, water, pesticides and fertilizers. Where did the idealized lawn aesthetic come from? Why has it been so widely adopted? Why are people obsessed with maintaining a “perfect” lawn (Jenkins 1994, Schultz 1999)? Few straightforward answers exist for these questions. Rather a multitude of factors have synergistically given rise to the idealized lawn aesthetic. A brief summary of the sociocultural history of the lawn concept, the technology and industry that supports idealized lawn management and analysis of popular attitudes about lawns is necessary to understand the origins and perpetuation of the contemporary lawn aesthetic. (Most of the following historical...
The origins of the lawn as a landscape design concept can be traced to the 1600’s in European gardens, especially in England and France. The angular, trimmed fields that surrounded aristocratic palaces (e.g., Versailles) reflected attitudes about the need for human control of nature through rigorously designed and maintained landscapes (Fig. 1b). Grassy fields were kept trim by hand with scythes or by grazing animals.

During the eighteenth century, colonists in North America adopted the principles of European landscape design and brought many typical lawn grasses with them from Europe. Exemplary colonial lawns were established on wealthy landowners' properties such as Thomas Jefferson’s Monticello and George Washington’s Mt. Vernon. For the majority of early settlers, however, lawn creation was unattainable due to lack of property and because environmental factors such as climate and soil did not permit lawn cultivation. Through the early history of America, lawns were not a predominant part of the typical human-inhabited landscape.

The American landscape began to change dramatically beginning in the mid-nineteenth century. At this time, residential developments expanded from urban centers into surrounding rural land due, in part, to expansion of rail lines. People could live in rural landscapes at greater distances from their places of work and build single-family homes (Fig. 1b). Synergistically, landscape architects began to develop a standard of aesthetics to guide what suburban housing developments should look like (e.g., Frederick Law Olmstead's Riverside, IL). Included in such guidelines were distances that houses should be located from the street. This “set back” distance provided space for lawns and helped create the illusion that houses were located within a continuous green field (Schroeder 1993). Such suburban designs were meant to foster a sense of community and gave the front lawn stature as the symbol of a landowner’s contribution to keeping the community looking neat and orderly (Fig. 1c; Nassauer 1988).

Maintaining an idealized lawn is impossible without a suite of technological innovations that were developed in the latter half of the nineteenth and throughout the twentieth centuries. The evolution of lawnmower designs shows improvements to facilitate more efficient mowing (Schroeder 1993, Schultz 1999). Turfgrass breeders have continually developed grass varieties that tolerate environmental stresses such as drought, heat, and disease and that provide aesthetic appeal such as fine texture and bright color. In addition, irrigation systems, fertilizers and pesticides (most originally developed for agriculture) have all been marketed as necessary lawn care materials. Indeed, the lawn care industry has heavily promoted the idealized lawn aesthetic through advertising to increase sales of their products (Fig. 1a; Robbins and Sharp 2003). The targets of such advertising were—and are—suburban homeowners who increased in number during and after the 1950’s and concomitantly have increased the acreage of lawns in America (Jenkins 1994). Thus, it is apparent that many factors worked in concert to permit and promote the spread of the idealized lawn as a cultural norm.

Over a century in the making, the idealized lawn aesthetic persists today and influences lawn management across the United States (Fig. 1e). An estimated 383,000 acres are transformed into lawn every year in the U. S. with a large percentage of them receiving chemical applications (Robins and Birkenholtz 2003). Lawn care industries continue to promote the idealized lawn aesthetic through advertisements showing lawns as centers of family fun and community pride (Robbins and Sharp 2003, Byrne personal observation). Recent surveys indicate that a majority of people apply chemicals onto their lawns because they feel it important to have an idealized lawn (e.g., Piekielik 2003, Law et al. 2004). Such feelings are often brought about by social pressures to conform to community landscaping standards. Where do such pressures come from? Often, public policies encourage adoption of the idealized lawn aesthetic.

**Weed laws and neighbors**

Public policies, either written or understood, are in place in many local governments and neighborhoods that regulate lawn management. So called “weed laws” (Rappaport 1992) restrict the height of vegetation in lawns and implement fines on homeowners who do not follow them (Hanchek 1994). Neighbors are often the enforcers of such legislation by calling the local authorities or leaving critical, and anonymous, notes at residences of untidy lawns. In some neighborhoods, especially wealthier ones, the lawn aesthetic is enforced by homeowner organizations that have regulations in place about landscape management to help maintain high property values (Fig. 1b; Piekielik 2003). Although few data exist on the number and consequences of public lawn policies across the country, it is clear that...
they have a strong effect on the adoption of the lawn aesthetic by homeowners. Rather than face the wrath of neighbors and fines, homeowners generally conform to accepted lawn management practices. (Although there are dissenters, they are few and far between. See Bormann et al. (2001) for examples.)

The relationship between the idealized lawn aesthetic and public policies (both written and unwritten) resembles the chicken-and-egg question; which came first? It is unclear which has influenced the other to a greater degree. Has popular preference for idealized lawn management put pressure on policy makers to create weed laws? Or do policies help convince people that the idealized lawn is the only socially acceptable form of landscaping? I propose that the answer is yes to both of these questions and that the relationship between policy and aesthetic preference is best understood as a feedback loop (Fig. 1d).

Lawmakers, facing pressure to appease popular opinion, created weed laws as a way to discourage those who would rather not mow from disrupting community peace. In turn, the presence of such policies reinforces the lawn aesthetic and feelings of social responsibility associated with the management of idealized lawns. Increasing concerns about the ecological effects of lawn management may ultimately drive policies in the other direction—toward stricter limitation of lawn management (Rappaport 1992, Bormann et al. 2001). To inform such policy changes, ecological science can be used to understand how lawn management affects ecosystems.

Lawn ecology

The earliest ecological investigation of lawns was by Falk in 1976. From his analysis, he concluded that lawns are highly productive ecosystems but their management requires as much energy as for a corn field without the production of edible biomass. In addition he found many more organisms inhabiting the lawn than just a few grass species. Although insightful, Falk’s work has not sparked widespread interest among ecologists to study lawn ecology. Most research has come from turfgrass scientists who focus on pest control and health of the grass. However, from the limited studies available, it is clear that landscape management practices affect the ecological patterns and processes in lawns (Fig. 1f).

The impact of pesticides and fertilizers on non-target organisms is one of the best studied aspects of lawn ecology. Generally, insecticides have been found to reduce abundances of beneficial predatory arthropods (e.g., spiders, beetles) in lawns immediately after application (Potter 1993). Although some effects may be transient with rebounding of populations, chemical lawn applications may lead to increased pest outbreaks due to disruption of food web structure (Potter 1993). Earthworms are another beneficial organism in lawns due to their effects on litter decomposition; abundant applications of pesticides can also reduce their abundances and lead to undesirable increases in thatch (Potter 1993). Other decomposer organisms such as soil microarthropods can be negatively affected by idealized lawn care and thus reduce the overall biodiversity of lawns (Byrne and Bruns 2005). Little is known about the effects of lawn management on other organisms such as soil microbes and vertebrates. Clearly, more research is needed on lawn biota to better understand how lawn management affects urban biodiversity.

Carbon (C) and nitrogen (N) cycling are important ecological processes in lawns because they regulate soil nutrient availability for plants. In addition, certain C and N molecules have negative environmental consequences such as the effects of carbon dioxide (CO₂) and nitrous oxide (N₂O) on climate change and nitrate (NO₃⁻) on water pollution. Because these molecules are associated with lawn dynamics, they will be the focus of this brief discussion.

Lawns are highly productive ecosystems meaning that they fix large amounts of CO₂ from the atmosphere into plant biomass through photosynthesis (Falk 1976). However, the decomposition rate of glass clippings may be high which releases CO₂ back into the air (Byrne unpublished data). In addition, CO₂ is produced from the burning of fossil fuels in lawn mowers. Unfortunately, few data exist on the contribution of CO₂ from lawn mowers to air pollution and its overall relationship to C cycling in lawns. Further research is needed to examine if lawns are net sinks of CO₂ due to their high productivity or net sources due to CO₂ production from lawn mowers (Bormann et al. 2001).

N cycling in lawns can be altered in several ways. Excess fertilizer applied to lawns increases the possibility of ground and surface water pollution through NO₃⁻ leaching and run-off (Guillard and Kopp 2004). The production of atmospheric nitrogen (NOₓ) from fuel burning in lawn mowers can contribute significantly to ground ozone and smog especially on weekends (Diem and Comrie 2001).
Changes to the soil biota can also affect N transformations in lawns. For example, Kaye et al. (2004) found that microbes in lawn soils produced significantly more amounts of N₂O than in nearby native grasslands. Although such research is sparse, interest in the effects of lawn management on both N and C cycles is growing. Future studies will provide useful insight into the effects of urbanization on the biosphere.

**Ecological aesthetics**

Increased environmental awareness over the past three decades has caused some to question the idealized lawn aesthetic: is it healthy for humans and other organisms (Bormann et al. 2001, Robbins and Birkenholtz 2003)? Although lawn alternatives are becoming more common as people seek less management-intensive, more diverse, and possibly more healthful urban landscapes (Bormann et al. 2001), it is clear that a large proportion of homeowners still prefer the idealized lawn aesthetic over alternatives (Schultz 1999, Piekielik 2003, Law et al. 2004). Is it possible that this preference could change? What might encourage people to dispense with lawn chemicals?

As described above, many factors have worked in concert to promote and facilitate the adoption of the idealized lawn as the best looking landscape, indeed as the only socially acceptable one (Fig. 1a,b,c,d; Jenkins 1994). However, aesthetic preferences about what looks “good” can be based on many ideas. Ecological knowledge about the effects of lawn management on organisms and ecosystem pollution (Fig. 1f) suggests that the look of the idealized lawn may hide some of its underlying negative consequences. Incorporation of such knowledge into aesthetics has led to new philosophies about what landscapes are preferable.

Ecological aesthetics is the perception that what looks good is that which does not have negative ecological consequences. It explicitly incorporates ecological knowledge into its foundation. Thus, landscapes managed to conserve biodiversity, reduce air and water pollution and reduce energy inputs are viewed as good-looking no matter what their outward appearance (Koh 1999). Idealized lawns can therefore be viewed as “ugly” because they can result in unwanted environmental outcomes. Although the structure of the idealized lawn itself does not change, when it is viewed through a different lens—that of ecological understanding—our perception of it changes. Although subtle, the widespread shift from a preference for the idealized lawn aesthetic to a preference for ecological aesthetics could revolutionize the predominant management style of America’s urbanized landscapes. The proponents of ecological aesthetics who wish to reduce the American obsession with perfect lawns face the challenge of undoing a century’s worth of popular acculturation to the concept of the idealized lawn. This challenge may be overcome, in part, through educational programs that seek to infuse ecological science into public policies, the public’s aesthetic sensibilities and the development of new technologies by the lawn care industry (Fig. 1g).

**Conclusion**

The lawn provides a perfect example of how human sociocultural systems influence ecological systems. As Figure 1 illustrates, a multitude of sociocultural factors have created the idealized lawn aesthetic that guides urban landscape management. The aesthetic has been heavily promoted by industry, adopted widely by the public and is now an unquestioned cultural symbol that reflects wealth and pride in the
The neat and orderly appearance of one’s property (Nassauer 1988, Jenkins 1994, Piekielek 2003, Bormann et al. 2001). The effects of lawn management on ecological patterns and processes are increasingly gaining scientific attention (e.g., Kaye et al. 2004). With greater knowledge of the potential negative consequences of lawn management, more people are searching for alternatives to the idealized lawn. However, alternatives often face opposition due to public policies that discourage management that goes against the predominant lawn aesthetic. Adoption of a preference for ecological aesthetics may provide the perspective needed to appreciate the appearance of more biodiversity (i.e., weeds) in lawns and reduce rates of chemical applications (Robbins and Birkenholtz 2003). No matter what aesthetic preference is adopted, it is clear from this analysis of the sociocultural and ecological dynamics of lawn management that aesthetic preferences impact ecological patterns and processes, especially in urban ecosystems. Thus, aesthetics should be considered as a key component of future studies about the relationships between sociocultural and ecological systems (Pickett et al. 2001).

References


Introduction

Urbanization, suburbanization, and economic development have extended human activities into natural and rural areas. This spread of human land use practices and infrastructure establishment often results in a simplification of the landscape due to the loss of natural species and complex habitats, or the generalization of land-use/land-cover types (Forman & Godron, 1986; Johnson, et al., 2002). Given evaluating fragmentation phenomena or fragmenting process of landscapes, landscape fragmentation measurement has been primarily applied to analyzing, evaluating, or predicting this type of landscape change and its impacts (Swenson & Franklin, 2000; Jongman, 2002; Cook, 2002; Young & Jarvis, 2001; Gulinck & Wagendorp, 2002; Wang & Moskovits, 2001; Luck & Wu, 2002; Herzog et al., 2001).

Two primary methodologies of landscape fragmentation measurements have been developed, landscape metrics and connectivity/dispersal measurement. Landscape metrics has been widely used in studying human disturbance, urban sprawl pattern, habitat suitability, habitat loss, and habitat isolation (Luck & Wu, 2002; Herzog et al., 2001; Riitters, et al., 1997). Connectivity/dispersal measurement has been employed in understanding the degree of connectivity, dispersal barrier, and dispersion trails among landscape components, and networks (Young & Jarvis, 2001; Lofvenhaft, et al., 2002; Serrano, et al., 2002; Vuilleumier & Prelaz-Droux, 2002; Jaarsma & Willems, 2002). These approaches involve developing a compatible land-use allocation, transportation/infrastructure plans, designating potential hot-spot habitats/biotopes in conservation areas, and establishing green/ecological networks. Such studies have demonstrated that measures of landscape fragmentation can serve as indicators, and planned objectives of representing the ecological values of landscapes. Furthermore, Leitã and Ahern (2002) have demonstrated how landscape metrics can be used as ecological planning tools for preserving spatial dimension of sustainability. Hence, ecological and spatial dimensions of landscape fragmentation measurement have suggested that land development and management policies or plans can incorporate this fragmentation concept into procedures for ecological exurban development.

The aim of this paper is to develop a theoretical conceptual framework for ecological exurban development by applying landscape fragmentation measurement as indicators, or theoretical goals. The outline of this paper is as follows. In section 1, applied ecological theories are briefly introduced for establishing relationship between landscape fragmentation and ecological impacts. In section 2, fragmentation measurement methods and applications are analyzed by examining some relevant studies and reviews for bridging measures and applications. In the 3rd and final section, a theoretical conceptual framework for exurban development by applying landscape fragmentation measurement is suggested to make an effective link between species and the physical environment.

Applied ecology theories for fragmentation measurement

The patch-corridor-matrix model based on landscape ecology theory is the underlying method to construct and summarize spatial pattern change of landscapes, and to connect spatial patterns with ecological values (Forman & Godron, 1986). Thus, the measurement of landscape fragmentation emerging from landscape ecology can examine dynamics of landscape structure through fragmentation process, and explore what factors may associate with these dynamics. To interlink fragmentation phenomenon with its ecological effects, applied theories such as ecosystem theory, hierarchical theory, island biological theory, metapopulation theory, and source-sink theory have been used (Forman & Godron, 1986; Pulliam and Johnson, 2002; Forman, 1995).

Given complexity of the flux of energy and materials in nature, ecosystem theory has been used for intensifying the concept that ecosystems function as highly interconnected networks (Pulliam and Johnson, 2002). Hence, a landscape containing interacting biotic and abiotic elements could be considered as an ecosystem (Grimm, et al., 2000), and the dynamic of any landscape pattern could be influenced by the context of broader landscape dynamics. Based on this concept, fragmentation
analysis should examine the areas beyond the site of interest for clarifying organization of its ecosystem network and for detecting influential factors which cause fragmentation but whose range is beyond its local extent. Lands can retain or reflect how natural factors (e.g., geological settings, climate conditions, species pools, hydrologic processes) and cultural practices (e.g., social and economic values, land-use regulations, and zonings) influence landscape development (Johnson, et al., 2002). The biophysical and cultural boundaries, thus, could be used for defining areas of the site and its broader context.

Hierarchy theory refers to that ranked levels of discrete functional elements or units can be used to construct the control hierarchies and link phenomena at the landscape level to those at sub-system levels for analyzing underlying processes and interacted factors (Forman, 1995; Pulliam and Johnson, 2002). An adequate ecological understanding of a landscape would require a consideration of a triadic structure of hierarchical systems at once (Hill, et al., 2002; O’Neill, 1989). The lowest levels can suggest how to define the components for detecting the dynamics; the next higher levels can provide constraints or boundary information.

Concerning how reserves or habitats are influenced by fragmentation process, island biogeography theory has been used for estimating the level of intervention caused by inhospitable habitats, of connectivity between related habitats, and of permeability of the matrix for target species (Pulliam and Johnson, 2002; Jongman, 2002; Gulinck & Wagendorp, 2002; Vuilleumier & Prelaz-Droux, 2002; Forman, 1995). This concept is based on that “reserves or habitats can be considered as “islands” in a “sea” of matrix composed of other habitats or land-use types” (Pulliam and Johnson, 2002, p56). The reserves or habitats with larger size and less isolation are presumed to have greater diversity of species. Corridors and stepping stones are the elements that can increase the connectivity between habitats (MacArthur and Wilson, 1967).

Extended from island biogeographical theory, metapopulation theory emphasizes that the level of exchange and the flow of populations among clusters of population can influence abundance of species in the long term and that larger and more contiguous habitats are also more likely to be occupied by more species (Levin, 1969, 1970). For emphasizing the quality of habitats, source-sink theory (Pulliam, 1988; Pulliam & Danielson, 1991), extended from metapopulation theory, emphasizes key habitat type for population persistence cannot be solely determined by the number of population distributed within habitat types (Pulliam and Johnson, 2002).

More detailed information such as local reproductive success and local mortality is required for defining source and sink habitat types. By evaluating dynamics of population migration among the clusters of habitats which are categorized by habitat quality (Young & Jarvis, 2001), the critical resource areas for the species of concern could be defined as hot-spot areas for reservation or conservation.

The above mentioned theories still need more empirical data, evidence, and knowledge for demonstrating their given assumptions and guidelines. However, the loss and the degradation of species/habitats have advocated the application of these theories to land development with ecological concerns.

**Landscape fragmentation measurement and application**

Landscape fragmentation is referred to as “the breaking up of a habitat, ecosystem, or land use types into small parcels” based on concepts from landscape ecology (Forman, 1995). The effects of this fragmenting process on species are primarily generated by habitat loss, habitat isolation, physical and biological edge effects, and disconnection of biotic and abiotic flows across landscapes (Johnson & Hill, 2002; Forman, 1995; Forman, 2003). The dispersal ability, habitat requirement and habitat sensitivity of species determine the level of the influence of fragmentation on species. Due to limited knowledge of the related biological information for each species (Pulliam and Johnson, 2002), composition and configuration of natural resources such as forests, grasslands, rivers, wetlands are used as agents to represent population distribution, habitat network, and dispersal ability. However, different foci on ecological effects caused by, and different definitions and demonstrations of fragmentation phenomena have shaped two primary methods of fragmentation measurement: landscape metrics approach and connectivity measurement.

**Landscape metrics approach**

The landscape metrics approach is a quantitative method that can measure diverse aspects of landscape pattern and structure decomposed by the patch-corridor-matrix model. This approach can be used to examine how urbanized areas fragment natural or important agricultural lands, how impervious areas expand to natural lands, how natural habitats are shrink or lost due to development (see table 1). For this approach, a scale-dependent patch classification
scheme based on landscape features (e.g. natural and cultural resources) is used. This method is a mathematical analysis in which patch values of each category or of entire landscapes are calculated by designated equations (Herzog, et al. 2001; Hargis, et al., 1998). Interrelationships among these measures, however, exist and must be greater understood due to mathematic kinship of their equations. Thus, understanding the limitations of each measure, the range of attainable values, and the scope of measurable and influential landscape characteristics can achieve a more meaningful interpretation of these measures (Hargis, et al., 1998; Jaeger, 2000; Letião and Ahern, 2002). Ritters et al. (1995) have examined 55 metrics adopted from real landscapes, and suggested six general measures of landscape pattern and structure: average perimeter-area ratio, contagion, standardized patch shape, patch perimeter-area scaling, number of patch types, and large-patch density-area scaling with this consideration. In emphasizing fragmentation process, Jaeger (2000) proposes new measures such as landscape division, splitting index, and effective mesh size for reflecting the pattern change of perforation, incision, dissection, dissipation, shrinkage, and attrition. Hence, correlation among different measures, the characteristics of each measure, and an interpretation of fragmentation phenomena are the fundamental factors to determine selected measurements.

**Connectivity measurement**

The connectivity measurement approach is a quantitative method that examines how the connectivity or barrier effects on landscape elements or flows can be influenced by the fragmentation process. Hence, this approach can be used to examine how new or current road systems split or fragment natural habitats, residential areas, and/or interrupt movement of key species or increase barriers for natural resource or energy exchange (see table 2). Its underlying concept is “the landscape’s lack of connectivity, the mechanisms that cause it and the subsequent alteration” (Serrano, et al., 2002, p113). Then, the landscape of interest needs to be decomposed and geometrized as a patch-corridor-matrix pattern in order to calculate the measurement values based on the definition of fragmentation process and related equations. The effects of linear landscape elements such as roads, sewers, ditches, and river corridor on habitat distribution, species movement, and habitat quality are of primary interests (Young & Jarvis, 2001; Wang & Moskovits, 2001; Lofvenhaht et al., 2002; Serrano et al., 2002; Jaarsma & Willems, 2002). Topographic maps that reveal road systems and settlement distribution are very important for representing human activity extension (Gulinck & Wagendorp, 2002; Serrano et al., 2002; Jaarsma & Willems, 2002). Supplementary data such as traffic flow, road kills, and green space percentage are used to determine threshold values for abstracting and classifying landscape elements (Serrano et al., 2002; Vuilleumier & Prelaz-Droux, 2002; Jaarsma & Willems, 2002). Also, species diversity or richness, species dominance, rare species, and the behavior, life-cycle, or home range of the species could be important data for defining key species of landscapes and their habitat requirement (Young & Jarvis, 2001; Serrano et al., 2002; Jaarsma & Willems, 2002).

**A theoretical conceptual framework for exurban development by applying landscape fragmentation measurement**

Landscape metric approach describes the characteristics of patchy structure; connectivity measurement suggests effects caused by linear landscape elements. Although landscape measurement methods are categorized to two primary methods in terms of the fragmentation definition and measurement framework (see figure 1) in this paper, the measures computed by these two methods are primarily used as indices to present the level of landscape change.

Comparing values of metrics measured between different periods of time or different scenarios/alternatives is necessary for demonstrating fragmentation process. However, the interpretation of these measures with biological or environmental meanings need to establish hypotheses and reference conditions in advance because landscapes are complex systems and can not represent behaviors of a single species or habitat. The theoretical conceptual framework for exurban development is suggested as follows.

- Define “fragmentation phenomena”/“fragmentation process”
- Define species/natural resources/human impacts of interest
- Available data for reference/baseline/current/scenario conditions
- Decompose the landscape in question to patch/corridor/matrix model based on research interests and fragmentation interpretation
- Define or select indices to examine fragmentation phenomena/fragmentation process
- Use as indicators to determine optimal scenario, evaluate ecological impacts caused by human development, evaluate the effectiveness of public

Urban Rural Interface Conference Proceedings
policies, or the threshold for controlling the level of development

References


Serrano, M., Sanz, L., Puig, J., & Pons, J. (2002). Landscape fragmentation caused by the transport network in Navarra (Spain): Two-scale analysis
and landscape integration assessment. Landscape and Urban Planning, 58(2-4), 113-123.

**Figure 1** the general framework of landscape metrics measurement and connectivity measurement applied to land development.
Table 1  Research using landscape metrics in landscape fragmentation

<table>
<thead>
<tr>
<th>Study</th>
<th>Usage of landscape metrics</th>
<th>study targets</th>
<th>Comments</th>
<th>Spatial scales/classification scheme</th>
<th>Data source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Luck and Wu (2002)</td>
<td>Patch richness,</td>
<td></td>
<td>Quantify urbanization pattern, and identify the urban center location by</td>
<td>Region/scal (6)</td>
<td>land-use maps derived from aerial</td>
</tr>
<tr>
<td></td>
<td>Largest patch index,</td>
<td></td>
<td>combining with gradient analysis</td>
<td></td>
<td>photographs</td>
</tr>
<tr>
<td></td>
<td>Patch density,</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Mean patch size,</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Patch size coefficient of</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>variation,</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Landscape shape index,</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Area-weight mean shape</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>index</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>urban center revealed by landscape-level change proved class-level metrics</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Fractal dimension and contagion metrics with erratic behavior and</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>great patch number requirement</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Greater scale and data resolution effects on measuring intensely utilized</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>patches</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wang and Moskovits (2001)</td>
<td>Patch area</td>
<td></td>
<td>Unable to detect finer pattern change of natural communities at the</td>
<td>Region/Landcover (5)</td>
<td>Vegetation maps Thematic map</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>regional scale due to data resolution. Sensitive to satellite images</td>
<td></td>
<td>GIS soil and wetland data</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>taking timing considering vegetation growing season</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Antrop and Eetvelde (2000)</td>
<td>Patch area, Corrected</td>
<td></td>
<td>Distinguish pattern gradient from urban center to suburban by</td>
<td>region/Landcover (10,20)</td>
<td>Aerial photographs thematic maps</td>
</tr>
<tr>
<td></td>
<td>perimeter-area shape</td>
<td></td>
<td>landscape metric assisted with visual image interpretation</td>
<td></td>
<td>Land-use maps</td>
</tr>
<tr>
<td></td>
<td>index,</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Two-forms of the Shannon</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>entropy, Fractal</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>dimension</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Classification scheme and shading effects on measure values. Holistic</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>landscape units distinguished by</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Fractal dimension and entropy index.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Swenson and Franklin</td>
<td>Patch area, Number of</td>
<td></td>
<td>Enhance the level of interpreting visual difference between the</td>
<td>Region Vegetation; land-cover</td>
<td>Vegetation, land-cover map, land-</td>
</tr>
<tr>
<td></td>
<td>patches, Landscape shape</td>
<td></td>
<td>landscapes which have no visually distinctive spatial pattern</td>
<td></td>
<td>ownership, county general plan,</td>
</tr>
<tr>
<td></td>
<td>index(LSI), Mean</td>
<td></td>
<td></td>
<td></td>
<td>elevation</td>
</tr>
<tr>
<td></td>
<td>proximity index(MPI),</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Edge length</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Edges, the landscape shape index, and number of patch habitats indices can</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>prove fragmentation phenomena. Core area measure is greater than patch</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>area measure at representing unaffected habitats</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Some measures are more sensitive to buffer widths around development than</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>those around roads</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Density related—number</td>
<td>Assess roads effects on forest fragmentation</td>
<td>Number of patches, the ratio of</td>
<td>region Vegetation/forest structure/</td>
<td>Aerial photographs, Topographic</td>
</tr>
<tr>
<td></td>
<td>of patches, mean patch</td>
<td></td>
<td></td>
<td>area of-edge influence to interior</td>
<td></td>
</tr>
<tr>
<td></td>
<td>area, Edge-related—mean</td>
<td></td>
<td></td>
<td>area, contrast, and total perimeter</td>
<td></td>
</tr>
<tr>
<td></td>
<td>patch perimeter, total</td>
<td></td>
<td></td>
<td>of the landscape prove road effects</td>
<td></td>
</tr>
<tr>
<td></td>
<td>perimeter, Shape-related</td>
<td></td>
<td></td>
<td>on fragmentation. Fragmentation</td>
<td></td>
</tr>
<tr>
<td></td>
<td>—mean patch shape;</td>
<td></td>
<td></td>
<td>reduces available interior habitats,</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Diversity-related—Shannon-</td>
<td></td>
<td></td>
<td>and increases distances between</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Wiener diversity index,</td>
<td></td>
<td></td>
<td>suitable interior habitat patches</td>
<td></td>
</tr>
<tr>
<td></td>
<td>dominance, contrast,</td>
<td></td>
<td></td>
<td>for interior species. Clearcuts and</td>
<td></td>
</tr>
<tr>
<td></td>
<td>contagion, and angular</td>
<td></td>
<td></td>
<td>roads have different edge effects</td>
<td></td>
</tr>
<tr>
<td></td>
<td>moment</td>
<td></td>
<td></td>
<td>due microclimate and associated</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>environmental changes. Use landscape</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>metrics value as environmental</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>indicators.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Herzog et al. (2001)</td>
<td>Number of patches,</td>
<td>Monitor landscape pattern change in a heavily disturbed environment</td>
<td>Correlation and factor analyses can</td>
<td>Landscape/Land-use (29)</td>
<td>Land-use maps derived from aerial</td>
</tr>
<tr>
<td></td>
<td>The largest patch index,</td>
<td></td>
<td>examine double-counting and ambiguous effects of indices. Fractal</td>
<td></td>
<td>photographs, topographic maps</td>
</tr>
<tr>
<td></td>
<td>Landscape shape index,</td>
<td></td>
<td>dimension measure cannot reflect landscape change</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Area weighted mean patch</td>
<td></td>
<td>Half used indices can quantify landscape structure</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>fractal dimension,</td>
<td></td>
<td>Delineate study area boundary by natural landscape units can reveal</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Patch richness density,</td>
<td></td>
<td>geomorphologic effects</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Simpson’s diversity index,</td>
<td></td>
<td>Integrate linear landscape elements in the analysis can affect landscape</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>The interspersion and</td>
<td></td>
<td>metrics value as environmental</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>juxtaposition index</td>
<td></td>
<td>indicators.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ritters et al. (1997)</td>
<td>Number of patches,</td>
<td>Compute habitat suitability score based on land cover amount and</td>
<td>Species home ranges can influence</td>
<td>Multiple Habitat (vegetation)(3)</td>
<td>Land-cover map by a spatial filtering</td>
</tr>
<tr>
<td></td>
<td>Largest patch size,</td>
<td></td>
<td>patterns within a windrow,</td>
<td></td>
<td>algorithms</td>
</tr>
<tr>
<td></td>
<td>Average patch size,</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Fractal dimension,</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>contagion</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Study</td>
<td>Connectivity measure</td>
<td>study targets</td>
<td>Comments</td>
<td>Spatial scales</td>
<td>Data source</td>
</tr>
<tr>
<td>-------------------------------------------</td>
<td>----------------------</td>
<td>---------------</td>
<td>---------------------------------------------------------------------------------------------</td>
<td>-----------------</td>
<td>-------------------------------------------------</td>
</tr>
<tr>
<td>Jaarsma and Willems (2002)</td>
<td>Use road density,</td>
<td>Examine the</td>
<td>Threshold for ecological barrier is species-specific build-up areas and rivers also can be</td>
<td>landscape</td>
<td>Road network, Built-up area, Traffic flows</td>
</tr>
<tr>
<td></td>
<td>Mesh-width, Mesh-size to quantify the attributes of continuous landscape units separated by rural roads which are determined by a threshold (the traffic flow per day) to define “a barrier for dispersing species”</td>
<td>the effects of implementing traffic calming rural area policy</td>
<td>considered as ecological barriers. The barrier effects of roads are not the same as road kill effects.</td>
<td></td>
<td>(converted to 1987)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Serrano, et al. (2002)</td>
<td>Use interior road length, bordering road length, and road density to quantify overloaded zones and territorial imbalance by transportation infrastructures</td>
<td>Examine accumulated ecological impacts caused by a set of roads and suggest the suitable route for new road construction</td>
<td>The required data for evaluating road impacts is scale-dependent. Combining with certain land uses (agricultural and urban development) can detect fragmentation effects caused by landscape management strategies.</td>
<td>region</td>
<td>Transport infrastructure and settlement</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vuilleumier and Prélaz-Droux (2002)</td>
<td>Crossing pressure, distance of influence, possibility to cross to evaluate dispersal ability on friction surface (determined by road network and buildings) among biotopes</td>
<td>Develop a method to simulate the impacts of human activities on species dispersal and to identify strategic places for accommodating game species</td>
<td>5m spatial resolution was suggested for applying to land-use planning at a local scale. Biotopes candidate areas for assuring the connection among biotopes and preventing from splitting habitats can be identified by landscape level measurement. Conflict areas can be identified by farmstead level measurement.</td>
<td>Region/landscape/farmstead</td>
<td>The National Map, Digitized orthophotos</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Young and Jarvis (2001)</td>
<td>fragmentation ratio (relative relationship between the number of connecting and continuous connections)</td>
<td>Develop a method for measuring habitat connectivity considering the whole landscape context</td>
<td>The definition of the land-use types can influence the determination of quality/non-quality habitats. This justification is human-oriented and species-specific. Measuring at a regional scale can suppress the influence of some linear habitat patches. The ecological values of “semi-natural habitats” or “green space” less than 1ha might be obscured due to the degree of spatial resolution.</td>
<td>Landscape/local</td>
<td>The land-utilization survey of Britain Habitat map derived from air photo</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gulinck and Wagendorp (1997)</td>
<td>The shortest or the average distance between every urban settlement(or building).</td>
<td>Prove the requirement of reference or baseline condition for landscape fragmentation analysis and interpretation.</td>
<td>The fragmenting factor/the fragmented object, landscape/functional unit should be decided in advance for meaningful interpretation of the measure values The measure result can provide as baseline information for spatial policies</td>
<td>Region</td>
<td>Old topographic maps*</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 2: Research using connectivity and barrier measurement in landscape fragmentation.
Future visions for urbanising tropical landscapes Case studies from Far North Queensland, Australia

Iris Bohnet, CSRIO Sustainable Ecosystems

Abstract

Tropical North Queensland is characterised by two World Heritage Areas, the ‘Great Barrier Reef’ and the ‘Wet Tropics’ rainforest. Agricultural production, economic development and urbanisation takes place everywhere around these World Heritage Areas. Economic pressures on primary industries, coupled with development pressures to subdivide agricultural land for urban expansion provide a challenge not only for the people living in these landscapes, but also for planners and natural resource managers. To address these issues, a participatory planning approach was chosen to develop future visions for two urbanising landscapes in tropical North Queensland. Based on initial interviews with farmers and land managers, landscape visions were developed based on their goals and aspirations. Landscape photographs were simulated to translate these landscape visions into images that could then be used to invite the wider community to discuss their preferred future. Workshop discussions revealed the complexity of the issues raised and highlighted the wide-ranging views regarding future development. The community workshops were also used as a platform to discuss potential trade-offs between different land use options and how to ‘best’ utilise the different parts of the landscape. Using participatory approaches in the planning of future landscapes provides the opportunity to include local views, build community capacity for change and inform planning and policy development.

Key words: future visions, tropical landscapes, participatory planning, landscape visualisation, local stakeholder involvement.

Introduction

The Wet Tropics and the Great Barrier Reef World Heritage Areas reflect the exceptional environmental values of tropical North Queensland (McDonald and Weston, 2004). The region contains the highest biological diversity in Australia and is recognized as one of the mega-diverse regions of the world (Williams et al., 2001). The World Heritage Areas are integrally connected to each other as they are to the surrounding areas. These outside areas – still agriculturally dominated but slowly urbanising landscapes – are undergoing significant changes due to economic pressures on primary industries and development pressures to subdivide agricultural land for rural residential subdivisions and urban expansion. Primary industries – in particular the sugar industry which is the main agricultural industry along the Queensland coast – are also challenged to change their farming practices in order to reduce sediment, nutrient and pesticide runoff entering the Great Barrier Reef lagoon (Great Barrier Reef Marine Park Authority, 2001). High land values and an aging farming population also contribute to changes in land use and management practices. Key issues the region is now facing include: water quality improvement, ecosystem function and biodiversity conservation, competing land uses and profitable land use systems, and the future basis of the rural communities.

To address this wide range of interrelated issues future visions for two urbanising landscapes in tropical North Queensland have been developed with local stakeholders. The aim was to provide local responses to key planning and natural resource management questions and to build community capacity through the process of creating shared visions for their future landscape.

Methods

Two neighbouring tropical landscapes have been selected for this study; Mossman a coastal landscape – dominated by sugarcane paddocks – and Julatten an upland landscape – characterised by a mixture of land uses. The Mossman coastal landscape is entirely surrounded by the two World Heritage Areas and about two thirds of the Julatten upland landscape is surrounded by the Wet Tropics World Heritage Area (Figure 1). These landscapes have been chosen as prototype landscapes of this region – a coastal and an upland landscape – to study the bio-physical and socio-cultural variation of the two landscape types which represent this region. Their close proximity to one another was another practical consideration in choosing these areas. It was also considered an advantage to study the interrelationships between these two landscapes at present and in developing future visions for these landscapes.
The research was conducted in two stages, each of which included a number of methodological steps. The first step in developing future visions for these landscapes was to gain an understanding of the current landscapes. Landscape in this study is perceived as the relationship between people and place (Tress and Tress, 2001). Landscape provides the setting for our day-to-day activities and results from the way that different components of our environment – both natural and cultural – interact and are perceived by people (Countryside Agency and Scottish Natural Heritage, 2002). Based on this landscape concept, the bio-physical, cultural and visual landscape components were studied by reviewing maps, local literature, and historical records and through landscape assessments in the field. To assess local attitudes towards landscape and environmental values, and the economic dimension of landscape in the case study areas, 30 qualitative interviews with 42 participants comprising a wide range of farmers and land managers in the Mossman and Julatten landscape were carried out in 2003 (Bohnet, 2004a; 2005). Based on the analysis of the interview data social profiles were developed, describing the people, their land use and management systems, landscape and environmental values, and their future goals and aspirations regarding the development of their land (Bohnet, 2004a; 2005).

Literature reviews, field studies and interviews provided detailed information which could then be summarised in landscape character descriptions and stakeholder perceptions and visions (Bohnet, 2004c). This first stage of the research incorporated a range of methodological steps which together provided a sound foundation for stage two of the research.

The landscape character descriptions were used to select landscape photographs of Mossman and Julatten reflecting the particular character of these landscapes. Landscape photographs were taken as part of the landscape assessments carried out in the first stage of the research in 2003. Based on the interviewees’ ideas and visions for the future of their places the selected landscape photographs were simulated with, for example, land uses and management practices replaced. The landscape visualisations approach was employed based on the successful use of this technique by landscape researchers and planners in other contexts to effectively illustrate change in the visual landscape and to assess the impacts of these changes (see for example Schmid, 2001). Landscape visualisations are also used in participatory planning processes when citizen stakeholders play a central role in envisioning alternative futures (Hulse et al., 2004), when discussing potential future landscapes with stakeholders (Bohnet, 1997), and when assessing stakeholders’ landscape preferences (Tress and Tress, 2003). In this research, the landscape photographs – current and two simulations – have been used to stimulate public debate about future landscape developments (Bohnet, 2004c). Landscape photographs, as a visualisation tool, have been chosen over descriptions or maps because they are easily accessible and attract people’s attention. Also, simulated landscape photographs clearly demonstrate that location and extent of change matter, which in descriptive or mapped landscape visions may be overlooked. The second step within stage two of the research process incorporated community workshops which were arranged in both study areas to further develop ideas and discuss visions for the Mossman and Julatten landscapes. The community workshops have been regarded as a next logical step in broadening the scope of the research by including other interest groups besides farmers and land managers in the process of developing future visions for their landscapes. The workshops have also been considered a participatory planning tool to include local views in the process of developing future visions which may assist in local government planning and policy making. They are of particular importance, as communication and co-operation have been identified as crucial for acceptance and implementation of planning projects (Luz, 2000; Luz and Weiland, 2001).

**Future visions for Mossman and Julatten**

*Results from the interviews (stage one of the research)*

Based on the interviews with farmers and land managers in Mossman and Julatten two distinct future pathways for the Mossman and Julatten landscapes were identified in the analysis of the qualitative interview data. Interestingly, these distinct future pathways, discussed by the interviewees, were found to be similar for both landscapes; one pathway considered the local sugar industry surviving, whereas the other pathway considered the local sugar industry collapsed. These polarised views, however, have different implications for the Mossman and Julatten landscapes, as about 40% of the Mossman landscape is currently used for sugarcane production whereas only 9% of the Julatten landscape is used for sugarcane production. Most of the land under sugarcane production in Mossman is managed by traditional, specialised sugarcane farmers. In contrast, sugarcane in the Julatten area is grown by farmers who, in addition to growing sugarcane, also breed and fatten cattle (Bohnet, 2004a). Sugarcane was
only introduced to Julatten about a decade ago to expand the industry and to increase ‘through-put’ at the Mossman mill. Therefore, growing sugarcane has no traditional roots in Julatten nor is it of cultural importance to the local residents. The opposite is true for Mossman where sugarcane has been grown for more than 100 years and the sugar industry plays an important role in the community’s identity.

However, everyone interviewed for this research agreed that landscape change is inevitable and necessary, even if the local sugar industry was to survive. Interviewees who strongly supported the local sugar industry proposed the following diversification options:

- introduction of cocoa to the area with the prospect to produce local chocolate;
- conversion to organic sugarcane production with the prospect of higher returns;
- value adding to sugar and its by-products, e.g. sugarcane juice, molasses, co-generation of electricity;
- establishment of tropical fruit orchards on sugarcane farms to spread business risk;
- development of new products such as tropical fruit wine and juice, jam and ice cream;
- farm stays and educational farm tours;
- rainforest timber afforestation as long term investment;

The landscape these interviewees envisioned for the future incorporated more land uses, some smaller paddocks compared to the current situation, a few more rural residential subdivisions, and a substantial increase in tree cover (including orchards and timber plantations).

Interviewees who thought that the local sugar industry was going to collapse envisioned a post-sugarcane landscape. Their landscape visions varied and included the following:

- opportunity to subdivide large sugarcane farms into smaller farms where more intensive farming such as vegetable and tropical fruit production can take place and provides local jobs and locally grown food;
- suburban sprawl manifest in large rural residential subdivisions with either manicured gardens or overgrazed paddocks; and urban developments.

The landscape envisioned by these interviewees therefore varied dramatically from a well managed rural landscape with vegetables fields and fruit orchards to an urbanised landscape.

The two distinct future pathways – one with and one without sugarcane – and the suggestions provided by the interviewees were used to prepare the following landscape simulations for Mossman and Julatten (based on the landscape photographs taken in 2003). Figures 2 and 3 present a series of landscape photographs, the first in the series shows an image of the Mossman/Julatten landscape in 2003. The two photographs that follow show simulations of the landscape in 2003, the first visualising a diversified future landscape with continued sugarcane in 2025, and the second visualising a post-sugarcane landscape in 2025 (Figure 2).

Results from the community workshops (stage two of the research)

The future visions developed for the Mossman and Julatten landscape are the result from seven community workshops held in Mossman and Julatten with, in total, 39 participants (Bohnet, 2004b). Workshop participants included farmers, land managers, environmentalists, indigenous people, concerned locals, industries, and members of community groups who were interested in presenting and discussing their views regarding future landscape developments. Workshop discussions confirmed the polarised views presented by the interviewees and visualised in the landscape simulations. However, not many workshop participants put it as bluntly as the one who stated: “I think the mill [Mossman mill] should be shut down and a museum be created, I really do.” The workshops provided a platform for focussed discussion and the opportunity to elaborate on the themes and issues brought up by the participants. The issues discussed by the workshop participants also included alternative land uses, similar to what the farmers and land managers spoke about during the interviews, however, this was only one of many topics discussed and untangled. Overall, workshop discussions focused far more on the landscape as a whole, in contrast to a single farm, and reflect the priorities and worldviews of the wide range of participants. Key issues discussed in the workshops included the following:

- survival of the local sugar industry and the Mossman sugar mill;
- diversification of land use and management options;
- water quality and quantity;
- protection of the natural environment and landscape;

Urban Rural Interface Conference Proceedings
- development pressures for rural residential subdivisions;
- quality of life;
- amenity of the area;
- social ambience;
- balancing the needs of tourism industry and local people; and
- close proximity to the coast and international tourist destinations.

The issues raised were discussed in different contexts as some participants focussed more on environmental, social, or economic topics. This was dependent on who the participants were and what their main concerns were.

As mentioned in the previous section, the implications of some changes, such as the loss of the local sugar industry, may be more dramatic for the Mossman landscape and its people than for Julatten, or as one participant suggested, to have the opposite effect in providing great opportunities. The close proximity to the coast and international tourist destinations has been identified, in the workshops held in Julatten, as one of the main drivers for further rural residential subdivisions in the area, as Julatten (an upland landscape) is a cheaper place to live compared to the coast. This is only one example of the interrelationships between the two landscapes and provides a glimpse of the complexity of the issues related to future landscape developments. It also provides a glimpse of contrasting stakeholders’ perceptions – what one may consider a threat may be perceived as an opportunity by another.

The results from the community workshops can be summarised in three distinct priorities for future landscape developments. These future priorities are: (1) continued agricultural production, (2) water quality improvement, and (3) biodiversity conservation and enhancement. Participants based their priorities on a wide range of assumptions and trade-offs.

Continued agricultural production was perceived by many participants as a means to “keep the rural feel of the area” that is highly valued by local residents as well as tourists. It was suggested to preserve the use of ‘good agricultural land’ for farming, also as a way to reduce pressures for rural residential subdivisions. This was also seen as a means to attract people with an interest in farming to the area. Organic or biodynamic farming practices were suggested to reduce the environmental impact of farming and potential conflicts between farmers and non-farmers

While many participants perceived continued agricultural production as the main priority to focus future efforts, some participants in the Mossman workshops strongly advocated that, in line with the Water Quality Projects conducted in the Mossman area, improving water quality had to be the main priority in the future. The Water Quality Projects are aimed to reduce sediment and nutrient run-off entering the Great Barrier Reef lagoon. It was suggested that agricultural land will need to be managed in the future so that no, or substantially reduced loads of, sediments and nutrients will run off farming land. Retaining a ‘certain amount of’ groundcover, establishing wetlands (including silt traps) and riparian buffer zones were considered as potential measures to improve water quality. Clean rivers and creeks were assumed to be highly attractive to locals and tourists.

Workshop participants in Julatten, who strongly felt that water quality as well as quantity should be of highest priority, argued that any future activities carried out in Julatten should be measured against the available water in the area. Participants put forward that any activities should not pollute water and should not be a drain on the water supply. This is in contrast to the participants’ advocating growing food in the area. ‘Water advocates’ argued that “proper farming” may use too much water and therefore land may be better managed according to the current available water supply without being an extra demand on the whole system.

Maintaining natural resources and protecting and enhancing biodiversity within the agricultural landscape were perceived by some participants as main priorities. These participants felt that it was important to protect native vegetation such as rainforest remnants on farms, as they provide important habitats for native animals but also have intrinsic values. Habitat networks, riparian corridors and reduction of agrochemicals were also considered effective measures to protect native vegetation. Enhancing biodiversity and establishing walking tracks and cycle paths were assumed to work hand-
stakeholder involvement builds community capacity and capacity for change, while at the same time improves our planning tools and processes. From a researchers’ perspective, local stakeholder involvement allows our work to be more responsive to the social, cultural and economic context and to serve a tangible need of the community. Furthermore, researchers also benefit from stakeholder involvement as they can address research questions that are meaningful to local people. Thereby researchers are able to contribute to an educational process by assisting local stakeholders in the development of their future visions that are based on experience, desires and the knowledge gained throughout the participatory planning process. Finally, participation in the design of future visions through a process facilitated by researchers leads to a feeling of ownership of the outcomes and increased likelihood that local people will participate in related initiatives such as planning for natural resource management (NRM).

Future visions to inform planning and policy making Comparing the priorities for the future visions developed by local stakeholders with the landscape in 2003 shows that the changes proposed for future landscape development largely depend on local government planning as well as environmental and agricultural policy choices. For example, local stakeholders proposed the following planning and policy measures to achieve their visions: protection of good agricultural land; provision of incentives for existing farmers to continue farming, potentially in a more environmentally friendly way, and preferably organic/biodynamic; incentive schemes for farmers and landholders to re-vegetate riparian buffer zones, and to establish natural habitats on farms. These and other measures such as better environmental education and information were proposed by the workshop participants in order to achieve their long-term goals for their landscape. Thereby the future visions inform planning and policy making by providing directions of where local stakeholders would like to see their local landscape developing; the suggested planning and policy measures reinforce their visions. Planning schemes as well as environmental and agricultural policies that are consistent with stakeholders’ preferences and aspirations have more chances of success than planning schemes and policies imposed without consideration of the local community affected by the policies (Kasemir et al., 2003). However, as the main aim of this research was not to develop a shared vision for the future, still puts a great degree of responsibility in the hands of decision-makers and scientists as to if and how the priorities, developed by the workshop participants, can be linked and

Discussion
Including local stakeholders in the development of future visions

The futures visions for the Mossman and Julatten landscape developed with local stakeholders reflect their different views, preferences and values regarding future land use and management practices. In particular, the priorities put forward by the workshop participants, based on core assumptions and trade-offs, provide the opportunity to clarify points of views which may assist in further refining and negotiating their visions. The central role stakeholders played in the vision development process as well as effectively communicating the project and its participatory components to the local communities assisted in raising public awareness. The workshops, and in particular the social learning experience they provided, were highly valued by the participants. Workshop discussions increased participants’ understanding of landscape issues that are complex, especially when environmental, social, cultural, and economic trade-offs between different land use options were being discussed. Subsequently, stakeholder involvement builds community capacity
translated into meaningful plans and acceptable policies. For example, how can the priorities put forward by the local stakeholders in this research be incorporated into local government and NRM planning if processes like the ones proposed in this research are not an official part of developing local planning schemes or a requirement for NRM planning? At the very least, these participatory planning processes provide strategies to increase awareness, information to improve knowledge and training to develop skills.

In addition, the visions developed with local stakeholders are scale-dependent; as Hulse stated: “Stakeholder involvement processes must always struggle to find a balance between a study area large enough to address major cultural and biophysical processes” (2004, p. 339). He also argues that “it is natural for people to be most interested in those places they know best and care most about” (2004, p. 340). I argue, that the scale chosen in this research has achieved the balance between size of the area and stakeholder interest. The priorities developed for the local landscapes of Mossman and Julatten are able to inform local government planning, planning for NRM and policy development at the local, regional, and state level; as the local landscape scale lies at the interface between local and regional planning.

However, considering the importance of the issues at stake, analysis and evaluation of potential new schemes and polices are essential before a decision is made, as these choices will not only affect land use and management practices, but also ecological health, social and economic structure of the communities and the broader public’s experience of these landscapes.

Concluding remarks

A participatory planning approach was employed in this research to integrate local stakeholders’ aspirations and knowledge with scientific knowledge in the design of future visions for two tropical landscapes. The priorities identified by local stakeholders in the community workshops, the trade-offs they discussed and the policy and planning recommendations they made reflect their concerns and provide useful information for landscape researchers, planner and policy makers. They also provide a clear message for the scientific community. Innovation in the design and implementation of landscape projects is urgently needed, in particular the trade-offs question needs to be addressed in a more rigorous way for improved decision-making. The visions discussed in this paper provide a basis for and may assist in the development of (inter-)disciplinary modelling approaches that are meaningful to analyse and evaluate trade-offs at the landscape scale. The analysis of environmental, social and economic trade-offs between the different visions developed in this study would enhance the research process and contribute significantly to more informed decision-making. However, social and economic models are in their infancy and even the most readily available models from other disciplinary areas (e.g. water quality models) do not include a wide range of linkages (e.g. water quality and aquatic biodiversity). To date, most of the existing models are run independently and linkages between different models (e.g. economic models and biodiversity models) and feedback loops are poorly understood. The development of platforms which enable the linking of different disciplinary models to assist in a more comprehensive analysis of trade-offs will be a major step that needs to be taken. Both the further development of disciplinary modelling approaches and greater understanding of the linkages and feedback loops between models is needed, as future planning and policy making will only be as good as the predications made by these models and the expert advice offered by the scientific community. Finally, the visioning process could be advanced by providing expert input into the evaluation of proposed visions and could thereby contribute to an iterative process that combines stakeholder and expert input, in the search for the most desirable future landscape.

<table>
<thead>
<tr>
<th>Distinct pathway</th>
<th>Future visions</th>
<th>Priority in the future landscape</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sugar industry survival</td>
<td>Agricultural production</td>
<td>Water quality improvement</td>
</tr>
<tr>
<td>Post-sugarcane landscape</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 1: Overview of six future visions for the Mossman and Julatten landscape developed in a participatory planning process with local stakeholders.
References

Bohnet, I. 2005. From production to urbanised landscapes: Reflections of technological, social and ecological transitions in the Wet Tropics of Far North Queensland. In: Emerging issues along urban/rural interfaces: linking science and society. Edited by: Laband, D., Auburn University, Center for Forest Sustainability & Forest Policy Centre, Alabama, USA.

Bohnet, I. 2004a. Agricultural landscapes in the Wet Tropics – Future visions balancing environmental, social and economic needs: Summary report prepared for the participants of the qualitative interviews, CSIRO Sustainable Ecosystems, Atherton, Australia.

Bohnet, I. 2004b. Agricultural landscapes in the Wet Tropics – Future visions balancing environmental, social and economic needs: Summary report prepared for the participants of the community workshops, CSIRO Sustainable Ecosystems, Atherton, Australia.

Bohnet, I. 2004c. Agricultural landscapes in the Wet Tropics: Future visions balancing environmental, social and economic needs. Mossman study area/Julatten study area. Two fact sheets, CSIRO Sustainable Ecosystems, Atherton, Australia.


Figure 1: Case study landscapes in context to World Heritage Areas.
**Figure 2:** Top – Mossman landscape in 2003; middle – a diversified landscape with continued sugarcane in 2025; bottom – post-sugarcane landscape in 2025.

**Figure 3:** Left – Julatten landscape in 2003; middle – a diversified landscape with continued sugarcane in 2025; right – post-sugarcane landscape in 2025.
Dynamic Models of Land Use Change In Northeastern USA: Developing Tools, Techniques, and Talents for Effective Conservation Action

Mary L. Tyrrell¹, Myrna H. P. Hall¹, and R. Neil Sampson¹

Abstract

America’s private forests are at risk, under threat of being converted to malls, housing developments, and personal green space. Using a dynamic simulation modeling tool—GEOMOD—we have demonstrated a scientifically rigorous method of projecting likely scenarios of forest fragmentation based on analysis of past rate and patterns of land use change in New England’s Thames Watershed and New York’s Catskill/Delaware watersheds. Results are being used for conservation and planning in both regions.

Catskill/Delaware private forests are being converted to non-forest uses at a rate of 1% per year, in a fragmented pattern. The area:perimeter ratio of forest patches was 187:1 in 1992; 150:1 in 2001, and is projected to be 105:1 in 2011. Smaller forest patches and more edge environment impacts wildlife habitat, deer and tick populations, water quality, the potential for timber harvesting, recreation, aesthetics, and local economies. Land parcelization data from 1985 to 2000 indicates that forestland that has been parcelized is 1.5 times more likely to be converted to other uses than land that has not been divided.

Of the 740,000 acres of forest not permanently protected from development in the Thames, 7.4% has been lost since 1985. The forests are more fragmented: the area:perimeter ratio dropped from 421:1 in 1985 to 381:1 in 2002. However, projections to 2022 indicate that development may follow a pattern of in-filling, hence elimination of smaller forest fragments and a mathematically higher area:perimeter ratio, although the remaining patches would not be larger than they were in 2002.

America’s productive private forests are at risk, under threat of being converted to malls, housing developments, and personal green space. Conservationists and officials in many localities are asking what they can do to help conserve their forests and maintain local forest-based economies. This study was designed to test the ability of a dynamic simulation modeling tool—GEOMOD¹—to illustrate local and regional land use changes, both in the recent past and in the near future. It stems from the idea that if people know how rapidly their forest resource is being lost, where it is being lost, and what forces seem to be driving the losses, they will be better equipped to take effective conservation action. Working with two sites, the Thames River Watershed in Connecticut and Massachusetts and the Catskill/Delaware water supply watersheds and surrounding region in New York, we have demonstrated a scientifically rigorous method of projecting likely future scenarios of development based on analysis of past rate and patterns of land use change.

There are some 10 million private forest ownerships in the United States, and that number has been estimated to be growing at the rate of around 150,000 a year (Butler and Leatherberry 2004). At the same time, the area in privately-owned forestland has stayed roughly the same for decades. The obvious result is that America’s forests are being divided into smaller and smaller ownerships. Nationwide, over 25 million acres of rural land were developed between 1982 and 1997, and over 10 million of those acres were forest before they were developed (USDA NRCS 1997). The clear implication is that forests are increasingly under threat from urban sprawl and other dispersed development.

These trends raise concerns in two general categories. The first is forest fragmentation—the breaking up of large contiguous forest areas into smaller, disconnected parcels separated by non-forest lands, roads, or other land use. The impacts of this fragmentation are often described in ecological terms. A landscape sprinkled with little patches of disconnected forest does not function in the same way as that landscape functioned when it was a single large forest. The second category of change is parcelization, the dividing up of private land into smaller ownerships.

Despite concerns in many communities over forest changes, there often seems to be little that can be done to address the situation. By the time the problem is recognized, it is nearly impossible to restore the integrity of fragmented forests. It is hard to evaluate how rapidly these processes are taking

¹ GEOMOD was developed by researchers at the State University of New York College of Environmental Science and Forestry (SUNY ESF) with funding from US Department of Energy.
place. Change often comes in the form of one small, seemingly insignificant event at a time, and the full effect of the cumulative change may not be evident for years. Before the parcelization or fragmentation occurs, however, there are effective preventative measures for a community to consider. This leads to the idea that communities could, if they knew where forest parcelization and fragmentation were most likely to occur in the future, design locally adapted conservation measures that would slow these changes or reduce their undesirable impacts. The question becomes: How does one see such phenomena in advance of their actual occurrence?

We began by studying the trends in landuse change over the recent past, using satellite imagery to identify where forests have been converted to other land uses. Once those areas were identified, we used GEOMOD to test which underlying factors or drivers might have been the most important contributors to the change, and project the future rate and spatial pattern of land conversion based on past land use change (Hall et al. 1995a and 1995b). Although there are many tools now being used by the conservation and land use planning communities, dynamic simulation, with its ability to visually portray the importance of cumulative effects, change over time, and driving forces, is an enormous enhancement to static GIS mapping or build-out analysis. Assuming that similar conditions or driving factors may continue to be important in future land use changes, conservation program efforts can be prioritized to those forests most at risk, with some hope that success will be improved.

Spatial models of future land use change require two types of parameters—those that project how rapidly land is converted to other uses and those that indicate where the change will take place, i.e. rate and location. GEOMOD, a spatially explicit land use change model, identifies through a rigorous calibration/validation process those spatially distributed biophysical, and/or socio-economic variables that explain past and current development patterns, and projects them into the future assuming business as usual.

The two study sites are largely forested places under tremendous pressure from local development and the sprawling metropolitan areas of New York City, Boston, Hartford and Providence (figure 1). As the largest unfiltered surface water supply in the country, the New York City Watershed is extremely vulnerable to potential changes in land use. Protecting the remaining forested landscape is a high priority for both the local communities and the urban population of New York City. The Thames River Watershed, in northeastern Connecticut and south-central Massachusetts, known as the “Last Green Valley” between New York and Boston, is home to the Quinebaug-Shetucket National Heritage Corridor, honoring both its present rural character and its past industrial history. Development pressures are typical of those experienced throughout the northeast, and there are active forest conservation efforts in both places.

Local input was considered vital to ensure both that assumptions could be tested against local knowledge and that the results would be meaningful and useful to the communities who are working to conserve their forested landscapes and rural character. Early on in the project, two community workshops were held, one in New York on March 19, 2002, the other in Connecticut on May 21, 2002. Attendees included representatives of various local and regional conservation organizations and government agencies; local citizens; and forest landowners. Follow-up workshops were held in each location to present the results and discuss ways to get this information into the local planning processes. Input and feedback from the participants was incorporated into the project plan, wherever feasible.

A working hypothesis about what is driving land use change in each area was developed during the first community sessions, based on local knowledge and intuition. In some cases, these conclusions were supported by the findings in the project; in others, the findings seem to point elsewhere. In either case, developing and testing a working hypothesis helped focus the study on important factors and provided a useful way to bring out new or surprising findings in the study.

The hypothesis for the New York Catskill/Delaware Watersheds was that parcelization is more of a current factor than fragmentation and will be hard to detect or predict, and that the pattern of forest fragmentation and conversion is determined primarily by distance from New York City, distance from major roads, distance from ski resorts/new resorts (growth nodes); New York City water supply watershed regulations; taxes; age of landowner; and

---

2 Since fragmentation and parcelization are very difficult to quantify, especially over a large land area, we used change in forest cover as a surrogate measure of the extent to which the forest has become fragmented and parcelized.
population of permanent residents vs. housing units (second home development).

In the Catskill/Delaware region we found that private forests are being converted to non-forest uses at a rate of a little over 1% per year, in a fragmented pattern. Without strong conservation intervention, that rate is likely to proceed for the next decade, resulting in the loss of another 162,000 acres of private forestland, and a much more fragmented forest resource, by the year 2011. Through statistical analysis, we found that in this mountainous region, the fragmentation that has occurred since 1992 follows a pattern of sprawling up the valleys and is most influenced by the proximity of urban areas, roads, and topography, particularly elevation and slope. Second home development is an important factor in regional land use change dynamics. Ski resorts and landowner age were slightly less important in predicting where development has occurred in the past. However, it should be noted that the scale of the window of analysis means that more importance will be given in the model to urbanized areas (since there are more of them) than rural development, such as ski resorts. Regulations and taxes were not tested due to unavailability of adequate time-series spatial data for these factors.

Using a simple measure of “area of intact forest” vs. “perimeter of forest patches,” the area:perimeter ratio was 187:1 in 1992; 150:1 in 2001 and is projected to be 105:1 in 2011. Forest patches are getting smaller, with more edge environment, which impacts everything from wildlife habitat, deer and tick populations, water quality, the potential for timber harvesting, recreation, aesthetics, and local economies.

Within the New York City Watersheds, forestland parcel size is decreasing and our analysis indicates that forest land that has been parcelized is 1.5 times more likely to be converted to other uses than land that has not been divided. The average parcel size in the region has gone from 18 acres in 1985 to 14 acres in 2000, clearly indicating increased parcelization of forestland since 1985 (LaPierre and Germain 2003). As evidence that parcelization (smaller ownerships) does lead to further forest fragmentation, our data from a sample of 122,000 acres, show that lands that had been parcelized between 1984 and 2000 experienced a higher rate of forest loss (8%) than those that had not been parcelized (5.5%).

For the Thames River Watershed, the hypothesis was that threats to forests are from parcelization, fragmentation, habitat destruction, and conversion and that the rate of forest fragmentation and conversion are being driven by population growth; zoning regulations; changes in timber markets; casino development; economic growth in nearby major cities; land prices; distance from major cities; upgrade and expansion of roads; and the collapse of the dairy industry. We assumed that the pattern would be a function of distance to roads, to major urban areas, casino development, and perhaps a variety of socio-economic factors that make places more attractive or more likely to be undergoing change.

Our finding were that fragmentation of forestland has occurred since 1985, although new development is projected to happen mostly on smaller, isolated fragments of forestland near already developed land. This is partly due to the fact that much of the forestland in this region is under some type of protection from development. In the Thames Watershed region, of the 740,000 acres of forest not permanently protected from development, 7.4% has been lost since 1985. This may seem like a fairly low rate over 17 years, but it is the pattern that is most troubling. If the same trend continues, we project that the Thames Watershed and surrounding towns will lose an additional 64,000 acres of forest, scattered across the landscape, in the next 17 years. The forests are more fragmented as shown by the area:perimeter ratio which was 421:1 in 1985, dropping to 381:1 in 2002. However, our projections out to 2022 indicate that the future trend may result in an infilling of developed areas hence elimination of smaller forest fragments and a mathematically higher area:perimeter ratio, although the remaining patches would not be larger than they were in 2002.

The pattern of forest loss is best predicted by distance from 1985 agricultural lands, soil type, and distance from urban areas. Population, casino development, and roads were somewhat less important drivers of land use change, as were most socio-economic factors analyzed. However, socio-economic factors, prior settlement patterns, and soil types are inter-related and thus probably co-dependent with the top three drivers. We did not have a way to incorporate the collapse of the dairy industry into the analysis; and data was not available at a useful scale and format for analyzing zoning regulations or changes in timber markets.

In both areas, already developed areas are nodes for expanded development. Towns with the least forest cover are losing the forest they have faster than towns that are mostly forested. Driving factors and indicators of development in the northeast are highly...
interdependent, thus no single one stands out as more highly predictive than others.

Socio-economic data, although useful in understanding the demographic trends in an area, did not provide better predictive power than just bio-physical (topography) and socio-political (development and roads) factors alone. This is good news for broad application of GEOMOD in the northeast, because of all the factors we analyzed, the socio-economic data were the most time consuming to collect and format for the model.

It is quite likely that our results in both regions actually overstate the amount of intact forest remaining. The land cover classification process, which uses 30-meter resolution satellite imagery, is much better at picking up concentrated development than low density rural development. For example, a housing subdivision with large lots and trees would show up as partial forest in the satellite imagery. However, this is no longer the same forested habitat for wildlife as a large tract of unfragmented forest, nor is it a forest that can be managed for timber or other forest products.

Nonetheless, our results demonstrate that the rate and location of recent conversions of forest to non-forest cover, detected by interpretation of satellite imagery, can be used not only to study the past but to visualize possible future conditions. Using GEOMOD, we were able to take those past changes, compare them with a wide range of geophysical and socio-economic data, and derive a statistically robust correlation between past patterns of land use and land cover change and the most likely future continuation of those patterns (figures 2 and 3).

As indicated by the discussions at the community workshops, local people know that their forests are becoming more fragmented and the rural character of their towns is changing, and they are asking for tools to help educate communities about the problems with growth and development in largely rural, forested areas. The result of our study is a visually powerful dynamic display of local land use change, coupled with a new understanding of the factors associated with that change. Using these tools, local leaders can bring new insight and energy to forest conservation and land use management programs. The stakeholders in both areas have expressed tremendous interest in the results, which they believe would be particularly useful in local- and county- or regional-level planning efforts.

References
USDA Natural Resources Service. 1997 National Resources Inventory (Revised December 2000). Washington, DC.

Acknowledgements
This project was funded by the USDA Forest Service Cooperative Forestry, the Yale School of Forestry and Environmental Studies (FES) Global Institute of Sustainable Forestry, and the State University of New York College of Environmental Science and Forestry (SUNY ESF).

We would like to acknowledge the work of students Steve Dettman, David Hobson, Susan Nixson, Sarah Deacon, Tagan Blake, and Michelle Decker. The University of Connecticut Center for Land use Education And Research (CLEAR) contributed a newly created set of temporal land cover maps; René Germain at SUNY ESF provided the 1984 – 2000 parcelization data for the portions of Greene, Schoharie, Sullivan, and Ulster Counties that lie within the NYC Catskill/Delaware watersheds; the New York City Department of Environmental Protection’s (NYC DEP) GIS unit provided the 2000 tax parcel information; and the U.S. Census data used in the analysis was obtained from GEOLYTICS, E. Brunswick, NJ.
Figure 1. Night lights over northeastern North America. The Catskill/Delaware (left) and Thames (right) watersheds are in the areas circled in red. Image from NASA Lights of the Earth web site.

Figure 2. Forest Fragmentation “Potentiality” or “Risk” Map for the Catskill-Delaware Region. In this map forested areas are categorized from high to low risk of development based on past regional patterns. Areas in red are those under greatest pressure for future development compared to other areas across the entire region.

Figure 3. Forest Fragmentation “Potentiality” or “Risk” Map for the Thames region. In this map forested areas are categorized from high to low risk of development based on past regional patterns. Areas in red are those under greatest pressure for future development compared to other areas across the entire region.
Land Use Change Determinants in Alabama

Indrajit Majumdar, Maksym Polyakov and Larry Teeter
Forest Policy Center, Auburn University

Abstract:
Changes in landuse, particularly forest use, have important consequences for the future availability of timber, wildlife habitat, and other benefits provided by forests. Landuse change models have typically been based on the proportion of land area to the total area in various categories and have ignored the value of information that can be provided through spatially explicit landuse models.

This paper analyzes the determinants of forestland changes in the state of Alabama using Forest Inventory and Analysis (FIA) plot level data as opposed to regional aggregated studies.

Spatially referenced socioeconomic variables, land and topography characteristics, market forces and ownership characteristics are used to explain the probability of forestland change to primarily urban and agricultural use. Results show that human factors play a significant role in affecting landuse changes.

Introduction:
Changes in land use and particularly forest use, have important consequences for the future availability of timber, wildlife habitat and other benefits provided by the forests. Empirical land use change models have been constructed using two approaches. The first being the area-based approach that describes the proportions of land in different use categories within geographically defined entities, usually counties, as a function of socio-economic and land characteristics (Alig 1986; Hardie and Parks 1987; Plantinga and others 1999). The second approach is the spatially explicit, generally, pixel-to-pixel basis which is at a much finer scale than the area-based approach (Bockstael 1996; Chomitz and Gray 1996; Munn and Evans 1998; Wear and Bolstad 1998). The latter approach relies on discrete land use data derived from satellite imagery, aerial photographs, or systematic land inventories combined with other spatially referenced data that describe socio-economic factors and geographical and physical land characteristics believed to affect land use.

These data are used to estimate the probability of a particular land use or land use change occurring at a given location and at a particular point of time using logit or probit regression models.

While the conventional area-based approach has the disadvantage of averaging the physical land characteristics for the unit of study, the latter approaches have found it difficult to obtain spatial socio-economic data at scales finer than the census tract level, which are non-existent.

Alternatively researchers have used population density and distance to major cities as a proxy for spatial socio-economic variables (Bockstael 1996; Munn and Evans 1998). A study by Kline et al 2000 used a combination of population and proximity to city centers to create a gravity index in their study of the urbanization impacts on land use conversion from forest and agricultural land in Oregon. The objective of this study uses a variation of Kline’s gravity index in explaining land use conversion from forest and non-forest (agriculture/urban) in Alabama using spatially disaggregated Forest Inventory and Analysis (FIA) survey data at a plot level. FIA conducts periodic nationwide assessments of all non-federal land in the United States at approximately 10-year intervals and includes data on land use and ownership characteristics on sample plots at points taken roughly on a 3-mile grid.

Conceptual and Empirical Framework:
The conceptual foundations of this study are based on the assumption that a landowner will convert a forest parcel ‘i’ to a non forest use (N) when the opportunity cost of keeping the land in forest use (F) (that is, the present value of net returns generated if the land was converted into non forest use minus the conversion cost) exceeds the present value of net returns generated by the parcel remaining in forest use.

Conversion to non-forest occurs when:

\[ V_{iN} \geq V_{iF} \]

Where \( V \) = present value of future net returns

Separating the deterministic and the stochastic components of eq (1) we can say that
\[ P(\text{nonforest}) = P(v_{iN} + \mu_{iN} \geq v_{iF} + \mu_{iF}) \]
\[ = P(v_{iN} - v_{iF} \geq \mu_{iN} - \mu_{iF}) \]

Where
\[ P \text{ (non-forest)} = \text{probability that parcel 'i' in forest use at time 't-1' will be converted to non forest use at time 't'} \]
\[ t = \text{represents time 't'} \]
\[ v = \text{represents the deterministic component of value} \]
\[ u = \text{represents the stochastic component} \]

For the purposes of this study we use FIA land use data at the plot level as the dependent variable and a combination of spatially referenced socio-economic variables and alternative land use rent variables as independent (explanatory) variables in the model.

The structural model estimated in the study can be written as
\[ y_i^* = \beta' X_i + \zeta_i \]

Where
\[ 'X' \text{ is a vector of explanatory variables describing the } v_{iN} - v_{iF} \text{ parameters in eq (2) and } \zeta_i \text{ representing the } \mu_{iN} - \mu_{iF} \text{ in eq (2)} \]
\[ y_i^* = \text{probability of land use change from forest to non forest} \]
\[ \beta = \text{vector estimated coefficients, and} \]
\[ 'i' \text{ indexes the FIA plots in the model} \]

In practice we don’t have information on \( y_i^* \) and we only \( y_i \) as a vector of dummy variables defined as
\[ y_i = 1 \text{ for all plots 'i' observed in forest use at one point of time and non forest use at a later time} \]
\[ y_i = 0 \text{ for all plots 'i' that were observed to be in forest use at both points of time} \]

Two separate models were estimated, one for a change from forest use to non forest use and the other a change from non forest use to forest use at a later time using a binomial logistic regression assuming the error to be logistically distributed as
\[ P(y_i = 1) = \frac{e^{\beta' X_i}}{1 + e^{\beta' X_i}} \]

Where \( 'e' \) represents the base of the natural logarithms

**Data:**
Data used in this study was obtained from the following sources: Census Bureau census data on population of Census Places for Alabama for the censuses 1970, 1980, 1990 and 2000; Forest Inventory and Analysis (FIA) plot and county data (for Alabama) for 1972, 1982, 1990 and 2000; National Agricultural Statistics Service (NASS) data by county (for Alabama) of the market value of all agricultural products sold in dollars for 1972, 1982, 1992 and 2002; and Bureau of Economic Analysis (BEA) data on per capita income by county (for Alabama) for 1972, 1982, 1990 and 2000.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gravity Index (GRA)</td>
<td>Links each Census Place (k) within 100km of Alabama to each FIA plot (i) at some points in time, t. See Eqn. (5)</td>
</tr>
<tr>
<td>POP30, POP60, POP90</td>
<td>Sum of populations of census places within 0-30 km, 30-60 km and 60-90 km rings around each FIA plot in the model</td>
</tr>
<tr>
<td>TIMBER_RET</td>
<td>FIA county data for growing stock removals in Million cubic feet</td>
</tr>
<tr>
<td>AGRL_RET</td>
<td>Market value of all agricultural products sold in dollars by county from National Agricultural Statistics Service (NASS)</td>
</tr>
<tr>
<td>PERCAPITA</td>
<td>Average per-capita income by county from Bureau of Economic Analysis (BEA)</td>
</tr>
</tbody>
</table>
Gravity index:
Gravity models were initially developed in geography by Reilly (1929) to describe the degree to which cities attracted retail trade from surrounding locations. In this study a gravity index was created to account for the combined influence of population and proximity to city centers as the socio-economic forces influencing land use change of FIA plots. A 100 km buffer around Alabama (AL) incorporating the influence of census places from the four contiguous states of Georgia (GA), Tennessee (TN), Mississippi (MS) and Florida (FL) in addition to all the designated census places within the state of AL was created. Gravity index was specified as,

\[ \text{gravity index} = \sum_{k=1}^{n} \left( \frac{\text{population}_{ik}}{\text{dis tan}_{ik}} \right)^{0.5} \text{eq (5)} \]

Where 
\[ k = 1 \ldots n \] represents all the census places within 100 km of each FIA plot in Alabama including the Census Places from the contiguous states of GA, TN, MS and FL 
\[ t = \text{time} \]

Distance was computed as the Euclidian distance between FIA sample plots and each census place included as explained above. By including the gravity index as a regressor in the model we could take into account the effect of the different population growth rates at different locations in the land use change model.

The other explanatory variables in the model were primarily alternative land use rent variables similar to those used in other non-spatial and spatial land use models.

FIA data from four inventories 1972, 1982, 1990 and 2000 for Alabama were used to create the discrete dependent variable vector based on actual observations of land use change on FIA plots at successive inventory occasions. In total we had 20,689 observations of beginning and ending land use over an average 10-year interval period. A time dummy was included to incorporate the temporal dynamics into the model.

Results:
Two models were estimated, one for the forest land use change and another for non-forest land use change, the results are shown in Tables 2 and 3 respectively. The estimated logit models are highly significant as indicated by the chi-square values of the likelihood ratio test for each of the models. The Hosmer-Lameshow test for goodness-of-fit showed that the forest land use change model is a better fit in comparison to the non-forest land use change model. All the variables were highly significant (\( P < 0.01 \)).

The significance of the socio-economic variables (POP30, POP60, POP90, GRA) in the model justifies our expectation that they play a vital role in land use changes. The significance and sign of the rent variables (TIMBER_RET, AGRL_RET) supported the hypothesis that higher returns to a particular land use are associated with higher probabilities of land being converted to that alternative use. This also validates the role of economic profits as drivers of land use changes. As expected the estimates reveal that there is a higher probability of land use change from forest to non-forest with increases in per-capita income (PERCAPITA) levels of the county location of the forested plot. In addition the estimated time dummies indicate important temporal trends as supported from historic land use data.

### Table 2: Estimated logit coefficients of probability that forestland is converted to non-forest use in Alabama

| Parameter  | Estimate | Standard Error | Pr > |chisq| |
|------------|----------|----------------|------|------|
| Intercept  | -9.0574  | 0.0145         | < 0.0001 |
| Year 1972  | 0.9476   | 0.00315        | < 0.0001 |
| Year 1982  | 0.1815   | 0.00165        | < 0.0001 |
| Year 1990  | -0.1857  | 0.00169        | < 0.0001 |
| GRA        | 0.00045  | 0.000011       | < 0.0001 |
| POP30      | 0.1291   | 0.000693       | < 0.0001 |
| POP60      | 0.1886   | 0.000821       | < 0.0001 |
| POP90      | 0.1073   | 0.000952       | < 0.0001 |
| TIMBER_RET | -0.00250 | 0.000073       | < 0.0001 |
| AGRL_RET   | 2.682E-6 | 1.496E-8       | < 0.0001 |
| PERCAPITA  | 0.000038 | 3.341E-7       | < 0.0001 |

### Table 3: Estimated logit coefficients of probability that non-forestland is converted to forest use in Alabama

| Parameter  | Estimate | Standard Error | Pr > |chisq| |
|------------|----------|----------------|------|------|
| Intercept  | -0.0304  | 0.0163         | < 0.0001 |
| Year 1990  | 0.1221   | 0.00101        | < 0.0001 |
| GRA        | 0.00249  | 9.032E-6       | < 0.0001 |
| POP30      | 0.0461   | 0.000757       | < 0.0001 |
| POP60      | 0.0129   | 0.000838       | < 0.0001 |
| POP90      | -0.2085  | 0.000930       | < 0.0001 |
| TIMBER_RET | -0.00741 | 0.000066       | < 0.0001 |
| AGRL_RET   | -8.89E-7 | 1.538E-8       | < 0.0001 |
| PERCAPITA  | -0.00007 | 3.059E-7       | < 0.0001 |
**Discussion:**

We investigated the effect of socio-economic variables on land use transition for forest and non-forest uses. GIS was employed to construct spatial socio-economic variables, which were the key to our investigations of the determinants of land use change in Alabama. The models estimated support the almost universal conclusion that most researchers have found in land use change models which is that land use rent variables are the major drivers of land use change. The effect of the time dummy variables on the model supported the historical shifts in land use during the last half a century due to governmental policies like the Conservation Reserve Program (CRP). Our study emphasizes the importance of inter-disciplinary research in explaining the spatial and temporal patterns of migration, distribution of population and government actions like Forestry Incentives Program (FIP) and (CRP) added to the market conditions on resulting land use changes.

**References:**


Birmingham-to-Atlanta: Returning longleaf pine and fire to where it belongs

John McGuire and John S. Kush, School of Forestry and Wildlife Sciences
Auburn University

Abstract:
Fire-maintained longleaf pine ecosystems once dominated much of the southeastern U.S. Longleaf pine was the tree species that built the U.S. and today, less than 3% of this once vast ecosystem remains. Historical accounts of the Birmingham, Alabama – Atlanta, Georgia corridor described relatively continuous tract of longleaf pine forests maintained by periodic fires. Much of the longleaf pine and fire was extirpated from this corridor decades ago. Remnant longleaf pine exists predominantly on public land such as the recently established Mountain Longleaf National Wildlife Refuge. Conditions acceptable for performing prescribed fires to maintain this forest have drastically altered as the number of smoke sensitive areas and fire prone developments continue to increase. The situation in the Birmingham to Atlanta corridor offers an excellent opportunity to educate the public about longleaf pine, prescribed burning and the associated benefits of each.

Introduction
The rationale for restoring longleaf pine habitat is based on three integrated ideas; ecology, economics and social benefits. From what was perhaps once the largest temperate forest type dominated by a single species of tree in the U.S. to occupying about 3% of its former range, mature, longleaf pine forests are now considered rare. Within these remnant longleaf pine forests, a few dozen species that wholly depend of the structure of these mature stands are now imperiled with global extinction. Furthermore, many scientists have begun to discover that high species richness (found mainly in the groundcover) accounts for longleaf pine forests being considered as regional hotspots of biodiversity. Economically, longleaf pine forests produce high quality products such as utility poles, saw timber, etc. which are less subject to market fluctuations compared to other lumber products such as pulp wood. Furthermore, as the market for pine straw used as garden mulch continues to evolve, longleaf pine will continue to pull ahead of the other pine species (with longleaf pine having larger, more decay resistant straw which maintains its color longer). Many entrepreneurs are discovering money can be made with longleaf pine forests from endeavors such as hunting leases (longleaf has high quality game habitat), endangered species mitigation, and even a blossoming market of carbon credits. Aside from being aesthetically pleasing, being able to store large volumes of greenhouse CO₂, and providing high quality game and non-game habitat, there is a strong social connection between southerners and longleaf pine forests. Longleaf pine was literally the tree that built the U.S. Countless generations of peoples living in the southeastern U.S. grew up with and died with the longleaf pine forest. The tree is venerated in town names (e.g., Pine Level), remembered in prose (e.g., the State Toast of North Carolina) and adored as state emblems (e.g., the state tree of Alabama).

Longleaf pine in the Southeast
The domain of longleaf pine forests was vast. The same open and park like longleaf pine forest seen in Virginia could also be found stretching all the way to eastern Texas. To put it another way, a few hundred years ago, a traveler could journey 600 miles north of Orlando, Florida and would have been in a longleaf forest the majority of time. Likewise, a traveler could pack their bags in Beaumont, Texas and travel eastward in an arch approximately 1500 miles to Norfolk, Virginia and be in a forest either dominated by longleaf pine or one where longleaf pine was a major component of the forest. For comparisons sake, today, one traveling this same route would have to travel 3 days of hard driving before they left the range that was once dominated by longleaf pine.

The common denominator of longleaf pine forests is fire. Longleaf pine forests are a true fire climax system. The diversity in this system is tied to the frequent occurrence of low-intensity fires. With fire, the forest takes on an open and park-like appearance. The overstory is dominated by longleaf pine, there is conspicuous lack of a mid-story, and the groundcover is diverse and dominated by C4 grasses. However, due to subtle differences in topography, soils, and species compositions, longleaf is generalized into five different habitat types: the longleaf pine sandhill region, the longleaf pine flatwood region, longleaf pine savannah region, the longleaf pine rolling hill region, and the mountain longleaf pine region.
The sandhill region has been characterized as sandhill ridges of loose, porous sand that starts in southern Virginia and runs through west Georgia at about 500 to 600 feet above sea level. A few isolated sand ridges exist on the Florida panhandle and peninsula. Likewise, longleaf pine sandhills are characterized as a forest of widely spaced pine trees with a fire-stunted under story of deciduous (scrub) oaks and a patchy ground cover of bunchgrasses and herbs. Today, sandhill longleaf sites make of some of the largest acreages of remaining longleaf pine habitat (despite comprising roughly 10% of the original landscape).

The longleaf pine flatwoods are characterized as high density, longleaf pine dominated forests where the ground’s surface is very level, poorly drained, and often interspersed with frequent and, sometimes large, swampy patches or wet prairies. The flatwoods region can start just above where the tidewater comes in and can extend inland to about 130 feet above sea level. The productivity of this region is high and longleaf pines can reach heights in excess of 120 feet tall. This longleaf pine habitat type has the highest diversity of ground cover of herbs and shrubs and since the soils are relatively poorly drained and typically have low reserves of available nutrients, numerous orchids and carnivorous plants are common in the ground cover. This region is found in seven of the eight states in the longleaf pine range and can often be described as both the Atlantic Coastal Flatwoods and the Gulf Coastal Flatwoods.

Soils of savannahs are similar to those of flatwood region. However, fire history has resulted in a landscape more similar to a sea of grass with islands of trees. These islands can be pure stands of longleaf pine or mixed with slash pine.

The longleaf pine rolling hills region is characterized as having a sufficiently rolling habitat that insures good drainage. Often the region has very productive sites capable of producing excellent longleaf pine timber. The longleaf pine rolling hills region is found at about 130 to 250 feet above sea level. It is speculated that 30% of the pre-settlement landscape was of the rolling hill habitat. The soil of this habitat is composed of brown, sandy loam uplands 10 - 15 inches in depth and often with fossiliferous materials found its composition. In some areas, the underlying parent material is composed of limestone. Occasionally, the limestone will push through the sandy loam and form outcroppings.

Within the Blue Ridge and Ridge and Valley physiographic landscape of north Alabama and Georgia, longleaf pine was the dominant forest cover on south and southwest facing slopes up to about 2000 feet in elevation. However, an outlier of this mountain habitat type is also found along Pine Mountain in Meriwether and Harris, Counties in Georgia. Although still a common tree, longleaf pine (and its associated pyrogenic ground cover) often faded out in damp bottomland valleys and north facing slopes where fire frequency and intensity was greatly reduced and allowed for the establishment of non-fire tolerant related species (such as American chestnut, Virginia pine, etc.). However, countless, microsite differences in elevation, slope, fuels, etc. allowed fire to either move into or to be generally excluded from the aforementioned areas.

**Historical Accounts of Longleaf Pine in the Birmingham-to-Atlanta Corridor**

There is some debate as to what is and where the mountain longleaf pine forests of Alabama and Georgia are and what the early landscape was like prior to significant perturbations by Euro-American settlers. One of the earliest accounts attributed to the montane area was by William Garrett, a Benton County resident (now Calhoun County) from the time of its establishment, writing in the Jacksonville Republican (Reed et al. 1994):

“On the 1st of January, 1833 … The Country was open, the annual burning of the woods by the Indians kept down the undergrowth, and really to a stranger riding through it looking over it as far as the eye could see, crossing the beautiful, clear streams of water with which it abounds, the impression was altogether favorable and the prospect encouraging.”

In the late 19th century, Mohr (1897) found longleaf pine to thrive on “beds of flinty pebbles and light sandy loam deposits in Calhoun county extending to the eastern side of the valley south of Childersburg”. Further, he observed that “on isolated ridges of old Silurian sandstone (Potsdam), and the metamorphic region adjoining, the longleaf pine is scattered and stunted and ascends to an elevation of 2000 feet”. After a more thorough examination, Mohr wrote: “From my observations in former years, I was convinced that the pine forests of the metamorphic regions of Alabama deserved no mention among the timber resources of the State, however valuable they might be as a resource for fuel in connection with the mineral resources of these parts of the State. I was not a little surprised to hear on my trip last week, of a sawmill with a daily output of from 65,000 to 73,000 feet of lumber of longleaf pine, situated in the lower part of Clay County. Yesterday morning I visited the
pine forests from which the supplies of this large and well-conducted establishment, at Hollins are drawn. There I found the foothills and narrow valleys between them, at an elevation of from 1,400 to 1,500 feet covered with truly magnificent forest of *Pinus palustris*, yielding to the acre as much merchantable timber as the best class of pine lands in the coastal belt from Alabama to Texas.”

A few decades later Harper (1913, 1928, and 1943) substantiated Mohr’s observations by noting longleaf pine forests on “the flanks of Cheaha Mountain, even on its north side, where it ascends to 1,900 and perhaps 2,000 feet”. Above 1,900 feet, Harper found “other pines” began to take the place of longleaf pine. In general, Harper found longleaf pine as “thriving best on the sunny southern slopes, but is not confined to them” and also growing in “rather rich-looking clay soils weathered from limestone”. A little farther north (albeit on the same range), Andrews (1917) in the early 1900’s found Lavender Mountain (up to a height of 1650 feet) to be “covered by the remains of a great longleaf pine forest”. The demise of the Georgia montane longleaf pine communities was tied to European settlement in the 1830’s. Most of these communities are represented but relict trees in a mixed pine-hardwood forest type that range up to the elevational limit of longleaf pine on Lavender Mountain in Floyd County near Rome, Georgia.

As part of government sponsored study of agricultural resources in the southeastern United States in 1880, E. Smith wrote the following of the timber resources in Alabama:

[Cherokee County, AL]. . .in the mountainous region in the lower part of the county, the land is gently undulating and the surface soil is sandy. . . This sandy land has a characteristic growth of longleaf pine with blackjack oaks, the genuine piney woods timber, and the pine belt extends through the county in Etowah County without material change.

"The longleaf pine grows upon the soils of all of the southwest part of Tuscaloosa County, and also east and northeast of the City of Tuscaloosa For a distance of 25 or 30 miles, or nearly to the county limits. The genuine piney woods are here, as elsewhere, rather poor and thinly settled.” Note that Harper called these "Salamander Hills" because of the presence of "Salamanders" or pocket gophers.

In the vicinity of South Lowell [Winston Co., AL], 6 miles north of Jasper, occupying perhaps a township, there is an isolated patch of longleaf pine forest. Harper (1928) wrote “Longleaf pine might have once been the most abundant tree in the United States and was certainly the most abundant tree in Alabama.” What follows are excerpts from the works by Harper with his observations of longleaf pine.

[Coosa Valley]: Many of the sandstone ridges and chert hills originally had a great deal of longleaf pine. In Cherokee and Etowah Counties there were considerable areas of longleaf pine flatwoods, with sandy and gravelly soil, resembling some flatwoods near the coast even to the extent of containing pitcher-plants.

[Blue Ridge]: In the forests of the Blue Ridge, oaks of several kinds are always in evidence, but there are four species of pine, and strange to say the longleaf pine was the most abundant tree of all. It naturally thrives best on sunny southern slopes, but was not confined to them. On the flanks of Cheaha, it ascended to over 1,900 feet above sea-level.

The rugged topography of the region made agriculture almost impossible and logging operations difficult, the valuable longleaf pine had been pretty well exploited by 1913. A large sawmill at Hollins, in Clay County, in the 1890’s had a tram road extending out to the mountains near by and cut a great deal of pines from their slopes.

[Piedmont area]: In travels through the Piedmont, Harper documented longleaf pines being boxed for turpentine on the rocky hills about a mile south of Marble Valley, Coosa County and on the steep hillsides of weathered gneiss along Chestnut Creek about three miles below Verbena, Chilton County.

[Northwest Georgia]: While on a train ride to collect plants in 1900 he observed that longleaf pine was the most important plant between Dalton and Atlanta. It was first seen in Paulding County at an altitude of about 1,100 feet and for the next 15 miles. In Polk and Floyd counties, longleaf was nearly always in sight. It disappeared in Floyd County at elevations below 600 feet.

During the winter of 1903-04, Harper traveled through northwest Georgia. In December 1903 he found longleaf common on its upper slopes of “Pine Mountain” (possibly Bear Mountain today), 3 miles east of Cartersville. It was encountered first at 1,000 feet and continued the rest of the way up to 1,500 feet above sea level.
Longleaf Pine in the Birmingham-to-Atlanta Corridor Today

There are few extensive tracts of longleaf pine left in the montane region today, the largest being on the Montane Longleaf National Wildlife Refuge near Anniston, Alabama. Of these acreage remaining, about 70% are on public land and remains in disrepair. Losses of this forest has been mainly attributed to forestry practices that emphasized conversion of cutover longleaf pine forests to tree fiber plantations managed on short rotations. Fire suppression activities have also played a significant role in the degradation of existing longleaf pine habitats. In the past, this suppression of the natural fire regime was mainly to misguided policy that viewed fire as a negative perturbation to forests. More recently, however, as the landscape has become highly fragmented, barriers of housing developments, fields and roads no longer allow fire to move freely across the landscape.

At a landscape level, the idea of restoring the mountain longleaf pine habitat is to connect the dots between the habitats that exist. By bringing together diverse ownership patterns and management objectives the restoration at the landscape level can be achieved. At a more precise level (e.g., forest stand), success in being able to replant areas with longleaf pine trees continues to rise. However, without fire, the functionally to this ecosystem cannot be restored. Although there are other methods to help reduce the buildup of catastrophic fuel loading (and begin to create a similar open and park-like forest structure), for the time being, prescribed burning remains the most cost effective method for maintaining the integrity of longleaf pine systems.

Fire in the Wildland/Urban Interface

Perhaps the largest threat to the future of prescribed burning the Southeastern U.S. is the increasing wildland/urban interface. In the southeastern U.S. there is a perception that wildfire is not a public safety concern. Since fires are not deemed as a threat, federal assistance (which could be used in public education) seldom reaches the southeastern states.

The news downplays the threat of wildfire in the southeast. Part of the reason is that large (fatal) entrapments of firefighters (such as that seen at the Thirty Mile Fire in 2001 and on Storm King Mountain in 1994) that have not happened in the South. Rarely do you hear about firefighters being killed fighting fires in the Southeast. Instead, fire related fatalities in southeast are a result of individual (rather than groups) of firefighters, become trapped in smaller (yet equally as fatal) fires; such as being trapped on tractors. Despite the lack of headline news, in 2004 (for example), out of the 10 wildland firefighters killed on the line of duty, 5 were killed in the Southeastern United States.

Most fires in the Ridge and Valley Region of Alabama and Georgia have been small in size because they are contained in a 24 hour period (i.e., not enough time for several camera crews to set up and report the incident). For example, in the years 2000 - 2004 (those six counties in Georgia where mountain longleaf grow) had around 2,300 wildfires (or 460 wildfires per year). These fires consumed about 15,000 acres (the average sized fire was slightly less then 500 acres). Data for Alabama is similar to that of Georgia. By looking at a map of wildfires in Alabama, there visually seems to be a high number occurring in those counties where mountain longleaf pine is found in the area between Birmingham and Atlanta.

Misperceptions of the threat of wildfire as a result of apathy and/or lack of education continues to result in houses being built in Alabama and Georgia on steep slopes, the tops of ridges, in amongst catastrophic fuel loads and with no defensible space between the house and the forest. Although the Ridge and Valley has not had wildfires that may take out entire subdivisions (such as that which occurred with the Cerro Grande fire in Los Alamos in 2000), structures are lost to wildfires. Consequently, the size of the fire matters little to homeowners who lose their home to a fire. To them, it probably matters little if the fire was either a 500,000 acre fire or a 500 acre fire because in either scenario their house is still destroyed. Regardless, the potential for wildfires in Georgia and Alabama that cause higher financial damage continues to grow as more expensive houses (and developments) are built farther out in the rural interface (e.g., million dollar homes burning up are deemed more newsworthy than a couple of single wide trailers). Contrast these homeowners who build on the beaches of Alabama and Georgia. In this later situation insurance companies recognize that hurricanes are an inherent risk to living on the beach and thus require homeowners to follow certain construction standards to be insured.

At present, the biggest threat to the overall public in the Southeast does not seem to be loss of structure due to being consumed from fire but from the effects of smoke. Prescribed burning puts off smoke. Along with an increasing wildland/urban interface there has been comparable increase in the number of smoke
sensitive areas such as homes, roads, airports, etc. Smoke can temporarily block visibility or can affect public health through long-term exposure (within smoke are found air pollutants such as CO, CO$_2$, and PM$_{10}$). As such, smoke is able to affect a much larger area and, ergo, number of people then the flames themselves.

Resulting primarily from industry and automobile emissions Atlanta Metro and Birmingham often fall out of compliance with air quality standards during the summer months. Once out of compliance, regulators often do not distinguish between air pollutants from a prescribed fire and those from an automobile (or the like). The state of Georgia has placed burn bans during summer "ozone" months of May through September in 19 counties in the Atlanta Metro area. Eleven additional counties in Georgia are proposed for a similar burn ban. It is important to note that burns for agriculture are excluded from this ban. It is reasonable to assume that Birmingham will eventually adopt the same policy as Atlanta. Since many plants have evolved a life history requiring fires that occur in summer months, these county bans on prescribed fire will likely have dire effects on species composition of forested ecosystems.

**Conclusion**

Due to the ever increasing wildland/urban interface and number of “smoke sensitive areas”, burn practitioners must now be able to do more then simply “keep the fire between the breaks”. In today’s environment, practitioners are also tasked with managing their smoke to minimize the inconvenience to the public. However, as longleaf ecosystems continue to find themselves more and more surrounded by urban areas, it becomes more difficult to force smoke in a direction that does not impact some kind of smoke sensitive area. The result is that smoke from prescribed fires causes litigation. If the increase in litigation continues, there will be a turning point when it is no longer cost effective to use prescribed burning as a tool in ecosystem management and reducing the threat of wildfire. If we lose our ability to burn, we lose the ability to manage longleaf pine forests.

**Literature Cited**


Urbanization: Forest Structure, Fragmentation, and Private Forestry
Effects of Urbanization on Diversity of Forest Tree Species in Alabama

Maksym Polyakov, Indrajit Majumdar, and Lawrence Teeter

Forest Policy Center, Auburn University

Abstract
Diversity is one of the major factors which defines stability and efficient functioning up of the forest ecosystem. Maintaining biodiversity is important for sustainable forest management. One of many factors affecting forest diversity is urbanization. This paper analyses the diversity of tree species in Alabama forests. Shannon's diversity index and species richness are used as the indicators of diversity. These indices were calculated for tree species diversity on each FIA sample plot. Influence of biological, climatic and anthropogenic factors during the period 1972-2000 is analyzed using regression analysis. Explanatory variables in the regressions included forest type, stand origin, DBH, volume, site class, ownership, and population gravity index. Population gravity index was determined using ArcGIS software and related to each plot. The diversity of tree species is negatively affected by the urbanization as indicated by population gravity.

Introduction
Biological diversity is the richness and evenness (relative abundance) of species amongst and within living organisms and ecological complexes. The importance of biological diversity comes from its connection to stability and productivity of ecosystems, soil protection, aesthetic value, etc. Diverse ecosystems provide greater variety of goods and services to humans. Tree diversity is a key component of forest ecosystem biodiversity. This is one of the reasons why biodiversity has been one of major topics of forest management and conservation since the Earth Summit in Rio de Janeiro in 1992. Forest diversity is an important criterion of sustainable forest management.

Diversity of a forest ecosystem is determined by the combination of natural and anthropogenic factors. The scale of natural factors determining and affecting diversity of ecosystems ranges from the global (climate, latitude) to regional (elevation, precipitation, physiographic region) and local (moisture, substrate, succession). Anthropogenic factors have a different level of influence on forest ecosystems. The most radical is the conversion of forest to other land cover types/land uses, such as urban or agricultural use. In managed forests, the influence depends on the goals and intensity of forest management. Finally, even unmanaged forests are indirectly affected by such anthropogenic factors as air pollution.

Among anthropogenic factors, urbanization has multiple effects on forest ecosystems. Urbanization means increased intensity of settlement and/or business and other activities (urban land uses) in an area over time. The obvious consequence of urbanization is the change from forest to urban land use; however, this effect will not be analyzed in this study. Urban pressure brings changes to forestry and agriculture (abandonment of agriculture and decreased intensity of forest management) in the immediate proximity to human settlements. For example, Munn et al. (2002) found that urbanization adversely affects probability of harvesting in the forests of the south central US. Urban sprawl leads to increases in road density and forest fragmentation, increasing the amount of forest edges and changing species composition. The goals of forest management may shift from timber production to recreational/aesthetic uses, which may or may not increase diversity of tree species. On the other hand use of forest for recreation could lead to land degradation. Last, but not the least, forests are affected by the pollution due to proximity to human settlements with higher populations.

In this study we investigate the effect of urbanization on diversity of tree species in Alabama forests.

Data
The main source of data used in this study is Forest Inventory Analysis (FIA) sample plot data. Historically, FIA data have been collected on approximately a 10-year cycle from sample plots located on roughly a 3 by 3 mile grid pattern. We used data from the inventories conducted in Alabama in 1972, 1982, 1990, and 2000. In total, the dataset contained 19705 observations (sample plots on forest lands). The demographic data come from 1970, 1980, 1990, and 2000 censuses conducted by the Census Bureau of the US Department of Commerce.
Method
To characterize diversity of tree species, we used two indices: species richness, which is the number of species in the ecosystem; and Shannon's index (Shannon and Weaver, 1963; Odum, 1971), calculated by the formula:

$$H' = - \left( \sum_{i=1}^{n} p_i \ln p_i \right),$$

where $H'$ is Shannon's index and the $p_i$ are the proportions of the individuals of each of the species of the system.

The distinctive feature of Shannon's index is that it allows us to characterize simultaneously the number of species and the variation of shares of individual species within an ecosystem. The value of the index increases with increasing numbers of species, achieving a maximum value when shares of individual species are distributed evenly.

There have been a number of studies investigating the effect of urbanization on land use change or forest management. To capture the effect of urbanization, studies used population density or/and proximity to population cities. Kline et al. (2001) used a modification of a gravity index, initially developed in regional science, to account for the combined influence of population and proximity on land use change. Their population gravity index specification accounts for the influence of the three nearest (to a plot) major cities (with population of more than 5000 persons):

$$G_i = \sum_{k=1}^{3} \left( \frac{P_k}{D_{ki}} \right)^{0.5},$$

where $G_i$ is the population gravity index for the point $i$, $P_k$ is the population of city $k$, and $D_{ki}$ is the distance between point $i$ and city $k$.

In this study we used the original functional form of gravity index, but included all the populated places within 100 km to the point for which index is calculated:

$$G_i = \sum_{k} \frac{P_k}{D_{ki}^2} \quad \forall k : D_{ki} \leq 100 \text{ km}$$

Results
We used semi-log specification OLS because for most distributions the quantitative explanatory variables are heavily biased towards zero. The results of the regressions are presented in Table 1. The estimated models are highly significant and provide reasonable goodness of fit (e.g., Polyakov and Teeter 2005). Coefficients of most explanatory variables are significant at above the 99% level.

Both Shannon index and species richness increase from south to north and with increases in elevation. Slope is positively related to the diversity in both models, probably because stands on steeper slopes have greater variation of microecotypes and are less accessible. As expected, coniferous stands are less diverse. Diversity increases with stands’ volume. The positive relationship of both Shannon’s index and species richness with stands volume is due to the fact that diverse stands are more productive and stands in rich conditions are more diverse. To see whether this relationship holds for planted forests, we included interaction effect of volume and a “planted” dummy. The values of this coefficient in both regressions indicate that diversity of artificial stands increases with volume, although at slower rate than in natural forests. Lower diversity of stands with the larger trees sizes (as indicated by mean dbh) can be explained by the smaller number of trees per unit area in those stands.

As expected, artificial stands are less diverse. Publicly owned forests are more diverse because public forest management agencies are mandated to maintain biodiversity and put more emphasis on environmental, aesthetic, and recreational uses. The “year” dummy variables indicate that diversity consistently increases during the study period. Population gravity negatively impacts diversity of
### Table 1. Estimated OLS coefficients of tree species diversity in Alabama forests*. N=19704

<table>
<thead>
<tr>
<th>Variable</th>
<th>Shannon index</th>
<th>Species richness</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Coefficient</td>
<td>Std error</td>
</tr>
<tr>
<td>Intercept</td>
<td>-6.163</td>
<td>0.462</td>
</tr>
<tr>
<td>Latitude</td>
<td>2.169</td>
<td>0.139</td>
</tr>
<tr>
<td>Elevation</td>
<td>0.031</td>
<td>0.006</td>
</tr>
<tr>
<td>Slope</td>
<td>0.007</td>
<td>0.001</td>
</tr>
<tr>
<td>Coniferous</td>
<td>-0.217</td>
<td>0.008</td>
</tr>
<tr>
<td>Volume</td>
<td>0.068</td>
<td>0.001</td>
</tr>
<tr>
<td>Dbh</td>
<td>-0.308</td>
<td>0.009</td>
</tr>
<tr>
<td>Planted</td>
<td>-0.074</td>
<td>0.013</td>
</tr>
<tr>
<td>Volume × Planted</td>
<td>-0.027</td>
<td>0.002</td>
</tr>
<tr>
<td>Public</td>
<td>0.063</td>
<td>0.015</td>
</tr>
<tr>
<td>Gravity × Year 1972</td>
<td>-0.037</td>
<td>0.008</td>
</tr>
<tr>
<td>Gravity × Year 1982</td>
<td>-0.055</td>
<td>0.008</td>
</tr>
<tr>
<td>Gravity × Year 1990</td>
<td>-0.037</td>
<td>0.008</td>
</tr>
<tr>
<td>Gravity × Year 2000</td>
<td>-0.065</td>
<td>0.006</td>
</tr>
<tr>
<td>Year 1972</td>
<td>-0.349</td>
<td>0.065</td>
</tr>
<tr>
<td>Year 1982</td>
<td>-0.143</td>
<td>0.065</td>
</tr>
<tr>
<td>Year 1990</td>
<td>-0.142</td>
<td>0.054</td>
</tr>
</tbody>
</table>

* Site class and physiographic class dummies are omitted.

Tree species as indicated by both Shannon index and species richness. Furthermore, this impact is increasing (with fluctuations) during the period of study.

### Discussion

This study attempts to analyze the effect of urbanization on diversity of tree species in forests of Alabama. To quantify urbanization, it utilizes a population gravity index, which reflects both population density and proximity. The results of the regression model indicate that population gravity negatively affects tree species diversity in Alabama forests. However, when interpreting these results, several reservations should be made. First of all, urbanization brings several effects, and each of them could impact diversity of tree species in different ways. This study indicates that the cumulative effect of urbanization is negative, while more detailed studies are required to quantify and explain individual effects. Secondly, although forest provides important habitat for many species of plants and animals, the effect of urbanization on diversity of different groups of species could differ from the effect of urbanization on diversity of tree species.

Finally, formulation of the gravity index implies an assumption that the effect of population is inversely related to the square of the distance to a populated place. However, the actual relationship could be non-monotonic, as was shown by Munn et al. (2001).

### Bibliography


Changes In Land Use, Forest Fragmentation, And Policy Responses

Ralph J. Alig, David J. Lewis, and Jennifer J. Swenson,
USDA Forest Service, Pacific Northwest Research Station, and Oregon State University

Introduction

Land-use conversion is a primary determinant of environmental change in terrestrial ecosystems. Projections are for more than 50 million acres of U.S. forest to be converted to developed uses (e.g., parking lots) over the next 50 years (Alig et al. 2004, Alig and Plantinga 2004), as the population grows by more than 120 million people. Land use change can lead to forest fragmentation—the transformation of a contiguous patch of forest into disjunct patches. Forest fragmentation is considered to be a primary threat to terrestrial biodiversity. We examine underlying behavioral factors affecting landowner decisions, and analyze the effects of land use policies on forest fragmentation.

More attention to date has been focused on biophysical aspects of forest fragmentation, in contrast to socio-economic and policy matters. If the country is facing the prospect of considerably more forest fragmentation, more attention to socio-economic and policy factors can aid in exploring the efficiency of options for addressing effects of land-use conversion and allowing society sufficient lead time to implement land conservation measures. A central part of this is better understanding of socio-economic determinants of land use conversion leading to forest fragmentation and the importance of land use decisions.

Impacts of Forest Fragmentation

Forest fragmentation has a multitude of effects on forest ecosystems. On the negative side, forest fragmentation is considered to be a primary threat to terrestrial biodiversity (Armsworth et al. 2004). In the United States, approximately twenty percent of resident bird species have experienced significant population declines in recent years (National Audubon Society 2002). Although there are many possible causes of these declines, one central factor is thought to be the fragmentation of forested habitat (Askins 2000). Particularly at risk are migratory songbirds, many of which nest in forests of the eastern U.S. These species are of significant conservation interest because they serve as indicators of ecosystem quality and are of considerable value to recreationists. Human health may also be impacted by forest fragmentation, as Jackson and Gilborn (2005) indicate that Lyme disease may increase with increased contact with wildlife as vectors because of more forest edge. Possible positive impacts include increased tree growth of many species if additional sunlight reaches trees that are closer to forest edges. Some wildlife species in forest ecosystems benefit from forest fragmentation, e.g., whitetail deer.

Our intent in this section is to point out examples of the many possible impacts of forest fragmentation, recognizing that not all are negative, depending on one’s point of view. The overall or aggregate impacts of forest fragmentation depends in part on the social weighting given to the different components of forest ecosystems. Such aggregate analysis is outside the scope of our paper. Our findings can be used in analyses where others desire to examine impacts and would be useful for policy analyses.

Forest Ecosystem and Land Use Setting

A recent GIS analysis of the fragmentation of contiguous U.S. forests indicates that most forested parcels are in fragmented landscapes (Ritters et al. 2002). Heavily fragmented landscapes have fewer interior parcels, i.e., forested parcels that are a certain minimum distance from the nearest edge. Such interior parcels provide the best habitat for many sensitive species (e.g., Askins 2002). For example, some species of interior-forest songbirds require habitat that is at least 200m from the nearest non-forest edge (Temple and Cary 1988). However, approximately 62% of forest in the contiguous 48 states is located within 150m of the nearest edge, which suggests that fragmentation of U.S. forests is so pervasive that edge effects influence ecological processes on most forested lands (Ritters et al. 1995, 2002).

We are interested in the future forest ecosystem setting, which will reflect the substantial further development of U.S. forests and a considerable exchange of land between forest and agricultural uses (Alig and Plantinga 2004). Overall, more than 200 million acres of U.S. forest land are projected to be involved in changes among land uses over the next 50 years (Alig and Plantinga 2004). Given that such land use changes will materially affect forest
ecosystems, including forest fragmentation, what policies should society be considering now? We draw upon findings from several related studies to outline an approach for analyzing the spatial structure of forest landscape change under alternative market conditions and policy scenarios.

To help set the stage for outlining our approach, we define relationships among land use change, forest fragmentation, parcelization, land management investment, and timber harvest. *Land use change* involves changes among human-defined uses of the land bases, such as urbanization (e.g., Alig et al. 2004, Kline and Alig 1999, Kline et al. 2001). Conversion of rural land uses to other developed uses has been the major cause of recent deforestation in the United States, as well as leading to fragmentation of remaining forested acres. U.S. developed area increased by 34% between 1982 and 1997, and is projected to increase by more than another 75 million acres by 2025 (Alig et al. 2004). Land use change can also be passive, as with afforestation due to seeding in old field succession. *Forest cover* pertains to the biophysical cover on forest land and can be affected notably by land use changes (e.g., Alig and Butler 2004 a,b).

*Forest fragmentation* is the transformation of a contiguous patch of forest into disjunct patches. Forest fragmentation results from land use conversion of forests to other uses. For example, conversion of forests to developed uses can fragment forests, and environmental and socio-economic factors are key predictor variables and next we highlight land quality as one of those determinants. *Forest parcelization* is the breaking up of retained forest land among smaller ownerships (Butler and Leatherberry 2004). Thus, forest parcelization can occur with or without forest fragmentation, although remaining forest may be managed differently by new owners. *Land management investment* can impact forest fragmentation by planned afforestation through investment, either by individuals or society. The latter means can be part of deliberate policies, either focused singly on the fragmentation issue or in a multiple issue mode, such as considering related impacts on global change mitigation. *Timber harvest* can be one form of land management disinvestment or divestiture in a forstry context. It is important to point out that while timber harvest can remove trees and lead to “age class fragmentation” (Alig et al. 2000), which we do not consider necessarily to be forest fragmentation because the land is still classified as forest until conversion to another use such as parking lots.

**Determinants of Forest Fragmentation**

Fragmentation of forestland is a consequence of human land use decisions. Thus, an understanding of the causes of fragmentation can begin by examining factors which influence land use decisions. The usual starting point is Ricardo and von Thunen’s land rent theories (van Kooten and Folmer 2004), which state that land use is allocated to maximize the present value of the flow of net revenue (or rent) from a land parcel of particular quality. Using land rent theory as a foundation, Butler et al. (2004) estimated determinants of human-caused forest fragmentation, which accounts for 20% of the total forest edge in the western portions of Oregon and Washington. They used a multiple metric approach involving percentage nonforest, percentage edge, and average interspersion metrics. Separate regression models for each metric and a composite index produced similar, but not identical, results. Results of the empirical models conformed to the hypotheses based on land rent theory that socio-economic (e.g., population density) and physical factors (e.g., slope) proved to be important predictors of forest fragmentation.

Research in progress is examining the importance of the spatial configuration of land quality in forest fragmentation processes. Land quality is an all-encompassing term, which can include many factors which would influence the value of land to different uses. For example, parcels that are further from urban centers are generally considered to be of lower quality for urban development than parcels which are close to urban centers. Likewise, parcels with high soil fertility and moderate slopes are generally considered to be more suitable to agricultural production than parcels with low soil fertility and steep slopes. Most aggregate land use models specify shares of land in forest/non-forest as functions of net-returns to different land uses (e.g., forest, agriculture, urban) and average levels of soil quality. A roadblock to including land quality in past studies has been assembling sufficient data. Our preliminary tests indicate that including land quality spatial pattern, based on soils properties, as an explanatory variable for western Oregon forest fragmentation increases the fit of the regressions substantially. The fit of the regressions is improved most when the dependent variable represents spatial pattern (e.g., percent edge, interspersion) rather than aggregate land use (e.g., percent nonforest). Specifically, the adjusted $r^2$ for a model of percent edge (interspersion) increases from 0.756 to 0.841 (0.673 to 0.751) upon inclusion of land quality spatial pattern as an explanatory variable. The influence of the spatial structure of
land quality on forest fragmentation is consistent with Ricardian land rent theory. These results suggest that regions with significant spatial variation in land quality will be more likely to have heavily fragmented landscapes than regions that are mostly homogeneous in land quality. Soil quality is only one possible component of the broader concept of land quality, and avenues for future research could explore alternative measures of the spatial structure of land quality, particularly as pertains to urban development.

Policy Considerations

The ecological and economic effects of policies to address forest fragmentation have seen relatively little theoretical or empirical analysis. However, fragmentation concerns are reflected in the design of conservation policies in the most recent U.S. Farm Bill. For example, reducing forest fragmentation is a primary goal in the Wildlife Habitat Incentives Program (WHIP) as administered by several states. Likewise, many wildlife conservation plans adopted by non-governmental agencies such as Partners-In-Flight have explicit goals related to the reduction of forest fragmentation. Managing forest fragmentation poses many challenges, particularly in regions dominated by private landownership. Landscape-level fragmentation on private landscapes is the result of thousands of individual land-use decisions and private landowners typically have insufficient incentives to coordinate decisions that affect landscape pattern. Land-use policies provide a mechanism for aligning private incentives with broader public goals, but there are several factors that need to be considered in the design of efficient policies.

Because the ecological effects of fragmentation are particularly important in the midwestern and eastern U.S., regions dominated by private landownership, a method is needed to analyze the effects of land use policies on the fragmentation of private lands. We describe ongoing research that develops a method to examine the effects of market-based incentives on forest fragmentation in the U.S. southeast (Lewis and Plantinga 2005). First, the study uses econometrics to model the effects of economic incentives on the probability of private land use conversion at the parcel level. Second, the econometrically estimated conversion probabilities are linked with GIS through a series of Monte Carlo simulations to depict the effects of alternative market conditions and policy scenarios on alternative measures of forest fragmentation. Results include distributions of landscape outcomes defined over various fragmentation indices.

The effects of alternative policy designs on the efficiency of reducing fragmentation are considered in this study. In particular, two principal land use policies were considered. First, a spatially uniform policy was simulated that offers a subsidy to any landowner who converts land into forest. This approach maximizes the area of agricultural land converted for a given outlay by the government (Plantinga and Ahn 2002). Second, a spatial subsidy was simulated that pays landowners to convert land into forest only if their parcel shares a border with a forested parcel, similar to an agglomeration bonus (Smith and Shogren 2002). The spatial subsidy offers a tradeoff relative to the uniform subsidy. For a given number of parcels converted, the spatial subsidy is more likely to reduce fragmentation. However, it is more expensive to convert parcels under the spatial subsidy because the set of parcels to select from is smaller than under the uniform subsidy. Therefore, the efficiency of reducing fragmentation under such policies is an empirical question. Lewis and Plantinga (2005) find that the marginal costs of increasing average forest patch size are lower under the spatial subsidy than the uniform subsidy, and the marginal costs of increasing core forest are lower under the uniform subsidy than the spatial subsidy. So, if efficiency is an important consideration in policy design, then the desired measure of fragmentation must be explicit. Lewis and Plantinga (2005) also find that the marginal costs of reducing all measures of fragmentation are lower on landscapes with a larger share of the landscape in forest.

If policy makers wish to alter fragmentation trends, private landowner behavior and incentives are major considerations (Butler et al. 2004, Lewis and Plantinga 2005). Looking ahead, most U.S. afforestation opportunities are in the South (Alig et al. 2003), but that region also has substantial projected population growth and deforestation (Alig et al. 2004). Coordinating multiple policies, such as for climate change, open space, and forest fragmentation, could increase the efficiency of incentives for inducing land use changes to help address forest fragmentation and fostering other co-benefits of afforestation (e.g., Matthews et al. 2002). However, a complete understanding of designing policies to reduce fragmentation requires multiple research components. First, there is little theoretical foundation for designing economic incentives to achieve spatial outcomes. Research is needed to
identify the factors that will potentially affect efficiency. Second, econometric modeling of parcel-level land use transitions would benefit greatly from improvements in the modeling of spatial autocorrelation in discrete-choice models. Third, application of the methodology created in Lewis and Plantinga (2005) to other regions will help understand regional differences in reducing fragmentation. However, this methodology is extremely data-intensive and requires land-use GIS data rather than land cover GIS data. At this time, land cover data are much easier to obtain than land use data.

**Literature Cited**


Abstract
One of structural changes taking place in the U.S., particularly in the South, is emerging TIMOs, and forestland ownership parcelization accompanied by increasing number of absentee owners from urban residents. Such changes will have profound impacts on socio-economic and environments in rural area and rural-urban interfaces. This paper attempts to use economic theory to explain relationship between urban sprawl, land ownership parcelization and timberland value, and use some evidence to support our arguments. Our major point is that urban sprawl and timberland parcelization are primarily caused by the change in relative value of timber production and non-timber production (or residential use) of timberland.

Introduction
One of the structural changes in timberland taking place in the U.S., and particularly in the Southeast, is the parcelization of forestland ownerships. For example, from 1978 to 1994, all private timberland ownerships in the southern U.S. increased by nearly one-third, or 1.1 million units. Acreage held in tracts less than 10 acres increased by 51%; and 10- to 99-acre tracts increased by 25% (Moulton and Birch 1995). Results from the most recent survey indicated that the total number of family forest owners had increased by 11% (from 9.3 million to 10.3 million) from 1994 to 2002 (Butler and Leatherberry 2004). Currently, NIPF owners hold an average of 24 acres per individual. The average size is expected to drop to 17 acres by 2010 (Tyrell and Dunning 2000). Such changes will have profound impacts and cause growing concerns on socio-economic and environmental problems in rural areas and rural-urban interfaces. For example, land fragmentation and land-use change, loss of habitats and biodiversity, deterioration of water quality, reduction of future timber supplies among others are all associated with ownership parcelization, and have been addressed in 2002 Southern Forest Resource Assessment (SFRA) (Wear and Greis 2002) and by Sampson and DeCoster (2000).

Another phenomenon is that America’s growing population is increasingly spreading into the countryside, constantly expanding the rural-urban interface. More and more Americans are moving from the cities to the rural suburbs, in search of peaceful country settings and large lots on which to build spacious homes. Not only forests in sub-urban areas in the US South are predicted to succumb to real estate development as well, timberland in New England is also increasingly being converted to accommodate second homes and recreational development. The Great Lakes states will also experience similar losses. In the Intermountain West, popular "livable" mid-size cities will expand further upslope to forested areas, and vacation home development will continue near national parks and other public lands (Best 2002).

For example, since 1972 Atlanta has grown from a small metropolitan area into a regional trade center. The metropolitan area as a whole grew by almost 40% between 1990 and 2000. The explosive suburban growth has brought larger malls, subdivisions of single-family homes, and loss of foliage and tree cover. As a result, Atlanta is more suburban than most other U.S. metropolitan areas and is less densely settled than most other metropolitan areas. The expansion shifted 65 % of the previously forested land surrounding the city, which has been converted into roads, buildings, and other built-up components of urban infrastructure. Deforestation and urban development directly impact agriculture and timberland structure.

If we closely examine the parcelization and urban sprawl, we can find that they are very much a same issue. Timberland parcelization is timberland ownership change (from large land owners to small land owners), while urban sprawl is more about land use change (from agricultural land and timberland to residential use). Timberland parcelization is partially a cause as well as result of urban sprawl for the timberland closer to the metropolitan area. They are temporally and spatially related. Timberland parcelization started from the 1960s, and accelerated since the 1980s, while urban sprawl more or less followed the same time pattern. Most fast urban sprawl has also been occurring at the area where timberland is also in the process of rapid parcelization.
Many studies examined the driving forces of the urban sprawl and timberland parcelization from different perspectives. In this paper, we would like to argue that they are fundamentally driven by the relative change in timberland value. As land value for timber production declines relatively more against other uses, land for timber production will shift to other uses. Timberland parcelization may be the case that only more weights are put on non-timber production but still keep it as primary forest cover, or forest cover is partially transformed into primary residential purpose use that is also called urban sprawl. Therefore, timberland parcelization and urban sprawl are occurring simultaneously and they just differ in intensity of land use and land ownership change.

**Urban Sprawl and timberland value**

Traditionally we often limited our visions of timberland only for timber production. If so, then timberland market value is no more than land expectation value, or present value of expected future net benefits in timber production. The land expectation value \(R\) is:

\[
R = \max_{T,E} \left[ pQ(T, E)e^{-rT} - wE \right](1-e^{-rT})^{-1}
\]

So the factors affecting on timberland value will be stumpage price \(p\), costs of the various input factors \(E\) including labor, fertilizers etc, and discounting rate \(r\), and the decision variables are the rotation \(T\) and management intensity \(E\). So if everything else equal, timberland value should increase at the same speed as stumpage price. So we have reason to say that the most important factor is stumpage price.

The stumpage price is determined by final wood products such as pulp and paper price, the harvesting and transportation costs, and probably the transaction costs (administration costs). The discount rate is important. Of course the technology of silviculture may have some positive impact on the timber land value. As the land value is largely dependent on the future return, different perception of the future price, costs and interest rate that are not known currently, different people have different perception of the land value. Based on the data from the past decades, likely the timberland value should be quite stable as stumpage price has been slightly increasing as a trend, and we assume that costs move in the same trend. It is hard to say how timberland value change for timber production, but we can reasonably argue that it is quite stable.

As the socio-economy has been changing so rapidly in the past decades, for a significant amount of timberland and the timberland value is no longer just reflected in timber production. Needless to say that timber land provides a variety of in situ value, such as wildlife habitats, water conservation, recreation, timber land can be used to build second or even primary home. Such increasing “non-timber” forest value substantially changed the land management objectives. The most obvious evidence is indicated...
by the timber land value which on average is increased by much faster speed than the stumpage price (let us assume the stumpage price is the indicator of land value for timber production).

Generally speaking, if we treat the land quality as identical timberland value is most strongly related to the location of timber consumer, which indicates primarily the pulp and paper mills and sawmill, while the non-timber production value is probably most related to residential location from urban center. Urban sprawl is nothing more than land use change from rural settings either in timberland or in agricultural land to urban settlement. The classic rural-urban interface is characterized by areas of urban sprawl and mixed with urban, forest, and agricultural land uses in advance of where the urban fringe is moving into the rural countryside (Macie and Hermansen 2002). Usually it is argued that urban sprawl is due to the changes in lifestyle and preference as income rises, and partly in response to government incentives, expanding networks of roads, and increasing reliance on the automobile.

Economically, timberland or any other kind of land use will change if such a change can lead to higher value. The most massive changes in the US in the past century probably were among agricultural land, forestland and urban use (industrial and residential). Population growth, income rise and technology in agriculture can change the relative value for the different uses. Land value used for timber production declines, more timberland will be used for other alternative, e.g., residential purposes and urban sprawl. So urban sprawl is primarily because land value for timber production cannot catch up to the land value for residential use.

The major points of the relative value change between timber and non-timber could be (but not limited to): (1) technology can improve timber production (same as in agriculture), which means that smaller land can produce more timber at less cost. Consequently the demand for timber caused by increasing population and income may not lead to more demand for land in timber production. In addition, wood products can be imported from the rest of the country and from other countries. Therefore, the prices of stumpage may not increase as fast as the population and income. (2) Technology (such as transportation advances) promotes the demand for space, particularly the recreation space.

**Timberland ownership parcelization and timberland value**

Timberland ownership change is more significant than the timberland use change in the past a few decades. In the same line, land ownership is always going to the holders who value the land highest. Now the question is why different holders value the land differently and what is the relationship between the land use change and land ownership change. For example, when the non-timber value (e.g., hunting value) rise comparatively more than the timber production value, the forest industry can adjust their objective by weighting more on non-timber value. So that cannot justify the change of ownership from forest industry to NIPF or TIMO. One such change is parcelization. Parcelization is the division of larger forest tracts held in a single ownership into smaller parcels with many owners. Concerns on parcelization are mostly associated with a tendency that these smaller parcels are highly fragmented by buildings, roads, cultivation, and other influences. Therefore, parcelization of forest properties and associated increases in population density tend to diminish forest functionality for wildlife, watershed, or timber.

The classical explanation for the larger number of small land holdings is related to the partitioning of forestland with land transfers from generation to generation. However, if dividing the forestland dramatically reduces the total value because of lower efficiency; there is no reason why it should be divided. Why does parcelization not occur in agriculture or in other industries? At least such situation has lasted for decades, even though we are not sure whether this trend will continue in the future. According to a survey in Florida by Jacobson (1998), 70% of forestland owners acquired their land through purchase. Another survey found that 64% of Alabama landowners acquired their land through purchase or trade. This perception is no longer very valid since current parcelization is mostly occurring from transformation of forest industry to TIMO and NIPF, and from TIMO to individual family or NIPFs. This is nothing related to heritage issue.

Another common explanation is the nature of multiple uses of forests and the increasing number of landowners with non-timber objectives, including residential use, aesthetic enjoyment, hunting, moral commitment, nature conservation, estate investment and so on. More evidence suggests that currently forested parcels are more likely to be purchased by people who value the land differently than the forest owner of the past. Rather than the farmer who owned
forestland and used it primarily to supplement their income or partly for self-employment purpose, many of today's new forest landowners are from urban areas and own forest primarily for recreational use or aesthetic values. These newer private owners are wealthier than past owners, and more likely to be absentee landowners. They have less motivation for timber management.

The above explanations may be partially right. But to economists, they are incomplete. We have multiple needs and a growing number of wants, but we are going to rely more on markets than self-supply. Our argument is that the fundamental reason for the growing number of smaller-scale NIPFs must lie in their efficiency, including production and consumption, production costs and transaction costs.

Ownership change should rely on the fact that the new owner can, or believes he or she can, manage or use the land more effectively even though the land still is in the same use (e.g., forest), or in modified use (e.g., change the species of the trees), or has been totally changed to another land cover (e.g., from forest land to agriculture land or residential house). Since there are some transaction costs from changing ownership as well as some sunk costs of investment either in forest or in agriculture or housing. Land ownership change and land use change could be very slow if the relative value for different use and for different owners does not change significantly.

Now let us explain why the change in relative value can lead to the change of ownership. Seen from Figure 2, suppose we have two time points and we have two kinds of owners. If the owners have same preference as indicated in Figure 2, the old owner can change the land use and does not have to sell the land. The key reason behind this is that they have different preferences. Suppose \((VT_i + VN_i) > (VT_{ni} + VN_{ni})\), it is clear that forest industry is the more efficient owner; but if the change in relative value make \((VT^*_i + VN^*_i) < (VT^*_{ni} + VN^*_{ni})\), then theoretically the small NIPF owner is a more efficient owner, so the land ownership changes.

The key and more important question here is why they have different preference. Coase (1937) has already answered this question theoretically—the transaction costs make firms and property rights (i.e., ownership) matter. Let us illustrate it a little more in our context. If the market is perfect, then the value generated from timber production and non-timber production could be same for either NIPF or forest industry, the both NIPF and forest industry will chose the same kind of trade-off between timber and non-timber production.

However, markets are not perfect and all transaction costs are not free. For forest industry that integrate the timber production and consumption, the true value of one unit of timber for forest industry is more valuable than the NIPF owners who need to sell the timber to mills even though the market price for them are the same (It is very often that forest management and wood processing are independently accounted and the wood price between them is determined by the price purchased from market). Similarly the true value of non-wood value to NIPF owners for the land may be more than the forest industry since the NIPF owners directly consume the products (It is also common that forest industry sells hunting permits to their forest to hunting clubs or individual.) More and more NIPFs owners buy land is exactly because he or she at least believes that owning the land is more efficient than buying the services from the forests (Zhang 2001).

![Figure 2 Timberland parcelization](image-url)

**Conclusions**

Timberland parcelization and urban sprawl are the same dynamic process of changes in land ownership, land use and land cover. Such changes are driven by the relative land value for different uses, such as timber production, building home and recreation. As timberland use value for timber production cannot catch up the value for other uses, land use change is inevitable. As real estate value is increasing much faster than agricultural and forest, metropolitan areas burgeon and development sprawl into formerly rural areas. Many forest landowners profited from the appreciation of real estate values by subdividing and/or selling to developers.

Urban Rural Interface Conference Proceedings
References
Harvey and Clark 1971
Jacobson (1998), 70% of forestland owners acquired their land through purchase.
Urbanization and Timberland Use by Ownership in Georgia: A Multinomial Logit Analysis

Rao V. Nagubadi and Daowei Zhang

Abstract
This paper uses multinomial logit approach to examine the determinants of timberland use by ownership using county level data from Georgia for the period from 1972 to 2000. In contrast to previous modeling efforts of aggregated groups of land use by forestry, agriculture, and urban and other categories, we model timberland use by private industry ownership and non-industrial private ownership, in addition to agriculture, and urban and other land uses. We include urbanization variables to infer the impact of urbanization on timberland use by industrial and non-industrial ownership. The results indicate that significant differences exist in the magnitude of the effect of different variables on timberland use by ownership.

Introduction
Nearly twenty five years ago, based on subjective opinion of experts, Hall (1981) projected that commercial timberland in Georgia would be 23.9 million acres by year 2000, with public, forest industry, and non-industrial private forest (NIPF) owners owning 1.5, 4.4, and 18.0 million acres respectively. However, timberland in the state declined to 22.8 million acres by 2000 (Table 1). While public and forest industry owned 2.0 and 4.7 million acres between them, the NIPF timberland declined to 16.1 million acres- a discrepancy of 12% between actual and projected numbers.

High population levels and economic growth tend to stimulate urban development and concomitant loss of forest cover (Wear and Greis 2002). Such a change in land use has implications for a wide variety of policy issues, from maintenance of water quality, protection of biodiversity, preservation of open space, to mitigation of global climate change. Changes in the forest ownership reflect different motivations of owning forestland and hence could imply changes in forest management and hence the services provided by the forests under differing ownerships. Therefore, realistic predictions on land use changes by ownership are needed.

Over the last two decades, a number of studies (e.g., Alig 1986; Hardie et al. 2000; Ahn et al. 2002) have dealt with modeling land use changes among aggregated groups such as forestry, agriculture, and urban. There has been insufficient attention to modeling land use with respect to more disaggregated use groups such as timberland by ownership and thus ignoring potential differences due to ownership characteristics. By pooling timberland across all ownerships, earlier studies may have inappropriately assumed that various factors have equal effects on timber land use for all ownerships.

In this study, our objective is to fill in this gap by developing a model of timberland use by ownership. We apply a multinomial logit technique using county-level data in Georgia. The next section presents the analytical framework used in the study, followed by a description of data. The remaining sections present the results by major land use category and timberland use by ownership and draw some relevant conclusions.

Methodology
We follow Miller and Plantinga (1999), and Hardie et al. (2000) who develop a comprehensive theory of land use change by combining Ricardian rural land rent and von Thünen’s urban land rent models. The resulting model depicts landowners’ decision problem of allocating a fixed amount of land to alternative uses.

In this study, the optimal land use shares, \( p_{kt} \) (proportion of land in \( i \)-th county in \( k \)-th use at time \( t \)) are specified as multinomial logistic functions of a linear combination of a vector of explanatory variables, \( X_{it} \), and a vector of unknown parameters, \( \beta_k \):

\[
(1) \quad p_{kt} = \frac{\exp(\beta_k'X_{it})}{\sum_{k=1}^{K} \exp(\beta_k'X_{it})}
\]

The land use, \( k \), can be private industry owned timberland use, NIPF owned timberland use, agricultural use, and urban/other uses. This specification is convenient because it constrains the predicted land use shares between zero and one and requires that they sum to one. If we normalize the equation system (1) by one land use type (for example, \( k=4 \)) and constrain \( \beta_4 = 0 \), the modified multinomial logit model becomes
transformation yields a K-1 equation system

\[ p_{ikt} = \frac{\exp(\beta_k' X_{it})}{1 + \sum_{k=1}^{K-1} \exp(\beta_k' X_{it})} \]

for \( k = 1, \ldots, K-1 \)

and share of the omitted land use is recovered as

\[ p_{ikt} = \frac{1}{1 + \sum_{k=1}^{K-1} \exp(\beta_k' X_{it})} \]

Forming a ratio of (2) and (3) and logarithmic transformation yields a K-1 equation system

\[ \ln \left( \frac{p_{ikt}}{p_{i4t}} \right) = \beta_k' X_{it} + u_{it} \]

for \( k = 1, \ldots, K-1 \)

where \( u_{it} \) are random errors. Since the optimal land use proportions, \( p_{ikt} \), are not observable and may be different from actual land use proportions due to random factors, they are replaced with actual (or observed) land use proportions, \( y_{ikt} \). Thus additional error terms are introduced in the system. The logarithmic transformation and use of cross sectional data induce heteroskedasticity which is corrected by multiplicative heteroskedastic regression estimated by maximum likelihood method (Harvey 1976; Greene 1993, p264-267).

Since the dependent variable is the log of the ratio of proportion of land uses, it is difficult to interpret the coefficients directly. Consequently, marginal effects and elasticities are estimated (Greene 1993, p666; Wu and Segerson 1995, p1037) at the mean levels of continuous variables and a value of one for dummy variables. The standard errors for marginal effects and elasticities are computed using the delta method (Greene 1993, p297).

**Data Sources**

We define county land area as the sum of timberland (excluding publicly owned), agriculture, urban/other uses and exclude water area, and unproductive and productive reserve forests. Data on timberland is obtained from Forest Inventory and Analysis (FIA). We exclude public owned timberland since changes in public timberland are governed by a different decision making process. We consider two ownership groups, private industry and NIPF. Agricultural use includes cropland, pastureland, and rangeland reported in agricultural censuses. Urban and other category includes urban land and land devoted to roads, rural transportation, and other special uses and is estimated by subtracting timberland and agricultural land from the county land.

Between 1972 and 2000, timberland and agricultural land declined while land use in urban and other use increased dramatically (Table 1). Changes in timberland across ownerships are not uniform; NIPF timberland declined, industry and public timberland increased. With in the NIPF, the share of miscellaneous corporations comprising Timber Investment and Management Organizations (TIMOs), Real Estate Investment Trusts (REITs) increased sharply, while the share of farmers vastly declined and that of miscellaneous individuals increased marginally.

We have three variables to represent urbanization process and real estate markets. A dummy variable is created to represent counties that include both central and outlying areas of metropolitan statistical areas (MSA) with a population of 50,000 or more. We use housing units per 1,000 acres of county land (HULAND) and consumer price index (CPI) adjusted median house values (MHVAL) obtained from Census Bureau. Since the data pertains to different years from that of FIA years, interpolations are used. We expect that these urbanization variables would be negatively related to all ownerships of timberland use and agricultural land use.

To represent timber returns, we use a weighted sawtimber stumpage price ($/MBF) of pine and oak sawtimmer, using their respective removals as weights. As county level prices are not available, we use prices for two TMS regions in the state. We use county-level net agricultural returns obtained from the National Agricultural Statistics Service (NASS). Per acre net agricultural returns are computed as the total cash receipts from all crops and livestock and total government payments minus total production expenses divided by agriculture acres. These returns are deflated using the producer price index (PPI) for all commodities (1982=100). Economic returns are expected to help explain timberland, agricultural or urban land use.

Data on population density and per capita income (CPI-adjusted) are obtained from Census Bureau. As population density increases, we expect a negative impact towards all ownerships of timberland and agricultural land use. We hypothesize that per capita income would negatively affect timberland (including all ownerships) use and agricultural land use.

The land quality ratings for a land parcel range from land capability class (LCC) 1 to 8 where 1=most productive, and 8=least productive. Average land quality (AVLCC) variable is constructed with acreage under each LCC as weight. Because of the
way of its construction, AVLCC may influence agriculture land use negatively and timberland use positively. The proportion of area in two higher LCC in the county land area (LCC1N2) is also used in the analysis. We expect that a high proportion of good quality land leads to more agricultural land use and less timberland use relative to urban/other land use.

**Results**

We estimate the parameters using a maximum likelihood method with multiplicative heteroskedastic correction. Before implementing this method, we have identified the variables or its forms (square or cubic forms) responsible for heteroskedasticity and incorporated them in the multiplicative heteroskedastic regression equations. We add dummy variables for FIA years to remove the effect of the time periods. The estimated results suggest reasonably good fits with conventional adjusted R-square values ranging from 0.38 to 0.58.

**By Major Land Use**

Table 2 presents the estimated coefficients, marginal effects, and elasticities for major land use categories, timberland and agricultural land use. The signs of most variables, for which the coefficients or marginal effects or elasticities are significant, are along expected lines in both equations. The effect of a county having a metropolitan statistical area (MSA) has the expected negative impact on timberland use and agricultural land use. Median house value (MHVAL) has the expected negative impact on the timberland use as indicated by the signs on the coefficient, marginal effects, and elasticities, but an unexpected positive impact on agricultural land use.

The returns to timberland use (WTDSTPR) have the expected positive impact on timberland use and negative impact on agricultural land use. Similarly, the returns to agricultural land use (NETAGRET) have the expected positive impact on the agricultural land use, and negative impact on the timberland use. Judged by the magnitudes of elasticities, it appears that the timber returns have much larger impact than the agricultural returns in the land use change between agricultural and timberland uses relative to urban and other land use.

Average land quality rating (AVLCC) shows the expected positive impact on the timberland use in contrast to the negative effect on the agricultural land use. Similarly, the proportion of higher land quality (LCC1N2) has the expected significant opposite effect on the timberland use (negative) and agricultural land use (positive).

The estimated marginal effects for variables show that higher land quality has the largest negative effect, while elasticities show that timber returns have the largest positive impact and house values have the highest negative impact on timberland use. For the agricultural land use, the elasticities indicate that average land quality rating and the timber returns have the highest negative impacts while higher land quality and house values have the highest positive impacts.

**By Timberland Ownership**

Table 3 shows the results related to timberland uses based on ownership. Again the coefficients, marginal effects, and elasticities for variables which are significant are as per expectations in all equations with the sole exception of the coefficient for housing density variable (HULAND) in the NIPF-owned timberland use equation.

The results show a vast difference in the response to variables between the two timberland ownership equations. Only the marginal effects and elasticities for higher land quality in the NIPF-owned timberland equation are significant. In the private industry owned timberland equation, marginal effects and elasticities for higher land quality, timber returns, agricultural returns, median house value, and metropolitan statistical area are all significant.

The estimated marginal effects indicate that higher land quality has the largest negative effect and timber returns have the largest positive effect for the private industry owned timberland use. The elasticities reveal that the median house value has the largest negative impact and timber returns have the largest positive impact on the private industry timberland use. Our results are generally in agreement with the notion that the objectives of private industry and NIPF landowners are completely different.

In our analysis based on timberland ownership, the gap between the predicted and actual shares of land use under agriculture narrowed from 0.17-0.20 to 0.18-0.20 while the gap between the predicted and actual shares of land use for overall timberland use declined from 0.70-0.65 to 0.69-0.65. However, the results should be viewed with caution as the gap between the predicted and actual shares for timberland ownerships is still large.

There is a need for further research on precisely what factors determine the timberland use under NIPF ownership. Further, we need to examine the factors determining the timberland use by other categories of owners: forest farmers and miscellaneous.
corporations. In our analysis, we have treated all these groups of timberland owners as NIPF since they have no wood product manufacturing facilities.

**Conclusion**

In this paper, we conduct an econometric analysis on the impact of urbanization on land use change and timberland by ownership in Georgia over period 1972 and 2000. Our results show that the relative returns to respective land uses, heterogeneous land quality, urbanization, demography, and economic growth are key factors driving land use change.

This study brings us to bear some implications on modeling land use changes. First, different factors impact timberland by ownership in different magnitudes and timberland under different ownerships cannot be treated as a homogeneous group for modeling purposes. The reason for this is diverse objectives of the timberland owners as shown by the non-response of NIPF owned timberland land use for most variables except land quality. This result could lead to building better land use models to forecast timberland use by ownership, forest type, forest conditions, and the products and services produced by forests.

Second, among the land uses for agriculture and timberland, the impact of forestry returns is much higher than that of agricultural returns. If the relative returns are more favorable to timberland use, then this raises the possibility of further loss of land in agricultural use and its conversion to forestry use in addition to its loss due to urbanization pressures.

Third, variables other than population density and per capita income added to our model capture the urbanization process and the associated impacts on the land use change. Presence of a large urbanized area (such as metropolitan statistical area) and median house values are key factors in our models. Omitting these variables could mean incorrect inference and prediction.

**References**


Table 1. Changes in land use and timberland ownership in Georgia: 1972-2000 (n=795).

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Timberland:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(a) Public</td>
<td>24,839</td>
<td>23,733</td>
<td>23,632</td>
<td>23,795</td>
<td>22,764</td>
<td>-2,075</td>
<td>-8.4</td>
</tr>
<tr>
<td>(b) Forest Industry</td>
<td>4,318</td>
<td>4,964</td>
<td>5,870</td>
<td>4,891</td>
<td>4,666</td>
<td></td>
<td>8.1</td>
</tr>
<tr>
<td>(c) NIPF:</td>
<td>18,949</td>
<td>17,186</td>
<td>16,117</td>
<td>17,153</td>
<td>16,083</td>
<td>-2,867</td>
<td>-15.1</td>
</tr>
<tr>
<td>(i) Misc. Corp.</td>
<td>1,451</td>
<td>1,885</td>
<td>2,049</td>
<td>2,827</td>
<td>2,543</td>
<td>1,092</td>
<td>75.3</td>
</tr>
<tr>
<td>(ii) Farmers</td>
<td>8,410</td>
<td>6,121</td>
<td>4,878</td>
<td>4,045</td>
<td>3,900</td>
<td>-4,520</td>
<td>-53.6</td>
</tr>
<tr>
<td>(iii) Misc. Indiv.</td>
<td>9,088</td>
<td>9,181</td>
<td>9,190</td>
<td>10,382</td>
<td>9,640</td>
<td>552</td>
<td>6.1</td>
</tr>
<tr>
<td>2. Agriculture</td>
<td>7,914</td>
<td>7,435</td>
<td>6,511</td>
<td>6,185</td>
<td>5,984</td>
<td>-1,931</td>
<td>-24.4</td>
</tr>
<tr>
<td>3. Urban &amp; Other</td>
<td>2,923</td>
<td>4,418</td>
<td>5,443</td>
<td>5,492</td>
<td>5,942</td>
<td>2,671</td>
<td>91.4</td>
</tr>
</tbody>
</table>

Table 2. Estimation results according to major land use, Georgia-1972-2000 (n=710).

<table>
<thead>
<tr>
<th>Variable</th>
<th>(a) Timberland</th>
<th>(b) Agriculture</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Coefficient</td>
<td>Margi. effect</td>
<td>Elasticity</td>
</tr>
<tr>
<td>Constant</td>
<td>2.978***</td>
<td></td>
<td></td>
</tr>
<tr>
<td>YR1982</td>
<td>-0.418***</td>
<td>-0.028</td>
<td>-0.040***</td>
</tr>
<tr>
<td>YR1989</td>
<td>-0.403***</td>
<td>0.011</td>
<td>0.016**</td>
</tr>
<tr>
<td>YR1997</td>
<td>-0.660***</td>
<td>-0.090**</td>
<td>-0.129***</td>
</tr>
<tr>
<td>YR2000</td>
<td>-0.579***</td>
<td>-0.088**</td>
<td>-0.126***</td>
</tr>
<tr>
<td>MSA</td>
<td>-0.172***</td>
<td>0.006</td>
<td>0.008</td>
</tr>
<tr>
<td>HULAND</td>
<td>0.004</td>
<td>0.0001</td>
<td>0.005</td>
</tr>
<tr>
<td>MHVAL</td>
<td>-0.016***</td>
<td>-0.003***</td>
<td>-0.177***</td>
</tr>
<tr>
<td>WTDSTPR</td>
<td>0.004***</td>
<td>0.001***</td>
<td>0.280***</td>
</tr>
<tr>
<td>NETAGRET</td>
<td>-0.0002*</td>
<td>-0.0001***</td>
<td>-0.016***</td>
</tr>
<tr>
<td>PD</td>
<td>-0.003***</td>
<td>-0.0001</td>
<td>-0.018</td>
</tr>
<tr>
<td>PCINC</td>
<td>-0.042*</td>
<td>-0.008</td>
<td>-0.087</td>
</tr>
<tr>
<td>AVLCC</td>
<td>0.026</td>
<td>0.042**</td>
<td>0.232**</td>
</tr>
<tr>
<td>LCC1N2</td>
<td>-0.923***</td>
<td>-0.371***</td>
<td>-0.168***</td>
</tr>
<tr>
<td>Adj. R-Sq.</td>
<td>0.40</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pred. Share:</td>
<td>0.7027</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Act. Share:</td>
<td>0.6549</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* Conventional; ** P< 0.05, *** P< 0.01.
Table 3. Estimation results according to land use by timberland ownership, Georgia-1972-2000 (n=710).

<table>
<thead>
<tr>
<th>Variable</th>
<th>(a) Private Industry Owned Timberland</th>
<th>(b) NIPF Owned Timberland</th>
<th>(c) Agriculture $^b$</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Coefficient</td>
<td>Margi. effect</td>
<td>Elasticity</td>
</tr>
<tr>
<td>Constant</td>
<td>1.820**</td>
<td>2.951***</td>
<td></td>
</tr>
<tr>
<td>YR1982</td>
<td>-0.084</td>
<td>0.145***</td>
<td>1.523***</td>
</tr>
<tr>
<td>YR1989</td>
<td>0.372**</td>
<td>0.032**</td>
<td>0.337***</td>
</tr>
<tr>
<td>YR1997</td>
<td>-0.620**</td>
<td>-0.053**</td>
<td>-0.561***</td>
</tr>
<tr>
<td>YR2000</td>
<td>-0.464</td>
<td>-0.063**</td>
<td>-0.666***</td>
</tr>
<tr>
<td>MSA</td>
<td>-0.147</td>
<td>-0.013</td>
<td>-0.133***</td>
</tr>
<tr>
<td>HULAND</td>
<td>0.003</td>
<td>-0.0002</td>
<td>-0.101</td>
</tr>
<tr>
<td>MHVAL</td>
<td>-0.056***</td>
<td>-0.004***</td>
<td>-1.724***</td>
</tr>
<tr>
<td>WTDSTPR</td>
<td>0.009***</td>
<td>0.001***</td>
<td>1.295***</td>
</tr>
<tr>
<td>NETAGRET</td>
<td>-0.0007***</td>
<td>-0.00007***</td>
<td>-0.087***</td>
</tr>
<tr>
<td>PD</td>
<td>-0.003*</td>
<td>-0.0001</td>
<td>-0.079</td>
</tr>
<tr>
<td>PCINC</td>
<td>-0.018</td>
<td>0.001</td>
<td>0.115</td>
</tr>
<tr>
<td>AVLCC</td>
<td>0.013</td>
<td>0.009</td>
<td>0.349</td>
</tr>
<tr>
<td>LCC1N2</td>
<td>-2.485***</td>
<td>-0.199***</td>
<td>-0.666***</td>
</tr>
<tr>
<td>Adj. R-Sq. $^a$</td>
<td>0.42</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pred. Share:</td>
<td>0.0951</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Act. Share:</td>
<td>0.1349</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

$^a$ Conventional; $^b$ The coefficients for the agriculture equation are the same as in Table 2. * P< 0.10, ** P< 0.05, *** P< 0.01.
Non-Native Plants In The Understory Of Riparian Forests Across A Land Use Gradient In The Southeast

Nancy J. Loewenstein and Edward F. Loewenstein
School of Forestry and Wildlife Sciences, Auburn University

Introduction

Urbanization has numerous interrelated impacts on forest ecosystems, including loss of habitat, fragmentation, altered hydrology, increased pollution, and altered disturbance regimes (Zipperer, 2002). In addition, in urban areas where ornamental plantings are commonplace, propagules from non-native plants can be quite abundant. The ample availability of propagules, in association with the disturbance factors outlined above, provide situations in which non-native plants may become easily established in forest fragments within the urban landscape (With, 2002).

As urban pressures expand into rural areas, it follows that the number of non-native plants at the urban-rural interface will increase. The overall objective of this study was to determine if the number and density of non-native plant species was higher in urban forests than in rural forests and if the incidence of non-natives was higher at the urban-rural interface. Because many authors suggest that riparian zones may be more prone to non-native invasion than upland sites (e.g., Malanson, 1993; Planty-Tabacchi et al., 1996) we concluded that these areas may serve as advance indicators of non-native pressure at the urban-rural interface. For that reason, and to allow comparisons with results from other biological studies within the WestGa project (see Lockaby et al., 2005), of which this study is a part, we chose to conduct our surveys in riparian forests within the watersheds selected for that endeavor.

Materials and Methods

Study sites were located within fifteen watersheds in west central Georgia, USA. Land use composition of the study watersheds ranged from predominantly urban (Columbus, GA), through varying combinations of second growth forest, managed pine, and pasture (Table 1). Three of the watersheds were located at the urban-rural interface where rapid suburban development is taking place. A more detailed description of the study sites can be found in Loewenstein and Loewenstein (2005).

Understory plants (native and non-native) were sampled within riparian forests near the watershed outflow, except in the urban watersheds where sampling primarily took place in riparian forest fragments within city parks. Quadrats (1 m²) were randomly placed at intervals of approximately 30 m along a transect established parallel to each stream, 1-2 m outside the channel. On most of the watersheds, the transect contained 18 quadrats and was approximately 540 m in length. However, there were several sites where land ownership boundaries and/or forest edge resulted in somewhat shorter transects. Percent cover of all plants within each quadrat was recorded using a short logarithmic scale, where 1=up to 2%, 2=3-10%, 3=11-25%, 4=26-50%, 5=51-100% (Causton, 1988). Tree and shrub seedlings in each quadrat also were counted. The number and identity of shrubs, saplings, and vines within a 1.3 m radius plot centered on the quadrats were also recorded. Plants were identified to species with the exception of some immature plants which were identified to genus. Taxonomic nomenclature and authority regarding biogeographic origin primarily follow the USDA Plants Database (http://plants.usda.gov). Sampling was conducted in June (summer) and in September (fall) of 2003.

Results and Discussion

A total of 182 plant species in the 1 m² quadrats and 79 species in the circular shrub plots were encountered across the fifteen watersheds through both seasons. Overall, 197 species were identified. Regression analysis indicated that plant diversity, as measured by number of species, average richness, and species density (Table 2) was not significantly related to land use (R²=0.0005, R²=0.015 and R²=0.022), respectively.

Twenty-nine (14.7 %) of the species encountered across the 15 watersheds were non-native. As hypothesized, the two urban sites had a significantly greater number of non-native species than the rural sites and regression analysis indicated that percent urban land cover was a fairly good predictor of number of non-native species: # of non-natives = 5.03 + 0.205(% urban area), (R²=0.55, p=0.0015). Of the 12 non-native species encountered only in the urban forests, all but two are used ornamentally.
reflecting the role of ornamental plantings in the spread of non-native plants.

The number of non-native plant species at the developing site closest to Columbus (SB) also had more non-native plant species than the more rural sites (Table 3). However, the number of non-native species at the other two developing sites was not higher than at the more rural sites. The relatively low number of non-native species at these two sites may reflect the lag phase associated with establishment of some non-native species (Kowarik, 1995). Additionally, propagule pressure from ornamental plantings may still be moderately low in these areas. Much of the nearby suburban development has occurred within the past five years and the upper reaches of both of these watersheds are still relatively undeveloped.

While the number of non-native species was higher in the urban watersheds, the overall importance values (IVs) of non-native species in these watersheds was no higher than in the more rural watersheds (Figure 1). This was a function of the fairly low frequency and abundance of many of the non-native species encountered in the urban watersheds and the high frequency and abundance of Ligustrum sinense (Chinese privet), Lonicera japonica (Japanese honeysuckle), and/or Microstegium vimineum (Nepalese browntop) in all of the more rural watersheds. At least one non-native plant was found in 78-100 percent of the quadrats along each transect in all watersheds. The highest non-native IVs occurred in two of the watersheds at the urban-rural interface (SB and SB2) and during the fall survey in one of the watersheds composed primarily of pasture (MU1).

Ligustrum sinense, Lonicera japonica, and Microstegium vimineum were the most commonly encountered non-native species. With the exception of MU3, which had no Ligustrum, these three species were found in each watershed. Additionally, these non-natives occurred at frequencies of ≥ 50% in at least half of the watersheds. The only two native species which were as common were Parthenocissus quinquefolia (Virginia creeper) and Smilax spp. (greenbrier).

Importance values for Ligustrum, Lonicera, and Microstegium are presented in Loewenstein and Loewenstein (2005). Regression analysis revealed no statistically significant relationships between land use and IVs; however, some trends were apparent. In general, IVs of Ligustrum were lower in the heavily forested watersheds. An exception to this was MK where forest cover comprised approximately 80% of the land use yet Ligustrum was particularly abundant and widespread. Ligustrum IVs were relatively high in one of the urban watersheds, in one of the watersheds with abundant pasture (MU1), and in all three of the “developing” watersheds at the urban-rural interface. Given that mature Ligustrum was present in the shrub plots of these watersheds, it is unlikely that the high IVs of this species at the urban-rural interface are a result of recent suburban development.

Importance values of Microstegium were substantially lower in the urban watersheds than in the majority of the more rural sites, but were quite high in two of the sites near the urban-rural interface (SB and SB2) and during the fall survey at MU1. An increase in Microstegium IV’s in many of the watersheds during the fall survey reflected a tendency for this species to increase in abundance and frequency over the growing season. Lonicera was fairly evenly distributed across the landscape. This species was encountered frequently, but coverage rarely exceeded 10%.

It is possible that dense populations of Ligustrum and Microstegium already present at the urban-rural interface may impact the invasion potential of additional non-native species in these watersheds. In Hawaii, areas colonized by an early invader were less successfully invaded by a woody perennial and several other widespread non-native species (D’Antonio and Mack, 2001). The non-native species Dactylis glomerata and Lonicera japonica also appeared to have a negative impact on the invasion potential of some species (Meiners et al., 2004; Yurkonis and Meiners, 2004). D’Antonio and Mack (2001) suggest that, in general, non-native perennials that form dense persistent populations are likely to have a negative impact on the establishment of other non-native plant species. The relatively strong population pressure from Ligustrum and Microstegium at the urban-rural interface watershed SB did not preclude the presence of numerous other non-native species; however, the ability of these or other non-native species to become abundant and widespread may possibly be constrained in areas of the watershed where Ligustrum and Microstegium are competitively dominant.

Cover of Microstegium and Ligustrum was negatively correlated with overall species richness and overstory reproduction. On MK, where Ligustrum formed a dense shrub canopy underneath the overstory trees, understory plant richness was 40% lower than the mean richness of other sites.
Merriam and Feil (2002) also reported a 40% loss in species richness in a *Ligustrum*-infested forest. On a quadrat level, richness was somewhat impacted when just one or two *Ligustrum* stems were present in the shrub plot and substantially reduced when the number of stems exceeded six (see Loewenstein and Loewenstein, 2005). Similarly, when *Microstegium* exceeded a cover class of 3 (11-25%), richness was reduced.

Overstory regeneration potential was also substantially impacted where relatively dense populations of *Ligustrum* or *Microstegium* were present. This dynamic may become very important over time as these riparian forest fragments age and senesce. If adequate numbers of stems of advance reproduction are not present in the understory assemblage, as overstory trees die, recruitment into the canopy may not take place and the forest fragment may degrade structurally into a shrub thicket or meadow (per Oliver and Larson, 1996).

**Acknowledgments**

Thanks are extended to Glenda Gil for invaluable assistance with the field surveys and plant identification, and to Gayla Trouse for her excellent field assistance. Curtis Hansen, Curator of the Auburn University Freeman Herbarium, provided assistance with plant identification. We are grateful to Dr. Philip Chaney and Brian Helms for calculating and sharing the 30 M land classification data and to Jon Schoonover for assistance with locating field sites. We also appreciate the cooperation of the many landowners who graciously granted us access to their properties. Funding was provided by Auburn University’s Center for Forest Sustainability.

**Note:** this manuscript is a condensed version of Loewenstein and Loewenstein (2005), published in Urban Ecosystems.

**Literature Cited**


Figure 1. Importance values (IVs) of non-native plants (as a group) at the fifteen study sites. IV’s were calculated as average cover (%) * frequency of occurrence (%).

Table 1. Land use composition of the fifteen study watersheds. Data were calculated from a 30-m resolution LANDSAT image taken March 10, 2002 using ArcView 3.2a, ATtILA software.

1- The transitional category included shrub land, young pine plantations and late successional old fields.
<table>
<thead>
<tr>
<th>Major land use</th>
<th>Watershed</th>
<th>Number of quadrats</th>
<th>Number of native Species</th>
<th>Number of Non-native species</th>
<th>Frequency Non-native (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>S</td>
<td>F</td>
<td>Tot</td>
<td>S</td>
</tr>
<tr>
<td>Urban</td>
<td>BU2</td>
<td>16</td>
<td>10</td>
<td>26</td>
<td>100</td>
</tr>
<tr>
<td></td>
<td>BU1</td>
<td>11</td>
<td>8</td>
<td>19</td>
<td>100</td>
</tr>
<tr>
<td>Developing</td>
<td>SB</td>
<td>9</td>
<td>7</td>
<td>16</td>
<td>100</td>
</tr>
<tr>
<td></td>
<td>SB2</td>
<td>4</td>
<td>3</td>
<td>7</td>
<td>100</td>
</tr>
<tr>
<td></td>
<td>SB4</td>
<td>5</td>
<td>3</td>
<td>8</td>
<td>100</td>
</tr>
<tr>
<td>Pasture</td>
<td>MU1</td>
<td>4</td>
<td>3</td>
<td>7</td>
<td>100</td>
</tr>
<tr>
<td></td>
<td>FS1</td>
<td>11</td>
<td>7</td>
<td>18</td>
<td>100</td>
</tr>
<tr>
<td>Managed forest</td>
<td>HC</td>
<td>3</td>
<td>4</td>
<td>7</td>
<td>94</td>
</tr>
<tr>
<td></td>
<td>MO</td>
<td>5</td>
<td>4</td>
<td>9</td>
<td>94</td>
</tr>
<tr>
<td></td>
<td>MU2</td>
<td>5</td>
<td>3</td>
<td>8</td>
<td>88</td>
</tr>
<tr>
<td></td>
<td>SC</td>
<td>3</td>
<td>5</td>
<td>8</td>
<td>100</td>
</tr>
<tr>
<td>Mixed Forest</td>
<td>BLC</td>
<td>5</td>
<td>3</td>
<td>8</td>
<td>100</td>
</tr>
<tr>
<td></td>
<td>BC</td>
<td>3</td>
<td>3</td>
<td>6</td>
<td>94</td>
</tr>
<tr>
<td></td>
<td>MU3</td>
<td>3</td>
<td>2</td>
<td>5</td>
<td>78</td>
</tr>
<tr>
<td></td>
<td>MK</td>
<td>5</td>
<td>5</td>
<td>10</td>
<td>100</td>
</tr>
</tbody>
</table>

Table 3. Native and non-native species richness (1 m² quadrats and shrub plots combined) in riparian forests across a land use gradient during the summer (S) and fall (F) of 2003. Frequency of occurrence of non-native plants is also presented.
Environmental Knowledge
Wildland-Urban Interface Professional Development Program

Martha C. Monroe,1 L. Annie Hermansen-Báez,2 Lauren W. McDonell1

1University of Florida, School of Forest Resources and Conservation 2USDA Forest Service, Southern Center for Wildland-Urban Interface Research and Information

Introduction

The USDA Forest Service, Southern Center for Wildland-Urban Interface Research and Information (Center), the University of Florida, and the Southern Group of State Foresters have partnered to develop a wildland-urban interface (WUI) professional development program. This program will provide state and federal natural resource agencies with the skills and tools that they need to successfully tackle WUI issues. This initiative evolved from the Southern Wildland-Urban Interface Assessment (Macie and Hermansen 2002), which revealed that natural resource managers feel stymied and sometimes helpless in the face of rapidly changing land use in the interface. The complex issues in the interface affect how interface forests can be managed, how natural resource professionals communicate and work with interface residents, and how they respond to and influence the development of local policies that affect natural resources.

Background

In 1998, Florida wildfires demonstrated the complexities of natural resource management in the wildland-urban interface. Shortly after these fires, the chief of the USDA Forest Service identified the wildland-urban interface as one of the main challenges for the Forest Service.

In response, the Southern Research Station and the Southern Region of the USDA Forest Service, in cooperation with the Southern Group of State Foresters, conducted an assessment to identify and better understand factors driving social and ecological changes within the wildland-urban interface, as well as the consequences of such changes (Macie and Hermansen 2002). The purpose of this assessment was to provide the foundation for establishing an interdisciplinary program of research and technology exchange within the USDA Forest Service. Consequently, the Southern Center for Wildland-Urban Interface Research and Information was opened in Gainesville, Florida, in January 2002.

The Southern Wildland-Urban Interface Council (SWUIC), a committee of the Southern Group of State Foresters, serves as the advisory council for the Center. SWUIC members developed the idea for a WUI professional development course that states can use to train their own staff and partner agency staff, in lieu of sending a few to annual conferences or regional training workshops. Other partners in this effort include U.S. Fish & Wildlife, Virginia Tech, Auburn University, North Carolina State University, and Cooperative Extension.

Module Topics

The professional development program consists of the following four modules, each addressing key areas of knowledge and skills needed by natural resource professionals working in the wildland-urban interface:

Module 1: Interface Issues and Connections—Introduces participants to the wildland-urban interface, describes key issues and how they are interconnected, explains why natural resource agencies should focus on interface issues, and describes the knowledge, skills, and tools necessary for natural resource professionals to be effective in the interface. Module 1 also sets the stage for the other three modules. Author: Annie Hermansen-Báez, with help from Lauren McDonell.

Module 2: Communicating with Interface Residents and Leaders—Discusses key tips for effective communication with WUI residents and community leaders, beginning with the need to understand the audience, strategies for effectively sharing information and planning programs, overcoming problems in communication, and working to resolve conflict and support changes in behavior. Author: Martha C. Monroe, with help from Lynn Weiss and Cassandra Johnson.

Module 3: Participating in Land-Use Decisions—Discusses land-use decision-making tools, the role of natural resource professionals in the decision-making process, and how natural resource professionals can get involved. Authors: Lauren McDonell and Terri
Mashour, with help from Josh McDaniel, Jay Tomlinson, Martha Monroe, and Ed Macie.

Module 4: Managing Interface Forests—Provides tools and knowledge for effectively managing natural resources in the WUI. Includes topics such as understanding interface landowners; practicing silviculture at the interface; small-scale harvesting systems; managing for wildlife, water, fire, and visual and recreational amenities; enterprise and marketing opportunities for landowners; and forest cooperatives. Authors: R. Bruce Hull, Sarah Ashton, and Rien Visser, with help from Bill Hubbard.

Program Features
The WUI professional development program is designed for state and federal agency use in training programs in the South. It addresses the need for in-state training at a reduced cost and consists of modules that are flexible and adaptable. Each module will contain:

Background information and instructions for the trainer—Provide an introduction to the topic, key points for training emphasis, specific examples, ideas for presentation, citations, supplemental material references, and suggestions for how to use the associated case studies, fact sheets, and exercises. Suggestions for locating guest speakers and field trip sites are included where applicable.

Exercises—Enable participants to discuss and apply what they are learning. They suggest a variety of group sizes, educational styles, and time options.

Case Studies—Provide examples of challenges, success stories, and scenarios from across the South. Discussion questions are included to facilitate deeper understanding and application of the information, as well as to encourage dialogue.
Fact Sheets—Outline important points, tools, strategies, and information for participants, which may be most useful if they want more background to read or distribute to others.

Powerpoint Presentations—Supplement the background information, case studies, and fact sheets by providing graphs, charts, and photographs; includes trainer notes on slides.

Supplemental Readings and Websites—Provide additional resources for more information.

Module 1 will also include a video that introduces interface issues to WUI residents.

Summary
A team of agencies and authors from across the South is developing a set of South-specific training modules (illustrated by examples and strategies from across the South), for federal and state agency use in training programs. Because each state will have different needs and opportunities, the modules will be extremely flexible, offering 2-hour units and 1- to 2-day versions, resources for additional information, and suggestions for guest speakers. The program is currently undergoing expert review and pilot testing. A final product will be released in the summer of 2005, with train-the-trainer workshops following soon after. The training package will be posted on the Center’s website, Interface South (www.interfacesouth.usda.gov).

For more information contact Martha Monroe, (352) 846-0878, mcmorone@ufl.edu, Annie Hermansen-Báez, (352) 376-3271, ahermansen@fs.fed.us, or Lauren McDonell, (352) 378-2159, mcdonell@ufl.edu
Potentials for Increased Farm Profits and Non-Farmer Awareness of Agriculture: An Assessment of Consumer Interest in Agricultural and Nature Tourism

Kristin Reynolds¹² and Desmond Jolly²³
University of California-Davis

Abstract
Small farms on the periphery of cities and towns may employ ecologically and socially beneficial production techniques, yet small farmers experience risks associated with low profitability, particularly in traditional lines of production. Low profits may lead to off-farm migration and eventual conversion of farmland to urban and industrial farming uses that rely heavily on mechanical and chemical inputs, causing environmental degradation. In addition to financial difficulties driven by economic markets, small, family farmers are threatened by inadequate societal interest in maintaining these farms as part of the rural landscape. Urban consumers’ disconnection with agriculture may be one underlying cause of disinterest, as lack of familiarity with the agrofood system does little to motivate inquiry into a lifestyle virtually unknown to them.

Due to the numerous causes of farmland conversion, a multi-faceted approach to farm preservation is essential to maintaining open spaces, ecologically diverse landscapes, and the communities that small farms support. In addition to economic strategies to diversify incomes and bolster on-farm profitability, educating non-farmers about the ecological and social implications of small-scale agriculture is being promoted as a means to enhance social and eventual political support of small, ecologically diverse farms. Preliminary data presented here is drawn from a consumer survey characterizing and assessing consumer interest in agricultural and nature tourism, and its potential to provide diversified incomes for small farmers, as well as education of non-farmers.

Introduction: The Agrofood System Interface
Urbanization alteration and loss of natural and agricultural ecosystems. Forman and Godron (1986) conceptualized land use change as a gradient with five stepping points along a continuum of natural, managed, cultivated, suburban, and urban land uses, and diversity also exists within each land use type. Agricultural systems, for example, range from small-scale diversified crop and animal systems to industrial mono-cropped and confined feeding operations. As urbanization and the increasing dominance of industrialized systems in the agricultural landscape occur, the gradient is weighted more heavily each year toward industrialized agriculture, suburban and urban landscapes, and away from natural-type and ecologically diversified (agro)-ecosystems.

Between 1974 and 2002 agricultural acreage in the United States declined by 8% (USDA, NASS, 2002). In California, the nation’s leading agricultural state, land in farming declined by 17% (USDA, NASS, 2002) during the same period. Farmland loss is particularly concentrated in peri-urban areas, the rural-urban interface, as in Figure 1, which shows

---
¹ International Agricultural Development Graduate Group
² UC Small Farm Center
³ Department of Agricultural and Resource Economics.
projections of prime and “unique” farmland loss to urbanization in California (AFT, 2002). The ecosystem changes inherent in urbanization have negative implications not only for wildlife and plant populations, but also for society. Natural and agroecological systems can provide amenities such as aquifer recharge, limitation of urban sprawl, scenery, and recreation, in addition to food production (Valley Vision, 2004), thus urbanization affects all those who derive benefits from the landscape, and thus agricultural land loss reduces opportunity for recreation and enjoyment.

As land is urbanized, the cultural landscape is “urbanizing” as well. In 2000, 5.6% of California’s residents lived in rural areas, while 94.4% lived in urban settings (US Census Bureau, 2000). Migration to urban areas causes depopulation of rural, agricultural areas, and reduced profitability for agricultural communities ensues, as small farms are consolidated. Thus, urbanization may lead to the decline of affected rural communities that depend on agriculture for their livelihoods. Urban consumers are also affected by these changes, as they become disconnected from the production of their food. Non-urban landscapes hold amenity values for their aesthetic and recreational uses.

The system described here can be characterized as the agrofood system, or “the set of activities and relationships that interact to determine what, how much, by what method, and for whom food is produced and distributed” (OECD, 1981). In this framework, consumer unfamiliarity with agricultural systems can have implications for small farmers and ranchers2, who already experience challenges to economic viability in the current agricultural marketplace. Demand for cheap food is exacerbated by the lack of information available to today’s urban consumers about where, how, and by whom their food is produced, processed and marketed. This perpetuates a system in which smaller producers are continually driven out of larger markets. Additionally, as policy measures affecting small-scale producers are at times put to public vote, legislation reflects consumer perceptions of the agrofood system.

In short, due to the conventional outlets through which consumers receive information about social, economic, and environmental aspects of agriculture, they may not be making informed decisions about food purchases and agro-environmental policy. To this end, efforts to familiarize consumers with agriculture are seen as one method by which to retain diverse, smaller producers as part of the agricultural landscape through increased economic and political support.

Tourism for Increased Farm and Ranch Vitality

As small farmers strive to maintain livelihoods in the wake of the complex economic, social and political marketing structures addressed above, many turn to off-farm sources of income and diversified farm enterprises to supplement profits. Niche marketing has been helpful for some small farmers in realizing increased profitability, and can include products as well as services. Agricultural and on-farm nature tourism (hereafter referred to as agritourism) are niche market enterprises operated by farmers and ranchers on their working agricultural operations for the enjoyment and education of visitors. Examples of agritourism activities include specialty products, (e.g., homemade preserves; crafts), services, (e.g., educational tours; bed and breakfasts), or a combination of the two (e.g., on-farm wine tastings), which add value to more traditional lines of agricultural production on the farm or ranch through increased sales and/or tour fees.

The increasing popularity of agritourism as a means for increasing on-farm and ranch profits motivates questions as to the potentials for continued demand for these products and services, as well as about who will profit from the growth in demand. Agritourism is currently of interest to at least three sectors: individuals or cooperative farmer groups; community economic development organizations; and larger agribusiness enterprises3. To this end, a study was conducted by the University of California’s Small Farm Center (SFC), which engages in research, education, and extension for small farmers and ranchers to assess consumer (visitor) demand for agritourism products and services. Research questions pertinent to the rural-urban interface included: 1. Which amenities, products and services do visitors to agritourism sites value; 2. What is the potential for increased on-farm income through agritourism; 3. How might agritourism affect and be affected by levels of knowledge about social and environmental aspects of agriculture, with implications for income and policy?

2 Small farms are defined by the USDA as farms that total less than $250,000 annually in gross sales (USDA citation).

3 For examples of each sector see: http://www.agadventures.org/index.html; http://www.calaverasgrown.org/; http://www.dole-plantation.com/ respectively
Study Site and Methods

Questionnaires were delivered to a random sample of 1,919\(^4\) residents in Sacramento and Yolo Counties in Northern California between November, 2004 and January, 2005. Sacramento Co. can be described as a mix of mainly urban and suburban landscapes, while Yolo Co. consists of mainly suburban and rural/ agricultural landscapes, and includes the University of California, Davis. The Napa Valley wine region is within 2-3 hours’ drive of most locations in Sacramento and Yolo Cos. Survey questions were close-ended with spaces for respondents to write-in additional remarks. Responses from the two counties were entered into SPSS and aggregated for analysis. This yielded a useable response rate of 15%. Self-identified distribution of respondents by region showed 20.7% living in rural areas or small towns, with 77.9% living in urban or suburban settings. Preliminary results are presented below.

Results and Discussion

Visitors to Agritourism and Nature Tourism Sites

Respondents were provided a list of options, ranging from wine tasting to technical agricultural tours and asked to indicate which they had experienced or purchased. Of the 294 survey respondents, 79.9% indicated that they had visited at least one agritourism or on-farm nature tourism site in the year immediately preceding the study. Due to the high percentage of respondents who indicated past experiences, we tested responses by excluding several of the categories, such as winery visits, (which we suspected to be more popular than some of the more obscure tourism activities), as well as certain categories that were suspected to have been misinterpreted. Even with this adjustment, response rates indicating participation in agritourism were above 75%.

Values of Landscape

As indicated above, respondents were asked whether they lived in urbanized or more rural settings. When asked which types of landscape elements were important in enhancing the quality of their experiences with agricultural tourism, differences were seen between the urban versus rural residents (Figure 2). Urban and suburban residents were more likely to place higher value on open spaces than were rural or small town respondents. Urban and suburban respondents rated Land in Orchards or Vineyards most frequently (38%), followed by Woodlands (25%). While 25% of small town/rural respondents also rated Woodlands as “important”, this subpopulation valued Land in Orchards or Vineyards less frequently (23%) than the urban/suburban group. Over twice as many urban/suburban respondents indicated that Cropland (16%) was important as Farmsteads (7%) in enhancing the quality of their experience. The opposite was true for the small town/rural respondents, who ranked Farmsteads more important (11%) than Cropland (8%). Farmsteads were also ranked more highly than Land in Pasture or Rangeland (5%) by small town/rural respondents, while the urban/suburban respondents valued Land in Pasture twice as often as Farmsteads (14% and 7%, respectively). The differences in response by these two subpopulations suggest a relationship between value and perceived scarcity (i.e., urbanites live in areas where open space is rare), as well value placed on familiar settings and situations (e.g., rural and small town residents may be more likely to be familiar with farmsteads and the amenities that they provide to rural communities).

Increasing On-Farm/Ranch Incomes

In order to assess potentials for increasing on-farm profits, we asked how much respondents would be willing to pay (WTP) for products and for entrance fees to agritourism operations. Of those respondents that had purchased products at agritourism sites in the past year (n=235), 65% indicated a willingness to pay equal [42%] or more [23%] to purchase these products on the farm, compared to what they would pay at their typical food outlets (Figure 3). These figures indicate a potential for farmers and ranchers to capture higher farm-gate prices through agritourism for their traditional or value-added

---

4 Count after insufficient addresses were removed from original count of 2,500.
products than they would through conventional markets, such as retail and wholesale outlets.

In addition to increased revenue from products, tour fees can also provide additional income to agritourism operators. Respondents, (regardless of whether or not they had visited agritourism sites in the past year), were asked how much they would be WTP for entrance and tour fees. Sixty-eight percent indicated that they would pay between $1 and $15, while 5% would pay more than $15, and 16% said that entrance and tour fees would not influence their decision to visit sites (Figure 4). Only five percent of respondents indicated that they would not be willing to pay for entrance fees These figures suggest potential for farmers and ranchers to increase incomes through agritourism, though expenses associated with operating and marketing an on-farm tourism enterprise must also be considered when evaluating potentials for increased profits. Further, a distinction must be made between what consumers say they are “willing” to pay and what they actually spend.

**Agricultural Knowledge and Implications for Agricultural Policy**

When asked about their familiarity with certain terms pertaining to contemporary agriculture, visitors to agritourism sites were generally more knowledgeable about certain terms than were non-visitors. Notably, visitors were more likely to have heard of the terms “Sustainable Agriculture” (52%) and “Biotechnology” (73%) than were those who had not visited agritourism sites (27% and 51%, respectively) (Figure 5). Whether their knowledge of these terms was preexisting or a result of their visits was not probed. However, respondents did indicate that their level of knowledge about Farming or Ranching Techniques; Agricultural/Rural Communities; Economic Aspects of Agriculture; and Environmental Aspects of Agriculture (Figure 6) had increased as a result of their visits to agritourism sites.

Pertaining to policy, sixty-six percent of respondents who had visited agritourism sites (n=235) indicated that they would be more likely to inform themselves about future legislation pertaining to agriculture as a result of their visit.

**Conclusions**

The preliminary results of this consumer demand study indicate that there is potential for agricultural and on-farm nature tourism to increase small farm and ranch socio-economic vitality by at least two paths. Directly, increased on-farm revenue through sales of products and tour/entrance fees seems likely, given the willingness of survey respondents to pay...
for these items and services. Indirectly, there appears to be a connection between consumers’ knowledge of agricultural issues (technical, economic, social, and environmental), and their on-farm/ranch experiences. This suggests potential to affect both consumption decisions and level of political awareness about agricultural issues, with subsequent effects on policy affecting small farmers and ranchers. Despite the prospects of increasing on-farm/ranch incomes, small farmers and ranchers’ entrance into the tourism sector should be judicious and strategic. As agricultural tourism gains the attention of larger entities, there is a risk that market will become mainstream, and that smaller producers will thus cease to hold a niche. Thus, agritourism operators will need to maintain a diversity of income sources, and may do well to cooperate on marketing strategies that help them evolve with the industry.

Sustainability in agriculture has become a measure of conscientious farming. If the agrofood system includes environment, farmers, ranchers, and consumers, agritourism research and extension should continue to address sustainability in the context of links between consumer education and farm profits. Finally, as agricultural land holds various amenity values for residents along the rural-urban continuum, measures that work toward maintaining an agro-ecological landscape will ultimately benefit not only farming communities, but all members of the agrofood system from soil organisms to urban consumers.

References
Assessing Visitor Awareness of Invasive Species and Attitudes toward Control Options

Melissa L. Baker, Mae A. Davenport, and John W. Groninger
Department of Forestry, Southern Illinois University

Introduction
Research in invasion biology, pest risk assessment, and pathway analysis has shown that certain non-native plant species are spreading from highly disturbed, cultural landscapes into natural landscapes and threaten many publicly protected natural areas. For example, one such protected area, Indiana Dunes National Lakeshore boasts some of the highest biological diversity in the national park system, yet because of its proximity to urban and industrial development it also leads other parks in the number of non-native species invading its boundaries. The need for public support for and participation in management and prevention has become increasingly apparent. This paper presents findings from a study of visitors to a publicly protected open space near a growing urban center in southern Illinois. Giant City State Park, administered by the Illinois Department of Natural Resources (IDNR), provides a diversity of recreation opportunities to its over one million annual visitors and serves as an important biological preserve for rare plant communities. As park managers begin to develop an invasive plant management plan and contemplate various control tactics, understanding the perspectives of park visitors becomes critical.

Literature Review
Theoretical models used in psychology, social psychology and sociology emphasize the importance of cognitions, including objective knowledge and subjective beliefs, in shaping attitudes and in turn, behavior. For example, the tripartite model of attitudes suggests that attitudes are derived from cognitions, emotions, and past behaviors (Tesser, 1995). In a study of public attitudes toward ecological restoration in Chicago, Bright, Barro & Burtz (2002) assessed the relationship between knowledge and attitudes. They found that participants who were highly knowledgeable about specific restoration issues were more likely than those with limited knowledge to have positive attitudes toward ecosystem restoration. Theory also indicates that attitude change is driven by a person’s ability and motivation to process new information. For example, the Elaboration Likelihood Model (Petty & Cacioppo, 1986) posits that attitude change endures when informational messages are comprehensibility and personally relevant. One primary goal of environmental education and interpretation is to influence both knowledge and behavior through designing audience appropriate messages (Hamm & Krumpe, 1996). Interpretive planners have had success. For example, a 1992 study of visitor interpretation programming in Australia National Parks, found that approximately 50% of participants reported that interpretive programs had stimulated changes in their personal behavior. Among reported changes were specific park-related behavior and an increased general appreciation of the environment (Beckman, 1999).

Many studies have assessed the ecological and economic implications of non-native and invasive species (Freemuth & Crawley, 1998; Hoddle, 2004; Lodge & Schreader-Frechette, 2003), but few have examined public perceptions of non-native and invasive species and their management. Furthermore, across the U.S. natural resource management agencies, conservation organizations, and public officials have teamed up to develop information campaigns and education programs aimed at increasing public awareness of invasives. However, little effort has been made to assess the effectiveness of these messages. As non-native and invasive species management plays an increasingly larger role in conservation strategies, insight into the human dimension, including knowledge and attitudes is needed (Donlan & Martin, 2004). Three of the primary objectives of this study were to 1) assess the relationship between participation in interpretive activities and knowledge of vegetation, 2) examine the relationship between perceived knowledge of vegetation and priority given to vegetation in management decisions, and 3) determine visitor support of specific control options.

Methods
The research objectives were accomplished through the use of two survey instruments: an onsite questionnaire and a mail-back questionnaire. A sample of visitors was drawn during randomly chosen days and times. Data collection methods and techniques for improving response were based on a
modified Tailored Design Method (Dillman, 2000). Statistical analysis was performed using the Statistical Package for Social Scientists 12.0.

**Study Site**
Giant City State Park (GCSP), located in southern Illinois, is a popular site for camping, horseback riding, hiking, rock climbing, fishing, and picnicking. Just 15 minutes south of Carbondale, IL, it is easily accessible to many local residents as well as the student body of Southern Illinois University. This provides for diversity in visitors to GCSP as well as the activities in which they participate. The park is comprised of 4,000 acres and is encompassed by the Shawnee National Forest. The park’s scenic character comes from the many natural communities, sandstone structures and bluffs throughout the area. It is also home to an abundance of flora and fauna including more than 75 species of trees. Park officials estimate the park gets over one million visitors yearly. The park offers interpretive programs such as wildflower hikes and a spring wildflower slide show. The recently constructed visitor center houses multiple exhibits on the natural features found within the park.

**Sampling plan**
The sampling period spanned October through December 2004. A stratified sampling plan was developed using random assignment of weekdays and weekends, as well as times of day. Field researchers approached as many visitors (18 years of age or older) as possible during sampling time blocks. Visitors were contacted at campgrounds, trailheads, parking lots, and outside the visitor center. Only one member per household was surveyed, except in cases in which college students shared seasonal housing. In this instance, each student was sampled.

**Instrumentation**
The on-site instrument was a one-page questionnaire. Names and addresses of participants were collected for potential reminder and replacement mailings. Eight additional questions gathered data on trip characteristics such as activities participated in, number of previous visits to GCSP and lodging accommodations during their visit. This instrument also gathered basic sociodemographic data. Consenting individuals were given a mail-back questionnaire comprised of 38 questions. The format of the questions includes fixed-choice, Likert scale, ranking, and open-ended questions. Questions targeted sociodemographics, trip characteristics, perceptions of park conditions and interpretive services, and perceptions of vegetation and its management.

**Data Analysis**
Survey responses were entered into SPSS for data analysis. Descriptive statistics such as mean, median, mode and measures of central tendency were calculated. T-tests were run for detection of statistical differences between group means.

**Study Limitations**
As with any study using on-site sampling, the findings represent park visitors and not those who may have been displaced from the park. In addition, sampling was done over three months which may exclude groups that only visit the park during other periods. Other limitations include the response rate of 49% and that respondents, on average, are older than non-respondents. For these reasons, results of this study may not be generalizable across the entire population of visitors to Giant City State Park or to areas outside of the park. However, the study provides a representative snapshot of visitors in the park during the sampling period.

**Results**
Two hundred sixty-seven of the 545 mail-back questionnaires distributed were returned for a response rate of 49%. No significant differences were found between respondents and non-respondents with regard to gender or local/non-local status. There was, however, a significant difference (P<.001) in age. The mean age of respondents was 46 years while the mean age of non-respondents was 41 years.

**Visitor and trip characteristics**
Respondents’ age ranged from 19 to 87 years of age with a mean of 46 years. Fifty-two percent of respondents were female while 48% were male. Over one-half of respondents were college graduates (52%) while an additional 36% had attended some college or trade school. Visitors engaged in a variety of activities while in the park. The top three primary activities of visitors were hiking (37%), camping (20%) and picnicking (11%). Thirty-three percent of visitors experienced a variety of interpretive program activities, including viewing nature exhibits, participating in guided hikes, and other employee led programs. The most common interpretive activity reported was visiting the visitor center (30%). However, 43% of all visitors engaging in interpretive activity had multiple interpretive experiences.

**Environmental interpretation and perceived knowledge of vegetation**
Of those 81 visitors who participated in interpretive programming activities during their visit, 31% agreed that interpretive programs taught them about the
park’s vegetation. Participants were asked to rate their familiarity with vegetation at GCSP using a five-point scale with one being “not at all familiar” and five being “extremely familiar.” On average, all study participants rated themselves as “slightly familiar” (2.2) with vegetation at GCSP. The average score for those with and without interpretive experiences also was 2.2. Participants were also asked to rate their knowledge of native vegetation at GCSP. Overall, study participants reported being “slightly knowledgeable” (2.2). The average score for those with interpretive experiences was 2.2 and without was 2.3.

Finally, participants were asked to rate their knowledge of non-native vegetation at GCSP. On average, all study participants perceived that they were “slightly knowledgeable” (1.9). Those without interpretive experiences scored 1.9 on average, while the average for those with interpretive experience was 2.0.

There were no significant differences between participants with and without interpretive experiences on any of the questions above.

Knowledge and attitudes toward management of non-native vegetation

Participants were asked what priority they believed non-native vegetations should receive in management decisions using a 5 point scale with 1 being no priority and 5 being very high priority. The average score for all participants was 2.9 or “moderate priority.” Those with no knowledge of non-native vegetation rated management priority at 2.8 or “moderate priority,” while the average score for participants with perceived knowledge of non-native plants was 3.2, also “moderate priority.” However, these means reflect a significant statistical difference (p=.05). Participants with perceived knowledge were more likely to view management of non-native vegetation as a high priority.

Participants were also asked to indicate the extent to which they support or oppose specific management actions as one-time and periodic control treatments. A combined or integrated approach and periodic native plantings garnered the most support—over 70% from study participants (Table 1).

<table>
<thead>
<tr>
<th>Table 1. Attitudes toward control options</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control Option</td>
</tr>
<tr>
<td>Combined or integrated approach</td>
</tr>
<tr>
<td>Plantings to increase native plant populations</td>
</tr>
<tr>
<td>One-time control treatment</td>
</tr>
<tr>
<td>Periodic control treatment as needed</td>
</tr>
<tr>
<td>Human power</td>
</tr>
<tr>
<td>One-time control treatment</td>
</tr>
<tr>
<td>Periodic control treatment as needed</td>
</tr>
<tr>
<td>Prescribed/controlled burns</td>
</tr>
<tr>
<td>One-time control treatment</td>
</tr>
<tr>
<td>Periodic control treatment as needed</td>
</tr>
<tr>
<td>Mechanized equipment</td>
</tr>
<tr>
<td>One-time control treatment</td>
</tr>
<tr>
<td>Periodic control treatment as needed</td>
</tr>
<tr>
<td>Herbicides</td>
</tr>
<tr>
<td>One-time control treatment</td>
</tr>
<tr>
<td>Periodic control treatment as needed</td>
</tr>
<tr>
<td>Use of non-native insects</td>
</tr>
<tr>
<td>One-time control treatment</td>
</tr>
<tr>
<td>Periodic control treatment as needed</td>
</tr>
</tbody>
</table>
Study participants were asked where they had gotten information about native and non-native vegetation. The most common sources were newspapers/television (31%), friends or family (29%), formal education (22%), information brochures (22%), and information exhibits (22%).

Finally, participants were asked to what extent they trusted GCSP management to make good decisions about non-native vegetation. 70% of study participants responded that they trusted GCSP managers very to extremely much.

Conclusions and implications
Study findings indicate that visitors are only slightly familiar with and knowledgeable about vegetation in the park. Only one-third of participants reported engaging in interpretive activities. One-third of those participants believed that interpretive programming enhanced their knowledge of park vegetation. Still, when comparing those with and without interpretive experiences, the activities themselves did not appear to have a significant effect on perceived knowledge of vegetation. These findings suggest that managers should reassess interpretative programming and perhaps adjust the content and delivery method of messages about non-native plants.

The study supports the notion that knowledge shapes attitudes. Findings demonstrate that increased knowledge of vegetation enhances the priority visitors place on non-native plant management. Overall attitudes toward specific control options vary, but reveal general support for integrative and periodic control efforts. What is perhaps most encouraging is that visitors trust GCSP managers to make good decisions about the control of non-native vegetation.

GCSP managers can expect broad visitor support in their non-native plant control efforts. However, to truly bring about increased social consciousness about the impacts of non-native plants within and beyond park boundaries and to influence behaviors of the local citizenry when landscaping their own backyards, park managers should concentrate on promoting environmental programs they offer and emphasizing interpretation of native and non-native vegetation.

Literature Cited


4-H Wildlife Stewards: Bringing Urban and Rural Oregon Together
-- One School at a Time

Maureen Hosty and Maggie Livesay, Oregon State University

Introduction
As the effects of urbanization accelerate in many parts of the world, impacts on the environment along urban-rural interfaces have emerged. At the same time, these new environmental conditions along the urban-rural interface have brought new opportunities. Oregon communities are among those that are rapidly changing and the urban-rural divide is especially pronounced in regards to how youth and adults feel their natural resources should be managed. In order to effectively make decisions about natural resource management youth and adults must first gain a platform of knowledge on which to base their decisions. The OSU Extension 4-H Wildlife Stewards provides pieces of that platform and bridges the divide between urban and rural Oregonians by bringing Oregon youth and adults together one school at a time.

Today during the school day, at lunch breaks, after school, and on weekends, young people are working side-by-side with adult 4-H Wildlife Stewards to discover scientific processes and observe nature as they transform 54 small plots of land into wildlife habitat education sites. These 4-H Wildlife Steward volunteers are trained by Oregon State University faculty to promote science learning and stewardship among youth and inspire, educate and connect communities, schools, natural resource agencies, and organizations. In August 2001, the 4-H Wildlife Stewards Program was awarded an $890,000 grant from National Science Foundation to develop this program into a national model and document the educational and scientific impacts of this project on students, teachers, and communities.

Urban-Rural Oregon
Economically and socially, Oregon is becoming more dynamic and complex every day. Forty-one percent of the total state population lives in the Portland metropolitan area, the state’s largest city. The Portland metropolitan area drives the state's economy. Its taxes pay for most of the states budget. Its size and wealth make it the most influential city in the region. High-tech corporations have surpassed the timber industry to become the state’s number one employer. Today, however, Portland is at a crossroads, gripped by a crisis of confidence in the wake of some of the highest urban job losses of the national recession.

By contrast rural Oregon is still relatively wild and varied, and its political power is drastically dwindling. Eastern Oregon comprises over half the total land in Oregon but only 4.3% of the population, which makes it one of the remaining frontiers of the country. Its business leaders and politicians are struggling against the loss of political power by trying to establish a foothold in state government through a newly created office of rural policy. As the region's economic underpinning erodes, the fissure between the state's most- and least-populated areas continues to widen. The Oregon State University Extension 4-H Wildlife Stewards Program is made up

Member schools by size of community 2003-04

Percentage of students in community, 2003-04
of volunteers who live in both the urban, suburban and rural areas of the state. Their views on the environment and natural resource management are as varied as the broader political landscape of Oregon.

**Urban vs. Rural Schools**

Today 4-H Wildlife Stewards Member schools serve urban (over 100,000 people), suburban (50,000-100,000 people), small town (10,000-50,000 people), and rural (less than 10,000 people) schools. Year-end reports from 36 schools in the 2003-04 school year indicated that these schools represent a variety of community sizes.

While urban and rural school student projects are similar in many ways there are also measurable differences. A typical urban school classroom participating in a 4-H Wildlife Stewards project will have 25-35 students in the classroom while in contrast rural schools participating in this project have an average class size of 17-25. The average size of the habitat education site also varies. Urban schools average 5075 square feet and rural schools average 40,463 square feet. For urban schools learning in an outdoor, hands-on learning situation often means riding a bus to a location many miles away, while in rural schools accessibility is convenient for a rich outdoor learning lab.

The amount and type of exposure to the outdoors also differs between urban and rural Oregon. Students in urban Oregon may have limited exposure to the outdoors and yet at the same time they are often exposed to a large variety of organizations and agencies that deliver environmental education programs for youth. They may grow up with a certain view of natural resource management such as “logging is bad”. Their connection to the environment and natural resources may also be very limited, depending on parental influence. Rural students, by contrast, are usually more comfortable in the outdoors and their families are more likely to own acreage. Their connection to the natural world and natural resource management may be much broader than students in urban areas. Organizations that deliver environmental and natural resource education programs may be very limited in rural communities. These students may have a very divergent definition of the word “environmental”. One goal of the 4-H Wildlife Stewards program is to establish an experiential science-based platform upon which young people can base their decisions about the environment resulting in a more balanced and unbiased approach to natural resource management decisions in the future. These program goals require further evaluation to validate observations. What we do know is that across Oregon, both rural and urban communities are participating equally in this program and youth are gaining knowledge in science and impacting their communities through their projects.

**Program Impact**

Today, the program brings new enthusiasm to local communities and has community leaders across Oregon energized. Parents and teachers are excited to see students engaged in experiential-based projects that impact their community. Due to increasing classroom size and shrinking school budgets, many Oregon public schools have struggled to offer their students these types of hands-on learning opportunities in the environmental sciences. Oregon educators are particularly concerned about this problem because Oregon benchmarks for public education require students to demonstrate mastery of basic natural science concepts including relationships between organisms and their environment. Through the 4-H Wildlife Stewards Program, students, teachers and 4-H Wildlife Stewards volunteers across Oregon work together to broaden the science curriculum schools are able to offer. Furthermore, through the 4-H Wildlife Stewards Program, parents and community neighbors who traditionally have a hard time connecting with their school or community have joined in the excitement. Entire communities have been mobilized, new volunteers involved and student interest in science elevated when a 4-H Wildlife habitat education site project begins.

The data on the five-year pilot initiative includes assisting 54 schools in transforming their school grounds into outdoor classrooms and habitat areas. In the 2003-04 school year the program served 11,247 students, 346 classroom teachers and 190 active 4-H members and 4-H Wildlife Stewards. At the outset of the 4-H Wildlife Stewards program schools were primarily in the Portland Metro area. In 2002 the program expanded to rural areas in the state. Today 32% of the schools are rural, 21% small town, 21% suburban and 26% urban.

Program evaluations reveal that 4-H Wildlife Stewards Schools have found that creating and maintaining natural outdoor classrooms provide an excellent opportunity to observe, participate, learn, and enjoy a changing, complex environment. Improving student attitudes and behaviors towards our environment begins by establishing an opportunity for regular and positive contact with the natural world. Studies indicate that school children spend an average of 25% of the school day outside,
yet school grounds are seldom designed with learning in mind. Too often school grounds are covered solely by asphalt, concrete, or turf grass, and surrounded by chain link fencing. The 4-H Wildlife Stewards Program is slowly reclaiming these school grounds.

**Urban-Rural Interface of 4-H Wildlife Stewards Volunteers**

Adult volunteers in the 4-H Wildlife Stewards program have many opportunities to come together around the issues of natural resource management and the environment. Many of these volunteers would not have the opportunity to interface if not for their involvement in this program.

Across Oregon, 4-H Wildlife Stewards volunteers in all different sizes of communities interface through 1) State 4-H Wildlife Stewards Trainings 2) State 4-H Wildlife Stewards Conferences and 3) a Central Oregon 4-H Wildlife Stewards Tour. Through each of these educational and networking opportunities, 4-H Wildlife Stewards come together to learn new skills, gain new knowledge, and share resources, ideas and challenges with other 4-H Wildlife Stewards. Two common interests bring these volunteers together, a passion for helping youth and a love for the outdoors and natural spaces. Despite the vast differences in the schools they serve and the communities where they live, 4-H Wildlife Stewards find they have much more in common than they do differences. In February 2005 focus group meetings were held at the State 4-H Conference. Twenty-five 4-H Wildlife Stewards volunteers shared the three most important things they have learned. The three common themes to come out of these discussions irregardless of whether they lived in a rural community or an urban community was: the importance of building community support, children are excited to learn about the outdoors, and the importance of staying open-minded and flexible. Whether the volunteers were from an urban school or a rural one the successes and concerns were very similar.

A unique urban–rural volunteer interface opportunity was offered in the early years of the 4-H Wildlife Stewards Program. The 4-H Wildlife Stewards Central Oregon Tour co-sponsored by Society for Range Management and was conducted every year during the first four years of the project (1997-2000). During these first years of the program, 4-H Wildlife Stewards only served the urban Portland Metro area. The 3-day tour was designed to provide a gathering of urban and rural Oregonians who have an interest in natural resource management. The goals of the tour were 1) to help participants gain a greater understanding of issues on natural resource management from both and urban and rural perspective; 2) to identify common goals and interests of both urban and rural Oregonians; and 3) to develop a camaraderie and a spirit of friendship with people from urban and rural Oregon who are involved in managing the land.

Urban 4-H Wildlife Stewards stayed in the homes of Oregon ranchers in Central Oregon. They had the opportunity to learn together in hands-on workshops, lively discussions and informal social gatherings. The spirit of camaraderie and friendship was an important outcome of these because it opened up communication between both sides of the mountains which divides the urban and rural parts of the state. Program evaluations indicated that it became clear to those who represent both urban and rural Oregon that urban and rural Oregonians have a common goal – managing our resources wisely. In four years, five tours were conducted for a total of 130 participants.

**Junior 4-H Wildlife Stewards (youth) Urban-Rural Interface**

Youth participants in the 4-H Wildlife Stewards Program, also known as Junior 4-H Wildlife Stewards have the opportunity to network and share with students from different sized communities in Oregon. Through the 4-H Wildlife Stewards Youth Summit, 4-H Junior Wildlife Stewards Camp and 4-H Corroborree, students from across Oregon come together to share in a common educational opportunity.

Since 2000 the 4-H Wildlife Stewards Program has sponsored the 5-day resident 4-H Junior Wildlife Stewards Summer Camp. Approximately 100 youth, teen counselors and adult staff from 4-H Wildlife Stewards Member schools are invited to participate in the camp. At the 2004 camp, 26% of the participants represented urban communities, 43% represented suburban communities, 17% represented towns and 14% represented rural communities. Campers participate in education workshops around wildlife themes, leadership classes, recreation and special all-camp programs. Campers from both urban and rural Oregon are placed in cabins together. Campers participating in this camp experience showed significant developmental gains in cooperating with others and workings as a team (Arnold, Camper Report, 2004).

The 4-H Wildlife Stewards Youth Summit is a culminating event for students from 4-H Member
schools. The focus of the event is to provide students a place in which to share their educational projects with the community. Students bring educational displays, PowerPoint presentations, skits and songs they have developed and present them to a judge. These students then rotate through hands-on natural resource activities provided by community partners.

The first Summit was held on April 22, 2003 at a rural school in Benton County. Six 4-H Member Schools sent teams of students, 3 were rural, 3 urban for a total of 145 students. The second Summit was held on April 22, 2004 at an urban school in Corvallis. 150 students participated with 4 rural schools and 5 urban schools in attendance. Evaluation results showed all youth participating were gaining interest and skills in science.

The 4-H Corroboree Project, an internet exchange program was created in 2004. Corroboree is an aboriginal word and means “a meeting or gathering.” This project has been designed to allow students to 1) exchange information that expands their understanding of natural, built and “reclaimed” communities; 2) recognize that their local environmental quality issues are similar to global issues; and 3) develop a new view of global sustainability and cultural diversity. Students post science data they collect from their habitat projects and share and compare their results with other students in Oregon and Australia. Early project evaluations results show students interest in science increases as a result of this project.

Data regarding financial support for school projects were gathered via the 4-H Wildlife Stewards annual report to the project director. In 2004, 35 of 41 schools completed the report. Of these schools: Twenty-four schools reported securing grant funds to support their school habitat for a total of $48,172. Ten schools reported raising funds to support the project for a total of $8,585. Fifteen schools reported receiving in-kind support for their project, for a total value of $12,510. Eight schools reported cash donations for a total of $11,750.

When comparing urban and rural schools, however, urban schools were able to raise significantly more money for their school projects. On average, urban schools raised $2500-$8000 for their school projects while rural schools typically raised $250-$1000. This is most likely due to the high number of foundations, donors and businesses located in the urban areas.

Results of the evaluation indicate that there is considerable support for the 4-H Wildlife Stewards Project. This is clearly evident in the amount of support volunteers and teachers feel that school administration gives to the project. In addition, both groups report that parent, family, and community involvement in the school has increased as a direct result of the program at their school. Finally, there has been a considerable investment in the program at local schools through grants, and cash and in-kind donations. (Arnold 2004)

Impact on Student Science Learning: The ultimate goal of the 4-H Wildlife Stewards program is that students demonstrate increased science interest and skills. The program theory predicts that if trained 4-H Wildlife Stewards form successful partnerships with local schools, teachers, and parents to create a habitat education site for science education, there will be a corresponding impact on student science interest and skill. The impact of the program on student science learning was measured in 3 ways. First through classroom assessments with 7 participating classrooms at 5 active schools; second, through an end of program evaluation given to student participants at each of two 4-H Wildlife Stewards Summits held in the spring of 2004; and third through the reports of 4-H Wildlife Stewards and teachers.

Students were asked to rate the following questions on a scale of 1 to 4, with a 1 indicating the statement is “not true!” and a 4 indicating that the statement is “true!” The mean scores were 1) science learning is fun (3.36); 2) habitat increases science learning (3.2).
3) making scientific observations (3.23); and 4) collecting data (3.5).

Students were also asked how much the program helped them to like science and to get better at science. Students rated these questions on a scale of 1-5 with 1 indicating “none!” and 5 indicating “a lot”. The mean scores were 3.98 for “I like science better” and 3.91 for “I am better at science.”

**Conclusion**

The 4-H Wildlife Stewards Program bridges the urban-rural divide in Oregon by bringing youth and adults together one school at a time. This program demonstrates that urban and rural Oregonians are brought together by a common interest – a love for the outdoors and natural areas and a strong desire to improve science education for youth. While Oregon scientists, environmentalists, the agriculture and forestry industry, and lawmakers continually debate and divide themselves over the many issues around the management of states natural resources, a growing group of enthusiastic and passionate volunteers are actively involved in educating youth to learn about natural resources and the environment. It is recognized that to increase the involvement of the American public in our natural environment, youth must become aware of the issues and be actively involved in some of the immediate solutions: Youth must also become involved in natural resource issues because the solutions to these problems are long-term and involve changing the ways that we think and live. The 4-H Wildlife Stewards program is doing just that: teaching youth how to think, not what to think and in the process bridging the urban-rural divide.

**References**


Species Conservation and Management
Central Cascades Habitat Conservation Plan Implementation: Keeping Promises for Adaptive Management
Bernice L. Smith, Environmental Design and Planning, Virginia Polytechnic Institute and State University

Introduction
Habitat Conservation Planning was introduced in 1982 as an amendment to the Endangered Species Act (ESA) of 1973. Administered by the U.S. Fish and Wildlife Service and National Marine Fisheries Services, the “Services”, habitat conservation plans (HCPs) are negotiated agreements between private landowners and the Services intended to mitigate the incidental “take” (killing, harming) of endangered and threatened species during a development or resource extraction project. In other words, private landowners receive a permit to proceed with their projects if they agree to prepare and implement a HCP. Researchers have found the scientific basis of approved HCPs to be inadequate and the efficacy of prescribed mitigation measures untested (Kareiva et al., 1999, Noss et al., 1997). Acknowledging shortcomings in the HCP at the time of permit issuance, the Services encourages adaptive management, particularly for regional scale HCPs “that would otherwise pose a significant risk to species” (USFWS/NMFS HCP Handbook 1996 and 2000).

Adaptive management involves a systematic and rigorous process of learning from the outcomes of management actions, accommodating change and improving management. It is assumed that HCPs with adaptive management commitments will result in continuous probing and improved understanding of biological responses to mitigation strategies leading to species/habitat improvements. However, little is known about the performance of HCPs in protecting endangered and threatened species. Adaptive management can play a critical role in improving the performance of a HCP, yet few scholars have evaluated the extent of adaptive management implementation. The purpose of this paper is to formatively examine adaptive management implementation for endangered species covered in the Central Cascades HCP. The following questions are posed:

- What is the extent of adaptive management implementation in the HCP?
- How do adaptive management approaches vary with ecosystem characteristics?

Case Summary
On June 27, 1996, the Services approved the Central Cascades Habitat Conservation Plan (HCP) and issued an Incidental Take Permit (ITP) to Plum Creek Timber Inc., authorizing the incidental “take” of four federally listed species. “Take” is permitted to occur in a HCP project area of 169,000 acres of company land while Plum Creek produces timber and manages its forest activities. The species are the: threatened northern spotted owl, (Strix occidentalis caurina), threatened grizzly bear (ursus arctos), threatened marbled murrelet (Brachyramphus marmoratus), and the endangered gray wolf (canis lupus. The plan also includes 311 unlisted vertebrate species of fish and wildlife whose habitat spans both east and west of the Cascade Mountain Crest in Central Washington. The permit was later amended to include bull trout (Salvelinus confluentus) and on March 29, 2001, Plum Creek received another permit authorizing the incidental “taking” of the Puget Sound chinook (Oncorhynchus tshawytscha), Middle Columbia River steelhead trout (Oncorhynchus mykiss), and Canada lynx ((Lynx Canadensis (Central Cascades HCP 2000 and 1996 Permit) The first fifty years are identified as Phase I. An additional fifty years, Phase II or Safe Harbor is added as an incentive “to improve wildlife and fish habitat to yield benefits beyond those anticipated in the 1996 agreement (Central Cascades HCP & Implementation Agreement 1996). The Central Cascades HCP, Implementation Agreement and Incidental Take Permit exist concurrently for 50-years. Plum Creek has regulatory certainty that additional mitigation, i.e., acres and expenses for protection, above and beyond what is agreed in the HCP will not be sought by the Services.

Encompassing King and Kittitas Counties, the HCP project area is intermingled with U.S. Forest Service (USFS) lands culminating in a 418,900-acre Planning Area and a checkerboard ownership pattern. The Planning Area is bisected by route I-90. Route I-90 corridor is identified as an “area of concern” in several forest-management studies (Lujan et al., 1992; Central Cascades HCP 2000) because of its
strategic importance for the north/south and east/west distribution of late successional species, such as the northern spotted owl.

The principle reason for Plum Creek’s pursuit of a Permit was to enable the company to conduct timber harvest and forest management that would displace spotted owls as a consequence of owl habitat modification (Central Cascades HCP 2000). The HCP is designed to complement the Northwest Forest Plan and Northern Spotted Owl Recovery Plan. Both Federal plans are aimed at (1) maintaining and protecting suitable habitat for spotted owls and other wildlife species, and (2) supplementing nesting, roosting and foraging (NRF) and foraging dispersal (FD) habitat to ensure the unimpeded movement of spotted owls throughout the I-90 corridor (Central Cascades 2000).

Methods

A qualitative formative evaluation was employed to assess whether: (1) implementation is consistent with the HCP and Implementation Agreement (IA), (2) conditions are being created for species as anticipated, and (3) objectives are being met for the HCP species and habitat. Understanding early compliance and progress provides insight into the prospect of species survival and recovery.

This evaluative framework is primarily shaped by the characterization of adaptive management in the literature. Criteria were derived based upon a synthesis of adaptive management theory and case study examples cited in the literature. An intuitive scale indicating “strong”, sufficiently represented; “moderate”, marginally represented; “weak”, insufficiently represented; and “absent”, does not exist; was developed based upon evidence of essential adaptive management components. Available documentation and interviews serve as supporting evidence. Publicly accessible material such as the HCP, Implementation Agreement, Environmental Impact Assessment, and Annual Reports were obtained from the USFWS. A five-year Review, Company Annual Financial reports, correspondence and technical reports were obtained from Plum Creek Timber, Inc. The collection and analysis of documents took place between April 2003 and March 2005.

Interview data consists of 1.5 hour intensive, semi structured in-depth interviews with twenty subjects conducted during January 2004 through June 2004. Subjects represented the perspectives of federal, state and tribal officials, and Company scientists, administrators, and foresters. Interviews were conducted solely by myself, and were recorded and transcribed. Subsequent contact was made with subjects to clarify issues and events and to request additional documents up until March 2005. Interviews and document reviews were conducted to triangulate data across multiple sources and diverse perspectives to better capture reality. Thus, research findings are placed in the context of what was implemented and the local circumstances that affected variation in implementation and short-term outcomes (Patton, 1990).

Preliminary Findings

The HCP identifies four adaptive management opportunities that include: the northern spotted owl, riparian management, watershed analysis, and cooperative experimental areas. Adaptive management is intended to address the uncertainty of plan mitigation strategies and to assess the capacity of the HCP to adequately protect species and associated habitat (Central Cascades HCP 1996 & 2000). Evaluating Plum Creek’s approach to adaptive management has resulted in understanding the company’s flexibility in managing suitable habitat for the spotted owl within prescribed sideboards articulated in the HCP. Although on the surface the opportunity for learning would appear to be limited given these constraints, habitat conditions for the northern spotted owl can potentially be improved while also allowing for forestry management and production (Services interview January 2004). However, there have been missed opportunities for actively learning about species responses to mitigation strategies. “Adaptive management” within the first eight years of HCP implementation has consisted of the refinement of resource definitions within the HCP that were unresolved during the planning phase and habitat protection enhancement based upon stakeholder suggestions during plan implementation (Services interview, January and March 2004; Plum Creek staff April 2004). Learning from management outcomes is not evidenced. In addition, landscape scale experiments that facilitate understanding of system processes, relationships and external threats are not occurring. Also, a monitoring protocol has not been established to test alternative hypotheses and to understand cumulative effects that develop over time and across the landscape.

Theoretically, adaptive management is intended to deal with uncertainty due to incomplete science. The company’s belief that their forest management has moderate to minimal risks to the species may have influenced their approach to adaptive management.
For example, the risks to the spotted owl were considered moderate since more is known about this species than any other species (Lujan et al., 1994, Service interview, February 2004). Plum Creek’s proximity to USFS land was also viewed as an advantage for spotted owls. Ironically, the spotted owl has significantly declined in the region. With regard to aquatic resources, the company viewed these species as having a relatively minimal level of uncertainty and asserted that significant modifications to their management strategies would not be necessary for species protection (Services interview, January 2004). Furthermore, the “goals for adaptive management were not extensive, so the bar was not set high” (Services interview, March 2004).

**Active adaptive management**
Plum Creek attempted to employ “active” adaptive management prior to the HCP. Active adaptive management involves deliberate experimentation to test alternative hypotheses about ecosystem function and the best management intervention. This approach is purported to yield more reliable information and leads to rapid learning (Borman et al., 1999, Walters 1990, Walters and Hilborn 1978). The company’s “active” activities included studies on small mammal (prey) density studies and foraging dispersal corridors. Prey density studies were designed to establish the cause and effect of timber harvest and prey density. This study involved different methods (cable yarding and tractor) to selectively harvest and clearcut timber in a 180-acre treatment area within a stand. In addition, representative large trees were left uncut followed by a post harvest inventory. The prey density study was conducted in 1994-1995, but the stand was exchanged with the USFS in 1999. The intent of foraging dispersal corridors was to facilitate movement and dispersal of owls and to determine corridor effectiveness. This 1997 study involved the establishment of 150-ft. width corridors arranged at various angles within a 145-acre harvest deferred owl site. In addition, a 100-ft. riparian habitat area buffer was placed on each side of a perennial stream within the stand. This study was not revisited after a couple of years of implementation.

These early experiments likely contributed to Plum Creek’s receipt of an incidental take permit and served as examples for the forester’s implementation. However, adaptive management is subject to the intent of the forester and Plum Creek’s forester intentions and decisions has not lead to active adaptive management during HCP implementation. Just keeping up with the state regulations and HCP baseline prescriptions alone can be complex. Silvicultural approaches vary based upon the type of forests, operational conditions and local opportunities at each stand and modifications to forests occur at the stand scale where foresters have experience with and control over operations (Plum Creek interview, April 2004). Subsequently, Plum Creek does not consider cumulative impacts of forest management activities that occur over time and on a larger spatial scale than in a particular stand of trees. However, activities occurring at the same time in different parts of the landscape may have much greater total effects on wildlife than could be expected from looking at a single stand or activity (Taylor et al., 1997).

Hence, active adaptive management is limited by the: 1) failure to use null and alternative hypotheses, 2) lack of replicates of treatment and control units, 3) lack of treatment and control units in time and space, to control for random variation; and 4) failure to allocate treatments in space and in time to control for bias and environmental gradients. While it may be impractical or impossible to employ replicates at the large scale for forestry, extrapolating results of replicable treatments from the small scale to the large scale can be controversial and uncertain (Taylor et al., 1997).

**Passive adaptive management**
**Monitoring.**
Plum Creek is employing passive adaptive management where learning occurs primarily through monitoring, descriptive and observational studies, expert opinion and local knowledge (Tribal and State agency observations and recommendations). Adaptive management is linked to a monitoring program designed to address key aspects of the HCP where assumptions and modeling were used to address gaps in empirical data or experience (Central Cascades 2000). For example, monitoring is conducted for the purpose of recalibrating the spotted owl carrying capacity model. However, the spotted owl carrying capacity model is assumed correct without factoring threats to the landscape, i.e. relationship between harvesting and spotted owl declines, and cumulative effects. In addition, external factors such as changes in the populations of their competitor, predator, and prey populations and fluctuations in the physical environment are not considered. Monitoring is also conducted to establish species baseline data and to detect trends in spotted owl demography, breeding bird surveys, and habitat conditions. This information provides circumstantial evidence to support or reject a particular management activity (Taylor et al., 1997).
Finally, Plum Creek monitors aquatic species and habitat to ensure that forestry best management practices (BMPs) for water quality are implemented as intended and comply with state regulations. Aquatic species presence and watershed health is assessed through stream surveys, stream temperature monitoring, and watershed analysis. All terrestrial and aquatic monitoring activities have designated reporting intervals for plan evaluation by Plum Creek and the USFWS. The maintenance of targeted forest structure and spotted owl habitat (nesting, roosting, and foraging--NRF) percentages in the Planning Area are reported on an annual basis. These activities are identified as short-term objectives.

**Compliance**

In addition to measuring the achievement of short-term objectives, the terrestrial and aquatic resource monitoring and reporting schedule serves as a vehicle to determine compliance. Plum Creek, endorsed by the Services believes that they are in compliance with the HCP requirements and that short-term objectives are being met. The company is implementing the HCP as agreed with two exceptions. First, an amphibian study has been temporarily discontinued. Second, Plum Creek will extrapolate best management practices from completed watershed analysis to nearby watersheds that have not gone through the watershed analysis process. Deviations from the implementation agreement for efficiencies and cost effectiveness have been approved by the Services. The monitoring timeline indicates that learning will diminish overtime as the company finds quick solutions that provide a cost-effective means of conservation.

Collaboration has benefited Plum Creek by providing a means to share the costs of research and to demonstrate the performance of the HCP. Monitoring and research activities are coordinated and shared with local universities, the Department of Fish and Wildlife and the USFS (Plum Creek staff interview, April 2004; Central Cascades 2000).

**Best management practices**

Plum Creek is most concerned about cost effective conservation measures and efficiencies that benefit natural resources in the HCP. The company views certainty to be essential for making strategic decisions and future investments. A decision to change management practices involves the weighing of “economic feasibility, biological credibility, legal defensibility and social responsibility (Plum Creek staff interviews, April 2004)”. Thus, Plum Creek does not view the HCP from a biological standpoint alone, but also from a legal and business perspective (Plum Creek staff and Services interview 2004).

HCP baseline prescriptions are derived from and monitored by the Forestry BMPs and State Forest Practices Rules and Regulations. Plum Creek uses BMPs to mitigate the impacts of forest management on water quality as proscribed by Section 319 of the Clean Water Act. BMPs are implemented through Plum Creek’s watershed analysis and riparian management strategy. Although Washington’s forestry regulations are considered stringent comparative to other states’, the strict adherence to BMPs and regulations without testing mitigation effectiveness through experimentation limits Plum Creek’s flexibility and willingness to learn about the ecosystem structure and function. Testing mitigation effectiveness is essential for understanding habitat conditions for the spotted owl.

**Resources for adaptive management**

The aquatic and terrestrial natural resources for which adaptive management is applied, consists of watershed analysis and spotted owl monitoring. Although the riparian management strategy is identified in the HCP as an opportunity for adaptive management, watershed analysis drives riparian management. Riparian management prescriptions are identified in the HCP as a baseline of protection for fish and non-fish bearing streams. Strategies for protection include buffer creation and road management prescriptions. These prescriptions are refined through the process of watershed analyses, which is also the linchpin of Plum Creek’s aquatic monitoring strategy. Cooperative experimentation with the USFS was also identified as an adaptive management opportunity, but such activity has not transpired. Some of the reasons for not cooperatively experimenting include: (1) irreconcilable differences in Plum Creek and USFS management objectives, (2) private property rights and assurances politics in the 1990s, (3) a land exchange between Plum Creek and the USFS, (4) changes in USFS priorities, and (5) the lack of USFS funding.

**Watershed analysis**

The watershed analysis process has the potential for hypothesis testing and the understanding of cumulative effects. However, Plum Creek has conceded to extrapolating best management practices from completed watershed analysis to nearby watersheds. Active adaptive management would be the solution for understanding key processes and relationships in the watershed. Ironically, the lack of scientific certainty about processes and their
relationships was the very reason Plum Creek decided to extrapolate (5 Year Review, May 2001). By applying replicates and a wide range of treatments throughout the HCP project area the company can understand the effectiveness of watershed analysis prescriptions. However, watersheds must be similar and treatments must produce differential responses (Hilborn, et al., 1996). Finding adequate replication and measurement of replicate response are rare; however, contrary to Plum Creek’s decision to extrapolate, lessons learned on one watershed may not apply to another system (Hilborn et al., 1996).

**Spotted owl monitoring.**

Other than forestry BMPs, the northern spotted owl monitoring strategy serves as an extra layer of harvest restrictions. Given the precipitous decline of spotted owl populations, Plum Creek might consider increasing the frequency of their spotted owl demography studies. At present, surveys are conducted for two consecutive years at seven-year intervals of the permit life. In addition, barred owls are purported to compromise spotted owl detection. This assumption is made because spotted owls are not responding to calls when barred owls are present. However, the survey protocol may no longer be valid for determining spotted owl nest occupation. Thus, Plum Creek might consider changing their current survey techniques (State official, February 2004).

There is potential for replication and transfer of historical experience for wildlife management (Hilborn et al., 1996). At the landscape level, maintaining forest animal diversity depends on maintaining an adequate range of habitats, from early-successional forest to mature and old growth stands (Paper Task Force, 1995). Implementing experiments to understand and compare species response to various harvesting activities (clear cutting, shelterwood, seed tree, and selection) is a way to determine the most effective mitigation strategy. In addition, testing the effectiveness of foraging and dispersal corridors by comparing species response to NRF with FD is another experimental opportunity.

**Institutional outcomes.**

Plum Creek’s Environmental Principles reflect their interest in fish and wildlife protection and company biologists incorporate these principles as they initiate terrestrial and aquatic research. A Sustainable Forestry Initiative is also implemented to sustain all forest values, including non-timber values such as wildlife habitat and water quality. Washington’s Forest Practices Act and Timber Fish and Wildlife Agreement that restrict timber harvest and govern the implementation of private landowner road maintenance and abandonment has been quite costly. In addition, shortly after HCP inception, the company realized their land to be a valuable commodity to numerous stakeholders for conservation, recreational use and development. Subsequently, Plum Creek engaged in a major land exchange with the USFS and has placed a number of stands and watershed administrative units under “Options to Buy”. Having just acquired over 300,000 acres in Oregon, the company is investing in other states and divesting their timber interest in Washington. Plum Creek is now “exploring lands sales in an upcoming HCP and will be looking to amend the Central Cascades HCP in the future, to bring land sales into the HCP as an accepted practice (Plum Creek interview, April 2004)”. Furthermore, Plum Creek now appears to be experiencing a drop in yield following years of extensive clear-cutting to maximize their returns on timber harvest. Regenerating forests, with species mixes, now replace old growth (Plum Creek interview, April 2004). Thus, there may be little economic incentive to maintain remaining old growth for the spotted owl over the long term.

**Conclusion**

Plum Creek has cultivated a very close relationship with the Services in preparing and implementing the HCP. Through negotiation the company was able to convince the Services that adaptive management “does not always have to be formal and that other contextual factors dictate the approach taken…if the company learns, they will change (Services interview, January 2004).” Thus, refinements to existing practices have occurred based upon observations from stakeholders concerned about protecting the last remnants of suitable habitat for the spotted owl. Plum Creek’s passive approach to adaptive management has not yielded new learning derived from an analysis and evaluation of species/habitat response to management strategies. The company has fulfilled their commitment in employing adaptive management for spotted owl monitoring and watershed analysis. However, Plum Creek has not extended itself beyond compliance with the monitoring and reporting schedule for these activities. Thus, it is unclear whether habitat conditions have been sufficiently established for species to inform the achievement of early stage outcomes.
HCPs are vehicles for accomplishing economic objectives and species conservation. This agreement must include incentives that encourage learning over the long term because scientific knowledge for species survival and recovery is often inadequate when the HCP is written. The business of forestry involves long-term management requiring regulatory certainty for timber companies to make future investments (Plum Creek interview, February 2004). In practical terms the rate of learning must be expedient to provide useful information for subsequent decisions (Hilborn et al., 1996). However, it is uncertain that monitoring, watershed extrapolation, and the small spatial and short temporal scale terrestrial experiments provide a platform for adequate learning (Hilborn et al., 1996).

Adaptive management is an iterative process and Plum Creek should expect to learn over the long-term. The value of long-term learning is better knowledge and reduced uncertainty for terrestrial and aquatic resources leading to species survival and recovery. The Services must clearly articulate its expectation for adaptive management and ensure that adaptive management goals are accompanied by measurable objectives that are assessed on a regular timescale. The assessment of results should become more frequent overtime rather than infrequent. Perhaps in the case of Plum Creek, adaptive management should be incorporated into the Sustainable Forestry Initiative. Moreover, foresters should be rewarded for implementing adaptive management. Without corporate commitment and incentives, individuals within organizations cannot build the capacity for learning alone.

Acknowledgements
Special thanks are extended to the Southern Regional Educational Board and the Virginia Tech Graduate School that provided tuition and research support thereby facilitating my pursuit of the doctorate. The U.S. Environmental Protection Agency in Washington, D.C. and in Corvallis, Oregon allowed me the time, office space and travel funds to collect data for my research. The National Science Foundation travel grant obtained through the Auburn University Center Forest Sustainability enabled my participation in the Urban-Rural Interface Conference. Finally, my advisor and dissertation committee encouraged my conference participation and have been a constant support through the doctoral experience.

References
Personal Interview, Plum Creek Timber Staff, February –April 2004, Corvallis Oregon and Seattle, Washington.
Personal Interview, U.S. Fish and Wildlife Service interview, January 24, 2004, Olympia, WA.
Personal interview, Washington Department of Fish and Wildlife, February 2004, Ellensburg, WA.
Using GIS To Rank Forest Restoration Potential: Integrating Core Area, Edge Density And Bird Habitat Criteria In The Kaskaskia River Watershed

Jean C. Mangun, Michael D. Gaskins, Andrew D. Carver, Karl W. J. Williard and James J. Zaczek,
Department of Forestry, Southern Illinois University

Abstract

The Kaskaskia River Watershed in southwestern Illinois is representative of the few remaining large patches of bottomland hardwood forest in the Midwest. Rapid land-use conversion to agriculture and encroaching sprawl from the St. Louis, Missouri metropolitan area have increased fragmentation and decreased the amount of interior forest habitat available for nesting migratory songbirds in the lower Kaskaskia River Corridor. This paper describes a GIS-based approach to prioritize individual landowner parcels in Clinton and Washington counties, Illinois, according to suitability for forest restoration efforts. Parcels were included in the calculations if parcel centers were within a study-defined one mile buffer of the Kaskaskia and its main tributaries. The parcel ranking produced by this study can be used as a decision-support tool to complement the Southwestern Illinois RC&D’s Hole in the Doughnut Land Conservation Program for reducing forest fragmentation in the lower Kaskaskia Watershed.

The Kaskaskia River Watershed in southwestern Illinois contains the state’s largest contiguous forest block, a 7,000 acre tract predominantly composed of bottomland hardwood forest that reaches widths of up to two miles (IDNR 2001). Within the expanse of this remnant forest resides one of the largest breeding bird communities of rare, local, and declining species characteristic of Illinois floodplain forests (Robinson 1997). Encroaching sprawl from the St. Louis, Missouri metropolitan area has shifted the boundary of the urban-rural interface throughout the watershed. Concurrently, rapid land-use conversion to agriculture has increased forest fragmentation thereby decreasing the amount of nesting habitat available for forest interior bird species.

Recognizing the ecological significance of the Kaskaskia River Corridor (KRC), the U.S. Fish and Wildlife Service (FWS) proposed the establishment of a 10,240 acre National Wildlife Refuge along a stretch of the lower river in 1992. Land acquisition was to be on a willing-seller or donor basis only with compensation methods that included: fee title acquisition, leasing of land, or purchase of easements (NASDA 1997). Most of the land under consideration was in private ownership, and the majority of landowners rejected the idea of government acquisition at that time. In response, the FWS agreed to support the formation of a broad-based stakeholder committee that was charged with developing a cooperative stewardship plan to protect KRC resources while allowing private ownership to continue (NASDA 1997). The outcome of these efforts, together with additional input from the region’s Southwestern Illinois Resource Conservation and Development, Inc. (SWI RC&D), was a resource protection strategy that is both private and voluntary.

At present, the bottomland forests and wetlands of the KRC remain uniquely positioned for restoration efforts (SWI RC&D 2002). Specific habitat recommendations made by SWI RC&D include: (1) maintenance of existing forest corridors and significant forest blocks that are being threatened by urban sprawl, agriculture, and general land conversion; and (2) reduction of bottomland hardwood forest fragmentation with special consideration given to developing additional, large contiguous forested tracts (SWI RC&D 2002). The ongoing SWI RC&D Hole in the Doughnut Land Conservation Program, has prepared a georeferenced database that delineates privately owned land parcels and remaining forest cover in the KRC.

A need exists for an objective, quantitative measure that ranks the suitability of individual parcels for conservation or restoration of bottomland forest habitat in the KRC. The purpose of the present study is to develop a parcel ranking using a Multi-Criteria Evaluation (MCE) in a Geographic Information Systems (GIS) environment that incorporates landscape metrics and riparian habitat criteria. This information will be of immediate use to KRC landowners and will have application to similar forested watersheds located in fragmented, agriculturally dominated landscapes across the Midwest.

Previous Work and Present Outlook

Saab’s (1999) analysis of bird-habitat relationships in remnant riparian forests indicates that the surrounding landscape matrix is a more important predictor of avian species occurrence and distribution.
than structural features of either micro or macro-habitat. The development and accessibility of GIS technology and its ability to manage, manipulate, and interpret spatially referenced data (Russell 1997) has facilitated integrated management response to habitat fragmentation at the landscape scale.

A growing body of literature exists that describes using GIS to delineate and quantify fragmentation within forest and riparian habitat. Vogelmann (1995) assessed pattern, extent, and rate of forest fragmentation in southern New England. A negative correlation found between a forest continuity index, derived from the natural logarithms of forest area-to-perimeter ratios, and human population density demonstrated that forest fragmentation increases as human population density increases. A similar study by Fuller (2001) quantified changes in forest area and spatial patterns of fragmentation using a set of four landscape metrics (a fragmentation index, center-versus-neighbors, perimeter-to-area ratio, and the square pixel metric) from eleven watersheds in a rapidly developing northeastern Virginia county.

An earlier pilot study by Ripple and colleagues (1991) tested the feasibility of measuring forest landscape patterns using GIS and a set of spatial statistics that included: a fragmentation index (sensitive to the abundance of patches and the amount of un-fragmented contiguous natural forest); matrix contiguity (natural forested land); interior habitat; and total managed patch edge (clearcut areas). In a similar study, Gustafson and Parker (1994) proposed use of a quantitative fragmentation index to evaluate alternative landscape designs in an Indiana agricultural landscape. The Gustafson-Parker metric was termed a “proximity index” (PX), which quantified the spatial context of a habitat patch in relation to its neighbors. The authors concluded that the spatial distribution of PX values across a landscape could reveal how organisms with specific movement scales perceive the effective fragmentation of the landscape.

Schumaker (1996) modified the concept of a landscape pattern index from one of fragmentation to one of cohesion. An index of patch cohesion was found to be the most effective predictor of habitat connectivity and wildlife dispersal success in old growth forests of the Pacific Northwest (Schumaker 1996). Tinker and colleagues (1998) compared the relative effects of clearcutting and road building on the forest landscape-scale fragmentation patterns of 12 national forest watersheds using a set of pattern metrics and the FRAGSTATS V. 2 spatial analysis program. FRAGSTATS V. 3 (McGarigal, 2002) is used by the present study for computation of landscape metrics that quantify the spatial configuration of the study area.

In addition to the ability to delineate and quantify habitat, a GIS approach has been applied to select and rank the potential suitability of sites for restoration or conservation of riparian and forested wetland vegetation (Narumalani et al. 1997, Russell et al. 1997, Wright and Tanimoto 1998, Carver et al. 2004). For example, areas deemed of critical importance for establishment of riparian vegetation buffer zones were identified along portions of the Iowa River channel by combining a digitized land cover map and GIS thematic layers of soils, hydrology, and areas of potential nonpoint source pollution (Narumalani et al. 1997). Russell and colleagues (1997) used GIS to select sites in a California watershed for riparian wetland preservation or restoration. Potential sites were identified by overlaying a digitized land cover map with a “wetness potential” index derived from USGS digital elevation models. Sites were ranked for preservation or restoration of riparian wetland vegetation according to criteria reflecting area size and proximity to existing riparian areas (Russell et al. 1997). Wright and Tanimoto (1998) incorporated GIS data layers reflecting factors of habitat diversity, land ownership, and development risk into an acquisition priority methodology for privately-owned land parcels within a national recreation area.

Recent research has demonstrated that MCE techniques combined with GIS can be used to develop land-use planning models. A study by Caselton (2000) employed MCE to allocate land-uses within a rapidly urbanizing Illinois county optimally. Carver and colleagues (2004) developed a GIS-based decision-support model for generating tree species planting recommendations based on site characteristics of private lands in the Cache River Basin of southern Illinois. This model can serve as a tool for landowners and decision makers interested in restoring riparian forests or creating managed forested buffer strips.

The objective of the present study is to develop a ranking of candidate parcels for reforestation efforts in the KRC based on habitat suitability criteria for migratory songbirds. Gaps in riparian forest cover are deemed candidates for reforestation if such efforts will reduce edge while increasing forest core area. An important feature of this study is the integration of private land ownership tabular data and digitized land parcel boundaries within a weighted, multi-criteria GIS decision-support framework.
Methods

Study Area. The study area included a segment of the lower KRC, traversing portions of Clinton and Washington Counties between Carlyle Lake and Fayetteville in southwestern Illinois (Figure 1). The analysis focused on a 200m corridor (100m buffer) of the Kaskaskia and its tributaries as the minimum acceptable width for migratory bird occurrence (see Keller et al. 1993).

Data development. Spatial data were assembled to examine current vegetation and land use in the KRC study area. Land-use data were re-classified as necessary into categories of forestland, available agriculture, and unavailable, urbanized land. Geospatial analysis was conducted primarily in raster format using ArcGIS 8.2 (ESRI 2002). Access to digitized maps of the KRC delineating the boundaries of privately owned land parcels was provided by SWI RC&D’s GIS Resource Center. Spatial data included county parcel information developed in ArcGIS shapefile format with Parcel Identification Number (P.I.N.), landowner registry, as well as geographic projection reference information. Land parcels were included in the MCE analysis if parcel centers were within the study-defined one mile floodplain buffer. FRAGSTATS, Version 3 (McGarigal, 2002) was selected for computation of landscape metrics necessary for parcel prioritization. An Excel table conversion was used to make FRAGSTATS tabular output compatible with ArcGIS tables. An ArcView 3.2 MCE extension standardized, weighted and combined nine GIS layers of decision criteria: “available” agricultural land acres; “doughnut hole” gap acres; edge density metric; distance to river value; 200m corridor acres; total forest core area metric; fringe core area acres; distance to primary core value; and primary core area acres. Land parcels were ranked in order of restoration potential importance by containing gaps whose reforestation would create the greatest impact on increasing forest interior area while decreasing the amount of forest edge.

Outcomes and Applications

Visual results of the methodology are presented in Figure 2. The final project GIS map layer provides a color-scale corresponding to restoration potential ranking. Parcel size, ownership data, and ranking score are included in the attribute table associated with the final GIS map of digitized land parcel boundaries.

The immediate application of this analysis is to provide an ecological rationale translated to ownership boundary for Southwestern Illinois RC&D, Inc.’s Hole-in-the-Doughnut Land Conservation Program. Several broader implications can be drawn from the outcomes: the linking of prioritized maps with digital plat maps and landowner addresses can provide a powerful tool for land management agencies and public-private partnerships seeking to: (1) identify high-priority land holdings; (2) automate sample selection for follow-up social science surveys of landowners; or (3) gauge interest for land swaps, sales, or application of incentive-based conservation practices such as conservation easements and enrollment in state and federal conservation reserve programs. The results of this study and similar efforts (Caselton 2000, Carver et al. 2004) further indicate that the MCE technique combined with GIS can assist land-use planners make allocation decisions in a variety of contexts at the urban-rural interface.
Acknowledgements
USDA CSREES McIntire-Stennis Project No. ILLZ-03-R-001;
Kevin Davie, GIS Support Services, SIUC Library Affairs;
Ed Weilbacher, Coordinator, Dave Eustis, Operations Mgr., and Julia Cole, GIS Resource Center,
Southwestern Illinois RC&D, Mascoutah, IL

Literature Cited
McGarigal, K., S. A. Cushman, M. C. Neel, and E. Ene. 2002. FRAGSTATS: Spatial Pattern Analysis Program for Categorical Maps. Computer software program produced by the authors at the University of Massachusetts, Amherst. Available at the following web site: www.umass.edu/landeco/research/fragstats/fragstats.html

Abstract
Increased size of human population and associated human activities adversely affect other species’ abundance, contributing to loss of biodiversity and increased species fragility in a given area. However, the relationship between the spatial distribution of a fixed-size human population and species fragility is not well documented and a generalized finding is lacking. Using country level data published by the International Conservation Union, World Resources Institute, United Nations, World Bank, and Oak Ridge National Laboratory, we conduct a transnational analysis to explore empirically the impact of human dispersion on species fragility. We find that the percent of ecologically fragile species in a country is influenced significantly (positively) by percentage of endemic species in that country and whether it is an island nation. However, we fail to find evidence that the percent of ecologically fragile species is influenced by a Gini-coefficient measure of the concentration in the human population.

Introduction
Species fragility generally refers to the ecological viability of the species population. Succession, endemism, and geography are some natural factors associated with species fragility. Habitat loss, habitat fragmentation, over-exploitation of populations (e.g., hunting or fishing), introduction of invasive species and diseases, pollution, and climate change - are frequently referred to as human-induced factors that affect species fragility (Soule 1991, Berger and Berger 2001, Sanderson et al. 2002). Biodiversity loss – that increases species fragility - is viewed largely as a function of human activities (Soule 1991, Forester and Machlis 1996) and increased human population size is considered as its most important driver (Wilson 1988, Kohn 1999, Cincotta and Engelman 2000, Naves et al. 2003, Liu et al. 2003).

However, even though the impact of alternative distributions of a fixed-size human population has barely been acknowledged, much less investigated thoroughly, by the scientific community, both public agencies and NGOs have formulated and advocate policies to control the dispersion of humans. Advocates of these policies claim they have strong environmental benefits, but evidence in support of their claims is conspicuously absent. For example, it is argued (Ewing et al. 2002) that the SmartGrowth principle of ‘compact building design’ reduces the footprint of new construction and in the aggregate preserves more green spaces for natural services, even though it generates higher runoff and pollutant loads within a development. This is because total runoff and pollutant loads are offset by reductions in surrounding undeveloped areas. But in terms of resource requirements, it seems reasonable to suggest that a fixed-size population requires the same amount of productive resources regardless of dispersion. Consequently, having the population located physically in one place does not necessarily imply that the rest of the area is untouched. Empirical support for these claimed benefits of smart growth and compact building design has not been well established.

Objective and Hypotheses
In this study, our objective is to explore the empirical validity of these claims by examining the impact of human dispersion on species fragility in an international context. Following the claim made by advocates of ‘compact building design,’ we hypothesize that species fragility is related to human dispersion. Specifically, the more uniform is human dispersion in a country, the more fragile are species living within that country, and vice versa.

Literature Review
In their study of human footprint mapping, Sanderson et al. (2002) found that 83% of the earth’s land surface and 98% of the area where it is possible to grow rice, wheat, or maize, is directly influenced by human beings. This implies that human activities, either positively or negatively impact species fragility. Human activities are cited as a prime cause of biodiversity loss (Forester et al. 1996, Kohn 1999, Cincotta and Engelman 2000, Naves et al. 2003, Liu et al. 2003). The causal factors and ultimate consequences of such losses (Wilson, 1988) have been well documented in the literature. Although, the causes of species fragility are complex and vary by social context (Soule 1991), potential anthropogenic drivers of species ecological fragility include deforestation (Rudel 1989), urbanization and urban sprawl (McKinney 2002), human population growth (Meffe et al. 1993), and economic
Researchers investigating links between biodiversity and urbanization stress that urbanization generally reduces biodiversity (Turner et al. 2004, McKinney, 2002) due to habitat loss, particularly for native species. However, some studies have shown (Blair, 1996) that due to invasion of non native species, particularly birds and butterflies, the number of native species decreases while the number of non-native species increases in suburban areas. Conversion of natural habitat to human uses, including urban development, agriculture, and extractive industries such as mining and intensive forestry (Saunders et al., 1991) and invasive species (Czech and Krausman 1999) reduces and fragments the amount of remaining natural habitat, thus increasing species fragility.

Although researchers consistently find that human population size significantly affects species fragility, there is a gap in the literature with respect to linkages between the structure of human populations and species fragility. One salient strand research is that developed by Liu and colleagues (2003), who found that there has been a rapid increase in the number of households and decline in average household size in biodiversity hotspots around the world. They argue that these trends imply higher per capita resource consumption and further pressure on biodiversity conservation. Naves et al. (2003) studied the habitat of Brown Bears in Northern Spain considering the number of villages (human diffusion), which describes human activities and found that villages are negatively associated with bear presence. However, Brown and Laband (2005) examined the impact of spatial concentration among humans across the United States on the fraction of all species identified by NatureServe as imperiled and failed to find a significant effect.

**Methods**

*Data and variables*

A cross-national database was developed for model variables that included the number of fragile species (threatened + endangered) in each country, the number of endemic species, population density, a Gini coefficient (GC) measure of population concentration, per capita gross domestic product (GDP), the total protected area in a country, and an island dummy. Data sources included: The World Conservation Union (IUCN 2003) and World Resources Institute (WRI 2003) for species data, World Bank (WB 2003) and WRI for economic data, United Nations Population Division (UNPD 2003) for population data, and Oak Ridge National Laboratory’s (ORNL, 2002) grided population data to construct our population GC.

Endemic species are those that exist only in a specific country; they are designated as endemic species by IUCN and listed in the WRI Earthtrends Environmental Portal. Population density is the ratio of the total population to the total land area of a country expressed in terms of person per hectare. Protected area in a country is based on IUCN classification of area (category I-V) such as – scientific reserves, national/provincial parks, natural monuments, wildlife sanctuaries/ managed nature reserves, and protected landscapes. Per capita GDP refers to the total value of the final output of goods and services produced by the domestic economy in 1995 constant dollars and is used as a proxy for per capita income.

*Gini Coefficient (GC)*

The Gini coefficient is a measure of inequality. It is based on the Lorenz curve, a cumulative frequency curve that compares skewness in the distribution of a specific variable (e.g. human presence) against a uniform distribution. GC values range from 0 to 1. Country values for our model were computed by superimposing a world political map on a gridded population map developed by ORNL using ArcGIS software. This overlay exercise produced the number of cell counts with corresponding population values for each country. The population GC for a country was then computed using the following formula as suggested by Dixon et al. (1987), and Damgaard and Weiner (2000):

\[
GC = \frac{\sum_{i=1}^{n} \sum_{j=1}^{n} |x_i - x_j| n_i n_j}{2n^2 \mu}
\]

For this study, the above formula is simplified as:

\[
GC = \frac{\left(\sum_{i=1}^{n} \sum_{j=1}^{n} |x_i - x_j| n_i n_j\right)}{2 * \sum_{i=1}^{n} n_i^2 * (\sum_{j=1}^{n} x_j) / \sum n_i}
\]

\[
= \frac{\left(\sum_{i=1}^{n} \sum_{j=1}^{n} |x_i - x_j| n_i n_j\right)}{2 * \sum_{i=1}^{n} n_i * (\sum_{j=1}^{n} x_j)}
\]

where,

\[i = \text{population counts (the number of cells that contain same number of people)}\]

\[j = \text{population values (the number of people per cell)}\]
**Model Specification and Analysis**

Lack of data on endemic species of fish limited the analysis to five taxa of species: amphibians, reptiles, birds, mammals and vascular plants. The total number of threatened, endangered, and vulnerable species in all five taxa, as described by IUCN, was aggregated into a single measure of country-specific species fragility; this permitted us to calculate the percentage of species in each country that is ecologically fragile - - our dependent variable. The independent regressors include – percentage of endemic species, population density, population GC, percentage of protected area, per capita GDP, square of per capita GDP and a dummy variable for geographic position of a country. Both ordinary least squares (Rensberg et al. 2004) and negative-binomial models (Naidoo and Adamowicz 2001) are appropriate for this type of regression analysis. We employed the ordinary least squares method to analyze the log transformed data in the following form:

\[
y_i = \beta_0 + \sum_{j=1}^{p} x_{ij} \beta_j, \quad i = 1, 2, \ldots, 105 \text{ (country)}
\]

\[j = \text{independent variables.}\]

Where, \(y_i\) is the ratio of fragile species to the total species expressed in percentage, and \(x_{ij}\) is the vector of independent regressors. For sign convenience, it is believed that the percent of fragile species is positively related with the percent of endemic species and population density, while it is inversely related with population GC, total protected area, and per capita GDP. All variables were transformed into natural log form and the data analysis was performed using the PROC REG procedure in SAS.

**Results**

The descriptive statistics are reported in Table 1 for the 105 countries (82 mainland and 23 islands) considered in the analysis.

The highest percentage of fragile species is observed in Seychelles (23.743), followed by Mauritius (23.012) and Sri Lanka (13.086), while Switzerland (0.27) has the smallest percentage of fragile species followed by Albania (0.45), and Austria (0.49). The highest percentage of endemic species is found in Australia (88.46), New Zealand (78.26), and Madagascar (68.36), while the lowest are found in Switzerland (0.029), Sweden (0.047), and Norway (0.049).

Population density is highest in Singapore (6,477 person/ha) and lowest in Mongolia (1.6 person/ha). Population dispersion index indicates that countries like Singapore (0.5897), Togo (0.6515), and Rwanda (0.6529) are more uniformly populated than countries such as Libya (0.9989), Mongolia (0.9986) and Australia (0.9981), which have highly concentrated human populations. Per capita GDP is highest in Japan ($37,500.46), Norway ($37,313.98), and the U.S. ($34,252.62) and least in Ethiopia ($99.52), Sierra Leone ($144.07), and Malawi ($150.10). Columbia (72.3%), Venezuela (70.3%), and Belize (56.2%) have the highest percentage of protected area and the Solomon Islands (0.1%), Libya (0.1%) and Lesotho (0.2%) have the least protected area.

Multiple regression results are presented in Table 2. The percent of endemic species and the island dummy are the only significant predictors of species fragility at the conventional (5%) significance level.

**Discussion**

The coefficient estimates are based on double log form of the model, so they can be treated as a measure of elasticity. For example, the coefficient for the percent of endemic species variable suggests that for 1% increase in the percent of endemic species there will be 0.19 % increase in the percent of ecologically fragile species. Our results support the findings of Brown and Laband (2005), who conducted a similar analysis within the United States and also failed to find evidence that concentration of the human population is related to species fragility. The statistically insignificant relationship between both per capita GDP and percent protected area with species fragility is rather surprising. A similar, but taxa-specific, study by Naidoo and Adamowicz (2001) found that per capita GDP is significantly (positively) related to imperilment of birds and significantly (negatively) related to imperilment of plants, amphibians, reptiles, and invertebrates.

The dummy variable used to separate island effects from mainland effects on species fragility was a strong predictor in every model we estimated. Out of 105 countries, 23 are islands with high population densities and high species richness. On average each island country has 5.4 % fragile species, 29.35%
endemic species and 511 people per hectare, while each mainland country has 1.64% fragile species, 8.8% endemic species and a population density of 79 person her hectare. This suggests that the relative importance of population dispersion may be 'hidden' in a model with both island countries and mainland countries included in a single sample. There may be structural differences between island countries and mainland countries with respect to the factors that influence species’ ecological fragility and in future work we plan to estimate separate models to investigate whether this is supported by the data.

We also note that our analysis was conducted at an aggregate level - with information from 5 taxa added together. However, not all taxa are created equal. The vascular plants, for example, are much more numerous than the other four taxa combined. Moreover, the impact of humans may not be consistent across taxa. Consequently, our aggregate analysis may mask important taxa-specific impacts. This additional level of analysis also awaits our attention.

Conclusion

In our analysis, we fail to find evidence to support the hypothesis that species’ ecological fragility is influenced by human population dispersion. In the absence of previous empirical support for this hypothesis, this raises a legitimate and highly relevant question regarding the scientific basis of the claims made about the ecological benefits to be had from public policies that ‘encourage’ humans to locate in densely populated urban areas. We do not claim to have shed definitive light on the underlying hypothesis, especially because our aggregate analysis may mask taxa-specific effects. However, our analysis does underscore the lack of science that currently girds public policy and suggests the very real possibility that there simply is no scientific evidence to support some of the claims that have been made about the benefits of SmartGrowth.

References

ORNL 2002. LandScan Global Population 2002 Database. Can be assessed at World Wide Web homepage:


Table 1: Descriptive statistics of model variables (N = 105).

<table>
<thead>
<tr>
<th>Variable</th>
<th>Mean</th>
<th>Std Dev</th>
<th>Minimum</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Percent Fragile Species</td>
<td>2.463</td>
<td>3.535</td>
<td>0.269</td>
<td>23.743</td>
</tr>
<tr>
<td>Percent Endemic Species</td>
<td>13.284</td>
<td>18.229</td>
<td>0.030</td>
<td>88.463</td>
</tr>
<tr>
<td>Population density</td>
<td>173.647</td>
<td>640.086</td>
<td>1.596</td>
<td>6477.420</td>
</tr>
<tr>
<td>Population GC</td>
<td>0.867</td>
<td>0.097</td>
<td>0.589</td>
<td>0.998</td>
</tr>
<tr>
<td>Per capita GDP</td>
<td>6274.430</td>
<td>9292.810</td>
<td>99.523</td>
<td>37500.460</td>
</tr>
<tr>
<td>Percent Protected Are</td>
<td>13.336</td>
<td>12.996</td>
<td>0.100</td>
<td>72.300</td>
</tr>
</tbody>
</table>

Table 2: Multiple Regression Results – Dep. Var. = % species imperilment

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Estimate</th>
<th>Std. error</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>0.73810</td>
<td>1.81967</td>
<td>0.6859</td>
</tr>
<tr>
<td>Endemic Species</td>
<td>0.18297</td>
<td>0.04664</td>
<td>0.0002</td>
</tr>
<tr>
<td>Population Density</td>
<td>0.02562</td>
<td>0.05783</td>
<td>0.6587</td>
</tr>
<tr>
<td>Gini Coefficient</td>
<td>0.89632</td>
<td>0.83273</td>
<td>0.2844</td>
</tr>
<tr>
<td>Per Capita GDP</td>
<td>0.17415</td>
<td>0.46879</td>
<td>0.7111</td>
</tr>
<tr>
<td>Per capita GDP2</td>
<td>0.01402</td>
<td>0.02977</td>
<td>0.6388</td>
</tr>
<tr>
<td>Protected Area</td>
<td>0.03335</td>
<td>0.05491</td>
<td>0.5450</td>
</tr>
<tr>
<td>Island</td>
<td>0.71922</td>
<td>0.19545</td>
<td>0.0004</td>
</tr>
</tbody>
</table>
Brij Mandal, India: Minimum operating plants diversity from the social perspective.

Nurmira M. Jamangulova, Ph.D., School of Public and Public Affairs, Indiana University

In the beginning were the waters. Matter readied itself. The sun glowed. And a lotus slowly opened, holding the universe on its golden pericarp. Indian creation myth.

Introduction

The area of Brij Mandal lies at latitude 27°14' to 26°58' N and longitude 77°15' to 78°15'E in northern India (Fig.1). It covers the entire Mathura district, the southwest of Alligarh, Agra and Firozabad districts of Uttar Pradesh and the southeast of Rajasthan (Bharatpur district) state.

The area of Brij Mandal was covered by tropical broad-leafed forest in the ancient times (BCE) but now it has been changed dramatically and there are only open thorn forests in existence. Brij Mandal has important religious, cultural and other impacts for all of India.

Brij Mandal covers the entire area of the Taj Trapezium Zone (TTZ) which is an attempt of the international scientific community to preserve the Taj Mahal, one of the seven wonders of the world. The Taj Mahal attracts people from all over the world. It has survived many historical cataclysms. Unfortunately, in the recent past, the marble of the Taj Mahal has started yellowing. It is being destroyed by air pollution, and by pollution of the Yamuna River and contamination of soil. In this situation, the diversity of plants, which are an important factor in reducing pollution, needs to be studied. As well, the changing diversity of plants in the TTZ reflects the historical changes in the society. Thus, through study of different sources comparative study of plant diversity changes was undertaken.

Background

Much of the world’s threatened biodiversity resides in the developing world; India contains significant plant biodiversity (Table 1). Since biodiversity conservation is not, understandably, a priority for the developing world, the resources needed for conservation must come from the North, while political commitment must come from the South and North alike, (Pearce, 1994).

Conservation priorities have to be defined in terms of both ecosystem fragility and biological diversity. The TTZ provides a case of extreme human impact but also long-term conservation of rare native plant species, even as the overall plant cover has been significantly altered.

According to Gadgil (1987), the diversity of life on earth is currently under serious treat; so is the diversity of human cultures. The intriguing question is: apart from establishing rights over resources, will the local communities, once they have returned to power in their own countries, bring back some of their earlier cultural traditions of conservation of biological diversity? There are some signs of this happening; for instance in the Valley of Flowers in Garhwal Himalayas and sacred groves on the Western Ghats tract, local farmers have taken the lead in establishing new sacred groves.

Plant use varies among cultures in India even in a single location. Gadgil and Thapar (1991) studied 25 plant species in different uses in Sirsitaluk of Uttara Kannada district of Karnataka State. The resource use was highly diversified. For instance, only Christians employed cane (Calamus sp.) to produce furniture, and only Chamagars used Phoenix palm to produce mats and brooms. Although both Badigars and Acharis use wood from Careya arborea, they fabricate different articles from it.

The variety of uses of plants is mentioned in age-old texts like the Rigveda (4000 - 1500 BCE), the Atharvaveda (1500 BCE), the Upanishada (1000 - 600 BCE) and Puranas (700 - 400 BCE), etc. “Memoirs of Babur” and other books written by
Mughal Emperors and palace poets, large number of photos give us an expression of that time plant diversity.

In more recent times, economic botany, ethnobotany, and other branches of botany also describe the uses of plants; plant use in India is thus well described (King 1869; Boadling 1925, 1940; Schultes 1941; Jones 1941; Ammal 1951 – 1954; Faulks 1958; Jain 1963, 1964, 1965, 19 67; Jain 1986, 1999). In Brij Mandal area, local studies of the flora of Agra district (Sharma and Dhakre 1995), Mathura district (Singh 1980) and Kaladeo National Park (Prasad, 1988, 1989; Prasad et al. 1991; Prennou and Ramesh 1987) have been undertaken.

Singh (1975) during the course of his phytosociological studies recorded 73 plants from Chalesar in the TTZ. In the rainy season there were 62 plant species, of which 1 herb, 13 grasses, 8 climbers, 7 shrubs, and 3 species of trees were common. During winter, the number of plants decreased to 41 which included 2 trees, 7 shrubs, 3 climbers, 2 herbs and 4 grasses. Prakash (1987) during his ecological study on Yamuna river bank plants at Agra recorded 14 trees (Acacia nilotica, Azadirachta indica, Borassus flabellifer, Casuarina equisetfolia, Dalbergia sissoo, Ficus bengalensis, F. religiosa, Phoenix sylvestris, Pongamia pinnata, Prosopis juliflora, Ricinus communis, Tamarix dioica – Tamarindus indica and Ziziphus mauritiana), 2 shrubs (Capparis decidua and C. sepiaria) and 25 crop weeds (most commonly Achyranthus aspera, Calotropis procera, Chenopodium album, Spergula arvensis, Tridax procumbens, and Vicia hirsuta). Chand (1986) in his studies of vegetation ecology of Fatehpur Sikri (another part of the TTZ) recorded 149 plant species.

Methods

I gathered plants from the two forests of the TTZ as well as in sacred groves, fields, and gardens. I did not visit all such areas in TTZ but attempted to document the breadth of plant diversity. I monitored a total of 10 plots among these four types (forest, sacred grove, field and garden) in order to document changes in plant diversity over the period November 1999 – December 2001 (Fig.1). I was also able to document change by comparing historical photographs and present-day observation. I investigated the uses of plants by the people living in TTZ through conversations with landowners, forest rangers, botanists, and local doctors, as well as through observations of fields and gardens. Finally, I read ancient and historical texts, both sacred and secular, that documented life in the TTZ to find references to sacred and useful plants.

Results And Discussion

The minimum operating plant diversity in Brij Mandal/TTZ, as in many human-dominated ecosystems, is only 20-30% of the plants present in the region. Regarding the number of species per activity, the medicinal plants (15 spp.) and common plants (15 spp.) are most diverse (Table 2), edible fruits (13 spp.) ranked second, then grazing plants (11 spp.). Interestingly, endangered species and sacred species are equally numerous (10 spp.). Nine species are used as fuel plants, 7 species are used for various daily use, and 7 for timber. Seven exotic plants were recorded, several of which are also listed as common used species, despite their foreign origins. Table 2 shows species according to their uses (A – H) and according to numerical status and origin (J – K).

The fact of using medicinal plants is a revival of Aurvedic traditions in Brij Mandal area; strong respect for plants is vital for local population. Allelopathic medicines are used for acute and urgent situations. Homeopathic doctors are very famous among all social groups and home-grown medicinal plants are considered as a fundamental domestic need. Almost every household has its own Acacia nilotica, Azadirachta indica, Aloe vera tourn, and Ocimum tenuiflorum. These are widely used plants for many purposes. Hibiscus rosa-cinensis has become more an ornamental plant rather than medicinal. Adhatoda vasica is a plant which grows widely has medicinal value, but not many families use it. However, plants are a traditional source of cures, and are regarded by local people as pure medicines without any side-effects. People are very knowledgeable of uses of plants for medicine.

Demographically, the population of the area is not rich and many families depend on natural resources such as fruits and forage for their cattle. For instance, mango trees are grown not only for the family fruit supply but also as for financial income. However, compared to other South Asian countries, the diversity of plants with social value in India is becoming more and more degraded. In many parts of the world, wild species and natural habitats still help support household food security – access by all people at all times to the food they need for a healthy life. In Nepal, for example, 135 tree species are used as fodder. In Ghana, most people depend on wildlife for their requirement of animal protein (Kumar,
The Mughals (1508 – 1857) introduced several different plant species. At the time of the early arrival of Mughals described in the “Memoirs of Babur” (written by the first Mughal ruler), there was no abundance of plants: “Three things oppressed us in Hindustan – its heat, its violent winds, its dust”. To recreate the floral wealth of Kashmir, which had impressed them when they traveled through it, the Mughals planted big gardens from Kashmir to South India. Agra city, which is a part of the Brij Mandal area, was established as a Mughal Empire capital and thus palaces with gardens were built. The Mughal period left behind beautiful gardens as Taj, Fatehpur Sikri, and Agra Fort. New species such as Platanus orientalis, Jasminium spp., Carissa carandus etc. were introduced in Brij.

The British period (1750 AD – 1947 AD) started after the death of last Mughal Emperor, Aurangzeb. The land use system was reformed and in 1773, the British introduced the system of auctioning the right of collecting revenue from the area to the highest bidder. The settlement destroyed the old village community, and changed the property relations. During this time, the deforestation rate was at its peak level because of clearing the forest to construct railways and highways. New exotic species were introduced: Eucalyptus spp. for timber production, Argemone mexicana and Prosopis juliflora for soil degradation. These species almost outcompeted native species, which were stressed by the long drying trend which had been occurring over centuries.

The contemporary Taj Trapezium Zone (TTZ) can be characterized as an area with poor plant diversity. There is an urgent need to plant more endemic plants as Ficus benghalensis, F. religiosa, F. racemosa, Mitragyna parvifolia, Mangifera indica, etc. in order to protect historical plant diversity. And exotic species as Eucalyptus spp., Prosopis juliflora and Capparis sepiaria need to be cut or at least not further planted due to their high water absorption and aggressive growth habits.

Jeffries (1997) lists the ultimate causes of loss of biodiversity as resource use, cultural attitudes, institutional failure and perhaps most pressing of all the failure of existing economic systems. Along similar lines, Gaston (2004) lists the principle proximate causes of biodiversity loss as: (i) direct exploitation; (ii) habitat loss, degradation and fragmentation; (iii) the effects of introduces species; and (iv) extinction cascades and the ultimate causes are the size of the human population, the rate of human population growth and the scale of the human enterprise etc. Pearce (1994) points out that if the
country in question receives no financial or other resources to pay for the global benefits that arise from its biodiversity (e.g., if biodiversity is conserved in a tropical forest, it yields a benefit to people in other countries, too) that country will have no incentive to look after its biological resources.

Conclusions

Minimum operating plant diversity from the social perspective reflects the changes of plants used by humans and thus gives us an opportunity to follow and analyze interlinked and interdependent social and ecological processes. The concept of minimum operating plant diversity can be used as a cross-disciplinary tool for systematic analyses which combines social processes and their botanical responses.

The precise start of the current biodiversity crisis, defined by the impact of humans, is hard to delimit. Unusual bursts of extinction coincided with the cultural values and land use system change in Ancient Brij Mandal or modern Taj Trapezium Zone.

In a period of globalization and market economy previous and current ‘hot-spots’ are being demolished. Cultural diversity is becoming homogeneous, which brings changes in plant diversity, too. Changes in plant diversity are difficult to evaluate because there are so many frames of reference that may apply. Whose perspective will control what grows in Brij Mandal now? Rapid urbanization processes should preserve its sacred plots and respect cultural diversity.

References


Chand, V. 1986. Investigations in vegetation ecology and flora of Fatehpur Sikri. Agra College, Dr. B. R. Ambedkar University, Agra


**Table 1.** The described and estimated plant diversity in the world and in India\(^1\).

<table>
<thead>
<tr>
<th>Species Described/Species Estimated</th>
<th>World</th>
<th>India</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Total plant species</td>
<td>12,00,000</td>
<td>45,000/50,000</td>
</tr>
<tr>
<td>2. Flowering plant species</td>
<td>3,00,000/5,00,000</td>
<td>15,000/18,000</td>
</tr>
</tbody>
</table>


**Table 2.** Plants of interest to humans in Brij Mandal/TTZ. The subtables A - H show species according to their uses; subtables J – K show species according to numerical status and origin.

### A. Medicinal plants

<table>
<thead>
<tr>
<th>N</th>
<th>Botanical name</th>
<th>Family</th>
<th>Uses</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Abutilon indicum</td>
<td>Malvaceae</td>
<td>Diarrhea, inflammation, fever, nerve tonic</td>
</tr>
<tr>
<td>2.</td>
<td>Acacia nilotica</td>
<td>Fabaceae</td>
<td>Diarrhea, stomata, conjunctivitis</td>
</tr>
<tr>
<td>3.</td>
<td>Achyranthes aspera</td>
<td>Amaranthaceae</td>
<td>Insect bites, hastens labor pains</td>
</tr>
<tr>
<td>4.</td>
<td>Adhatoda vasica</td>
<td>Acanthaceae</td>
<td>Asthma, antispasmodic, dysentery, epilepsy</td>
</tr>
<tr>
<td>5.</td>
<td>Aloe vera tourn</td>
<td>Liliaceae</td>
<td>Hair tonic, skin disease, constipation</td>
</tr>
<tr>
<td>6.</td>
<td>Argyreia speiosa</td>
<td>Convolvulaceae</td>
<td>To cure swelling, nerve system</td>
</tr>
<tr>
<td>7.</td>
<td>Asparagus racemosus</td>
<td>Liliaceae</td>
<td>Dysentery, inflammation, blood, liver, eye disorders</td>
</tr>
<tr>
<td>8.</td>
<td>Azadirachta indica</td>
<td>Meliaceae</td>
<td>Blood purifier, leucoderma, liver, tooth brush</td>
</tr>
<tr>
<td>9.</td>
<td>Datura metel</td>
<td>Solanaceae</td>
<td>Asthma, bronchitis, rheumatism, neuralgic pains, dandruff</td>
</tr>
<tr>
<td>10.</td>
<td>Hibiscus rosa-cinensis</td>
<td>Malvaceae</td>
<td>Irritation of genito-urinary tracts, hair tonic</td>
</tr>
<tr>
<td>11.</td>
<td>Nyttanthes nigrum</td>
<td>Oleaceae</td>
<td>Chronic fever, malaria, children round worm, thread worms</td>
</tr>
<tr>
<td>12.</td>
<td>Solanum nigrum</td>
<td>Solanaceae</td>
<td>Enlargement of liver, spleen &amp; jaundice, skin disease, burns</td>
</tr>
<tr>
<td>13.</td>
<td>Tinospora cordifolia</td>
<td>Mevyspermaceae</td>
<td>Rheumatic arthritis, jaundice, genito-urinary disorders, diarrhea</td>
</tr>
<tr>
<td>14.</td>
<td>Terminalia arjuna</td>
<td>Caesalpiniaceae</td>
<td>Diarrhea, inflammation, fever</td>
</tr>
<tr>
<td>15.</td>
<td>Ocimum tenuiflorum</td>
<td>Lamiaceae</td>
<td>Cold, cough, hair tonic, menthol</td>
</tr>
</tbody>
</table>

### B. Fuel resources

<table>
<thead>
<tr>
<th>N</th>
<th>Botanical name</th>
<th>Family</th>
<th>Local name</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Acacia nilotica</td>
<td>Mimosaceae</td>
<td>Babul</td>
</tr>
<tr>
<td>2.</td>
<td>Azadirachta indica</td>
<td>Meliaceae</td>
<td>Neem</td>
</tr>
<tr>
<td>3.</td>
<td>Capparis sepia</td>
<td>Capparaceae</td>
<td>Heens</td>
</tr>
<tr>
<td>4.</td>
<td>Dalbergia sissoo</td>
<td>Fabaceae</td>
<td>Shisham</td>
</tr>
<tr>
<td>5.</td>
<td>Ficus racemosa</td>
<td>Moraceae</td>
<td>Gular</td>
</tr>
<tr>
<td>6.</td>
<td>Prosopis juliflora</td>
<td>Moraceae</td>
<td>Vilayati babul</td>
</tr>
<tr>
<td>7.</td>
<td>Salvador persica</td>
<td>Salvadoraceae</td>
<td>Pilu</td>
</tr>
<tr>
<td>8.</td>
<td>Tamarindus indica</td>
<td>Caesalpiniaceae</td>
<td>Imli</td>
</tr>
<tr>
<td>9.</td>
<td>Tamarix spp.</td>
<td>Tamaricaceae</td>
<td>Jhaau</td>
</tr>
</tbody>
</table>

### C. Grazing resources

<table>
<thead>
<tr>
<th>N</th>
<th>Botanical name</th>
<th>Family</th>
<th>Local name</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Acacia catechu</td>
<td>Mimosaceae</td>
<td>Khair</td>
</tr>
<tr>
<td>2.</td>
<td>Acacia nilotica</td>
<td>Mimosaceae</td>
<td>Babul</td>
</tr>
<tr>
<td>3.</td>
<td>Anageius pendula</td>
<td>Combretaceae</td>
<td>Dhoy</td>
</tr>
<tr>
<td>#</td>
<td>Botanical name</td>
<td>Family</td>
<td>Local name</td>
</tr>
<tr>
<td>----</td>
<td>-------------------</td>
<td>-------------</td>
<td>--------------------</td>
</tr>
<tr>
<td>4</td>
<td>Balanites roxburghii</td>
<td>Rutaceae</td>
<td>Hingota</td>
</tr>
<tr>
<td>5</td>
<td>Carissa spinarum</td>
<td>Apocynaceae</td>
<td>Karunda</td>
</tr>
<tr>
<td>6</td>
<td>Diospyros melanoxylon</td>
<td>Ebenaceae</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Flaucortia indica</td>
<td>Flaucortiaceae</td>
<td>Khatai</td>
</tr>
<tr>
<td>8</td>
<td>Lantana indica</td>
<td>Verbenaceae</td>
<td>Tulsidal</td>
</tr>
<tr>
<td>9</td>
<td>Mayenus emarginata</td>
<td>Celastraceae</td>
<td>Kakera</td>
</tr>
<tr>
<td>10</td>
<td>Woodfordia fruticosa</td>
<td>Celastraceae</td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>Ziziphus nummeralia</td>
<td>Rhamnaceae</td>
<td>Jharber</td>
</tr>
</tbody>
</table>

**D. Timber plants**

<table>
<thead>
<tr>
<th>#</th>
<th>Botanical name</th>
<th>Family</th>
<th>Local name</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Dalbergia sissoo</td>
<td>Fabaceae</td>
<td>Shisham</td>
</tr>
<tr>
<td>2</td>
<td>Tectona grandis</td>
<td>Mimosaceae</td>
<td>Sagwan</td>
</tr>
<tr>
<td>3</td>
<td>Acacia nilotica</td>
<td>Mimosaceae</td>
<td>Babul</td>
</tr>
<tr>
<td>4</td>
<td>Azadirachta indica</td>
<td>Meliaaceae</td>
<td>Neem</td>
</tr>
<tr>
<td>5</td>
<td>Eucalyptus spp.</td>
<td>Myrtaceae</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Mangifera indica</td>
<td>Anacardiaceae</td>
<td>Aam</td>
</tr>
</tbody>
</table>

**E. Edible fruits**

<table>
<thead>
<tr>
<th>#</th>
<th>Botanical name</th>
<th>Family</th>
<th>Local name</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Psidium guava</td>
<td>Myrtaceae</td>
<td>Amrood</td>
</tr>
<tr>
<td>2</td>
<td>Phyllanthus emblica</td>
<td>Euphorbiaceae</td>
<td>Amla</td>
</tr>
<tr>
<td>3</td>
<td>Ziziphus mauritania</td>
<td>Rhamnaceae</td>
<td>Ber</td>
</tr>
<tr>
<td>4</td>
<td>Aegle marmelos</td>
<td>Rutaceae</td>
<td>Bel</td>
</tr>
<tr>
<td>5</td>
<td>Punica granatum</td>
<td>Punicaceae</td>
<td>Anar</td>
</tr>
<tr>
<td>6</td>
<td>Artocarpus heterophyllus</td>
<td>Moraceae</td>
<td>Kathal</td>
</tr>
<tr>
<td>7</td>
<td>Grewia subinaqualis</td>
<td>Tiliaceae</td>
<td>Falsa</td>
</tr>
<tr>
<td>8</td>
<td>Citrus lemonum, cinensis, reticulata</td>
<td>Rutaceae</td>
<td>Nimbu</td>
</tr>
<tr>
<td>9</td>
<td>Carissa carentua</td>
<td>Apocynaceae</td>
<td>Karonda</td>
</tr>
<tr>
<td>10</td>
<td>Tamaindus indica</td>
<td>Caesalpiniaceae</td>
<td>Imli</td>
</tr>
<tr>
<td>11</td>
<td>Mangifera indica</td>
<td>Anacardiaceae</td>
<td>Aam</td>
</tr>
<tr>
<td>12</td>
<td>Moris indica</td>
<td>Moraceae</td>
<td>Shahtut</td>
</tr>
</tbody>
</table>

**F. Crops**

<table>
<thead>
<tr>
<th>#</th>
<th>Botanical name</th>
<th>Family</th>
<th>Local name</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Pennisetum typhoides</td>
<td>Poaceae</td>
<td>Bajra</td>
</tr>
<tr>
<td>2</td>
<td>Sorgum vulgaris</td>
<td>Poaceae</td>
<td>Jowar</td>
</tr>
<tr>
<td>3</td>
<td>Cajanus cajan</td>
<td>Malvaceae</td>
<td>Cotton</td>
</tr>
<tr>
<td>4</td>
<td>Zea mays</td>
<td>Poaceae</td>
<td>Maize</td>
</tr>
<tr>
<td>5</td>
<td>Triticum aestivum</td>
<td>Poaceae</td>
<td>Wheat</td>
</tr>
<tr>
<td>6</td>
<td>Cicer arietinum</td>
<td>Poaceae</td>
<td>Gram</td>
</tr>
<tr>
<td>7</td>
<td>Hordeum vulgare</td>
<td>Poaceae</td>
<td>Barley</td>
</tr>
<tr>
<td>8</td>
<td>Lens culinare</td>
<td>Poaceae</td>
<td>Masur</td>
</tr>
<tr>
<td>9</td>
<td>Phaseolus mungo</td>
<td>Fabaceae</td>
<td>Urd</td>
</tr>
<tr>
<td>10</td>
<td>Brassica juncea</td>
<td>Brassicaceae</td>
<td>Mustard</td>
</tr>
<tr>
<td>11</td>
<td>Nicotiana tobaum</td>
<td>Solanaceae</td>
<td>Tobacco</td>
</tr>
<tr>
<td>13</td>
<td>Saccarum ofticinarum</td>
<td>Poaceae</td>
<td>Sugar-cane</td>
</tr>
<tr>
<td>14</td>
<td>Arahis hypogea</td>
<td>Fabaceae</td>
<td>Ground-nut</td>
</tr>
<tr>
<td>15</td>
<td>Crotalaria juncea</td>
<td>Fabaceae</td>
<td>Sheh-hemp</td>
</tr>
<tr>
<td>16</td>
<td>Phaseolus tribulus</td>
<td>Fabaceae</td>
<td>Chawal</td>
</tr>
</tbody>
</table>

**G. Daily use plants**

<table>
<thead>
<tr>
<th>#</th>
<th>Botanical name</th>
<th>Family</th>
<th>Uses</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Chenopodium album</td>
<td>Chenopodiaceae</td>
<td>Vegetable</td>
</tr>
<tr>
<td>2</td>
<td>Argemone mexicana</td>
<td>Papaveraceae</td>
<td>Reclaim “usar” land</td>
</tr>
<tr>
<td>3</td>
<td>Brassica campestris</td>
<td>Brassicaceae</td>
<td>Seeds for anointing the body</td>
</tr>
<tr>
<td>No.</td>
<td>Botanical name</td>
<td>Family</td>
<td>Local name</td>
</tr>
<tr>
<td>-----</td>
<td>----------------------</td>
<td>-----------------</td>
<td>----------------------------</td>
</tr>
<tr>
<td>4</td>
<td>Abutilon campestris</td>
<td>Malvaceae</td>
<td>Making ropes</td>
</tr>
<tr>
<td>5</td>
<td>Cassia fistula</td>
<td>Caesalpiniaceae</td>
<td>Dying, vitamin for new born child</td>
</tr>
<tr>
<td>6</td>
<td>Acaia nilotica</td>
<td>Mimosaceae</td>
<td>Fuel, medicine, tanning</td>
</tr>
<tr>
<td>7</td>
<td>Carandrum sativum</td>
<td>Umbelliferae</td>
<td>Vegetable, spices, pickles</td>
</tr>
<tr>
<td>8</td>
<td>Jasminium spp.</td>
<td>Oleaceae</td>
<td>Ornamental and worshipping plant</td>
</tr>
<tr>
<td>9</td>
<td>Rosa damascena</td>
<td>Rosaceae</td>
<td>Gulab, making sweets</td>
</tr>
<tr>
<td>10</td>
<td>Santalum spp.</td>
<td>Santalaceae</td>
<td>Chandan, in worshipping ceremonies</td>
</tr>
</tbody>
</table>

**H. Worshipping plants**

<table>
<thead>
<tr>
<th>No.</th>
<th>Botanical name</th>
<th>Family</th>
<th>Local name</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Ficus religiosa</td>
<td>Moraceae</td>
<td>Peepal</td>
</tr>
<tr>
<td>2</td>
<td>Aegle marmelos</td>
<td>Rutaceae</td>
<td>Bel</td>
</tr>
<tr>
<td>3</td>
<td>Polyalthia longifolia</td>
<td>Rhamnaceae</td>
<td>Ashok</td>
</tr>
<tr>
<td>4</td>
<td>Ziziphus mauritania</td>
<td>Rhamnaceae</td>
<td>Ber</td>
</tr>
<tr>
<td>5</td>
<td>Ocimum spp.</td>
<td>Lamiaceae</td>
<td>Tulsi</td>
</tr>
<tr>
<td>6</td>
<td>Mitragyna parvifolia</td>
<td>Rubiaceae</td>
<td>Kadam</td>
</tr>
<tr>
<td>7</td>
<td>Musa paradisiaca</td>
<td>Musaceae</td>
<td>Kel</td>
</tr>
<tr>
<td>8</td>
<td>Jasminium spp.</td>
<td>Oleaceae</td>
<td>Ak gul</td>
</tr>
<tr>
<td>9</td>
<td>Rosa damascena</td>
<td>Rosaceae</td>
<td>Gulab</td>
</tr>
<tr>
<td>10</td>
<td>Santalum spp.</td>
<td>Santalaceae</td>
<td>Chandan</td>
</tr>
</tbody>
</table>

**I. Endangered plants**

<table>
<thead>
<tr>
<th>No.</th>
<th>Botanical name</th>
<th>Family</th>
<th>Local name</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Asparagus racemosus</td>
<td>Liliaceae</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Evroaha carambola</td>
<td>Malvaceae</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Ficus benghalensis</td>
<td>Moraceae</td>
<td>Bargad</td>
</tr>
<tr>
<td>4</td>
<td>Hibiscus spp.</td>
<td>Malvaceae</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Rauwolfia serpentina</td>
<td>Apocynaceae</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Mangifera indica</td>
<td>Moraceae</td>
<td>Aam</td>
</tr>
<tr>
<td>7</td>
<td>Santalum album</td>
<td>Santalaceae</td>
<td>Kand</td>
</tr>
<tr>
<td>8</td>
<td>Saraca asoka</td>
<td>Caesalpiniaceae</td>
<td>Asok</td>
</tr>
<tr>
<td>9</td>
<td>Stachytarpheta indica</td>
<td>Verbenaceae</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>Withania somnifera</td>
<td>Solanaceae</td>
<td></td>
</tr>
</tbody>
</table>

**J. Exotic plants (only commonly found plants have local names)**

<table>
<thead>
<tr>
<th>No.</th>
<th>Botanical name</th>
<th>Family</th>
<th>Local name</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Eucalyptus spp.</td>
<td>Myrtaceae</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Bougainvilla spp.</td>
<td>Nyctaginaceae</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Cassia alata</td>
<td>Caesalpiniaceae</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Cassia siamea</td>
<td>Caesalpiniaceae</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Ipomea quamoclit</td>
<td>Convolvulaceae</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Parthenium hysterophorus</td>
<td>Asteraceae</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Prosopis juliflora</td>
<td>Moraceae</td>
<td>Vilayati babul</td>
</tr>
</tbody>
</table>

**K. Common plants**

<table>
<thead>
<tr>
<th>No.</th>
<th>Botanical name</th>
<th>Family</th>
<th>Local name</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Acacia nilotica</td>
<td>Mimosaceae</td>
<td>Babul</td>
</tr>
<tr>
<td>2</td>
<td>Azadirachta indica</td>
<td>Meliaceae</td>
<td>Neem</td>
</tr>
<tr>
<td>3</td>
<td>Achyranthes aspera</td>
<td>Amaranthaceae</td>
<td>Chirchita</td>
</tr>
<tr>
<td>4</td>
<td>Argemone mexicana</td>
<td>Papaveraceae</td>
<td>Satyanasi</td>
</tr>
<tr>
<td>5</td>
<td>Capparis sepriaria</td>
<td>Capparaceae</td>
<td>Heens</td>
</tr>
<tr>
<td>6</td>
<td>Capparis aphylla</td>
<td>Capparaceae</td>
<td>Karil</td>
</tr>
<tr>
<td>7</td>
<td>Calotropis procera</td>
<td>Asclepiadaceae</td>
<td>Ak</td>
</tr>
<tr>
<td></td>
<td>Scientific Name</td>
<td>Family</td>
<td>Common Name</td>
</tr>
<tr>
<td>---</td>
<td>----------------</td>
<td>--------------</td>
<td>--------------</td>
</tr>
<tr>
<td>8.</td>
<td>Cassia siamea</td>
<td>Caesalpiniaceae</td>
<td>Cassia</td>
</tr>
<tr>
<td>9.</td>
<td>Dalbergia sissoo</td>
<td>Fabaceae</td>
<td>Shisham</td>
</tr>
<tr>
<td>10.</td>
<td>Datura metel</td>
<td>Solanaceae</td>
<td>Dhatura</td>
</tr>
<tr>
<td>11.</td>
<td>Ipomea aquatica</td>
<td>Convolvulaceae</td>
<td>Sarnali, Nari</td>
</tr>
<tr>
<td>12.</td>
<td>I. fistulosa</td>
<td>Convolvulaceae</td>
<td>Sarnali</td>
</tr>
<tr>
<td>13.</td>
<td>Prosopis juliflora</td>
<td>Moraceae</td>
<td>Vilayati babul</td>
</tr>
<tr>
<td>14.</td>
<td>Salvadoria persica</td>
<td>Salvadoraceae</td>
<td>Pilu</td>
</tr>
<tr>
<td>15.</td>
<td>Pongamia pinnata</td>
<td>Fabaceae</td>
<td>Anar</td>
</tr>
</tbody>
</table>
Introduction

Seemingly obvious historical examples (e.g., the passenger pigeon and American bison) notwithstanding, it has been argued that hunting is not responsible per se for drastic declines in certain fish and game species. Rather, the absence of well-specified and enforced private property rights precipitates tragedies of the commons (Hardin, 1968). Individuals’ property rights to fish and game are defined implicitly as ‘first in time, first in use,’ meaning that each fisherman and hunter has a strong private incentive to catch/kill early and often, before depletion by others. Since everyone has the same incentives, overexploitation of the resource is the inevitable result. The tragedy of the commons can be overcome by assignment of private property rights to fish and game. In the U.S., state governments claim ownership of fish and wild game species, and manage the populations by restricting the number of licenses issued, the length of the hunting/fishing season, and/or the legally permitted take. It might be argued that the adverse impacts of hunting and fishing could be avoided for the most part (except from poaching) if state governments simply eliminated hunting and fishing as legal activities.

However, hunters and fishermen maintain that they promote the ecological well-being of the species they hunt because their license revenues fund research on species reproduction, health, management, habitat enhancement and so on. Moreover, in the absence of hunting, certain formerly-hunted species (e.g., possum, raccoon, deer) that thrive in the presence of mankind’s altered habitat conditions reproduce at rates that, in turn, create ecological problems for a large number of other species, including man. For example, now-burgeoning populations of raccoons, foxes, coyotes, and possums decimate populations of songbirds (Putz, 2003).

But there is an equally-compelling reason to believe that hunting and fishing promote the ecological viability of game species: private landowners have an economic incentive to set aside and/or develop habitat conditions that game species favor. If they can demonstrate to prospective hunters and fishermen that desired game species are available on their property, private land owners can profit by selling hunting and/or fishing rights. As a by-product of promoting the ecological well-being of the target species, private land owners’ preservation and development of habitat for game species also increases habitat for non-game species that share ecosystems with game species. To the extent this is correct, states with relatively high levels of recreational hunting and fishing should have lower levels of observed species fragility than states characterized by relatively low levels of recreational hunting and fishing, ceteris paribus.

We test this hypothesis using state-by-state data on NatureServe’s ‘at-risk’ species. Controlling for a broad spectrum of factors that potentially influence species fragility, we reject the null hypothesis of no effect, and accept the alternative hypothesis that increased intensity of recreational hunting/fishing activity is associated with lower numbers of at-risk species.

Methods

Following Rawls and Laband (2004), we expect the number of ecologically fragile species in a state to be influenced by a combination of natural and anthropogenic factors, including the total number of species known to exist in that state, the number of species endemic to that state, miles of coastline, rainfall, proportion of federal land, population density, hunting and fishing participation rates, and per capita income.

Since the dawn of life on earth, species extinctions have occurred naturally. This is no less true now than before Homo sapiens evolved away from the great apes several million years ago. For a given rate of naturally-occurring extinctions at any given point in time (Wilson, 1988), the number of ecologically fragile species in a given geographic area will be greater in areas characterized by relatively large numbers of species than in areas that
do not support much biodiversity. Further, by virtue of having wider ranges of moisture, temperature, and geophysical attributes, some states have greater numbers of unique ecological niches than others, which support plant and animal species found nowhere else. By definition, these endemic species are more likely than species with wider ranges of habitat to be characterized by low populations. All other things equal, we expect the number of ecologically fragile species in a state to be a positive function of the total number of species found in that state and, especially, a positive function of the number of species endemic to that state.

The health and/or ecological viability of plant and animal species also may be influenced (for better or worse) by anthropogenic activity. It seems reasonable to suggest that the seriousness and extent of any adverse impacts is related in a positive fashion to the significance and extent of man’s activity. Human depredation (hunting and gathering food) directly reduces populations of plants and animals. Consequently, as human populations increase, they ‘crowd out’ other species. If such crowding out of other species by increasing human population pressures occurs to the point of jeopardizing the viability of those other species, the number of ecologically fragile species should be greater in states with higher population densities of Homo sapiens than in states with lower population densities of Homo sapiens.

Sheer population pressures aside, human activities clearly affect plant and animal populations indirectly through alteration of habitat. For example, clear-cutting trees on otherwise heavily forested land creates ecological opportunity (damage) for certain (other) species. Man diverts water, plants trees, deliberately or carelessly transports plants and animals around the world, moves earth, and so on. In a myriad of ways, he alters the living conditions for many other species. By and large, the nature and extent of these activities reflect man’s economic well-being and the exact relationship between man’s economic well-being and the impact on species fragility is an empirical matter.

The theoretical link between economic well-being and environmental degradation that has been proposed runs as follows: desperately poor people are willing to accept increased environmental degradation as a necessary by-product of generating an improved material standard of living. As individuals’ standard of living improves, they are able increasingly to turn their attention away from exploiting the natural environment for food, shelter, and other necessities of life, and toward appreciation of the wonders of nature. That is, plants and animals become valuable to humans not only because they can be used to improve man’s well-being (in terms of providing food, shelter, medicines, etc.), but because their mere existence becomes important to us. In terms of empirical application, this implies a relationship characterized by an inverted U-shape between measures of economic well-being, such as per capita income, and measures of environmental degradation - - the so-called Environmental Kuznets Curve (EKC).

Following the lead of McPherson and Nieswiadomy (2005), we include real per capita income (as well as its squared and cubed values) as an explanatory variable in our model. However, given the relatively narrow range of per capita income across the constituent states of the U.S. (as compared to the range of per capita incomes across the countries of the world), it may be difficult to observe a statistically significant effect in this regard in the current analysis.

There are at least two sources of information on the number of ecologically fragile species per state: the U.S. Fish and Wildlife Service, which lists threatened and endangered species under mandate from the Endangered Species Act (1973), and NatureServe, which is a derivative organization from the Nature Conservancy. NatureServe compiles and maintains a detailed database of what it terms ‘at-risk’ species, defined as the number “of a state’s plants and animals that are at risk of extinction due to rarity or other factors.” This measure includes species with a conservation status of extinct, imperiled, or vulnerable (corresponding to Global Heritage Conservation Ranks of GX, GH, G1-G3). We used NatureServe’s ‘at-risk’ species as our measure of species fragility rather than ESA listings, because ESA listings are subject to political influences (Ando, 1999; Rawls and Laband, 2004) and therefore do not truly reflect species fragility.

The specific model we estimate is:

\[
\text{At-risk}_i = a_0 + a_1 \text{Species}_i + a_2 \text{Endemic}_i + a_3 \text{Rainfall}_i + a_4 \text{Coastline}_i + a_5 \text{Popden}_i + a_6 \text{Popden}_i^2 + a_7 \text{RPCI}_i + a_8 \text{RPCI}_i^2 + a_9 \text{RPCI}_i^3 + a_{10} \text{FedLand}_i + a_{11} \text{HuntFish}_i + \sum a_i \text{Regional Dummies}_i + \varepsilon_i,
\]

where At-risk\(_i\) is the number of species in state \(i\) identified by NatureServe as ecologically ‘at-risk’ in 2003; Species\(_i\) is the number of plant and animal

Urban Rural Interface Conference Proceedings
species found in state i; Endemic\textsubscript{i} is the number of species endemic to state i; Rainfall\textsubscript{i} is the average annual rainfall on state i (in inches); Coastline\textsubscript{i} is state i’s number of miles of ocean coastline; Popden\textsubscript{i} is the average population density in state i over the period 1973-2000, calculated by dividing the average population of state i across these 28 years by the total square miles of land in state i; RPCI\textsubscript{i} is the average real per capita income in state i over the period 1973-2000, calculated by summing 1982-84 constant-dollar per capita income across each of these 28 years, then dividing by 28; FedLand\textsubscript{\%i} is the percent of state i’s area that is comprised of federal land in 1991; HuntFish\textsubscript{\%i} is the percent of state i’s population (age 16 and over) participating in hunting or fishing in 1991; Region\textsubscript{i} are dummy variables for New England states, East North Central states, West North Central states, Middle Atlantic states (the omitted control category), South Atlantic states, East South Central states, West South Central states, Mountain states, and Pacific states; and \( \varepsilon_i \) is the error term.

The model presented in equation (1) was estimated for U.S. states, excluding Hawaii, using spatial autocorrelation correction. Spatial econometric techniques have been developed to model relationships among neighboring entities. Tobler’s (1979) first law of geography describes the problem as: “everything is related to everything else, but near things are more related than distant things.” For example, if threats to species are high in one state, it is likely that species in neighboring states may be affected. Two types of spatial regression models have been used most often: spatial lag models and spatial error models.

There are serious consequences of ignoring these spatial correlations. If spatial lag dependence is ignored, ordinary least squares (OLS) estimators will be biased and inconsistent. If spatial error dependence is ignored, OLS estimators will be unbiased but inefficient and the standard errors of the estimators will be biased. Test statistics have been developed to determine which model best fits the data (Anselin, 1988, pp. 58-59).

There are several possible spatial weights matrices that have been used in the literature. We use a binary contiguity matrix of Moran (1948) and Geary (1954). If two entities share a common border they are considered to be neighbors and a 1 is assigned to the weights matrix; if they do not share a common border a value of 0 is assigned. A contiguity matrix is \( N \) by \( N \). For our example of 49 U.S. states, the contiguity matrix has 2,401 cells of zeros or ones. (Note that Alaska has no neighboring states.)

**Findings**

Only the results for the spatial lag model are presented in Table 1 because the likelihood ratio tests for spatial lag dependence are highly significant while the Lagrange multiplier test for presence of spatial error dependence are insignificant. These results indicate that the spatial lag model is most likely the best specification. The model fit is extraordinarily high for a cross-section analysis - - the independent variables explain 98.6 percent of the variation in the number of ‘at risk’ species per state.

As expected, the number of ‘at-risk’ species in a state is shown to be influenced strongly and positively by the total number of species identified as living within that state, the number of species endemic to that state, average annual rainfall in the state, miles of coastline, and the percent of land owned by the federal government. We also find evidence of a statistically significant cubic relationship between real per capita income and the number of ‘at-risk’ species per state. Population density appears to affect the number of ‘at-risk’ species per state in a “u-shaped” manner. In terms of the hypothesis that motivates this research, we find that the number of ‘at-risk’ species per state is significantly, inversely related to the percentage of the population that hunts and/or fishes.

**Discussion**

The first point of interest is the presence of spatial correlation, indicated by the significant term on coefficient of the at-risk species in adjoining states variable. This variable is akin to a lagged endogenous variable. It indicates that the number of species ‘at-risk’ increases by 0.13 for every one unit increase in the number of ‘at-risk’ species in neighboring states. Factors threatening species in one state evidently cut across state lines. Even with this spillover effect of spatial correlation controlled for explicitly in our model, we also observe statistically significant regional differences. As compared to the omitted control region (the Middle Atlantic states), both the South Atlantic and East South Central states have significantly greater numbers of ‘at-risk’ species, while the West South Central states have significantly fewer ‘at-risk’ species. We do not have a compelling explanation for these findings at this time.
Table 1. Maximum Likelihood Regression Estimation Results
Dep. Variable = Number of ‘at-risk’ species per state

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>Std. Error</th>
<th>z-value</th>
<th>Probability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>-4527.670</td>
<td>1610.970</td>
<td>-2.81</td>
<td>0.00</td>
</tr>
<tr>
<td>Species#</td>
<td>0.080</td>
<td>0.014</td>
<td>5.72</td>
<td>0.00</td>
</tr>
<tr>
<td>Endemic#</td>
<td>1.035</td>
<td>0.056</td>
<td>18.57</td>
<td>0.00</td>
</tr>
<tr>
<td>Rainfall</td>
<td>2.732</td>
<td>1.022</td>
<td>2.67</td>
<td>0.01</td>
</tr>
<tr>
<td>Coastline</td>
<td>0.016</td>
<td>0.010</td>
<td>1.59</td>
<td>0.11</td>
</tr>
<tr>
<td>Popden</td>
<td>-0.312</td>
<td>0.168</td>
<td>-1.86</td>
<td>0.06</td>
</tr>
<tr>
<td>Popden Squared</td>
<td>2.255E-04</td>
<td>1.412E-04</td>
<td>1.60</td>
<td>0.11</td>
</tr>
<tr>
<td>Real per capita income (RPCI)</td>
<td>0.985</td>
<td>0.354</td>
<td>2.78</td>
<td>0.01</td>
</tr>
<tr>
<td>RPCI squared</td>
<td>-7.124E-05</td>
<td>2.548E-05</td>
<td>-2.80</td>
<td>0.01</td>
</tr>
<tr>
<td>RPCI cubed</td>
<td>1.684E+09</td>
<td>6.036E-10</td>
<td>2.79</td>
<td>0.01</td>
</tr>
<tr>
<td>FedLand%</td>
<td>1.659</td>
<td>0.918</td>
<td>1.81</td>
<td>0.07</td>
</tr>
<tr>
<td>HuntFish%</td>
<td>-5.434</td>
<td>1.878</td>
<td>-2.89</td>
<td>0.00</td>
</tr>
<tr>
<td>New England</td>
<td>-11.117</td>
<td>21.718</td>
<td>-0.51</td>
<td>0.61</td>
</tr>
<tr>
<td>East North Central</td>
<td>12.051</td>
<td>24.403</td>
<td>0.49</td>
<td>0.62</td>
</tr>
<tr>
<td>West North Central</td>
<td>10.462</td>
<td>22.037</td>
<td>0.47</td>
<td>0.63</td>
</tr>
<tr>
<td>South Atlantic</td>
<td>42.005</td>
<td>24.061</td>
<td>1.75</td>
<td>0.08</td>
</tr>
<tr>
<td>East South Central</td>
<td>81.244</td>
<td>33.969</td>
<td>2.39</td>
<td>0.02</td>
</tr>
<tr>
<td>West South Central</td>
<td>-65.249</td>
<td>29.422</td>
<td>-2.22</td>
<td>0.03</td>
</tr>
<tr>
<td>Mountain</td>
<td>53.647</td>
<td>38.811</td>
<td>1.38</td>
<td>0.17</td>
</tr>
<tr>
<td>Pacific</td>
<td>17.174</td>
<td>31.739</td>
<td>0.54</td>
<td>0.59</td>
</tr>
<tr>
<td>At-risk species in contiguous states</td>
<td>0.131</td>
<td>0.078</td>
<td>1.68</td>
<td>0.09</td>
</tr>
<tr>
<td>R-square</td>
<td>0.986</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Likelihood statistic</td>
<td>-245.065</td>
<td>N = 49</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

At the level of analysis that our data permit, species fragility appears to be influenced most strongly by the number of species endemic to a state. The coefficient on “Endemic#” is approximately equal to one, indicating that the number of species ‘at risk’ increases one unit for every unit increase in the number of endemic species. While this is a very sizable effect, it is a plausible one. By definition, endemic species have relatively small ranges and therefore almost certainly smaller and more ecologically fragile populations than non-endemic species. The coefficient on “FedLand%” indicates that the number of at-risk species increases by 17 for every 10% increase in federal land ownership in a state. Likewise, the number of ‘at risk’ species increases 0.08 for every one more species existing in a state. We note with interest the positive relationship between the number of ‘at-risk’ species and the average annual “Rainfall”of a state. This may be due to relatively richer variety of species that exist in wetter climates. Similarly the freshwater/saltwater interface (“Coastline”) produces special conditions that contribute to the evolution of diverse species, a portion of which will be ecologically fragile at any specific point in time.

For population density, there was some indication of a u-shaped relationship - - the number of ‘at-risk’ species at first falling with increasing population density, then rising. The stationary point (the population density at which additional increases are associated with higher numbers of ‘at-risk’ species) was 692 persons/square mile.

We take the statistically significant cubic relationship between the number of ‘at-risk’ species in a state and the real per capita income of the state’s population as evidence in support of the environmental Kuznets curve.
We now turn to the inverse relationship between the number of hunters/fishermen in a state and the number of ‘at-risk’ species in that state. The number of at-risk species decreases 54.3 for each 10% increase in hunters/fishers. As noted previously, private land owners have financial incentives to preserve and develop habitat favored by game species. This implies that as the level of hunting and fishing rises, so will the stock of habitat for relevant target species. This almost certainly means that collateral species that also favor the game species’ habitat benefit as well. This said, we are still reluctant to conclude that hunting and fishing promote biodiversity.

There is much that we simply do not understand about the causes of species fragility, especially causes that may be anthropogenic. For example, it is possible, if not likely, that forest (or ecosystem) fragmentation stresses plant and animal species. Let us suppose for the moment that hunting/fishing activity is inversely correlated with ecosystem fragmentation - - which is consistent with the notion that private landowners will conserve/develop habitat for game species. In this case, we will observe statistically an inverse correlation between intensity of hunting/fishing and the number of ‘at-risk’ species. But the correct interpretation is that intensity of hunting/fishing merely serves as a proxy for less ecosystem fragmentation and that a relatively low number of ‘at-risk’ species in a state is due to the presence of relatively intact ecosystems. This is not to deny the possibility that hunting and fishing activity contribute affirmatively to conditions that promote biodiversity. For now, however, it seems premature to make such a strong declaration based on our findings.

References
Wildlife Management on the Urban-Rural Interface: Cooperation and Conflict between Science and Society

By Daniel J. Decker, Heidi E. Kretser, Meredith Gore, Kirsten Leong, and William F. Siemer, Human Dimensions Research Unit, Cornell University

Abstract:
The theoretical perspective underlying most research on public attitudes and values with respect to wildlife and wildlife management has focused on higher level cognitions. This perspective holds that measured beliefs and attitudes about wildlife or wildlife management actions, and behavioral intentions to support or oppose an action, are grounded in values and mediated by context. Measurements of beliefs, attitudes, norms, and behavioral intent have limited utility when not grounded in relevant experience. Newly experienced human-wildlife interactions, such as those occurring on the urban-rural interface, may result in previously unfelt impacts and lead to new beliefs or attitudes associated with wildlife. Research is needed to determine the fundamental source of such attitudes and associated behaviors. Furthermore, more collaborative decision-making processes can help managers understand and manage the relationship between people and wildlife on the urban-rural interface.

Introduction
Residential and commercial development has expanded in recent years well beyond core cities and established suburbs, increasing the scale of the urban-rural interface (URI). Development on the URI has influenced wildlife as well as people; as habitats are altered or lost, some wildlife species are forced into remaining rural areas or toward extinction, whereas others adapt to living close to people and proliferate. Members of society can have different opinions about the benefits from development versus wildlife protection. These situations may create conditions for increased human-wildlife interactions, whose impacts are both positive and negative. In 2002, the United States Department of Agriculture tallied 237,766 reported negative human-wildlife interactions (Clayton 2004). As a result, managers, policy makers, and local leaders find themselves in difficult situations when negative human-wildlife interactions arise on the URI.

Wildlife managers are charged with managing wildlife as a public trust resource, to be protected and preserved in trust by the government for the benefit of current and future generations (Baer 1988). Yet, human-wildlife interactions can lead to challenges between wildlife professionals who are grounded in scientific training and members of society who may evaluate these interactions based on different values (Slovic et al. 1985). Values are key in articulating goals, objectives, and preferences for management actions, and thus play an important role in determining the focus of management. Understanding relevant values and how they translate into people’s beliefs and attitudes, tolerance of problems, and preferences for management is fundamental to effective management planning and implementation (Purdy and Decker, 1989, Fulton et al. 1996).

For more than two decades the Human Dimensions Research Unit at Cornell University has measured human values and public attitudes towards wildlife and management actions to address wildlife issues on the urban-rural interface. Most studies of human values towards wildlife have assumed existence of a wildlife-specific set of values. We believe the values underlying reactions of people to wildlife must be understood within the context of broader societal and cultural values relating to human health and safety, economic security, and many other core determinants of people’s beliefs and attitudes. We propose that wildlife professionals need to gain a broader understanding of the system of values that underlie people’s beliefs, attitudes, and behavior triggered by interactions with wildlife. By fundamentally changing the approach to understanding human values (and beliefs and attitudes) regarding wildlife, an opportunity exists to improve the relationship between science and society. Increasing the quality and degree of engagement between professionals and stakeholders in URI communities could lead agencies and communities to better understand each other’s values, creating opportunities for collaboration, shared wildlife management responsibilities, and fewer negative human-wildlife interactions.

Evolution of Public Involvement in Wildlife Management
Early in the history of the wildlife profession in North America, science-based management became the dominant philosophical principle. This meant using science to: (a) understand the biological/ecological aspects of the management
system; and (b) predict biological consequences of management interventions. Social science was not part of the original concept of the science upon which to base management. In practice, the values of wildlife professionals (as representatives of science) often prevailed over stakeholders (as representatives of society) with respect to deciding what ought to be done. Distinctions between professional opinion and societal values were easily blurred in this situation (Decker et al. 1991).

The conventional top-down approach to wildlife management often conflicts with the desires of contemporary stakeholders and their communities. Key reasons are: (a) inadequate understanding of stakeholder values with respect to wildlife and wildlife management; (b) ineffective integration of such values into management planning and decision making; and (c) resistance to engaging stakeholders in management planning, decision making and implementation. These shortcomings are gradually being addressed in wildlife management in response to public expectations. Cooperation between wildlife professionals and communities is essential to effective wildlife management, especially in places facing rapid changes, such as the URI. Fortunately, cooperation is occurring with increasing frequency as managers and communities are innovating to meet the needs of society and wildlife (e.g., Raik et al. 2004).

Approaches to incorporating public input into wildlife management have been evolving, reflecting a shift in the degree to which scientists and managers seek to understand, consider and incorporate stakeholder values in formulating fundamental management objectives and choosing management interventions. Six major approaches (Figure 1) are extensively detailed in Decker et al. (2002) and refined in Leong (In prep.). We highlight key concepts here to illustrate the Inquisitive, Intermediary, Transactional, and Co-Managerial approaches which actively seek input and involvement of stakeholders in wildlife management. Authoritative and Passive-Receptive approaches do not actively pursue public involvement.

**Inquisitive approach:** The inquisitive approach typically employs social survey methods to assess beliefs, attitudes and behaviors with respect to wildlife and wildlife management. Concepts and measurement scales have been developed (Kellert 1984, Purdy and Decker 1989, Fulton et al. 1996). Key findings from this line of research include: (1) in the absence of first-hand experience of negative interactions with wildlife, people tend to prefer non-lethal over lethal methods to control wildlife; (2) people make species distinctions with respect to preferred methods; and (3) people who have experienced an undesirable human-wildlife interaction (negative impacts) differ in management preferences from those who have not.

**Intermediary approach:** The intermediary approach involves two-way communication between wildlife managers and stakeholders, but not necessarily between stakeholders. In this approach, managers may feel pulled in many different directions by various stakeholders because they act as intermediaries in deciphering the similarities and differences in stakeholder positions and interests. This approach can deteriorate into a “decide-announce-defend” model, where public meetings are used ritualistically to announce and defend policies while the public comes to express disagreement or dissatisfaction with the process.

**Transactional approach:** The transactional approach involves two-way communication between wildlife managers and stakeholders, but not necessarily between stakeholders. In this approach, managers may feel pulled in many different directions by various stakeholders because they act as intermediaries in deciphering the similarities and differences in stakeholder positions and interests. This approach can deteriorate into a “decide-announce-defend” model, where public meetings are used ritualistically to announce and defend policies while the public comes to express disagreement or dissatisfaction with the process.

**Co-Managerial approach:** The co-managerial approach involves shared management among stakeholders and professionals. It emphasizes the importance of collaborative decision-making and the need for respectful dialogue among participants. This approach recognizes that wildlife management is a complex and dynamic process that requires the input and involvement of multiple stakeholders.

**Authoritative and Passive-Receptive approaches:** These approaches do not actively pursue public involvement. In an authoritative approach, experts make decisions based on scientific knowledge without consulting stakeholders. In a passive-receptive approach, stakeholders are consulted after decisions have been made. Both approaches are less effective in addressing public concerns and improving management outcomes.

**Figure 1** Approaches to wildlife management with increasing public participation. (Adapted from Decker and Chase 1997 and Leong In prep.)
have contributed to the widespread development of this approach, also known as community-based wildlife management.

**Comanagement approach:** Comanagement is a form of collaborative effort between managers and stakeholders in wildlife management (Chase et al. 2000). This approach is recently gaining popularity in URI communities where stakeholders want to play a greater role in wildlife management. Such collaboration is evidenced by stakeholder participation in setting management objectives, providing leadership, financial resources, services, and other elements of capacity to accomplish wildlife management (e.g., Raik et al. 2004).

**Improving Understanding of Stakeholder Perspectives**

Effective management increasingly relies on managers working with stakeholders to understand the values underlying how people perceive their interactions with wildlife. Human-wildlife interactions may be perceived as having positive or negative impacts. Impacts are defined as the outcomes of a human-wildlife interaction that stakeholders recognize and deem important enough to warrant management attention (Riley et al. 2002). These impacts directly reflect stakeholders’ values. Approaches to wildlife management involving more public participation allow for stakeholders to interact with one another to discuss impacts and associated underlying values.

Inquiry about human-wildlife interactions and resulting impacts is needed to understand how values manifest themselves when different impacts are experienced by different stakeholders. Such understanding may help wildlife professionals address wildlife issues by formulating, with stakeholders, socially acceptable and ecologically feasible wildlife management on the URI. An approach for accomplishing this has been described recently—adaptive impact management (AIM) (Riley et al. 2002). AIM is based on the tenet that “Wildlife management is the guidance of decision-making processes and implementation of practices to purposefully influence interactions among and between people, wildlife, and habitats to achieve [valued] impacts” (Riley et al 2002: 586). Elucidating stakeholder values in decisions about goals, objectives, and actions is essential to an AIM process. A combination of public involvement and social assessment tools is needed to improve understanding of these values and their relationship to stakeholder defined impacts. We identify three challenges to focusing on impacts and improving the effectiveness of wildlife management on the URI.

**URI residents hold diverse beliefs and attitudes.** The URI attracts a heterogeneous mix of people from a variety of backgrounds. Some URI residents hold utilitarian and consumptive attitudes toward wildlife. Others believe in animal rights and regard wildlife much as if they were free-ranging pets. These diverse perspectives about wildlife present a daunting wildlife management challenge not historically encountered in traditional rural communities.

**Management approaches can fail to identify and respond to the goals and objectives desired by diverse stakeholders.** Conventional manager-centered approaches to developing wildlife management goals and objectives that do not employ community-based stakeholder involvement may not be accepted by stakeholders. Instead, stakeholders may force wildlife management to occur on a ballot or in a courtroom (Loker and Decker 1995). Management approaches that incorporate public participation and stakeholder values in setting management goals and objectives may narrow the divide between science and society.

**Conventional management alternatives are largely limited to lethal control, and do not include strategic communication.** Many well-studied URI wildlife issues involve a perceived “overabundance” of wildlife (e.g., white-tailed deer, beaver) and excessive negative interactions with humans that cause impacts to surpass the tolerance or acceptance capacity of significant numbers of stakeholders (Jonker et al. 2004). Public acceptance of conventional population reduction responses using lethal methods, such as hunting and trapping, might be lower on the URI than historically typical in rural environments (Deblinger et al. 1999). Yet, wildlife managers often continue to prescribe such generally unacceptable solutions. This leads to credibility and trust issues between the public and their wildlife management agency (i.e., society versus science). Wildlife issues on the URI can also involve species declining in numbers (e.g., black-footed ferret, gray wolf) and species ill-adapted to the human-built environment (e.g., grizzly bear). Traditional top-down management practices lack strategies to address this spectrum of wildlife issues, which can widen the credibility and trust gap between managers and some stakeholders.
**Interpreting Human-Wildlife Interactions**

Measures of wildlife value orientations can provide valid and useful insight when they are based on actual experience with human-wildlife interactions, but such experience is frequently lacking among respondents. Where stakeholders have accumulated such experience, and measurable cognitions such as beliefs, attitudes, behavioral intentions, and behaviors have been consistent, stakeholder response to interactions and management interventions can be predicted (Roskaft et al. 2003). Absent experience with particular interactions, people's responses to attitude measures are poor predictors of their attitudes and behaviors following actual experience. Current attitude measures may mask more fundamental concerns related to human-wildlife interactions, including health and safety, economic security, or respect for nature. However, such fundamental concerns can trump wildlife-centric characterizations of people's values orientations. We propose that fundamental values of society, which are largely developed irrespective of wildlife, determine the nature of perceived impact from wildlife.

For example, individuals who in general reflect an attitude of tolerance, nonutilization and even protection of wildlife may be expected to desire a variety of impacts from white-tailed deer in their neighborhood. But, their general wildlife preservation orientation and preference for nonlethal control occurs in the context of other considerations, such as risks of deer-car collisions and/or contracting Lyme disease. A fundamental value—personal and family health and safety—may be weighed as more important than a value orientation about protection of deer. The overall importance of these fundamental values is a plausible explanation for the inconsistencies research might observe between measured wildlife value orientations and actual management preferences expressed by stakeholders.

**The Imperative for Effective Wildlife Management on the URI**

The imperative for effective wildlife management on the URI goes beyond the obvious desire to maximize benefits and minimize costs associated with human-wildlife interactions. A farther-reaching concern is preventing people’s perceptions of wildlife from slipping from valued resource to tolerated nuisance, and perhaps worse, sliding to intolerable “hazard” (Conover 1998, Omundi 1995). This is an undesirable outcome and a communication challenge for wildlife professionals, planners and others working on the URI. Improved understanding of stakeholder values is necessary for effective communication about wildlife and wildlife management between scientists and society. The insights from research will need to be integrated into a new paradigm of management that is built upon collaboration, such as community-based approaches that have emerged over the last decade. It is insufficient to view human-wildlife interactions as strictly a wildlife management and stakeholder issue. Effective management will need to actively engage other entities working in the URI, such as land-use planners, transportation designers, landscape architects, and local government leaders. Local and state levels of policy may need revision to accommodate changes in how wildlife management issues are approached. These changes are a logical consequence of an evolving management environment and an adapting management paradigm in urban-rural interfaces experiencing rapid change.

**Literature Cited**


A Social Hangout or an Appetizing Food Source: Glaucous gull (*Larus hyperboreus*) Abundance at the Barrow Landfill

Rebecca Nemec, and Henry Horn, Department of Ecology and Evolutionary Biology, Princeton University, 
Nora Rojek, United States Fish and Wildlife Service, 
Fairbanks, Alaska

**Abstract**

From June 17th, 2004 to July 9th, 2004, a population of glaucous gulls (*Larus hyperboreus*) was counted at the Barrow city landfill. The number of gulls at the landfill was censused to determine if the regional glaucous gull population was responsive to changing levels of waste delivered to the landfill. Because previous studies have shown that many gull species, including the glaucous gull species, use landfills as a place to meet other gulls, (and not necessarily a place to feed) gull behavior was also observed during the census period.

The results of this study show that glaucous gull population in the Barrow region is using the Barrow landfill not only as a social gathering area, but also as a food source and that there is a delayed response to deliveries made to the landfill by the gulls. Finally, the data shows a density-dependant relationship between the gulls present at the landfill and the amount of food (waste) available for consumption.

**Introduction**

The glaucous gull (*Larus hyperboreus*) is found near Barrow, Alaska and is nest predator to many waterfowl that migrate and breed in the summer in this region. Glaucous gulls are also known to congregate at landfills across the North Slope of Alaska. Gulls typically use the landfills for food and for a social meeting area. Many studies have shown that gull species, including the glaucous gull, are attracted to traditional putrescible-waste landfills because of the availability of food items (Gabrey, 1996). Because the glaucous gull is an important predator in the Arctic, there is concern that a supplemental food source such as a landfill might increase the number of glaucous gulls in the Barrow region, which might impact the population size of various prey species in the area.

More generally gulls constitute the genus *Larus*, and approximately 50 species are contained in this subgroup. Birds in the genus *Larus* are known to be highly social birds. They live mainly in colonies and feed in flocks (Spaans et. al, 1987). This behavioral pattern produces a great number of confrontations with other conspecific species and other seabird species during breeding and feeding periods (Spaans et. al, 1987). Moreover, birds in the genus *Larus* have considerably diversified foraging methods and habitats. Gulls are known to forage in a variety of habitats including wet fields to the open ocean and employ a variety of feeding strategies appropriate for specific prey items and habitats (Hunt and Hunt, 1973 and Mudge and Ferns, 1982).

Predation on breeding birds in the Arctic is an important factor in determining the density and nesting success of various nesting bird species. Predation by glaucous gulls and other predatory birds is the main cause of nest failure of the various birds that use the Arctic to nest each summer and spring (Sage, 1986). Glaucous gulls are omnivorous but they predominantly search for animal food, which includes bird eggs and young birds (Sage, 1986). Glaucous gulls have also been known to take a heavy toll on the eggs and young of Brent geese in the Barrow region and in other Arctic regions throughout the world (Sage, 1986).

**Study Site**

The study was conducted at the Barrow, Alaska city landfill and sewage lagoon. Barrow is the largest village on the North Slope of Alaska and has a population of approximately 4,500 and accumulates on average approximately 800,000 pounds of anthropogenic waste/month. This waste is delivered to the Barrow city landfill each day by various waste management services in the city. Figure 3.3 is a map of the Barrow region with major structural features labeled, including the landfill (Rojek, 2005). The landfill is located to the East of the center of the city of Barrow and lies directly south of the Chuchki Sea. The landfill’s major refuse site is approximately 500 m².

**Methods**

The study period began on 17 June 2004 and ended on 9 July 2004. The counts were conducted from the southern side of the landfill on the road running parallel to the landfill’s southern-most boundary at a distance to the center of the landfill of approximately 150 m. A scope (Pentax PF-80 ED with 20X-60X...
A zoom lens was used to make the gull counts. Gulls were differentiated into two categories, sub-adults and adults. It was practical to differentiate these two groups by feather color and pattern. Sub-adult glaucous gulls have brown coloration on most of their bodies and adult glaucous gulls are a clean snowy-white color, except on the wing, which is grey in color. Counts were taken approximately 3 times per day at a variety of different times each day. In poor weather conditions – including fog, rain, and more generally poor visibility – counts were taken once, twice, or zero times a day.

**Results**

The census data and the observations made at the landfill show that the regional population of glaucous gulls are using the landfill for food. From the data collected it appears that the landfill is being used by both adults and sub-adults. The average number of adults and sub-adults at the landfill each day also shows no significant difference, as figure 5.1 illustrates. This figure illustrates that neither age class dominated the landfill over the time of the study period. However, glaucous gulls go through four different plumage colorations in the first four years of life (three colorations in the sub-adult phases, and one in the adult phase). As a result, it is possible that different sub-classes within the sub-adult class could be utilizing the landfill more than other classes of sub-adults. But because of time constraints and constraints on count methods, the three classes of sub-adults were not differentiated. But for the purposes of this experiment, the exact age of the glaucous gulls was not critically important, only the distinction between adults and all other age classes of sub-adults.

Figure 5.1 is a comparison of the number of adults and sub-adults in attendance at the landfill on each day of the study period. The data in figure 5.1 also shows that on a daily basis there was no preferential use of the landfill by the different age classes of glaucous gulls.

One of the most obvious trends in figure 5.2 and figure 5.3 is the number of gulls present on weekends in contrast to the number of gulls present on the landfill during the weekdays. Because waste is not delivered on the weekends, there were typically very few gulls at the landfill on the weekends. June 19-20, June 26-27, July 3-4, and July 10-11 are all weekend days in which no waste was delivered to the landfill. The number of gulls on these days is generally significantly lower than on weekdays, as can be seen.
Figure 5.2

Total Gull Abundance and Waste Availability at Landfill

SD of weight = 259.00
SE = ± 56.51
SD gulls = 424.22
SE = ± 41.78

Spearman Rho Correlation P = .1903

Figure 5.3

Relationship of Gull Abundance and Waste Availability at Landfill (gulls + one day)

SD of weight = 259.00
SE = ± 56.51
SD gulls = 424.22

Spearman Rho Correlation P = .1690
This pattern can be attributed to no in waste delivery on the weekends. Figure 5.2 is a direct comparison between gull abundance at the landfill and the amount of waste delivered to the landfill. This graph shows that glaucous gulls are responding to increased waste loads delivered to the landfill. However, the graph also shows some time delay, that is, a decrease or increase in gull abundance tends to follow an increase or decrease in waste loads by approximately one day. In order to account for this possible “response delay,” gull abundance and waste delivery weight were plotted again with a time delay factor. In figure 5.3, the numbers of gulls are plotted one day ahead of the waste delivery weight data in order to account for this delayed response by the glaucous gulls using the landfill.

Figure 5.3 shows a similarly correlated relationship between the number of gulls in attendance at the landfill and the amount of waste being delivered to the landfill on a daily basis. However, like in figure 5.2, there are a number of days in which gull abundance does not cycle with the amount of waste that is delivered to the landfill. This could be a result of human disturbances, and error in the sampling method.

Figure 5.5-5.6 are “Lotka-Volterra analogy” plots. These plots were made to determine if there is a density-dependence relationship between the “predator” and “prey” in this study; the prey being the waste and the predator being the glaucous gulls at the landfill. The Lotka-Volterra predator-prey model is typically used to determine if a predator and prey oscillate with respect to one another (Vandermeer and Goldberg, 2003). Figure 5.4 is the theoretical model of the Lotka-Volterra predatory prey model. This model can be compared with figures 5.5-5.6 in order to determine if there is a possible density-dependence relationship between the predator and prey in this study.

A strongly accepted caveat to the Lotka-Volterra model is that there will never be a population of predators and prey that will even closely follow the pattern in figure 5.4. Because the environment is continually changing, and populations are continually being “shifted to new values” a true Lotka-Volterra cycle will never occur (Townsend et. al, 2003). So the Lotka-Volterra model fits well with the data collected from the Barrow landfill because it has the standard predator and prey that is needed for this model. Therefore, the waste can be considered a prey item in the sense that the gulls are consuming it and the amount of waste available at the landfill decreases as the number of gulls at the landfill increases. However, the prey item (waste) also decreases as a result of covering by landfill management practices and decomposition, but this is simply an aspect of a changing environment, much like the lynx or hare population would change as a result of human activities (i.e. hunting).

Interestingly enough, figures 5.5-5.6 hint to the idea that there is some kind of density dependence relationship between the trash available and the number of gulls present at the landfill. This is intuitive when thinking about how the density of the gulls at the landfill could increase to the point where they could consume all of the waste readily available to them. In the two figures that are modeled after the Lotka-Volterra model, there are instances in which there is an oscillating effect in the number of gulls and the amount of trash available at the landfill. This is also evident in figures 5.2 and 5.3, in which there is an oscillation in the amount of waste and number of gulls present at the landfill, with respect to one another. As seen in figure 5.2, there is a delay in the change in the number of gulls at the landfill and a change in the amount of waste available at the landfill. This further suggests as density-dependence relationship between the gulls and the trash being consumed at the landfill.

Arrows on figures 5.5-5.6 are used to illustrate the direction of the data through time, which help illustrate the predator prey cycle. Figure 5.5 has some of the features that are present in the theoretical version of the Lotka-Volterra predator-prey model. It appears that at lower levels of glaucous gull numbers at the landfill there is a stronger density-dependence relationship between the predator and the prey. Figure 5.6 displays the Lotka-Volterra profile more than any of the other models. It is possible that it is
more similar to the theoretical version because of the time delay that was used, like the time delay used in figure 5.3. While these models are relatively inconclusive, it is interesting to note that there is some oscillation (which the Lotka-Volterra model would attribute to a density-dependence relationship) with respect to the number of gulls present at the landfill and the amount of garbage present at the landfill.

**Discussion**

The results of this study show an important trend in the number of glaucous gulls in attendance at the Barrow landfill. From the data presented in this paper there is confidence to say that glaucous gull populations are responsive to changes in waste levels at the landfill. This will ultimately have an impact on not only glaucous gull populations, but the populations of other bird species across the North Slope. As the human population grows on the North Slope, greater development occur, which will result in increased waste production in Barrow and at most likely at many of the villages across the North Slope. From the results of this study, Human population growth across the North Slope could have an impact on various bird populations throughout the region.

**Sources Cited**


---

**Figure 5.5 (left) and 5.6 (right): Oscillation of gull and waste abundance at the Barrow landfill.**
Peri-Urban Agriculture
Agricultural Viability At The Urban Fringe

Adesoji Adelaja, Kevin Sullivan, Mary Beth Lake*

Introduction
The retention of farmland provides many benefits to the farming and non-farming community alike. Its economic benefits include strengthening the agricultural economy, lowering infrastructure costs to taxpayers, and supporting tourism activities related to open space, wildlife, and farming. Environmental benefits include protecting groundwater recharge areas, providing wildlife habitat, and retaining natural character. Social benefits include securing a future for young farmers, providing a safe, fresh food supply, and preserving scenic open space (MFCA 2004). Many states, local governments and nonprofit organizations have recognized the benefits of protecting agricultural land and have established farmland preservation programs as a result (AFT 2004).

Many of the benefits provided by farmland are a result of its agricultural use. Unfortunately, preservation of farmland does not guarantee that the land will remain in farming and continue to provide these benefits. Farmers across the country are struggling to remain viable in the face of increasing development pressures on the urban fringe, competition from large-scale agricultural producers, increasing transportation costs, competition from agricultural imports, weather and disease related crises, and a lack of business management skills. Simply securing the land base without tending to the viability of agriculture will miss both the complexity of the situation and the opportunity that farmland preservation programs provide to maintain agriculture’s benefits.

Therefore, states must develop agricultural policies that both protect farmland that promises to be viable in the future and provide farmers with tools that help them to sustain their business. Such policies must be based on a sound understanding of the nature of agriculture, its unique features and critical infrastructure. Long-term viability of agriculture, and of the communities in which it exists, must go hand in hand with preservation efforts. Those farms that have, or can develop, greater resiliency from an ecological, social and economic standpoint, can be compatible with other uses of land, and can contribute to broader state objectives, must receive priority as we seek to use limited state resources in achieving preservation and sustainability.

The Case of Michigan
Michigan agriculture is in danger of losing its viability as an industry, and its ability to provide amenities to the non-farm community, because of the challenges of land conversion and decreasing farm profitability. The Michigan Land Resource Project (PSC 2001) projected that, by the year 2040, Michigan will have lost 17 percent of its 1980 farmland base, or 1.9 million acres. The report predicted that the areas of the state with the best soils, access to markets, and availability of other critical success factors, are also the most vulnerable. These lands are some of the most important ones for an expanded farmland preservation program in Michigan to target. In addition, many farms in Michigan are struggling to survive. In fact, 57 percent of farms in Michigan experienced a net economic loss in 2002 (NASS 2002).

Consequently, the State of Michigan has identified farmland preservation and retention of viable agriculture as important state policy objectives (MLULC 2003). The purpose of this study has been to gather information about the ecological, social and economic characteristics of Michigan farms in order to assist the state in targeting acreage for preservation efforts that will enhance state agricultural viability. This information was used to develop several scenarios for a statewide preservation program, which indicates the highest ranking acreage in the state, as well as the estimated cost of such a program. This report presents one of those scenarios.

Characteristics of Resilient, Diverse, and Flexible Agriculture
The selection of farms for preservation must be conducted in the context of a vision for the future of agriculture. The vision for Michigan is a resilient,
diverse and flexible agriculture. Agricultural resiliency requires a balance of ecological, social, and economic factors that reflect both the agricultural community as well as the broader social and economic context in which it operates. The translation of the vision of resiliency into a framework for determining the priorities for preservation is the subject of this report.

The basic characteristics of farmland that must be considered for preservation purposes are agriculturally based. For instance, prime farmland has the soil quality, growing season, and moisture supply needed to economically produce sustained high yields of crops when treated and managed according to acceptable farming methods. In addition, Michigan’s unique geography presents a number of regions that are particularly suited for growing specific crops to their full potential. Such unique farmland, often characterized by specific combinations of soil, topography and climate, presents a considerable advantage and opportunity for the production of unique crops. These characteristics are the foundation of a viable and resilient agriculture.

Farmland production is inextricably linked to environmental conditions as well as management practices. The long-term productivity of agricultural systems is also dependent on the natural environment’s ability to support the industry’s polluting emissions and use of natural resources. Both natural and managed ecosystems provide society with many benefits, collectively called ecosystem services (Daily 1997). Some of these services include wildlife habitat, biodiversity, and groundwater recharge. Environmentally-conscious farming practices contribute to the sustainability of ecosystems that in turn support the agricultural business and make it more viable long term.

At the farm level, economic viability translates into net income and the ability of farm operators to support their families and invest in the future. Agriculture’s long-term economic viability is dependent not only on its production efficiency, but also the ability to weather fluctuations in both yield and market demand and to access to relevant markets. Farms and farming communities producing a diversity of agricultural products can more easily adapt to both economic and production-related downturns. Innovation in growing and processing is also a positive contributing factor to economic viability (Adelaja 2000). Many farms are adding to their bottom line by adding value to farm products. On-farm markets, u-pick operations, and agro-tourism all present additional income-generating opportunities for farm families on the urban fringe. Access to fair and stable markets is critical for the viability and resiliency of agriculture. The demand for fresh, locally grown vegetables and fruits is growing among urban populations. The number of farmers’ markets in the state is now over 120 and rising. Farms in physical proximity to population centers have clear advantages in their ability to cost-effectively access direct market and tourism-related opportunities.

The socio-demographic characteristics of a region also play a role in its ability to maintain a viable agriculture. For example, the income and education of the consumer base can influence demand for specialty and value-added agricultural products. Ethnic diversity within the farming community is important due to the need for migrant labor on farms, and to the growing evidence that minority business owners are some of the most resilient in the nation (U.S. Department of Commerce, 2001).

A resilient agriculture must be capable of maintaining an appropriate land base in the face of developmental pressures, which allows for a diversity of farm sizes covering a range of production scales. An appropriate land base also clusters agricultural activities in order to minimize right-to-farm conflicts and maintain necessary supporting infrastructure such as seed sales, equipment repair, and veterinarian services. Threats to this land base include growth pressure from population centers and competition for other land uses. If an appropriate land base is not retained, state agricultural viability will not be achievable.

Targeting Preservation for Resiliency

In understanding how many different characteristics of farms contribute to their resiliency, one can conclude that a comprehensive approach is required in selecting the target acreage for farmland preservation. The approach used in this study is to select such criteria that the study team deemed important as assets that could be capitalized upon in the future by agricultural producers. In order to determine which agricultural lands have the best characteristics for resiliency, farmland across Michigan was ranked on the basis of its agricultural, ecological, economic, social, and land use characteristics. The research team collected data on 20 indicators of these resiliency characteristics, which are:

- Prime Farmland.
Current Preservation.

One way that the state can choose to focus its farmland preservation program is by targeting acreage that is under threat of development. A special analysis was conducted to evaluate the cropland acreage in Michigan that is in eminent danger of being converted to development. The analysis involved determining the acres of farmland that the Michigan Land Resource Project (PSC 2001) predicted would be converted to “built environment” by the year 2020. Without discriminating with respect to agricultural, ecological, economic, and social factors, this analysis reveals that 1 million acres, or approximately 10 percent of Michigan farmland, will likely be converted to the built environment. In order to preserve all of this farmland today, the state would have to expend about $2.5 billion.

With this high cost, it is clear that not all acreage at risk can be preserved. In order to identify a framework for targeting farmland within the at-risk areas for preservation, one approach would be to employ a scoring system based on the resiliency characteristics described above. The research team used the data from the indicators to devise a scoring system for the counties. The aggregate score for a particular county reflects the suitability of land in

**Figure 1 Priority Acreage for Farmland Preservation in Michigan**
In order to prioritize the acreage by county that is most desirable for preservation, the scores of farmland by county were applied to the acreage facing the threat of development by 2020. By converting the scores to equivalent percentages, a proportionality measure was derived which allows the narrowing of “threatened acreage” to achieve “priority threatened acreage.” Through this method, the research team was able to limit the number of acres for preservation under this scenario to 765,450 acres, which would cost approximately 2 billion dollars. The number of acres and the cost can be further limited by strengthening the criteria by which farmland is chosen for preservation. This method not only saves the state money, but it allows the preserving agency to better target acres within these threatened zones which are also resilient, flexible and diverse. See Figure 1 for a map of the targeted acreage for preservation in the state of Michigan using this method.

**Developing Programs that Enhance Viability**

Preserving farmland, even the most resilient farms, will not be sufficient to sustain and grow the agriculture industry in most states. Policies and programs that provide producers with the necessary tools to maintain their resiliency are likewise important. Many of these programs (e.g. the Farm Bill, Cooperative Extension resources, the Agricultural Experiment Station, etc.) are already in place. However, new opportunities for understanding how the characteristics of farms and farmers impact viability can contribute to the development of programs and policies that enhance agricultural viability.

In a New Jersey study, Adelaja (2000) found many interesting relationships between viability and farmers’ attitude, involvement, business climate, regulatory climate, and environmental characteristics. For instance, this study reported that farmers who have longer planning horizons are more profitable. Farmers who work regularly with extension and are involved politically and with their neighbors tend to be more successful. Innovative farmers are more viable. Right-to-farm conflicts reduce agricultural viability, as does wildlife damage. Finally, as land values rise (from land development pressure in the urban fringe, for instance), viability falls.

This valuable information about the characteristics that impact agricultural viability can be used to design and enhance programs and policies to benefit farmers. For example, in the New Jersey study, Adelaja found that farmers who owned and knew how to operate computers were more successful than those who did not. The Rutgers Cooperative Extension program created a computer accessibility program, which trained farmers on the uses of a computer for their farming operation and, in lieu of a diploma, gave them a donated computer. Similarly, the finding that innovative farmers are more successful might encourage the development of a funding source or business development program for farmers who have creative ideas. Information about farmer attitude and involvement can influence a producer to make changes in his own perspective and seek relationships with extension agents, policy makers, and neighbors.

There are a vast number of potential benefits to this type of knowledge. Studies focused in particular states can provide the needed information to decision makers for developing the necessary policies and programs to keep their agricultural industry thriving. A similar study to that which was conducted in New Jersey is being investigated for Michigan.

**Conclusion**

The State of Michigan has identified farmland preservation and retention of viable agriculture as important state policy objectives. However, Michigan is faced with limited resources, and choices must be made that will facilitate the largest return to taxpayer funds. In setting priorities for farmland preservation, one must combine various factors, including farmland most under threat of development, farmland with the best agricultural and ecological characteristics, farmland with the best economic and market prospects, and farmland with the highest potential social and quality of life contributions. This report proposes one potential solution to targeting farmland preservation dollars with the most effective result for maintaining a resilient, flexible and diverse agriculture for Michigan. It also recommends further research into the farm and farmer characteristics that impact agricultural viability in order to better tailor policies and programs that assist farmers in achieving success and sustaining their farms. Studies like these provide valuable information which can be used to devise a comprehensive strategy for agriculture at the state level.
References


Agriculture and Territorial Changes In Periurban Zones Of Central Mexico.

Héctor Avila Sánchez

The object of this paper is to discuss different concepts regarding the existence of periurban spaces, as one of the diverse manifestations of the restructuring of territories in a global context. Above all, its interest lies in an analysis of these transformations within the context of the old rural spaces, those which have been affected by the advance of urbanization. The development of peri-urban agriculture in some cities of Central Mexico has established important patterns of territory transformation, either in changes of use of land or in the structure of production, or in social and cultural changes. Periurban agriculture is one of the several activities in this territory, that remains with another non-farming activities, mainly manufactures and tertiary, that are having an quick diffusion.

Regional Economic Geography and Periurbanization.

The evolution of territorial processes which have occurred over the last thirty years, in the context of productive restructuring, has given a new impetus to the discussion of concepts and postulates in different disciplines; geography, which has territory as its object of study par excellence, has not remained far removed from this debate, and has felt the need to re-discuss its concepts and postulates.

Currently, various different schools of thought address the analysis of territories, converging in two major positions: the first reinforces the idea about spaces, where the expression of phenomena can be quantified and can establish prospects through the use of models, etc. In the second, a series of approaches exist, which, if they do not exactly deny the importance of the above approach, concede a greater validity to the variables of a social kind which affect economic actions, political roles and the representations established, or formed, by social actors from their own territory.

In the first of the positions in this debate, the notion of economic space as a category of analysis is reinforced, especially under the Spatial Economic Theory Approach. The central idea established here is the validity of the centre/periphery approach. So-called geographical economics is referred to in terms of “the localization of production in space” (Cfr. Krugman, 1996: 1-3). Recently this question has been emphasized; “rediscovery of geography” is the term used to describe the process in which new techniques and tools have emerged (especially models) which analyse industrial organization, international trade and economic growth, where inequalities in populational densities play an important role, as well as conditions in the natural environment (existence and potential of natural resources) (Cfr. Fujita, M.; P. Krugman and A. J. Venables, 1999: 1-12).

Also, even if the theory on the organization and restructuring of regions within the globalization process has been critically revised and redefined over the last decade, the debate and/or paradigm on the reestablishment of industrial districts in the post-Fordist model of flexible production, one of whose principal manifestations can be seen in the differentiation of spaces in terms of their insertion in a global context, i.e. the existence of regions considered as either “winners” or “losers” (Benko and Lipietz, 1994), is still in force. In such an approach, the role which urban regions play in the organization of spatial processes is re-evaluated or, rather, reaffirmed, as well as the role of the “world cities” as props in the global system. In this approach, which highlights the prevalence of global productive processes, the idea of territory as a social construct is central. A sphere where political decisions, which are neither foreseeable nor quantifiable, play a role of vital importance; where social expressions, experiences, daily life and perceptions of the environment play a central role in this characterization, the same as, or more than, economic or spatial concerns.

In fact, the economic dimension of territorial relations plays an essential role, as the laws of economy ultimately control the mechanisms of territorial organization; they have the power to create it, but also to destroy it. However, the territorial superstructural spheres (public powers, ideologies, parties and political associations) can take advantage of the economic structure and develop a certain grade of autonomy in terms of the inventive cultural capacity of human societies, and the multiple
problems involved in their daily existence (Di Meo, 1998: 58). Territoriality then, as an expression of social relations in space, has a diverse character whether we are talking about an individual or a small group, according to their activities or functions, as well as their social property and the spatial appropriations made from their environment. In terms of integration in relation to the social and material environment, networks are formed in the territory, with a clearly-defined organization and social behaviours. In summary, we are talking about a point of view or approach in which territory is identified as a limited social construct in a spatial dimension, given meaning and life by a social group (Piolle, 1998: 83).

Therefore, the spatialization of diverse social relations also occupies an important place in the analysis of territories; in a given space, where, at the same time, activities, knowledge, attitudes, representations and identities are seen. Geographic-economic reality is nourished by the conjunction of these perceptions (Benko and Lipietz, 2000: 9-15). An approach of this nature responds to methodological requirements for an analysis of territorial spheres and societies, where natural aspects have a great importance and play a central role in determining political and economical actions. For example, in Latin-American agrarian societies, despite the productive and social restructuring processes imposed by economic liberalization, the relationship these social groups have with their territorial environment continues to be very complex with cultural processes still playing a central role.

Nowadays, the approach or idea of the New Rurality has permeated the analysis of rural spaces, in the distinct disciplines which are concerned with studying them. Aspects such as productive restructuring, rurbanization or periurbanization, rural environmental questions, agricultural modernization, rural tourism, periurban agriculture, female agricultural work etc. constitute a fundamental core in researching rural themes.

Metropolitan Expansion and Periurbanization.
A recent outcome of metropolitan expansion can be seen in the development of periurban zones. Even if urban growth rates have been modified over the last few decades, cities still keep on expanding. Latin-American capitals continue to exert a substantial influence and they establish norms in terms of the use and appropriation of urban-rural spaces in contact. Spaces which until recently maintained an important agricultural vocation, have now adapted to the cities’ functions and requirements.

Within the framework of a change in the paradigm of post-Fordist production, the international territorial tendency of the last two decades, what is known as the new “flexible territorial model” has been formed, which is derived in turn from the territorial fragmentation of the productive processes affecting urban systems and the rural and urban sub-spaces within their sphere. The new territorial model has led to megalopolitan structures in a complex urban-rural network, incorporating smaller cities and urban-rural areas with precise functions for the whole urban system, on different spatial levels (Aguilar, 1999: 147-151).

Within the new centrality caused by globalization in local territories, rural spaces are made increasingly dependent on cities, but they continue to exist in new forms and with diverse operation strategies, adapting to new circumstances, whether in terms of production or of social and cultural aspects; in periurban territories, hybrid forms arise containing elements from both urban and rural settings. These periurban territories present new physical-spatial characteristics, as well as novel attitudes and social behavioural forms of the social actors living there. The system of activities in rural zones is transformed and they also receive the influence of certain activities and social transformations linked to periurbanization.

Globalization and Territorial Reorganization in Mexico
After the high urbanization rates of the seventies, the eighties were fundamental in the formation of the urban system in Mexico; factors such as the acute economic crisis, the process of greater economic opening and the accompanying structural changes necessary for operational capacity, modified the pattern of population distribution in the territory. In this way, since the mid-eighties, Mexico has experienced a gradual incorporation into economic globalization processes, whose maximum expression up until now can be seen in the North American Free Trade Agreement in 1994. In principle, this is a reflection of economic tendencies towards globalizing markets and transformations in Mexican economic geography.

Since the eighties, a territorial reorganization in Mexico has been witnessed, characterized by the emergence of a stratum of medium and small-sized towns around the principal metropolises: Mexico
City, Guadalajara and Monterrey (see map 1). This is the result of a redefinition of the international division of labour and the subsequent adjustments in the previous economic model; this process could modify the ambits of rurality (the social and productive polarization of agricultural producers), at the same time as it would affect socio-spatial restructuring and accentuate a territorial concentrated structure. In the central region of Mexico, around the central metropolitan nucleus – the agglomeration of Mexico Valley - the dilated periurban space denominated the regional crown of Mexico City (as this is at its centre) is in formation. We are talking about a dense patchwork of urban networks where most of the region’s cities converge (the metropolitan areas of Mexico City, Toluca, Cuernavaca, Cuautla, Puebla, Pachuca and other localities with more than 15 thousand inhabitants; see map 2). This territorial scheme includes the development of rural industrialization districts (Delgado 1999).

**Periurban Agriculture as a Manifestation of the New Rurality.**

Nowadays, the impact of agricultural practices on distinct areas of the urban economy is rarely studied. It is one of the most recent manifestations of territorial restructuring, specifically from those derived from periurban territories. Its novel manifestations are another expression of the so-called New Rurality. Up until now, the principal contributions of this practice can be seen in the existence of the activity as a foolproof way of incorporating self-sufficiency into the family diet and/or consumption; in terms of employment, urban agriculture represents a source of income, mainly part-time. In some countries, especially in Africa, it constitutes a type of back-up option in times of high unemployment.

The persistence of agricultural activities, as an expression of the New Rurality, appears to be the clearest indicator of this type of relationship between cities and their immediate rural surroundings. Mexican urban economies display a high demand for agricultural products as well as for labour and land, the latter being for either productive or urban (housing or speculative) purposes. Since the nineteen-nineties, agricultural practices in several different Mexican cities have reformulated the different variables which affect economic growth (particularly employment and productive activities), the maintenance of sustainable development policies and the life and cultural practices of local communities (Torres, 2000: 9-15).

In Mexico, various research projects have already been drawn up, especially regarding the appearance of this phenomenon in the periphery of Mexico City (Torres, 2000). In the same manner, given the pattern of national urban growth, periurban agricultural practices have spread to many medium-sized cities in central Mexico, such as Cuernavaca and Cuautla (Avila, 1997), Querétaro (Ramírez, 2000) or Texcoco (Aguilar and Escalona, 2000), amongst others, with important territorial and productive implications.

**Agriculture in Periurban Spaces in Mexico**

Nowadays, territorial transformations, which have occurred as a consequence of the uncontrolled expansion of urban zones in Mexico, are evident; both large and medium-sized cities grew uncontrollably in the seventies. Although the tendency began to be reverted towards the eighties, progress did not come to a complete stop. Enormous expanses of agricultural land were incorporated into the hierarchy and organization of big cities. For example, in the east of Mexico City, one of the biggest conurbations in the country was set up. New urban sub-centres were consolidated and others of lesser standing experienced territorial transformations displaying a transition between rurality and urbanity, with no clear tendency towards either one.

The growth experienced by Mexico City has taken place mainly on agricultural lands, 60% of which were at the time under the regimen of collective property, in ejidos and/or agricultural properties. In the fifties, substantial expanses of ejidal or communal lands were incorporated into urban zones, generally in the form of expropriations; lands which were originally destined for agricultural uses became susceptible to urbanization, even when the changes were carried out by agricultural authorities. Towards the end of the seventies, deprived urban areas began to spread onto communal and ejidal lands in immense proportions. The growing migratory pressure caused illegal sales of social property. In this way, deprivation and marginality are two phenomena which have accompanied urban expansion during the second half of the twentieth century (Seyde, 2000: 72-73).

Other rural spaces bordering Mexico City have suffered the onslaught of urbanization and have been transformed. Some examples are Chalco Valley and the South of the Federal District (Xochimilco, Tláhuac and Milpa Alta). If these spaces still maintain a rural feel, the urbanization drive is slowly changing the image and functions of these lands, with some functions that could be identified with both
urban and rural settings. Currently, the agricultural plots are being abandoned, as contaminated water in Xochimilco Lake has reduced the productive capacity of the traditional crops, under the system of chinampas (man-made islands). Watering these crops with sewage water has caused a process of biological contamination and the salinization of the soil. In 1930, Xochimilco was situated outside of Mexico City and had 73 hectares of urban space; this increased to more of 2,500 hectares in 2000, and is now totally swallowed up by the urban stain of Mexico City.

In 1992, a constitutional reform to article 27 took place. The possibility of privatizing ejidos was established, so ejidatarios are now free to do as they like with their property. In an urban context, the Agrarian Law anticipated that the ejidal lands situated in the growth area of a population centre should abide by the regulations and laws on human settlements: the Agrarian law no longer restricts developers and beneficiaries of expropriations of ejidal and common land, who can now carry out this action personally; in this way, agricultural expropriations, previously considered as social property, can now become incorporated into the land market where generally they are used for housing (González and Vargas, 2000: 62).

Even if periurban agricultural practices do not have a great importance in terms of generating urban income, these practices in Mexico, and other Latin American countries, appear as one of the most important options in terms of employment and self-sufficiency in food supplies. These processes require further study, especially with the existence of an increasingly impoverished agricultural sector, releasing substantial numbers of workers who migrate principally to the periphery of urban centres, where they continue to carry out some kind of agricultural activity. Knowledge about the way in which periurban agriculture is practised can be seen as particularly relevant, because of its growing participation in urban markets and in the formation of food systems of periurban spaces, and in the generation of local employment. It would be interesting to study in depth the forms of part-time agricultural employment, which is characteristic of periurban agriculture.

Another aspect would contemplate the use of periurban lands in terms of effects on the environment; for example, the spoiling of landscapes and the way in which natural resources are used. In terms of the environment in urban-rural spaces, a study of the intense degradation of bodies of water, soils and treatment of solid waste is urgent. Periurban agricultural production with water from urban-industrial discharges or with treatments of dubious quality, has not found adequate solutions and represents a serious health risk.

A question of utmost importance in the analysis of periurban spaces relates to territorial transformations due to economic factors, especially those which are derived from structural adjustments in the economy (changes in the form of land tenancy, social policies and investments in urban and rural settings etc.). It is also important to know their significance and effects on the local economy, like the changes in land use (from agricultural to urban uses and vice versa, industrial etc.), the development of industrial, handcrafts and/or maquila activities, the practice of primary activities (agriculture, livestock farming, forestry, aquaculture etc.) at the family level, or the gradual growth of the service sector, a phenomenon which has been widely developed in Mexico and in Latin America.

From the point of view of the construction of land identity by the periurban inhabitants, one must analyse the new roles and strategies which local actors adopt in urban-rural transition zones; the social-territorial networks which exist there; the new identities which the periurban inhabitants build. The social imaginary, the feeling of territorial belonging and the link between symbolism and territoriality regarding cultural patrimony.

In conclusion, the different manifestations witnessed in periurban spaces constitute an important area of study, as this is a phenomenon which we will see for some time to come under new forms and types of global economy.

Bibliography.


Avila, H. (1997) “Agricultura, urbanización y cambios territoriales en el estado de Morelos” in


MAP 1. NATIONAL URBAN SYSTEM AND REGIONS OF MEXICO

SOURCE: SEDESOL, CAM-SAM, IIEc-UNAM

MAP 2. SUBSYSTEM OF CITIES IN CENTRAL MEXICO

LOCALITIES OF THE SUBSYSTEM CENTRAL CITIES
- Rank 1
- Rank 2
- Rank 3
- Rank 4

LINKS BETWEEN CENTRAL PLACES

METROPOLITAN COUNTIES
Chemical Use Reductions In Urban Fringe Agriculture

Adesoji Adelaja, Kevin Sullivan, Ramu Govindasamy*

Introduction

Chemical usage has direct implications for productivity and profitability in agriculture. Excessive usage implies unnecessary production cost, negative externalities, and reduced welfare of rural residents. The concern about farm chemicals is greatest at the urban fringe where non-farmers and farmers must coexist. Non-farmer complaints impose significant legal and compliance related costs on agriculture (Adelaja et al. 1998). The choice of farmers regarding chemical use is an issue of significant interest to farmers and non-farmers at the urban fringe.

While many studies have looked at chemical use in agriculture (Rendleman 1991, Painter et al. 1995, Lee 1992), the cause of changes in chemical use overtime is of particular importance, as are the effects of farmer socio-demographics and attitudinal and farm structural factors on chemical use. Understanding the factors that have led farmers to reduce chemical usage over time is important to policy makers, farmers, environmentalists and producers of agricultural chemicals. Of particular importance is information on how chemical use choices are affected by the regulatory climate by “right to farm” conflicts arising at the urban fringe and by factors at the urban fringe which hinder normal farming activities. Such information can be used in designing an incentive system for the adoption of sustainable agricultural practices.

This paper summarizes the findings of a comprehensive study on chemical use reduction. The objective of a larger study was to investigate the economic, socio-demographic, regulatory and attitudinal factors that contribute to the adoption of reduced use of on-farm chemicals. The paper conceptualizes the demand for chemicals, and uses stated information on changes in use to estimate empirical logit models of reduced insecticides, fungicides, herbicides, and fertilizer uses, as well as an aggregate model of chemical use in agriculture. A unique Survey of New Jersey Farms (SNJF) by Adesoji Adelaja and a team of researchers at Rutgers University provided the source of data for this analysis.

Conceptual Framework

The conceptual framework is based on the production function used by Adelaja et al. (1998), but augmented by incorporating an external cost component such that farmers can be made to internalize the externalities arising from chemical use by regulators who chose the level to which farmers are regulated.

Denote the chemical use by the \(i^{th}\) farmer by \(c_i\) and the external costs per unit of chemical usage of the \(i^{th}\) farmer by \(\beta\). \(\beta\) \((\alpha)\) is the full cost of eliminating the adverse effects of chemical use on society. Further, denote external costs borne by farmers by \(\alpha \beta c\) where \(\alpha\) is the proportion of the full external cost to society imposed on the farmer via regulation or via the effects of right to farm conflicts. Farmers must chose an optimal level of chemical use consistent with profit maximization and this depends not only on \(\beta\), but also on \(\alpha\) \((\alpha\) ranges from zero to one). The profit maximizing farm’s decision problem becomes one of choosing input values via an augmented production function framework. The optimal quantity of inputs demanded by the farmer can therefore be expressed as

\[
q^* = \theta q^* (k^*, l^*, c^*, r^*, m)
\]

where \(q\) is the quantity produced by the \(i^{th}\) farmer, \(\theta\) is the technological or structural parameter of the \(i^{th}\) farmer, and \(k, l, c, r, m\) are capital, labor, chemical, miscellaneous inputs, and management capability of the \(i^{th}\) farmer, respectively. The first order conditions for profit maximization for chemical use \((c^*)\) suggest that the amount of chemicals a farmer uses depends on product price, the price of inputs, including chemicals, regulatory climate, and indicators of pollution abatement. Variables are the basis of the empirical model that follows.
Data and Econometric Model

The 1994 SNJF (Adelaja et al 1995) involved a re-survey of 216 New Jersey farmers that had previously participated in the Farm Costs and Returns Survey (FCRS) conducted by the National Agricultural Statistics Service (NASS). The survey generated information not only about the structure of farms, but also about other issues for which data are usually lacking. It probed farmers about their socio-economic and demographic characteristics, as well as their opinions and attitudes about a whole series of regulatory, taxation, business climate, land use, marketing, farmland retention, production system, leadership, communication, and public policy issues. It further probed into their plans with respect to land use, investments, sale of land, etc., and into a many other issues. The survey contains 152 questions covering topics related to these dimensions of farming.

Based on the data available and the factors suggested by the conceptual framework above, a number of variables were identified as determinants of chemical use. Prices are expected not to vary by location. However, it is expected that the business and regulatory climates and external costs do vary by location. These factors, as well as various technological factors and farm structural characteristics are hypothesized to affect chemical usage. The hypothesized determinants of farm chemical usage include (1) farm size; (2) farm profitability; (3) primary farming activity; (4) location or region of the farm; (5) ownership structure; (6) changes in land use; (7) regulatory climate; (8) conflicts with neighbors; (9) farmer socio-economic and demographic characteristics (e.g., age, farming experience and education); (10) degree of innovation and production efficiency; and (11) exposure to crop and livestock damage.

The following linear function was specified to explain the changes in chemical use:

\[
\text{CHEM} = b_0 + b_1 \text{IGFI} + b_2 \text{PROFIT} + b_3 \text{DNURSE} + b_4 \text{DVEG} + b_5 \text{DDAIRY} + b_6 \text{DFRUIT} + b_7 \text{DANIMAL} + b_8 \text{REG1} + b_9 \text{REG2} + b_{10} \text{REG3} + b_{11} \text{ACOWNPCT} + b_{12} \text{DINCAC} + b_{13} \text{DDECAC} + b_{14} \text{DRTFCON} + b_{15} \text{DPINE} + b_{16} \text{EXPER} + b_{17} \text{OPERAGE} + b_{18} \text{OPEDUC} + b_{19} \text{INNOV} + b_{20} \text{INFOIND} + b_{21} \text{DAMCOST} + b_{22} \text{DPFIN} + b_{23} \text{DREGWATER} + b_{24} \text{DREGSOIL} + b_{25} \text{DREGLAND},
\]

where CHEM is a measure of the change in chemical usage. Equation (2) was first estimated for each chemical type separately using logit models. The dependent variables in the four models are FERT, INSECT, FUNG, and HERB for fertilizer, insecticide, fungicide, and herbicide uses, respectively. Each dependent variable is defined as 0 if the farmer decreased use, or 1 if the farmer increased use or remained the same. The description of each independent variable with expected sign and unit of observation are given in Table 1. Equation (2) was also estimated using simple linear regression. In this case the dependent variable was a summary index for all four chemical types. The dependent variable (CHEMIND) ranges from -4 to 4 and can be thought of as a continuous cumulative binary variable (CCBV). The model itself can be thought of as a Cumulative Binary Dependent Variable (CBDV) model.

Empirical Results

The estimated coefficients for the four models and the estimated coefficients of the aggregate chemical use model are presented in Table 2. Specification 1 represents the full model and it includes all variables hypothesized to be important. Specification 2 involves the deletion of insignificant variables.

Few variables are significant in the fertilizer demand logit model compared to the other three chemical uses. This may suggest a structural difference in fertilizer use demand which is highly correlated with yield and production. While the other chemicals are also related to yield, they tend to be used on demand when a problem arises. It is found that farm characteristics, farmer socio-demographic and attitudinal characteristics, and other non-market factors play less of a role in determining fertilizer use.

The coefficient for DINCAC is negative and statistically significant except in the case of insecticides. Hence, growing farms tend to be more judicious in chemical use. Profitable farms are also generally more judicious in chemical usages, vegetable farms tend to use insecticides, fungicides, and herbicides more intensively than growers of field crops. DRTFCON is statistically significant and negative for fertilizer, insecticide and fungicide, suggesting the beneficial effects of “right to farm”
Table 1 Description of Each Independent Variable

<table>
<thead>
<tr>
<th>Variable</th>
<th>Description with Expected Sign</th>
</tr>
</thead>
<tbody>
<tr>
<td>INTERCEPT</td>
<td>Intercept</td>
</tr>
<tr>
<td>IGFI</td>
<td>Gross Farm Income</td>
</tr>
<tr>
<td>PROFIT</td>
<td>Net Income per Acre</td>
</tr>
<tr>
<td>DNURSE</td>
<td>Nursery Crops</td>
</tr>
<tr>
<td>DVEG</td>
<td>Vegetable Farm</td>
</tr>
<tr>
<td>DDAIRY</td>
<td>Dairy Farm</td>
</tr>
<tr>
<td>DFRUIT</td>
<td>Tree Fruit and Berry Farm</td>
</tr>
<tr>
<td>DANIMAL</td>
<td>Poultry Cattle Horse Farm</td>
</tr>
<tr>
<td>REG1</td>
<td>Central New Jersey</td>
</tr>
<tr>
<td>REG2</td>
<td>North-West New Jersey</td>
</tr>
<tr>
<td>REG3</td>
<td>North-East New Jersey</td>
</tr>
<tr>
<td>ACOWNPCT</td>
<td>Acres Owned Percentage*</td>
</tr>
<tr>
<td>DINCAC</td>
<td>Increased Acreage**</td>
</tr>
<tr>
<td>DDECAC</td>
<td>Decreased Acreage*</td>
</tr>
<tr>
<td>DRTFCON</td>
<td>Right to farm Conflicts*</td>
</tr>
<tr>
<td>DPINE</td>
<td>Farm within Pinelands*</td>
</tr>
<tr>
<td>EXPER</td>
<td>Operator Experience*</td>
</tr>
<tr>
<td>OPERAGE</td>
<td>Age of Operator*</td>
</tr>
<tr>
<td>OPEDUC</td>
<td>Education of Operator*</td>
</tr>
<tr>
<td>INNOV</td>
<td>Innovation Index*</td>
</tr>
<tr>
<td>INFOIND</td>
<td>Use of Information*</td>
</tr>
<tr>
<td>DAMCOST</td>
<td>Animal Damage Cost**</td>
</tr>
<tr>
<td>REGFIN</td>
<td>Regulation Index**</td>
</tr>
<tr>
<td>REGWATR</td>
<td>Regulation - Water**</td>
</tr>
<tr>
<td>REGSOIL</td>
<td>Regulation - Soil**</td>
</tr>
<tr>
<td>REGLAND</td>
<td>Regulation - Land Use**</td>
</tr>
</tbody>
</table>

* Expected Sign "negative"
** Expected Sign "positive"

Vegetable farms tend to use insecticides, fungicides, and herbicides more intensively than growers of field crops. DRTFCON is statistically significant and negative for fertilizer, insecticide and fungicide, suggesting the beneficial effects of “right to farm” conflicts on the environment. Results from the aggregate chemical use demand model are also consistent with the results from the fertilizer, insecticide and fungicide models. The coefficient of “right to farm” conflicts is negative and statistically significant. Overall, the results seem to indicate significant consistency in the way that farmers make decisions about changes in chemical use, except in the case of fertilizer.

**Conclusion**

This paper estimates empirical logit demand models of reduced insecticide, fungicide, herbicide and fertilizer usage, as well as a cumulative binary dependent variable (CBDV) model of reductions in aggregate chemical use. Results suggest the importance of farm structural factors and individual farmer characteristics in decision making about the uses of chemicals. Fertilizer demand appears to be less affected by these factors, suggesting an inherent uniqueness and possibly greater reliance on market factors in fertilizer demand and decision making. Novel findings include the tendencies of larger and more commercial farms, and farmers that have experienced “right to farm” conflicts, to be more judicious in chemical usage. Also novel is the finding that farmers tend to intensify chemical use in an attempt to accommodate lost productivity and profitability from deer damage. Overall, the results suggest the importance of farm structural factors on chemical reduction choices.
Table 2 Parameter Estimates of Chemical Use Logit Models and Aggregate Chemical Use Models

<table>
<thead>
<tr>
<th>Variable</th>
<th>Chemical Type</th>
<th>Specification 1</th>
<th>Specification 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>INTERCEPT</td>
<td>2.4926</td>
<td>2.0011</td>
<td>1.6324</td>
</tr>
<tr>
<td>IGI</td>
<td>-1.21E-06</td>
<td>-3.08E-06 *</td>
<td>-5.57E-07</td>
</tr>
<tr>
<td>PROFIT</td>
<td>-0.00056</td>
<td>0.000011</td>
<td>-0.0008 **</td>
</tr>
<tr>
<td>DNFUSE</td>
<td>165.1</td>
<td>2.4242 **</td>
<td>7.4083 *</td>
</tr>
<tr>
<td>DVEG</td>
<td>0.1372</td>
<td>1.9722 **</td>
<td>3.2106 **</td>
</tr>
<tr>
<td>DDAIRY</td>
<td>0.8908</td>
<td>-0.0831</td>
<td>11.717</td>
</tr>
<tr>
<td>DFRUIT</td>
<td>-0.1921</td>
<td>0.0664</td>
<td>0.2695</td>
</tr>
<tr>
<td>DANIMAL</td>
<td>-0.9628</td>
<td>1.7808</td>
<td>-1.6444</td>
</tr>
<tr>
<td>REG1</td>
<td>0.6677</td>
<td>0.3075</td>
<td>2.1424 **</td>
</tr>
<tr>
<td>REG2</td>
<td>1.1633</td>
<td>0.0747</td>
<td>1.1469</td>
</tr>
<tr>
<td>REG3</td>
<td>-154.1</td>
<td>9.3629</td>
<td>3.9646</td>
</tr>
<tr>
<td>ACOWNPCT</td>
<td>-0.1335</td>
<td>-0.1024</td>
<td>-0.0871</td>
</tr>
<tr>
<td>DINCAC</td>
<td>-1.5872 **</td>
<td>-0.5245</td>
<td>-2.6737 *</td>
</tr>
<tr>
<td>DDECAC</td>
<td>-1.0576</td>
<td>-1.9696</td>
<td>-1.3002</td>
</tr>
<tr>
<td>DRTFCON</td>
<td>-2.2811 *</td>
<td>-1.5885 **</td>
<td>-3.0672 *</td>
</tr>
<tr>
<td>DPINE</td>
<td>-1.16</td>
<td>-0.738</td>
<td>-2.1219</td>
</tr>
<tr>
<td>EXPER</td>
<td>-0.05</td>
<td>0.00341</td>
<td>-0.0225</td>
</tr>
<tr>
<td>OPERAGE</td>
<td>0.016</td>
<td>-0.00273</td>
<td>0.00782</td>
</tr>
<tr>
<td>OPEDUC</td>
<td>-0.1699</td>
<td>-0.4456</td>
<td>-0.409</td>
</tr>
<tr>
<td>INNOV</td>
<td>-0.1023</td>
<td>-0.00809</td>
<td>-0.2285</td>
</tr>
<tr>
<td>INFOIND</td>
<td>-0.954</td>
<td>-0.4233</td>
<td>-0.5311</td>
</tr>
<tr>
<td>DAMCOST</td>
<td>0.00104</td>
<td>0.00103</td>
<td>0.00086</td>
</tr>
<tr>
<td>REGFIN</td>
<td>0.1007 *</td>
<td>0.066</td>
<td>0.0591</td>
</tr>
<tr>
<td>REGWATR</td>
<td>-0.1918</td>
<td>-0.7758 *</td>
<td>-1.444 *</td>
</tr>
<tr>
<td>REGSOIL</td>
<td>-0.5421</td>
<td>0.1199</td>
<td>1.3741 **</td>
</tr>
<tr>
<td>REGLAND</td>
<td>0.1556</td>
<td>0.0907</td>
<td>0.4399</td>
</tr>
<tr>
<td>Chi Square</td>
<td>45.779</td>
<td>33.859</td>
<td>45.66</td>
</tr>
<tr>
<td>p-value</td>
<td>0.0068</td>
<td>0.111</td>
<td>0.007</td>
</tr>
<tr>
<td>McFadden R2</td>
<td>0.37</td>
<td>0.29</td>
<td>0.48</td>
</tr>
<tr>
<td>Adj. R-Squared</td>
<td>0.1712</td>
<td>0.1936</td>
<td></td>
</tr>
</tbody>
</table>

A single asterisk (*) indicates the coefficient is significant at the =.05 level.
A double asterisk (**) indicates the coefficient is significant at the =.10 level

References
Urban Sprawl Towards Eden Gardens

Isabel M. Madaleno, Portuguese Tropical Research Institute, Lisbon, Portugal

The paper reports empirical data extracted in Belen, Brazil (1998), Santiago, Chile (2003) and Lisbon, Portugal (2002), regarding urban and peri-urban agriculture practices, bringing to light the political and economic forces that mould urbanization trends and city sprawl. It focus the causes and consequences of specific urban planning policies to the lives of urban gardeners and peripheral farmers, so as to discuss adequate methods and techniques to assess current evolution and ecological awareness of green belts, and debate better ways to deal with the unhealthy effects of urbanization in the urban / rural interfaces vis a vis increasing demands for environmental amenities and ongoing Eden gardens nostalgia.

Introduction

There are more residents in cities than in the countryside. The trend has been explosive from the second half of the twentieth century onwards and possibly about 60.8% of world population will be urban by the year 2030 (UN 2004). Until recently statistics indicated poverty to be mostly a rural phenomenon. The gap was economic, but also social and cultural, and the main reason for rural exodus. Newcomers frequently counted on solidarity chains, either within families, ethnic groups, people sharing the same faith, traditions or else, tending to facilitate their integration in the urban realm. Life is however becoming harder and harder, and ancestral alliances tend to disappear for most of the cities and citizens are coming to limits of sustenance. Employment sought by migrants is in general poorly qualified, self-employment and informal activities of any sort, micro-enterprises being the rule. Agriculture is not excluded, as one might think, because either within the urban tissue or around urban centers there are a good number of cultivated plots and farms.

The Mango City Of Belen, Brazil

Urban agriculture is by far more complex than rural agriculture because it is mobile in space as in time, and production is risky for eviction is common in informally cultivated plots (Smith, Moustier, Mougeot and Fall 2004). In 1998 the Portuguese Tropical Research Institute extracted a sample on household heads or members engaged with food and health crops that lived and worked within the municipal boundaries of Belen, Brazil. Inquires to 555 families of urban growers, totaling a population of about 2,800 people, included questions about the three main meals menu in order to establish links with front- and backyard cultivation (Madaleno 2000).

Brazilians are, in general, great meat consumers, in special red meat alias ox and cow. One of Eastern Amazon dramas is deforestation along trans-Amazon and Belen-Brasilia roads in the function of growing pastures intended for extensive cattle production. The process started in the 1970’s during a military regime and under an integrated colonization project legislative framework. Whilst cattle raisers increased at the rate of 3% a year in the whole country, animal farming grew 7% per year along the forest roads. Less devastative effects do have the swelling peri-urban properties, sometimes quite small in size, where vegetable and animal farming are practiced in rotation, even permitting the forest to partially regenerate. Communion with nature and sustainable farming diversifies production, food and income sources, combining cattle with fruit culture, honey and wood extraction, and medicinal herbs assemblage. Two husbandry types can be found in the state of Para though, with opposite side ecological effects, because they exercise different exploitation regimes: 1. Mono-cultivation is by far, for vegetable as for animal farming, the most unsustainable and depredator farming system. 2. Coping with biodiversity whereas combining several activities, produce and rotation of cultures are the best ways to respect nature and its limits, even as small pioneer plots are less competitive and quite fragile in economic terms.

Cities are widely perceived as solidly built up with no area to spare. Yet Belen has a number of under-utilized surfaces within the urban fabric that are used for agriculture. Spaces include idle public lands; extensive areas not suited for built-up use, namely the ones located at less than 4 meters height; and, in general, many household areas, for the backyard gardens are remarkable in this city. Research suggests that most of the food produced inside the urban tissue is grown by the less wealthy and is primarily family subsistence oriented. Results show that lower-income households (49%), receiving less than 100 dollars per month, spend two thirds of their incomes on food. Urban agriculture is also a female
sort of activity, in fact 69.7% of the urban growers interviewed. Additionally, urban agriculture offers opportunities to underemployed and unemployed workers, the last being about 11.4% of the inquired population universe. More than half urban agriculture actors are part-time growers, whereas about 15.1% were retired and 4.1% pensioners, remainder being mostly housewives. A significant part of the families inquired were urban migrants, coming either from interior areas located in the same state of Para (30.8%) or from other Brazilian states (13%). Some of them still have strong links to the rural realm, coming together with knowledge and appreciation for working the land.

The sample found fruit trees to be the most ubiquitous way to improve the quality of family nutrition. Tropical fruits like açaí (Euterpe oleracea), guava, rose-apple, papaya, banana, mango, lime, coconut, acerola cherry and cashew are abundant within the urban environs, in front- and backyards, as well as vacant lots, private and public food gardens. Medicinal plants were the second major occurrence within the city, Wild Lemmon Bush, a natural antidepressant and Citronelle, a popular ache killer, being adamant, followed by spices (pepper, hot and sweet, basil) and vegetables, namely chicory and Talinum, extensively consumed and part of local gastronomy. One third of the households raised livestock, especially chickens, ducks, rabbits and pigs, a quite appreciated activity either for subsistence or commercial purposes. Ducks were quite numerous in poor neighborhoods, particularly in frequently flooded areas, not only because the animal floats and swims, but for its high market value, not to forget the municipal program because the animal floats and swims, but for its high market value, not to forget the municipal program that promotes duck’s husbandry in peri-urban areas. Cereals and tubers were only cultivated in open peripheral spaces, for the majority of city farming reported is practiced on 50 to 500 m2 dimensioned plots (61.3%). A common feature in Latin-American cities and a clear inversion to well-known Burgess model is that the less wealthy in Belen usually occupy the distant, and less served peri-urban areas (Mertins 1995; Madaleno 2002).

Methodology drawn for this case-study was quite similar to the one proposed by different researchers on the subject (UNDP 1996; Van den Berg et al 1998) involving extensive field visits to the urban areas under scrutiny, participant observation over primary activities, various meetings with central government and municipal agents, especially prepared sessions with local university experts, gatherings with non-governmental organizations dealing with urban poverty, to finalize with semi-structured and structured interviews to urban agriculture practitioners. The insights of all the observations, meetings and interviews conducted in Belen were the basis for developing themes around which subsequent case studies were designed. The following field research undertaken in Presidente Prudente, the year 1999, a medium sized S. Paulo state city, corroborated much information taken from the Amazon metropolis (then totaling about 1,500,000 inhabitants), using the same sampling techniques and questionnaire. And the most important conclusion was that one third of Belen’s residents grow food and health crops, either inside or around city boundaries, in order to ameliorate household nutrition and / or generate additional income. From the golden natural rubber cycle (late 1800’s till around 1920), Belen inherited the nickname of Mango City considering the suitable fruit tree mayors have elected to shade the historical center streets.

**Santiago, Paradigmatic South American Capital City**

Chile is one of the narrowest countries in the world, compressed between towering Andes Mountains and Pacific Ocean deep waters. Historically Spanish colonization benefited central graben areas that East-West transversal streams irrigate and fertilize, kind of oasis valleys in domineering unfavorable topographies and climates that have conditioned hamlets for millennia concomitantly hardening human activities, and swiftly pushing populace to the cities, notably to the capital city. In the beginning of the 20th century Santiago only gathered 10% total population; by the end of the century the metropolis had conquered 35.74% Chilean inhabitants (INE 2002). Great Santiago currently has 6 million residents spread over 1.5 million hectares, quite dense within the core while extended toward the periphery, in general a horizontal agglomeration disseminating as an oil spot.

Facts and figures about Chile confirm ongoing studies and established theories on Latin American urbanization trends as well as increasing population mobility to the evolving countryside and smaller satellite towns, in close articulation with residential segregation, functional fragmentation towards an urban diffusion scenario. Research undertaken revealed relevant urban and peri-urban agriculture projects and practices elsewhere in Brazil, yet thus far none was as lasting, ideologically sustained, politically backed, community based, solidarity inspired, environmentally supported, and landscape noteworthy as the workers and family micro-farms.
investigated in Southern Santiago municipality of La Pintana.

A joint University of Chile and Portuguese Tropical Institute team has researched 3 micro farm units dating from the 1940’s and 1950’s, following a Congress Law (1941). The initiative can be integrated in contemporary cooperative movements, but was definitely introduced in Chile by eminent politicians after French and Swedish models, aiming provision of plots able to capacitate poor households self-sufficiency (Maza 1947). It was an expensive solution for urban poverty though, for the government had to use public property or to buy land from private owners, in order to organize the process, define priority situations, give credit, build standard one floor houses and all the necessary infrastructure, and additionally even train the potential food growers, funding having been legislated as Popular Housing Fund mission, a public institution devoted to house development in Chile, which had to attribute 30% of its own budget to this Law application only. The proposal was to create two distinctive groups of settings, associated to differently dimensioned plots: 1. Workers and Family Gardens (*jardines obreros y familiares*), 500 to 5,000m2 properties, located inside the urban tissue and in suburban areas. 2. Workers and Family Micro-Farms (*huertos obreros y familiares*), enhanced 0.5 to 1 ha plots, to be located in peripheral areas, with standard 3 room houses (46.5 m2 to 70.5 m2 dimensioned), in spacious locales that could enable families to work out home industries, and particularly engage in vegetable or animal farming intended for family nutrition amelioration, a business profitable enough to pay for mortgage and self-support the households.

Several cooperatives persist around Chilean settlements in close association with the institutionalized micro-farms, but the sole example in Santiago’s surroundings endures at La Pintana municipality in Southern metropolitan space, an administrative unit dating from the year 1981, sited over Maipo valley and sandwiched between two fast growing municipalities: San Bernardo (W) and Puente Alto (Madaleno & Gurovich 2004). Domestic industries and artisan work of any sort were promoted via 1941 Law, for they were seen as adequate for female family members, who should be committed to tasks like seeding, tending, cleaning, irrigating, animal husbandry and manual cropping, besides cooking, jam producing, sewing, child and family caring on a daily basis. Male members, on the other hand, had to perform heavier activities like manual or mechanical soil preparation, fruit cropping, tree plantation, produce transport and commercialization, in addition to their regular job duties unless they managed to survive on farming only. Times have changed, however, and gender labor division is not as clear these days; research results (2003) proved remainder micro-farms evidence a wide range of households owning, leasing or caring for the plots diverging from prototypical male wage earner, female housewife and children. In most cases, up to three generations inhabit and care productive green spaces, cooperation being necessary and gender (55% male farmers) not as relevant as age, the average food growers standing above their 50’s, about 40% landowners being more than 60 years old and frequently complaining about their offspring lack of interest and work deficit on gardening.

Mixed land uses were detected by means of surveys, the method applied being similar to Belen case study, consisting on street-by-street balanced inquiries, using a sample questionnaire, but targeting the whole population this instance

### Table 1 – Family and Workers plots existent at La Pintana municipality, Santiago, Chile

<table>
<thead>
<tr>
<th></th>
<th>Las Rosas</th>
<th>Mapuhue</th>
<th>José Maza</th>
<th>Total or average</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of Plots</td>
<td>189</td>
<td>322</td>
<td>493</td>
<td>1004</td>
</tr>
<tr>
<td>Total Surfaces in Ha</td>
<td>134.36</td>
<td>316.60</td>
<td>301.33</td>
<td>752.29</td>
</tr>
<tr>
<td>Total Population</td>
<td>1,598</td>
<td>2,178</td>
<td>3,083</td>
<td>6,859</td>
</tr>
<tr>
<td>Human Density (inhabitants/ha)</td>
<td>11.89</td>
<td>6.88</td>
<td>10.23</td>
<td>9.18</td>
</tr>
<tr>
<td>Number of Inquiries</td>
<td>21</td>
<td>40</td>
<td>50</td>
<td>111</td>
</tr>
<tr>
<td>Inquired Plot Owners or Managers (%)</td>
<td>11.1</td>
<td>12.4</td>
<td>10.1</td>
<td>11.1</td>
</tr>
</tbody>
</table>

Source: Madaleno & Gurovich (2004)
Industrial and commercial activities were recorded at Jose Maza and Las Rosas, but not Mapuhue, where animal and vegetable farming still predominates (77.5% land uses). The cooperative movement, contested sometimes, particularly by the owners that shifted to non-agrarian uses, is strong even at Las Rosas (47.6% farmed plots), a settlement halved by a heavy traffic road connection to neighbor densely populated municipality of Puente Alto (E). Socio-economic status is quite heterogeneous within the micro-farms, for whist Mapuhue has a notable dominance of low-middle income classes and less wealthy households, mostly earning the minimum salary or equivalent income (55%), a majority middle-class families were found at Las Rosas (59%) and a small proportion of high income households (10%) at José Maza. Community based elective bodies have a noble role in promoting solidarity alliances, difficult to maintain in a society based in personal achievement, pending to a universal individualism. As unique fingerprint, cooperatives and irrigation water communities facilitate preservation of links between the urbanites and nature in conjunction with manual work, for food and gardening workforce is reduced and not always affordable by families that kept the initial agro-residential land uses. The most remarkable conclusion is that most micro-farm residents have a chlorophyll friendly philosophy, cherishing their gardens and food gardens, stubborn commercial haciendas and fighting against municipal tendency to consider their settlements as public servicing non-profitable, associating whenever necessary and lobbying for their cause against urban planning cabinets in order to keep Eden garden tampons, claiming multifunctional land uses to be the best practice in order to harmonize rural and urban realms in Chile.

**Lisbon – The Natural And Agriculture Reserves, Portugal**

From 2002 onwards, the Portuguese Tropical Research Institute has been strengthening studies about the causes and consequences of regional and municipal planning to the lives of urban gardeners and peri-urban farmers. Sample field research, using a similar questionnaire to Brazilian fieldwork again, structured and semi-structured interviews to city farming actors, indicates there are 5 categories of farmed spaces in Lisbon Metropolis: 1.Home gardens persist in backyards and around small houses or apartment blocks, ranging from scarce 50 m2 to 1 hectare. 2.Pedagogical gardens, used for environmental education, pullulate all over inside public and private school patios, museums, prison yards and in City farms. 3.Shifting farmed plots, fresh vegetable, spices, medicinal herbs specialized and market oriented, are quite common in peri-urban environments, even along commuters’ freeways and highways. 4.Peri-urban farms (quintas) ranging from 5 to hundreds of hectares are animal and vegetable farming properties, good businesses for middle class agriculture friendly people, and mere recreation for the wealthy ones. Vineyards, flower culture, horse breeding are just some of the favorite options. 5.Finally, there are public properties in use. Last census to agriculture and husbandry recorded about 1,165 ha of public farmed land inside Lisbon Metropolis, plus Leziria Company, the biggest peripheral agrarian space (about 2,000 ha), located along Tagus river and alluvial soils produce rice, maize, and fodder where bulls and horses share the lovely planes with migratory birds.

The heterogeneity of land uses in Lisbon metropolis is by far bigger than in Santiago, intra urban gardening being not as abundant as in Belen but peripheral farming quite prolific and intertwined with urbanized areas. Private landownership being adamant (47% cultivated plots), the process of city sprawl is regulated by regional cabinets as well as concise municipal laws that tend to be highly protective towards natural parks (REN) and farmed spaces (RAN), corresponding to national ecological reserves and national agrarian reserves, respectively. In principle, those areas can only be developed after several publicized demarches and following a majority poll in Municipal Assembly, where the owners and all residents have a saying about land use changes. The legislative blend, in spite good intentions in controlling the unhealthy effects of urbanization and concrete spread, is in continuous evolution and results into a mosaic of diverse land uses, making surveys within the Portuguese capital metropolitan space a very difficult task. That was the reason why the team combined fieldwork with remote sensing techniques, trying to recognize more accurately where do the urban residents practice gardening and the real extent of peripheral farming in Lisbon.

Remote sensing is based upon detection and record of targets radiance. Even though either Landsat 5 Thematic Mapper and Landsat 7 Enhanced Thematic Mapper sensors have merely a 30 meters spatial resolution, the presence of relatively bright or dark objects, highly reflective sources, sometimes in strong contrast with their background, such as rivers, sand or alluvial beds, even bridges, makes them detectable and therefore they can be quite effectively displayed (Mather, 2001). Using a 1987 and a 2000
Landsat satellite images, supervised and unsupervised classifications were performed using an IDRISI software, aiming to detect all green surfaces and discriminate them from continuous and discontinuous urban tissues, meaning built-up areas. Resulting digital work made spontaneous green areas categorization, as well as farmed plots discrimination, even rice paddies exact location. Farmed spaces were not always adequately displayed however because two summer Landsat images were the teams choice (for the least cloudy days) and due to software limitations (Madaleno 2003).

The final step was a complex images overlay process, which files are far too heavy and long, compelling us to look into numbers subsequent to multi-temporal analysis: 1. Mixed vegetation surface increased 2%; 2. Continuous urban tissue 1.66%; 3. Discontinuous urban tissue augmented 1.02%; 4. Herbs and farmed plots decreased 3.11%. Brief analysis confirms the urban sprawl registered between 1987 and the year 2000 in Lisbon and outskirts, urban and peri-urban forestry registering small decrease in surface, whilst mixed vegetation proliferates. The most remarkable and profitable peripheral farming space confirmed by remote sensing was Leziria Company clearly drawn in any spectral band image. Crown and church property since the 12th century, it became a privately owned society in the 1830’s, and was finally nationalized after the Carnage Revolution (1974). It is the biggest single rice producer in Portugal and a peri-urban Eden garden, amazingly beautiful, with the unique characteristic of being simultaneously an ecological paradise and a farming open area. The public company was named after the Portuguese jargon for wide flat alluvial beds fewer than 5 meters high. A natural reserve either, it was institutionalized in 1976 to protect migratory birds, and integrated in the European Union Ramsar Convention by 1988.

**Conclusion**

Farming is a conflicting urban land use less contested and regulated the least developed is the country. Heterogeneity of land uses and mosaics of farmed plots noticed inside cities are not always end results of compelling survival needs but can be the outcome of ancestral food gardening habits, a cultural bias that better living conditions do not necessarily eradicate. Nevertheless, city planning and management are, in general, pro urban sprawl toward farming areas, advocating that any other land use is more profitable than agriculture. Hence, research results pointed out that endurance of Eden gardens can be determined via strong community lobbying against concrete spread, in support of democratic governance and rooted in rising ecological awareness within concerned citizens.

**References**


Urban Rural Interface Conference Proceedings
A Livelihood Strategy for the Urban Poor: Enhancing the Productivity of Urban Food Supply among Low-Income Households in African Cities

Lola Lawrence, Department of Rural Economy, University of Alberta

Abstract:
The galloping world-wide trend in urbanization is one of the processes that have happened without planning in most cities. Studies have shown that a significant proportion of the whole world’s population growth expected between the years 2000 and 2030 will be concentrated in the urban areas. Urban population was estimated at about 2.9 billion in 2000, and is projected to be about 4.9 billion by 2030. Most of this increase targeted to be in cities of less developed countries, which had an urban population of about 1.9 billion in 2000, and projected to increase to about 3.9 billion by 2030. These figures show that the cities of the Third World have been growing at an unprecedented high rate. Rapid urbanization has been accompanied by increasing urban poverty. As a result of this worsening of poverty within urban areas, many low-income households suffer from food insecurity and they are turning to urban and periurban agriculture (UPA) for the production of food for own consumption and income generation. Food production and food consumption process in these cities are based on recent changes in producer-consumer relations and some of the problems arising from the recent trends in urbanization in relation to agriculture. This contribution is intended to give an in-depth overview of the livelihood strategy adopted by low-income households in food self-provisioning in the urban areas of major African cities.

Background
Rapid urbanization has been accompanied by increasing urban poverty in most developing countries especially in the Sub-Saharan regions. Research studies show that poverty levels are high in the major cities of Africa and have been on the increase. The “urbanization of poverty” within urban areas is seen as one of the reasons why many low-income households suffering from food insecurity turn to livelihood strategies that can enhance the productivity of urban food supply (King’ori 2004). Urban agriculture has proved to be a promising production activity that can be sustained within the cities and perimeter of urban locations by low-income households especially when carried out in an environmentally-friendly manner and also when incorporated within the city and urban regional planning, for the production of food for own consumption and income generation. Urban and Peri-urban agriculture (hence forth UPA) has therefore become one of the livelihood strategies that vulnerable urban dwellers have over the time engaged in to produce cheap source of food items like vegetables, milk and milk products, meat, egg and fish. An IFAD Study show that about 72 million people living in the urban cities of Africa are in extreme poverty and this urban poverty in African cities is expected to increase as a result of rising rural-urban drift transfer of rural poverty to urban areas.

Despite global food production that has kept pace with world population growth, population growth rate especially in urban centers has outstripped the growth rate of food production significantly in developing countries especially in Sub-Saharan African cities (DeRose, Messer, and Millman 1998). There has been a widening income gap as a result of this increasing urban poverty in some of these major cities. In 1990, Sub-Saharan African population was estimated at 527 million and by 2010 this is expected to increase to 937 million. By 2025 this population is projected to be 1362 million with a population growth rate of 258 per cent from 1990-2025. While urban population in 1990 was estimated at 149 million people and this is projected to increase to 387 million in the year 2010 and by 2025 an urban population of 705 million is expected which implies that Sub-Saharan urban population is growing at an astronomical rate of 473 per cent from 1990-2025 fig.2 (World Bank 2001). This implies that urban growth rate is growing faster at an alarming rate than food production in the Sub-Saharan African major cities.
**Need for Livelihood Intervention Strategies**

Definition of Urban and Peri-urban agriculture: Mougeot 1999 defined urban agriculture “as an industry located within (intra-urban) or on the fringe (peri-urban) of a town, an urban centre, a city or a metropolis which grows or raises, processes and distributes a diversity of food and non-food products and services found in and around that urban area, and in turn supplying human and material resources, products and services largely to that urban area”.

Rising urban poverty implies that a growing number of urban households would not be able to provide the food needed to meet minimum dietary requirements. Therefore, the adoption of livelihood strategies such as urban and peri-urban agriculture has proved to enhance urban food supply within the cities to meet with the goal of achieving food security by urban poor. This has been one of the challenges that low-income households has to face to feed fast growing urban areas with high levels of poverty.

by creating an intervention strategy of livelihood. This evidence is supported by studies carried out in some major cities in Africa to show the proportion of urban dwellers involved in UPA. The table 1 below illustrates the proportion of urban dwellers involved in Urban Agriculture in some major African cities as revealed in the study conducted by Smith 2001.

Considering all these figures in the table suggest that UPA has the potential of contributing substantially to meeting urban food security in terms of the quantity of the food produced (Physical access). Also the increased level of urban food insecurity and malnutrition as experienced by low-income households can be stepped down by developing sustainable and appropriate production systems such as UPA.

<table>
<thead>
<tr>
<th>CITY</th>
<th>Proportion of Urban Dwellers Involved in UA in some major African cities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kano</td>
<td>75%</td>
</tr>
<tr>
<td>Ouagadougou</td>
<td>36%</td>
</tr>
<tr>
<td>Yaoundé</td>
<td>35%</td>
</tr>
<tr>
<td>Zaria</td>
<td>80%*</td>
</tr>
<tr>
<td>Kumasi</td>
<td>25%*</td>
</tr>
<tr>
<td>Lusaka</td>
<td>45-60%</td>
</tr>
<tr>
<td>Harare</td>
<td>80%</td>
</tr>
<tr>
<td>Kampala</td>
<td>25-57%</td>
</tr>
<tr>
<td>Nairobi</td>
<td>29%</td>
</tr>
<tr>
<td>Kitui</td>
<td>57%</td>
</tr>
<tr>
<td>Mombasa</td>
<td>30%</td>
</tr>
<tr>
<td>Dar Es Salaam</td>
<td>44-70%</td>
</tr>
</tbody>
</table>

* Livestock keepers (goats, sheep and poultry)
Source: Smith, O.B (2001) IDRC, Ottawa, Canada

**Conclusion**

As far as research needs are concerned and based on documented literatures reviewed there are research gaps to fill up if the productivity of urban food supply is to be enhanced by meeting the food security needs of the urban poor in major African cities. There is need for studies on the economic profitability and contribution to urban economy of livelihood strategies such as urban and peri-urban agriculture. Socio-economic research studies should also focus on urban poverty reduction and not just rural poverty reduction. Policies should be developed that will not only promote economic growth but also alleviate urban poverty. Further research should also be directed towards developing urban planning policies that will adopt UPA as a livelihood strategy for urban poor.

**References**


King’ori, Peter. 2004. Assessment of urban and peri-urban agriculture research in the Centers of the Consultative Group on International Agricultural Research (CGIAR) in Sub-Saharan Africa. 35 pp, International Potato Center.


Venard, J. L. 1995. Urban Planning and Environment in Sub-Saharan Africa. UNCED

Fire
Would I Stay or Would I Go? Exploring Stated Wildfire Evacuation Behavior\textsuperscript{1}

Nejem Raheem and Robert P. Berrens, Ph.D\textsuperscript{2}

**Introduction**

Why do some people choose to evacuate their homes during a wildfire while others remain behind? A detailed understanding of the determinants of this behavior would help develop effective community evacuation plans and warnings. Such information would be especially useful in the Wildland Urban Interface (WUI), where residential development is intermixed with forested wildlands, and wildfires have been increasingly encroaching on human habitation (Bosworth 2003). Despite the increasingly common patterns of observed evacuations in response to growing wildfire risk in the American West and elsewhere, there is little systematic social science information about actual or expected household evacuation behavior. As an initial exploratory study using household survey data, this paper econometrically models the expected decision to evacuate from a wildfire as a function of a vector of socioeconomic and risk perception variables. We analyze stated evacuation behavior under both mandatory and voluntary wildfire evacuation orders. Across several specifications of logit probability models (1=Yes would evacuate, 0=No would not), results indicate that women were significantly more likely to evacuate than men, residents with livestock were significantly less likely to evacuate than those without, and self-identified members of either major political party (evidence of a possible social network effect) were more likely to evacuate than non-affiliated residents.

**Background And Literature Review**

Critical fuels build-up, combined with concomitant population growth in the WUI has led to increasing wildfire risk exposure over the last several decades in the American West, and elsewhere. This fuels build-up can be traced to several variables that have brought about a change in the structure of western forests (Talberth 2004, Bosworth 2000). This new, denser structure tends toward devastating crown fires rather than historic cooler-burning grass. In addition to increased risk of fire, more people are moving to the forest’s edge (Rains and Hubbard 2002). Between 1990 and 2000, the West saw the greatest population increase in the country, a 19.7\% increase. This development is relatively recent and is often concentrated in the WUI, “the area where relatively untouched wildlands and residential areas meet” (Rossomando 2000, 29). Western fire seasons have been intensifying for some time, with evacuations running into the thousands of households for some fires (Spagat 2003; Broder 2003; Bosworth 2000; Rossomando 2000). With wildfire risk comes evacuation – rapidly moving potentially large numbers of people out of their homes. When people don’t move, or don’t move quickly, critical emergency response resources are often targeted toward them. Thus, understanding expected evacuation behavior is a critical part of the planning puzzle.

Evacuation planning is usually the responsibility of counties, typically the sheriff’s office. Most incident management teams inform the county sheriff that there is the potential for a community evacuation and when that evacuation might need to take place. The incident commander and sheriff decide a trigger point that if the fire reaches that location an evacuation will be necessary. The public is notified through news agencies and the sheriff’s office about the possibility of an evacuation so they can start packing their important belongings. If the fire reaches the trigger point the evacuation begins.\textsuperscript{2} In order for these evacuation routes and plans to be useful, communities and disaster planners need to know who is and is not likely to evacuate. Despite the apparently increasing numbers observed with recent fire seasons since 2000, there does not appear to be any systematic social science research addressing this issue for wildfires.

However, there is a small and growing body of related research with respect to evacuation to natural hazards more generally. Risk perception is one of the most important determinants of evacuation behavior

---

\textsuperscript{1}Research support provided by USDA Forest Service, Rocky Mountain Research Station, Flagstaff AZ (Carl Edminster) under Research Joint Venture Agreement (02-JV-11221615-039).

\textsuperscript{2}Department of Economics, University of New Mexico, Albuquerque, NM 87131.

Personal communication with Richard Reitz (USFS) April 6, 2005.
(Whitehead et al. 2000a; Riad and Norris 2000; Tyndall Smith 1999). Tyndall Smith (1999) found that “crying wolf,” or overstating the intensity of hazards to instigate greater cooperation, may reduce the credibility of the agencies’ decisions. Riad and Norris (2000) found that four categories of variables affected the decision to evacuate: risk perception, preparedness, social influence and perception of resources. Smith (1999) and Whitehead (2000) mention that whether the respondent was female tended to have significant effects in the choice to evacuate, but not on how. Riad et al. (1998) found that women tended to be more likely to believe that the disaster would be bad, while men were more likely to feel “in control” and safe. Whitehead et al. (2000a) found that pets made evacuation less likely. Alexander (2000) found that, unfortunately, pet owners often left their animals behind, as motels or shelters did not accept them.

A recent survey-based empirical investigation of the probability of expected hurricane evacuation behavior provided the template for our own design. While (thankfully) not available here, the Whitehead (2003) study was further able to match expected evacuation (stated behavior) in a validity test against subsequent actual hurricane evacuation behavior. Whitehead (2003) found that stated-preference survey data were 83% accurate in predicting hurricane evacuation. Roughly 50% of those who said they would evacuate did, while 92.6% of those who said they would not evacuate did not. From the inference that stated behavior about natural hazards provides some core level of validity and is transferable to a wildfire risk context, we explore stated behavior for expected household evacuation in the WUI.

**Research Design And Results**

The East Mountains area is outside of Albuquerque in Bernalillo County NM, and near the Cibola National Forest. The area is primarily year-round residential with approximately 4000 homes, and has experienced a 207.8 % increase in population since 1970 (County of Bernalillo 2004). East Mountains residents are wealthier, more conservative, middle-aged and better educated than the NM state averages. Residents are also more recent. So in some sense this population is what is thought of as the classic group of newcomers to the West. There is only one escape route, State Highway 14. This combination has made it one of the top 20 at-risk WUI communities for wildfire in New Mexico (EMNRD 2002).

During the spring and summer of 2003, a survey questionnaire about wildfire risk was mailed to 3,998 households in the Bernalillo County portion of the East Mountains area near Albuquerque, NM. The number of usable surveys returned was 1018, representing a response rate of 27.3% (after eliminating bad address returns, etc.). As part of this larger survey, respondents were asked whether or not (Yes=1 or No=0) they would evacuate under two scenarios: a voluntary (VOL) and a mandatory (MAND) evacuation order.3

Logit models were used to evaluate the probability that an individual would answer Yes (=1) to an expected evacuation question, VOL or MAND. While they produced similar statistical determinants, the logit models for predicting behavior under the mandatory order performed slightly better. Given space constraints, we focus here on the econometric results from the mandatory order, and discuss some of the results concerning the voluntary order. The sample mean of the expected mandatory (MAND) evacuation order was around 89%, versus 59 % for the expected voluntary (VOL) evacuation order. Sample means for males (females) were 50% (70%) expected evacuation under a voluntary order, and 85% (94%) under a mandatory order.

Estimated coefficient results and predicted marginal effects (in italics) from several specifications of the logit probability model, with MAND (Yes=1 or No=0) as the dependent variable, are presented in Table 2.4 Overall model fit is reasonably good. Results indicate that livestock owners were 6% less likely to evacuate than non-owners. Those respondents self-identified as affiliated with a major political party were 6% more likely to evacuate. (It made no difference when we combined or separated Republicans or Democrats on this issue). How respondents rated their sense of risk (on a 1-10 increasing scale) had a positive and small effect. While the binary CONCERN variable was never significant in the MAND models it was always positive and very significant in the VOL with those concerned up to 17% more likely to evacuate. Females are much more likely to evacuate than males. In the MAND models, they were 8-9% more likely to evacuate than males, and in the VOL models, up to 22% more likely. The simple provision of a wildfire risk map for the area, as a split sample treatment variable, had a negative, though occasionally non-significant effect. However, if the respondent received a map and was able to self-identify whether they lived in a significant (high or moderate) risk area was negative and highly significant across all specifications, decreasing the

---

3 Full details of surveys and sampling are available upon request.
4 All econometric analyses are available upon request.
probability of evacuating by approximately 5%. Finally, respondents’ length of residence in the areas was significantly inversely related to the probability of evacuating. Respondents who expected to go to a motel (versus shelter or other arrangement) were 4-7% more likely to evacuate.

Conclusions

These exploratory results suggest some footholds, or possible strategies for community forest and emergency response planners. For example, results suggests that the populations to target in terms of “getting the word out” about evacuations would be livestock owners and long-time residents, as they show an expressed likelihood of staying behind. Planners can identify expected motel space, and suggest livestock owners had appropriate trailers and known corral space. In contrast, female respondents, those with a prevailing concern about the risk level, and those self-identified to a major political party (a possible social network effect), were much more likely to expect to evacuate. This appears to be the first paper dealing with stated evacuation behavior for wildfires. As wildfire risk is an increasing public policy concern in the American West and elsewhere, it seems essential to begin to understand both expected and actual evacuation behaviors. We hope this investigation spurs additional research efforts in this area.

References


Table 1: Descriptive Statistics

<table>
<thead>
<tr>
<th>Variable</th>
<th>Description</th>
<th>N</th>
<th>Mean</th>
<th>St. Dev.</th>
</tr>
</thead>
<tbody>
<tr>
<td>fem</td>
<td>1 if respondent is female, 0 if male</td>
<td>1018</td>
<td>0.34</td>
<td>0.48</td>
</tr>
<tr>
<td>Pol</td>
<td>1 if respondent identifies as registered in major political party (Democrat or Republican), otherwise</td>
<td>908</td>
<td>0.29</td>
<td>0.45</td>
</tr>
<tr>
<td>NA</td>
<td>1 if respondent identifies as having no political affiliation, 0 otherwise</td>
<td>908</td>
<td>0.17</td>
<td>0.37</td>
</tr>
<tr>
<td>pets</td>
<td>1 if respondent household owns pets, 0 if not</td>
<td>1009</td>
<td>0.81</td>
<td>0.39</td>
</tr>
<tr>
<td>stock</td>
<td>1 if respondent household owns livestock (cows, horses, goats, sheep, etc), 0 if not</td>
<td>919</td>
<td>0.16</td>
<td>0.37</td>
</tr>
<tr>
<td>INC</td>
<td>Household income strata (1-12 in $10K increments)</td>
<td>860</td>
<td>7.07</td>
<td>3.39</td>
</tr>
<tr>
<td>lived</td>
<td>How long respondent has lived in the East Mountains in years</td>
<td>999</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CONCERN</td>
<td>1 if respondent is concerned about wildfire endangering home, 0 if not</td>
<td>990</td>
<td>0.82</td>
<td>0.38</td>
</tr>
<tr>
<td>FIRES</td>
<td>Estimated number of fires respondent has heard about in E. Mountains area</td>
<td>988</td>
<td>3.51</td>
<td>8.10</td>
</tr>
<tr>
<td>motel</td>
<td>1 if respondent would expect to relocate to a motel, 0 otherwise</td>
<td>984</td>
<td>0.29</td>
<td>0.45</td>
</tr>
<tr>
<td>Shelter</td>
<td>1 if respondent would expect to relocate to a shelter, 0 otherwise</td>
<td>983</td>
<td>0.02</td>
<td>0.15</td>
</tr>
<tr>
<td>SMOKE</td>
<td>Average days per year household bothered by smoke from wildfire</td>
<td>963</td>
<td>2.36</td>
<td>5.52</td>
</tr>
<tr>
<td>Map</td>
<td>1 if the respondent was provided a map detailing the fire risk to areas in the East Mountains. 0 otherwise.</td>
<td>1018</td>
<td>0.50</td>
<td>.50</td>
</tr>
<tr>
<td>hirisk</td>
<td>1 if respondent received map, and identified themselves as living in either high or medium risk area, 0 otherwise</td>
<td>1018</td>
<td>0.20</td>
<td>0.40</td>
</tr>
<tr>
<td>lorisk</td>
<td>1 if respondent received map, and identified themselves as living in low risk area, 0 otherwise</td>
<td>1018</td>
<td>0.14</td>
<td>0.35</td>
</tr>
<tr>
<td>AMENities</td>
<td>Rating of East Mountain environmental amenities, scale from 0 (unimportant) to 10 (very important)</td>
<td>991</td>
<td>9.03</td>
<td>1.53</td>
</tr>
<tr>
<td>RISKRATE</td>
<td>Rating of risk of wildfire in the East Mountains area, scale from 0 (unimportant) to 10 (very important)</td>
<td>1003</td>
<td>7.91</td>
<td>2.04</td>
</tr>
<tr>
<td>AGE</td>
<td>Respondent’s age in years</td>
<td>983</td>
<td>52.3</td>
<td>12.10</td>
</tr>
<tr>
<td>Yrs edu</td>
<td>Respondent’s years of schooling</td>
<td>978</td>
<td>16.15</td>
<td>2.78</td>
</tr>
</tbody>
</table>
Table 2: LOGIT Model Coefficients and Marginal effects

<table>
<thead>
<tr>
<th>VARIABLES</th>
<th>Model 1</th>
<th>Model 2</th>
<th>Model 3</th>
<th>Model 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>fem</td>
<td>1.48 (3.68***)</td>
<td>1.41 (3.54***)</td>
<td>1.52 (4.43***)</td>
<td>1.50 (4.35***)</td>
</tr>
<tr>
<td>pol</td>
<td>1.02 (2.76***)</td>
<td>1.01 (2.72***)</td>
<td>0.80 (2.52***)</td>
<td>0.80 (2.51**)</td>
</tr>
<tr>
<td>na</td>
<td>0.81 (1.59)</td>
<td>0.87 (1.71)</td>
<td>0.37(0.89)</td>
<td>0.38 (0.93)</td>
</tr>
<tr>
<td>pets</td>
<td>-0.81 (-0.83)</td>
<td>-0.35 (-0.95)</td>
<td>-0.05**</td>
<td>-0.05**</td>
</tr>
<tr>
<td>stock</td>
<td>-1.01 (-3.0***)</td>
<td>-1.02 (-3.0***)</td>
<td>-0.99 (-.50***)</td>
<td>-1.0 (-3.59***)</td>
</tr>
<tr>
<td>lived</td>
<td>-0.04 (-2.58**)</td>
<td>-0.05 (-2.7***)</td>
<td>-0.02 (-.78***)</td>
<td>-0.02 (-1.97**)</td>
</tr>
<tr>
<td>yrs edu</td>
<td>0.03 (0.63)</td>
<td>0.03 (0.59)</td>
<td>0.03 (0.67)</td>
<td>0.03 (0.67)</td>
</tr>
<tr>
<td>age</td>
<td>0.02 (1.37)</td>
<td>0.02 (1.35)</td>
<td>0.03 (0.67)</td>
<td>0.03 (0.67)</td>
</tr>
<tr>
<td>inc</td>
<td>0.03 (0.55)</td>
<td>0.03 (0.67)</td>
<td>0.03 (0.67)</td>
<td>0.03 (0.67)</td>
</tr>
<tr>
<td>concern</td>
<td>0.23(0.64)</td>
<td>0.28 (0.76)</td>
<td>0.28 (0.76)</td>
<td>0.28 (0.76)</td>
</tr>
<tr>
<td>map</td>
<td>-0.53 (-1.82*)</td>
<td>-0.39(-1.56)</td>
<td>-0.68(-1.99**)</td>
<td>-0.61 (-2.05**)</td>
</tr>
<tr>
<td>hirisk</td>
<td>-0.02 (-1.22)</td>
<td>-0.02 (-1.06)</td>
<td>-0.06 (-0.14)</td>
<td>-0.06 (-0.14)</td>
</tr>
<tr>
<td>lorisim</td>
<td>-0.01 (-1.68* )</td>
<td>-0.17 (-1.59)</td>
<td>-0.16 (-1.57)</td>
<td>-0.15 (-1.49)</td>
</tr>
<tr>
<td>amenities</td>
<td>-0.19 (-1.68*)</td>
<td>-0.17 (-1.59)</td>
<td>-0.16 (-1.57)</td>
<td>-0.15 (-1.49)</td>
</tr>
<tr>
<td>fires</td>
<td>0.12 (1.67*)</td>
<td>0.12 (1.66*)</td>
<td>0.01*</td>
<td>0.01*</td>
</tr>
<tr>
<td>riskrate</td>
<td>0.04*</td>
<td>0.04*</td>
<td>0.05***</td>
<td>0.05***</td>
</tr>
<tr>
<td>smoke</td>
<td>0.71 (1.79*)</td>
<td>0.77 (1.95**)</td>
<td>1.06(2.98***)</td>
<td>1.01 (3.05***)</td>
</tr>
<tr>
<td>motel</td>
<td>0.41 (0.41)</td>
<td>0.41 (0.26)</td>
<td>3.32 3.29***</td>
<td>3.20 (3.19***)</td>
</tr>
<tr>
<td>shelter</td>
<td>-0.60 (-0.69)</td>
<td>-0.74 (-0.83)</td>
<td>-0.68(-1.99**)</td>
<td>-0.61 (-2.05**)</td>
</tr>
<tr>
<td>Intercept</td>
<td>0.66 (0.41)</td>
<td>0.41 (0.26)</td>
<td>3.32 3.29***</td>
<td>3.20 (3.19***)</td>
</tr>
</tbody>
</table>

Notes: Marginal Effects in italics represent the % change in probability of evacuation given a unitary increase in a variable (or change from 0 to 1 in the case of binary variables). For instance in specification one, women are 8% more likely to evacuate than men. Marginal effects only provided for significant variables. T-statistics in parentheses; asterisks indicate statistical significance (* = 10%, ** = 5%, *** = 1%). INC is a categorical variable, representing income categories.
Emerging bio-energy technology solutions to reduce fire risk along the Wildland Urban Interface

Michael Andreu, Kristiina Vogt, Daniel Vogt, Anne Andreu, Chadwick Oliver and Robert Gara, University of Washington

As the Wildland Urban Interface (WUI) continues to expand into forested parts of the western US, we are increasingly faced with the problem of house structures being at high risk of burning due to their proximity to federally owned overly dense forests. Policies have focused on reducing fuel loads in the WUI by treating forests using mechanical thinning methods. However, the product of these thinning operations is often small diameter and low quality wood with little to no commercial value. This wood biomass must be transported from the site and deposited into a landfill or burned offsite. As a result of transportation costs and tipping fees at landfills, the high direct costs of the fuel reduction treatments constrain the number of acres that can be treated so that the fire risk to communities remains high. The indirect costs associated with these treatments are also undesirable: emissions of greenhouse gasses (e.g., CO₂), particulate pollutants and acceleration in the decommission rate for landfills. These costs must be borne by all tax payers while relatively few tax payers receive the benefits of the treatments.

Our research has focused on integrating small-scale, mobile, wood biomass chemical conversion systems (producing methanol) with emerging technologies in the renewable-energy sector (hydrogen fuel cells). The added values of using this integrated system are its production of a carbon neutral energy from a negatively valued product while providing silvicultural options to promote a fire safe and vigorous forest that will lead to fire safe homes. In addition, the goals of sustainable forest management can also be achieved.

Introduction

Over the last decade, the Wildland Urban Interface has expanded in the Pacific Northwest (PNW). When homes are built in areas prone to forest fires, typical of interior forest regions in the PNW, they have a high risk of being lost due to wildfires. Increasingly during the fire season, more resources are being shifted to protecting these structures at the expense of protecting the forests. The resulting loss of forested area means the environmental benefits (e.g., habitat; water and air quality; carbon sequestration) provided by these forests are lost to society and restoring those benefits is costly in a temporal and economic sense. These negative environmental effects and costs have stimulated the implementation of projects to treat the fuels mostly in the vicinity of homes and small towns throughout these fire prone areas (Vince, Duryea et al. 2004). But by treating the forest immediately surrounding the house structures, one has only treated a symptom and not addressed the problem directly. The problem is not simply high fuel loads around isolated houses but their abundant distribution across the landscape. This means a treatment program needs to reduce fuel loads at the landscape level as well as reduce extreme fire behavior and events when the worst weather conditions exist (high winds, low humidity).

In general, fuel reduction treatments generate large amounts of small diameter and low quality wood biomass with little to no monetary value in current markets of the interior PNW. Even if the markets were to become viable again, the mill infrastructure required to process these materials is being lost (e.g., 18 mills utilizing small diameter wood closed in OR and WA since 1989; (PPRC 2003)). Today, the remaining infrastructure capable of utilizing this biomass is mainly located west of the Cascade Mountains of OR and WA. Some have argued a need to re-establish the infrastructure (e.g., build more pulp mills, OSB plants, cogen/co-fire facilities) so that markets are created for wood chips (USFS 2003) since this would also facilitate the use of this underutilized resource. While in principle this is a good solution, it is flawed on the basis that centralized facilities using large amounts of biomass require: 1) large capital investments (small pulp mill costs ~$80 - $150 million to build, an OSB plant costs ~$70 - $120 million, a co-gen/co-fire facility costs ~$25+ million (13MW)); and 2) a guaranteed supply of raw material or feedstock. In many parts of the interior PNW, investors recognize wood supplies are available but believe access to this wood will be limited due to the large federal ownership of timberlands. So the incentive to rebuild the infrastructure does not exist in the PNW and a large number of mills continue to close in the region (PPRC 2003). Since forest products are sold as commodities, investors have shifted to participate in
markets with lower operating costs and where supply availability has less risk (e.g., South America, Finland, New Zealand).

When market mechanisms are not in place to offset costs of reducing fire risk, one of the lowest cost alternatives for fuel reduction is to cut, pile and burn the wood biomass. While relatively cost effective, this option has negative impacts including: legal and health liabilities associated with smoke management, negative impacts to soils (sterilization beneath piles) (DeBano, Neary et al. 1998), and increased emissions of climate change gasses. Biomass can also be transported to a landfill but this alternative can cost over $2500/acre due to high transportation costs and tipping fees (Legg 2004). Since landfills are costly to permit and build, filling them with biomass is undesirable and only hastens the rate at which they have to be decommissioned (WADoE 2004). In addition, biomass in landfills will decompose over time emitting the once sequestered carbon and increasing greenhouse gas emissions.

Given these realities what options are available to cost effectively manage the WUI in the interior PNW? Forest managers do have the option of participating in newly emerging markets that would utilize small diameter and low quality material (Vogt, Andreu et al. 2005). As the cost of crude oil increases (recently exceeding $55/barrel of crude), the impetus is increasingly to look for alternative and reliable sources of energy produced from renewable domestic resources. Currently, <1% of Washington’s energy production comes from biomass and mainly it is combusted to generate heat and steam. These bio-energy systems have several drawbacks: 1) low efficiency (~40%) of conversion of wood to energy; 2) heat and steam not captured and converted to electricity is wasted unless another onsite facility is capable of using this energy (e.g., greenhouses); and 3) these systems are centralized so wood biomass transportation costs are high, similar to the traditional forest products mills.

Even though wood is a good source of energy, it is difficult to use this energy efficiently in its solid form. One way around this dilemma is to transform solid wood into a user friendly liquid or gas form (Klier 1982). This goal is not unrealistic since gasification technology has existed for decades and was used in Europe during WWII to create gas from wood to power vehicles (Reed and Gaur 2001). Gasification is a process of heating wood biomass to create syngas (CO, CO₂, H₂) and ash (inorganic residual, minerals). Gasification can occur efficiently at a small scale (<1MW) so large centralized facilities are not required. The existing problem is that the end-product is a gas which is difficult to handle, store, and transport.

However, syngas can be reformed into a more stable and useable liquid form (methanol or wood alcohol; (White and Plaskett 1981)) that has many applications in the energy sector as well as in the chemical industry (e.g., antifreeze, solvents, a building block for other chemicals) (Gebauer and Jordan 2002). It is used to power vehicles such as Indy race cars as well as municipal buses in several US cities. While direct combustion of methanol to produce energy is an option, the conversion of methanol to energy is more efficient when used as a source of hydrogen in a fuel cell. Methanol is an ideal carrier of H because its molecular structure is simple (CH₃OH) compared to other liquid fuels (e.g., gasoline, diesel, ethanol) so less energy is required to produce the H (IdaTech 2001).

The challenge is not in converting wood to methanol (this technology exists at various levels of maturity) but in making this system economically feasible. Economic feasibility studies generally involve assessing the costs and benefits of different solutions and selecting that which gives the best value. Any discussion on the feasibility of generating economic return to a forest owner from collecting small diameter wood materials has to consider whether a centralized or decentralized system will be used to transform wood. The costs associated with procuring the raw material can be greatly reduced if the transportation distance of the wood material is limited and only the higher valued products are transported over longer distances. The current cost of hauling wood biomass is around $72 per hour ($3 – $5/ton/hr) (Schiess 2005). The small, modular gasification system (BioMax 15) commonly used today to generate electricity from biomass is not mobile (Diebold and Walt 2004). Unless the energy is needed onsite or can be sold to the grid, this system does not produce an easily transportable product that a landowner could use to offset costs of fuel treatment. Thus our research is focusing on the development of a mobile system to gasify and reform wood biomass to methanol (Vogt, Andreu et al. 2005). A mobile, fully integrated system that transforms wood biomass at the site to an energy-dense product (i.e., methanol) should optimize the cost-benefit ratio of using wood to produce energy. The next section will explore the trade-offs a landowner needs to consider when converting biomass to methanol. At this time, the operation costs of a mobile wood transformation system are not available since a fully operational prototype has not
been built; however, price thresholds have been estimated for the system that include its building costs ($96 - $245 BDT) (Polagye 2005).

### Analysis

The purpose of this analysis is to assess the economic feasibility of converting biomass to methanol compared to other costs to manage forests to reduce its fire risk. A decision support tool (www.cfr.washington.edu/research.Forest_Energy/projects/) allows users to conduct customized feasibility assessments by changing input values for the following variables: 1) green tons/acre to be converted to methanol (i.e., MeOH); 2) conversion of green to dry biomass weight in tons (default at 2:1); 3) gallons of MeOH produced per Bone Dry Ton (BDT) (default - 186 gallons); 4) thinning cost per acre; 5) MeOH production cost per BDT, and 6) selling price of MeOH. The wholesale price of methanol (March, 2005) produced from natural gas is $0.95/gal when purchasing a minimum of 10,000 barrels (www.methanex.com). A survey of methanol distributors in the PNW region found the price of methanol ranged from $3.00 - $10.00/gal when purchased in small quantities (55 to 5 gallons, respectively). For this scenario, four pricing points were used: Low price ($0.95/gal), Mid price (2X Low price), High price ($3.00/gal), and Green price (Mid price + 35%). The Green price reflects the premium that bio-diesel sellers are currently selling above the price of diesel produced from petroleum. A survey of four Seattle based bio-diesel distributors and one local newspaper report (Dizon 2005) found prices were 35% - 70% (55% average) higher than non-green prices. Using these input variables for the decision support tool, one can calculate the cost of producing and selling methanol and compare the net gain or loss when managing a ton of wood or wood on a per acre basis.

<table>
<thead>
<tr>
<th>Scenario</th>
<th>(GT)/acre</th>
<th>Thinning cost $/GT</th>
<th>Conversion cost to MeOH/GT &amp; (BDT)</th>
<th>Cost to produce MeOH/gal.</th>
<th>Net Gain/Loss per Acre</th>
</tr>
</thead>
<tbody>
<tr>
<td>High Fuel $3.00/gal</td>
<td>10 (5)</td>
<td>$30 ($60)</td>
<td>$152 ($304)</td>
<td>$1.96</td>
<td>$970.00</td>
</tr>
<tr>
<td>Green Fuel $2.57/gal</td>
<td>10 (5)</td>
<td>$30 ($60)</td>
<td>$152 ($304)</td>
<td>$1.96</td>
<td>$565.45</td>
</tr>
<tr>
<td>Mid Fuel $1.90/gal</td>
<td>10 (5)</td>
<td>$30 ($60)</td>
<td>$152 ($304)</td>
<td>$1.96</td>
<td>$53.00</td>
</tr>
<tr>
<td>Low Fuel $0.95/gal</td>
<td>10 (5)</td>
<td>$30 ($60)</td>
<td>$152 ($304)</td>
<td>$1.96</td>
<td>$936.50</td>
</tr>
</tbody>
</table>

The cost and benefit ratios of producing methanol from wood are highly sensitive to the selling price of methanol in the marketplace (Table 1). In this analysis, if the selling price of methanol exceeds $1.96/gal or is between the Mid fuel and Green fuel price, the forestland owner has generated sufficient revenue to cover management costs.

An initial review suggests that the feasibility of converting wood biomass to methanol does not cover landowner costs at the Mid to Low price ranges. However, landowners are paying to have their stands treated to reduce fuel loads so this analysis needs to also include the costs of alternative fuel reduction treatments. The decision support model allows the user to input costs associated with the following alternative treatment cost variables: burning/acre and tipping fee cost per ton of wood. These values should be added to the thinning cost to calculate the total cost of these two treatment options. For the purposes of this analysis, a burning cost of $25/acre was used and a tipping fee cost of $30/ton for the landfill treatment. It should be noted that the cost for the landfill option does not include the cost of transporting the material to the landfill and therefore is a conservative estimate of the actual treatment costs. Additionally, the tool allows the user to input a value for stumpage or delivered price per ton if a chip market exists in the area. For the analysis in Table 1, a stumpage value of $10/green ton was used for comparison purposes though this is not realistic for most areas in the interior PNW as the cost to harvest and transport roundwood exceeds the delivered price received. Finally, for this scenario, it was assumed that the landowner had a fixed budget of $10,000 to complete a fuel treatment.

The tradeoffs associated with treating the stands by thinning and burning onsite, landfilling (not including transportation cost), converting to methanol and
selling methanol at four price levels, and selling to a potential chip market are illustrated in Table 2. From a landowner’s perspective, the question to explore is: How can one maximize the number of acres treated for a given amount of money ($10,000)? The three treatments that result in a net profit (Green, High, Roundwood) indicate that the landowner can treat an indefinite number of acres because net profits accrue from producing and selling methanol or roundwood. (Note that the sale of methanol at the Green and High selling prices results in much greater returns ($565 and $970/acre, respectively) than if wood was sold as roundwood ($100/acre) for use as fuel for combustion, pulp, or in the production of OSB.) When methanol can be sold for the Mid price ($1.90) range, well below the lowest retail price quoted ($3.00), six times the number of acres (189 vs. 31) can be treated compared to using the cheapest fuel reduction treatment option of piling and burning wood with a fixed budget of $10,000. Converting wood to methanol is a net loss at the low and mid price ranges for the methanol treatment as it is for the two alternative fuel treatments (i.e., piling and burning, hauling thinned material to a landfill). Despite this net loss

Table 2. Scenario Results

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Number of Acres Treated for $10,000</th>
<th>Net Gain/Loss/Acre</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pile and Burn</td>
<td>31</td>
<td>($325)</td>
</tr>
<tr>
<td>Landfill</td>
<td>17</td>
<td>($600)</td>
</tr>
<tr>
<td>Low $0.95/gal.</td>
<td>11</td>
<td>($937)</td>
</tr>
<tr>
<td>Mid $1.90/gal.</td>
<td>189</td>
<td>($53)</td>
</tr>
<tr>
<td>Green $2.57/gal.</td>
<td>∞</td>
<td>$565</td>
</tr>
<tr>
<td>High $3.00/gal.</td>
<td>∞</td>
<td>$970</td>
</tr>
<tr>
<td>Roundwood</td>
<td>∞</td>
<td>$100</td>
</tr>
</tbody>
</table>

to produce methanol at the lower market prices for methanol, selling methanol can greatly offset the cost of thinning and allow a landowner to treat fuels across the landscape rather than just adjacent to individual structures, giving them the ability to reduce fire risk over a larger land area. It should be noted that the analyses did not include transportation costs for any product since these costs will vary depending on distances required to haul materials.

This exploratory analysis is valuable to examine the different options available to a forest landowner but fails to include other emerging economic options that forests can provide in the global markets because of their role in mitigating climate change (Birdsey, Alig et al. 2000). Many environmental services (e.g., clean water/air, reduced health costs associated with smoke, reduced fire risk, aesthetic values) have been hard to quantify because they do not have a monetary value in the global markets. However one value that can be quantified is the CO₂ emission offsets when using methanol to produce electricity from a hydrogen fuel cell (Vogt, Andreu et al. 2005). This is an area where real market value can be placed on utilizing small diameter wood for methanol production that will make the marginal scenarios provided above more economically feasible. Additional sources of revenue also exist since federal subsidies are being discussed to reduce fire risk by harvesting biomass at a rate of $20 per ton of biomass removed from the forest (http://energycommerce.house.gov/108/energy_pdf.shtm). These potential economic gains highlight that the economic feasibility of linking wood to energy production is a moving target and can be readily altered by both domestic and global policies.

Exploring the possible trade-offs for a forest landowner to obtain economic returns from their lands demonstrates that some scenarios provide realistic opportunities to generate positive economic return from removing small diameter forest materials. This analysis also demonstrates that there are trade-offs and assumptions that a landowner has to include when determining which option to pursue. These analyses also demonstrate that even the conservative but realistic Mid price scenario, where the landowner had a negative economic return, creates enough revenue from selling methanol produced from small diameter wood to allow fire risk reduction management across more acreage. A landowner will also be able to acquire additional revenue by participating in Carbon Trading Markets if they pursue the option of generating electricity from biomass methanol with fuel cells. A forest owner or land-owner living in the wildland-urban interface will have to have a positive revenue stream in order to manage the fire risk of their lands. If forests are to persist in the WUI to provide environmental services and resources, land owners in the Wildland Urban Interface need a positive revenue stream generated from the management of their lands. Active forest management is necessary in order to manage fire risk in the WUI, but forest management needs to be climate friendly and be part of the solution to mitigate greenhouse gas emissions. Producing methanol from small diameter wood removed in fuel reduction thinnings provides an environmentally sound and potentially profitable solution.
References Cited


Legg, J. 2004. Personal Communication, Program Manager, Shoshone County Fire Mitigation Program. in, Wallace, ID.


Schiess, P. 2005. Personal Communication, Professor of Forest Engineering, University of Washington. in, Seattle, WA.


**Community Advisor: Firewise**

Richard Reitz, USDA Forest Service, Athens, GA

**Introduction**

It is not unusual for people from outside a community to be recruited by that community for assistance in solving urban/rural interface (URI) issues. In many cases these “outsiders” are people who are employed by agencies, such as, city and rural fire departments, land management agencies, or universities. In other instances, these individuals come from the private enterprise sector. Some individuals might even be volunteers from one or more service organizations. Whoever these people are they are united in their cause to reduce URI fire risks to humans and property. These individuals, who will now be referred to as community advisors in this paper, provide advice to community members on a variety of aspects related to risk reduction.

Community advisors are an appropriate means to assist communities achieve some level of URI fire risk reduction success, by matching community questions to science-based authoritative answers. These advisors are available to community groups and provide information, or find an authority to provide information, to a community making URI fire risk reduction decisions. The advisor may be an expert in his or her own rite, as well. It is expected that the community has, or will soon have, a formal citizen-based URI committee. The community advisor is not a member of that committee and will not make decisions for the community. The advisor is merely there to assist the community arrive at a decision based upon those scientific disciplines related to ecosystems, economics, and social considerations.

This approach builds upon, and places, URI risk reduction activities into an ecosystem management framework. It moves theoretical and applied science regarding such disciples as ecology, silviculture, URI fire behavior, community planning, innovation diffusion, communication, decision-making, risk assessment, economics, and protection into citizen hands for deciding the level of future risk to themselves and their community. Linking science and society at this level encourages development of unique solutions for each community, and their corresponding ecosystems, using interdisciplinary resources that seek to find URI fire risk reduction solutions applied through community collaboration.

People moving to URI areas are generally unaccustomed to their new fire-prone environment. For this reason, community advisors can be an immense benefit to URI communities in at least three ways. First, they are often able to identify URI fire risks to the community. Second, they can offer authoritative scientific advice to community leaders as they struggle with solving their URI fire issues. Finally, they may be able to provide many of the professional services necessary to reduce identified URI fire risks.

This paper identifies the prime directive of community advising, major roles of the community advisor, and several scientific tools used by the community advisor to accomplish the prime directive.

**The new focus of fire protection in the URI**

Most people have seen those haunting images that television camera crews send around the world every fire season of communities reduced to ashes by URI fire. In some places it is one or two homes, in another place it is hundreds of homes. At either end of the spectrum fire service organizations were ineffective in protecting those structures in URI fire. Why? This occurs because fire service organizations are not, or ever will be equipped, to sacrifice a person’s life to protect even one home in the center of an inferno. All hope is not lost however. Homeowners can, and have, reduced risk of loss to their property by starting to think as protectors, rather than as victims. In making this mental change, and following through with tangible risk reduction efforts made to their home and its immediate surroundings, homeowners and fire service agencies enjoy a healthier relationship as partners in risk reduction. When a URI fire occurs, with this partnership implemented, low home ignitability and community awareness increase firefighter effectiveness and safety resulting in less lives and homes lost to URI fire (Cohen 2000).

**Prime Directive: defensible space or risk reduction?**

What is the prime directive for dealing with URI fire in communities? Some say it is defensible space. Defensible means “capable of being defended against assault or injury.” Is our present model of fire...
protection effective? Are all homes defensible in the URI? Is this what we are promising to each and every homeowner? No matter what condition your home is in and what surrounds it we, the fire service, will risk our lives to protect it. Is the message to the homeowner that they are the victim and the fire service is their protector? If these questions are answered based upon evidence displayed every fire season, with hundreds of homes burning to the ground, the conclusion must be that many URI homes are not defensible.

The alternative to defensible space is reducing risk of loss. Like defensible space, it is action taken to reduce risk of fire loss, but without the implied promise that someone will be standing by the home to protect it. Homes can have risk of loss reduced, but it cannot be eliminated. Even with risk greatly reduced there are still no guarantees. Doing everything possible to a home to reduce its risk of loss from URI fire may still not protect it when fire arrives. That is the foundation of risk reduction – no guarantees, just increasing the probability that money spent, and action taken, will save lives and reduce property loss. It is this message of risk reduction that people need to hear and heed. Reduced risk in the URI is the prime directive of the community advisor.

Individuals and communities decide their level of risk reduction for the resources they have available. Community advisors help communities assess, and then plan the appropriate level of risk reduction for the time and with the resources made available by the community.

Even the lowest level of risk reduction planning might be a “deal breaker” when a community, or even an individual homeowner, realizes the extent of their URI fire risk problem, their lack of resources, and time commitment necessary to solve their URI issues. For some it will be easier to let things be and exchange proactive action on their part today, for reactive action taken by an insurance company tomorrow, which followed yesterday’s URI fire event.

**Getting started in a community**

There are probably numerous ways a community advisor begins working with a community, but it usually starts after the party who realizes there is are URI hazards discovers a person or agency that is willing and able to help. Although there are many efforts occurring in the URI, many people do not see these efforts as important until they themselves become aware of the need.

In some ways an agency’s eagerness to assist their adjacent communities really begins the linkage between the two principle parties. Agencies express their eagerness to help through various means, but in the end the people they are trolling for surface and make contact with them. Agencies troll the community with booths at fairs, rodeos, and popular school or community activities. Agencies may also use mass media and advertise or write op-ed pieces in newspapers, speak on radio programs, sponsor billboards, or use URI fire as a platform to inform the public about prevention activities and programs. More and more people contact agencies during and following attendance at a national or local Firewise workshop.

Once an agency is contacted there is usually a community advisor (these come with many different names) who becomes a liaison between the community group and the agency. More often then not, these community advisors eagerly accept their role while their agency remains somewhat aloof and at times even reluctant to have employees accept this role.

**Community Advisor Roles**

The community advisor fulfills responsibilities of guide, science officer, social science counselor, safety officer, and protector for the community. His/her role is to educate, motivate, counsel, and protect individuals within the community. State-of-the-art science and social science tools are used to fulfill these roles. The following table displays some tools used by community advisors in fulfilling their various roles.

**Table 1 –Tools Available to Community Advisors**

**Linking Science and Society**

In fulfilling their various roles as a community advisor these individuals are effectively and efficiently moving science to the very core of society – to its individual members and their small groups. These members of society then use science to make decisions about sustainable ecosystems, community stability, and social acceptance. The following paragraphs identify some examples of how society might use the tools displayed in the Table 1 are highlighted.

Applying BehavePlus, a fire behavior model, allows community members to vicariously witness the effects of URI fire in their very community. BehavePlus also allows them to model various changes to their vegetation and see differences their
treatments make on fire intensity and rate of fire spread.

Forest Vegetation Simulator-Fire and Fuels Extension (FVS-FFE) is another model that is available to assist communities make decisions about vegetation changes and see the effects of tree spacing on fire intensity, now and in the future. This model has a window that allows the user to visually see the intensity and spread of a fire across the landscape as well as its effect upon the stand of trees it burns through. Following fire passage, additional windows may be viewed that display the stand of trees through a series of time intervals beyond the fire event. Besides the visual display of the tree stand, there are tables that feature stand characteristics through time.

Every disturbance has a response. Vegetation responds to fuel reduction activities in numerous ways – some beneficial and others potentially high risk. For instance when trees are thinned, crowns are separated allowing additional light and moisture to reach the ground. Thinning activities may also disturb surface litter covering soil and allow dormant seed and spores to now come into contact with soil. With a seedbed, increased moisture, and sunlight come another generation of plants. Before vegetation is disturbed the homeowner and community should ask three basic questions:

1. Will this new generation of vegetation decrease or increase fire intensity and spread?
2. Is the cost to maintain this new vegetation more than maintaining the old vegetation?
3. Is the “old” or the “new” more sustainable?

An enormous help answering questions about response to disturbance, or plant succession, is available through the Fire Effects Information System (FEIS). This system is available in two forms. It is on the internet and it is also available as a series of publications.

Whatever inaction or action the community takes it should be purposeful and designed to meet the goals of the community. Community advisors are there to help lead community members identify those activities that will sustain and protect the community and warn them against activities that will increase URI fire intensity, severity, maintenance cost, and risk of severe damage.

When it comes to people and landscapes, aesthetics is another important aspect of that interaction. A person’s perception of a place is often based upon what they see and experience. Aesthetic values “imply a degree of purity, an appreciation of the landscape for what it is rather than how it might be changed to serve human needs and desires” (Gobster 1999). Using aesthetic perception as a measure of acceptability of a risk reduction activity would seem to oversimplify that which is complex and perhaps controversial; however, these perceptions must not be over trivialized (Ribe 2002).

Anything a community plans must meet its criteria for social acceptability or be rejected and not implemented. Community advisors using the following five strategies can focus community action toward integration of aesthetics into risk reduction management. The strategies are:

- Treat social acceptability as a process.
- Develop capacity within community organizations to respond to community concerns.
- Approach trust-building as the central, long-term goal of an effective community process.
- Provide leadership to develop a shared understanding of risk and risk reduction.
- Focus on the contextual conditions of risk (Shindler et al. 2002).

The previous five summaries of the use of science by society are just a small enumeration of the many disciplines necessary to resolve URI fire risk reduction issues. These five summaries identify potential tools that may be used to vicariously display fire behavior, identify possible effects of a variety of fuel treatments and their subsequent effects upon fire behavior and stand growth, how to anticipate the degree of vegetative response to disturbance, and the

<table>
<thead>
<tr>
<th>Role</th>
<th>Science</th>
<th>Potential Tool</th>
</tr>
</thead>
<tbody>
<tr>
<td>Educate</td>
<td>URI Fire Behavior</td>
<td>BehavePlus</td>
</tr>
<tr>
<td>Fuel Treatment Effects</td>
<td></td>
<td>FVS-FFE</td>
</tr>
<tr>
<td>Plant Succession</td>
<td>Fire Effects Information System</td>
<td></td>
</tr>
<tr>
<td>Aesthetics</td>
<td></td>
<td>Gobster 1999, Ribe 2002</td>
</tr>
<tr>
<td>Stages of Learning</td>
<td>O’Connor and Seymour 1993</td>
<td></td>
</tr>
<tr>
<td>Adult Learning Styles and Activities</td>
<td>Jacobson 1999</td>
<td></td>
</tr>
<tr>
<td>Social Acceptability</td>
<td>Shindler et al. 2002</td>
<td></td>
</tr>
<tr>
<td>Decision Analysis</td>
<td>Kepner and Tregoe 1981</td>
<td></td>
</tr>
<tr>
<td>Motivate</td>
<td>Diffusion of Innovations</td>
<td>Rogers 2003</td>
</tr>
<tr>
<td>Traits and Patterns</td>
<td>Charvet (1995)</td>
<td></td>
</tr>
<tr>
<td>Acceptance and Avoidance</td>
<td>Smith and Rebori 2001</td>
<td></td>
</tr>
<tr>
<td>Counsel</td>
<td>Believability</td>
<td>Kumagai et. al. 2004</td>
</tr>
<tr>
<td>Trust</td>
<td></td>
<td>Winter et. al. 2004</td>
</tr>
<tr>
<td>Protect</td>
<td>Threat</td>
<td>Cohen 2000</td>
</tr>
</tbody>
</table>
lessons learned about the importance of aesthetics when desiring social acceptance.

As an educator, the community advisor often brings new ideas into a community. To be successful, the advisor needs an understanding of the learning styles found in community members. Science disciplines dealing with adult learning styles, stages of learning, and knowledge of activities that accompany those learning styles at various learning stages greatly improve community member learning success.

Another aspect that is useful for the community advisor to present to community members is an understanding of the affects of change on people, time necessary for adoption of a new idea, and factors community members use when deciding whether to accept change or not. Knowing something about the affects of change on people reduces frustration in everyone and helps community leaders devise strategies to move their members through change with minimum impact.

Community decision-making needs to be done in logical fashion displaying the purpose, objectives, alternatives, quantification of alternatives when measured against the objectives, and adverse consequences. Community advisors can help a community do this successfully.

**Mitigating around those who won’t participate**

It is not very likely that everyone in a community will choose to participate in risk reduction activities. That is their right and there should be no negative reaction to the exercise of those rights. Without much additional planning, strategies can be developed, and tactics modified, to provide a safe secure community from URI fire without evoking everyone’s participation.

Using a fire spread model, like FARSITE, numerous alternative fuel break scenarios can be modeled to determine the best fuel reduction pattern that meets a community’s aesthetic, sustainability, and security needs while protecting an individual’s rights.

**Summary**

Community advisors are essential for providing a bridge between the scientific disciplines vital for solving URI issues and the people called upon to solve those issues. Community advisors typically fulfill the role of educator, motivator, counselor, and protector as they identify and encourage community members to use available scientific tools while making URI decisions that will affect them and their neighbors. Linking science and society, sustains ecosystems, brings about community stability, and is socially acceptable when proposing change to achieve security by reducing risk of loss from URI fire events.

**References**


Cohen, J.D. 2000. What is wildland fire threat to homes? Presented as the Thompson Memorial lecture, School of Forestry, Northern Arizona University, Flagstaff, AZ.


Soil and Water Quality
Evidence for the negative impacts of land alteration and urbanization on surface and subsurface water has been mounting since the early 1960’s (Felton and Lull 1963; Antoine 1964; Espey, Morgan et al. 1966; Leopold 1968; Anderson 1970; Hammer 1972; Loehr 1974; Beard and Chang 1979). Concurrent with this early and growing interest in water quality impacts, the International Joint Commission (IJC) first looked at urbanization and its impact on the Great Lakes through the Pollution from Land-Use Activities Reference Group (PLUARG). Established in 1972, PLUARG focused on “land use water quality relationships” (International Reference Group on Great Lakes Pollution from Land Use Activities 1973). Their final report released in 1978 (International Joint Commission 1978) was consistent with the other leading scientific literature of the time and definitive in its finding that urbanization was a significant contributor to the water quality problems of the Great Lakes Basin (International Joint Commission 1978).

Subsequent studies by the IJC and others continued to identify urban land-use development as a major source of stress to the Great Lakes ecosystem. In 1996, the State of the Lakes Ecosystem Conference (SOLEC) documented extensive threats from non-point source pollution, particularly affecting lakes Michigan, Erie and Ontario (Thorp, Rivers et al. 1997). Annex 13 of the Great Lakes Water Quality Agreement (1989) was enacted to delineate programs and measures for the abatement and reduction of non-point sources of pollution from the alteration of land for human uses. However, studies continue to show increasing effects from non-point source pollution originating from urbanizing land uses. The key question for today is how best can local, state and federal government be effective in getting the United States and Canada, and their jurisdictions, to improve management of non-point source pollution issues when the land use trigger is primarily a local government issue?

Using a regional planning approach to watershed protection requires the incorporation of development and open space planning into a regional growth management strategy. This goes far beyond simply recommending cluster developments, buffers, and conservation oriented subdivision design standards, to the siting of new development in the least sensitive areas of the watershed, and maintaining adequate mature forest stands and areas of open space that have not been impacted by human disturbance. The greatest impediment to the regional planning approach is that land use planning is a local initiative and decision makers are not oriented towards thinking about planning and growth management regionally, beyond the limits of their jurisdiction. Regional coordination requires strong leadership, beginning on a local level to: identify critical resources to preserve; direct growth within a watershed to areas best suited to assimilate the associated impacts; and use a menu of currently available growth management tools in concert with site specific BMPs and apply them on a regional basis.

Is there a Role for the Federal Government?
Since the early 1980s, a number of programs have been created to care for the Great Lakes at nearly every category of government; some have a demonstrated track record of successes while others can point to long-term investment of federal dollars. As of 2003, the Government Accountability Office (GAO – formerly the General Accounting Office) identified 148 federal and 51 state programs receiving funding for environmental restoration activities in the Great Lakes Basin (Government Accountability Office 2003). Whereas many of these efforts are characterized as either nationwide or statewide programs that may or may not specifically focus on the Great Lakes, GAO identified 33 federal Great Lakes-specific programs, and an additional 17 Great Lakes-specific programs funded by states.

Although funding for Great Lakes water quality restoration is not routinely tracked for many of these programs, GAO did identify a total of nearly $3.6 billion in basin-specific projects for fiscal years 1992 through 2001 (Government Accountability Office 2003). The report found a key problem in these efforts: the number of incongruent Great Lakes environmental strategies used at the bi-national, federal, and state levels. Currently, these strategies
are not coordinated in a way that ensures effective use of limited fiscal resources (Government Accountability Office 2004). Because of the physical scale of the Great Lakes basin and the numerous units of government – local, state, federal and international – who play key roles in guiding how restoration takes place, a consistent overarching strategy should be crafted and used to guide management and restoration efforts.

**Federal Interagency Task Force**

Nearly 200 federal and state programs are already in place to fund restoration activities in the Great Lakes Basin, 148 of which are federal and 51 are in place in state government (Government Accountability Office 2004). In an effort to coordinate restoration and management of the Great Lakes, and in response to a number of GAO Reports to Congressional Requestors (Government Accountability Office 2004) (Government Accountability Office 2003), President George W. Bush on May 18, 2004 signed an Executive Order creating a federal interagency Task Force on Great Lakes protection and management. It assigned the Administrator of the Environmental Protection Agency (EPA) to head the group. The Executive Order responded to the findings in a GAO report (Government Accountability Office 2003) citing the lack of coordination among more than 140 federal and state programs dealing with the Lakes (Michigan Environmental Council 2004).

**Need for Consistent Indices**

While root of the problem at the federal and state level of government is the absence of a comprehensive strategy and critical gaps in organizational leadership, it is also difficult to determine the overall progress of restoration efforts. The key issue is that each state measures and monitors different standards and then reports those in a different way around the basin, making determining the health of the Great Lakes more difficult. The findings of two GAO reports support the need for consistent monitoring practices.

The ultimate success in developing water quality indices for the Great Lakes is not clear since the measures of Great Lake’s water quality rely on resources voluntarily provided by several organizations. This dependence on volunteer efforts to monitor water quality is not unique to the region of the Great Lakes. When watershed restoration budgets become limited, one of the first areas of spending to be cutback is water quality monitoring. Although the lapses can be mediated by citizen or other volunteer efforts (Metropolitan Washington Council of Governments 1990), relying on volunteer efforts can leave gaps or uncertainties in collected data and indicators for determining the overall health of riparian systems. The challenge in establishing indicators for measuring the health and vitality of Great Lakes’ water quality lies in a centralized and effective coordination of efforts.

**Improve Regional Watershed Planning Effort: Coordinated regional, state and county- wide planning**

A variety of options, or models, exist for how each of the Great Lakes states can go about initiating coordinated regional land use planning to protecting water quality and coastal resources (Gale 1992; Deyle and Smith 1998; Carruthers 2002; Hamin 2003; State of Wisconsin 2000). Similarly, there are also directed ways in which the federal government can influence the process (EPA 2004). Two examples of regional land use planning are the incentive-based approach of Maryland and Florida (Deyle and Smith 1998). According to these approaches, each state government directs local units of government – county, township, city or village – to develop land use and growth management plans with an emphasis on protection and conservation of critical resources.

However, for the federal government to suggest that state governments enact coordinated land use planning mandates without funding is not effective policy. Many Great Lakes states are in the middle of an economic downturn and are only slowly beginning to see budgets stabilize as a result of aggressive cost-cutting. Many Great Lakes states did not fully experience the economic boom of the late 1980s and decade of the 1990s. As such, sales tax revenue has for many years been less than adequate to fund even basic and essential state services.

**Actions in Great Lakes States Relative to Smart Growth**

Whereas statewide growth management laws have not been uniformly enacted in many Great Lakes states, there are a number of smart growth initiatives being considered as programmatic or policy changes on the state level. Some have been adopted through state planning and other legislation as part of their comprehensive planning laws such as Wisconsin; others are recommendations prepare through bipartisan commissions or councils as in the Land Use and Leadership Council report in Michigan. Table 1 summarizes smart growth initiatives under way in six Great Lakes states. What is needed next is for each of the states to coordinate these smart growth initiatives and work to enact them uniformly, perhaps thorough regional planning organizations.
Table 1: Smart Growth Initiatives in Great Lakes States (Victoria Pebbles, Great Lakes Commission, unpublished work, 2004.)

<table>
<thead>
<tr>
<th>State</th>
<th>Initiative</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Illinois</td>
<td>Illinois Tomorrow</td>
<td>Creation of a Balanced Growth Cabinet to evaluate and coordinate state programs to ensure they are being used effectively</td>
</tr>
<tr>
<td>Michigan</td>
<td>Michigan Land Use Leadership Council Report Recommendations</td>
<td>More than 160 recommendations; new legislation, modification of existing rules and regulations</td>
</tr>
<tr>
<td>Minnesota</td>
<td>Minnesota Smart Growth Initiative</td>
<td>Established a statewide smart growth framework with: bonding criteria; smart buildings partnership; state development strategy; guide for local planning; model ordinances</td>
</tr>
<tr>
<td>Ohio</td>
<td>Ohio Balanced Growth Initiative</td>
<td>Establish Watershed Planning Partnerships; designate Priority Conservation Areas and Priority Development Areas</td>
</tr>
</tbody>
</table>
| Pennsylvania| Growing Smarter and Growing Greener (Volumes I and II)                          | • Interagency Land Use Team; established Center for Local Government Services; revamped state planning laws to encourage TDR, multi-municipal planning, etc; planning grants  
• $800 million bond initiative for farmland & open space; environmental cleanup; community revitalization--paid for by fees on waste and pollution |
| Wisconsin| Comprehensive Planning and Smart Growth                                     | Legislation defines “comprehensive plan,” outlines procedures for adopting the plans, requires consistency between zoning and adopted plans; provides grants for planning. |

**Improve Effectiveness of Regional Planning Organizations**

Within the eight states in the Great Lakes Basin, there are 38 regional planning agencies. Although this paper does not examine each of these regional entities in detail, these regional councils of governments (COGs) and their member governments cover an extensive region bordering each of the Great Lakes states and provide a basis for improved regional planning efforts. Rather than creating new governmental organizations charged with developing and administering coordinated regional growth management, using existing Regional Planning Agencies – in association with state offices of planning – could provide a needed outlet for implementing necessary actions and funded programs for protecting water quality within the Great Lakes basin.

These 38 established COGs should be engaged in a coordinated fashion to promote growth management and water quality protection between various units of local government throughout the Great Lakes region. To varying degrees, some of this coordination is already taking place. If funding dollars were available to promote and implement regionally mandated policies.

**Improve the inclusion of the public in the planning process**

In addition to the need for coordinated regional state and county-wide planning, many existing efforts have been criticized for not better including the public in the planning process through round table discussions and long-term visioning (Michigan Environmental Council 2004). Seeking out and actively soliciting the opinions, desires, and involvement of the public in watershed and natural resource planning is a key point which has a history of being either overlooked or underestimated by government.

Experiences in Michigan provide further insight into state growth management efforts. In spite of the inability of legislators to respond to studies and reports citing unmitigated sprawl as the culprit which damages water resources, land use reform evolved out of a grass roots, citizen and non government lead movement unlike Maryland where the impetus for a Smart Growth Initiative came from both local and state government. Led by the Public Interest Research Group in Michigan (PIRGIM), Michigan's environmental community reached out to more than 20,000 citizens to engage them in the Michigan Land Use and Leadership Council process (Michigan Environmental Council 2003). Created by executive order in February 2003, the group worked for six months to reconcile politics with the restructuring of...
local land use planning, all in an attempt to address both sprawl and urban decline. It was the desire to address both sprawl on farmland and associated decline of urban centers which made this effort unique. The effort did not assume that by reining in suburban sprawl, urban centers and higher density downtowns would quickly begin to revitalize through gentrification. The effort did make the argument that Michigan could no longer support the price associated with “flight” from established urban areas onto rural township landholdings.

The Michigan Land Use and Leadership Council report suggested increasing coordination among the 1,800 local units of government involved in planning; Michigan relies on township government and local planning commissions to form land use policies. Historically, there has not been effective regional planning, but rather a myriad of piece-meal attempts to foster growth control. The report also recommended providing an increased role for state participation and better targeting of state funding. Other recommendations included directing re-development funds and expertise into existing urbanized areas that already have sufficient infrastructure needed to meet demands for growth. The approach was very similar to that of the Maryland Smart Growth Initiative’s Priority Funding Areas (PFAs).

Key Recommendations

Central Coordination and Local Control:
Incentive Based Approach
State and or regional planning authorities should provide incentive funding for local government to develop coordinated land use growth management plans at the watershed level.

Actively Engage the Federal Interagency Task Force in Regional Watershed Planning Efforts
The Interagency Task Force was charged with using regional collaboration to bring hundreds of regional, state, local, tribal and other interests together for the purpose of developing an overall strategy for protecting the Great Lakes.

The federal government should take advantage of this leadership role by making funding available to state and regional authorities who wish to develop joint or regional growth management plans.

GAO recommended in its April 2003 report that the Administrator, of the Environmental Protection Agency ensures that the Great Lakes National Program Office fulfill its coordination responsibilities and develop an overarching Great Lakes strategy. A cornerstone of this strategy should be regional coordinated land use planning.

Make Better Use of Regional Planning Groups (COGs)
A key recommendation would be to actively engage the 38 established COGs in each of the eight states in a coordinated fashion to promote growth management and water quality protection between various units of local government through out the Great Lakes region. This might involve re-delegation of greater planning and implementation power to the COGs. Many local units of government are already members and have representation and should have a voice in regional decision making.

Institute Uniform Standards for Measuring Water Quality
The GAO recommended that either EPA or the states develop environmental indicators and a monitoring system for the Great Lakes Basin that can be used to measure overall restoration progress.

States should establish uniform standards for determining Great Lakes water quality. A consistent method for monitoring and reporting will help the IJC and others in their efforts to recommend land use planning practices relative to protecting water quality and achieve the President’s Order calling for measurable results of clean up efforts.

Promote Smart Growth Initiatives
There are a number of smart growth initiatives being considered as programmatic or policy changes at the state level. Some have been adopted through state planning legislation as part of their comprehensive planning laws. What is needed next is for each of the states to coordinate these smart growth initiatives and work to enact them uniformly, perhaps through the 38 regional planning organizations.

References


Impact of Land Use on Fecal Coliform Levels in Surface Waters of Fairfax County, Virginia

Judith A. Buchino, George Mason University

**Introduction**

Elevated fecal coliform levels in surface waters pose a problem of concern for the use of streams as recreational areas and as sources of drinking water for citizens (Geldreich, 1966; Madigan et al., 1997; Geldreich, 1970). Although not always disease producing themselves, fecal coliform (FC) serve as indicator organisms for possible pathogens that are present in fecal material. Despite the great advances in wastewater treatment management, fecal coliform contamination is still persistent, especially in metropolitan regions. Sources of the fecal coliform material include human sewage attributable to leaky septic systems, faulty wastewater treatment systems, domestic animals, farm animals, the use of manure on agricultural plots, and wildlife (Geldreich and Kenner, 1969). To investigate this problem, Fairfax County, Virginia, was selected as a regional area that exemplifies this type of problem. This study has reviewed the monitoring data from the Fairfax County Health Department and garnered additional information from other data sources to include environmental variables and hydrologic parameters. In extending the use of the data beyond its original scope, we must consider the framework of the experimental design.

The framework is a concept originating in the computational sciences (Parker et al., 2003) and is basically a conceptual way of viewing reality. The experimental frame defines the boundaries around a subset of the real world and defines what perspective we bring to the research problem. A real-world system can be viewed by many different experimental frames, each having its own research questions and bodies of knowledge. Ziegler (1976) defines an experimental frame as the “limited set of circumstances under which the real system is to be observed or experiment with.”

The framework of the Fairfax County Health Department (FCHD) monitoring protocol was different from the framework of this research work. The FCHD was interested in whether the fecal coliform (FC) levels fell within the water quality criteria. If the FC levels exceeded the water quality criteria, then there may be a problem and corrective action would be taken as required. The framework of this study is to investigate the elevated levels of fecal coliform, to determine what factors are important in explaining these elevated levels, and to consider the impact of land use.

**Hypotheses**

This project will investigate the hypothesis: land uses associated with increasing urbanization are correlated with elevated fecal coliform levels in surface waters of Fairfax County, Virginia.

**Study Location**

The study location is Fairfax County, which is the largest county in Virginia, occupying 399 square miles (255,360 acres) with a population of 969,749, according to the 2000 Census (Fairfax County, 2001). The average monthly temperature is 53.9 ºF (Fairfax County, 2001). Fairfax County, Virginia, is located just outside Washington, DC in northern Virginia. There are thirty (30) watersheds within Fairfax County and twenty-five (25) of these watersheds are routinely monitored by the Fairfax County Health Department. The physiographic provinces of Fairfax County are important in describing the geology and soils of the region which impact the natural quality of the water. There are three provinces within Fairfax County: the Coastal Plains, the Piedmont Upland and the Triassic Basin (Frye, 1986).

**The sample and sampling procedures**

The samples for the Fairfax County Public Health data are collected by the staff of the Environmental Services Section of the Department of Health’s Division of Environmental Health (Fairfax County, 2002). These are grab samples collected twice a month, when possible. The primary objective of this program is to monitor stream water quality. Data are collected from 72 sampling sites in 25 of the 30 watersheds in Fairfax County. The Stream Water Quality program was initiated in the Fall of 1969. The parameters originally selected as criteria for stream water quality were fecal coliform and dissolved oxygen. The parameters were expanded in 1979 to include pH, nitrate nitrogen, and total phosphorus, and again in 1982 to include temperature.
Database
A spatially and temporally matched database was constructed with the water chemistry data set and the fecal coliform data set which have been collected by the Fairfax County Health Department, Division of Environmental Health. Also included in this database is the precipitation data (NCDC data for Dulles International Airport), streamflow (USGS data for Accotink Creek), drainage area, average distance from the stream to the sanitary sewer line, percent saturation of dissolved oxygen and percent impervious surface (Fairfax County SPS Report, 1997).

Regression Analysis
Stepwise multiple regression was used to develop the statistical models (Venables and Ripley, 1997; Sokal and Rohlf, 1969; Snedecor and Cochran, 1967; Neter et al., 1983; Lewis-Beck, 1980; Berry and Feldman, 1985; Schroeder et al., 1986; Draper and Smith, 1966).

Because the data for the fecal coliforms are truncated, logistic regression (Menard, 2002; Hocking, 2003; Kleinbaum, 1994; Christensen, 1997) was used to develop models for FC levels in compliance or not in compliance with the stated water quality criteria.

These models are run with the median value of each parameter that was aggregated over the five year period 1995 to 1999 (See Table 1).

Model 1 includes both IMPV and LU data (impervious surface and land use data) in the model. The R^2 value for this model is 0.6585 and the equation is:

\[ \ln FCOLI \sim \text{IMPV} + DO + pH + \ln NO + \text{LDR}\]

Model 2 is the equation that was developed using only land use and the environmental variables (i.e. dropping out percent impervious surface). The R^2 value for this model is 0.6042.

\[ \ln FCOLI \sim DO + pH + \ln NO + \ln DA + \text{HDR} + \text{IND} + \ln NO + \text{LDR} + \text{LIC} \]

Model 3 includes only impervious surface and the environmental variables and its R^2 value is 0.6420.

\[ \ln FCOLI \sim \text{IMPV} + pH + \ln NO + \text{PCTSAT} \]

A useful comparison between Model 1 and Model 3 is shows that the p-value is 0.1060, which is not adding any new information to the model. The impervious surface variable seems to be explaining a major portion of the variability in the fecal coliform levels and the specific land use is not coming into play, when impervious surface is included as an explanatory model in the variable. However, when impervious surface is omitted from the model, then the R^2 value is a respectable 0.6042. Further elucidation of land use and impervious surfaces is warranted.

The logistic models run the regressions based upon the calculated variable COMP which is the factor variable constructed from the fecal coliform values (See Table 2):

\[ \text{COMP} \sim \text{IMPV} \text{LU} \text{HDR} \text{LDR} \]

Values that are equal to 1,000 cfu/100ml are considered to be “IN” compliance, and values greater than 1,000 cfu/100ml are considered to be “OUT” of compliance. The value of 1,000 is obtained from the Virginia Department of Environmental Quality (VADEQ) and is the instantaneous water quality criteria for fecal coliforms. This is the water quality criteria that is promulgated for use in the TMDL (Total Maximum Daily Loads) studies by VADEQ.

The logistic model for impervious surfaces and land use is:

\[ \text{COMP} \sim \text{IMPV} + pH + \ln NO + \text{HIC} + \text{LIC} + \text{MDR} \]

In this model, the explanatory model IMPV contributes the most to the deviance residual. For the model that includes the LU variable only, the variables that were most important were HDR (high density residential) and LDR (low density residential):

\[ \text{COMP} \sim \text{HDR} + \text{LDR} \]

The logistic model that includes IMPV only as an explanatory variable is listed below:

\[ \text{COMP} \sim \text{IMPV} + pH + \ln NO \]

Note that the explanatory variable IMPV contributes the largest portion of the deviance residual.
The correlation between IMPVcum and HDRcum is 0.6108. High density residential (HDR) is the land use that it most highly correlated with impervious surface. When impervious surface is not allowed in the equation, then HDRcum comes in as a proxy.

Impervious surface seems to be the key explanatory variables: if it is not included in the model, then the next variable that is mostly highly correlated with IMPVcum enters the model. In this example, that would be HDRcum. The nitrates come into every model. Dissolved oxygen comes into the model either as DO or as percent saturation of DO (PCTSAT). Another explanatory variable is pH, which enters all three models. This is an overall summary of all the watersheds.

**Seasonal Analysis**

Another way to examine the data was to look at the seasonal effects. Because temperature has a seasonal variability and was correlated to the FC levels ($r = 0.2804$, and $p = 0$), a seasonal analysis was done. The FC data were separated into seasons that were determined by the equinox/solstice dates (approximate: i.e. Summer started on June 21). The seasonal analysis showed that different explanatory variables emerged as significant for each of the four seasons.

We seem to see an overlapping pattern in some of the land uses that entered the model. For example, industrial (INDcum) was present in the Fall and Winter models, which might suggest the importance of runoff from industrial regions where contamination from pollutants and ground debris may be of more importance. Light intensity commercial (LICcum) entered the models for Winter and Spring, suggesting that more intense uses of land impact the dormant time periods. Low density residential (LDRcum), the dominant land use in Fairfax County, was present in all models except Fall. Percent saturation dissolved oxygen (PCTSAT) played a role in the models for Summer and Fall when temperatures were higher, while dissolved oxygen (DO) occurred in the Winter model, when water temperatures were lower, and higher levels of dissolved oxygen would be expected to occur naturally in the waters. The transition from one season to another resulted in a carry over effect of which variables were included in the models.

**Conclusion**

This study integrated the Fairfax County Health Department water quality monitoring data with archived data sets of other relevant environmental data. Based upon these data and the models that were generated, the following conclusions can be made.

- **Land Use is Correlated to Percent Impervious Surface**
- **Percent impervious surfaces were highly correlated with the land use designation. It was positively correlated with High Density Residential, ($R^2 = 0.6108$) and negatively correlated with Open Spaces ($R^2 = -0.3538$) and Low Density Residential ($R^2 = -0.2851$).**
- **Percent Impervious Surface is the Best Explanatory Variable**

The main explanatory variable for the fecal coliform levels of surface waters in Fairfax County, Virginia, was the percentage of impervious surface in the watersheds. This variable alone explained up to 40% of the variation in fecal coliform levels in the annual median value models. Percent impervious surface is highly correlated to land use, and often, when the impervious surface was identified as a crucial variable in the model, the land use parameters were no longer a factor in the equation because the variability was already accounted for by the most significant explanatory variable.

This is not to say that impervious surface was the cause of elevated levels of fecal coliforms, only that it was an indicator of conditions that correlate to higher levels of coliforms (Arnold and Gibbons, 1996). With increased urbanization of land use, areas of land that previously filtered runoff during precipitation events were severely reduced. To compound things, conventional water management plans have relied upon collection and conveyance systems to remove runoff from congested areas directly to streams. This was done to avoid flooding in local residential areas and to protect life, property and health (NAHB Center, 2003). Consequently, the change in hydrology has impaired the normal condition of streams, eroded riparian areas, and resulted in scouring flows, all factors that have negative impacts on water quality and aquatic life (Booth, 1990; Booth and Jackson, 1997; Jones and Clark, 1987).

This study has advanced the knowledge and understanding of this watershed in its failure to improve water quality due to increased urbanization. Impervious surface coverage, a characteristic of increased urbanization, was identified as the major explanatory variable in the models. Low impact development strategies need to be implemented to mimic pre-development conditions and thereby counteract the effect of increased urbanization.
## Table 1. Models for Annual Median Values for 1995 - 1999 for all Watersheds

<table>
<thead>
<tr>
<th>Variables</th>
<th>IMPV + LU</th>
<th>LU only</th>
<th>IMPV only</th>
<th>IMPV + LU</th>
<th>LU only</th>
<th>IMPV only</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(R² = 0.6585)</td>
<td>(R² = 0.6042)</td>
<td>(R² = 0.6420)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intercept</td>
<td>10.0723</td>
<td>8.2547</td>
<td>10.5994</td>
<td>171.8035</td>
<td>-5.5878</td>
<td>40.1766</td>
</tr>
<tr>
<td>IMPVcum</td>
<td>0.0218</td>
<td>0.0202</td>
<td></td>
<td>6.9312</td>
<td>0.3300</td>
<td></td>
</tr>
<tr>
<td>TEMP</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DO</td>
<td>0.0956</td>
<td>0.0645</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>pH</td>
<td>-0.6705</td>
<td>-0.5445</td>
<td>-0.7370</td>
<td>-42.7342</td>
<td>-6.7952</td>
<td></td>
</tr>
<tr>
<td>lnNO</td>
<td>0.0929</td>
<td>0.1239</td>
<td>0.1129</td>
<td>13.3824</td>
<td>2.5538</td>
<td></td>
</tr>
<tr>
<td>PCTSAT</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>lnDA</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>HDRcum</td>
<td>0.0387</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.4546</td>
</tr>
<tr>
<td>HICcum</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>-7.1578</td>
<td></td>
</tr>
<tr>
<td>INDeum</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.0457</td>
<td></td>
</tr>
<tr>
<td>LDRcum</td>
<td>0.0030</td>
<td>0.0067</td>
<td></td>
<td></td>
<td>0.0506</td>
<td></td>
</tr>
<tr>
<td>LICcum</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>-3.8588</td>
<td></td>
</tr>
<tr>
<td>MDRcum</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>-2.6169</td>
<td></td>
</tr>
<tr>
<td>Oscum</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The dependent variable is lnFCOLI

Coefficients for each variable are given

- COMP ≤ 1000 IN
- COMP > 1000 OUT
<table>
<thead>
<tr>
<th>Variables</th>
<th>Models</th>
<th>Combined (R²=0.6585)</th>
<th>Spring (R²=0.4319)</th>
<th>Summer (R²=0.6020)</th>
<th>Fall (R²=0.4116)</th>
<th>Winter (R²=0.5269)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td></td>
<td>10.0723</td>
<td>8.7776</td>
<td>11.1783</td>
<td>7.1358</td>
<td>6.3646</td>
</tr>
<tr>
<td>IMPVcum</td>
<td></td>
<td>0.0218</td>
<td>0.0247</td>
<td>0.0204</td>
<td>0.0350</td>
<td></td>
</tr>
<tr>
<td>TEMP</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.0442</td>
</tr>
<tr>
<td>DO</td>
<td></td>
<td>0.0956</td>
<td></td>
<td></td>
<td></td>
<td>0.0857</td>
</tr>
<tr>
<td>pH</td>
<td></td>
<td>-0.8706</td>
<td>-0.4459</td>
<td>-0.8000</td>
<td>-0.5242</td>
<td>-0.6044</td>
</tr>
<tr>
<td>lnNO</td>
<td></td>
<td>0.0929</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PCTSAT</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.0115</td>
<td>0.0128</td>
</tr>
<tr>
<td>lnDA</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>HDRcum</td>
<td></td>
<td>0.0587</td>
<td></td>
<td></td>
<td>0.0268</td>
<td></td>
</tr>
<tr>
<td>HICcum</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>INDcum</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.0354</td>
<td>0.0503</td>
</tr>
<tr>
<td>LDRcum</td>
<td></td>
<td>0.0030</td>
<td>0.0099</td>
<td>0.0101</td>
<td>0.0240</td>
<td>0.0299</td>
</tr>
<tr>
<td>LICcum</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.0122</td>
<td></td>
</tr>
<tr>
<td>MDRcum</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>OSCcum</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.0204</td>
</tr>
</tbody>
</table>

The dependent variable is lnFCOLI.
Literature Cited


Fairfax County Stream Protection Strategy Report: Baseline Study, 1997. Fairfax County Stormwater Planning Division, DPWES, Fairfax County, VA.


Nutrient Recycling from Organic Waste for Urban and Peri-urban Agriculture in West Africa: Really a win-win situation?

Drechsel Pay and Danso George, International Water Management Institute (IWMI)

Abstract
The major challenge of urbanisation to decision makers is the provision of sufficient food for the emerging mega-cities and appropriate urban sanitation management. This paper focuses on the results of a project carried out by International Water Management Institute (IWMI) in three major cities of Ghana. The project was designed to provide decision support for nutrient recycling from organic waste in urban and peri-urban areas, i.e. through waste composting or co-composting with nightsoil. Experiences from Nigeria, Benin and Togo were also taken into consideration. Apart from technical aspect, the study looked at actual waste supply and its quality, a quantification of the compost demand as well as economic viability of different scenarios and legal implications. Among other findings, the analysis shows that municipalities need large volumes of waste to be composted to reduce waste transport costs while compost sale (and use) is not a necessary condition. Although farmers expressed interest in compost, a cost vs. willingness-to-pay (WTP) analysis showed that the effective demand is low. The paper concludes that closing the rural-urban nutrient cycle through composting is unrealistic though it could be possible to close the loop partially by serving urban and peri-urban farmers. Financial viability is however unlikely except although there are options for win-win situations.

Introduction and background
According to the UN-Habitat (2001) urbanization is one of the major problems facing mankind in this millennium. In Africa for instance, the current average urban population growth rate of 3.5 is more than thrice the rate of the rural population growth. The report further indicates that by 2015 (2030) there will be 25 (41) countries in Sub-Saharan Africa (SSA) with higher urban than rural populations. Policy-makers in these countries have started to respond to this demographic shift. The major related challenge is the provision of sufficient food for the emerging mega-cities, and appropriate urban sanitation. Both challenges are linked as the urban food supply contributes the majority of the urban waste (Drechsel and Kunze, 2001). The recycling loop aims at nutrient recovery from organic waste for agriculture. The panacea is that if well planned, the costs of waste disposal could be reduced. However, what appears like a logical win-win situation for city authorities and farmers, is seldom in the developing world. A combination of factors accounts for why urban areas have not been able to successfully constructs and operate composting stations. The most notable ones in West Africa are lack of affordable equipment, technical personnel, frequent mechanical breakdowns, and financial restrictions (Drechsel et al., 2004; Asomani-Boateng et al., 1996). In situations where funding is secured from donor agencies, the conditions accompanying such funds are often disincentives to good practice. Technological know-how on financial analysis, engineering design of composting facilities and transport schedule modelling have been very much limited in developing countries (Cointreau-Levine, 1997). In addition, technological transfers of compost processes and equipment from developed countries were often done in the past without considering local constraints (Hoornweg et al., 1999; Etuah-Jackson et al., 2001) and the technologies transferred were often not applicable in the receiving country. Also comprehensively planned composting stations, based on a demand-supply analysis, are unusual. In fact, waste management authorities in West Africa have hardly the “luxury” to plan for recycling but to focus their limited resources on the priority needs “waste collection” and “safe disposal” which are consuming an immense share of the municipal budgets in low-income countries as cost recovery is low (Drechsel et al., 2004).

Initiated through a pan-African conference on (peri)-urban agriculture and nutrient recycling (Drechsel and Kunze, 2001), IDRC agreed to co-sponsor a corresponding project in Ghana in order to develop nutrient recycling strategies to close the rural-urban nutrient loop. The objective was to develop decision support for three Ghanaian municipalities on waste composting. The project received French support allowing the construction of a pilot co-composting station in Kumasi, which is so far unique in Africa and allowed us to gain practical insights into compost station management and co-composting.
Study Area and Methods
The study focused on Accra (1.6 million inhabitants), Kumasi (1.0 million inhabitants), and Tamale (200,000 inhabitants), each located in a different agro-ecological zone in Ghana, and was accompanied by a sub regional survey of compost stations in Nigeria, Ghana, Togo and Benin. The multidisciplinary character of the project required a holistic (Drechsel et al., 2004) and a large project team involving more than 15 different university departments of three national and several European universities including about 100 student projects over a period of four years. Other project actors were urban and peri-urban farmers, communities, municipal authorities, especially the waste management departments, schools, and parts of the private sector. The project considered five main study segments of the recycling loop (Fig.1).

Results and Discussions
3.1 The institutional and legal framework
In general, all institutions expressed their supportiveness and willingness to participate in case a composting project was to be initiated. It was mentioned that in order to overcome obstacles, care must be taken in all planning stages so that all stakeholders’ inputs are considered. The survey revealed a constellation of stakeholders’ roles to play in project implementation based on the expertise and abilities of each organization. A cluster analysis was used to group the identified stakeholders into four general clusters: 1) Regulators: i.e. institutions in power to draft by-laws, legal instruments, and policies; 2) Organisation & Management: institutions in charge of running composting plants; 3) Supporters of initiatives: institutions providing external support (financial, material, knowledge); 4) Beneficiaries: users of sanitation services (households and markets), communities and workers receiving income through composting (composting producers), and farmers (users of compost). Some of the institutions fall into more than one cluster; they are in the position to work as inter-cluster channels of linkage facilitating the flow and exchange of information. The institutional platform at the centre of the rural-urban nutrient cycle is to facilitate the framework of regulations, managerial and technical sophistication and the actual and potential transport capacity of the city-specific waste collection system. Besides computer-based simulation models, standard economic indicators, such as the Net Present Value were used.

Figure 1 The nutrient recycling loop framework
organisation skills, and external support to the beneficiaries. In the case of Kumasi, at the very centre is the Kumasi Metropolitan Assembly (KMA), this institution plays a role as regulator, a manager, a supporter of initiatives and as a beneficiary due to municipal savings; its central role doesn’t mean it should be the chief institution or the one in charge, but it should be the main facilitator. More information on this can be found in Vasquez et al (2003).

The supply segment
The analysis of the waste supply and demand segments of the recycling loop confirmed our initial expectation that the availability of organic waste is not the limiting factor for compost production in our study cities. The supply analysis helped to avoid an overestimation of the amount of actually available organic waste. Not every waste is available as there are often alternative uses (fodder, fuel etc) and seasonal variations. The study showed that in all cities the largest share is household waste. However, market and industrial waste are usually more accessible for compost operators as their sources are concentrated in some few points and often of better quality for composting. Waste analyses conducted in Accra and Kumasi indicated relatively low levels of heavy metal contamination. Similar results are reported from other West African cities (Drechsel et al., 2004). Especially market waste combines very high organic content and a low potential of metal contamination. The analysis of the seasonality of the waste supply shows among others that more food products are produced, traded and processed in the rainy season than the dry season. As matured, dried compost can be stored, we concluded that there should be no significant seasonal shortage. A comparison of waste generation and availability along a South to North gradient from Accra, Ghana to Ouagadougou in Burkina Faso showed that with decreasing biomass production also the amount of organic waste and related nutrient availability per capita decreases progressively as dryer eco-zones are entered.

The demand segment
In relation to other segments, our assumption was that the design capacity of a municipal compost station(s) will largely depend on the quantification of the compost demand. Different compost clients such as farmers growing vegetables, staple crops, fruits, and ornamentals were identified. The results indicate that most of the farmers have positive perceptions and are willing to use compost but mostly without related experience. The study showed that compost use, even from farm residues, is not common in Ghana’s forest belt but known in its savannah. Compost was mostly compared with “black soil”1. Farmers’ interest in compost concerned both, a plant-growth enhancing (fertility) effect and soil amelioration. Large variations in WTP were recorded between farmers with and without compost experience, different farming systems, urban and peri-urban farmers, as well as between different cities with different compost alternatives. Although most of the farmers were positive, the actual amount farmers were willing to pay was low (0.2 to 2.0 USD per 50kg bag), often explained with the low price of poultry manure. The reference price of compost reflecting self-sustaining stations was set as ca. 3-5 USD per 50kg bag. Only a relatively small group of commercial pineapple growers (and exporters) around Accra expressed a corresponding WTP under the condition that product quality and (fertilizer like) packaging would be satisfying. The WTP expressed by farmers who already used compost was in several cases lower than among (still) non-users. This discouraging result was based on the unsatisfying performance of e.g. the compost produced in Accra (Teshie plant) or the negligible market demand for “organically” produced crops in Kumasi. The municipal compost produced in Ghana is generally low in heavy metals but also in nitrogen, especially if compared to poultry manure. We could conclude that a better product might raise the WTP. However, due to large quality variations among the waste inputs, a standardized high value compost product was so far only achieved in the Bodija plant in Ibadan through blending with mineral fertilizer (Drechsel et al., 2004).

Without subsidies, only few farmers, mostly in compost station vicinity, could afford a viable compost production price of USD 5 per 50 kg. Scenarios assuming a fully subsidized production, on the other hand, showed spatial limitations in compost dissemination due to transport costs. The consideration of transport costs showed clearly that the idea to “close the rural-urban nutrient loop” is not realistic. While it is feasible to transport high value (food) products over long distances and different middlemen into the city, it is not feasible to transport a low value product the same way back. Another reason is the practice of shifting cultivation in the rural areas, which has lower (opportunity) costs than any intensification measures. Thus mostly urban and peri-urban agriculture (UPA) with no or very short fallow periods could benefit from compost

---

1 Dark, mostly organic soil from old waste dumps, which is considered very valuable.
application. Another exception is commercial pineapple growers in Accra and cotton growers near Tamale. A significantly higher demand for compost was estimated from estate developers than from UPA farmers around the three cities. The house-building sector is generally using black soil from local waste dumps for gardening and landscaping and is contributing to land degradation through topsoil mining where black soil is scarce. If a policy could be applied that the use of compost could become mandatory for all “black soil” suppliers of real estate companies, significant amounts of compost could be sold especially in Accra. In comparison with agriculture, the real estate sector has much lower qualitative requirements as compost will mostly be used for lawns and ornamentals. Thus the real estate sector could be the “favorite” customer group with interesting options for private-public partnerships and win-win situations as the first example in Accra shows. The financial strength of the estate sector could in this set-up even subsidize parts of the compost production for agriculture.

The comparison with the ‘Supply analysis’ showed, that the amount of waste required to satisfy UPA and estate development could be provided solely from the waste generated on the city markets in Accra, Kumasi and Tamale. This would in addition guarantee quality and easy collection.

While the study put much emphasis on actual compost demand and economic feasibility to cover at least station running costs, city authorities stressed that composting is principally reducing waste volume and transport costs, thus compost production - even without any market - is saving money which could be used to finance composting. Compost sales were considered a secondary issue or bonus. This perception is based on increasing problems of authorities to find community-supported landfill sites in city vicinity, while local communities are less reluctant to accept a compost station. From this point of view, compost stations should be planned as close as possible to the points of waste generation. To reduce transport costs for supply and demand several stations around the city would best serve potential users.

The process and economic segments

The analysis was carried out for two contrasting years in terms of interest rate on borrowed capital (2001, 2004) on the assumption that whoever builds the compost station will have to pay for it, i.e. the establishment will not be for free. The studies revealed that all the stations surveyed in the sub-region were established (and are in part running) with financial aid and are not profitable and sustainable. The survey also showed that the reasons are often poor partnerships with the local communities or a poor market analysis. Thus all stations in the subregion sell their compost under production value, which can vary between USD 200 and 500 per ton of compost under consideration of discounted investment costs. Sales prices are usually in the range of 15 to 30 USD per ton and often hardly covering station running costs. Even under consideration of collection fees etc., a deficit remains. A reasonable (unsubsidised) price would be 60 to 100 USD per ton or 3-5 USD per 50 kg. This, however, is hardly competitive in view of alternative local poultry manure and black soil except with a convincing evidence of better quality than the so far available compost.

A comparison of land-filling, incineration and composting in Ghana confirmed that no alternative is actually profitable. However, the overall cost of building and operating composting facilities in the Accra-Tema Metropolitan Area is much lower than the other two methods. Further more, land-filling is about 95% cheaper than incineration under prevailing Ghanaian conditions. The unavailability of land for landfills, incinerators and their transfer stations, and the requirements for meeting environmental quality standards are the major causes of the high capital cost of land-filling and incineration in the area. On the benefits side, composting urban solid waste appears to have the highest total economic benefits especially through labour-absorption. A combination of land-filling with other methods could be associated with higher economies of scope and scale than any single method.

Our analysis considered two basic scenarios, a) of a fully subsidized production, and b) a self-sustaining production. The later addressed the vulnerability of many stations due to common arrears in payments. It considered cost recovery, actual compost demand, station running costs and farmers’ willingness to pay. Our project stakeholders preferred the first scenario stressing that compost production makes already sense without any demand as it is reducing the waste volume.

The general challenge we see is that potential/actual savings through composting were in no case study used neither to invest in composting nor to maintain existing stations. One reason might be that the waste volumes were insignificant and station costs higher than any savings. The challenge would become even larger, if different public and private entities would
be in charge of compost station, waste collection, and landfill operation. This confirms the need for a clear legal/financial framework describing tasks and duties. While the project had its main focus on municipal compost stations, the municipal stakeholders stressed the importance (but also risks) of household composting. The general consent was that household composting should not be mandatory but focus on awareness creation among those households with highest potential (middle income, space in backyards and own urban gardens).

**Conclusion**

The study showed that the amount of organic waste available for composting is seldom the limiting factor. Already the market waste would be sufficient in every city to satisfy compost demand from agriculture and estate development. Compost contamination does not appear as limiting factor, while the nutrient content is only modest. A detailed demand and stakeholder analyses appears crucial for compost sale and station set up, especially where subsidies might not be lasting. Major prerequisites for long-term success and project sustainability are besides careful financial planning also effective project partnerships linking public and private sectors, the local community and (at least for monitoring) research institutions. One lesson was that the target to close the rural-urban loop would remain a myth. As compost is no high-value product, transport costs would quickly raise too high. Thus it will only be possible to close the loop partially by serving urban and peri-urban farmers and estate developers, but not rural ones. Other key lessons are:

- Waste management including composting is costly if done at any significant scale. However, large scale composting is less costly than incineration or landfilling. The scenarios show that composting is not automatically a classical win-win situation for farmers and municipalities. Municipalities need large waste volumes composted for any significant impact. Large sales, however, are neither matched by farmers’ willingness to pay, nor the agricultural demand. In the best case (Accra), the real estate sector (plus urban and peri-urban farming) could absorb about 20% of the available organic waste. Still, a financial breakeven is unlikely, thus subsidies will be needed for set-up and maintenance of any compost station. A related win-win situation could be private-public partnerships linking public compost stations and private real estate developers.
- City authorities stressed that composting is generally reducing waste volume and transport costs, thus compost production - even without any market - is saving money, which could be used to finance the stations. Compost sales were considered a secondary issue or bonus, thus the capacity of the stations should go far beyond actual demand.
- If such external support/subsidies are uncertain, compost stations do not appear to be sustainable as it is unprofitable. Low-cost alternatives are controlled waste dumping and mining at landfills (the product - “black soil” - has in Ghana an excellent reputation).

**References**


GTZ-GFA. 1999. Utilization of organic waste in peri-urban centers. The decision makers’ guide to compost production (with financial analysis tool); Software Tool - Economic Model, Version 0.9 E, GFA, Germany

Hoornweg, D., Thomas, L., and Otten, L. 1999. Composting and Its Application in Developing

Urbanization puts growing pressure on forest ecosystems by increasing intensity of forest management. Forests intensively managed for timber production undergo loss of nutrients from ecosystem. Thus, growth of the next forest generation may lead to a decreased nutrient status in soils. While there is significant literature on forest nutrient cycling and nutrient losses from different levels of trees utilization, the questions of the long-term dynamics of ash elements and nitrogen in managed forests have been scarcely addressed. The question of whether harvesting leads to forest soil exhausting, or is compensated by natural weathering and other inputs, remains open in the literature. The hypothesis tested in this paper is that forests managed for timber production undergo gradual soil exhaustion that leads to decreased forest productivity. The aim of this work is to evaluate the influence of forest management activities, primarily clear cutting, on the fertility of forest soils.

Kimmins (1977) showed the influence of rotation length, utilization standards, and rates of nutrient replacement on the long-term nutrient capital. He concluded that the shorter the rotation, the greater the rate of utilization and the slower the replacement of nutrient losses leading to greater reduction in the long-term site nutrient capital.

Soon after harvesting nutrients are incorporated into the soil with logging slash and dead roots of fallen trees. This may lead to temporary improvement of subsequent stand growth (if it is not overcome by soil erosion). The flush of nutrients after harvesting is called the Assart effect. Its magnitude depends on utilization rates (whole-tree or stem-only harvesting). The Assart period depends on the nutrients circulation speed, which is proportional to tree growth energy. In Ukraine, with 80-year rotation pine and spruce stands and stem-only harvesting, all additional nutrients are exhausted by new stand biomass, when the stand is about 40-years old (Polyakova, 2002). When the Assart effect is over, further stand growth leads to soil exhaustion (fig. 1), which may be compensated by weathering and other inputs. Thus, the long-term impact of harvesting on nutrient content in soil is complicated, polysemantic and, depending on time, may have alternate results.

Does natural weathering and atmospheric deposition compensate nutrient removals in the harvested logs? Based on simple nutrient budget approaches that compared nutrients removed during harvest against soil reserves plus natural input from mineral weathering and atmospheric deposition, it was generally concluded that stem-only harvest would not deplete site nutrient reserves and would not impact soil quality or site productivity (Fox, 2000, Wells and Jorgensen, 1979). The input of nutrients from atmospheric deposition and soil weathering is hard to quantify. However, those inputs take place equally in stands which undergo and do not undergo harvesting. Soils in undisturbed forests serve as a logical control to evaluate the long-term influence of harvesting on soil fertility. In this work I compared soil properties in second-growth forests with soil properties in undisturbed forests.

**Case study 1. Ukraine, plain conditions**

This study investigates the influence of timber harvesting on fertility of gray forest soils in Golosiiv Forest (Kyiv, Ukraine). For this study I selected 2 forest plots: a natural 200 year-old hardwood stand in climax stage (timber volume 450 m$^3$ha$^{-1}$) and 65 year-old second-growth hardwood stand (timber volume 420 m$^3$ha$^{-1}$), which was created after clear cutting (stem-only harvesting) part of the old forest. It was calculated that after the Assart period, this second-growth forest removed from the soil nearly 300 kg of nitrogen, 260 kg of phosphorus and 170 kg of potassium (Polyakova, 2000). For comparison: winter wheat removes 90 kg of N, 25 kg of F and 60 kg of P from the soil per year. How does harvesting and second-growth forest impact soil fertility? The following methods of soil analyses were utilized: organic matter was estimated according to Turin; cation exchange capacity (CEC) according to Kappen-Hlicovic; hydrolytic acidity according to Kappen; mobile P$_2$O$_5$ according to Kirsanov; mobile K$_2$O according to Peive; total nitrogen according to Kornfeld; and Ca, Mg were extracted using Trilon B.
Soil Ph was estimated using pH-indicator. I determined soil properties at a depth of 10 cm due to impact of harvesting and post-harvesting processes on the upper soil layers. Soil samples (10 from each stand) were taken from A- and B-horizons. Soil properties of 2 stands were compared using t-test.

A-horizon of investigated soil is acidic and requires liming. But, without simultaneous fertilizing, will lead to rapid utilization of nutrients by plants. The retaining capacity and soil organic matter in second-growth forest are lower than in natural old forest throughout the whole soil profile. The essential reduction of base saturation, P and K in second-growth forest was established in the A-horizon (table 1). Theoretically, no more than 0.1% available nutrients will be lost from soils in second-growth forest. Actual reduction in soil fertility is much larger than this. This could be explained by nutrient leaching from the soil profile due to increased water, which is more available in the soils after clear cutting due to reduction of evapotranspiration in forest canopy. After 65 years following harvesting, fertility of forest soil is far from being restored.

**Case study 2, Ukraine, mountain conditions**

On plains, fertilizing could restore soil fertility; whereas in mountains fertilizers are washed down the slope and reduce water quality in streams and rivers. That is why the soils of mountain forests are more sensitive to harvesting. We analyzed the impact of timber harvesting on the fertility of Carpathian mountain forest soils in Ukraine by comparing soil properties in virgin and artificial (or naturally regenerated) forests on Goverla forest district (Ukraine Carpathians) at elevations of 1000 to 1300 m above the sea level. In Ukraine, clear-cut silvicultural system with stem-only harvesting and 80- or 100-years rotation is practiced. The lower slopes of mountains are closer to human settlements, more accessible, and covered by artificial or naturally regenerated stands, whereas the upper slopes are less accessible and inhabited by virgin forests. In this study, I randomly selected soil samples on the Prut river basin with slopes 25-30° in two virgin (plots 1, 2) and 3 artificial (plots 3, 4, 5) stands. Their position and stand characteristic are given in table 2.

The dominant soil types in the Goverla Mountain are mountain podsols and peat-mountain podsol soils. They are underdeveloped (no differentiation on eluviated and illuviated horizons), shallow (20-50 cm), with mid to heavy detritus. Soil profiles consist of peat horizon Ap up to 8 cm depth, rich in roots, and humus horizon AB, rich in detritus minerals.

Soils are very acid (Ph=3.1-3.7), highly-organic (up to 14 % organic matter under the peat layer, which gradually decrease below), enriched by K, but depleted by P. Upper soil layers are more acidic, because of oxidization of spruce litter-fall.

Soil properties in the mountains are determined by both natural factors (climate and vegetation) and forest management. Upper slopes receive more precipitation and are characterized by colder weather than lower slopes. Forest productivity increases from up to down slope. Soil depth also increases on lower slope due to soil deposition. The peat layer increases at upper slopes due to lower temperatures and higher moisture, slowing litter-fall decomposition. The ratio organic matter (C) to Ca is greater on the upper slopes. An increase in moisture and a decrease in temperature at high hypsometric levels lead to carbonate lixiviation from soil profile. Table 3 shows the comparison of soil properties in experimental plots.

The soil on the lower slopes, where forests have undergone long-term harvesting, have lower organic matter and nitrogen content, compared with soil in virgin forests. Mineral soil (AB-horizon, see plot 5, which most accessible) is exhausted in Ca and Mg. In the deepest soil layer (Cb-horizon), the amount of Ca and Mg increases due to contribution of parent material. Soil erosion in the mountains does have some positive contributions. The removal of the upper, exhausted soils enables the cycling of the deepest fresh nutrient soil layers.

**Case study 3, USA, Forest Reserve, Auburn, AL. Impact of land utilization on soil fertility**

Urbanization and development often leads to land use change, transforming forest lands in to non forest lands and visa versa. These transformations lead to changes in soil properties. In this study, I analyzed the influence of prolonged agricultural utilization on fertility of forest soils and productivity of forest stands.

I compared soil fertility in an old-growth uneven-aged forest, and in an adjacent pine stand, which was under cotton cultivation before the 1940’s and under moderate pasture use until the 1970’s (fig. 2). Whole area was forested before the Civil War. The old-growth forest consists of loblolly pine (60%), red oak (22%), water oak (15%), sweetgum (2%) and red maple (1%). The forested old-field consists of loblolly pine (99%) and sweetgum (1%). The following methods were used in this study: pH (KCL) was estimated using Adams-Evans reagent
buffer, C&N were estimated using Perkin-Elmer analyzer (thermal combustion type); the amount of bases were analyzed according to Baker and Suhr. P was estimated colorimetrically on spectronic, using molybdate ascorbic acid (Auburn university soil testing laboratory method); and K was estimated using an atomic spectrophotometer.

Soils belong to Gwinnett series that formed in crystalline materials of the Piedmont. This soil is N-depleted (I failed to find any with Perkin-Elmer analyzer) and P-depleted. Upper layers of forested old-field soil has a lower Ph due to acidification of pine litter compared with the mixed pine-hardwood stand on the control. I expected to find compressed soil beneath the arable horizon on the forested old-field, but I found that bulk density had restored with time. Soil, which had been in agricultural use (forested old-field), has reduced amounts of K and Mg (table 4). However, some properties of these soils are better than in the old-growth forest. Thus, this soil has increased amount of P in the A-horizon and organic matter (C) in the B-horizon. But most impressive is the huge stock of Ca in the B-horizon, which was almost inaccessible for agriculture crops and herbaceous vegetation, but becomes available for forest vegetation now. Ca accumulation in the B-horizon could be explained by prolonged lime lixiviation (farmers use lime in this area for soil fertilization and to stabilize soil Ph). This peculiarity could explain the excellent forest growth on this site, the pine on the old-field being 3.5 times more productive than on the old-growth plot.

Conclusion.

1. In most cases the nutrient status of soils under second- (and more-) growth forests are worse, than under the initial forests. Nutrients or soil properties that are restored with a time depends on soil type and initial soil fertility.
2. Harvesting (clear-cutting) leads to nutrients leaching from the soil profile.
3. Natural soil erosion has a positive aspect for uplands forests, because washing the upper exhausted soil layer enable the cycling of the deepest, fresh parent material.
4. Agricultural utilization changes properties of forest soils. These changes may be beneficial for forest vegetation.

Literature

Polyakova O.G. 2000 c. Impact of forest harvesting on grey forest soil fertility in Golosiiv forest. P. 81-84 in Proc. of Ukrainian State Forestry University, Issue 10.4. Lviv.
Polyakova O.G. 2002. For the question about the reasons of spruce stands damage by Heterobasidion annosum (Fr.) Bref. in Ukrainian Carpathian. P. 159-162 in Proc. of National Agrarian University, Issue 54: Forestry. NAU, Kyiv.
Table 1. Soil properties under first and second-growth forests

<table>
<thead>
<tr>
<th>Soil characteristics</th>
<th>Old-growth forest (control)</th>
<th>Second-growth forest</th>
<th>%control</th>
<th>Significance level (N=5)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>X- 0.05; XX- 0.01 levels of probability; NS- non-significant</td>
</tr>
<tr>
<td>A-horizon, samples from the 10-20 cm deep</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ph kcl</td>
<td>3.9</td>
<td>3.9</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>Soil texture</td>
<td>Sandy-loam</td>
<td>Sandy-loam</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>CEC, meq kg⁻¹</td>
<td>22</td>
<td>19</td>
<td>86</td>
<td>NS</td>
</tr>
<tr>
<td>Retaining capacity, mg kg⁻¹</td>
<td>65</td>
<td>60</td>
<td>91</td>
<td>X</td>
</tr>
<tr>
<td>Base saturation, %</td>
<td>33</td>
<td>25</td>
<td>76</td>
<td>X</td>
</tr>
<tr>
<td>Organic matter, %</td>
<td>1.54</td>
<td>1.30</td>
<td>86</td>
<td>X</td>
</tr>
<tr>
<td>P, mg kg⁻¹</td>
<td>110</td>
<td>87</td>
<td>80</td>
<td>X</td>
</tr>
<tr>
<td>K, mg kg⁻¹</td>
<td>130</td>
<td>54</td>
<td>42</td>
<td>XX</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>B-horizon, samples from the 50-60 cm deep</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ph kcl</td>
<td>4.3</td>
<td>4.2</td>
<td>98</td>
<td>NS</td>
</tr>
<tr>
<td>Soil texture</td>
<td>Sandy-loam</td>
<td>Sandy-loam</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>CEC, meq kg⁻¹</td>
<td>17</td>
<td>16</td>
<td>94</td>
<td>NS</td>
</tr>
<tr>
<td>Base saturation, %</td>
<td>42</td>
<td>42</td>
<td>100</td>
<td>--</td>
</tr>
<tr>
<td>Retaining capacity, meq kg⁻¹</td>
<td>55</td>
<td>38</td>
<td>68</td>
<td>X</td>
</tr>
<tr>
<td>Organic matter, %</td>
<td>0.65</td>
<td>0.53</td>
<td>81</td>
<td>X</td>
</tr>
<tr>
<td>P, mg kg⁻¹</td>
<td>55</td>
<td>57</td>
<td>104</td>
<td>NS</td>
</tr>
<tr>
<td>K, mg kg⁻¹</td>
<td>47</td>
<td>47</td>
<td>100</td>
<td>--</td>
</tr>
</tbody>
</table>

Table 2. Altitude and forest inventory characteristics of experimental stands

<table>
<thead>
<tr>
<th>Plot#</th>
<th>Altitude, m above sea level</th>
<th>Stand composition</th>
<th>Age, years</th>
<th>Average D, cm</th>
<th>Average H, m</th>
<th>Volume, m³ha⁻¹</th>
</tr>
</thead>
<tbody>
<tr>
<td>1, virgin</td>
<td>1300</td>
<td>100% spruce</td>
<td>Uneven aged</td>
<td>48</td>
<td>31</td>
<td>390</td>
</tr>
<tr>
<td>2, virgin</td>
<td>1150</td>
<td>100% spruce</td>
<td>Uneven aged</td>
<td>52</td>
<td>33</td>
<td>450</td>
</tr>
<tr>
<td>3, artificial</td>
<td>1150</td>
<td>100% spruce</td>
<td>115</td>
<td>65</td>
<td>12</td>
<td>220</td>
</tr>
<tr>
<td>4, artificial</td>
<td>1050</td>
<td>100% spruce</td>
<td>65</td>
<td>42</td>
<td>34</td>
<td>950</td>
</tr>
<tr>
<td>5, artificial</td>
<td>1000</td>
<td>80% spruce 10% fir 10% beech</td>
<td>95</td>
<td>42</td>
<td>34</td>
<td>950</td>
</tr>
</tbody>
</table>

Table 3. Soil properties under the virgin (#1,2) and artificial (#3,4,5) forest stands at Goverla mountain (Ukraine).

<table>
<thead>
<tr>
<th>Plot #</th>
<th>Soil horizon</th>
<th>Ph</th>
<th>Organic matter, %</th>
<th>Base saturation, %</th>
<th>CEC</th>
<th>Hydrolytic acidity</th>
<th>Ca</th>
<th>Mg</th>
<th>P</th>
<th>K</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>AB</td>
<td>3.5</td>
<td>9.3</td>
<td>7</td>
<td>24</td>
<td>334</td>
<td>13</td>
<td>11</td>
<td>6</td>
<td>212</td>
<td>263</td>
</tr>
<tr>
<td>2</td>
<td>AB</td>
<td>3.7</td>
<td>13.8</td>
<td>14</td>
<td>58</td>
<td>357</td>
<td>43</td>
<td>15</td>
<td>3</td>
<td>250</td>
<td>269</td>
</tr>
<tr>
<td>3</td>
<td>AB</td>
<td>3.6</td>
<td>8.0</td>
<td>12</td>
<td>63</td>
<td>368</td>
<td>38</td>
<td>25</td>
<td>3</td>
<td>185</td>
<td>198</td>
</tr>
<tr>
<td>4</td>
<td>AB</td>
<td>3.7</td>
<td>8.3</td>
<td>5</td>
<td>20</td>
<td>399</td>
<td>15</td>
<td>5</td>
<td>6</td>
<td>177</td>
<td>218</td>
</tr>
<tr>
<td>5</td>
<td>AB</td>
<td>3.7</td>
<td>5.2</td>
<td>18</td>
<td>36</td>
<td>165</td>
<td>33</td>
<td>3</td>
<td>6</td>
<td>212</td>
<td>179</td>
</tr>
<tr>
<td></td>
<td>AB</td>
<td>3.7</td>
<td>4.0</td>
<td>35</td>
<td>76</td>
<td>141</td>
<td>65</td>
<td>11</td>
<td>6</td>
<td>212</td>
<td>165</td>
</tr>
</tbody>
</table>

Urban Rural Interface Conference Proceedings
Table 4. Soil properties under the virgin forest and naturally forested old-field.

<table>
<thead>
<tr>
<th>Soil properties</th>
<th>Old pine-oak forest (control), biomass 40.6 t/ha, height 33 m</th>
<th>Forested old-field (thick pine stand), biomass 136.3 t/ha, height 29 m</th>
<th>%control</th>
<th>significance level (N=5) (X- 0.05; XX- 0.01 levels of probability; NS- non-significant)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>A-horizon, samples from the 5-10 cm deep</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ph</td>
<td>4.6</td>
<td>4.22</td>
<td>92</td>
<td>X</td>
</tr>
<tr>
<td>Soil texture</td>
<td>sandy-loam</td>
<td>sand</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>C, %</td>
<td>1.29</td>
<td>1.25</td>
<td>97</td>
<td>NS</td>
</tr>
<tr>
<td>Bulk density, g/cm³</td>
<td>1.32</td>
<td>1.38</td>
<td>105</td>
<td>NS</td>
</tr>
<tr>
<td>P, mg/kg</td>
<td>0.2</td>
<td>1.1</td>
<td>550</td>
<td>XX</td>
</tr>
<tr>
<td>K, mg/kg</td>
<td>49.8</td>
<td>26.2</td>
<td>53</td>
<td>NS</td>
</tr>
<tr>
<td>Mg, mg/kg</td>
<td>35</td>
<td>14</td>
<td>40</td>
<td>X</td>
</tr>
<tr>
<td>Ca, mg/kg</td>
<td>45</td>
<td>44</td>
<td>98</td>
<td>NS</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>B-horizon, samples from the 30-40 cm deep</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ph</td>
<td>5.08</td>
<td>5.28</td>
<td>--</td>
<td>NS</td>
</tr>
<tr>
<td>Soil texture</td>
<td>Sand</td>
<td>sandy-loam</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>C, %</td>
<td>0.19</td>
<td>0.29</td>
<td>152</td>
<td>XX</td>
</tr>
<tr>
<td>Bulk density, g/cm³</td>
<td>1.51</td>
<td>1.56</td>
<td>103</td>
<td>NS</td>
</tr>
<tr>
<td>P, mg/kg</td>
<td>0</td>
<td>0</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>K, mg/kg</td>
<td>54.9</td>
<td>17.5</td>
<td>32</td>
<td>XX</td>
</tr>
<tr>
<td>Mg, mg/kg</td>
<td>75</td>
<td>59</td>
<td>79</td>
<td>NS</td>
</tr>
<tr>
<td>Ca, mg/kg</td>
<td>22</td>
<td>276</td>
<td>1254</td>
<td>XX</td>
</tr>
</tbody>
</table>
Fig. 1. Impact of harvesting on long-term soil nutrient capital.

Fig. 2. Land use change 1939, 1956, 1996. Most of area was under cotton cultivation before the 1940’s, pasture before 1970’s and forest vegetation now (Auburn University Forestry Preserve).
Impacts of Urbanization on Nitrate Export in Two Northern Virginia Watersheds

Ryan Albert, Laura Vacherlon, and R Chris Jones, George Mason University

Introduction

Fast paced suburbanization has resulted in significant changes for many formerly rural or forested watersheds. As the nation continues to increase in population, housing and demographic patterns have changed and average suburban population density has decreased. As a result, cities continue to develop outward and urbanize many surrounding counties, consuming land for urban purposes at a faster rate than the rising urbanized population would seem to indicate. Between 1950 and 1990, metropolitan areas have almost tripled in size (Dwyer et al., 2000). As of the year 2000, urbanized areas were found on 3.5 percent of total land area in the lower 48 states and accounted for 75% of the population.

Many of our current urban land use practices are detrimental to watersheds and water quality, a result of increasing forest fragmentation, increased nonpoint source pollution, and air and thermal pollution. Nonpoint source pollution is the major cause of impairment of US waters (Baker, 1992). Furthermore, land use plays a crucial role in determining the intensity of nonpoint source pollution (Allan & Flecker, 1993). Imperviousness increases in urbanized areas, which leads to increased peak runoff and runoff that often contains pollutants from industry, atmospheric deposition, and automobiles. There are documented increases in loadings from heavy metals, phosphorous, nitrogen, sediment, and pathogens from urban and suburban watersheds (Jones & Holmes, 1985).

Nitrogen loading has been shown to be higher from urban watersheds than from forested watersheds. In a study in the Neuse River watershed, Stow et al. (2001) found that total nitrogen loading had increased since the mid-1980s in an urbanizing subwatershed mostly due to increases in nitrate concentration. Wahl et al. (1997) found a 7.5 fold increase in loading per hectare from the urbanized watershed. In the Great Lakes watershed, Glandon et al. (1981) found that total nitrogen export rates from an urban watershed were 3.69 kg/ hectare in the urbanized watershed, versus .585 kg/hectare in marshland and 5.96 kg/hectare in an agricultural watershed. These increases in nitrogen loading could have significant consequences for downstream areas. For instance, nitrogen can cause significant eutrophication of estuaries (Baker, 1992). Mallin et al. (2004) noted that concentrations of nitrate-nitrogen as low as 50 micrograms per liter were enough to stimulate algal growth in three saltwater tidal creeks with largely urban and suburban watersheds. They further found that nitrate stimulated growth in the freshwater portions of the tidal creek, though these areas were also occasionally stimulated more by phosphorous inputs.

Study Area and Methods

Accotink and Pohick watersheds are located in central and southern Fairfax County Virginia, about 10 to 20 miles southwest of Washington, DC. Accotink, the watershed closest to DC, experienced peak urbanization from the 1950s to the 1990s. The Pohick watershed experienced peak urbanization from the 1980s to the present. Both streams flow into Gunston Cove, a small tidal embayment on the Potomac River. Benthos, fish, plankton, and water quality have been monitored in the cove by George Mason University since 1984.

Accotink and Pohick Creeks have had various monitoring efforts. From 1984 to 1992, George Mason University monitored two sites on Pohick, one
upstream of the Noman M. Cole Sewage Treatment facility (Site 1), and one downstream of the sewage treatment facility (Site 2). Accotink has been monitored shortly before discharging into Accotink Bay (Site 13). Parameters monitored include total suspended solids (TSS), volatile suspended solids (VSS), total Kjehldahl nitrogen (TKN), nitrate nitrogen (NN), ammonia nitrogen (NH3N), total phosphorous (TP), soluble reactive phosphorous (SRP), temperature, pH, and dissolved oxygen (DO). Fairfax County Health Department has monitored select sites on the stream since 1986, using low sensitivity tests for total phosphorous, nitrate nitrogen, and temperature. A USGS gage station located in the middle of the Accotink’s drainage that has been collecting data since 1947. Starting in 2005, we began monitoring the three George Mason University sites and the USGS site (site 20) for later use in site analysis and model calibration and validation.

Pohick and Accotink watersheds were manually delineated using Fairfax County contour GIS layers (Fairfax County Government 1999). In order to identify temporal changes in land use, landcover data derived from the LANDSAT remote sensing program from the years 1972, 1992, and 2000 were used. 1992 and 2000 data were part of the National Land Cover Dataset. Data from 1972 was at a 57 meter resolution and had 7 land use classifications, whereas data from 1992 and 2000 had 28.5 meter resolution and had 21 land use classifications. In order to make comparable land use classifications, 1992 and 2000 land use classes were resampled from 28.5 meter resolution to 57 meter resolution and reclassified to 7 land use categories. The 1972 land use data overestimated urban land use. Hence, an additional estimation of land use for each year from 1975 to 2001 was created by using ratios based on increases in total households in the Pohick and Accotink Sewersheds as presented in the Fairfax County Demographic and Standard Reports (Fairfax County, 1975-2004) and the 1992 and 2000 NLCD data. This method, hereafter known as the ‘household method,’ divided the number of households by the total urban area to yield households per kilometer of urban area.

Figure 3 (left). There is a significant difference in urban land use estimations for 1972 remotely sensed values and the ‘household’ method values. The 1972 values clearly overestimate urban land use, while the ‘household’ method data likely underestimate urban land use until the mid 1980s. Though the ‘household’ method estimations have limitations, we believe they are a more accurate representation of than those from the 1972 observed data.
classified in the National Land Cover data. The annual Fairfax County household estimates were then multiplied by the density estimate to extrapolate annual urban land use estimates. These estimates provide an alternative estimate of urban land use in the watershed in the 1970s and 1980s, but have limitations in that they likely underestimate urban land use due to lower known land use density per household in 1975 versus 2000.

In order to analyze water quality data, load duration curves were created for nitrate nitrogen with the 1984-1992 George Mason Data and USGS flow data. Due to the absence of additional flow data, flow patterns found downstream of the USGS station in the Accotink watershed and overall in the Pohick watershed were assumed to resemble those found in the portion of the Accotink watershed monitored by the USGS station. After finding high nitrate concentrations in high flow events, we also plotted nitrate concentrations versus flow for each season to explore seasonal affects. Load Duration curves were also created for nitrate nitrogen using Fairfax County Health Department Data (1986-2002). We also used box plots and performed one-way ANOVA at county sites to look for statistically significant differences in nitrate concentrations between both county sampling sites and years. Streams are being sampled in the 2005 field season to allow for comparison to previous George Mason University Data.

**Results**

Urban land use increased significantly in the two watersheds, although relative growth was much more dramatic in Pohick than in Accotink. The majority of the Accotink watershed was developed by the year 2000 with the exception of a small portion of the central watershed and the lower watershed. The Pohick watershed had less total developed land as of the year 2000, most likely due to its greater distance from Washington DC. However, if current trends continue, the Pohick watershed will fully develop in the next ten to twenty years.

Peak and low flow events have increased in the upper portions of the Accotink watershed as a result of urbanization. For the county data from 1986 to 2003, nitrate concentrations in Pohick Creek were not shown to vary significantly by year (p = .074), but did vary significantly by station (p < .0001). The site with least urbanized and most forested part of the watershed had the lowest nitrate concentrations.

*Figure 4. Nitrate Loadings versus flow percentile in Accotink creek.*
Similar results were found for Accotink: concentrations were shown to vary significantly by station ($p<.0001$) but not by year ($p=.35$). Once again, lowest nitrate export came from the most forested parts of the watershed and higher nitrate concentrations were found in the more urbanized parts of the watershed. We hypothesize that the low level increases in nitrate that would be expected with low level temporal increases in urbanization were masked by more dominant factors, such as previous land use and climate. An alternative hypothesis is less nitrate is reaching water bodies from new urban sources due to increased efficiency of BMPs.

Load Duration Curves of GMU data show that nitrate concentrations and loadings are elevated during precipitation events in Accotink and Site 1 of Pohick, indicating significant non-point source pollution and/or stormwater runoff. For the time period analyzed (1983-1992), Accotink appears to have a greater percentage of its loading coming from nonpoint source pollution than Pohick above the sewage treatment facility. The loading versus flow $R^2$ for site 13 (Accotink) was 0.679 while it was 0.6027 for site 1 (Pohick). Note the exponential regression $R^2$ is highest with Accotink which shows that though the flow data are acceptable to use with Pohick, they fit best with downstream characteristics of Accotink. Also note, the kg per day loading has not been adjusted based on watershed area or expected increases in flow to allow consistency in this analysis. Loading of nitrate below the sewage treatment facility appear to be dominated by the point source discharge during the time period analyzed. After completing our current field monitoring, we will compare these to more current results.

At the Accotink and Pohick stations, we observed an increase in nitrate concentration with increased flow, opposite of what we expected. However, the phenomena was more exaggerated in the more urbanized Accotink Watershed. Much of this is explained by the figure 5: note the high flow events in spring and summer contain high concentrations of nitrate relative to Fall and Winter. This is likely explained by fertilizer runoff from lawns, golf courses, and parks. In fall, note the high concentration of nitrate during low flow events. This is possibly explained by seasonal shedding of leaves, decay of detritus and subsequent leaching. This serves as further evidence that nonpoint source pollution from urban runoff is the major contributor of nitrate to the Accotink and upper portions of Pohick watersheds.

**Future Research**
This project is being pursued in greater detail as part of a doctoral dissertation. We are currently sampling...
at 4 stations in the two watersheds for nitrate, ammonia, total phosphorous, and suspended solids to compare current conditions to historic data. We are also exploring how better to reconcile disparities between 1972 classified land use and estimated land use. Once reasonable values are obtained, we plan on analyzing data using factor analysis to explore relationships between TSS over time, flow, nitrogen loading, existing land use, and construction. We then plan on using potential land use forecasts (using a Cellular Automata land use model and land use planners build out scenarios) in conjunction with modeling components in EPA’s BASINS package to estimate impacts of this land use change on future water quality. Finally, we will look at what loading reductions per unit urban area need to be made to keep conditions at present day levels (2005) and also to improve conditions.

Acknowledgements
The authors would like to thank Matt Cline for his significant contributions to database management and data analysis, Bruce Cleland for his help with load duration curves, Jessie Parker for her assistance with an important GIS script, and Beth Fine for help editing. We would also like to thank the National Science Foundation for funding the student travel grant to make presentation of this research at this conference possible.

References
Fairfax County (1975-2004). Standard Reports (Demographic Reports). Fairfax County Office of Management and Budget, Fairfax County, Virginia.
Economics and Urban Sprawl
A Spatial-Temporal Model of Residential Property at Urban/Rural Interface

Huiyan Lin¹, Molly Espey¹, Kang Shou Lu², Zhe Zhang³

Abstract
The objective of this study is to estimate impact of various spatial characteristic variables on residential housing prices at the rural-urban interface in Greenville County, South Carolina using hedonic analysis. A spatial-temporal model is employed to improve upon these estimates through estimation of spatial-temporal autocorrelation. The spatial-temporal model reduces the problem of error correlations with the nearest neighbors relative to the non-spatial OLS model and offers an efficient way of modeling the residential property value at the urban/rural interface.

Keywords: urban/rural interface, hedonic, spatial-temporal.

Introduction
Urban sprawl has been blamed for aggravated pollution and degraded rural and natural areas. It also places fiscal burdens on cities and towns to extend services and infrastructure. South Carolina is mainly a rural state but currently one of the fastest growing states in the United States, particularly in the I-85 corridor of the upstate between Atlanta, Georgia and Charlotte, North Carolina. The urbanized areas are expanding beyond the city limits as the demand for residential and non-residential development increases. In this process, once rural areas are transformed into urban/rural fringe and small communities are deeply affected by this transition.

Urban areas provide more job opportunities and convenience than rural areas while rural areas supply more recreational opportunities and less traffic congestion, noise and pollution. As a mixture of urban and rural areas, the urban-rural interface provides a complex combination of rural and urban amenities and disamenities. This research estimates the impact of various environmental amenities and disamenities on residential property values at the rural-urban interface in Greenville County, South Carolina. The hedonic pricing method, which uses existing markets to estimate marginal values, was used to identify valuation of environmental attributes of locating in the urban/rural interface.

Recent Literature
The hedonic pricing method is based upon the idea that environmental characteristics, such as air or water quality, will affect the productivity, and thus the rent, of a given parcel of land (Freeman 1993). Accessibility is perhaps the most important differentiating factor across neighborhoods which may result in positive or negative externalities on residents. Incorporating the influence that location has on house prices is important for accurate hedonic house price estimation. While most structural characteristics are relatively easy to measure and are typically included in publicly available data, location characteristics such as distance to transportation networks, distance to nearby nonresidential land uses such as parks, railway and so on are more difficult to measure and rarely included in publicly available data.

In spite of these difficulties, there is increasingly effort to account for the important role of location plays in measuring residential property values because of rapid development of GIS techniques. Do and Grudnitski (1995) indicated that proximity to golf courses increased property sales prices by 7.6%. Bockstael (1996) concentrated on spatial characteristics in the modeling of land use change. Espey and Owusu-Edusei (2001) found that parks proximity generally has a positive and significant impact on property values in Greenville, South Carolina. Irwin (2003) found that surrounding farmland increased land values relative to residential development.

While much information exists concerning values associated with urban areas or rural areas, information related to the value of urban/rural fringe areas is limited. Hite (2003) examined factors that bring about land use change and found that access to sewer lines is an important risk factor for development. Fakhruddin (2004) found both location in the urban/rural fringe and lake proximity have a positive impact on residential property values in Anderson, Pickens and Oconee Counties, South Carolina. This study estimates the accessibility to various amenities and disamenities at the urban/rural interface of Greenville county, South Carolina and

¹Department of Applied Economics and Statistics, Clemson University.
²Strom Thurmond Institute, Clemson University.
³Department of Mathematical Sciences, Clemson University.
spatial econometric procedures are used because of the importance of location in this area and because of the potential statistical problems discussed below.

**Hedonic Method and Spatial Autocorrelation**

Hedonic pricing method endeavors to explain variation in house prices using property structural and location characteristics. Hedonic pricing method assumes that the sales price of a house reflects the house's structural, environmental and neighborhood attributes. Taking the partial derivative with respect to each argument in the hedonic model yields the marginal price of each characteristic. However, the residuals produced by hedonic method are frequently spatially correlated. Hedonic house price parameters are usually estimated using procedures that assume independent observations. If hedonic residuals are autocorrelated, the resulting parameter estimates will be inefficient. In addition, the standard tests used to determine the statistical significance of housing characteristics assume uncorrelated residuals. Spatial autocorrelation in hedonic residuals violate these assumptions, and the standard statistical tests will yield inaccurate conclusions.

One reason house prices may be spatially autocorrelated is that property values in the same neighborhood capitalize shared location amenities and disamenities. Anselin (1988) constructed a comprehensive approach to the incorporation of spatial effect in econometrics to deal with spatial dependence and spatial heterogeneity. Dubin (1992) presents an approach for modeling spatial autocorrelation in hedonic house price residuals by omitting all neighborhood and accessibility measures from the hedonic specification to examine residual spatial autocorrelation using a negative exponential correlogram. Basu and Thibodeau (1998) estimate hedonic and spherical autocorrelation parameters separately using estimated generalized least squares (EGLS). This paper will employ the method discussed by Pace et al (2000) to model the spatial as well as the temporal dependence.

In this study, the empirical hedonic specification is:

\[
\ln(\text{PRICE}_i) = \beta_0 + \beta_1 \cdot \text{BATH} + \beta_2 \cdot \text{BEDR} + \beta_3 \cdot \text{SQFT} + \beta_4 \cdot \text{DHOSPITAL} + \beta_5 \cdot \text{DSEW} + \beta_6 \cdot \text{DSCHOOL} + \beta_7 \cdot \text{DGOLF}
\]

**Data**

To define the urban/rural interface, Marek (2001)
Research by Eddins (2004) has resulted in categorization of Greenville county into rural, urban, and urban-rural interface based on housing density and land use as shown in Figure 1. Data of transaction prices of single-family properties for the period January 1994 to June 2000, including sales price, data of sale, and housing structural characteristics, has been collected from Multiple Listing Service (MLS). Housing sales data within the urban-rural interface area was extracted using GIS and includes over 1600 sales. Location of the houses is shown in Figure 2. Structural characteristics include the number of bedrooms (bed), number of bathrooms (bath), and square footage of the house (sqft). Environmental characteristics include distance to hospital (dhospital), distance to sewer line (dsew), distance to school (dsc), distance to golf course (dgolf), distance to airport (dair), distance to railway (drail), distance to park (dpark), and distance to highway (dhight).

Empirical Models
Semilogarithmic functional form of hedonic model is employed and is estimated using ordinary least square method. The coefficient estimated represents the percentage change in the price of a house for a one-unit change in the explanatory variable. The OLS method is essentially a cross-sectional model (i.e., no lagged variables are included).

Initial inspection of the data with the value of Moran’s I equal to 0.18 indicate the presence of spatial autocorrelation in house prices. An autoregressive error process is employed to model the spatial autocorrelation:

\[ Y = X\beta + u, \quad u = \lambda Wu + \epsilon \]

It can be rewritten as:

\[ (I - \lambda W)Y = (I - \lambda W)X\beta + \epsilon \]

where \( Y \) denotes the \( n \) by 1 vector of observations on the dependent variable, \( X \) denotes the \( n \) by \( k \) matrix of observations on the independent variables of interest, \( \beta \) denotes the \( k \) by 1 vectors of parameters, \( \lambda \) is an unknown autocorrelation parameter, \( \epsilon \) denotes an \( n \) by 1 vector of normal i.i.d. errors, \( u \) denotes the autocorrelated errors, and \( W \) denotes an \( n \) by \( n \) spatial-temporal weight matrix. Then \( W \) is partitioned into a matrix \( S \) which specifies spatial relations among nearby observations and \( T \) which specifies temporal relations among previous observations. The matrix was weighted in time and space by the autoregressive parameters \( \phi = [\phi_s, \phi_t, \phi_{ST}, \phi_{TS}] \).

\[ W = \phi_3 S + \phi_4 T + \phi_{ST} ST + \phi_{TS} TS \]

The spatial-temporal linear model is employed to completely generalize (1) and (2) as:

\[ Y = Z\theta + X\beta + TX\beta_3 + SX\beta_4 + STX\beta_5 + TSX\beta_6 + \phi_7 TTY + \phi_8 SY + \phi_{TS} STY + \phi_{TS} TSY + \epsilon \]

where \( Z \) indicates the \( n \) by \( p_1 \) matrix of observations on independent variables without associated spatial, temporal or spatial-temporal lags, \( \theta \) indicates the associated \( p_1 \) by 1 vector of parameters, \( X \) indicates the \( n \) by \( p_2 \) matrix of observations on the independent variables that have spatial, temporal or spatial-temporal lags, and \( \beta, \beta_3, \beta_4, \beta_5, \beta_6, \beta_7, \beta_8 \) indicate the \( p_2 \) by 1 vectors parameters connected with the spatial, temporal, and spatial-temporal lagged variables.

Based on preliminary fitting, 15 spatial neighbors \( (m=15) \) and 120 temporal neighbors \( (m=120) \) were selected. \( \lambda \) was set equal to 0.65. The general model as expressed by (3) was rewritten equivalently in terms of differences over time plus lags which yielded model 2.

\[ Y - TY = \beta_0 + Z\theta + (X - TX)\beta_1 + S(X - TX) \]

\[ \beta_2 + TX\beta_3 + STX\beta_4 + TSX\beta_5 + \phi_7 TTY + \phi_8 SY + \phi_{TS} STY + \epsilon \]

where spatial lags of the dependent and independent \( Y - TY = \beta_0 + Z\theta + (X - TX)\beta_1 + S(X - TX) \]

\[ \beta_2 + STX\beta_4 + \phi_7 SY + \phi_{TS} TSY + \epsilon \]

variables are used to reduce spatial error dependence. Model 3 was then created by deleting the time related independent variables and \( TY \).
Empirical Results

Table 1 shows the estimated results using non-spatial OLS model, spatial-temporal model and spatial model. Figure 3 identifies the reduction of the problem of error correlations with the nearest neighbors obtained by the spatial-temporal model relative to those produced by the non-spatial OLS model. Fitting the spatial-temporal model leads to a 7% lower SSE than the OLS model. In all of the models, the structural characteristic variables, bathroom and square foot, are significant and of the expected sign. Bedroom is not significant due to its high collinearity with bedroom. In the OLS model, all environmental characteristic variables except the variable Dschool (distance to school) are significant. For example, an increased distance from golf courses, parks, and highways all have a positive impact on housing prices while increased distance from hospitals, airports, powerlines, and railways all have a negative influence on housing prices. Some of these results are counter-intuitive. For example, housing prices would be expected to decrease, not increase, with distance from golf course and parks in general. Conversely, prices would be expected to increase rather than decrease with distance from powerlines and railway lines. After correcting for spatial autocorrelation, however, the t-statistics decrease such that many of these variables are no longer significant and the sign for powerlines and parks both change.

Conclusion

This study examines spatial autocorrelation in house prices using data for 1693 transactions at urban/rural interface in Greenville County, South Carolina. Hedonic pricing method and spatial econometric procedures are employed to model residential property values at the urban/rural interface. The value of houses has capitalized both amenity and disamenity. Statistical measures of fit generally indicated improved results for the spatial-temporal model over the model estimated using OLS procedures. Comparison of measures of fit which include likelihood and SSE indicated that the spatial-temporal model better fit the data than the OLS model.

Integration of spatial econometric and GIS procedures is an effective way of developing improved urban/rural residential land use model. Further research should continue to explore alternative functional forms, and to develop better measures of the effects of location and economic development in the urban/rural interface area.
Figure 3: Empirical error correlation vs. nearest neighbors.

References
A Spatially-Explicit Approach to Economic Impact Assessment Modeling: Applications In The Rural/Urban Interface

Richard Thurau, School of Public and Environmental Affairs (SPEA), Indiana University, Andrew D. Carver, Department of Forestry, Southern Illinois University, John G. Lee, Department of Agricultural Economics, Purdue University

Abstract

Though forestland provides many economic and environmental benefits to communities, local land use planners and zoning boards rarely consider forest management as the best use of rural land. St. Clair County, located in the southwestern corner of Illinois is one of the fastest urbanizing areas in the state. Containing portions of the Kaskaskia River basin, St. Clair County is home to Illinois’ largest contiguously forested tract of land. The general objective of this study was to integrate GIS and IMPLAN to create a spatially explicit economic assessment model to aid in describing the income-maximizing land use allocation of rural land uses within the urban-rural interface of St. Clair County, Illinois. Results indicate that the current rural land use allocations (favoring row-crop production) do not represent the income maximizing allocation. Reallocation to the income-maximizing land allocation scenario identified by the spatially explicit model increases the regional profitability and employment in the agriculture and forest management industries. Our model identifies net revenue increases of nearly $44 million to related industry output, $33 million to aggregate economic effects, and $15 million to industry value added, all within St. Clair County. The aim of the authors is to demonstrate that increasing the profitability of rural land uses through efficient land use allocation has the potential of reducing the current trend of sprawl and urbanization.

Introduction

St. Clair County lies at the threshold of the rural/urban interface in Illinois. Historically covered by deciduous forest, the county’s adjacency to St. Louis, Missouri has led to sprawling residential, commercial, and industrial development. Even though the St. Clair County Comprehensive Land Use Plan seeks to maintain regional ecological and social integrity in the face of a growing economy, development has continued largely unabated. One of the primary problems caused by this urban sprawl is habitat fragmentation due to increasing pressure to relocate agricultural production into ecologically sensitive areas, i.e., bottomland hardwood forests and riparian areas.

In 1992, the Kaskaskia River watershed became a battleground in Illinois, between state and federal organizations aiming to preserve regional ecological integrity through large public agency holdings, and private land owners determined not to relinquish control of their ownership rights. The U.S. Fish and Wildlife Service proposal to create a 4,144 hectare National Wildlife Refuge inspired local land owners, in cooperation with the Southwestern Illinois Resource Conservation and Development, Inc. (SWIRC&D), to create the Kaskaskia Resources Private Lands Initiative (KRPLI) Committee (Evans et al 1995). The KRPLI Committee represents a wide array of public and private interests within the Kaskaskia River watershed and was created to ensure that the voice of the private landowner was heard. While the creation of a National Wildlife Refuge was thwarted, the public meeting process revealed that the development and enhancement of both economic and ecological resources within the region was in the interest of public and private stakeholders.

Land use patterns are a product of a cycle of continuous development between regional policies, and current economic, ecological, and social conditions (see Figure 1). Land use policies are enacted to promote development decisions that reflect regional policy goals. These decisions ultimately shape the landscape, impacting both the environment and economy of a region. An understanding of land owner decisions is vital for establishing a land use policy that enhances both individual economic opportunities as well as long term social responsibility.

Economic analysis tools allow the measurement of impacts that occur as a result of changes in an economy. Also, natural resource managers have enlisted prediction-based computer models of landscape change to understand regional environmental impacts. While several researchers have sought to combine economic impact and land use change models (e.g., Irwin and Geoghegan 2001;
Chomitz and Gray 1996; Ahn et al 2002; and Fischer and Sun 2001), these efforts have fallen short in their ability to simultaneously predict spatially explicit economic and environmental impacts. The purpose of this study is to employ a spatially explicit economic impact assessment tool, to aid in understanding the relationship between economic pressure and agricultural conversion of bottomland hardwoods. Specific objectives of this study are: 1) to apply the tool to compare the current allocation of land uses (corn, soybeans, hay, and forest) in St. Clair County, Illinois with an income-maximizing land allocation scenario; and 2) examine the regional economic impacts of shifting from the income-maximizing scenario. The aim of the authors is to demonstrate that increasing the profitability of rural land uses through efficient land use allocation has the potential of reducing the current trend of sprawl and urbanization.

Limitations of Conventional Input-Output Analysis and Land Use Modeling

Through input-output (I-O) analysis, industry-specific information is collected, categorized, and analyzed to report industry-specific or aggregate impacts resulting from a single transaction within the economy (Miernyk 1965; Shaffer 1989). Impact Analysis for Planning (IMPLAN) (Siverts 1985) is an I-O analysis computer model employed in this study to report the economic changes in the St. Clair County economy resulting from changes in land use. Input-Output (I-O) analysis can be a powerful tool in providing answers to key development questions; however, the major shortfalls of I-O analysis is in the aspatial nature of the model’s reporting. County-wide results from I-O analysis indicating a shortfall in corn production, for example, treat the county as a homogeneous plain. Regional variation in soil productivity and population will greatly influence the economic impact of site selection for the planting of additional corn.

Land use models created with the aid of GIS, are designed to predict the rate and direction of land use change resulting from economic aspects of human behavior (Irwin and Geoghegan 2001; Baker 1989). Irwin and Geoghegan (2001) categorize models of land use change as being either non-spatially explicit or spatially explicit. Non-spatially explicit economic models of land use change attempt to estimate where land use change is likely to occur based on the assumption of a homogeneous landscape (von Thünen 1966). The available “resolution” of these land use change models is considered ineffective for identifying variation at the field or pixel level (Irwin and Geoghegan 2001). Spatially explicit economic models of land use change are characterized by the application of economic value as determined by a number of attributes that are unique to each pixel in the study area (Irwin and Geoghegan 2001).

Methodology

Study Area

St. Clair County is located in southwestern Illinois along the Mississippi river. The U.S. Census Bureau (2003) estimates St. Clair County’s 2002 population at 257,904. St. Clair County possesses a variety of land uses from urban to wetland. Productive soils and close proximity to major shipping ports in St. Louis, MO and the Mississippi river have also allowed St. Clair County to become a chief contributor to the Illinois agricultural sector. St. Clair County contains around one hundred thousand hectares (57 percent of the county) allocated to the production of various agricultural goods, as well as over twenty-two thousand hectares (13 percent) allocated to forest and forested wetlands (USDA 2002). Soybeans and corn have been the main agricultural products with thirty-seven thousand hectares of soybeans and twenty-nine thousand hectares of corn being produced in 2001 (USDA 2002).

The Kaskaskia River flows southward through more than forty-five kilometers of St. Clair County’s southeastern corner (Figure 2). 133,546 hectares (76 percent) of St. Clair County is located within the Kaskaskia Watershed. St. Clair County’s current land use within the watershed includes nearly 65,000 hectares of row crops, 400 hectares of hay and pasture land, and 16,000 hectares of forest.

Spatial Database Development

Spatial data were collected in this study to examine the current land use in St. Clair County and to evaluate the economic returns that would be expected from the current land uses (i.e., corn, soybeans, hay, and forest production). Geospatial analysis was conducted primarily in raster format utilizing ArcGIS 8.x (ESRI 2002).

The current allocation for each land use was derived from the USDA's cropland data layer (USDA 2002). Production levels for the three traditional agricultural crops (corn, soybeans, and hay) were taken directly from the soil survey geographic database (SSURGO) produced by the USDA (1999). This digital soil database identifies production levels for many agricultural crops at a mapping scale of 1:24,000 for St. Clair County. According to the SSURGO data, the range of corn production in St. Clair County is between 57 and 163 bushels per acre (bpa) with the
mean production at 102.9 bpa. Soybean production ranges between 20 and 54 bpa with a mean of 34.8 bpa. Hay production ranges between two and six tons per acre with a mean of 3.3 tons per acre. Forest production ranges between 2.9 thousand board feet (Mbf) and 9.8 Mbf with a mean of 3.8 Mbf per acre per year.

Forest productivity in St. Clair County was determined by soil class using soil surveys provided by the USDA (1978) Natural Resource Conservation Service for St. Clair and neighboring Illinois counties (Washington, Clinton, Randolph, Monroe and Madison). The surveys list site index (SI) for soil types containing forest vegetation at the time of the survey. Additionally, site index data presented by Woolery, Olson, Dawson, and Bollero (2002) were also used where soil types in the study area matched soil types used in the Woolery study.

Net income or return to farm layers, were calculated in a GIS by subtracting from the gross income layer, all expenses incurred with production of the respective land uses. To measure incurred expenses, an enterprise budget was constructed for each land use. Corn, soybean, and hay budgets were created by the University of Illinois extension office (UIUC Farmlab 1999) for Illinois agriculture, and were then modified by researchers at Southern Illinois University Carbondale to more accurately represent expenses for the southern Illinois region (see Peterson 2003). Forest budgets were constructed based on information obtained from the Illinois Department of Natural Resources (IDNR) district forester for St. Clair County. The IDNR provided estimates of inputs necessary to establish and manage a one-acre forest stand for a fifty-year rotation (Brown 2003).

**Economic Analysis of St. Clair County**

Impact Analysis for Planning (IMPLAN) is used to conduct an economic analysis and comparison of St. Clair County under the current and income-maximizing land use allocation. Total industry output, total output, total value added, and total employment were measured to compare economic impacts. Total industry output values were derived based on land use allocation, land use unit production, and price per unit. This value was then input in IMPLAN, which calculates output, value added, and employment for each land use. A national IMPLAN model was used in this analysis to simulate a closed economic system within St. Clair County. Regional Purchase Coefficients (RPC) for each sector in IMPLAN identify the percentage of purchases that are made within the region of analysis. RPCs within the primary sectors of this analysis for the national model are 0.94 or greater.

**Results**

**GIS-Based Analysis**

Graphical results showing a comparison between the current land use allocation and the income-maximizing allocation scenario are provided in Figure 3. GIS analysis of land use in St. Clair County reveals a large difference between current and income-maximizing land use allocations. Currently, there are about 8.2 million bushels of corn and 3.4 million bushels of soybeans produced on a combined 66,368 hectares, or 38 percent of the 172,800 hectare county. 199,000 thousand tons of hay are currently produced on 374 hectares. Annually, over 164 million board feet of fiber are produced on 17,160 hectares within St. Clair County.

The income-maximizing scenario prescribes a reduction in row crop (corn and soybeans) production, and an increase in both hay and forest production in St. Clair County. Corn production would be severely reduced to just below 63 thousand bushels on approximately one and a half thousand hectares. Reductions in soybean production are not as severe, however only fourteen thousand hectares would be allocated for the production of nearly 1.36 million bushels. A change toward the income-maximizing land use would stimulate the greatest increase in hay production of 460,000 tons on over 40,000 hectares. Forest production would also increase to 260 million board feet fiber per year on 25,000 hectares.

**Economic Impact Analysis of Current versus Income-Maximizing Land Use in St. Clair County**

Economic impact results indicate that in the four areas examined in this analysis (industry output, total economy output, total value added, and total employment) great opportunities exist for increased income generation by adopting the income-maximizing land use scenario. Industry output for corn and soybeans is reduced by approximately $27 million under the income-maximizing allocation, however a $44 million increase in hay production, and a $26 million increase in forest production yield a $43.7 million net expansion within the four land uses examined in this study.

IMPLAN results indicate that total economy output, or value of products created from the land use industry outputs, will expand by over $32 million.
under the income-maximizing land use allocation. Total value added throughout the economy would also likely expand by more that $14 million. Finally, under a shift to the income-maximizing land use allocation, St. Clair County would benefit in the creation of 724 jobs.

Discussion and Conclusions

There are many factors that impact land use decisions, economic returns being just one (Leopold 1949). Land economics literature has traditionally considered income-maximization as having the greatest influence on land use allocation and therefore land use policy (e.g., Christaller 1966; von Thünen 1966). Yet, results of this study, in the form of extensive disagreement between the current land use and the income-maximizing land use scenario, remind us that it is a mistake to assume that land use income maximization and land owner income maximization are the same. Survival of the contemporary farmer/rural landowner requires the comprehension of the importance of income diversification and opportunity cost. While a land parcel represents one spatial unit of potential income generation, different uses of that parcel require varying units of temporal intensity (i.e., time). Growing hay in a field in St. Clair County may generate the greatest revenue from that parcel of land, but if cutting and bailing several times a season conflicts with a land owner’s 9-to-5 job, the land use decision is complicated.

At the center of this analysis is the interconnectedness between land use decisions and the economic and environmental health within the study area. It is revealed through spatially explicit economic analysis that St. Clair County may have the opportunity to exemplify harmony in land use planning for economic and environmental health, through the economic advantage of reducing row crop production, and the economic and environmental advantages of conserving forests in the Kaskaskia River basin. Regional economic development will benefit more from policies encouraging industries reliant on hay (i.e., dairy) and forest (i.e., recreation) as opposed to those industries that demand inputs mostly from row-crop commodities (e.g., ethanol). Importantly, increasing the profitability of rural land uses through improved spatial land allocation can act to decrease the relative incentive to “sell out” to developers, resulting in the irreversible conversion of rural land to urbanization.

Literature Cited


Peterson, W. C. 2003. Personal communication. Southern Illinois University, Agricultural Business Economics Department. wpetersn@siu.edu


**Figure 1.** The continuous development loop of land use patterns and policy.
Figure 2. St. Clair County study area. Surrounding counties contain portions of the Kaskaskia River watershed.
Figure 3. Model results comparing the current versus the income maximizing land use in St. Clair County suggest that a shift from row crop to hay and forest production could provide significant economic benefits.
Spatial Dependency and Heterogeneity of Housing Density in Tennessee’s Six Metropolitan Statistical Areas

Seong-Hoon Cho, Christopher D. Clark, William M. Park and Alexander Young
Department of Agricultural Economics, University of Tennessee

Abstract
A community choice out of Tennessee’s Six Metropolitan Statistical Areas and housing density are modeled in a two-stage multinomial logit selection model. The study found that there are distinctive heterogeneities both in the characteristics of the MSAs and in the relationship between the housing density and the ratio of residents born in South within Johnson City MSA. The analysis of spatial dependency shows while Memphis' neighborhoods are on average relatively densely populated, there is a relatively weak spatial relationship between the more densely populated neighborhoods. While Johnson City, which has the lowest housing density and lowest ratio of block groups with high housing density, has the highest Moran’s Index score, indicating that while Johnson City’s neighborhoods are, on average not that densely populated, the neighborhoods with the higher housing densities do tend to be located near each other.

Key Words: community, housing density, spatial dependency, spatial heterogeneity

Introduction
Urban Americans are increasingly living in areas with lower housing densities. One-third more land per person was consumed by urban use in the 1990s than in the 1970s (Daniels and Bowers, 1997). As housing densities decline, the pace of development increases. From 1992 and 1997, an average of 2.2 million acres of land was developed in the US each year, which is more than 1.5 times the average for the previous ten-year period (1.4 million acres a year). What is truly remarkable is that the growth of urbanized land is occurring even in metropolitan areas that are losing population. For example, the Pittsburgh, Pennsylvania metropolis lost 8% of its population between 1982 and 1997; yet its urbanized land area grew by close to 43% during this period (Fulton, et al., 2001). A variety of reasons can be cited for this trend. For example, the rise in new households plays an important role, whether it is due to population growth, the aging of the population, increased divorce rates or higher incomes (Katz, 2002).

This trend of lower housing density, while offering affordable private spaces set back from streets and commercial areas, has taken its toll on open space and environmental amenities. A recent report by the American Farmland Trust revealed that every year in the United States, one million acres of productive farmland and open space are developed for other uses (American Farmland Trust, 2002). Wetland have also fallen victims to sprawl, with approximately 110,000 acres of these natural filters disappearing each year due to sprawl (Sierra Club, 1999). As the pace of decentralization increases, so do the concerns over the social and financial burdens associated with an expanding infrastructure. Studies suggest that gasoline consumption could be 20 to 30% lower in cities like Houston and Phoenix if their urban structure more closely resembled that of Boston or Washington (Newman and Kenworthy, 1989, 1999). Many local governments have taken to imposing impact fees to address the higher infrastructure costs, such as water and sewer hookups, associated with outlying developments (Snyder and Bird, 1998).

One response to these processes has been the promotion of “smart growth” policies emphasizing the preservation of open space through higher housing densities and more clustered housing (e.g., USEPA, 2004). An important component of smart growth policies is the promotion of higher density housing. These policies rely on not only modifying land use patterns on newly-developed land, but also by increasing housing supply in existing neighborhoods and on land served by existing infrastructure (Smart Growth Online).

However, to implement these policies it is desirable, if not necessary, to have a firm understanding of the two aspects of spatial patterns of development: the spatial dependency² and heterogeneity³. The

² Also known as spatial autocorrelation. Dependency is inherent in all geographic data as is expressed by Tobler’s (1979) First Law of Geography, which states that, “everything is related to everything else, but near things are more related than distant things”.
³ A homogeneous neighborhood is defined as a spatially contiguous region of the city with sufficient population to be considered a neighborhood in which all resident households and housing units have the same characteristics (similar?). A
development of tests for spatial dependence in linear regression models, as well as the development of efficient and consistent estimators for these types of models, has been an important part of the spatial econometric literature for the last few decades (e.g., McMillen, 2003; Tse, 2002; Leung et al., 2000; LeSage, 1997; McMillen, 1992; Anselin, 1988; Cliff and Ord, 1973; Dubin, 1992; Can, 1990 and 1992). Various localized modeling techniques were proposed to capture spatial heterogeneity (Casetti, 1972; Getis and Ord, 1992; Fotheringham and Brunsdon, 1999). Some models incorporate both spatial dependency and spatial heterogeneity (Anselin, 1998; Can, 1992). While such models of spatial dependency and heterogeneity have focused on modeling stochastic processes of interrelation of point locations, the socio-demographic factors of urban housing have not been similarly modeled within a spatially-explicit context, to our knowledge.

In this study we posit that housing location decisions are not conducted in isolation but start with a selection of community, based, in part, on the households’ demographic characteristics. The choice of Metropolitan Statistical Area (“MSA”) is modeled to examine the effects of demographic characteristics. The spatial dependencies of housing density given choices of MSAs are analyzed on the basis of the relationship between pairs of centroid points of census-block groups. The spatial dependency of each MSA represents the overall degree of clustering. Once a community of a MSA is selected, the housing density of a census-block group enters into the selection of a specific neighborhood. The housing density explaining local relationship of demographic characteristics is modeled for each MSA. We assess influences of the demographic characteristics on spatial dependency of housing density. The spatial heterogeneity of demographic characteristics on the local housing density is tested for each MSA.

heterogeneous neighborhood is one in which such characteristics vary in one or more dimensions.

The general concept of a metropolitan Statistical area (MSA) is one of a large population nucleus, together with adjacent communities that have a high degree of economic and social integration within that nucleus. Each MSA must contain either a place with a minimum population of 50,000 or a Census Bureau-defined urbanized area and a total MSA population of at least 100,000. A MSA comprises one or more counties. A MSA may also include one or more outlying counties that have close economic and social relationships with the central county. An outlying county must have a specified level of commuting to the central counties and also must meet certain standards regarding metropolitan character, such as population density, urban population, and population growth.

### Empirical Model

While the housing density for a census-block group is a continuous variable, the choice of a MSA is a discrete choice. Thus, the housing density for a census-block group is estimated within the constraint of the household’s choice of a MSA using a two-stage multinomial logit selection model (Greene, 1995, pp 656-661).

In the first-stage, the probability of a household’s choice of a MSA is estimated as a function of the household’s characteristics. For this study, the household’s choice is assumed to be limited to Tennessee’s six MSAs – Chattanooga, Jackson, Johnson City, Knoxville, Memphis, and Nashville. The household’s choice among the six communities is modeled in a multinomial logit framework. In the second stage, we estimate the housing density per acre for a census-block group, conditional upon the choice of a MSA, using a sample selection model to correct for the selection bias that would occur from the estimation due to systematic differences in the characteristics of those selected MSAs.

Because individual data on the more than 1 million households in these six MSAs is not available, the model is framed so as to utilize the attributes of the 2,783 census-block groups that are contained within the six MSAs. The census-block group is the smallest level of geography in which detailed household characteristics are publicly available. Following Lee (1983), the model for the likelihood of a household choosing to locate in one of the six MSAs is estimated using the following form of multinomial logit model,

\[
\text{Pr}(J = j) = \frac{\exp(Z_j \cdot \gamma_j)}{\sum_{i=1}^{5} \exp(Z_i \cdot \gamma_i)},
\]

where \( J = 0, 1, 2, 3, 4, \) and \( 5 \) represent MSAs of Jackson, Johnson City, Memphis, Chattanooga, Knoxville and Nashville, respectively. We assume that the characteristics of households at a census-block group, \( Z_j \), are represented by the median, mean, and ratio that measure central tendency.

To avoid indeterminacy, the parameter vector of Jackson MSA, \( \gamma_0 \), is normalized to zero. This normalization renders the estimated parameters \( \gamma_j \) un-interpretable. We can however draw inferences from the computed “marginal effects” of the elements of \( Z \) relative to sample averages. The marginal
Effects in the model are partial derivatives of the probabilities with respect to the determinants:

\[ m_j = \frac{\partial P_j}{\partial \gamma_j} = P_j (\gamma_j - \sum_{j=1}^k P_j \gamma_j) P_j (\gamma_j - \bar{\gamma}) \]

The statistical significances of these effects are estimated by the asymptotic covariance matrix of \( m_j \) (Greene 1997, p.916-17). While the parameter vector \( \gamma_0 \) is normalized to zero, the vector of marginal effects \( \delta_j \) is constrained to sum to zero. This normalization means that any one marginal effect \( \delta_j \) can be interpreted as the net effect of an increase in the value of the corresponding determinant \( Z \) on the decision to live in a particular MSA. The estimated marginal effects and the statistical significance of these effects are shown in Table 3 (see Table 1 for definitions of all the variables used in the analysis and Table 2 for the mean values and standard deviations of these variables, both in aggregate for all six MSAs and individually for each MSA).

The multinomial logit model of equation (1) is estimated by maximum likelihood, retaining the coefficients, estimated asymptotic covariance matrix, and the full set of predicted probabilities to compute lambda, \( \lambda_j \) to be used for the second stage estimation of the sample selection model,

\[ \hat{\lambda}_j \equiv \phi(\Phi^{-1}(\hat{P}_j))/\hat{P}_j. \]

In the second stage, the housing density per acre for a census-block group is estimated using the sample selection model (Lee, 1983) which is expressed as

\[ y_{ij} = \beta' Z - \theta_j \lambda_j + \eta_j, \]

where \( y_{ij} \) is housing density of a block group \( i \) conditional upon the choice of community \( j \) in the first stage, \( Z \) is a vector of household characteristics influencing housing density and \( \eta_j \) is a residual capturing errors. We call the equation (4) as a global model opposed to local model we are deriving at the following.

When we estimate the equation (4), we forego the implicit assumption that relationships between variables measured at different locations are constant over the space of the MSA. If there are essential structural variations of housing density within the MSAs, then constant variables measured at different locations within a MSA would represent a misspecification of the data. A geographically weighted regression (GWR) model proposed in Fotheringham et al. (2002) is adopted to identify spatial variations in relationships at the neighborhood level under the sample selection model. We estimate the following local housing density equations for the six MSAs of Tennessee (note that the notation \( j \) denoting a MSA is omitted for the simplicity of presentation of the model):

\[ y_i = \sum_{k} [\beta_k (u_{ik}, v_i) Z_{ik}] - \beta_k (u_{i}, v_i) \lambda_i + \eta_i \]

where \( (u_{ik}, v_i) \) denotes the coordinates of the \( i \)th point in space and \( \beta_k (u_{i}, v_i) \) is a realization of the continuous function \( \beta_k (u, v) \) at point \( i \). That is, we allow there to be a continuous surface of parameter values, and measurements of this surface are taken at certain points to denote the spatial variability of the surface (Fotheringham et al., 2002).

In this local housing density model, an observation is weighted in accordance with its proximity to point \( i \) in order to account for the fact that an observation near point \( i \) has more of an influence in the estimation of the \( \beta_k (u_{i}, v_i) \)s than do observations located farther from \( i \). That is,

\[ \hat{\beta}(u_{i}, v_i) = (Z_k W(u_{i}, v_i)Z_k)^{-1}Z_k W(u_{i}, v_i)y \]

where \( W(u_{i}, v_i) \) is an \( n \times n \) matrix whose diagonal elements \( w_{ii} \) denotes the geographical weighting of each of the \( n \) observed data for regression point \( i \) and a specific point \( l \) in space at which data are observed, and the off-diagonal elements are zero. \( Z_k \) is a vector of explanatory variables. The diagonal elements of the weight matrix, \( w_{ii} \) are equal to:

\[ w_{ii} = \exp[-1/2(d_{il}/b)^2] \]

where \( d_{il} \) is the Euclidean distance between point \( i \) and \( l \) and \( b \) is a bandwidth. The bandwidth can be determined using the cross-validation procedure. The parameter takes the form:

\[ \text{Distance between objects or values that is computed as a straight line.} \]
\[ \Delta(b) = \sum_{i=1}^{n} (y_i - \hat{y}_i(b))^2 \]

where \( \hat{y}_i(b) \) is the fitted value \( y_i \) with the observation at location \( i \) omitted from the fitting process. Choose \( b_0 \) as a desirable value of the bandwidth such that \( \Delta(b_0) = \min \Delta(b) \). If \( i \) and \( l \) coincide, \( w_{il} = 1 \) and the weighting of other data will decrease according to a Gaussian curve as the distance between \( i \) and \( l \) increases.

To examine the extent to which housing dependency differs at the levels of block group, the ratio of block groups with at least 2 houses or more is counted. To have summary measure of magnitude of variation in housing dependency by a MSA, we borrow Gini index typically measuring income inequality. The Gini index is the mean of the difference between every possible pair of block groups, divided by the mean \( \mu \),

\[ G = \frac{\sum_{i=1}^{n} \sum_{j=1}^{n} |y_i - y_j|}{2n^2 \mu} \]

where \( y_i \) and \( y_j \) are the aggregate housing density per acre for census-block groups \( i \) and \( l \) and \( n \) is number of observations (Dixon et al., 1987; Damgaard and Weiner, 2000).

The Moran’s Index is estimated to measure the spatial dependency of overall area of the MSA. The Moran’s index is applied to zones and points with continuous variables associated with these zones or points. The formula to calculate Moran’s index (M) is as follows:

\[ M = \frac{N \sum_{i=1}^{n} \sum_{j=1}^{n} W_{ij} (y_i - \overline{y})(y_j - \overline{y})}{(\sum_{i=1}^{n} \sum_{j=1}^{n} W_{ij} \sum_{i=1}^{n} (y_i - \overline{y})^2} \]

where \( N \) is the number of cases, \( y_i \) is the aggregate housing density per acre for a census-block group \( i \), \( \overline{y} \) is the mean of the housing density, and \( W_{ij} \) is a distance-based weight, which is the inverse of the distance between census-block groups \( i \) and \( l \). The \( I \)-value is similar to a correlation coefficient, varying between -1 and 1. When autocorrelation is high, the coefficient is correspondingly high and an \( I \)-value greater than zero indicates positive autocorrelation, while an \( I \)-value below zero indicates negative autocorrelation.

**Study Area and Data**

We used 2000 Census Long Form Data at census-block group level of Tennessee’s six MSAs in spatial form. Tennessee’s six MSAs – Chattanooga, Jackson, Johnson City, Knoxville, Memphis, and Nashville – encompass areas, not only in Tennessee, but also in Virginia, Georgia, Mississippi, and Arkansas, as Johnson City, Memphis, and Chattanooga are located along the state boundary (See Figure 1 for a map depicting the six MSAs). The principal data used in this study is 1990 and 2000 census block-group data in a shape file format.

Tennessee’s six MSAs comprise an interesting subject for a number of reasons. First, Tennessee has the fourth highest rate of land development among U.S. states, according to the 1997 National Resources Inventory (NRI). Between 1982 and 1997, Tennessee’s developed area increased from 1.50 million acres to 2.37 million acres, for a gain of 58%, which greatly exceeded the national average of 34% over this time period. Of the 870,000 acres of land developed during this time period, about 340,000 acres or 39% was converted from prime farmland including cropland and pastureland. Further, the pace seems to be increasing. From 1982 to 1992, an average of 46,000 acres of farmland, forests and other open space were developed each year, while this rate increased to 80,000 acres per year during the period from 1992 to 1997 (NRCS, 2000). Similarly, the State’s population growth rate increased from 29,000 people per year during the 1980s to 81,000 people per year during the 1990s (U.S. Census Bureau, 2000). Further, this growth is disproportionately occurring in Tennessee’s metropolitan areas; the majority of the State’s population growth between 1990 and 2000 was concentrated in the 21 Tennessee counties comprising the Knoxville, Nashville and Memphis MSAs, while the remainder was spread among Tennessee’s 74 other counties. The area also provides a relatively uncomplicated study site for testing our methodology because institutional factors such as land use regulations have only a minor influence on the area’s housing choices.

In addition, the six MSAs span Tennessee’s three Grand Divisions - East, Middle and West Tennessee (See Figure 1 for a map depicting the three Grand Divisions). These divisions not only have political implications (e.g., no more than two of the State’s five Supreme Court justices can come from any one Grand Division), they also reflect geographic and socioeconomic differences (Ballard, 1996). East
Tennessee is mountainous and historically isolated and its three MSAs - Knoxville, Chattanooga, and Johnson City – are all located along the western edge of the Great Smoky Mountains. The highlands of Middle Tennessee present a rolling to steeply sloping landscape that has come to be largely dominated by Tennessee’s most populous city and the area’s only MSA - Nashville. Finally, Memphis and Jackson are located in the lowlands of West Tennessee, which are largely flat and rural.

**Summary and Conclusions**

A community choice of a MSA and housing density are modeled in a two-stage multinomial logit selection model. The housing density within the choice of a MSA is modeled to examine the effects of demographic characteristics. The housing density is modeled using a global regression which is typical OLS and a local regression which captures spatial heterogeneity of the relationships between variables measured at different locations over the space of a MSA.

The multinomial logit model correctly predicts 57% of the location of census-block group (see Table 3). The lambda values representing self-selection bias in the global model detects the fact that community choice would not have the same effects on housing density which implies a distinctive heterogeneity in the characteristics of the MSAs. The housing density model presents that neighborhoods with a higher proportion of residents born in northeast and a foreign country, female households, bachelor degree, and professional degree are more likely to be more densely populated. Conversely, neighborhoods with a higher income, at least 65 years old, and a tenure of five or more years tend to be less densely populated.

The mapping of the marginal effects using the estimates from the local regression show that the marginal effect of the ratio of born in South on housing density is positive in one area and negative in another area within Johnson City MSA (see Figure 2) even though the global regression estimates positive and significant marginal effect of ratio of the variable in a MSA (see Tables 4 and 5). This implies distinctive spatial heterogeneity in the relationship between the housing density and the ratio of born in South within Johnson City MSA.

The analysis of spatial dependency shows while Memphis’ neighborhoods are on average relatively densely populated, there is a relatively weak spatial relationship between the more densely populated neighborhoods. While Johnson City, which has the lowest housing density and lowest ratio of block groups with high housing density, has the highest Moran’s Index score, indicating that while Johnson City’s neighborhoods are, on average not that densely populated, the neighborhoods with the higher housing densities do tend to be located near each other (see Table 6).

Our study benefits planners of the six MSAs in the State of Tennessee who try to encourage “smart growth” in which promotes higher housing density. Because the two important features of housing density, spatial dependency and heterogeneity are analyzed, the information from the study can be used for planning a “smart growth” policy such as Urban Growth Boundary whose one of the objectives is to increase housing density. More specifically, the information about spatial dependency at the level of MSAs will find a community of MSAs with more needs of “smart growth” policy. The information about spatial dependency at the level of block groups will help to indicate site specific area for the policy. The spatial heterogeneity in the relationship between the housing density and household characteristics gives hint how different characteristics of households would react different to the policy that encourage higher housing density at site specific level.

**References**

Ballard, D., 1996. “Three for One: East, Middle, and West Tennessee; why they’re different and likely to stay that way.” Tennessee Alumnus Winter, 9-10.


NRCS., 2000. Summary Report 1997 National Resources Inventory. USDA.

### Table 1: Variables and Variable Definitions

<table>
<thead>
<tr>
<th>Variable</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Housing Density</td>
<td>Number of housing units per acre</td>
</tr>
<tr>
<td>Income</td>
<td>Median family income in 1999 (dollars)</td>
</tr>
<tr>
<td>Ratio of Residents Born in Northeast</td>
<td>The ratio of those individuals born in the Northeast to the total population</td>
</tr>
<tr>
<td>Ratio of Residents Born in Midwest</td>
<td>The ratio of those individuals born in the Midwest to the total population</td>
</tr>
<tr>
<td>Ratio of Residents Born in South</td>
<td>The ratio of those individuals born in the South to the total population</td>
</tr>
<tr>
<td>Ratio of Residents Born in a Foreign Country</td>
<td>The ratio of those individuals not native to this country to the total population</td>
</tr>
<tr>
<td>Ratio of Female Householders</td>
<td>The ratio of female householders in non-family&lt;sup&gt;6&lt;/sup&gt; households to total households</td>
</tr>
<tr>
<td>Ratio of Bachelor Degree</td>
<td>The ratio of male and female individuals 25 years or older who have received a Bachelor’s degree to the total population 25 years or older</td>
</tr>
<tr>
<td>Ratio of Master Degree</td>
<td>The ratio of male and female individuals 25 years or older who have received a Master’s degree to the total population 25 years or older</td>
</tr>
<tr>
<td>Ratio of female householder</td>
<td>The ratio of male and female individuals 25 years or older who have received a Professional degree to the total population 25 years or older</td>
</tr>
<tr>
<td>Ratio of Doctorate degree</td>
<td>The ratio of male and female individuals 25 years or older who have received a Doctorate degree to the total population 25 years or older</td>
</tr>
<tr>
<td>Ratio of Senior Citizens</td>
<td>The ratio of individuals 65 years or older to the total population</td>
</tr>
<tr>
<td>Ratio of five or more years residents</td>
<td>The ratio of individuals who have been residents for five years or more to the total population</td>
</tr>
<tr>
<td>Number of kids</td>
<td>The ratio of the number of children in family households to total households</td>
</tr>
</tbody>
</table>

<sup>6</sup> Non-family as defined by the US Census bureau is a householder living alone or with non-relatives only
<table>
<thead>
<tr>
<th></th>
<th>Jackson</th>
<th>Johnson City</th>
<th>Chattanooga</th>
<th>Knoxville</th>
<th>Nashville</th>
<th>Memphis</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Income</td>
<td>41,009</td>
<td>38,492</td>
<td>44,284</td>
<td>44,363</td>
<td>51,447</td>
<td>44,824</td>
<td>45,679</td>
</tr>
<tr>
<td></td>
<td>(16,540)</td>
<td>(12,852)</td>
<td>(16,015)</td>
<td>(19,431)</td>
<td>(26,280)</td>
<td>(25,663)</td>
<td>(22,841)</td>
</tr>
<tr>
<td>Housing Density</td>
<td>0.9458</td>
<td>0.7392</td>
<td>1.0654</td>
<td>1.0747</td>
<td>1.5886</td>
<td>2.4310</td>
<td>1.5783</td>
</tr>
<tr>
<td></td>
<td>(1.1129)</td>
<td>(0.9657)</td>
<td>(1.0993)</td>
<td>(1.5813)</td>
<td>(1.8957)</td>
<td>(2.4776)</td>
<td>(1.9743)</td>
</tr>
<tr>
<td>Ratio of Born in Northeast</td>
<td>0.0145</td>
<td>0.0299</td>
<td>0.0265</td>
<td>0.0393</td>
<td>0.0402</td>
<td>0.0205</td>
<td>0.0306</td>
</tr>
<tr>
<td></td>
<td>(0.0137)</td>
<td>(0.0248)</td>
<td>(0.0223)</td>
<td>(0.0309)</td>
<td>(0.0350)</td>
<td>(0.0254)</td>
<td>(0.0300)</td>
</tr>
<tr>
<td>Ratio of Born in Midwest</td>
<td>0.0864</td>
<td>0.0493</td>
<td>0.0563</td>
<td>0.0835</td>
<td>0.0954</td>
<td>0.0643</td>
<td>0.0740</td>
</tr>
<tr>
<td></td>
<td>(0.0438)</td>
<td>(0.0279)</td>
<td>(0.0356)</td>
<td>(0.0427)</td>
<td>(0.0565)</td>
<td>(0.0416)</td>
<td>(0.0480)</td>
</tr>
<tr>
<td>Ratio of Born in South</td>
<td>0.1123</td>
<td>0.2563</td>
<td>0.2775</td>
<td>0.1582</td>
<td>0.1595</td>
<td>0.2397</td>
<td>0.2068</td>
</tr>
<tr>
<td></td>
<td>(0.0507)</td>
<td>(0.1138)</td>
<td>(0.1455)</td>
<td>(0.0625)</td>
<td>(0.0672)</td>
<td>(0.1132)</td>
<td>(0.1106)</td>
</tr>
<tr>
<td>Ratio of Born in a Foreign Country</td>
<td>0.0166</td>
<td>0.1193</td>
<td>0.0252</td>
<td>0.0201</td>
<td>0.0468</td>
<td>0.0310</td>
<td>0.0303</td>
</tr>
<tr>
<td></td>
<td>(0.0284)</td>
<td>(0.0154)</td>
<td>(0.0327)</td>
<td>(0.0311)</td>
<td>(0.0742)</td>
<td>(0.0505)</td>
<td>(0.0524)</td>
</tr>
<tr>
<td>Ratio of Female householder</td>
<td>0.1473</td>
<td>0.1652</td>
<td>0.1629</td>
<td>0.1696</td>
<td>0.1700</td>
<td>0.1544</td>
<td>0.1632</td>
</tr>
<tr>
<td></td>
<td>(0.0754)</td>
<td>(0.0802)</td>
<td>(0.0811)</td>
<td>(0.0964)</td>
<td>(0.1036)</td>
<td>(0.1060)</td>
<td>(0.0977)</td>
</tr>
<tr>
<td>Ratio of Bachelor degree</td>
<td>0.1125</td>
<td>0.1043</td>
<td>0.1216</td>
<td>0.1324</td>
<td>0.1628</td>
<td>0.1252</td>
<td>0.1335</td>
</tr>
<tr>
<td></td>
<td>(0.0898)</td>
<td>(0.0739)</td>
<td>(0.0952)</td>
<td>(0.0959)</td>
<td>(0.1215)</td>
<td>(0.1090)</td>
<td>(0.1068)</td>
</tr>
<tr>
<td>Ratio of Master degree</td>
<td>0.0391</td>
<td>0.0343</td>
<td>0.0413</td>
<td>0.0510</td>
<td>0.0550</td>
<td>0.0463</td>
<td>0.0473</td>
</tr>
<tr>
<td></td>
<td>(0.0385)</td>
<td>(0.0300)</td>
<td>(0.0398)</td>
<td>(0.0472)</td>
<td>(0.065)</td>
<td>(0.0590)</td>
<td>(0.0542)</td>
</tr>
<tr>
<td>Ratio of Professional degree</td>
<td>0.0128</td>
<td>0.0123</td>
<td>0.0149</td>
<td>1.0160</td>
<td>0.0197</td>
<td>0.0170</td>
<td>0.0167</td>
</tr>
<tr>
<td></td>
<td>(0.0197)</td>
<td>(0.0164)</td>
<td>(0.0210)</td>
<td>(0.0239)</td>
<td>(0.0331)</td>
<td>(0.0299)</td>
<td>(0.0276)</td>
</tr>
<tr>
<td>Ratio of Doctorate degree</td>
<td>0.0066</td>
<td>0.0081</td>
<td>0.0064</td>
<td>0.0118</td>
<td>0.0098</td>
<td>0.0068</td>
<td>0.0086</td>
</tr>
<tr>
<td></td>
<td>(0.0087)</td>
<td>(0.0154)</td>
<td>(0.0101)</td>
<td>(0.0187)</td>
<td>(0.0173)</td>
<td>(0.0132)</td>
<td>(0.0153)</td>
</tr>
<tr>
<td>Ratio of Senior Citizens</td>
<td>0.1340</td>
<td>0.1619</td>
<td>1.1445</td>
<td>1.438</td>
<td>1.191</td>
<td>1.115</td>
<td>1.292</td>
</tr>
<tr>
<td></td>
<td>(0.0713)</td>
<td>(0.0725)</td>
<td>(0.0638)</td>
<td>(0.0668)</td>
<td>(0.0779)</td>
<td>(0.0769)</td>
<td>(0.0754)</td>
</tr>
<tr>
<td>Ratio of Five or more years residents</td>
<td>0.9318</td>
<td>0.9457</td>
<td>0.9404</td>
<td>0.9419</td>
<td>0.9355</td>
<td>0.9252</td>
<td>0.9351</td>
</tr>
<tr>
<td></td>
<td>(0.0331)</td>
<td>(0.0208)</td>
<td>(0.0248)</td>
<td>(0.0265)</td>
<td>(0.0331)</td>
<td>(0.0403)</td>
<td>(0.0333)</td>
</tr>
<tr>
<td>Number of Kids</td>
<td>0.7059</td>
<td>0.5611</td>
<td>0.6420</td>
<td>0.5886</td>
<td>0.6710</td>
<td>0.8140</td>
<td>0.6852</td>
</tr>
<tr>
<td></td>
<td>(0.1706)</td>
<td>(0.1453)</td>
<td>(0.1952)</td>
<td>(0.2031)</td>
<td>(0.2700)</td>
<td>(0.3034)</td>
<td>(0.2655)</td>
</tr>
<tr>
<td>Number of block groups</td>
<td>82</td>
<td>314</td>
<td>335</td>
<td>469</td>
<td>770</td>
<td>839</td>
<td>2809</td>
</tr>
</tbody>
</table>

Numbers in parenthesis are standard errors
Table 3. Marginal Effects of Multinomial Logit Model

<table>
<thead>
<tr>
<th></th>
<th>Jackson</th>
<th>Johnson City</th>
<th>Chattanooga</th>
<th>Knoxville</th>
<th>Nashville</th>
<th>Memphis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>0.0549</td>
<td>0.0757</td>
<td>-0.4868</td>
<td>0.7909***</td>
<td>0.6044</td>
<td>-1.0390***</td>
</tr>
<tr>
<td>(0.0372)</td>
<td>(0.1322)</td>
<td>(0.3321)</td>
<td>(0.2983)</td>
<td>(0.3737)</td>
<td>(0.4471)</td>
<td></td>
</tr>
<tr>
<td>Income (1,000 USD)</td>
<td>-0.00017</td>
<td>-0.0023***</td>
<td>-0.0021***</td>
<td>-0.0033***</td>
<td>0.0043***</td>
<td>0.0035***</td>
</tr>
<tr>
<td>(0.00012)</td>
<td>(0.0004)</td>
<td>(0.0081)</td>
<td>(0.00074)</td>
<td>(0.00088)</td>
<td>(0.0011)</td>
<td></td>
</tr>
<tr>
<td>Housing Density</td>
<td>-0.0024**</td>
<td>-0.0404***</td>
<td>-0.0615***</td>
<td>-0.0382***</td>
<td>0.0217***</td>
<td>0.1208***</td>
</tr>
<tr>
<td>(0.0011)</td>
<td>(0.0050)</td>
<td>(0.0081)</td>
<td>(0.0068)</td>
<td>(0.0070)</td>
<td>(0.0092)</td>
<td></td>
</tr>
<tr>
<td>Ratio of Born in Northeast</td>
<td>-0.3075***</td>
<td>0.5809***</td>
<td>0.4823</td>
<td>2.5497***</td>
<td>3.2610***</td>
<td>-6.5664***</td>
</tr>
<tr>
<td>(0.0970)</td>
<td>(0.1537)</td>
<td>(0.4319)</td>
<td>(0.3356)</td>
<td>(0.4756)</td>
<td>(0.6839)</td>
<td></td>
</tr>
<tr>
<td>Ratio of Born in Midwest</td>
<td>0.1198***</td>
<td>-1.0700***</td>
<td>-2.2900***</td>
<td>0.9157***</td>
<td>3.1340***</td>
<td>-0.8098**</td>
</tr>
<tr>
<td>(0.0376)</td>
<td>(0.1448)</td>
<td>(0.2730)</td>
<td>(0.2028)</td>
<td>(0.2787)</td>
<td>(0.3690)</td>
<td></td>
</tr>
<tr>
<td>Ratio of Born in South</td>
<td>-0.2035***</td>
<td>0.3465***</td>
<td>1.5738***</td>
<td>-1.6971***</td>
<td>-3.6664***</td>
<td>3.6467***</td>
</tr>
<tr>
<td>(0.0421)</td>
<td>(0.0557)</td>
<td>(0.1183)</td>
<td>(0.1289)</td>
<td>(0.1769)</td>
<td>(0.1929)</td>
<td></td>
</tr>
<tr>
<td>Ratio of Born in a Foreign Country</td>
<td>-0.0617**</td>
<td>-1.0411***</td>
<td>0.4049*</td>
<td>-1.7024***</td>
<td>1.1468***</td>
<td>1.2535***</td>
</tr>
<tr>
<td>(0.0394)</td>
<td>(0.1775)</td>
<td>(0.2223)</td>
<td>(0.2756)</td>
<td>(0.2131)</td>
<td>(0.3020)</td>
<td></td>
</tr>
<tr>
<td>Ratio of Female householder</td>
<td>-0.0228**</td>
<td>-0.1707***</td>
<td>-0.1097</td>
<td>-0.3924***</td>
<td>0.2509*</td>
<td>0.4443**</td>
</tr>
<tr>
<td>(0.0192)</td>
<td>(0.0524)</td>
<td>(0.1263)</td>
<td>(0.1105)</td>
<td>(0.1470)</td>
<td>(0.2039)</td>
<td></td>
</tr>
<tr>
<td>Ratio of Bachelor degree</td>
<td>0.0450**</td>
<td>0.1808***</td>
<td>0.1802</td>
<td>0.1256</td>
<td>0.2725</td>
<td>-0.8042***</td>
</tr>
<tr>
<td>(0.0213)</td>
<td>(0.0628)</td>
<td>(0.1583)</td>
<td>(0.1329)</td>
<td>(0.1746)</td>
<td>(0.2391)</td>
<td></td>
</tr>
<tr>
<td>Ratio of Master degree</td>
<td>0.0205**</td>
<td>-0.3300**</td>
<td>-0.5075*</td>
<td>0.0909</td>
<td>-0.5345</td>
<td>1.2606***</td>
</tr>
<tr>
<td>(0.0204)</td>
<td>(0.1319)</td>
<td>(0.3014)</td>
<td>(0.1961)</td>
<td>(0.3113)</td>
<td>(0.3642)</td>
<td></td>
</tr>
<tr>
<td>Ratio of Professional degree</td>
<td>0.0330</td>
<td>0.13091</td>
<td>0.4289</td>
<td>-0.3114</td>
<td>-1.7669***</td>
<td>1.4854*</td>
</tr>
<tr>
<td>(0.0631)</td>
<td>(0.2066)</td>
<td>(0.4861)</td>
<td>(0.4166)</td>
<td>(0.5223)</td>
<td>(0.6507)</td>
<td></td>
</tr>
<tr>
<td>Ratio of Doctorate degree</td>
<td>0.1505**</td>
<td>1.0780***</td>
<td>-1.2387</td>
<td>3.4977***</td>
<td>-0.2996</td>
<td>-3.1880***</td>
</tr>
<tr>
<td>(0.0971)</td>
<td>(0.2866)</td>
<td>(0.8391)</td>
<td>(0.5612)</td>
<td>(0.84519)</td>
<td>(1.105)</td>
<td></td>
</tr>
<tr>
<td>Ratio of Senior Citizens</td>
<td>0.0298</td>
<td>0.1426***</td>
<td>0.0837</td>
<td>0.2279*</td>
<td>-0.1364</td>
<td>-0.3476</td>
</tr>
<tr>
<td>(0.0195)</td>
<td>(0.0523)</td>
<td>(0.1451)</td>
<td>(0.1216)</td>
<td>(0.1757)</td>
<td>(0.2293)</td>
<td></td>
</tr>
<tr>
<td>Ratio of Five or more years residents</td>
<td>-0.0322*</td>
<td>0.1779</td>
<td>0.5857*</td>
<td>-0.0860</td>
<td>-0.3477</td>
<td>-0.2977</td>
</tr>
<tr>
<td>(0.0376)</td>
<td>(0.1358)</td>
<td>(0.3396)</td>
<td>(0.3074)</td>
<td>(0.3873)</td>
<td>(0.4604)</td>
<td></td>
</tr>
<tr>
<td>Number of Kids</td>
<td>-0.0083**</td>
<td>-0.2004***</td>
<td>-0.1477***</td>
<td>-0.4668***</td>
<td>-0.1487***</td>
<td>0.9719***</td>
</tr>
<tr>
<td>(0.0071)</td>
<td>(0.0288)</td>
<td>(0.0552)</td>
<td>(0.0517)</td>
<td>(0.0612)</td>
<td>(0.0768)</td>
<td></td>
</tr>
</tbody>
</table>

Numbers in parenthesis are standard errors; Pseudo R-square is 0.31; Correct Prediction is 57%; *, **, *** denote statistically significant 10%, 5%, and 1% respectively.
Table 4. Parameter Estimates for Global regression

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Jackson</th>
<th>Johnson City</th>
<th>Chattanooga</th>
<th>Knoxville</th>
<th>Nashville</th>
<th>Memphis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>-0.7097</td>
<td>4.7938</td>
<td>5.6378</td>
<td>3.2847</td>
<td>4.1288</td>
<td>8.7699</td>
</tr>
<tr>
<td>(4.1534)</td>
<td>(2.4821)</td>
<td>(2.4697)</td>
<td>(1.3966)</td>
<td>(1.3900)</td>
<td>(1.6710)</td>
<td></td>
</tr>
<tr>
<td>Income (1,000 USD)</td>
<td>-0.049***</td>
<td>-0.021***</td>
<td>-0.022***</td>
<td>-0.040***</td>
<td>-0.021***</td>
<td>-0.043***</td>
</tr>
<tr>
<td>(0.012)</td>
<td>(0.0046)</td>
<td>(0.0060)</td>
<td>(0.0064)</td>
<td>(0.0040)</td>
<td>(0.0062)</td>
<td></td>
</tr>
<tr>
<td>Ratio of Born in Northeast</td>
<td>3.0522</td>
<td>10.4526**</td>
<td>12.7288***</td>
<td>0.15689</td>
<td>-0.6122</td>
<td>8.7699***</td>
</tr>
<tr>
<td>(10.4658)</td>
<td>(4.3244)</td>
<td>(4.8820)</td>
<td>(2.4449)</td>
<td>(1.9105)</td>
<td>(3.7736)</td>
<td></td>
</tr>
<tr>
<td>(3.1342)</td>
<td>(3.3854)</td>
<td>(3.4048)</td>
<td>(1.5118)</td>
<td>(1.768)</td>
<td>(2.2363)</td>
<td></td>
</tr>
<tr>
<td>Ratio of Born in South</td>
<td>3.6807</td>
<td>8.6601***</td>
<td>10.1047***</td>
<td>0.8444</td>
<td>-1.7898**</td>
<td></td>
</tr>
<tr>
<td>(3.7472)</td>
<td>(3.3482)</td>
<td>(3.3010)</td>
<td>(1.1645)</td>
<td>(0.7108)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Country</td>
<td>(4.2439)</td>
<td>(3.1086)</td>
<td>(1.9746)</td>
<td>(0.858)</td>
<td>(1.6077)</td>
<td></td>
</tr>
<tr>
<td>Ratio of Female householder</td>
<td>3.4186*</td>
<td>5.0824***</td>
<td>3.9862***</td>
<td>7.5295***</td>
<td>5.9858***</td>
<td></td>
</tr>
<tr>
<td>(2.0590)</td>
<td>(0.8125)</td>
<td>(0.9212)</td>
<td>(0.7492)</td>
<td>(0.8230)</td>
<td>(0.9256)</td>
<td></td>
</tr>
<tr>
<td>Ratio of Bachelor degree</td>
<td>2.1880</td>
<td>0.8928</td>
<td>0.8081</td>
<td>-0.7313</td>
<td>5.9858***</td>
<td></td>
</tr>
<tr>
<td>(2.1353)</td>
<td>(0.9902)</td>
<td>(1.2019)</td>
<td>(1.1412)</td>
<td>(1.4280)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ratio of Master degree</td>
<td>4.7807</td>
<td>-0.7432</td>
<td>1.5080</td>
<td>-1.6464</td>
<td>3.144**</td>
<td></td>
</tr>
<tr>
<td>(3.9578)</td>
<td>(2.3125)</td>
<td>(2.1793)</td>
<td>(1.1603)</td>
<td>(1.7162)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ratio of Professional degree</td>
<td>7.0005</td>
<td>-4.6472</td>
<td>-2.6486</td>
<td>10.2722***</td>
<td>9.6750**</td>
<td></td>
</tr>
<tr>
<td>(6.7630)</td>
<td>(3.1624)</td>
<td>(3.5286)</td>
<td>(4.0501)</td>
<td>(3.8010)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ratio of Doctorate degree</td>
<td>5.2973</td>
<td>-8.4275***</td>
<td>-3.0842</td>
<td>14.8174***</td>
<td>10.6580</td>
<td></td>
</tr>
<tr>
<td>Ratio of Senior Citizens</td>
<td>1.1389</td>
<td>1.7010</td>
<td>-1.0596</td>
<td>-2.5877**</td>
<td>-3.7522***</td>
<td></td>
</tr>
<tr>
<td>(2.0844)</td>
<td>(0.9202)</td>
<td>(1.0666)</td>
<td>(1.0609)</td>
<td>(1.2326)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ratio of Five or more years residents</td>
<td>3.5245</td>
<td>-4.5795</td>
<td>-2.8477</td>
<td>-3.6047***</td>
<td>-6.296**</td>
<td></td>
</tr>
<tr>
<td>(4.1710)</td>
<td>(2.6601)</td>
<td>(2.6238)</td>
<td>(1.4173)</td>
<td>(1.7186)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of Kids</td>
<td>0.9687</td>
<td>0.0017</td>
<td>-0.0654</td>
<td>0.7204</td>
<td>-0.7237**</td>
<td></td>
</tr>
<tr>
<td>(0.8217)</td>
<td>(0.4374)</td>
<td>(0.3937)</td>
<td>(0.4076)</td>
<td>(0.3703)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lambda</td>
<td>-1.2221</td>
<td>-0.90701***</td>
<td>-1.3655***</td>
<td>0.0031***</td>
<td>0.0071***</td>
<td></td>
</tr>
<tr>
<td>(0.9219)</td>
<td>(0.3875)</td>
<td>(0.4068)</td>
<td>(0.0012)</td>
<td>(0.0017)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Adjusted R-square</td>
<td>0.32</td>
<td>0.43</td>
<td>0.25</td>
<td>0.28</td>
<td>0.22</td>
<td></td>
</tr>
</tbody>
</table>

Numbers in parenthesis are standard errors; *, **, *** denote statistically significant 10%, 5%, and 1% respectively.
Table 5. Median Value of Parameter Estimates for Local Regression

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Jackson</th>
<th>Johnson City</th>
<th>Chattanooga</th>
<th>Knoxville</th>
<th>Nashville</th>
<th>Memphis</th>
<th>Income (1,000 USD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>-0.8098</td>
<td>(0.8600)</td>
<td>2.5247</td>
<td>5.8010</td>
<td>3.5082</td>
<td>4.1710</td>
<td>11.2617</td>
</tr>
<tr>
<td>Ratio of Born in Northeast</td>
<td>4.3605</td>
<td>(0.6100)</td>
<td>17.2352</td>
<td>8.4181</td>
<td>2.468**</td>
<td>-1.2580</td>
<td>2.8967</td>
</tr>
<tr>
<td>Ratio of Born in Midwest</td>
<td>-2.1829</td>
<td>(0.8300)</td>
<td>-5.6300</td>
<td>-11.4474</td>
<td>-1.9902*</td>
<td>0.7013</td>
<td>1.2248</td>
</tr>
<tr>
<td>Ratio of Born in South</td>
<td>3.9226</td>
<td>(0.1400)</td>
<td>14.1014*</td>
<td>6.2221</td>
<td>-2.0944</td>
<td>3.035</td>
<td>-3.2774</td>
</tr>
<tr>
<td>Ratio of Born in a Foreign Country</td>
<td>9.4869</td>
<td>(0.7200)</td>
<td>13.8225</td>
<td>1.4765</td>
<td>8.4234</td>
<td>3.3070</td>
<td>6.1556</td>
</tr>
<tr>
<td>Ratio of Female household</td>
<td>3.3877</td>
<td>(0.3300)</td>
<td>4.1250</td>
<td>2.3108</td>
<td>3.6522</td>
<td>6.8444</td>
<td>4.0537</td>
</tr>
<tr>
<td>Ratio of Bachelor degree</td>
<td>2.1831</td>
<td>(0.9700)</td>
<td>-0.4048</td>
<td>-1.3836</td>
<td>3.9737</td>
<td>-2.5853</td>
<td>2.1708</td>
</tr>
<tr>
<td>Ratio of Master degree</td>
<td>4.4374*</td>
<td>(0.9700)</td>
<td>-3.9220*</td>
<td>3.5230</td>
<td>0.5052</td>
<td>-2.0459</td>
<td>-5.3688</td>
</tr>
<tr>
<td>Ratio of Professional degree</td>
<td>7.1185</td>
<td>(0.7200)</td>
<td>-0.6897</td>
<td>0.0298</td>
<td>11.1098</td>
<td>10.9300</td>
<td>7.1136</td>
</tr>
<tr>
<td>Ratio of Doctorate degree</td>
<td>5.7140</td>
<td>(0.5100)</td>
<td>-8.4656</td>
<td>-9.0680</td>
<td>11.7042</td>
<td>13.6522</td>
<td>6.2348</td>
</tr>
<tr>
<td>Ratio of Senior Citizens</td>
<td>1.2722</td>
<td>(0.5400)</td>
<td>0.6556</td>
<td>-2.5190</td>
<td>-2.6168</td>
<td>-3.1548</td>
<td>-4.2429</td>
</tr>
<tr>
<td>Ratio of Five or more years residents</td>
<td>3.8274</td>
<td>(0.6400)</td>
<td>-0.8359</td>
<td>-2.5317</td>
<td>-1.0328</td>
<td>-2.8190</td>
<td>-6.6331</td>
</tr>
<tr>
<td>Number of Kids</td>
<td>0.9868</td>
<td>(0.7500)</td>
<td>0.2451</td>
<td>-0.5398</td>
<td>-0.7875</td>
<td>0.7786</td>
<td>-1.3619</td>
</tr>
<tr>
<td>Lambda</td>
<td>-1.3347</td>
<td>(0.2500)</td>
<td>-1.4315</td>
<td>-1.0190</td>
<td>0.0027</td>
<td>0.0032</td>
<td>0.0662</td>
</tr>
<tr>
<td>Adjusted R-square</td>
<td>0.32</td>
<td>0.43</td>
<td>0.44</td>
<td>0.34</td>
<td>0.35</td>
<td>0.32</td>
<td></td>
</tr>
</tbody>
</table>

Numbers in parenthesis are p-values; * and ** denote statistically significant 10% and 5% respectively.

Table 6. Spatial Dependency

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Jackson</th>
<th>Johnson City</th>
<th>Chattanooga</th>
<th>Knoxville</th>
<th>Nashville</th>
<th>Memphis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ratio of census-block group with at least 2 houses per acre within a MSA</td>
<td>20%</td>
<td>11%</td>
<td>19%</td>
<td>18%</td>
<td>31%</td>
<td>50%</td>
</tr>
<tr>
<td>Gini Coefficient</td>
<td>0.67</td>
<td>0.65</td>
<td>0.56</td>
<td>0.61</td>
<td>0.58</td>
<td>0.49</td>
</tr>
<tr>
<td>Moran’s Index for housing density per acre</td>
<td>0.06</td>
<td>0.27</td>
<td>0.25</td>
<td>0.20</td>
<td>0.18</td>
<td>0.03</td>
</tr>
</tbody>
</table>
**Figure 1** Six MSAs of Three Grand Division of Tennessee at Census-Block Group Level

**Figure 2.** Spatial Distribution of Marginal Effect of the Ratio of Residents Born in South on Housing Density at Johnson City MSA
Complex Connections: The role of non-timber forest products in urban and rural livelihoods in Nicaragua

Laura Shillington, Jeffrey K. McCrary, and A. L. Hammett
Department of Natural Resources, Virginia Tech

Abstract:
The remnant forests in the Pacific region of Nicaragua are under increasing stress as both agriculture and urbanization expand, raising concerns as to the future of forests in this region. NTFPs have long been an important component of household livelihood strategies in Nicaragua, but little has been documented on the extent and role of these products in household economies. This paper considers the role of two NTFPs extracted from Laguna de Apoyo Nature Reserve (LANR) – coco-fern baskets and brooms – in rural and urban household livelihood strategies in Central Pacific Nicaragua at various stages of their commodity chains. We examine specifically the gender roles and relations at harvesting, processing, and marketing stages, and how these influence the importance of NTFPs in the households. The results of this study show that women control the majority of NTFP income, this making this income key to households. By showing this, the study also demonstrates the importance of incorporating women in NTFP development activities in a management plan in LANR. This study has revealed how NTFP commercialization can contribute simultaneously to household income and conservation, which we consider is actually helping to protect this important forest on an urban-rural edge.

Key Words:
Nicaragua, non-timber forest products, household economy, informal economy, gender, conservation, development, protected area.

Introduction
Many communities, development agencies, and environmental organizations worldwide have struggled to address the dual, sometimes contradictory goals of conservation and development (Wilhusen et. al. 2002; Brechin et al. 2002). A diverse range of initiatives have been proposed and implemented in an attempt to conserve forest biodiversity while simultaneously recognizing the dependency of human communities on those forests. The establishment of protected areas has become a significant initiative, one that changes the legal relationship of communities and forests. This type of initiatives has sought to provide alternative sources of income such as eco-tourism and ‘sustainable’ extractive industries. The commercialization of non-timber forest products (NTFPs) is one such alternative.

Commercialization of NTFPs has often been proposed as a mechanism for assuring sustainability of forest use, especially in the face of pressure from large-scale timber extraction (Panayotou and Ashton 1992). However, as Neumann, and Hirsch (2000) have pointed out, NTFP commercialization is complex and can have negative impacts, especially when the benefits are distributed unevenly. It is important to understand not only the economic issues of NTFP commercialization, but also the social factors that influence who benefits and in what ways. This paper is an attempt to better understand the role NTFPs play in households in Nicaragua by looking at social relations and economic distribution in two NTFPs – coco-fern baskets and brooms - in household livelihoods in communities surrounding Laguna de Apoyo Nature Reserve (LANR). We analyze the importance these two NTFPs play in household economics at the various stages - harvesting, processing, and marketing - of their commodity chains, paying particular attention to the gender roles and relations at each stage. We then ask whether these products represent an already ‘sustainable’, low-impact use of the forest, illustrating the importance of better understanding the role of NTFPs in household livelihoods to answer this question.

Study Area
The area of study extended over the Managua-Granada corridor in Central-Pacific Nicaragua. The study centred, however, in the communities surrounding LANR, where the extraction and processing of the NFTPs takes place. The reserve is located approximately thirty-five kilometers south of Managua and is the largest intact dry tropical forests of the region (about 1700 hectares of mostly steeply graded closed forest) (McCrary et al. 2004a). Established as a nature reserve in 1991 (Sánchez 1999), LANR does not have a management plan and
has more than 174,000 individuals living within three kilometers of the reserve's boundary (INTA 1994). Research was also conducted along these commodity chains in the markets of Masaya, Managua and Granada.

**Data Collection Methods**

Using the concept of commodity chain as proposed by Hopkins and Wallerstein (1986) and others (Dunaway 2001; Gereffi et al. 1994; Vellenga 1985), we conducted semi-structured and open-ended interviews at five identified sequential stages in the local commodity chains of two NTFPs - woven coconut-fern baskets and brooms - from August to November 2001. These stages comprise extraction, cultivation, production, trading, intermediaries, and retail. Interviews were conducted with the various actors involved at these stages to collect the following information: demographic composition of household, income sources of household, division of labor in activity (at each stage by gender), cost, location and time period of activity, sources of materials and ecological knowledge about their activities. In addition, we asked questions regarding the social and economic context of the extraction, production, and selling in these two commodity chains. We interviewed between 5 and 10 people at each stage. A total of 48 individuals were interviewed in the broom community chain and 26 in the basket commodity chain.

**Results**

Rural households surrounding the LANR utilize a variety of plant and tree materials to produce brooms and baskets. Coco-fern baskets are produced from the veins of coconut palm leaves (Cocos nucifera) and a fern vine known as crespillo (Lygodium venustum). The coco palms are collected both within the nature reserve and outside, as these are common throughout the Nicaraguan rural and urban landscape. The fern vines are collected from within LANR, mainly in areas of secondary growth and along paths. Brooms are produced from cultivated straw or palm leaves and limbs or shoots, principally from three tree species: guácimo (Guazimo ulmifolia), patre or sardinillo (Tecoma stans), and madero negro (Gliricidia sepium). The tree shoots are harvested with a machete near the base of the shoot. Beginning with the households that extract these materials, several stages in the commodity chains of baskets and brooms were identified.

We categorized the straw broom commodity chain into seven distinct stages: extraction, cultivation, production/processing, household traders, intermediaries, retail, and final consumption. Each of these stages is linked to another through either a monetary or non-monetary exchange of a product. Non-monetary exchange occurs when there is an exchange of goods between two stages without the act of buying and selling. There is usually a non-monetary exchange when the actors of the different stages are the same person or in the same household. In the broom commodity chain, this type of exchange occurs between cultivator and producer, extractor and producer, and producer and household trader. In many households, the producer also cultivates broom straw or extracted the broomsticks from LANR, so there is no monetary exchange to acquire the necessary straw or purchase prepared broomsticks. In all cases, the household trader does not purchase the brooms from the producers, as both are part of the same household. The household trader transfers the brooms from the house to urban markets in Nicaragua.

The coco basket commodity chain is simpler than the straw brooms commodity chain and involves fewer actors. There are six stages to this commodity chain: extraction, production, household trading, retail vendors, intermediaries, and final consumption. The non-monetary exchanges in the coco basket chain are situated between extractor and producer, and producer and household trader. As in the broom commodity chain, the extractor gives the producer the necessary supplies, and the producer gives the household trader the baskets to sell, as tend to be part of the same household. There are fewer monetary changes in this commodity chain and most of the baskets are sold primarily in urban centres of Nicaragua, although some intermediaries periodically sell in Costa Rica and Honduras.

The allocation of income produced from these NTFPs for common household needs is largely determined by the gendered division of labor and income. Figures 1 and 2 illustrate that extraction and production in the broom commodity chain tended to be dominated by males; however, women dominate the retailing of brooms. In the basket chain, women carry out more of the stages as compared to the broom chain. The majority of income from both brooms and baskets is realized at the trading and retailing stages, where women collect and therefore, control it. However, males obtain and control some income realized in the cultivation and extraction stages of the broom commodity chain. Control over

---

7 No one interviewed was aware of brooms sold outside Nicaragua.
Discussion and Conclusion

What do these two findings mean for the question of whether these products represent an already ‘sustainable’, low-impact use of the forest? NTFPs are commonly presumed to be less damaging than timber harvesting and thus are often promoted as a means of sustainable development. The idea of sustainable development, although very vague and subjective, is to promote conservation of natural resources while sustaining the local community (Nepstad and Schwartzmann 1992). The secondary growth characteristics and resistance of the plants used in brooms and baskets make them easily managed for sustainable harvest in the context of maintenance of a multiple-use, natural forest. Their use does not threaten the closed forest structure, while generating improved incomes for the families in this market chain (McCrary et al. 2004b).

The extractors and producers of both baskets and brooms are clearly aware of the effects that their activities have on the forest. For example, broomstick extractors stated that they know cut specific limbs in order to obtain continuous multiple harvests from a given tree. Lygodium venustum extractors know that even when they pull the vine from its roots, that the vine continues to spread through the area. However, most of these women and men do not view their activities as encouraging or discouraging conservation specifically; their attitudes of conservation are based on satisfying basic needs and their desire to continue their livelihood activities.

The varied roles played by females and males along these commodity chains situate them as specific stakeholders in conservation: the position of males as main extractors and females as “need-be” extractors necessitates a conservation strategy involving both as different, yet equal stakeholders. Ghatak (1995: 174) lists three key constraints to involving women in NTFP development: (1) limited access to markets, value-added technology, training, and credit, (2) lack of decision-making power, and (3) foresters’ lack of incorporation of women’s knowledge, needs and preferences in forest action plans. The second constraint and at least part of the first do not inhibit women’s involvement in these two present cases. This study demonstrates the importance of incorporating women in NTFP development activities in a management plan in LANR. Conservation management in Nicaragua has not incorporated many gender issues nor NTFP utilization, but as only a few of the protected areas have management plans, there is great potential for the integration of both issues in the near future. This study has revealed how NTFP commercialization can contribute simultaneously to household income and conservation, which we consider is actually helping to protect this important forest on an urban-rural edge. These aspects of
NTFPs are important to consider when planning conservation management strategies.

Acknowledgments
This research was supported by a grant from Women in Technical Development Assistance (WIDTECH) and USAID, and strategic support from Asociación Gaia, the University of Central America, and the College of Natural Resources of Virginia Tech.

References

Brechin, S. R., P. R. Wilshusen, C. L. Fortwangler, and P. C. West. 2002. Beyond the square wheel: toward a more comprehensive understanding of biodiversity conservation as social and political process. Society and Natural Resources 15:41-65.


Figures 1 and 2: Gendered Division of Labour along the Broom (left) and Basket (right) Commodity Chains.
Figures 3 and 4: Main Sources of Income for Participants in the Broom (left) and Basket (right) Commodity Chain
Urban Forests and Forestry
Public Conceptions of and Attitudes towards Urban Forestry in Alabama

Yaoqi Zhang, School of Forestry and Wildlife Sciences, Auburn University; Anwar Hussain, Forest & Wildlife Research Center, Mississippi State University; Neil Letson, Alabama Cooperative Extension System

Abstract
In this paper, we summarize responses from a survey of Alabama urban residents’ attitudes toward urban forest. Overall, most Alabama residents have a strong appreciation for the state's urban forest. We particularly analyze the attitudes to supporting urban forestry by using ordered probit analysis. Overall, Alabamian Our results showed that being aware of forest related programs, holding a full time job, being in the age group of less than 56 years, and having an annual income greater than US$75,000 increased the probability of donating money and voluntarily contributing time toward urban forestry programs and activities. In addition, having children less than 16 years old was found to increase adult’s willingness to donate time. Race, gender and residence were not statistically significant based on our data.

Keywords: ordered probit model, willingness to pay, community participation, volunteer.

Introduction
Since urban trees have a nature of public goods and are often referred to as green infrastructure, how to manage urban forests is a kind of public choice, and it is important to understand public conceptions and attitudes towards urban forests. To get such information and conduct analysis could be the first step to formulate our management strategy. A comprehensive survey and investigation could be the primary approach. To meet those needs, the Center for Governmental Services at Auburn University for the Alabama Cooperative Extension System with support from the Alabama Urban Forestry Partnership conducted statewide telephone survey from July 14 to July 24, 2003. In order to participate in the survey, a respondent needed to be at least 18 years old and to reside in an incorporated Alabama municipality. In this paper, we summarize responses from this survey. In the next section, we will first present the summary of the survey. Then we analyze the attitudes to supporting urban forestry by using ordered probit analysis.

Public attitudes towards urban forestry activities in Alabama
Overall, most Alabama residents have a strong appreciation for the state's urban forest. Specifically, 69 percent feel the state's urban forest is sizable when compared to those found in other states. In addition, a resounding 98 percent of respondents recognize that urban trees provide positive benefits to people and their communities with aesthetics, shade, and improved air quality listed as the top three benefits. The survey found that urban trees play a role in people's decisions to locate. When asked what effect urban trees would have on choosing a place to live, 75 percent said trees were very important in selecting a home, while 77 percent said trees are very important in selecting a community to live.

A total of 93 percent of those surveyed report having at least one mature tree growing on their place of residence. The survey also revealed that 97 percent had either planted or cared for an urban tree. When asked what type of urban forestry service activity they would provide if asked, 56 percent said they would donate money, with an almost equal amount saying they would volunteer their time. Of those who said they would volunteer their time, almost 9 out of 10 listed "tree planting" as their preferred activity.

In the survey, several questions were asked regarding statewide urban forestry issues. A surprising 43 percent strongly believe that tree topping is a legitimate tree care option, with an additional 38 percent saying they somewhat agree with this practice. Only 9 percent strongly disagree with tree topping. According to the survey, there is strong support for government involvement in urban forestry programs.

Almost 7 out of 10 strongly agree with the need for local ordinances requiring tree protection during construction. This support drops significantly, though, when questioned about government regulations affecting a homeowner's property. For example, 76 percent favor local ordinances regulating trees on public property, while only 36 percent
support local ordinances regulating trees on private property. Alabama residents support government funding for urban forestry programs, though this support is stronger at the local government level. While 70 percent of the respondents favor using local municipal tax dollars to support the planting and maintenance of trees on public property, support slips to 62 percent when asked about using state tax dollars for the same purpose and it dips further to 52 percent for using federal tax dollars.

**What determine the attitudes towards personally supporting urban forestry?**

It is interesting to understand what determine the individual preferences and motivations (See for instance, Yen et al. 1997; Saz-Salazar and Menendez, 2001). Increasingly it is believed socioeconomic and demographic underlie differences in individual opinions and motivations.

In this paper, we follow the hypothesis that each individual has a different attitude towards supporting urban forestry programs and activities. Such attitudes can be explained by economic, social, psychological, education, experience, perception, and residential location. For example, in the literature on charitable giving to environmental conservation, an individual is assumed to choose the level of donation, along with the levels of other consumer goods that maximize utility subject to a budget constraint (Yen et al. 1997).

**Methodology**

To analyze the relationship between discrete choices and the personal characteristics, random utility models are the most used. Individuals choose their options based on their preference that is supposed to be a function of a variety of individual characteristics (e.g., their education, profession and income, age, etc.), the subject issues (e.g., where they live and the city). But the analyst is supposed to have incomplete information for different reasons and, therefore, uncertainty must be taken into account. The uncertainty can come from unobserved alternative attributes, unobserved individual attributes, measurement errors, etc. The utility is modeled as a random variable in order to reflect this uncertainty.

The multinomial probit or logit model is most often used in econometric specification. Considering the ordinal nature of dependent variables in our study, we use the ordered probit model described below:

\[ y_i^* = \beta' x_i + \varepsilon_i \]

where \( y_i^* \) is related to a continuous latent variable, ranging from \(-\infty\) to \(+\infty\), indicating an individual’s intensity of concern about the potential implications of participation in or attitudes towards urban forest; \( \varepsilon_i \) are the unobserved thresholds defining the boundaries between the different levels of concern.

Of the 3 (J=3) threshold levels, only 1 threshold level can be estimated. Given the relationship between \( y_i \) and \( y_i^* \) and the distribution of error term \( \varepsilon_i \), the probabilities of observing an individual as having a value 0, 1 and 2 of the index \( y_i \) are respectively written as:

\[
\begin{align*}
\text{Prob} (y_i =0| x_i) &= 1 - \Phi ( \beta' x_i) \\
\text{Prob} (y_i =1| x_i) &= \Phi ( \mu - \beta' x_i) - \Phi ( -\beta' x_i) \\
\text{Prob} (y_i =2| x_i) &= 1 - \Phi ( \mu - \beta' x_i)
\end{align*}
\]

The corresponding marginal effects as:

\[
\begin{align*}
\frac{\partial}{\partial x_i} \text{Prob} (y_i =0| x_i) &= - \Phi ( \beta' x_i) \beta \\
\frac{\partial}{\partial x_i} \text{Prob} (y_i =1| x_i) &= \Phi ( \mu - \beta' x_i) - \Phi ( -\beta' x_i) \beta \\
\frac{\partial}{\partial x_i} \text{Prob} (y_i =2| x_i) &= \Phi ( \mu - \beta' x_i) \beta
\end{align*}
\]

where \( \Phi ( \cdot ) \) and \( \Phi ( \cdot ) \) are respectively the cumulative normal distribution function and standard normal density function. The expressions for marginal effects only partially suggest the signs of the estimated marginal effects. While the sign of the marginal effect for \( J=0 \) is opposite to that of \( \beta \), the sign of the marginal effect for \( J=2 \) is the same as that of \( \beta \) since the density, \( \Phi ( \cdot ) \), is nonnegative. The sign of the marginal effect for the category \( J=1 \) will depend on the densities for \( J \) and \( J-1 \) and cannot be determined from the estimates alone. For this reason, interpreting the marginal effects of changes in the explanatory variables can be difficult without additional computations (Greene 2003, p.739).

**Data**

The survey received 506 completed responses, yielding a +/-4.5% margin of error. An important aspect of the survey was to investigate attitudes toward supporting community forestry program activities that were measured in five perspectives (see Table 1). Seen from Table 1, we can find that the personal attitudes to supporting community forestry program activities are similar in terms of contributing time and money, but are a slightly more likely to support contributing time. A great majority of the respondents wished local, state and federal government to financial support of community forestry programs, but in a decreasing order.

We hypothesize that attitudes are a function of personal characteristics, including income, age, gender, race, employment, residential environment and awareness of community forestry programs. Due
to data limitation, we have recoded our dependent variables and independent variables. There are about 10% of the respondents who did not release their annual income. Since the income is so strongly related to education, the information related to education is used to replace the missing information on income: we use less than $20,000 for education less than high school, $20,000-$39,000 for high school diploma/GED, some college and associate/technical and bachelor’s, $40,000-$74,000 for Master’s or higher.

Respondents were also asked for their awareness of forestry services and programs. These are: 1) USDA Forest Service, 2) National Arbor Day Foundation, 3) American Forest, 4) International Society of Arboriculture, 5) Alabama Forestry Commission, 6) Auburn University School of Forestry and Wildlife Sciences, 7) Alabama Urban Forestry Association.

Empirical Results
The results are presented in Table 2. First, the 2 models fit well as judged from the chi-squared statistic. Also, the threshold parameter estimates are statistically significant, suggesting the reasonableness of the outcome variable grouping into the three categories of “very likely/very important,” “likely/not so important” and “not likely/not important.”

Results corresponding to “the willingness to donate time” and “willingness to donate money” models (Table 2) show that knowledge of natural resource related programs, being full time employee, being in the age group of less than 56 years and having annual income greater than US$75,000 increases the probability of donating time or money to community forestry program and activities. Race, gender and residence were not statistically significant. The only difference between the two models pertains to the significance of the variable “families with children age less than 16 years” which is significant only in the “willingness to donate time” model. Differences and similarities between the two models get pronounced when we look at the marginal effects. Thus, we find that while the probability of willingness to donate time increases by 5-6 percent when an individual belongs to the less than 56 years category, the corresponding increase in the case of willingness to donate money is 16 to 19 percent. On the other hand, for the variables “being a full time employee” and “being aware of natural resource related programs” the marginal effects are strikingly similar: being a fulltime employee and being aware increases the probability of willingness to donate either time or money by 4 percent and 2 percent respectively.

Acknowledgements
We appreciate financial support provided by the Urban and Community Financial Assistance program of USDA Forest Service. All opinions and errors are responsibility of the authors.

References
### Table 1: Summary of attitude to financing urban and community forestry

<table>
<thead>
<tr>
<th></th>
<th>very important (likely)</th>
<th>Somewhat important (likely)</th>
<th>somewhat unimportant (unlikely)</th>
<th>not at all important (unlikely)</th>
<th>Don't know</th>
</tr>
</thead>
<tbody>
<tr>
<td>How likely would you be to volunteer your time to support urban trees activities ( (y_1) )</td>
<td>94</td>
<td>201</td>
<td>95</td>
<td>89</td>
<td>27</td>
</tr>
<tr>
<td>How likely would you donate money to support urban trees activities ( (y_2) )</td>
<td>64</td>
<td>219</td>
<td>112</td>
<td>76</td>
<td>35</td>
</tr>
<tr>
<td>Importance of local government funding the planting and maintenance of trees on public property ( (y_3) )</td>
<td>349</td>
<td>121</td>
<td>11</td>
<td>10</td>
<td>15</td>
</tr>
<tr>
<td>Importance of Alabama state government funding to help communities to plant and maintenance of trees ( (y_4) )</td>
<td>311</td>
<td>140</td>
<td>17</td>
<td>21</td>
<td>17</td>
</tr>
<tr>
<td>Importance of the Federal government funding to help individual communities to plant and maintenance of trees ( (y_5) )</td>
<td>263</td>
<td>150</td>
<td>29</td>
<td>47</td>
<td>17</td>
</tr>
</tbody>
</table>

### Table 2: Results for ordered probit models (Observations = 506)

<table>
<thead>
<tr>
<th>Variable</th>
<th>description</th>
<th>coding</th>
<th>Willingness to donate time</th>
<th>Willingness to donate money</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Coeff. (t-value)</td>
<td>Coeff. (t-value)</td>
</tr>
<tr>
<td>ONE</td>
<td>Constant term</td>
<td></td>
<td>-0.543 (1.916)</td>
<td>-0.699 (2.407)</td>
</tr>
<tr>
<td>AWRNS</td>
<td>Be aware of the forestry services and programs</td>
<td>= number of programs</td>
<td>0.109 (3.999)</td>
<td>0.082 (3.100)</td>
</tr>
<tr>
<td>CITY</td>
<td>The resident place</td>
<td>= 1 for living in city, 0 otherwise.</td>
<td>-0.012 (0.113)</td>
<td>0.096 (0.890)</td>
</tr>
<tr>
<td>FULL</td>
<td>Full time job individual</td>
<td>=1 if yes, 0 otherwise.</td>
<td>0.232 (1.588)</td>
<td>0.194 (1.449)</td>
</tr>
<tr>
<td>PART</td>
<td>Part time job individual</td>
<td>=1 if yes, 0 otherwise.</td>
<td>0.136 (0.618)</td>
<td>0.250 (1.057)</td>
</tr>
<tr>
<td>RETIRED</td>
<td>Retired individual</td>
<td>=1 if yes, 0 otherwise.</td>
<td>0.132 (0.620)</td>
<td>-0.008 (0.034)</td>
</tr>
<tr>
<td>CHILD</td>
<td>Family with children</td>
<td>=1 if yes, 0 otherwise.</td>
<td>0.183 (1.474)</td>
<td>0.133 (1.115)</td>
</tr>
<tr>
<td>AGE_35</td>
<td>Age less than 34</td>
<td>=1 if yes, 0 otherwise.</td>
<td>0.329 (1.589)</td>
<td>0.786 (3.427)</td>
</tr>
<tr>
<td>AGE_56</td>
<td>Age between 34 and 56</td>
<td>=1 if yes, 0 otherwise.</td>
<td>0.281 (1.449)</td>
<td>0.656 (3.119)</td>
</tr>
<tr>
<td>INC_L</td>
<td>Annual Income less than $40,000</td>
<td>=1 if yes, 0 otherwise.</td>
<td>-0.177 (1.350)</td>
<td>-0.215 (1.674)</td>
</tr>
<tr>
<td>INC_M</td>
<td>Annual Income between $40,000 and $74,000</td>
<td>=1 if yes, 0 otherwise.</td>
<td>-0.360 (2.082)</td>
<td>-0.235 (1.421)</td>
</tr>
<tr>
<td>WHITE</td>
<td>White people</td>
<td>=1 if yes, 0 otherwise.</td>
<td>-0.078 (0.669)</td>
<td>-0.014 (0.121)</td>
</tr>
<tr>
<td>MALE</td>
<td>Gender</td>
<td>=1 if yes, 0 otherwise.</td>
<td>0.009 (0.078)</td>
<td>-0.026 (0.226)</td>
</tr>
<tr>
<td>Mu(1)</td>
<td></td>
<td></td>
<td>1.359 (17.016)</td>
<td>1.206 (16.761)</td>
</tr>
<tr>
<td>Chi-squared(12)</td>
<td></td>
<td></td>
<td>41.69</td>
<td>76.53</td>
</tr>
<tr>
<td>Log-likelihood</td>
<td></td>
<td></td>
<td>-477.61</td>
<td>-490.08</td>
</tr>
<tr>
<td>ResLog-likelihood</td>
<td></td>
<td></td>
<td>-498.45</td>
<td>-528.35</td>
</tr>
</tbody>
</table>
Estate Thomas Experimental Forest, U.S. Virgin Islands: An Urban Forest In The Middle Of St. Croix

Peter L. Weaver, International Institute of Tropical Forestry

Introduction
St. Croix, one of the U.S. Virgin Islands, occupies 221 km². Plantation agriculture transformed the island's landscape in the past but today, demand for commercial, residential, and tourist uses for land have replaced agriculture. Forest Service experience on the island spans 75 years, more than 50 of them with the International Institute of Tropical Forestry (IITF). In 1953, the IITF began preliminary forestry studies at Estate Thomas. Subsequently, many IITF studies incorporated St. Croix as dry zone planting site for comparisons with humid sites in Puerto Rico. Forest Service activities on the estate since the mid-1990s have been run mainly through the IITF's State and Private Forestry (S&PF) program with visits for law enforcement, salvage timber sales, and other cooperative activities. Despite the IITF's limited presence on St. Croix, many Cruzans have expressed strong support for continued Forest Service management of the estate.

The purpose of this report, adapted from a U.S. Forest Service General Technical Report currently in review, is to provide information on Estate Thomas -- its physical setting, climate, past history, flora, fauna, and past research. Economic change has paved the way for an expanded forestry program -- one that demonstrates the estate's past role of multiple use management and forestry research, and highlights its future role as an outdoor laboratory for environmental education and interpretation aimed at the island's younger generation.

Human Influence on St. Croix
Indians first arrived in St. Croix in 300-400 B.C. and attacked Columbus on his arrival in 1493. Since then, the islands have been under Spain, England, Holland, France, the Knights of Malta, Denmark, and finally, the United States.

In 1735, the Danish began establishing cotton and sugar cane plantations. Cotton prospered between 1740 and 1770; by the 1790s, however, more than one-half of the island was planted in sugar cane. About 1825, the Cruzan economy began to decline mainly as a result of lower sugar prices elsewhere. In 1917, the U.S. acquired the Virgin Islands from Denmark. World War I, the depression, and World War II would delay economic development. After the mid-1950s, the Virgin Islands witnessed a rapid economic expansion, including the lucrative tourist industry.

During settlement, plantation agriculture resulted in the widespread use of fire, the diversion of water for irrigation, severe erosion of soil, and the introduction of livestock and exotic plants -- all measures which had an impact on the island's environment and its native species. St. Croix also inherited the rich legacy of its colonial past.

Environmental Setting
The 60-ha Estate Thomas, ranging between 80 to 130 m in elevation and with slopes between 5 and 70 percent, has an intermittent drainage running through the property. Kingshill marl, an early Miocene limestone underlying the estate, was formed as part of a coral reef when the island was uplifted. The soil, Arawak gravelly loam, weathered from calcareous marine sediments, is shallow and well-drained. Alluvium covers 5 percent of the estate.

St. Croix, lying in the path of the easterly trades, has a tropical maritime climate. Easterly waves produce most rainfall from May through November. Tropical storms and hurricanes occasionally develop, and moderate to severe droughts are not uncommon. Rainfall on Estate Thomas averages about 1000 mm/yr, ranging from 44 mm in February to 154 mm in November. Mean monthly temperatures vary from 24.7 °C in February to 27.7 °C in July and August. Relative humidity is near 80 percent for the year and the annual evaporation is about 1850 mm/yr.

Flora and Fauna
St. Croix has two ecological life zones: subtropical moist forest, confined to the northwestern one-sixth of the island, and subtropical dry forest in which Estate Thomas is located. The mid-1970s classification of the forest types for the island based on moisture regimes appeared to designate Estate Thomas as deciduous forest. Small leaf mahogany (*Swietenia mahagoni*), big leaf mahogany (*Swietenia macrophylla*) and teak (*Tectona grandis*), major timber species, were all introduced to St. Croix, the first about 1770, the second in 1907, and the last in 1954.

When agriculture and grazing were abandoned on the hills of Estate Thomas in 1928, small leaf mahogany
regenerated. A 1997 forest survey of the estate showed:

- 110 species of plants, 83 percent woody and 14 percent exotic
- a mean density 1,672 trees/ha and mean basal area of 17.6 m²/ha
- trees averaging about 10 cm in dbh, with the largest to 60 cm
- a mean canopy height of about 8 m, with the tallest trees to 18 m
- small leaf mahogany comprised 50% of the trees and 67% of the basal area

The fruits, pods, or leaves of nine of the recorded species, six of them trees, are used as forage by deer, and 17 of the native tree species are recommended for local landscaping. In the past, many islanders used the local flora in search of remedies for illness, parasites, or evil spirits, an interest that persists today. A published list of medicinal plants for the U.S. Virgin Islands includes 35 herbaceous species, 11 trees, 12 shrubs, and 10 vines. Eight of the trees, one shrub, and three of the vines were found on Estate Thomas.

Four species of bats, 138 species of birds, and 18 species of reptiles and amphibians (excluding sea turtles) are listed among St. Croix's indigenous fauna. A preliminary survey of indigenous wildlife carried out at Estate Thomas during the late 1990s identified only 16 species of birds, 2 lizards, and 2 bats. The island's largest mammal -- White-tailed deer introduced for hunting in the 1790s -- is present on the estate. Fourteen of the bird species observed on the estate are species that could be attracted to urban gardens by tree planting. Also tallied were a tree lizard and a gecko.

Forest Service Activities: 1930-1962
Chaos and unemployment characterized St. Croix's agricultural sector in 1930, and the Bureau of Efficiency of the U.S. Navy requested the Forest Service to survey forest conditions in the Virgin Islands. During occasional visits between 1940 and 1952, foresters suggested tree planting, stand improvement, and utilization. In 1953, Estate Thomas was reserved as a forestry research and demonstration area. Among the field activities carried out from 1953 to 1962 were:

- experimentation in seed collection, storage, handling, treatment, and germination
- attempts at aerial and broadcast seeding on different sites
- trials with bare root and potted stock seedlings under different conditions
- observations of early seedling establishment, tending, and growth
- weed control by mechanical and chemical means
- stand improvement -- release of naturally occurring small leaf mahogany by thinning
- sawmilling and fence post treatment for the benefit of the local community
- the initiation of adaptability trials
- planting 86,000 mahogany and 37,500 teak seedlings by 1961.

Forest Service Activities: 1963-2000
The IITF partitioned the estate into compartments or blocks to facilitate management. Some thinning of small leaf mahogany was done on hilly lands. Drainages and lower slopes, with leveler land and better moisture conditions, favored experimental plantings.

Mahogany Provenance Trials -- In 1964 and 1965, seeds collected from natural stands of big leaf mahogany and Pacific mahogany on 18 sites in Mexico, Guatemala, Honduras, Nicaragua, Costa Rica, and Panama, and from small leaf mahogany in St. Croix, were germinated and planted in Puerto Rico and St. Croix. The different sources showed morphological differences in seed pods, leaves, and seedling characteristics, as well as survival after planting, susceptibility to shoot borer attack, and growth rates. In 1990, four months after the passage of Hurricane Hugo, the small leaf mahogany and the northern sources of big leaf mahogany showed the most resistance to storm damage. A more recent analysis of the provenance study showed:

- mahogany had 10 times more genetic variation among species than among provenances
- big leaf mahogany showed the greatest mean growth (height, diameter, and volume)
- both species and several populations showed distinct responses in survival and growth when exposed to different life zones and soil types
- provenances became genetically more distinct with an increase in distance among sources

Hybrid Mahogany -- Big leaf and small leaf mahogany hybridize where they grow in proximity. In 1960, a trial of small leaf, big leaf, and hybrid mahogany was established at 11 sites on St. Croix. Hybrid mahogany appears to combine the drought resistance and wood quality of small leaf mahogany with the faster growth of big leaf mahogany. The hybrid also has better form than small leaf mahogany and may be more resistant to shoot borer damage than big leaf mahogany.
Other Mahogany Studies -- Other formal studies were carried out with mahogany including root pruning of nursery stock, thinning stands by peeling and frilling unwanted competition, planting plum pudding mahogany (with an attractive grain), and planting Pacific coast mahogany.

Cedrela Provenance Trials -- In 1969, seeds from eight provenances of *Cedrela (C. odorata, C. mexicana, C. tubiflora)* collected from Argentina, Belize, Costa Rica, Jamaica, and Mexico were planted in Puerto Rico and St. Croix. Differences in several performance factors were observed in the nursery phase, and seedling growth differences after outplanting. The overall conclusion was that none of the provenances grew satisfactorily on any of the sites.

Teak Provenance Trial -- The teak planted in Puerto Rico, and subsequently introduced to St. Croix, originated in Burma and arrived via Trinidad. To determine if other provenances were available that grew better, a trial was designed to test 16 teak seed provenances -- 11 from India, 3 from Thailand, and 1 apiece from Indonesia and Ghana. In 1975, two sites in Puerto Rico, and one in St. Croix were planted. By 1986, an Indian provenance showed the most rapid growth. Estate Thomas was judged as a poor site for teak. Later, teak was also shown to be heavily impacted by hurricanes.

Species Adapatability Trials -- Between 1961 and 1966, bare root seedlings of 14 exotic tree species including five conifers were tested at seven sites on St. Croix for their suitability as fast growing timber and urban trees. The results showed that: seven species, including all of the conifers, were unsatisfactory; hybrid mahogany and small leaf mahogany were adapted; two species merited further trials; two species were interesting because of hybridizing potential; and one species was questionable.

Other Plantings -- In 1969, lignumvitae, listed as endangered in the Virgin Islands, was planted at Estate Thomas where it has grown successfully for 23 years.

Conservation, Education, and Demonstration
Population growth and urban sprawl on St. Croix have placed pressures on existing forest land. The major values of many remaining secondary woodlands are for wildlife habitat, recreation, soil and watershed protection, and aesthetics. The IITF, working with its partners on St. Croix, is developing a local capacity in urban and community forestry, providing assistance to landowners, helping with programs in fire protection and forest health, and continuing multiple use management on Estate Thomas. The major S&P activities are:

- **Estate Thomas: management situation** -- unpublished document describing the site, vegetation, wildlife, resource and management issues, and social and economic environment.
- **Management planning** -- planning for Estate Thomas involving government agencies, non-government organizations (NGOs), the university, the island's high school, environmental groups, and the public. Moreover, special use permits could be issued for school projects, research by IITF cooperators, small leaf mahogany harvest for artisans, and special events.
- **Forest stewardship plans** -- plans were developed for Estate Thomas and with private landowners on St. Croix to better manage their forest resources, maintain the productivity of their lands, and increase their economic and environmental values.
- **S&P management practices** -- the practices were aimed at forest protection and tree use and included cooperative activities during the 1990 Pink Mealy Bug infestation, fire protection measures with the Virgin Islands Fire Department, timber salvage operations at Estate Thomas after Hurricane Marilyn of 1995, and the planned transplanting of young mahogany trees from Estate Thomas to select urban sites.

Potential Role of Estate Thomas
St Croix has several protected areas under the management of U.S. government agencies (e.g., the Park Service and Fish and Wildlife Service), the Virgin Islands government, NGOs (e.g., The Nature Conservancy, St. Croix Environmental Association, St. Croix Landmarks Society, and St. George Botanical Garden), and private holdings. Some of the estates are managed as wildlife habitat to protect plant and animal species and have restrictions on use. Others are for intensive use such as aquatic recreation and sports, or highlight the island's historic and cultural past.

What could Estate Thomas offer that is not emphasized elsewhere on St. Croix? The estate uniquely serves as the only large public forest located in the most congested part of St. Croix, the Sion Farm subdistrict, where one-quarter of the island’s population resides. Its location is central -- near Christiansted, the Agricultural Experiment Station, the university, the high school, and the Cruzans. At least one tourist guide recognized the estate as St. Croix's experimental forest, mentioning past...
plantings of lignumviate, teak, and mahogany. With little effort, Estate Thomas could serve as an outdoor laboratory where residents and visitors may observe current and past forestry research and protected areas management, as follows:

**Flora --**
- demonstrating the role of St. Croix in forestry research (plantations, adaptability studies, species trials, and provenance work) using seeds from throughout the world
- managing small leaf mahogany timber for demonstration and educational purposes, including thinning, and selective harvest of small amounts of high value timber for the production of furniture and handicrafts by the island's artisans
- pruning and transplanting small leaf mahogany for island shade tree projects such as Market Square
- evaluating native tree species for restoration of Estate Thomas and planting elsewhere on St. Croix (germination requirements, early growth, and methods for establishment on degraded sites)
- studying the ecology of forest trees and shrubs, notably rare native species
- determining tree species-site relationships, notably for urban trees
- determining the role or impact of invasive plant species
- improving wildlife habitat at Estate Thomas
- conducting periodic inventories and monitoring permanent plots to assess changes in forest structure and composition at Estate Thomas and elsewhere in the Virgin Islands

**Fauna --**
- assessing and monitoring wildlife species
- determining habitat requirements for declining or threatened native species
- Recreational Opportunities
- establishing hiking trials for bird watching and learning more about the forest
- constructing walk-up towers with views of Christiansted harbor and St. Croix's southern shoreline

**Educational Programs**
- field laboratories for high school science programs in a natural setting (e.g., the permanent demonstration plot established for long-term ecological research near the main gate on Centerline Road in April 2004)
- developing interpretative signs for important sites (e.g., historical, cultural, botanical, research, scenic views) at Estate Thomas
- explaining the value of tree species found at Estate Thomas (e.g., as forage for deer, or for landscaping, medicinal uses, or to attract bird species to home gardens)

St. Croix is the island where history is treasured, the place to which people come from afar to view the ruins of the sugar cane plantations and to know more about their ancestors, information archived at Estate Whim. The Forest Service should add to this legacy by highlighting the role St. Croix in international forestry. The Cruzans who want the Forest Service to remain at Estate Thomas would certainly embrace this modern day addition to their island's heritage.

**Acknowledgments**
This paper drew heavily on the previous work of Robert Nobles, Juan Muñoz Cortés, and Frank H. Wadsworth of the IITF, and Eric (Larry) Bough, formerly with the Virgin Islands Agricultural Experiment Station. Shiel Ward's excellent history of research at Estate Thomas, provided a useful guide. Grizelle Gonzalez and David Laband made helpful comments on the text. This work was done in cooperation with the University of Puerto Rico at Rio Piedras.
Introduction:
To aid in preserving urban parks, gardens, and street trees, scientists and modelers are developing quantitative methods to assign monetary value to urban trees as a sink for the removal of airborne pollution. Our study focuses on quantifying the potential for urban trees to reduce fine particulate pollution (PM$_{2.5}$) concentrations in the air people breathe. The Environmental Protection Agency (EPA) defines PM$_{2.5}$ as a class of regulated particulates based on a size designation of $\leq 2.5\,\mu m$ mean diameter. PM$_{2.5}$ is considered to be a hazard to human health if concentrations exceed EPA regulatory limits. The current National Ambient Air Quality Standards (NAAQS) for PM$_{2.5}$ are a 24-hour average = 65 $\mu g\,m^{-3}$ and an annual average = 15 $\mu g\,m^{-3}$ (US EPA, 2004). PM$_{2.5}$ particles penetrate into the deeper regions of the respiratory system and are associated with asthma, the onset of chronic bronchitis, heart arrhythmias, heart attacks and even premature death (Peden, 2005; Bernstein, 2004). Daily mortality in six U.S. cities was strongly associated with short-term increases in PM$_{2.5}$ concentrations (Vedal, 1997).

Conventional wisdom indicates that trees collect dust, and they are commonly planted as barriers to airborne pollution. A number of studies have quantified the dry deposition of ozone and other gaseous pollutants as well as coarser particulate matter, PM$_{10}$ (mean diameter $\leq 10\,\mu m$), in the urban forest. The USDA Forest Service uses quantitative modeling to assess the health and value of the urban forest in Chicago, IL and Brooklyn, NY in the following reports. McPherson et al. (1994) quantifies the benefits and costs of planting and maintaining trees in Chicago and focuses on climate, air quality, atmospheric carbon, and energy used for heating and cooling. Nowak et al. (2002) estimates that hourly air quality improvement in Brooklyn due to removal by trees averages 0.26 % for ozone and 0.25 % for PM$_{10}$. Estimates are based on the UFORE-D model, which assumes 50 % re-suspension of PM$_{10}$ and correlates average daily EPA concentrations with a detailed survey of tree-canopy coverage and deposition velocities from the literature. Deposition velocity ($V_d$) is defined as the flux of particles to a surface divided by the concentration of particles in the air stream, and it is a function of pollutant properties, surface properties (including roughness and the amount of deposition surface), atmospheric stability, and wind speed. One of the difficulties with interpreting many reports in the literature is that they often neglect to measure concentrations in the air and rely on particle concentrations on the leaf surface to quantify $V_d$ (Lovett, 1994; McMahon and Denison, 1979; Ould-Dada and Baghini, 2001; Shaw et al., 1994). One study examining both surface and airborne concentrations used gravimetric analysis to determine total particulate loads on leaves and scanning electron microscopy to determine particle sources, but the results do not provide a size distribution for particle load; neither do they distinguish between PM$_{10}$ and PM$_{2.5}$ (Beckett et al., 2000). EPA PM$_{2.5}$ methods for continuous monitoring are gravimetric, and therefore some of the accuracy associated with the size distribution of individually counted particles is lost. Furthermore, respiratory function is affected to a greater extent by the number of particles than the total mass, which is biased in favor of larger particles. A single 2.5 $\mu m$ particle has as much mass as many smaller particles. Count-based concentrations are the preferred alternative to mass-based measurements. However, particle counts obtained through surface analysis can be misleading because the amount of surface that can be examined is limited by the time required to make the counts. Wash off methods that capture particles on a filter for subsequent analysis under SEM share this problem plus the added limitations of particle loss during processing and ambiguity in particle identification. Both gravimetric analysis and surface microscopy may not always detect real changes in PM$_{2.5}$ concentration over time. Our primary objective is to systematically measure species-specific PM$_{2.5}$ deposition and re-suspension velocities using both surface and air-dependent concentrations as a function of varying leaf area and surface characteristics, while maintaining the source and concentration of PM$_{2.5}$ particles, atmospheric stability, and wind speed. These data will be an important contribution to the extension the UFORE-D model to smaller particles.

Materials and Methods:
Surface Analysis:
Instruments of analysis were selected in order to calculate $V_d$ by examining fluxes of PM$_{2.5}$ concentration on leaf surfaces and in the air. A Micro-XAM non-contact surface profilometer using
**MapVue** analysis software (ADE Phase Shift, Westwood, MA) was used to determine an overall value for the average roughness of the leaf surfaces of 2 urban tree species, both abaxial and adaxial sides, and 1 sandpaper reference surface (150 grit). Results are summarized in Table 1. Three species, *Pyrus calleryana*, *Platanus x acerifolia*, and *Picea abies* were selected to bracket a wide range of surface features and leaf morphologies. *Picea abies* was not characterized using the surface profilometer because the needles were too thick for the fine scale instrument. We chose the root mean squared deviation in surface height to be the numerical value for surface roughness and assigned a total value for apparent roughness to each side of the leaf for each species based on the spatial averages of different regions on the leaf surface. First-degree (1°) roughness elements are defined as primary veins. Second-degree (2°) roughness elements include any veins that are not a primary veins. And finally, third degree (3°) roughness elements constitute all the leaf area that is not occupied by veins. Apparent roughness for *Platanus x acerifolia* differed greatly between greenhouse and field collected samples indicating that trichome density is a function of the degree of environmental weathering to which the leaf is exposed.

**Sources of PM$_{2.5}$:**
Arizona Test Dust (Powder Technology Inc., Burnsville, MN) is calibrated specifically for filter testing in wind tunnels (Kievit et al., 1996; Fletcher and Bright, 2000; Sreenath et al., 1996; Lehtimäki and Heinonen, 1994). Arizona Test Dust (ATD) is mainly composed of SiO$_2$ and Al$_2$O$_3$ with traces of Fe, Na, Ca, Mg, Ti, and K. The particle size distribution is 0.67 – 20.0 μm with a mean diameter of 3.8 μm. Fluorescent powder (@utomated Entertainment, Little Rock, CA) is a non-toxic pigment for cosmetics and was selected for its bright orange fluorescent signal under UV illumination and small particle size. Fluorescent powder is not pre-calibrated for size distribution, and the manufacturer would not reveal the proprietary chemical composition. We used an aerosol spectrometer (Model 1.108, GRIMM Technologies, Inc., Douglasville, GA) to measure the particle size distribution within the range of 0.37 – 20.0 μm. The size distributions for both ATD and fluorescent powder are shown in Figure 1. Concentrations below 1 μm diverge, and although the concentrations appear very low for the ATD, a closer look at the y-axis reveals the concentration is about 1 million particles m$^{-3}$. Size distributions were measured after suspension and circulation in a closed loop wind tunnel.

**Wind Tunnel:**
We designed a closed loop, variable speed wind tunnel to maintain a controlled air flow (0.85 m s$^{-1}$ in the center of the working section near the outlet transition to the return loop) and contain an injected pulse of PM$_{2.5}$ dust. The working section of the wind tunnel is a horizontal rectangular column with a cross section of 40 x 40 cm and a length of 238 cm. The sides of the working section are equipped with glass and wooden doors for easy insertion and monitoring of vegetation samples.

We fabricated a particle generator consisting of a 40 l acrylic cylinder containing a reservoir of particles several cm deep on the bottom. Particles are suspended in the headspace in a high velocity vortex created by a 0.5 HP squirrel cage fan plumbed into the cylinder through tangential ports at the top and bottom in a re-circulating loop. Particles are bled from the headspace in timed pulses via a Venturi tube, passed through a Kr-85 aerosol neutralizer (Model 3012A TSI Inc., Shoreview, MN) to eliminate static created inside the generator, and introduced into the tunnel upstream from the working section to ensure mixing before reaching the sample.

**Decay Curves and Deposition Velocity ($V_d$) Calculations:**
Three tree species, *Pyrus calleryana*, *Platanus x acerifolia*, and *Picea abies*; two commercial furnace filters; and a flake of hay were tested in the wind tunnel for filter efficiency. Downstream PM$_{2.5}$ concentrations were measured every six seconds using the aerosol spectrometer for each filter and then compared to empty tunnel concentrations. These values were used to generate decay curves for treatment comparisons. Excised leaves and branches for each species were tested separately in the tunnel at both typical densities found in natural canopies and at densities far above what would occur naturally. Each test consisted of an initial period of air circulation to establish a baseline concentration, a 10-second pulse of suspended ATD, and re-circulation of the particulate plume until it decayed back to background. The temperature and relative humidity inside the tunnel was recorded once every minute during sampling.

Deposition velocity (cm s$^{-1}$) is defined as the flux of particles to the test surface (# cm$^{-2}$ s$^{-1}$) divided by the concentration of particles in the ambient air (# cm$^{-3}$). The decrease in ambient concentration over each 6-second interval is a function of deposition to the surfaces inside the tunnel, including the inner walls of the tunnel as well as the surface area of our samples. A range of $V_d$’s was calculated directly
from decay curve data for the empty tunnel, each of the test species, commercial reference filters, and the hay flake. These \( V_d \)'s represent the net balance between deposition and re-suspension over the sampling period.

\( V_d \) Calculations using Fluorescent Particles:
An Olympus BX60 System microscope using UV illumination, FlashPoint 128 video camera, and Image-Pro Image Analysis software (Media Cybernetics, Silver Spring, MD), was used to determine fluorescent particle concentrations on leaf and sandpaper surfaces. \( V_d \)'s for both adaxial and abaxial sides of \textit{Platanus x acerifolia} were compared to the 150-grit sandpaper reference surface. Samples were prepared by fastening each test surface to a glass slide using Krazy glue. Each sample was inserted into the tunnel containing high PM \textsubscript{2.5} concentrations and exposed for 2 minutes. Fluorescent particle counts on the test surfaces were used to determine the flux term (# cm\textsuperscript{-2} s\textsuperscript{-1}), and \( V_d \)'s were subsequently calculated. Deposition velocities calculated using both air and surface dependent variables were compared.

**Results:**
Filters comprised of leafy branches arrayed inside the tunnel at natural densities had no observable effect on the ambient PM \textsubscript{2.5} concentration inside the tunnel. The large air spaces between leaves and branches in their natural configuration allow micron-sized particles to pass through with very little potential for surface contact. Decay curves for each of the tree species in densely packed configurations, commercial filters, and the hay flake are compared with empty tunnel decay in Figures 2 through 6. Plots of the natural log of count concentration with time determine the decay constants for each set of conditions. Table 2 compares the leaf area index (LAI) and leaf density for each of the 3 species and the hay flake with closed canopy LAI's from the literature. There is no filtering effect for densely packed \textit{Pyrus calleryana}. Figures 3 and 4 show a more rapid decay for \textit{Picea abies} and \textit{Platanus x acerifolia}, but only at these extremely high densities. Therefore, the filtering effect measured here is not biologically relevant; these high densities will never occur in naturally growing vegetation. The decay curve for the hay flake starts to approach those measured for the commercial filters. The leaves contribute to the resistance term, where the flux of particles to the surface is a function of the potential resistance gradient of the medium. Leaf area per se has no effect on filtration rate and approaches that of a deliberately designed air filter only when the leaves are tightly compressed against each other.

Deposition velocities for each of the test filters are summarized in Table 3. \textit{Pyrus calleryana} has the lowest \( V_d \) by an order of magnitude. \textit{Picea, Platanus}, and the empty tunnel inner surface all have \( V_d \)'s that are similar. The flake of hay is one order of magnitude greater, and the commercial filters have the largest \( V_d \) for PM \textsubscript{2.5}. The UFORE model (Nowak et al., 2002) uses an average \( V_d \) of 0.064 cm\textsuperscript{-1} s\textsuperscript{-1} for PM \textsubscript{10} for all tree species and multiplies that by the cumulative leaf area index of the mixed urban forest. Our results show that \( V_d \) is species specific for PM \textsubscript{2.5}, and it is likely that PM \textsubscript{10} deposition is also species specific. Using an air-dependent variable to measure \( V_d \) is a more accurate approach to modeling particulate removal because it reflects what people are actually breathing, rather than what happens to be on the surface of a leaf at any given time. Concentrations were recorded over the entire pollution event, and the resulting \( V_d \)'s reflect both deposition and subsequent re-suspension from the test surfaces.

Deposition velocities measured by counting and sizing particles directly on leaf surfaces were examined for abaxial and adaxial surfaces of \textit{Platanus x acerifolia} and a 150 grit sandpaper reference surface. These samples were exposed to high concentrations of fluorescent powder for 2 minutes. \( V_d \)'s calculated using this surface-dependent variable differed greatly for the abaxial side of \textit{Platanus}. This is most likely due to a greater trichome density on the abaxial surface. \( V_d \)'s and apparent roughness values for both sides of \textit{Platanus} and the sandpaper reference are summarized in Table 4. The abaxial side of \textit{Platanus} has a greater apparent roughness due to the high density of trichomes, and this resulted in a particle density of 157 particles mm\textsuperscript{-2}. The adaxial side was much smoother, and the particle density was only 3 particles mm\textsuperscript{-2}. This was the same for the sandpaper surface eventhough it had a higher apparent roughness. We can conclude that not all leaf surfaces or sides of a leaf are created equal in terms of PM \textsubscript{2.5} deposition, and likewise, not all roughness elements retain particles as effectively as others. Deposition velocities calculated by air-dependent variables can differ by several orders of magnitude to those found via surface analysis.

**Discussion and Conclusions:**
Species-specific deposition velocities were measured for \textit{Pyrus calleryana}, \textit{Picea abies}, and \textit{Platanus x acerifolia} using ARD as a source for PM \textsubscript{2.5}. Surface-specific deposition velocities were measured for both sides of \textit{Platanus x acerifolia} and a 150 grit sandpaper reference using fluorescent particles as a source for PM \textsubscript{2.5}. Trichome density has a large

Urban Rural Interface Conference Proceedings
The leaf surfaces of \textit{Platanus x acerifolia} are not uniform in trichome density which results in a wide range of deposition velocities for a single leaf (0.00571 cm/s, adaxial; 0.299 cm/s, abaxial). \(V_d\)'s calculated from tunnel decay measurements do not capture fine-scale differences such as particles concentrated on trichomes, and fine-scale variation creates a sampling challenge when attempting to characterize a large amount of surface area (i.e., groups of leaves and branches). We plan to address these differences in a follow-up experiment that will test both methods of \(V_d\) calculation, via air concentrations and surface concentrations simultaneously for \textit{Pyrus calleryana}, \textit{Tilia tomentosa}, \& \textit{Tilia cordata}. We will insert both packed leaf area configurations and microscope slides secured with the same species into the wind tunnel and expose them to the same dose concentration of fluorescent particles. Both air concentrations and surface counts will be used to calculate \(V_d\) independently for each of the 3 species. Both abaxial and adaxial sides of \textit{Tilia tomentosa}, \& \textit{Tilia cordata} have been characterized by the non-contact profilometer. We selected these because we are interested in comparing \(V_d\)'s for different species within the same genus that have radically different surface textures.

Questions arise about the effect of humidity on deposition velocity. We know changes in humidity can potentially change the viscosity of air, affect electrostatic charges on both particles and surfaces, and initiate changes in particle aggregation. Although the results are not presented here, we do have relative humidity and temperature data for all of our wind tunnel experiments, and we are planning a statistical analysis to include humidity as a covariate in order to determine if it has affected the \(V_d\)'s measured in these experiments. Relative humidity was not controlled for these experiments, but there were no drastic changes recorded over the sampling time periods. Questions also arise about the effect of surface wetness, and we have planned another experiment to isolate this effect. We will insert \textit{Tilia tomentosa} and \textit{Tilia cordata} secured to microscope slides in the wind tunnel, and compare PM \(_{2.5}\) \(V_d\)'s to dry and wetted surfaces using the surface counting techniques employed with \textit{Platanus}.

In order to see the larger processes of PM \(_{2.5}\) deposition, it is not enough to look at the leaf surface and get a number for \(V_d\). Scientists have to start quantifying what remains in the air after it passes through a putative filter if we are to get accurate estimates of what people are actually breathing. PM \(_{2.5}\) needs to be controlled at the source. Trees provide many benefits to people in urban areas, but planting trees will not reduce PM \(_{2.5}\) concentrations in the air we breathe.

**References:**


Peden, David B., 2005. Journal of Allergy and Clinical Immunology 115(2), 220.


The Hidden Forests of the Amazon: issues surrounding the protection and use of urban forests in Belém, Brazil.

Brenda Baletti, Department of Geography, University of Texas at Austin

Research addressing forests in the Amazon traditionally focuses almost exclusively on development and deforestation in rural areas. Recent research on urbanization in the Amazon centers on the processes driving systemic change and settlement patterns in smaller cities on the frontier (Browder and Godfrey 1997). However, urbanization in the Amazon region also affects established metropolitan areas whose spatial composition continues to change (Lima 2001), resulting in a situation where vast undeveloped forest spaces remain inside and on the periphery of urban areas. These urban forests are unique and fundamental elements of the urban/rural interface. Because these essentially rural spaces exist within the urban landscape their structure is dependent on ecological, political, and economic issues that span the urban/rural divide. The activities and issues surrounding their development and use traditionally though of as “urban” or “rural” such as urban housing, extractivism, and natural resource management become blurred, complicating governance of these areas.

Belém, Brazil contains several forests within the city and on its periphery that have experienced both deforestation and intensified management over the past decade. Urban forest users and managers must negotiate a complex network of laws and policies pertaining to these spaces. This paper will consider the issues surrounding protection and use of the urban forests managed by the municipality of Belém, and the state of Pará.

Growing international environmental awareness manifest in concern over worldwide biodiversity loss and climate change over the past few decades has focused international attention on the Amazon region and affected government policy there. In the 1980s and 90s, international aid organizations such as the Inter-American Development Bank and the World Bank began to include environmental protection clauses as conditions for loans. There has also been a proliferation of national and international NGOs working throughout the region. The worldwide focus on “sustainability” that grew out of the 1992 United Nations Conference on Environment and Development in Rio de Janeiro has been integrated into Brazilian federal policies. As these concerns and policies become institutionalized, the government is enforcing previously un-enforced laws as well as creating new ones. Recently, poverty alleviation has also become part of the conservation package, and some foreign governments have begun to mandate poverty alleviation as a condition of project funding (Fearnside 2003)

Worldwide neoliberal and decentralization reforms have been championed by their proponents as offering strategies for improving public sector efficiency as well as offering greater accountability and transparency in government (Willis et al 1999). Brazil has not been an exception to the larger pattern of decentralization processes of Latin American governments. As a result, state and municipal governments are delegated more responsibility for a wide array of different services including natural resource management. In practice, the benefits of decentralization have been highly variable, demonstrating that the benefits of these reforms are not automatic (Anderson 2003). Where shifting responsibility is not accompanied by the establishment of a legal, physical, social and fiscal infrastructure to support the transfer of power, the results can be complicated.

Urban Forest managers implementing the new or at least newly implemented policy within changing infrastructures must negotiate not only environmental policy where municipal, state and federal governments often have conflicting priorities (Fearnside 2003), but also the interests of the urban population. These issues plague most major Brazilian cities and generally surround ideas of access and property. In Belém, where there is an extreme shortage of urban housing and employment, illegal, but socially sanctioned and economically necessary practices such as illegal land occupation and extractivism are common and pose some of the greatest challenges for managers.

Below, I briefly describe the current situation surrounding the urban forests of Belém, Brazil. Then I review and analyze four key pieces of federal legislation that directly or indirectly affect urban forest management: the forest code, the Brazilian Constitution, the National System of Units of Conservation, and the City Statute. Within this analysis, I discuss the complex set of social and environmental issues that arise in these uniquely urban and rural spaces. I conclude with a discussion
of the limitations of the current system to address these issues and emphasize the need for flexibility among policy makers, communication among stakeholders, and conflict resolution strategies.

**Urban forests in Belém**

Belém, a city of nearly 1.4 million people in Northern Brazil, is the capital of Pará and the principal port city and urban center of the eastern Amazon. It is a low-lying peninsular city distributed over a mainland and 43 islands. Established as a center for trade and geopolitical control by the Portuguese in 1616, Belém became a major urban center during the rubber boom 1872-1920. In the 1950s and 60s, with the regionalization of the Amazonian region, the city began a second period of rapid growth.

Since this time, the urban periphery has been the target of various types of occupation. Initial urban growth was characterized the establishment of large restricted areas of relatively undeveloped institutional land. The subsequent proliferation of the urban poor resulted in two additional types of development in these areas: **conjuntos** or state housing projects, and illegal occupation, called “invasions”, of both public restricted access, and private land by the urban poor. Though the population explosion in urban Belém has slowed considerably, the housing deficit remains one of the most significant problems facing urban development (Lima 2001). Today, Belém is a city with intense socio-spatial segregation and the urban periphery is affected by not only housing demands by migrants and the urban poor, but also suburban real estate development.

The precise definition of “urban area”, especially in Amazonian cities, is a highly debated subject that has been extensively addressed by other authors and will not be discussed in depth here (Veiga 2002). The majority of the islands that comprise Belém are scarcely populated (<2 people per hectare) and many remain completely forested, whereas ninety-seven percent of the municipal population of 1.4 million people resides on continental Belém (Paranaguá et al. 2003). Therefore, in this investigation, I considered mainland Belém to represent the urban area. To understand change in Belém’s forests, the reason for intensified management, I analyzed satellite imagery (Landsat TM and ETM+)1 from 1986 and 2001. The urban forests of mainland Belém have lost 47% of their previously forested area, or an average of approximately 2.7 % deforestation per year (Figure 1).

The forests that remain within urban Belém are nearly all located in restricted areas managed by the municipal, state, or federal government, and are organized into different types of units of conservation. These units range from individual street trees managed by the municipality, to small urban parks managed by the city or federal research organizations, to large closed canopy protected areas managed by the city or state governments. There are also large tracts of forest, often near the urban periphery located on institutional or military property managed by the federal government. With the exception of two small (fee entrance) parks located near the urban center, all of the green areas containing urban forests have either highly restricted access or no access at all for urban residents. The Municipal Secretary for the Environment (SEMMAR) was established in 2003. Municipal level laws for urban forest management do not yet exist, therefore the municipality and the state government draw primarily on federal policies.

The forest code, (federal law 4771/1965) enacted in September 1965, legally provides complete and permanent protection for forest and other vegetation existing in specific areas. These protected areas are called Areas of Permanent Preservation and include forests and other types of vegetation located near water and the surrounding areas, the tops of hills and mountains, areas with an incline of more than 45%, the edges of plateaus, areas with an altitude above 1800 meters, any forest that stops erosion, secures dunes, provides protection along roads, provides defense for national territory, has exceptional beauty or scientific or historic value, provides habitat for flora or fauna threatened with extinction, or secures conditions of well-being for the public. The Forest Code has clear implications for urban forests as these forests fall into many of the above mentioned categories. In Belém, because the municipality does not yet have its own specific code for protecting these spaces, the Forest Code remains one of the major legal sources for forest conservation. However, many spaces protected by the law have not actually been protected.

In Belém, socio-spatial segregation tends to marginalize poor people from the more advantageous geographical position and many people have settled in the flood plains along rivers, lakes, and igarapes (small channels), establishing large baixadas (inundated areas occupied by the poor) in various parts of the city in areas that are theoretically protected by the Forest Code. This phenomenon is not specific to Belém. The distribution of urban poor into geographically precarious areas has been part of the urbanization model of the majority of large

---

1 Satellite imagery generously provided by Imazon, an NGO in Belém. Imazon technicians classified the imagery into urban area, forest, and water. I conducted the analysis of change based on their classifications.
Brazilian cities. Though these settlements exist contrary to the Forest Code, their presence is sometimes regularized by the public power through urban legislation, or more often, ignored and allowed to expand. The Forest Code has been systematically ignored or suppressed in many Brazilian cities due to poverty and the proliferation of these settlements.

In addressing environmental issues, the Brazilian constitution of 1988, specified that legislation should strive to organize conservation for “ecological equilibrium” and mandated “sustainability” (article 225). Urban and environmental policies are addressed in different sections of the constitution. The Urban Policy section focuses on ensuring social functioning of the city and regularization of occupied land and makes no mention of environmental issues. The environmental section outlines the protection of “nature” such as flora, fauna, and natural ecosystems.

After the UN Conference on Development and Environment, “sustainability” became part of the global development agenda, and achieved great popularity in Brazilian policy. Ideas that came out of this conference and the changing political climate inspired a movement in Brazil to reform environmental policy, initiating a shift to a more integrated conservation approach to land management as opposed to the previous preservationist approach which had often excluded human activity from protected spaces.

In July 2000, after ten years of contentious debate, the federal government implemented a new national system of units of conservation (SNUC law 9985/2000), which designed two categories of units of conservation (strictly protected areas and areas of sustainable use) along with a system of implementation that includes public participation. The controversy surrounding SNUC related to the “people in parks” question, which concerned creating units of conservation that would allow for the presence of “traditional” people within certain types of parks. Whereas the new legislation is sensitive to the needs of traditional people, it does not speak to the question of the urban poor.

SNUC contains only one unit of conservation, areas of environmental protection (APAs), which can be implemented in urban areas where a variety of property types and land use already exist. Generally, the objective in these areas is to organize the process of occupation, the use of natural resources, and to enhance the quality of life and general well-being of the proximate population. In practice, APAs (which actually existed prior to SNUC) have been historically difficult to manage (Podem 2001). According to officials at SECTAM, the state agency in Pará responsible for management of APAs, the spaces are so large and diverse, that their management is nearly impossible. In fact, the majority of APA inhabitants are unaware that they live within a unit of conservation and the managers do not have the resources to implement management measures for these usually vast spaces. The committees of various social actors which, according to the management plan should exist to manage these spaces in a way that accounts for a variety of interests, do not. APAS are therefore not effective tools for resource management.

Urban Forest managers in Belém tend to use the “Park” designation of SNUC to protect forests. This designation excludes both residents and extractivists from utilizing the forests for their purposes. The parks do not currently function according to their intended use, which includes both conservation and recreation, because the municipality and the state do not have the economic resources to provide the parks with infrastructure for tourism. Funding for these areas generally comes in the form of occasional one time grants from private agencies or the federal government, however the city has no constant source of funding for constant maintenance. Therefore, both state and municipal agencies have closed the parks to public use, are in the process of removing all people living within their boundaries, and police the areas to prevent new settlements or extractivists from entering them. They are able to meet management goals for conservation, but in doing so have eliminated nearly all people’s access to these spaces, which, according to their guidelines, are intended for certain types of public use.

As mentioned above the process of regionalization through road building in the Amazon in the 50s and 60s resulted in significant rural to urban migration, with migrants frequently settling in the baixadas (Trinidadde 1998). Nearly all Brazilian cities experienced a similar process, referred to as favelization of the cities. As land became valorized near the urban centers, the poor were bought or forced out, and settled in the nearest available areas, which tend to be environmentally sensitive and precarious. People that live in these areas not only lack land tenor, but also basic urban services such as water, sanitation, electricity and others. This method of land settlement proliferated throughout the country and became endemic. In the 1980s as the environmental movements began to take shape, so did movements for urban reform and social justice.

---

2 The “Environment” section, article 225, is listed under the “Social Order” section and “urban policy”, articles 182 and 183, is listed under the “Economic and Financial Order” section.
The goal of urban reform was to set a new standard in public politics that called for democracy, regulation of land use to provide a just distribution of benefits, and an inversion of priorities to favor the popular class (Ribeiro 2003).

The movement to implement urban reform with a view towards social and environmental justice along with regularization of land use was implemented legally with the establishment of the City Statute, federal law (10157/2001), to provide cities with a mechanism to address urban land use and the socio-environmental inequalities inherent in the process of development. Though the Constitution of 1988 addressed illegal occupation of land, legitimizing claims on private property that is occupied uncontested for 5 years (right of usucapão), local implementation was variable. The City Statute sought to establish norms for sustainable management and urban planning so that uses of urban property contribute to the well-being of the population and to environmental equilibrium. Though noble in its intentions, the statute has been highly criticized for being unrealistic in its goals. In practice, it is often impossible to attain social and environmental sustainability given current situations.

Illegal occupation of land in Brazil, though technically illegal public land, is common practice and a socially sanctioned activity. In Belém, several areas of forest have illegal occupations existing with them that are anywhere from 1 to 20 years old. The residents, especially those that have lived there uncontested for nearly two decades, believe that they have a right to stay, while the government managers want them to move out. The state housing department, COHAB, has implemented a program that moves forest residents to conjuntos. The residents argue that living in the forest provides them not only with a home, but with a livelihood because they practice agroforestry and resource extraction. They believe the government’s offer is unjust. Though some of the residents have organized into a community association to fight for their land, they have received no audience with government officials who intend to remove them from the forest regardless of their argument, because they live extremely close to the urban watershed. The two groups rarely communicate.

Conclusions
Given the complex social and political conditions surrounding urban forestry in Belém, it is not difficult to understand why the management system is not functioning effectively according to the generalized goals of decentralized government, or meeting the legal directives for management and use of these spaces, especially with regard to community access. Environmental mandates for protection, undeveloped political, social, and economic infrastructure for management along with social problems including lack of sufficient urban housing, and means for livelihood among the urban poor create a complex situation where urban social and rural environmental policies and goals have fundamental contradictions.

Figure 1: Urban Belém Forest Change 1986-2001
that managers must reconcile in management of these spaces.

For policy makers, restricting access to the forest offers an appealing method for which to meet management goals of resource conservation. The lack of participation by other forest stakeholders in the design and implementation of these policies, however, is troubling. If decentralization is truly to represent a shift from government to governance, there must be communication both within the government and with other actors who have an interest in the spaces. It has been suggested that municipalities that have developed institutions for repeated interactions between the government and the primary actors with interests in the area are more likely to be effective service providers in forestry (Anderson 2003). Because urban forests are such particular spaces, with a complex set of urban and rural interests involved in their management, these institutions are especially important.

Where local people, such as those occupying forest spaces and government managers with conservation concerns have directly competing interests, communication and specific conflict resolution strategies are essential. Finally, because existing social and environmental and urban and rural policies can be contradictory, management of these spaces would benefit from flexibility while a specific policy for such emerging issues is developed.

References


Stakeholder preferences among various forest management regimes at the wildland-urban interface

Randall P. Rawls; John M. Lhotka; Edward F. Loewenstein; Joshua M. McDaniel; Matthew F. Smidt, School of Forestry and Wildlife Sciences, Auburn University

Abstract
Socially acceptable forest management at the wildland-urban interface (WUI) is often limited to individual tree removal by arborists or other landscape professionals as trees succumb to overcrowding, insects and disease, or old age. Perhaps, the reason that a more proactive approach to managing forest health is rarely attempted lies in the fact that many natural resource managers find it difficult to communicate alternatives to landowners. These professionals typically describe the forest in numeric terms such as number of trees, basal area, and volume of wood per acre. Conversely, few landowners are familiar with such abstract descriptors and are more likely to consider management implications from a visual perspective (e.g. What will it look like?). With the ability to produce computer generated, graphical images of a forest stand, the Stand Visualization System (SVS) may offer forest managers and their constituents an interactive means of communication that bridges the gap between their two perspectives. To determine the limits of social acceptance of active forest management, SVS was used to project future forest conditions based on five treatment scenarios applied to a pine plantation prior to divestiture of the property by forest industry and its subsequent development. SVS was then used to graphically depict the forest at 0, 10, and 20 years following treatment. The five scenarios presented are alternatives to the typical ‘real estate’ cuts made prior to sale of property by forest industry. A survey was developed using the graphical and numeric information produced by modeling these alternative scenarios. It was designed to determine relative stakeholder preference for the aesthetics, economics, and wildfire potential associated with each regime over time.

Introduction
A trend of forest industry consolidation and woodland divestiture over the past decade, combined with the increasing population along the wildland-urban interface (WUI) have caused many pine plantations that were once in a rural setting to become more valuable as real estate. Wear and Greis (2002) cited urban sprawl as the primary threat to forestland in the south for the next 40 years. In fact, they state that approximately 31 million acres of forestland may be lost to development by the year 2040. As the population at the WUI grows, large contiguous pine plantations are being fragmented into to smaller residential properties. Economic factors, as well as social resistance to typical even-aged management practices such as clearcutting, use of herbicides and prescribed fires make plantation management difficult if not impractical on smaller tracts, particularly in close proximity to residential areas. However, due to a low tolerance of southern pines to competition and the associated threats of insect, disease and wildfire potential, simply abandoning typical management practices in favor of natural succession may not be in the best interest of the WUI stakeholders. Because the forested setting is often one of the primary attributes attracting new residents to the WUI, total removal of the plantation may be just as undesirable.

The goal of this study was to determine WUI preferences for five different management regimes that can both modify existing plantations so the resulting forest structure is stable and can feasibly be implemented by current forest operators. The factors of greatest concern associated with these management regimes include: aesthetics, economics, and wildfire potential.

Methods
Study Area
The study was located within a 40 hectare area belonging to Alabama Power Company and was of high real estate value due to its proximity to Lake Martin near Dadeville, Alabama. The site consisted of an 18-year old pine plantation that contained an overstory of approximately 27.5 square meters of pine basal area per hectare and another 1.9 square meters of hardwood basal area per hectare in the understory. Soils on this site are typical of the Piedmont soil region of Central Alabama. Slopes are moderate slopes and the site is transected by a stream that empties directly into Lake Martin at the edge of the property.

Treatments
Five treatments representing a gradient of removal intensities and spatial distributions were applied to the stand. These same treatments were projected 20
years into the future using the Forest Vegetation Simulator (FVS) growth and yield software. The treatments are as follows:

(1) No Removal – no removal was simulated throughout the projection period. The stand was allowed to continue growing without management. Regeneration is not expected to occur in this stand.

(2) Conventional removal – a typical fifth row thin with operator select on the residual rows, reducing the residual basal area to approximately 16.0 square meters per hectare. This treatment left most of the larger trees and provided them with resources needed for growth while relatively little regeneration is expected to occur.

(3) Heavy thin – a typical fifth row thin with operator select on the residual rows reduced the residual basal area to approximately 9.2 square meters per hectare. This treatment left only the largest trees and provided them with resources needed for growth while moderate amounts of regeneration are expected to occur.

(4) Strip Removal – complete removal of two strips totaling one third of the stand at each of three entries. The Conventional thin was applied to the residual portion of the stand at each ten year cycle. This treatment is the quickest means of converting the stand to mixed species and provides a protected view of the ongoing forest conversion from a downhill perspective. Large amounts of regeneration are expected in the strips.

(5) Maintenance Removal – a typical fifth row thin with operator select on the residual rows, reduced the residual basal area to approximately 16.0 square meters per hectare and maintained this amount throughout the life of the stand. This treatment results in progressively fewer but larger trees in the stand throughout time. Relatively little regeneration is expected during the projection period.

Factors of Interest
Three pieces of information from the projections are of particular interest:

- Aesthetics - SVS used FVS output to produce several images for each treatment. The time series of images included: initial stand conditions prior to any removal treatments, the post treatment stand, and an image of the stand at each ten year interval. Two view perspectives, a profile view and a perspective view, of each image were produced.

- Wildfire hazard - Using the fire and fuel extension of FVS, we produced a relative wildfire fire hazard based on flame length. Each image was assigned to one of three wildfire hazard categories including: low (0 to 1.19 meters), moderate (1.20 meters to 1.83 meters), and high (1.84 meters and higher).

- Economics - Each time the prescription called for a removal, a cost and revenue for each image and a net present value of each management regime was calculated over the entire projection cycle.

Additionally, an estimate of wildlife species one might expect to find utilizing the forest structure existing at each point in time, for each management regime is presented.

Each of these factors was included in the survey instrument.

Survey Instrument
A survey instrument consisting of two parts was produced to determine the preferences for each of the management regimes. Part I collected demographic data, knowledge of forest management, and experience with forest management. Part II asked the respondent to rate their preference for each image on a Liekert scale and to rank their preference for each alternative relative to the others. Each image included the aesthetic, economic, fire hazard, and wildlife information outlined above. This section of the survey also included a time series of images for each management regime.

Four different stakeholder groups were included in the target population including: (1) an urban residence group, (2) a rural residence group, (3) a wildland-urban interface residence group, and (4) all county commissioners in Alabama. The first three groups provide an idea of how the preference for each strategy will change across a population density gradient, while the commissioner group provides a policy perspective.

Results
We are currently in the data collection phase of the project. The management scenarios have been developed, the research protocol was submitted and approved by the Office of Human Subjects Research, the survey instrument has been finalized and tested, and the target population has been contacted and invited to participate in the survey. Completion of the study is projected for August 2005.

Literature Cited
Animal Logging Application in Urban Forestry

Suraj P. Shrestha, School of Forestry and Wildlife Sciences, Auburn University

Abstract - Forest harvesting with animals is a labor-intensive operation. Due to development of efficient machines and high volume demands from the forest products industry, mechanization of logging developed very fast leaving traditional horse and mule logging behind. A market niche for horse and mule loggers may be small woodlots in urban forestry. While mechanized logging is very efficient for large tracts of timber, it is often disruptive to the soil. Five different horse/mule logging performances for soil disturbance, damage to residual trees and cost of log production were studied in the US South in the partial cut of mixed pine/hardwood forests. About 75 percent of soil was undisturbed and 22 percent of the remaining soil disturbance was slightly disturbed. Only 3 percent of the soil was classified as deeply disturbed and rutted. Utilization of animals was averaged 22 percent and 44 percent for equipment for five animal logging operations studied. Average onboard truck logging cost was $28.12 per cord. In addition, very low noise pollution from animal logging is advantage in urban forestry. Low soil disturbance, residual tree damage and competitive harvesting cost in the partial cut in mixed pine/hardwood forests from horse and mule logging seems to be applicable for urban forestry with almost no noise pollution. More studies in this field will assist in the application of animal logging in urban setting.

Key words: Horse logging, mule logging, forwarder, side loading truck, long stick cable loader truck soil disturbance.

Introduction

The need for more lumber increased due to growing villages and later the booming towns of the eastern seaboard in the US (Creighton, 1997). Waterson (1994) pointed out that in the past; horses were one of the main sources of timber extraction. But after the potential for higher outputs and cost reduction from mechanization, horses were restricted to limited areas. Dykstra and Heinrich (1996) emphasized that proper forest harvesting operations must meet economic, silvicultural, environmental, and social objectives. In general, a logging operation can be divided into activities such as tree felling, limbing, bucking, bunching, skidding or forwarding, loading, and hauling to mills. Heinrich (1985) identified three levels of logging operations: 1) labor intensive, 2) intermediate technology, and 3) fully mechanized. Timber harvesting with animals is a labor-intensive. Environmental concern is increasing in logging operations. Utilization of manpower, machines, and/or animals is a key factor to increasing overall system productivity and reducing cost of harvesting per unit of timber. Available literature reports very little information on the ground disturbance, utilization of animal logging components and cost of log production particularly when machines are combined with animals including in urban forestry.

Objective

The goal of this study was to examine appropriateness of animal logging operations in urban forestry.

Methodology

Mainly, five types of animal logging operations working in partial cut with cut-to-length (CTL) during summer of 1999 to spring 2001 were invested in Alabama to determine soil disturbance, utilization of operators, system, functions (felling and processing of trees, skidding of logs and loading/forwarding of logs), animals, machines, and productivity and cost of log production. They were: 1) horses with forwarder (H/FWD), 2) mules with forwarder (M/FWD), 3) horses with side loading truck (H/SLT), 4) horses with knuckleboom loader (H/KBL), and 5) horse with long stick cable loader trucks (H/LSCLT). Ground slopes were almost flat with less than 10% for five animal logging operations. Other animal logging operations from US, and European countries were also investigated for discussion. Soil disturbances among different logging operations were compared.

Ground disturbance measurements: Systematic grids, 160 by 120 feet, were laid out in each harvested area within a week after harvesting but before any rain event. The grid covered both horse/mule and machine travel areas. To maintain uniformity among samples plots, north-south base lines were installed every 40 feet with plots placed every 40 feet along the lines. A total of 100 sample plots were taken for the five horse/mule harvesting operations. A 30-foot transects centered on and
perpendicular to the north-south base line was installed at each sample plot for measurement of soil disturbance. Lengths of soil disturbance by categories as used by Lanford and Stokes (1995) were recorded along transects. Least squares regression with dummy variables for the five horse/mule harvesting operations was used to compare soil disturbances.

**Utilization:** The proportion of time involved in each activity was obtained by work sampling of operators, functions, and animals/machines (Miyata et al. 1981). Observations were recorded at five-minute intervals for activities for each operator, animal, and machine indicating whether the activity involved production as the primary task, production as a secondary task, servicing, repairing, or idle time. Utilization was defined as the ratio of productive time to total time. Estimation of utilization, which was calculated as binomial variables, using least squares regression analysis.

**Cost:** Ownership, operating, and labor costs were established from personal interviews with owners and crewmembers using machine rate calculation methods discussed by Miyata (1986). Eight percent annual interest rate was used for the alternative rate along with straight-line depreciation and 5 percent for insurance as suggested by owners. Workman’s compensation in Alabama for these operations was $3.00 per cord, and Social Security (FICA) and Federal Unemployment Insurance (FUTA) were 9.65 percent of labor cost.

**Results And Discussion**

**Ground disturbance:** Summary of ground disturbances for five animal logging operations is shown in Table 1. Except undisturbed ground for horse with forwarder rest of animal logging operations had similarity in all coded of ground disturbances. Average of deeply disturbance and rutting was about three percent for five animal logging operations studied.

**Utilization:**

**Crew and function utilization**

Table 2 shows the function utilization and utilization of crew. Tree felling and processing function utilization among the crews found to be similar except the mules with forwarder crew, which was significantly lower. Log skidding function utilization had no significant difference between skidding with mules or horses with forwarder crews or horses with long stick cable loader truck crews. However, skidding with horses with side loading trucks or knuckleboom loaders had significantly higher utilization. Log loading and/or forwarding function for the horses with long stick cable loader truck operation was significantly higher than the horses with forwarder operation. Loading or forwarding utilization for the other crews was significantly lower. When utilization for the five animal operations was compared, mules with forwarder and horses with side loading truck operations had significantly lower utilization.

**Utilization of animals and machines**

Figure 1 compares the utilization of ten animals and figure 2 for machines. The two horses used in horses with forwarder crew were used equally as were the horses used with the knuckleboom loader crew and the mules in the mules with forwarder crew. Only the horses with side loading truck crew were used a disproportional amount of time. On average, animals were utilized 22 percent of the work day. When utilization of machines was compared, the forwarders had the highest utilization – 74 percent with horses and 68 percent with mules (Figure 2). The side loading truck and one of the trucks with long stick cable loader were used 24 percent. The knuckleboom loader was used the least. The situation for other long stick cable loader truck is described earlier.

**Cost and productivity:**

Table 3 summarizes crew size scheduled machine hour (SMH) per day, productivity and costs for the five animal logging operations. Average cost per cord for the five crews was $28.12 per cord for wood onboard truck with highest of $36.12 per cord from H/SLT and least at $19.30 per cord with H/LSCLT. It is noticeable that about 2/3rd of cost of log production were in labor expenses followed by variable costs.

**Comparison of ground disturbances:**

A comparison of ground disturbances for 16 logging operations having similar ground disturbance codes is shown in Table 5. Mechanical skidders and forwarding did more ground disturbance when compared to animal logging operations in combination with machines. Deeply disturbance and rutting was least from animal logging operations except for two mechanical harvesting methods reported by Sexia et al. (1995). When logging operations were grouped together, animal logging operations had the least deeply disturbed and rutting combined (2%) compared to mechanical forwarding (partial cuts) (10%), skyline (clear cut) (12%), mechanical skidding (clear cut) (17%) and mechanical skidding (partial cut) (21%).
Results from other studies on animal logging operations:

Anonymous (1995) reported that a horse/mule weighs about 1,600 lbs. This would be environmentally superior compared to a 10,000 lb mechanical piece of equipment. A logger and a horse can be hired for $125-$175 per day. Animal logging operation is a small scale harvesting operation total investment under $10,000 which is about the cost of a tire for skidder. Anderson (1995) concludes that horse skidding causes considerable less ground disturbance than tractor. Caudell (1995) identifies horse logging is better than heaving machines for environmentally sensitive areas, final felling in small wood stands, thinning, having sparse skid road network, extraction of seed trees and wind fallen timber, rough terrain and fuel-wood clearing. Damerrow (1994) found that ground impact is negligible from animal logging operations, well trained horse/mule do not depreciate, purchase and maintenance costs for animal logging are very low compared to mechanical and it could be used where machines are not accessible. Deignan (1997) confirmed that animal logging is quieter, less damaging to soil and can be profitable in short skidding distances compared to mechanical logging.

Greenwell (1996) reported selective logging operations with animals maintain health and growth of trees left behind and benefit the local economy compared to mechanical logging operations. Hedmen (1986) found animal logging operations suitable for very small area in final harvest, thinning areas with sparse road network, difficult terrain and extraction of fuel-wood.

However, in selective cutting, animal-powered skidding costs more than mechanized logging. McNamara and Kaufman (1985) found that horse logging can compete economically with tractor in dense stand but it is slower and takes longer time to log. Horse logging is a viable alternative for small landowners who are concerned with the visual impact of logging. Waterson (1994) emphasized animal logging operations have minimal ground compaction and disruption, negligible damage to standing crops with suitability for small and difficult areas. However, he found that animal logging had limited output, limited extraction distance and the care of animals was needed throughout the year.

Conclusion

Results from this and other studies show that animal logging operations have very low soil disturbance so can be applicable in urban forests where soil disturbance is big concern to maintain clean water. In addition, animal logging operation with short skidding distance can be useful in where wide roads are limiting factors. The nature of equipment used in animal logging operation confirms that it has very low noise level compared to mechanical logging. Mostly, animal loggings are used for selective logging to maintain the health of the forest and are more visually - appealing compared to mechanized operation.

Animal logging operation could be considered to be economically viable in small forest areas in urban forests compared to mechanical harvesting due no move-in cost. Low start-up cost and low input for log production from animal logging should be considered as an advantage compared to mechanical harvesting in small tracts of urban forests. SMH from five animal logging operations in Alabama revealed that there is room to increase the log production with increase of 20% of SMH per day. By increasing daily scheduled work hours, cost of log production could be reduced below $28.12/cord by reducing fixed hourly costs.

Animal logging operations in Alabama had 22 percent utilization of horses or mules and 44 percent for machines. Thompson and Sturos (1984) found utilization of horses up to 60.5 percent in California. Fieber and Robson (1995) however, found utilization of horses to be 36.6 percent in northern USA. This indicates that there is an opportunity to increase utilization of animals in Alabama as well for machines. This could be possible by coordinating the three functions (felling and processing of trees, skidding of logs and loading/forwarding) and reducing delay time. Labor input is the major part of expenditure in animal logging eventually provides long-term benefits to local labor employment. More research and training are needed to improve utilization, productivity, and lower the cost of log production of animal operations for its further applications in different situations.

Literatures Cited

Table 1. Summary of ground

<table>
<thead>
<tr>
<th>System</th>
<th>Disturbance percent with code</th>
<th>Total Disturbance (2+3+4)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Undisturbed</td>
<td>Slightly disturbed</td>
</tr>
<tr>
<td></td>
<td>(1)</td>
<td>(2)</td>
</tr>
<tr>
<td>H/FWD</td>
<td>78.5</td>
<td>19.6</td>
</tr>
<tr>
<td>M/FWD</td>
<td>84.3</td>
<td>9.0</td>
</tr>
<tr>
<td>H/SLT</td>
<td>62.8&lt;sup&gt;b&lt;/sup&gt;</td>
<td>30.8</td>
</tr>
<tr>
<td>H/KBL</td>
<td>74.1</td>
<td>25.6</td>
</tr>
<tr>
<td>H/LSCLT</td>
<td>73.4</td>
<td>26.2</td>
</tr>
<tr>
<td>Average</td>
<td>74.6</td>
<td>22.2</td>
</tr>
</tbody>
</table>

<sup>b</sup> = significantly different from others.

Table 2. Crew and function utilization for five animal logging operations

<table>
<thead>
<tr>
<th>Utilization type</th>
<th>Animal logging operations with utilization in %</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>H/FWD</td>
<td>M/FWD</td>
</tr>
<tr>
<td>Felling and processing function</td>
<td>23</td>
<td>13*</td>
</tr>
<tr>
<td>Log skidding function</td>
<td>13</td>
<td>16</td>
</tr>
<tr>
<td>Loading/fording function</td>
<td>32</td>
<td>14*</td>
</tr>
<tr>
<td>Crew</td>
<td>68</td>
<td>43*</td>
</tr>
</tbody>
</table>

* = Significantly different

Table 3. Cost summary for five animal logging crews.

<table>
<thead>
<tr>
<th>Animal logging operations</th>
<th>Crew members</th>
<th>Scheduled work hours per day</th>
<th>Daily log production in cords</th>
<th>Costs ($/SMH)</th>
<th>Cost of log Production Per cord</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Fixed (%)</td>
<td>Variable (%)</td>
</tr>
<tr>
<td>H/FWD</td>
<td>3</td>
<td>6.8</td>
<td>13.20</td>
<td>10.37 (19.5)</td>
<td>9.70 (18.2)</td>
</tr>
<tr>
<td>M/FWD</td>
<td>5</td>
<td>5.7</td>
<td>25.00</td>
<td>31.74 (29.2)</td>
<td>14.94 (13.8)</td>
</tr>
<tr>
<td>H/SLT</td>
<td>3</td>
<td>5.2</td>
<td>6.50</td>
<td>2.52 (6.1)</td>
<td>5.37 (13.1)</td>
</tr>
<tr>
<td>H/KBL</td>
<td>1</td>
<td>7.0</td>
<td>5.50</td>
<td>2.66 (14.2)</td>
<td>5.00 (26.7)</td>
</tr>
<tr>
<td>H/LSCLT</td>
<td>3</td>
<td>6.2</td>
<td>20.00</td>
<td>7.74 (14.8)</td>
<td>11.23 (21.5)</td>
</tr>
<tr>
<td>Average</td>
<td>3</td>
<td>6.2</td>
<td>14.04</td>
<td>11.0 (16.8)</td>
<td>9.2 (18.7)</td>
</tr>
</tbody>
</table>
### Table 4: Comparison of ground disturbance from 16 harvesting operations.

<table>
<thead>
<tr>
<th>Study</th>
<th>Harvesting system/silvicultural operation</th>
<th>Soil disturbance type (%)</th>
<th>disturbance total</th>
<th>Deeply + ruts</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Lanford and Stokes (1995)</td>
<td>Skidder/Thinning</td>
<td>48</td>
<td>13</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Forwarder/Thinning</td>
<td>62</td>
<td>09</td>
<td>0</td>
</tr>
<tr>
<td>Klepac et al. (1999)</td>
<td>Skidder/Thinning</td>
<td>60</td>
<td>29</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>Skidder/Group selection</td>
<td>54</td>
<td>32</td>
<td>13</td>
</tr>
<tr>
<td></td>
<td>Skidder/Patch cut</td>
<td>45</td>
<td>35</td>
<td>19</td>
</tr>
<tr>
<td>Stokes et al. (1995)</td>
<td>Skidder/Single tree selection</td>
<td>41</td>
<td>41</td>
<td>12</td>
</tr>
<tr>
<td></td>
<td>Skidder/Group selection</td>
<td>29</td>
<td>49</td>
<td>13</td>
</tr>
<tr>
<td></td>
<td>Skidder/Shelterwood</td>
<td>18</td>
<td>60</td>
<td>13</td>
</tr>
<tr>
<td></td>
<td>Skidder/Seed tree</td>
<td>12</td>
<td>64</td>
<td>13</td>
</tr>
<tr>
<td>Miller and Sirois  (1986)</td>
<td>Cable skyline/Clearcut</td>
<td>64</td>
<td>25</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>Skidder/Clearcut</td>
<td>58</td>
<td>25</td>
<td>4</td>
</tr>
<tr>
<td>Sexia et al. (1995)</td>
<td>Harvester/Forwarder/Partial cut</td>
<td>38</td>
<td>63</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Manual felling/Horse/Forwarder Partial cut</td>
<td>46</td>
<td>54</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Feller -buncher/Forwarder/Partial cut</td>
<td>34</td>
<td>66</td>
<td>0</td>
</tr>
<tr>
<td>Hamilton (1998)</td>
<td>Horse with forwarder/Partial cut</td>
<td>91</td>
<td>06</td>
<td>3</td>
</tr>
<tr>
<td>This study</td>
<td>H/FWD, M/FWD, H/SLT</td>
<td>75</td>
<td>22</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>H/KBL, and H/LSCLT</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Ground disturbance codes: 1 = undisturbed, 2 = slightly disturbed, 3 = deeply disturbed and 4 = rutting*
Hazards and Human Health
Hazards and Society in the Peri-urban Interface

Abdullah Adam-Bradford, Centre for Developing Areas Research, Department of Geography, Royal Holloway, University of London

Introduction

In this paper ‘hazards and society’ in the peri-urban context of developing countries are examined and consequently a call for a more nuanced approach to urban disaster studies is made. Case study materials from the mudslides of Caracas, Venezuela in December 1999 are used to illustrate the link between disasters and the peri-urban interface (PUI). These illustrations provide substantial evidence that physical vulnerability (e.g. fragile and/or marginalized environments) and social vulnerability (e.g. overcrowding and/or poverty) may be especially high in peri-urban areas and thus result in higher levels of risk for peri-urban communities when exposed to natural and anthropogenic hazards.

Merging Paradigms

Research into hazards and society in the peri-urban context has remained largely elusive (for notable exception see Pelling, 2003a), consequently, the concept of the peri-urban interface (PUI) has largely been ignored in disaster studies literature (e.g. Alexander, 2000; Singh, 2000; Pelling, 2003b; Smith, 2004; UNDP, 2004; Wisner et al. 2004). Even in the more pertinent urban disaster studies (e.g. Mitchell, 1999; Velasquez et al. 1999; Sanderson, 2000; Bull-Kamanga et al. 2003; Pelling, 2003c), the peri-urban concept is reduced to fleeting references of events that have occurred on the ‘outskirts’ or ‘fringes’ of cities; for example:

“In areas such as Mexico City, Manila, Lagos, and Accra, development has caused the city to grow in a way which exacerbates disasters because it forces more and more people to live in hazardous or disaster-prone areas. An example of this is the hurricane which visited Caracas, Venezuela, in 1993. The disaster caused by this hurricane resulted in deaths and destruction along the city outskirts, which were mainly areas of poor and squatter settlements” (Velasquez et al. 1999: 163).

In urban disaster and development literature there are frequent references to informal settlements and slums that are located on the city fringe or in the urban region (Velasquez et al. 1999; Alexander, 2000; Sanderson, 2000; Potter et al. 2004; UNDP, 2004; Wisner et al. 2004). For example, Pelling (2003c: 44) refers to the “pathways through which environmental processes and change influence the geography of environmental risk in the city and its urban region” (emphasis added). However, in Pelling (2003c), and other urban disaster work, there are no specific references to the burgeoning PUI literature and moreover to the specific problems encountered within the PUI, which such literature addresses. This overlook has become a commonality in urban disaster discourse; consequently, opportunities to provide a more nuanced understanding of urban disasters have been missed. In this paper, the author explicitly argues that many so-called urban disasters should rather be considered in their peri-urban context, as otherwise important lessons that can be gleaned from studies of the urban-rural continuum, such as integrated natural resource management approaches, will be lost (see McGregor et al. 2006).

Hazards and the Peri-Urban Interface (PUI)

Birley and Lock (1999) comment that there is no universally accepted definition of ‘peri-urban’, although in simple terms, it can be defined as the areas around cities and towns characterised by rapid demographic, economic, environmental, social and cultural interactions and changes (Adam-Bradford et al. 2006). Indeed, as Adam-Bradford et al. (2006) observe general commonalities in peri-urban discourse emphasise the importance of these transitional processes rather than the spatial defined geographical location (see Binns, 1994; Rakodi, 1999; Brook and Dávila, 2000; Brook et al. 2003; Tacoli, 2003; Simon et al. 2004; Lynch, 2005; McGregor et al. 2006). As Simon et al. (2004: 239) stress “[t]his is more appropriate for examining the continuum between the poles of urban and rural and understanding the dynamics of change as they affect particular parts of the peri-urban zone, as well as shifts in the position of the zone as a whole”.

These ‘dynamics of change’ are what make studies of the PUI particularly relevant to disaster management. However, in a similar vein to the neglect of the PUI concept in disaster studies, the burgeoning work on
rural-urban interactions and the PUI has not yet addressed issues of hazards, risk or vulnerability (see UN-Habitat, 2004). Instead predominately focussing on urban and peri-urban agriculture, formal and informal land markets and the related (and often rapid) land-use changes (Simon, et al. 2004); incidentally, all of which have a role to play in managing disasters in the PUI. Notably, the only reference made to ‘disaster’ in the UN-Habitat (2004) Urban Rural Linkages: An Annotated Bibliography 1994-2004 is Atkinson’s (2001: 1) paper entitled the juggernaut and peri-urbanisation, in which he warns that:

“the unconsidered activity of both rich and poor in spatial redistribution, including the peri-urban interface, and evolving lifestyles represent the ultimate in profligate misuse of resources presaging an environmental disaster of unimaginable proportions in the years ahead”.

In August 1993, tropical storm Bret hit Caracas, and the pursuing mudslides in the PUI resulted in the death of over 150 people and made thousands homeless (Potter et al., 2004), but this was only a prelude to the flash flooding and mudslides in December 1999, when 30,000 people were killed and 100,000 people were displaced (Wisner et al. 2004). Noteworthy, is a response after the mudslides from the BBC environment correspondent, Alex Kirby (1999), who wrote an article entitled ‘Disaster - but was it natural?’. Atkinson (2001: 1) clearly provides the answer addressing the ever-increasing political nature of disasters in the PUI:

“[n]eo-liberalism today represents the triumph of the pessimistic view that sees poverty and human degradation as acceptable in spite of spectacular life transformations for some. Paradoxically, in this context the development ideology is ‘succeeding’, where in more optimistic times it failed. The mass of southern peasants are being both pressured and lured to participate in the global commercial economy even with little or no hope of moving beyond the impoverished margins” (Atkinson, 2001: 1).

Indeed, the worst manifestation of this process can be found in the peri-urban areas of Caracas, where “40 per cent of Venezuela’s population of about 24 million is concentrated into less than 2 per cent of the national land area” (Wisner et al. 2004: 71). This process of rural-urban migration, natural resource degradation, and rapidly expanding informal- and slum-settlements are now all too often familiar components of the PUI. Hence, by examining in greater detail the Caracas mudslides of 1999, using the Wisner et al. (2004) pressure and release model we can illustrate some of the linkages that need to be made between disasters and the PUI.

**Pressure and Release (PAR) Model**

Wisner et al. (2004) ‘Pressure and Release’ (PAR) model provides a useful tool for examining the ‘progression of vulnerability’ or the ‘chain of causation’ that can lead to catastrophic events in the PUI. Indeed, as Wisner at al. (2004: 87) highlight:

“the Pressure and Release (PAR) model, which shows in diagrammatic terms how the causes of vulnerability can be traced back from unsafe conditions, through economic and social (‘dynamic’) pressures, to underlying root causes. PAR is an organising framework outlining a hierarchy of causal factors that together constitute the pre-conditions for a disaster... It is a sequence of factors and processes that leads us from the disaster event and its proximate causes back to ever more distant factors and processes that initially may seem to have little to do with the causing the disaster”.

In Figure 1, the PAR model is applied to the Caracas mudslide disaster that occurred in December 1999. By no means, is this a comprehensive assessment of the progression of vulnerability, but rather a static overview that resulted in the tragic – but all too familiar – mudslide events of December 1999 (see Figure 1).

In Potter et al. (2004), two maps are used that clearly illustrate how the root causes, dynamic pressures and the unsafe conditions (progression of vulnerability) overlaps with the informal settlements (barrio areas) in peri-urban Caracas (see Maps 1 & 2).
Map 1 Main areas of landslide activity and frequency of events in Caracas (Source: Potter et al. 2004).

Figure 1 PAR model for Caracas mudslides, December 1999

<table>
<thead>
<tr>
<th>Progression of Vulnerability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Root Causes</td>
</tr>
<tr>
<td>Unequal asset ownership and income.</td>
</tr>
<tr>
<td>Dependence on oil economy, no incentive to develop rural economy.</td>
</tr>
<tr>
<td>Lack of local institutions.</td>
</tr>
<tr>
<td>Deforestation.</td>
</tr>
<tr>
<td>Weakened livelihoods following previous disasters.</td>
</tr>
<tr>
<td>Settlement on Steep slopes.</td>
</tr>
<tr>
<td>Limited rainwater infiltration.</td>
</tr>
<tr>
<td>No disaster Preparedness.</td>
</tr>
<tr>
<td>Dynamic Pressures</td>
</tr>
<tr>
<td>Torrential rains</td>
</tr>
<tr>
<td>Flash flooding</td>
</tr>
<tr>
<td>Unsafe conditions</td>
</tr>
<tr>
<td>Mudslides</td>
</tr>
<tr>
<td>Hazard</td>
</tr>
<tr>
<td>Disaster</td>
</tr>
</tbody>
</table>

Map 1 Main areas of landslide activity and frequency of events in Caracas (Source: Potter et al. 2004).
Potter et al. (2004) case study of Caracas is used to illustrate the potentially hazardous relation between urbanisation and the environment, and interestingly it succinctly addresses many elements of the progression of vulnerability that resulted in the ill-fated disaster of December 1999. For example, root causes, such as the rapid urban expansion of Caracas following the development of the oil industry are included. In 1950, the city’s population stood at 500,000; but by 1981, this had increased to over two million (Potter et al. 2004). Such rapid growth in urban expansion remained largely unmanaged and consequently over-spilled onto the steep hillsides in the peri-urban areas, where land was available, albeit of a precarious nature. Such development coupled with the failure of the political elites to invest oil industry revenues into rural poverty ensured a constant flow of rural-urban migrants to Caracas. Furthermore, dynamic pressures included the deforestation of the steep slopes where the barrios were spreading thus providing the unsafe conditions for flash flooding and mud slides during the heavy seasonal rains.

The Caracas mudslide disaster clearly illustrates several processes that although are not unique to the PUI, are certainly concentrated and thus exacerbated within the interface (McGregor, D. pers. comm.). Some of these processes include the rapid transformations of the PUI and also what the author terms ‘peripheral neglect’, to describe processes in which local authorities use their resources in core rather than peripheral areas.

**Conclusion**

In context of hazards and society in the PUI, the concepts of transitional change, be it demographic, land use or resources, are all highly relevant, as these very processes, often occurring at rapid rates, manifests itself in the form of increased vulnerability in the PUI. Furthermore, these associated rapid transitional changes are compounded by the inability of municipal and/or local governments to effectively manage the PUI. This phenomenon is exacerbated by a lack of appropriate planning and policies for the PUI, particularly, as these zones are often located on municipal/district boundaries and thus receive less development as municipal and district authorities use their resources in core rather than peripheral areas. It is this process of ‘peripheral neglect’ coupled with the rapid transitional changes that together constitute the rather unique problem of managing hazards and society in the PUI. For that reason, practitioners, policy makers and researchers alike, should not neglect the PUI, as many of the so-called urban disasters should rather be considered in their peri-urban context. Such perspectives can then draw from the important lessons that can be gleaned from
studies of the urban-rural continuum, such as integrated natural resource management approaches; thereby maximising the effectiveness and efficiency of interventions and implemented policies in the PUI.

References
Spent CCA Treated Wood from Residential Decks can be a Resource for Reuse and Recycling

Bob Smith, Dept. of Wood Science and Forest Products, Virginia Tech, Phil Araman, USDA Forest Service, Southern Research Station, David Bailey, Pallet One Enterprises, Matt Winn, USDA Forest Service, Southern Research Station

Abstract
The volume of CCA treated wood being disposed of in landfills is growing at an alarming rate. In order to reduce the demand on landfills and timber harvest, more environmentally responsible alternatives for spent CCA treated wood have to be addressed. The objective of this study was to determine feasible products that can be produced from CCA treated wood.

Several products were produced from CCA treated wood recovered from dismantled residential decks. The products chosen were practical to make and used in residential and public applications. The products made were a picnic table, trellis, trash container, pallets, patio chair and table, sawhorses, a deck, deck components, planter boxes, and a porch swing. All products made required little training or carpentry skills, low monetary investment in tools and hardware, and required a low amount of time to complete. Therefore, the spent CCA treated wood is feasible to be recycled by most landfills and recycling organizations. Pallets produced from recycled CCA treated wood were tested and their performance found to be similar to pallets using untreated virgin wood. From interviews with MSW and C&D landfills, recycling centers, and potential users, there appears to be a communication barrier between the groups. Many landfills managers and recyclers do not know of a market for the recycled CCA treated wood and do not feel they receive a large volume to make CCA wood recycling profitable. The potential users were found to be willing to use the recycled CCA treated wood, but did not know where to get the material. Awareness and partnerships are needed to recycle CCA treated wood from residential decks.

Introduction
The volume of disposed CCA treated wood from spent residential decks is enormous, and many investigators have predicted the rate of disposal to increase of the next several years. Recent estimates of CCA decking materials being or predicted to be disposed in landfills are between 1-5,000,000,000 board feet per year (Alderman, 2001 and McQueen and Stevens, 1998). The heavy burden of disposal is placed primarily on municipal solid waste (MSW) and construction and demolition (C&D) landfills (Alderman, 2001 and McQueen and Stevens, 1998). The large volume of spent CCA treated wood reaching landfills has instigated several studies on the environmental and safety impacts of this material in landfills (Townsend and Solo-Gabriele, 2000 and Cooper, 1993). Most research has suggested that alternative disposal practices need to be initiated in order to mitigate the possible detrimental impact that spent CCA treated wood disposed in landfills, especially unlined, will have on human health and environmental safety. If stricter disposal regulations are enacted then higher tipping fees will mostly likely follow. In order to reduce the demand on landfills and extend the useful life of CCA treated wood recycling practices need to be developed for this material.

Recycling is prevalent and successful in many industries. Metals, plastics, and several wood products have developed recycling programs that have helped decrease the potential of government regulations, negative public opinions towards the disposal, and increase social acceptance of the material. Wood recycling was 5% in 1997, but was projected to increase to 10% by 2000 (EPA, 1998). An increase in virgin wood prices and an increased consumer demand for recycled materials are main reasons for the increase (Sherman-Huntoon, 2001). The recycling rate will increase as more regulations are implemented and tipping fees are raised at landfills.

R. Marutzky (1996) stated the following preconditions for successful recycling of wood waste:

- The assortments are available continuously and in sufficient amounts
- The quality of the assortment is in accordance with the proposed recycling
- The recycled wood products have a market
The recycling produces no new disposal problems.

Meeting these criteria is important for successful recycling of CCA treated wood waste, and the industry has several barriers associated with these conditions to overcome. Research has suggested that the building contractors are important factors in recyclers receiving sufficient amounts of spent CCA treated wood from residential decks. Alderman (2001) suggested that in order to receive an adequate supply of spent CCA treated wood for recyclers, marketing campaigns and financial incentives need to be used to entice building contractors to bring in the material to be recycled. Also, the CCA treated debris must be separated from other wood debris. Townsend and Solo-Gabriele (2000) found that approximately 6% of C&D landfill wood debris is CCA treated. If CCA treated wood is not separated from untreated wood, than the quality of the material will not meet the needs of the proposed recycling.

Research has been performed on finding markets for spent CCA treated lumber. There has been a large amount of research in using spent CCA treated lumber in wood-based composite products (Vick et al., 1996; Mengeloglu and Gardner, 2000; Munson and Kamdem, 1998). The researchers varied with their results, depending on the wood based composite made and the amount of CCA treated lumber used, but in most of the research it would be a viable option for spent CCA treated lumber. Composite manufacturers have been evaluated to see if they are a viable option in using spent CCA treated wood, but most research has found that they are reluctant to consider spent CCA treated lumber as a possible raw material source (Smith and Shiau, 1996 and Falk, 1997). The main reasons found were concerns with the health and safety of mill workers, residual chemicals that the material may still have, and products made from recycled treated wood may not have the same resistance to decay and insects as the original treated wood product. Therefore even though wood-based composite products could be produced from spent CCA treated lumber it does not seem to be a practical option for manufacturers in the near future.

Research has also been performed to remove the treating chemical from the spent CCA treated wood. If this process can be performed successfully then the CCA treated wood can be mixed with other wood waste for recycling. Clausen and Smith (Wilson, 1997) and Glasser (Alderman, 2001) have experimented with this method. Clausen’s work has been successful in removing 92% of the copper and 42% of the arsenic, but there has been no success of removing the chromium because it is bond tightly to the lignin (Wilson, 1997). Shiau, Smith, and Avellaer (2000) were successful in extracting over 80% of CCA chemicals in the wood particles with citric acid. Another barrier associated with removing the treating chemical from the wood is that it is currently more expensive to do this than it is to dispose of the treated wood in a C&D landfill (Avellaar and Glasser, 1995). As stated previously, incentives need to be developed for building contractors to bring spent CCA treated wood to recyclers. This will only happen if recyclers find economic viable products and markets for the recovered CCA treated wood. The following research examines potential products and market barriers associated with the successful recycling of spent CCA treated wood from residential decks.

**Objectives**

Determine feasible products that can be produced from recovered CCA treated wood.
Recognize barriers that exist for landfills, recycling centers, and organizations in reusing CCA treated wood from residential decks.

**Products From Recovered CCA treated wood from residential decks**

**Methodology**

The products manufactured were chosen because they were practical, easily fabricated, required little carpentry training or skill, a small number of inexpensive tools, and effectively utilized the recovered CCA treated wood from the residential decks. This will aid recycling centers in hiring and training qualified employees, and also easily produced products can be performed by people or organizations that acquire the recycled wood for do-it-yourself (DIY) outdoor projects. The designs of the products made for this research were from DIY outdoor wood furnishings designs, taken from published books or over the Internet. The tools used to produce the products was a 12” compound miter saw, a 12” table saw, a 10” circular saw, cordless drill (with several different drill bits), a reciprocating saw, and other miscellaneous tools such as hammers, tape measure, and wrenches. The hardware used were different sizes of galvanized decking screws, galvanized lag bolts and screws, and galvanized nails.

It should be noted that strict safety procedures were followed when handling and machining the CCA treated wood. Proper dust masks, clothing, safety gloves, glasses, or goggles, and hearing protection was worn by at all times while working with the
CCA treated material, and all exposed areas were thoroughly washed after work was completed. For each product, the worker-hours required, amount of hardware and cost, and type and volume of material were documented.

**Products Manufactured**

Several products were made that fit the criteria of being practical to use and make, cost feasible, and required little previous experience and training in wood carpentry. Table 1 displays the products made from recycled CCA treated lumber, along with the type of CCA treated wood used, volume, type of hardware, cost of hardware, and the worker-hours needed to create the product.

Pictures of the products made are located in Figure 1. It should be noted that the worker-hours needed to complete each product will be much lower than the ones shown in Table 1 if they are mass produced, because the learning curve and time to produce each product will reduce after several of the same product is produced. The only products that required unused CCA treated wood were the deck that used new 5/4x6 decking, and the trash container that required treated plywood for the lid. Table 2 shows the volume of material used to make the 13 products shown in Table 1. The 2x8, 4x4, and 2x6 material was the most utilized dimensional material. In this study we found that 2x6 and 2x8 were the most successfully recovered material and the highest volume from spent CCA treated residential decks. Therefore, it is beneficial that 2x6 and 2x8 lumber was utilized in the manufacturing of the products. All products were uncomplicated to make, and required a small investment in hardware (from Table 1 only the deck, trellis, patio table, and picnic table required hardware that cost $10.00). Other material used in the making of the products included: latex stain ($18.99/gallon), white latex paint ($10.99/quart), white sealer primer ($6.99/quart), deck stain ($17.99/gallon), sandpaper ($0.40/sheet), and paint brushes ($3.99/brush).

**Market Assessment**

Six C&D and six MSW landfill managers, six recycling companies, and four potential users of the recovered CCA treated wood were interviewed. Several barriers exist in the reuse of recycled CCA treated wood. Landfills stated that they receive little CCA treated wood, and believed that separating it from other waste would not be cost effective because there are no markets. Recycling centers also claimed it would not be possible to recover the material, most citing that there are no markets and not a consistent supply of spent CCA treated wood. Several potential users stated that they could use the material, but did not know where to get it. From the personal interviews it appears that the biggest barrier in the recycling of CCA treated wood waste is lack off communication between all interested parties.

**What needs to be done**

The objectives of this research were to make products that could feasibly utilize recycled CCA treated wood from residential decks, and to determine barriers that may exist in the reuse of spent CCA treated wood. Several products were made from recovered CCA treated wood. The products produced, in this study, included outdoor home furnishings, landscaping products, pallets, and residential decks and components. Those produced were uncomplicated designs that allowed researchers with limited knowledge or skill in wood carpentry to complete successfully. The products were also inexpensive to produce, requiring a small amount of monetary investment in tools and hardware. The products also utilized the highest volume of CCA treated wood coming from spent residential decks, which are 2x6s and 2x8s. This study made only a few products that could be made from recovered CCA treated wood, several other items can be made, including but not limited to, benches, raised walkways, walking bridges, trail guides and paths, and in residential and commercial landscaping. Pallets made from the recovered CCA treated wood were found to perform similar to that of untreated wooden pallets, of the same species and similar quality. The recycled CCA treated wood can be used in several different above ground applications as effectively as new CCA treated wood.

Several groups will influence the success of recycling CCA treated wood from residential decks. These groups include manufacturers of CCA treated wood, building contractors, or other “waste” producers, government organizations, and landfillers/recyclers. Many manufacturers have not evaluated the effect their product has on their profitably after it has been sold. This has already occurred with the ban of CCA treated wood in residential applications at the end of 2003. The environmental groups and media attack on the use of CCA treated wood, though questionable, has forced the industry to spend millions of dollars on new chemical development and treatment processes, and also a loss of market share which might have been avoided if the issue was confronted earlier. The industry is currently facing another negative attack on its products with the possible adverse safety and environmental side affects on the disposal of spent CCA treated wood.
CCA treated wood. Therefore the industry must be proactive and support the development of recycling programs and markets, through financial incentives or other forms of support in order to keep CCA wood markets sustainable.

Building contractors currently dispose of CCA treated wood in landfills because it is less expensive than to recycle and there are no other alternatives. Therefore, the development of recovery programs for landfill and recycling centers are needed, and also required is support by the local government. Incentives need to be given to CCA waste producers that bring separated CCA treated wood waste into the facility. This can be achieved by lowering tipping fees for sorted CCA treated wood waste, or by raising the fees to accept unsorted C&D wood waste. The CCA treated wood waste producers will only make an effort to recover the waste if there are no cheaper alternatives.

To make CCA treated wood recycling successful, local governments need to support and initiate programs that foster communication and awareness of the amount of CCA treated wood reaching landfills and the potential reuse of the material. Landfills, recyclers, and potential users (individual citizens, parks and recreation, non-profit organizations) need to be informed how each sector can benefit from the recovery of CCA treated wood. Government officials should help develop markets for the material, and aid recyclers in developing business opportunities in making recycled CCA wood profitable. Government officials and recyclers should develop easy drop off and purchase sites for CCA treated wood.

In summary, the recycling of CCA treated wood from residential decks can be achieved if all affected parties are aware of the issues and potential reuse of the material. If the industry, builders, governments, recyclers, and users associated with the use, disposal, and recycling of CCA treated wood understand the needs of each party, and response accordingly, then the barriers in the reuse of spent CCA treated residential decks can be diminished.

**Literature Cited**


Table 1. Products manufactured, material and volume used of CCA treated wood, type and cost of hardware, and worker-hours need to complete.

<table>
<thead>
<tr>
<th>Product</th>
<th>Material (bd.ft.)</th>
<th>Total Board Feet</th>
<th>Hardware</th>
<th>Cost of Hardware</th>
<th>Worker-Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>Porch Swing</td>
<td>2x4 (8.4), 5/4x6 (14.8)</td>
<td>23.2</td>
<td>3-1/2&quot; &amp; 2&quot; screws, 3-1/2&quot; lag screws, 3-1/2&quot; lag bolts</td>
<td>$8.68</td>
<td>2.5</td>
</tr>
<tr>
<td>Chair</td>
<td>2x4 (6.7), 1x4 (4.4)</td>
<td>11.1</td>
<td>2-1/2&quot; screws, 3-1/2&quot; lag bolts, 3-1/2&quot; lag screws</td>
<td>$8.71</td>
<td>3</td>
</tr>
<tr>
<td>Trash Container</td>
<td>1x4 (5.1), 2x2 (1.8), Lattice (14 ft²)</td>
<td>6.9</td>
<td>1-3/4&quot; screws, 1-1/4&quot; nails</td>
<td>$2.00</td>
<td>4</td>
</tr>
<tr>
<td>Trellis</td>
<td>2x6 (22), 2x4 (7), 4x4 (81.7), 2x8 (15.4), 2x2 (7.5)</td>
<td>133.6</td>
<td>corner bracket, 5-1/2&quot; lag screws, 3-1/2 lag bolts, 3&quot; &amp; 2-1/2&quot; screws</td>
<td>$28.70</td>
<td>27</td>
</tr>
<tr>
<td>Planter Box</td>
<td>5/4x6 (4.5)</td>
<td>4.5</td>
<td>1-3/4&quot; screws, 1-1/4&quot; nails</td>
<td>$1.20</td>
<td>1.5</td>
</tr>
<tr>
<td>Planters</td>
<td>2x4 (12)</td>
<td>12</td>
<td>3-1/2&quot; &amp; 2-1/2&quot; nails</td>
<td>$0.60</td>
<td>2</td>
</tr>
<tr>
<td>Patio Table</td>
<td>4x4 (18.4), 2x2 (3.8), 5/4x6 (12.4), 1x6 (5)</td>
<td>39.6</td>
<td>2&quot; &amp; 3&quot; screws, 6&quot; lag screws</td>
<td>$18.00</td>
<td>8</td>
</tr>
<tr>
<td>Picnic Table</td>
<td>2x6 (65), 2x4 (6.2)</td>
<td>71.2</td>
<td>2-1/2&quot; &amp; 3&quot; screws, 3-1/2 lag bolts</td>
<td>$18.31</td>
<td>8.5</td>
</tr>
<tr>
<td>Porch Railing</td>
<td>2x2 (10), 2x4 (8.1), 4x4 (8.2)</td>
<td>26.3</td>
<td>all tread, 2-1/2&quot; nails</td>
<td>$6.75</td>
<td>8.5</td>
</tr>
<tr>
<td>Deck</td>
<td>2x8 (108.8), 5/4x6 (100.8), 4x4 (36.8)</td>
<td>246.4</td>
<td>joist hangers, 2-1/2&quot; screws, 1-1/2&quot; nails</td>
<td>$26.18</td>
<td>22</td>
</tr>
<tr>
<td>Saw Horse</td>
<td>2x6(10.3), 1x6 (2.2)</td>
<td>12.5</td>
<td>3-1/2&quot; &amp; 2-1/2&quot; nails</td>
<td>$0.35</td>
<td>1.25</td>
</tr>
<tr>
<td>Block Pallets</td>
<td>1x4 (3.8), 1x6 (5), 5/4x6 (9.7), 4x4 (4.8)</td>
<td>23.3</td>
<td>2-1/4&quot; and 1-5/8&quot; spiral shank nails</td>
<td>$4.83</td>
<td>2.25</td>
</tr>
<tr>
<td>Stringer Pallets</td>
<td>2x4 (5.3), 1x4 (5.1), 1x6 (4)</td>
<td>14.4</td>
<td>2-1/4&quot; spiral shank nails</td>
<td>$2.52</td>
<td>1.75</td>
</tr>
</tbody>
</table>
Table 2. Volume and percent of recovered CCA treated wood used to manufacturer products.

<table>
<thead>
<tr>
<th>Material</th>
<th>Volume (bd.ft.)</th>
<th>Percent Volume</th>
</tr>
</thead>
<tbody>
<tr>
<td>2x6</td>
<td>97.3</td>
<td>18.6</td>
</tr>
<tr>
<td>2x4</td>
<td>53.6</td>
<td>10.2</td>
</tr>
<tr>
<td>2x8</td>
<td>124.2</td>
<td>23.7</td>
</tr>
<tr>
<td>2x2</td>
<td>23.1</td>
<td>4.4</td>
</tr>
<tr>
<td>5/4x6</td>
<td>41.4</td>
<td>7.9</td>
</tr>
<tr>
<td>1x4</td>
<td>18.4</td>
<td>3.5</td>
</tr>
<tr>
<td>1x6</td>
<td>16.3</td>
<td>3.1</td>
</tr>
<tr>
<td>4x4</td>
<td>149.9</td>
<td>28.6</td>
</tr>
<tr>
<td>Total</td>
<td>524.1</td>
<td>100</td>
</tr>
</tbody>
</table>

Figure 1. Products Made From Spent CCA
Do Sprawling Counties in Georgia Adversely Affect Health? A Focus on Obesity and Cancer

Inas Rashad, Georgia State University Department of Economics
Michael Eriksen, Georgia State University Institute of Public Health

Introduction And Background
Changes in the built environment are not often thought to directly affect public health. Yet soon urban planners might be inclined to start thinking about how their decisions might adversely affect life expectancy, as ways in which the built environment and technological advances have affected our lifestyles and behaviors have recently been highlighted.

Obesity and sedentary lifestyle have been shown to increase the risk for several types of cancer, the second leading cause of death in Georgia (Vainio and Bianchini 2002). Researchers have found that many types of cancer that were not previously linked to obesity were significantly affected by excess body weight (Calle et al. 2003). The study by Calle and her colleagues followed over 900,000 Americans over 16 years and shed light on the importance of nutrition and physical activity in preventing cancer. (According to the American Cancer Society, apparently only one percent of Americans in 2002 identified maintaining a healthy weight as a way to prevent cancer.) It has been estimated that up to 70 percent of all cancer is attributed to diet (Doll and Peto 1981). Particular focus has been on the positive effects of foods such as vegetables, fruit, green vegetables, and tomatoes on preventing lung and breast cancer. While cigarette smoking is still the most common cause of lung cancer, there is a strong protective effect of changes in diet for both smokers and non-smokers in terms of developing lung cancer (Steinmetz and Potter 1996; Yong et al. 1997). A protective effect is yet to be shown for prostate cancer (Hsing et al. 1990). The World Cancer Research Fund and the American Institute for Cancer Research formed a panel that concluded in Food, Nutrition and the Prevention of Cancer: A Global Perspective that 30 to 40 percent of cancer cases throughout the world can be prevented through diet.

One area that is arguably not given enough attention is prevention through analyzing social and behavioral aspects contributing to the incidence of various types of cancers. Exploring this area can shed light on changes in public policy (including the built environment) that directly or indirectly contribute to cancer incidence and mortality, and can thus have important policy implications for cancer prevention. One of the goals of the National Cancer Institute is to “[d]iscover genetic, environmental, and lifestyle factors and their interactions that define cancer risk and inform strategies for cancer control.” Some studies estimate that as many as 50 to 75 percent of cancer deaths in the United States are caused by behaviors or conditions that can be altered. It has been estimated that overweight and obesity can account for about 20 percent of cancer deaths in women and 14 percent of cancer deaths in men in the United States. Interpreting this, one can conclude that approximately 90,000 cancer deaths in the United States could be prevented if people maintained a normal body weight (Calle et al. 2003).

Data from the Behavioral Risk Factor Surveillance System reveal that as of 2001, 22.1 percent of adults in Georgia could be classified as being obese, or having a body mass index of 30 kg/m² or greater, well above the national average for that year of 20.9 percent. Obesity legislation in the state of Georgia,

---

1 The cancer incidence rates for various counties in Georgia are shown in Figure 1.
with one of the highest rates of obesity in the United States, has not gone very far. So far there has been a “Common-Sense Consumption Act” providing limited liability for claims of obesity. Therefore, the only “obesity” legislation currently has to do with protecting junk food companies from getting sued and does nothing to actually reverse obesity trends. According to data from the Behavioral Risk Factor Surveillance System, Georgia reported the greatest rate of increase in prevalence of adult obesity from 1991 to 1998. Compared to the US average, Georgia went from being lower than the US average in 1991 to being higher in 1998 (see Figure 2).

Urban sprawl can be defined as how conducive a city is to exercise, or the degree to which land growth outpaces population growth. Our aim is not to look at the costs and benefits of sprawl, which are numerous and can be quite debatable, but rather to focus on the possible health effects of sprawl in Georgia, particularly those of obesity and cancer.

![Figure 2](image)

**Figure 2**

Obesity Rates, Georgia vs. US Average, 1991 and 1998

Source: Behavioral Risk Factor Surveillance System

Measuring sprawl can be complex, and most studies have focused on measuring it simply using changes in population density using data from the Census. Smart Growth America has recently come up with a more comprehensive measure of urban sprawl that combines four factors. In particular, they measure sprawl in terms of residual density, land use mix, degree of centering, and street accessibility. Residual density is defined in terms of gross and net densities and proportions of population living at different densities; seven variables made up the metropolitan density factor. Land use mix is defined in terms of the degree to which land uses are mixed and balanced within subareas of the region; six variables made up this factor. Degree of centering is defined as the extent to which development is focused on the region’s core and regional subcenters; six variables made up this factor. Street accessibility is defined in terms of the length and size of blocks; three variables made up this factor. Using this measure, the Atlanta metropolitan area ranked fourth in the nation in terms of sprawl, and was one of the few found to sprawl according to all four factors. Sprawl indexes were measured for 83 metropolitan areas in the nation, with only one (the Atlanta metropolitan area) for Georgia. We therefore use a simpler county sprawl index to measure urban form at the county level. Also created by Smart Growth America, it is a linear combination of six variables from the larger set, these six being available for counties whereas many of the larger set are available only for metropolitan areas. This is shortcoming of using county-level sprawl data, as only two factors are thus captured at the county level, namely residual density and street accessibility.

Using these data, Ewing et al. (2003) found that residents of sprawling counties were likely to walk less during leisure time, weigh more, and have greater prevalence of hypertension than residents of compact counties. Defining urban sprawl as a function of how density is distributed across a metropolitan area, using data from the US Census, Lopez (2004) also found an association between urban sprawl and obesity.

Regardless of the measure of sprawl used, one thing to note is that the Atlanta metropolitan area always comes out as one of the top sprawling metropolitan areas. According to the US Census, the Atlanta urbanized area was the number one sprawler from 1970 to 2000. The Metro Atlanta Chamber of Commerce found an urgent need to combat this problem of disorganized use of land and put together a panel to tackle it last autumn. “Without a dramatic improvement in growth management, the panel concluded, metro Atlanta is destined over the next couple of decades to lose its edge as an affordable region with a high quality of life” (“Has Atlanta’s Sprawl...” 2004).

---


3 Defining sprawl as spreading out of a city and its suburbs over more and more rural land at the periphery of an urban area, the US Census found that Atlanta had a sprawling value of 701.7 square miles between 1970 and 2000.
Our aim is to outline factors such as sprawl, payroll per capita for food and grocery stores, and the per capita number of health care facilities influencing obesity and cancer in Georgia while controlling for demographic characteristics. In our empirical work, we use time-series cross-sectional data for Georgia from 1998 to 2002 from the Behavioral Risk Factor Surveillance System (BRFSS), and cancer data from the Georgia Department of Human Resources, Division of Public Health’s Online Analytical Statistical Information System (OASIS). We merge these data with county-level data for population, payroll for food and grocery stores, and number of health care facilities from County Business Patterns; and urban sprawl data from Smart Growth America.

### Empirical Analysis

Claritying the effects that county-level economic factors have on obesity and cancer and how these effects operate through the choices that people make will help us identify factors affecting the incidence rates of various types of cancer in Georgia. Our focus is on Georgian adults 18 years of age and older. A set of county-level variables correlated with health outcomes in a county is used consisting of economic factors influencing decision-making behavior in people within a county are controlled for on the right-hand side. The Behavioral Risk Factor Surveillance System (BRFSS) is an individual-level data set containing data on the body mass index and various demographic characteristics. The county that the individual resides in is included in this survey, allowing us to merge BRFSS data with our county-level data. Only eight Georgia counties for which we have both data on body mass index and urban sprawl are available. We are conducting an analysis that will shed light on correlations between the built environment and health outcomes and yet are nevertheless limited by the data available.

The economic framework behind maximizing utility is based on the SLOTH model (Cawley 2004), where an individual is assumed to act in his or her own interest (i.e., maximize utility or lifetime happiness) based on how they allocate their time through: Sleep, Leisure, Occupation, Transportation, and Household work. Resources such as time and money are scarce, and people analyze the trade-offs involved in their decision-making process. If time and money were limitless, people would be as healthy as they can be – the public health approach, one might say. Yet people face constraints, and must eat, travel to work, engage in sedentary work to make a living, with limited resources. And it is the low-income people in the country, and in the state of Georgia, who have trouble obtaining a healthy lifestyle because of the way the built environment is constructed. While obesity has a large genetic component, it generally results from an excess of caloric intake relative to caloric expenditure. Controlling for urban sprawl addresses caloric expenditure, or physical activity. In order to somewhat control for caloric intake, as well as income in a county, we include payroll for food

<table>
<thead>
<tr>
<th>Independent Variables</th>
<th>Dependent Variable: BMI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sprawl</td>
<td>0.814**</td>
</tr>
<tr>
<td>Sprawl squared</td>
<td>-0.004**</td>
</tr>
<tr>
<td>Food and grocery stores per capita payroll</td>
<td>-11.499</td>
</tr>
<tr>
<td>Food and grocery stores per capita payroll squared</td>
<td>6.647</td>
</tr>
<tr>
<td>Age</td>
<td>0.301***</td>
</tr>
<tr>
<td>Age squared</td>
<td>-0.003***</td>
</tr>
<tr>
<td>Black Non-Hispanic</td>
<td>2.015***</td>
</tr>
<tr>
<td>Hispanic</td>
<td>1.583</td>
</tr>
<tr>
<td>Other race/ethnicity</td>
<td>0.945***</td>
</tr>
<tr>
<td>Elementary</td>
<td>4.386</td>
</tr>
<tr>
<td>Some high school</td>
<td>3.446</td>
</tr>
<tr>
<td>High school</td>
<td>2.914</td>
</tr>
<tr>
<td>Some college</td>
<td>2.589</td>
</tr>
<tr>
<td>College</td>
<td>1.812</td>
</tr>
<tr>
<td>Male</td>
<td>0.751**</td>
</tr>
</tbody>
</table>

Sample size
Note: Standard errors are reported in parentheses. All regressions employ robust standard errors that allow for county clustering.

*Significant at the 10% level. **Significant at the 5% level.
***Significant at the 1% level. The eight Georgia counties included are: Cherokee, Clayton, Cobb, Columbia, De Kalb, Fulton, Gwinnett, and Richmond.

Our aim is to outline factors such as sprawl, payroll per capita for food and grocery stores, and the per capita number of health care facilities influencing obesity and cancer in Georgia while controlling for demographic characteristics. In our empirical work, we use time-series cross-sectional data for Georgia from 1998 to 2002 from the Behavioral Risk Factor Surveillance System (BRFSS), and cancer data from

Urban Rural Interface Conference Proceedings
and grocery stores. The health outcome variable (either obesity or cancer) is a function of these factors as well as personal characteristics. Thus, our general, simplified model is as follows:

\[ \text{Outcome}_{ijt} = f(\text{Sprawl}_{ijt}, \text{FoodPayroll}_{ijt}, X_{ijt}, \varepsilon_{ijt}) \]

where \( i \) is the individual or county, \( j \) represents county, \( t \) is the year, \( \text{Outcome} \) is either obesity or cancer, \( \text{Sprawl} \) is the county-level urban sprawl variable, \( \text{FoodPayroll} \) is a county-level variable representing per capita payroll for all food and grocery stores within the county, \( X \) is a vector of exogenous variables specific to an individual or characteristic of a county that might increase the propensity to develop cancer, and \( \varepsilon \) is an error term encompassing unobservable factors (such as genetic components) and unanticipated shocks. The vector of exogenous variables includes age, gender, race/ethnicity, and education. Due to the aggregate nature of our county-level variables compared to the individual-level units of observation in the BRFSS, regressions allow for clustering by county, as unclustered OLS regressions would lead to incorrect standard errors.

**Data**

The Behavioral Risk Factor Surveillance System (BRFSS) is an individual-level data set put together by state health departments in conjunction with the Centers for Disease Control and Prevention. It is conducted annually through telephone surveys. In 1990, there were 45 states in the BRFSS; by 1996, all 50 states in addition to the District of Columbia, were included. (Georgia is included in all years.) We use years 1998 through 2002 in our empirical analysis in order to increase our sample size for Georgia.

The Georgia Department of Human Resources, Division of Public Health’s Online Analytical Statistical Information System (OASIS) is a suite of tools used to access the Georgia Department of Human Resources, Division of Public Health’s standardized health data repository. The standardized health data repository contains Vital Statistics, Georgia Comprehensive Cancer Registry, Hospital Discharge, and population data. All data can be selected by age, race, gender, county, and year. 159 Georgia counties are available; we use the 24 for which we have urban sprawl data. Morbidity statistics for various types of cancer are available through OASIS. We use data from 2000. As defined by OASIS, cancers refer to the uncontrolled growth of abnormal cells which have mutated from normal tissues. Cancer can kill when these cells prevent normal function of affected vital organs or spread throughout the body to damage other key systems. Colon cancer arises from the lining of the large intestine. We also use incidence of major cardiovascular diseases in our analysis. These are defined by OASIS as diseases related to the major parts of the circulatory system, and include high blood pressure, heart diseases, hypertensive heart disease, obstructive heart diseases, heart attack, stroke, and hardening of the arteries.

County Business Patterns, from the Bureau of the Census, provides payroll information from 1994 to 2001 for food and grocery stores (SIC code 5410 from 1994 to 1997; NAICS code 4451 from 1998 to 2001). These data are available for 159 counties in Georgia, of which we use 24. We use the year 2000 in our analysis.

Smart Growth America provides information on urban sprawl for 448 urban counties across the United States (and 24 in Georgia). Sprawl measures development patterns and can give us information on how conducive a city is to exercise. Urban sprawl is defined as the process through which the spread of development across the landscape far outpaces population growth. Those urban areas that offer more transportation choices, are more compact, and have a variety of stores and activity centers within reach have lower rates of obesity.
Results And Discussion

Note that higher values of urban sprawl indicate less sprawl, while lower values indicate more sprawl. The national average is set at 100, with a standard deviation of 25. In the US, the Riverside, CA, and the New York, NY, metropolitan areas are outliers, with the lowest (most sprawling) and highest (least sprawling) values of urban sprawl, respectively. Table 1 shows results where sprawl and its square were used in order to account for the quadratic nature that sprawl may have. In particular, if a county is only slightly sprawling, one might still be encouraged to walk (or bike), allowing one to be more physically active, but as the centers of activity get further away that same person might be more inclined to drive. Squared terms were put in for all RHS variables that were not dichotomous in nature (namely, sprawl, per capita food payroll, and age). We find that, sure enough, more sprawling counties indicate thinner people (or those with lower body mass indexes) at first, then higher body mass indexes later, with sprawl turning negative at the mean. We obtain a value of -0.004 at the mean sprawling value in our sample, indicating that more sprawl means a higher body mass index.\textsuperscript{5} Reflecting both the income in a county and the higher prices of food, food and grocery stores per capita payroll have a negative value of -8.825 at the mean, indicating that variable’s negative effect on body mass index. It is well-documented that although obesity has been termed a disease of affluence and affects developed countries more than developing countries, within a developed country it is those with lower incomes that tend to be obese.

Table 2 shows county-level results with the colon cancer incidence rate as the dependent variable in the first column, and the incidence of cardiovascular diseases in the second column. These data are from OASIS and are merged with 24 Georgia counties for which sprawl data from Smart Growth America are available. While the small sample size is troublesome, we can see the negative (although insignificant) effect that less sprawling counties have on both colon cancer incidence and cardiovascular diseases. Note that dependent variables are rates and thus take population into account. Figure 3 shows the slight negative correlation between the total cancer incidence rate and urban sprawl values in Georgia, indicating that more sprawling counties have higher cancer incidence rates.

Our results suggest that the lifestyles Georgians have adopted living in sprawling suburbs might be one of many reasons for the negative health outcomes the state faces. More comprehensive measures of sprawl that cover all counties are not yet available, and this study suffers from data limitations. It is suggestive, however, that altering lifestyle and encouraging “smart growth” or more compact urban areas can carry with it numerous positive health outcomes.

\textsuperscript{5} Again, keep in mind that higher values of sprawl indicate less sprawl.
Focus on interdisciplinary work when approaching issues of cancer prevention is key in implementing prevention strategies. Approaching the problem through an economic framework will allow us to focus on how people allocate their scarce resources (whether they be time or money) to maximize their lifetime utility or happiness in making their decisions when it comes to health. This is of particular importance when looking at behaviors that may directly influence the contraction of cancer. Our snapshot of how sprawl could potentially affect health has taken a very narrow view of sprawl, which has many dimensions. People when moving out of urbanized areas are voting with their feet in the Tiebout sense, and “sprawl is delivering what most consumers want: safe neighborhoods, appreciating housing values, and unrestricted use of their automobiles” (Burchell et al. 2002). Public health advocates have health goals of individuals and society in mind, viewing optimizing health outcomes and life spans as the primary goal. Economists, on the other hand, believe people are rational and maximize their happiness given their current time and monetary constraints. Unfortunately, with advancements in technology, increased emphasis on market-based solutions, and changes in the built environment, current trends and long term health outcomes appear to be in conflict (Hill et al. 2004). Yet this need not be the case. Focused research can help provide the economic and health analyses that can result in more informed public policies, as well as individual decisions.

### Literature Cited


Hsing, AW; McLaughlin JK; Schuman, LM; Bjelke, E; Gridley, G; Wacholder, S; Chien, HT; Blot, WJ. 1990. “Diet, Tobacco Use, and Fatal Prostate

### Appendix: Georgia County Urban Sprawl Indexes

<table>
<thead>
<tr>
<th>County in Georgia</th>
<th>County Urban Sprawl Index</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fulton</td>
<td>105.46</td>
</tr>
<tr>
<td>De Kalb</td>
<td>103.94</td>
</tr>
<tr>
<td>Richmond</td>
<td>102.47</td>
</tr>
<tr>
<td>Cobb</td>
<td>101.01</td>
</tr>
<tr>
<td>Clayton</td>
<td>99.61</td>
</tr>
<tr>
<td>Gwinnett</td>
<td>93.76</td>
</tr>
<tr>
<td>Columbia</td>
<td>87.30</td>
</tr>
<tr>
<td>Catoosa</td>
<td>85.61</td>
</tr>
<tr>
<td>Cherokee</td>
<td>85.22</td>
</tr>
<tr>
<td>Spalding</td>
<td>85.19</td>
</tr>
<tr>
<td>Rockdale</td>
<td>82.82</td>
</tr>
<tr>
<td>Paulding</td>
<td>82.10</td>
</tr>
<tr>
<td>Walker</td>
<td>81.26</td>
</tr>
<tr>
<td>Coweta</td>
<td>80.87</td>
</tr>
<tr>
<td>Douglas</td>
<td>80.29</td>
</tr>
<tr>
<td>Newton</td>
<td>79.44</td>
</tr>
<tr>
<td>Butts</td>
<td>78.71</td>
</tr>
<tr>
<td>McDuffie</td>
<td>78.00</td>
</tr>
<tr>
<td>Barrow</td>
<td>77.67</td>
</tr>
<tr>
<td>Dade</td>
<td>77.61</td>
</tr>
<tr>
<td>Fayette</td>
<td>75.74</td>
</tr>
<tr>
<td>Henry</td>
<td>74.13</td>
</tr>
<tr>
<td>Forsyth</td>
<td>72.04</td>
</tr>
<tr>
<td>Walton</td>
<td>69.61</td>
</tr>
</tbody>
</table>

Note: Lower values indicate more sprawling counties.
Source: Smart Growth America
Cancer: Results from the Lutheran Brotherhood Cohort Study.” Cancer Research 50(21): 6836-6840.


Yong, LC; Brown, CC; Schatzkin, A; Dresser, CM; Slesinski, MJ; Cox, CS; Taylor, PR. 1997. “Intake of Vitamins E, C, and A and Risk of Lung Cancer – The NHANES I Epidemiologic Followup Study.” American Journal of Epidemiology 146: 231-243.
Vulnerability and Adaptation to Climate Change in Central Peruvian Andes Cities

Alejandra G. Martínez1 and Ken Takahashi2

Abstract
The lack of policies and effective urban management in the planning of sectors like transport, health, industry and housing are common characteristics to high level urbanization cities like Huancayo, the largest city in the Central Andes of Peru and located in the Mantaro River basin.

The effects that climate change will have in cities are not well-known yet, and the purpose of this study is to show that climate changes in the next 50 years might increase the population vulnerability in cities like Huancayo.

Estimates of climate change to the year 2050 in the Mantaro River basin based on IPCC projections and statistical downscaling methods indicate an increase in temperature and a decrease in rainfall during the rainy season (summer). In a city that has grown vertiginously and without planning in the last 30 years and that has already suffered serious droughts in the past; this new factor will aggravate the increasing problems of potable water supply for its use in human consumption and industry due to the population growth and the change land use from agriculture and forest use to urban use.

The adaptation measures to face this situation include a broad range of possibilities, but they must consider social, economic, ecological and political factors, and the roles and opinions of stakeholders involved. We consider that nonstructural measures - incentives to sustainable land use; good use practices of water resources, etc. - rather than structural ones, could be more effectively adopted by local governments - and population - as adaptation measures to the negative consequences of climate change.

Statistical Downscaling
Estimated changes in the local temperature and specific humidity for the Mantaro Basin were taken from the projections done in various research centers participating in the IPCC by using numerical climate models for the corresponding grid cells. The changes in rainfall were estimated using a linear regression model, which was built based on interannual variability in rainfall observations, for which local changes in relative humidity associated with temperature variability was the best predictor. Changes in relative humidity associated with climate change were estimated from the temperature and specific humidity changes.

Estimates of the effect of climate change on the Mantaro Basin to the year 2050 indicate the following: an increase in temperature of the order of 1°C, an increase in specific humidity of 1 g/kg, but a decrease in relative humidity of 6%, and a decrease of 19% of the precipitation during the summer, which corresponds to the peak of the rainy season.

All of the climate models considered projected increases in both temperature and specific humidity but decreasing relative humidity and rainfall, with relatively low spread among the estimates.

Case Study Area
Huancayo (12°03'51S, 75°12'30"W, 3249 masl) is the largest city in the Central Andes of Peru and is located in the Mantaro River basin and its set of problems is considered representative of the cities in this region. Huancayo has a population of approximately 325,000, and is the economic and commercial center of the Central Andes of Peru.

City Development And Water Resources
During the dry season, the potable water of Huancayo is provided by the melting of the Huaytapallana glacier (5550 msnm), located in the Eastern Cordillera, only 35 km from the city. The melt water forms Lasuntay and Chuspicocha lagoons, which drain into the Shullcas River, a tributary of the Mantaro, the main river of the basin. The water from the Shullcas River is also widely used for irrigation in the numerous agricultural fields that surrounds Huancayo.

Huaytapallana has been experiencing deglaciation in the course of the last decades. This, added to the high seismicity of the zone, has brought as a consequence
occasional ice mass slides that have caused overflows of the lagoons surrounding the glacier. This happened by the end of 1990, when the overflow of Chuspicocha lagoon created a water and ice flood 30 km down the Shullcas river, causing numerous damages in the zone, and affecting urban and rural infrastructure. To avoid subsequent overflows of the lagoons, retaining walls were constructed in the western side of the Huaytapallana, as well as a small dam on Lasuntay lagoon.

Less than 15 years later, the building of the infrastructures in Lasuntay and Chuspicocha lagoons is being called into question, since they have apparently contributed - along with population growth, land use changes and deforestation - to the current shortage of water supply for both human consumption and agriculture.

**Vulnerability And Adaptation**

The problems related to water resources – level of deglaciation, lack of potable and irrigation water, etc - that at the moment undergoes the city of Huancayo, as well as the surrounding agricultural zones, are likely to become more and more serious in the next years if we consider the effects of climate change, which may include reduced precipitation and higher temperatures. If we add to this the fast population growth, migration, land use change and deforestation, the situation could become unmanageable in a few years time.

The measures proposed to remediate this situation must consider the roles and opinions of the stakeholders involved, which include the city population and their municipal authorities, Regional Government, Irrigation Users Board Commissions, Civil Defense, Regional Agricultural Office, etc., in order to be effectively adopted. Also, the biophysical, ecological, social, economic, political and institutional aspects, that are integral parts of the problem, should be considered when devising such measures.

In the past, structural measures have been predominant. Examples of these include the construction of dams, filter galleries, potable water networks extensions, and lately the building of numerous wells for obtaining potable and irrigation water. Nevertheless, due to factors affecting the decision making associated with the implementation of structural measures, such as institutional weakness, overlap of functions between organizations, political opportunism, weakened democracy, corruption, and lack of stakeholders participation, along with the lack or misuse of biophysical information, these measures have only had medium or little success. We anticipate that this will be no different under future scenarios.
In cities near Huancayo like Concepción and Jauja nonstructural measures like incentives to sustainable land use and good use practices of water resource, with the knowledge and support of population have been having good results in the rational management of water resources and other associated subjects like solid waste management. We consider that it is necessary to strengthen the institutions in the region and the role of stakeholders, and that nonstructural measures could be more effectively adopted by local governments and population, like an adaptive strategy against the negative consequences of climate change.

**Bibliography**


**Figure 2** Huaytapallana Glacier and Lasuntay lagoon view

**Figure 3** Dam on Lasuntay lagoon
Community Planning and Perspectives
The role of GIS in facilitating public participation in planning for urban growth in Kiama, New South Wales, Australia.

Emma McIntyre, University of Wollongong,

Abstract
Public participation has long been recognised as a desirable component of planning processes. Traditional consultation methods have not always been able to engage a sufficiently broad cross-section of the community to be truly representative, largely due to the relative complexity of the discussions that take place. There is, therefore, a growing need for more effective communication between the decision making agency and the lay audience. Visual tools, particularly GIS maps and visualisation techniques, have been identified as an effective means of overcoming this barrier. However, relatively little research has been conducted to investigate how an audience responds to such techniques, and what components of a GIS might influence their decisions in a planning process. This research aims to demonstrate the ability of GIS to be used as a tool for improving community capacity in environmental decision making processes in Australia. The research will be largely based on a case study with Kiama Municipal Council, which is conducting extensive community consultation as part of a major review of the Local Environment Plan. Kiama, a rural residential municipality located 130 kilometres south of Sydney on the east coast of Australia, is experiencing development pressures mainly due to the ever-increasing number of Sydney residents who seek a lifestyle change. Kiama Municipal Council currently faces several options for housing the expected population growth and is seeking new and innovative ways to communicate these options effectively with local residents. The research component of this project will evaluate the feedback from public participants in this process, who will be provided with access to Council’s GIS data and a range of visualisation techniques.

Introduction
One of the most powerful tools in land management today is Geographic Information Systems (GIS) (Johnson and Walker 1997; Oh 2001; Nelson 2002). The data contained in a GIS can be combined, manipulated and analysed to generate maps showing patterns and trends which can assist natural resource management and environmental decision making. GIS also has the ability to clearly illustrate relationships between data layers that may otherwise be identified, thus allowing its users to visualise the implications of alternative planning decisions.

Traditionally GIS has been used by government agencies assigned with the role of land use planning. However, with the increased involvement of community groups and individuals in environmental management and decision making process, the demand for access to GIS data has also grown (Bosworth et al. 2002; Walker et al. 2002; Weiner et al. 2002). An Australian example of this demand was demonstrated recently by the New South Wales Southern Catchment Management Board at the Natural Resource Management Community Forum in Brisbane in 2003. The Board claimed that more efficient and effective implementation and evaluation of natural resource management projects would result from public access to GIS data that is currently held by local government agencies (Southern Catchment Management Board 2003).

The use of GIS by residents of Jamberoo: A mini case study
In November 2004, the community of Jamberoo, a rural township of 900 people located within the municipality of Kiama, on the south coast of New South Wales, was consulted by Council regarding future residential planning controls. A public meeting was held, which was attended by 120 people who all expressed concerns regarding the limited capacity of the town to house large population increases. At this meeting, a presentation was made to the audience by the research student, illustrating a series of GIS layers placed over an aerial photo of the town. Layers included steep slopes, areas of high conservation value, riparian corridors, areas of land affected by soil erosion and areas of land affected by acid sulphate soils. The result was a map of the current physical limitations to urban development in the town. Surveys were distributed by the research student with the GIS information presented. Of the 43 people who completed and returned the surveys, 35 felt that GIS was “useful” to them in some way. Some quotes from the survey results include:

“Gave a good visual overview of issues to be considered in planning”;
“Extremely useful way to explain all the issues together”;

Urban Rural Interface Conference Proceedings
“This is an excellent tool which helps the layman better understand large scale complex issues”.

Two weeks later, a focus group of 12 randomly selected local people met to prepare a vision statement for the future of Jamberoo. It was put to the group that Council currently does not have any data regarding the area of flood prone land in Jamberoo or the area of active farming land, and that this data would assist planning decisions that need to be made for the town. The group assisted the research student to map both the area of flood prone land and the area of active farming land directly on to the GIS. These maps were projected on to a large screen so that the whole group could observe this and make comment when required. Surveys were also distributed to this group to gain data about how they interacted with the GIS information provided and to compare this with the results of the survey conducted at the public meeting. All 12 members of the focus group completed and returned the survey and all indicated that the GIS was useful to them in some way. Some quotes from the results of this survey include:

“We felt as though we had an input to what was going to happen in Jamberoo”;
“A good way to see feedback”;
“A must for the proper planning of the future of Jamberoo to allow Council to have the feelings and thoughts of the community”.

Reviewing the Kiama Local Environment Plan: A major case study

The main window into this research is a case study conducted in collaboration with Kiama Municipal Council in New South Wales, Australia. Kiama Local Government Area is 130 kilometres south of Sydney on the east coast of Australia. It has an area of 256 square kilometers and an estimated resident population of 20,255 people. The population has grown at an average rate of 1.5% per annum since 1995, and at a rate of 2.43% from 2000 to 2003.

In New South Wales, each Council has a Local Environment Plan (LEP). The LEP is the primary planning instrument and therefore informs all planning decisions in the area. The LEP sets the zonings, defines what activities can go where, defines building heights, and sets broad strategic directions for all locations and activities. Each LEP is in place for ten years, after which a major review is conducted. Kiama Municipal Council will complete the review of its Local Environment Plan by 2006, and it will then be in place until 2016.

Public participation techniques

According to Konisky and Beierle (2001) the common debate surrounding public participation in environmental decision making is no longer a “government versus citizen participation” debate, but a discussion of what type of public participation approach is best. There is a wide range of participation methods in use in environmental management in Australia and around the world. The International Association for Public Participation has summarised these approaches in a spectrum demonstrating the level of public impact achieved, illustrated in Table 1 below.

Research Objectives

The specific objectives of this research project are to:

1. Evaluate the capabilities of a GIS to act as a decision support tool in a public participation exercise;
2. Investigate whether the use of GIS can enhance the expertise and satisfaction level of participants in an environmental decision making process;
3. Investigate whether the use of GIS by public participants provides the decision making agency with a more informed contribution from these stakeholders; and
4. Develop a model for Australian local government to provide public access to GIS data for environmental decision making purposes.
Increased level of public impact

<table>
<thead>
<tr>
<th>INFORM</th>
<th>CONSULT</th>
<th>INVOLVE</th>
<th>COLLABORATE</th>
<th>EMPOWER</th>
</tr>
</thead>
<tbody>
<tr>
<td>Public Participation Goal:</td>
<td>To provide the public with balanced information to assist them in understanding the problems, and/or solutions</td>
<td>To obtain public feedback on analysis, alternatives and/or decisions</td>
<td>To partner with the public in each aspect of the decision, including development of alternatives and identification of the preferred solution.</td>
<td>To place the final decision making in the hands of the public.</td>
</tr>
</tbody>
</table>

Promise to the public:

- We will keep you informed
- We will keep you informed, listen to and acknowledge concerns and provide feedback on how public input influenced the decision
- We will work with you to ensure your issues are directly reflected and provide feedback on how input influenced the decision
- We will look to you for direct advice and innovation in formulating solutions and incorporate your advice and recommendations into decisions to the maximum extent possible.
- We will implement what you decide.

Examples:

- Fact sheets
- Web sites
- Focus groups
- Surveys
- Public meetings
- Workshops
- Citizen Advisory Committees
- Consensus building
- Citizen juries
- Delegated decisions

Table 1: The spectrum of public participation (after International Association for Public Participation 2004).

The Consultation Process

Councillors have appointed a Steering Committee, whose purpose is to oversee fairness of the process. Steering Committee members include three Councillors, a Department of Primary Industries representative, a Department of Infrastructure Planning and Natural Resources representative, a District Chamber of Commerce representative, a local Historical Society representative, a local dairy farmer, a local architect, a local environmental planner and a local environmental campaigner. This Committee has supervised the random selection of 16 local residents who will form a Community Panel. The Panel will meet in late May and deliberate for four consecutive days on the following priority questions posed by Council:

1. How might the LEP protect the agricultural and scenic landscape, and also support a diverse, changing and viable economy and community?
2. How should town centres and surrounding residential neighbourhoods be developed to create vibrant town centres with increased business and employment opportunities, and living areas that have high amenity, accessibility, safety and a sense-of-place that reflects the coastal charm and character of the place?
3. What level of population growth is appropriate for Kiama over the next ten years and how can it be housed?
4. What are the appropriate LEP mechanisms to protect ecologically important natural systems and biodiversity in the Kiama Municipality and what opportunities exist to enhance degraded systems through the LEP process?

The Steering Committee has also invited expressions of interest from people who wish to present their case to the Community Panel as ‘expert presenters’. The Committee will select presenters who are able to demonstrate an adequate understanding of local planning issues and are able to present this in a concise format to the Panel.

Following the Community Panel, it is highly likely that there will be a number of issues that the panel may have had difficulty reaching consensus on. If this is the case, a series of public Issues-based Workshops will be conducted with the aim of focusing on each specific issue and obtaining...
A synthesis stage will then follow the workshops. The consultants will work to compile the community recommendations to Council in the form of responses to the priority questions originally posed to the Community Panel. This will form the basis of the community contribution to the Council’s decision making process regarding the review of the Local Environment Plan.

**The research component**
This research is aimed at evaluating and comparing a number of methods of providing GIS access to community participants in an environmental decision making process. Table 2 below outlines the research aims for each of the consultation techniques that will be applied in the review of the Local Environment Plan.

### Table 2: Research aims for each of the Kiama LEP consultation techniques.

<table>
<thead>
<tr>
<th>Consultation Process</th>
<th>Research aims</th>
</tr>
</thead>
</table>
| **Councillor Workshop** | • Inform Council of research aims and methodology;  
• Survey Councillors to determine their views on the use of GIS by community participants in the LEP Review. |
| **Steering Committee** | • Inform Steering Committee of research aims and methodology;  
• Present data created for use in Community Panel;  
• Survey Committee members to determine their views on the use of GIS by community participants in the LEP Review. |
| **Community Panel** | • Liaise with Community panel ‘expert’ presenters prior to deliberation phase and establish GIS data set to illustrate each presenter’s case;  
• Present GIS data to Community Panel in user-friendly format to assist with decision making phase;  
• Observe interaction of Panel members with GIS and their use of data to illustrate decision options which will be to put to wider community;  
• Interview Panel members during deliberation phase to determine their views on the impact of GIS on their final decision;  
• Record the Panel proceedings on audio tape;  
• Survey Panel members after deliberation phase to determine their satisfaction level in the overall process as well as in the GIS component. |
| **Issues-based Workshops** | • Present GIS maps to Workshop participants that illustrate the range of decision options for each issue;  
• Record the Workshop proceedings on audio tape;  
• Survey participants to determine their use of this data in their deliberation and in their final decision. |
| **WebGIS** | • Present GIS maps on an information website that reports on the consultation process at each stage, thus allowing the wider community to participate;  
• Provide the 2D maps and 3D models prepared by the Community Panel to illustrate the decision options on the website and allow users to nominate their preferences online;  
• Provide online survey for website users to comment on their use of GIS data and whether this assisted them to contribute to the process. |

consensus in the form of a solution which most people can ‘live with’. 

Evaluation
The audio tape transcripts, interview responses and survey results from the consultation process will be compiled and used to assess the use of GIS by public participants in the review of the Kiama Local Environment Plan. A comparison of this data will then be made to determine if the experience of the participants in each of these consultation techniques in accessing and using GIS in their decision making differed according to the consultation technique they participated in. Using this comparison, and based on
results of other case studies where GIS is used by community participants in environmental decision making process, a model for the provision of public access to GIS data by local government in Australia will be proposed.

References
A New Generation of Public-Private Partnerships for Forest Conservation in the Urbanizing Tropics: Case Study of the former Rodman Naval Base, Republic of Panama

Andrew D. Carver¹, Nestor J. Correa¹, Gerald P. Bauer², Peter L. Weaver², Jean C. Mangun¹, and Pedro M. Gascón³

Abstract
All too often, improving protected areas management in the tropics is seen as a job for international environmental non-governmental organizations (NGOs) and their local affiliates whose primary mission is biodiversity conservation and/or land preservation. However, application of this model within the rural-urban interface can lead to the development of adversarial relationships and polarization between environmentalists and developers (i.e., local business interests). To the contrary, success of many conservation projects relies not on opposing the business community but instead relies on their inclusion as conservation partners.

The objective of this paper is to examine a new conservation partnership in the Republic of Panama formed between a local environmental NGO and a civic organization whose primary mission is not conservation. Specifically, this paper outlines the creation of a public park undertaken by the Club Rotario Panamá Nordeste (Rotary Club Panama Northeast) with support from cooperators with land management expertise. The cooperators include the Panamerican Conservation Association, Southern Illinois University’s Department of Forestry and the U.S. Forest Service International Institute of Tropical Forestry. Known as EcoParque Panama, this 400 ha. portion of the former U.S. Rodman Naval Base will conserve lowland tropical rainforest and improve the quality of life for residents of the expanding Panama City metropolitan area.

Introduction
While the Republic of Panama may be best known for the Panama Canal (which saves ships a seventy-nine hundred mile trip around Cape Horn), the country is also situated in one of the most biologically diverse regions in the world (Condit et al., 2001). The area that surrounds the Panama Canal, known as the Panama Canal Watershed (PCW), encompasses approximately 714,628 acres of land and is home to thousands of plant and animal species, including 2,581 species of vascular plants of which 146 are endemic to the region, 159 species of mammals, and 564 birds (Greenquist, 1996).

The country of Panama and its residents, particularly in the PCW region, have experienced dramatic changes over the last two decades as the United States began returning the canal and surrounding lands to the Panamanian government. In 1999, economists projected an annual economic loss for the country totaling between U.S. $177 million and $350 million after the shutdown of the remaining U.S. military bases (Bounds, 2000). In part to fill the economic void left by the U.S. pullout, commercial development within the former Canal Zone has been an economic priority of the Panamanian government. Even though Panama has created national parks to help protect the area’s vital forests, Heckadon (1993) cites population growth, mining, industrialization, urbanization and road construction as leading economic development practices that are currently deteriorating the Panama Canal Watershed.

Historical Context and Legal Framework
Under the provisions of the Torrijos-Carter Treaties of 1977, the Republic of Panama and the United States of America agreed to the reversion of what was formerly known as the Panama Canal Zone to Panamanian jurisdiction. In 1993, the Panamanian Legislative Assembly created the Autoridad de la Región Interoceánica (Interoceanic Regional Authority or ARI) to administer the lands in accordance with the Treaties. This autonomous state agency is responsible for promoting the economic development of the Interoceanic Region (areas adjacent to the Panama Canal), for optimal utilization of its resources. ARI is responsible for planning, coordinating and execution of programs and projects for the use, preservation and development of the former Canal Zone, including the rent, sale, or granting of reverted lands and assets. Contrary to some public opinion, the ARI is not just a real estate
agency that must sell or rent all of the reverted areas for commercial or housing development. To the contrary, the ARI also seeks to create social benefits and public spaces to balance the more intensive development.

Similar to the comprehensive plans typical in U.S. cities and counties, development within the former Canal Zone is guided by a land use plan and associated land use (i.e., zoning) map (Intercarib and Nathan Associates, 1996). Together these documents outline the specific geographic areas that may be developed as well as the intensity of development allowed. Importantly, areas critical to the preservation and maintenance of the watershed hydrology and wildlife are recognized in the land use classification system. Additional conservation also exist in higher-use areas such as those designated for future housing because land use classifications represent the upper limit (maximum) of development intensity. This hierarchical approach to zoning parallels Euclidean zoning regulation common in the United States.

Study Area
The U.S. Department of Defense was an important land manager within the former Canal Zone. In fact, military installations occupied approximately 30,000 ha. along the canal. The vast majority of these lands are covered by tropical forest (80 percent), much of which remains relatively undisturbed (ANCON and TNC, 1996). The particular study area addressed in this paper consists of a portion of the former Rodman Naval Base along the western Pacific slope of the Panama Canal (see Figure 1). Approximately 400 ha. in size, this former ammunition depot is characterized by rolling hills occupied by semideciduous seasonal mixed forest. This complex forest type consists of a diverse structure with canopies reaching 35 meters. Endangered wildlife species found on the site include among others, the Jaguarundi (Felis yaguarondi), Southern river otter (Lontra longicaudis) and Titi Monkey (Saguinus Oedipus Geoffroyi) (ANCON and TNC, 1996). While the area supports a wealth of biological diversity, it also contains numerous attributes of historical importance, including a buccaneer trail and U.S. military bunkers built prior to World War I.

The study area is undergoing development pressure as the demand for housing increases within commuting distance to Panama City. Conserving the area is important from a social standpoint because it would provide recreational opportunities currently unavailable on the west side of the Canal. From a biological standpoint, the area provides a buffer zone between the accelerating urban expansion of Panama City and vast, neighboring tracts of forestland currently classified for wildlife and watershed protection.

Partnership Formation and Park Creation
The preliminary vision for preventing intensive urban expansion within the heavily forested portions of the former Rodman Naval Base site originated with the Interocanic Region Authority (ARI). Yet, finding an entity able and willing to manage the land for conservation proved challenging, especially since the National Park System of Panama is overwhelmed with it’s current management responsibilities and many of the larger environmental NGO’s are plagued with problems of their own (see Dougherty, 2002).

Given the close proximity of the site to the urban center of the country, ARI thought “out of the box” and proposed that trusteeship of the land be given to a local civic organization. Club Rotario was one such civic organization identified by ARI. The Club had already distinguished itself in the successful implementation of a number of large urban as well as rural service projects aimed at quality-of-life improvements for the Panamanian people. However, the Club Rotario membership possessed little expertise in conservation land management. Hence, the Club enlisted a local environmental NGO and international cooperators to develop a formal proposal and feasibility study for consideration by ARI. The cooperators include the Panamerican Conservation Association (an independent affiliate of GAIA España), Southern Illinois University’s Department of Forestry and the U.S. Forest Service International Institute of Tropical Forestry. The plan was accepted and the creation of EcoParque Panama was formalized with the 2004 passage of two ARI resolutions (Resol. de JD de la ARI Nos. 078-04 and 066-04). Cooperating organizations participate through representation on the Park’s Advisory Committee.

The expected opening of EcoParque Panama is late 2005. The primary objectives of the Park are twofold. First, the Park will provide opportunities for recreation and heritage interpretation in a natural environment. Second, the Park will develop a model of sustainability for similar urban-interface parks in Central America. The following strategic goals will be embedded into the Park’s mission:
• Promotion of economic growth and social development in harmony with sound stewardship of the environment and natural resources.
• Promote public participation in the process of environmental decision making.
• Promote and foster economic and social stability at the local community level by working with partners in the development of a sustainable tourism industry that is accessible to local citizenry as well as international markets.
• Promote the use of good governance to assist local NGOs and communities in enacting and implementing their own conservation strategies or programs.

The EcoParque Panama financial approach combines the fundraising experience of the Rotary Club Panama Northeast with growing international interest in biodiversity conservation and ecotourism opportunities. Initial EcoParque Panama offerings will include world-class birding and wildlife viewing, hiking, biking, camping, and opportunities for long-term research in the biological and social sciences. Later developments will include museums and educational centers providing interpretation in tropical ecosystems and the cultural and historical aspects of life in the Canal Zone.

**Figure 1.** EcoParque Panama is located adjacent to Panama City on the west slope of the Panama Canal.

**Conclusions**
This innovative conservation partnership gains government and community trust and support through the involvement of a respected local civic organization. Similarly, the Rotary Club’s reliance on recognized land management organizations for the on-the-ground management of the Park ensures that conservation and sustainability remains paramount in the long term. Through the creation of EcoParque Panama the Republic of Panama has taken a first step in recognizing that a healthy forests at the urban interface coupled with affordable access to it, represents an improvement in quality of life and economic opportunity for it’s citizens.

**Literature Cited**
Leadership Structures in Regional Economic Development Partnerships: Charisma, Conflict, and Competition

Jeffrey Sachse, Department of Political Science, Center for Transportation Education, University of Wisconsin

Abstract
As pressures for expanded development have clashed with an opposing concern for environmentally responsible “Smart Growth” policies, small rural governments have been faced with a difficult series of decisions in defining the character of development strategies in this framework of competing pressures and limited resources. An analysis of the state of rural Wisconsin shows a significant need for a coordinated or regional development plan to address the dual concerns of lower household income and higher unemployment caused by the substantial loss in agriculture capacity over the past forty years. However, as is consistent in previous analyses of regional growth regimes in metropolitan areas, a survey of 921 elected officials in Wisconsin’s townships reveals that an undercurrent of pro-growth and anti-growth sentiments leads to conflict. To reconcile these concerns, the emergence of a charismatic leader is needed to moderate and drive appropriate development efforts.

Introduction
Rural America finds itself in the middle of a paradigm at the dawn of the 21st Century. The combined impacts of the slow decline of the family farm and increasing pressures precipitated by urbanization and sprawl have forced rural residents and government officials alike to make a series of difficult decisions.

Pressures for increased development in rural communities have been driven by the growth of metropolitan America. According to the 2000 Census, 56 million residents lived in non-metropolitan counties in the United States, which accounts for 20 percent of the nation’s population. Interestingly, this tally is misleading. Isserman finds that 38 million residents in this group live in areas adjacent to cities with a population of 20,000 or more, with the bulk of residents living in counties adjacent to metropolitan areas (Isserman, 43). A product of the urban sprawl that marked development and migration in the years following World War II, this non-metropolitan metropolitan population generally benefits from many of the amenities of urban America, while maintaining a semblance of its agrarian past in the form of small townships, large lot sizes, and the need to commute from home to the workplace.

The more rural American population, as exemplified in the forty-two non-metropolitan counties of Wisconsin, faces a series of much more significant challenges. As illustrated below, marked income disparities exist between metropolitan and rural households. This disparity is the result of both the decline of family farming in the state and a decrease in employment by firms supporting agriculture. The resulting increase in unemployment has eroded household incomes in the state.

Literature Review
Much focus has been placed on the role of regional governance in improving the fortunes of a number of government responsibilities and services. Coordination of a single service, such as waste disposal, public safety, or public housing, by a number of metropolitan governments has become the norm in modern urban America (Downs 1994, and Rusk 1993). Similarly, the complete consolidation of municipal sovereignty in the formation of a metropolitan government has met with varying degrees of success (Orfield 1997). Because (Due to) the wealth of urban examples and the capacity for consolidation and coordination in metropolitan areas, a large share of the literature concerning regionalism has a distinctly urban focus. However, this focus should not be misconstrued as an implicit assumption that more rural areas are not interested in regional practices.
Rural areas have been driven, both by demand and by state mandate, (Gainsborough, 509) to explore possible ways of fostering regional partnerships. The push for regionalism in rural areas can be linked to a variety of benefits derived from such collaboration, including: consolidation of redundant services, capacity building, and the elimination of inter-community competition. Economic development partnerships may prove beneficial to rural areas both as a means to coordinate relatively limited resources through the creation of a coordinated marketing campaign, and to eliminate competition between communities for a limited number of development possibilities (Olberding 488).

**Methodology**

In an effort to explore the extent to which regional interest has permeated the mindset of rural township governments in Wisconsin, a survey of all 4,155 elected township officials of the state’s 1,264 towns was administered by doctoral students and faculty at the University of Wisconsin – Milwaukee on behalf of the Wisconsin Towns Association in January 2003. While the survey addresses a broad range of issues, from intergovernmental relations, constituent relations, Smart Growth legislation, and term limits, the present analysis is restricted to officials’ views of regionalism and economic development. The results of a selection of questions from a sample of 921 respondents (22 percent) are listed below.

**Interpretation and Discussion**

The interpretation of the survey results presented above, as well as those included in the complete survey instrument, reveal a number of interesting conclusions regarding perceptions of regionalism among rural elected officials. While support for the concept of regional partnerships in general is reasonably high, this support varies across policy areas. In their significant resistance to support regional planning and land use commissions, township officials reveal their implied intent to “protect one’s turf.” This protectionist attitude is restated in the strong agreement with the assertion that regional partnerships threaten local control. This may result, in part, from recognition that town governments have traditionally held control over a far narrower spectrum of policy areas and services than an average municipal official. As such, the issue of sovereignty, particularly with respect to controlling the rate of development of a rural community, plays a much stronger role than the potential characterization of township officials as “antigrowth entrepreneurs.” (Schneider and Teske, 1993)

While the protectionist tendencies among township officials may lead to a general tendency to oppose measures encouraging development or comprehensive planning, such as regional collaboration or Smart Growth planning policies, there also appears to be a strong tendency among officials surveyed to support efforts to promote economic development in their communities. This is
reflected in a number of different areas. First, general support for economic development partnerships (35.2 percent) is relatively high and ranks third among those policy areas included in the survey. Additionally, there is general agreement among those surveyed that regional partnerships significantly aid development (54.6 percent). While general support for economic growth is high, a potential explanation for support of regional partnerships in this area can be found in the moderate agreement category suggesting conflict among board members concerning economic development issues. Given these two findings, it is logical to conclude that pro-growth rural officials view regional partnership as a means of circumventing conflict at the local level.

The final substantive finding brought out by the survey results suggests that the study of regionalism at the rural level is certainly deserving of future consideration. While the supporting data or case studies may not be as numerous or fruitful, the potential benefits of the regionalism movement may be found in greater abundance in rural areas. The potential for consolidation of resources, leadership, and the building of capacity to compete for a limited number of development opportunities naturally makes regional collaboration another powerful tool in the rural economic developer’s toolkit.

Acknowledgements
I wish to thank Dr. Douglas Ihrke, Scott Sager, Theresa Johnson, and Wisconsin Towns Association for the use of the preliminary survey data presented in this analysis. I look forward to reviewing their forthcoming analysis of the data and the implications of Smart Growth planning requirements on rural townships. I would also like to thank Mary Jo Maciejewski, Julie Paulson, and Donna Stroud for their helpful comments on earlier drafts of this work.

References
### Table 1. Approval Scores for a Sampling of Regional Partnership Areas

<table>
<thead>
<tr>
<th>Partnership Area</th>
<th>No Response</th>
<th>Strongly Disagree</th>
<th>Disagree</th>
<th>Neutral</th>
<th>Agree</th>
<th>Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>Health Care</td>
<td>21.5%</td>
<td>10.0%</td>
<td>9.3%</td>
<td>22.9%</td>
<td>25.7%</td>
<td>10.6%</td>
</tr>
<tr>
<td>Land Use/Zoning</td>
<td>17.8</td>
<td>21.2</td>
<td>12.0</td>
<td>13.3</td>
<td>25.1</td>
<td>10.6</td>
</tr>
<tr>
<td>Economic Development</td>
<td>20.8</td>
<td>11.3</td>
<td>11.0</td>
<td>21.7</td>
<td>27.4</td>
<td>7.8</td>
</tr>
<tr>
<td>Education</td>
<td>20.8</td>
<td>9.8</td>
<td>10.0</td>
<td>25.4</td>
<td>25.5</td>
<td>8.6</td>
</tr>
<tr>
<td>Transportation</td>
<td>21.5</td>
<td>11.2</td>
<td>11.6</td>
<td>23.0</td>
<td>24.6</td>
<td>8.1</td>
</tr>
<tr>
<td>Water/Sewer Services</td>
<td>23.1</td>
<td>16.1</td>
<td>13.9</td>
<td>23.8</td>
<td>15.4</td>
<td>7.8</td>
</tr>
<tr>
<td>Affordable Housing</td>
<td>21.7</td>
<td>16.3</td>
<td>16.0</td>
<td>23.3</td>
<td>17.7</td>
<td>5.1</td>
</tr>
<tr>
<td>Workforce Development</td>
<td>24.0</td>
<td>13.1</td>
<td>14.1</td>
<td>29.1</td>
<td>15.4</td>
<td>4.3</td>
</tr>
<tr>
<td>No Partnerships</td>
<td>52.4</td>
<td>7.1</td>
<td>6.5</td>
<td>11.7</td>
<td>11.2</td>
<td>11.1</td>
</tr>
</tbody>
</table>

### Table 2. Agreement with Statements Related to the Success of Potential Regional Partnerships

<table>
<thead>
<tr>
<th>Issue Statement</th>
<th>No Response</th>
<th>Strongly Disagree</th>
<th>Disagree</th>
<th>Neutral</th>
<th>Agree</th>
<th>Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>Good IGR Partnerships</td>
<td>0.3%</td>
<td>2.4%</td>
<td>6.5%</td>
<td>8.8%</td>
<td>46.9%</td>
<td>35.1%</td>
</tr>
<tr>
<td>Enhance Growth</td>
<td>0.7</td>
<td>6.6</td>
<td>15.2</td>
<td>22.0</td>
<td>39.6</td>
<td>16.0</td>
</tr>
<tr>
<td>Good IGR Partnerships</td>
<td>0.4</td>
<td>3.7</td>
<td>15.0</td>
<td>22.5</td>
<td>37.5</td>
<td>21.0</td>
</tr>
<tr>
<td>Take Control</td>
<td>1.5</td>
<td>43.6</td>
<td>36.8</td>
<td>11.5</td>
<td>4.6</td>
<td>21</td>
</tr>
<tr>
<td>Conflict High</td>
<td>37.1</td>
<td>6.5</td>
<td>9.5</td>
<td>22.7</td>
<td>16.7</td>
<td>7.3</td>
</tr>
</tbody>
</table>

### Table 3. Correlations of Conflict in Responses Concerning Support for Regional Partnerships

<table>
<thead>
<tr>
<th>Issue Statement</th>
<th>Correlation with Support for Partnerships in Economic Development</th>
<th>Correlation with Support for Partnerships in Land Use/Planning</th>
</tr>
</thead>
<tbody>
<tr>
<td>Partnerships Threaten Local Control</td>
<td>-0.260*</td>
<td>-0.316*</td>
</tr>
<tr>
<td>Conflict on Board is High</td>
<td>0.016</td>
<td>0.006</td>
</tr>
<tr>
<td>Opposition to Smart Growth</td>
<td>-0.267*</td>
<td>-0.295*</td>
</tr>
<tr>
<td>Conflict on Board over Economic Development Issues</td>
<td>0.224*</td>
<td></td>
</tr>
<tr>
<td>Conflict on Board over Land Use Issues</td>
<td></td>
<td>0.103*</td>
</tr>
</tbody>
</table>

*Correlation is Statistically Significant at 0.05 Level
Introduction
Over the last decade, the spread of NIPs has resulted in widespread environmental damage and ever-increasing economic liabilities in the U.S. Many biologists and ecologists have responded, investigating how NIPs are introduced, why they spread, and what control methods are most effective. Economists have estimated the costs of NIP damage and control efforts to various public and private sectors. The spread of NIPs has been associated with landscape characteristics, land use changes, urban development, and population distribution patterns, making the urban-rural interface particularly vulnerable. Despite considerable research exploring the ecological implications and costs of NIPs, controversy rooted in public policy and social acceptability persists. As Lodge and Shrader-Frechette (2003) acknowledge, while biophysical science can provide statistical probabilities of the success or failure of a plant’s introduction and model the spread of invasions, characterizing these events as good or bad requires a fundamental value judgment. This paper presents the preliminary results of a study using a focus group approach to better understand how people perceive NIPs and how perceptions are shaped by knowledge, values, and emotions. Specific study objectives were to: 1) review current NIP literature concerning the human dimensions of NIPs, including NIP ethics and policy, 2) identify community stakeholder perspectives relating to nature, vegetation, native and non-native plants, and management options, and 3) develop recommendations to guide natural resource officials and community leaders in NIP management planning, public involvement, and outreach strategies. Qualitative and quantitative data were collected through a series of focus groups with stakeholders in southern Illinois. Understanding public perceptions of NIPs will assist natural resource managers and community officials in incorporating public values into management and policy making, developing effective education and outreach programs and building social acceptance of and participation in control efforts.

The ecology, economics, and human dimensions of non-native and invasive plants
According to Cully, Cully, and Hiebert (2003), biological diversity and ecosystem processes are significantly impacted by the distribution and abundance of non-native species. Researchers have identified several ecological and anthropogenic factors that hasten the spread of NIPs and contribute to ecological impacts such as increased fire frequency, differences in water utilization, carbon dioxide changes, soil nutrient depletion, and competitive reduction of indigenous species (Carruthers, 2004). The economic losses and expenditures related to NIPs also have garnered the attention of researchers. Economists estimate that NIPs cost the U.S. over $100 billion annually (Pimentel, Lach, Zuniga, & Morrison, 2000). Agriculture and forestry sectors are among the most significantly impacted, but other industries such as public health and recreation have sustained losses. Although much has been learned about the ecological and economic implications of NIPs, Donlan and Martin (2004) argue that public perception will eventually dictate future NIP policy. Understanding the perceptions of diverse stakeholder groups is central to developing social acceptability and in turn, public support for control efforts. Yet, the importance of integrating the human dimension, including stakeholder attitudes, emotions, and beliefs, into natural resource planning and management is commonly overlooked (Gobster & Westphal, 2004). Research exists on people’s landscape preferences (Gobster & Westphal, 2004), visions of nature (Gobster, 2001; Hull, Robertson, & Kendra, 2001), and perceptions of landscape change (Davenport, in press; Stewart, Liebert, & Larkin, 2004). More recent investigations have examined differences in landscape preferences among urban and rural communities (Gobster & Westphal, 2004; Ariazza, Canas-Ortega, Canas-Madueno, & Ruiz-Aviles, 2004). Little research has explored the human dimensions of NIPs, in particular.
Methods and Procedures

A focus group approach was selected for this study to promote discussion among group participants and reveal in-depth information about key topics, including natural resource values, knowledge about and attitudes toward NIPs, and support for control options. The study design followed protocol outlined by Krueger and Casey (2000).

Three focus groups were conducted with a total of twenty-one residents of Jackson County, Illinois. Study participants were contacted through a purposive sampling strategy from three organizations with a stake in natural resource management: a National Wildlife Refuge volunteer group, an environmental organization, and leaders from the city of Carbondale. Participation was voluntary. Seventy-five percent of the participants were male, the mean age was 62, and 65 percent had at least a college degree.

The number of participants ranged from four to 11 people in each focus group. Food and beverages were offered as incentives. An array of data was collected through nominal group processes, open-ended discussion questions, worksheets, and a self-administered survey to establish a demographic profile of each group. Each focus group discussion was transcribed verbatim and analyzed using qualitative analysis procedures. Key phenomena were coded and categorized into categories and subcategories. This form of coding generates patterns and themes that were validated by the data (Strauss & Corbin, 1990). To ensure trustworthiness of study findings, detailed notes were taken throughout and following each session. Multiple data sources were used to improve the credibility of the study interpretations. The study’s findings may not be generalizable to a larger population because of the small sample and highly contextual nature of the topics. However, interpretations may be applicable to similar settings with similar issues.

Results

The overall aesthetic and visual qualities of southern Illinois were emphasized throughout each focus group session. Participants were asked what they liked and disliked about nature in southern Illinois. Participants stressed the importance of visual elements in nature such as scenic beauty, wildlife, topography and seasonal changes. Other qualities described included the diversity of natural settings, accessibility to natural areas, and the area’s recreational opportunities. One participant expressed his desire for natural diversity and aesthetic elements:

I greatly enjoy seeing the different faces of nature in just a few miles. For example, as I drive...south on 51 then get on 57 and on down to Cairo...the whole picture changes and it changes pretty rapidly. Some landscapes that one drives in are the same for hours, but when you start driving across southern Illinois, you get a lot of variety pretty quickly. ...where the old ancient bed of the Ohio River was, you can see the level flatbed and the bluffs that were on each side and imagine what that was when the Ohio River flowed there. And then you get down a little further and you’re down in the country of cotton and rice and you’ve just gone from one natural setting to another to another in just a few miles and that’s rather unusual.

Aspects of nature that participants did not like were also commonly associated with aesthetic and visual elements such as vegetation overgrowth and litter. Careless development was troubling for some participants. When asked what they did not like about nature in southern Illinois, one participant said, “I think the loss of habitat. I’ve watched subdivisions go in lately with total disregard to whatever trees were there. Just knock them all down where you can put in subdivisions without keeping things with some semblance of the nature that was there. That bothers me.” Several participants referred to certain plants and animals as something they did not like about nature in this area. Discussions of invasive plant species, especially autumn olive and poison ivy, were common.

When participants were asked to discuss their biggest concerns about the protection and management of nature in this area, three major themes emerged: lack of stewardship, careless development, and overprotection of nature. Lack of stewardship included pollution, recreation visitor impacts, lack of educational programs, and lack of government concern. Careless development was characterized by a lack of planning within communities and inadequate land use protection. One participant linked invasive plants to careless development:
Another thing I notice to my dislike is the spread of dwellings across the landscape. I go out from Carbondale in any direction and I don’t see fields of corn and beans and woodlots. I see homes with very neatly mowed lawns and a neatly mowed lawn is kind of a biological desert compared to other venues. Then they plant exotic shrubs and trees when the most beautiful tree in our area is the eastern red cedar. But it’s regarded as a trash tree. There are no better, more beautiful and useful trees than the red cedar. But the new homeowners don’t plant the red cedar. They’ll bring in some exotic... but, I’d sort of like to keep all of the homes concentrated in town and have a much more natural landscape surrounding it. That’s not going to happen, but I regret that.

In contrast, the overprotection of nature was also discussed. Concern about natural resource managers’ personal agendas and differing visions of forest protection contributed to this theme.

Participants were then asked what they liked and disliked about vegetation in the area. Responses revealed a range of perceptions. Participants valued the diversity and variety of vegetation brought about by southern Illinois’ location within an ecological transition zone. Aesthetics and visual appeal, as well as the overall abundance of vegetation were significant to participants. One participant explained,

A lot of the variety and the diversity comes from the fact that we’re in an interesting transition zone. You can go sixty miles south... to places where you think you’re in Tupelo, Mississippi because of the transition zone with the tupelo swamps and the cypress that we have. It’s very interesting. Year round there are green things to see whether you’re driving or if you’re walking in the woods. There’s still green vegetation in the middle of December.

When discussing what participants did not like about the vegetation in this area, weed and invasive species, especially kudzu and autumn olive were discussed by participants. Specific plant characteristics such as thorns and resulting allergic reactions, landscaping trends, and the inability to manage invasive plants were other elements that participants did not like about vegetation. Non-native ornamental plants and current landscaping trends were described by one participant as the “the Bradford pear mentality. Gee, let’s buy something that’s a landscape variety that’s been bred for the cuteness-pretty effect versus a native species.” Another participant added, “[Native species] that could provide food for wildlife.” Enforcement was depicted as important in managing invasive plants. One participant said,

It’s going be a very hard thing to police. You know, some homeowners would love to have Bermuda grass and Bermuda grass is not a native grass of southern Illinois and it’s almost a noxious weed once it gets going. But they want a solid, nice even yard, so they plant Bermuda grass. The same thing for ornamentals. They’ll want it for privacy, but then it gets out of hand. So that’s going to be a hard thing to police.”

Another participant expressed concern about the commercial availability of the native landscape plants. “You can’t run to Lowe’s and buy native plants. If you do, they’re ten times the cost of something that’s shipped in from a nursery in Arizona.”

Participants were asked to discuss the acceptability of various NIP control option. Differences in option acceptability were tied its location and the technique used. Within residential areas, biological and mechanical methods were generally acceptable, while grazing and prescribed burns were deemed less acceptable. Most methods of control were considered generally acceptable in both public and agricultural areas. One participant discussed the techniques, location, and thus, the social acceptability of various control options:

With chemicals it depends on the kind of application. If you’re talking about aerial application of herbicides, forget that, but on the other hand careful manual
application of herbicides is fairly commonly accepted in most residential areas. In publicly protected areas, there’s an element of the populace that’s got a thing about chemicals. So you’ve got to be careful with how you handle it. You don’t want to get carried away with it, where you’re just spraying everywhere. But, in public land managed for recreation and environmental protection, I think just go at it. Whatever is most effective for a particular location and circumstance. I don’t think anybody’s going to complain. There are probably some people that get all bent out of shape about prescribed burns, but the reality is it’s just needed.

The impacts and social acceptability of control options emerged as significant themes. Participants acknowledged the importance of weighing the effectiveness of control options with options that are desirable to the public. Some participants discussed economic factors, such as the cost of control options versus the benefits these options provide. The long-term effects of each control option were often considered and suggested that many participants would support management techniques that focus on prevention. Participants called for an emphasis on prevention versus merely control of established infestations. One participant described the need for preventative measures: “I would like to see some kind of legislation passed that nurseries need to carry some [native plants] or need to better screen some of the plants they do sell. There are quite a few states that do that [like] Hawaii, Florida…..”

Participants were finally asked if they trust natural resource managers and community leaders to make decisions about NIPs. Participants discussed several barriers to trust, such as shifts in personnel, distant management, lack of long range planning, and politics. However, there were also opportunities for trust. Natural resource professionals were seen as knowledgeable and capable in their management abilities. One participant described politics as a barrier to trust.

[Do I trust] community leaders? Not at all. Natural resource people? Very capable. Community leaders too often are politically motivated and they only do what’s politically beneficial to them and they’re overall concern sometimes may not be as it should be. Professionals are very capable of doing a fine job.

Another participant characterized natural resource professionals as knowledgeable. He explained, “I trust natural resource professionals a lot. Thirty years ago, some bad decisions were made about non-natives, but I think they are probably more knowledgeable now. But who knows, forty years from now, we may be saying the same thing.”

Conclusions and Implications
The study demonstrates the key role vegetation, and specifically native vegetation plays in perceptions of nature. Study participants were largely cognizant of the threat of NIPs and factors that contribute to the spread of NIPs, such as a general lack of stewardship, careless development, and landscaping trends in southern Illinois. While competing views were expressed related to the need for regulations, many participants agreed that increased education and NIP prevention and control measures are needed in southern Illinois. Overall, participants trust natural resource managers to make decisions about NIP management.

Cultivating social awareness, support, and change is critical to the development of effective NIP policies and management strategies. Building on the existing appreciation and recognition of natural diversity, public awareness of particular NIP species, trust in natural resource professionals, and support for integrative management will establish a foundation for social change. This study explored the perceptions of three groups who represent concerned stakeholders. The preliminary findings presented here provide insight into key issues relevant to these stakeholders. Future research should explore these issues and their relevance to the broader public.

Literature Cited
prairie fragments. Conservation Biology, 17(4), 990-998.


Urban Form and Efficiency
For decades, in Canada, public debate on the nature of urbanism has concentrated on the ideal of public cost minimization. Unfortunately, the concept of "sustainability", as it pertains to urban land-use organization, has not taken us far beyond these traditional arguments advocating growth boundaries, densification and, in most cases, recentralization. In urban debate "sustainability" has become the latest fashion, but its argument is weakly founded and one which, in large part, is a function of the urban paradigm in which the position is rooted.

The case for ever-increasing densities, of tightening the links to the core, and of containing the lateral growth of the city, is usually associated with the acceptance of the normalcy of the monocentric paradigm of urban structure, along with a "neo-malthusianism", and a concentration on the role of large cities as the root of negative environmental impacts. Unfortunately, the essential processes operative in the modern city do not encourage monocentricity; malthusianism is in retreat; and a better case can be made for the large city as environmental solution than environmental pariah.

James Vance's brilliant redefinition of the nature of urbanism in terms of the polynucleate "city of realms" model forces a reconsideration of the traditional arguments regarding urban efficiency (Vance, 1964). Within the context of the "urban realms" model, the negative effects of moderate density suburban expansion is not as readily apparent as within the monocentric alternative. The journey-to-work, and shop and play may not increase with the expanding "realms". Housing prices may be reduced and their form more that of the single family house, the one which William Michelson, CMHC, and Cox and others) have found people clearly prefer. Also, net urban out migration to the low density environments of smaller communities, often on high quality land, may be reduced and rural land conservation even increased. The "neo-traditional" planner's reincarnation of the form of the turn-of-the-century small town (including the dominant single family house) may become more attractive as an alternative to the massed housing imposed in many Canadian large city suburbs which, in considerable measure, reflect the planner's and engineer's attempts at efficiency maximization. They may well have encouraged what one might expect from fixing the land quantity variable in Alonzo's budget equation -- a diversion of demand from the high density suburbs both inward to the pre-restrictive city and, more ominously for the environment, to the furthest reaches of the urban field (Alonzo, 1964, Code and Bailey, 1989).

The Strategies of Containment, Densification, And Recentralization:

Strategies for pretentiously named “smart growth” are essentially nostalgic, harking back to the structure and morphology of the industrial mass transit cities of the late 19th century -- although presumably not in their Dickensonian form. They extend a tradition stretching through at least three quarters of a century. This vision gives pre-eminence to a refocusing of the urban population on the historic core of the city, and the promotion of ever-increasing residential and commercial densities. In Canada, the major tools for the advancement of this conception are the familiar ones of containment, implemented through impoverished budgets for roads and peripheral servicing, inadequate radiating mass transit services, the encouragement of high density housing, and increasingly, high lot levies and recently in Toronto a massive greenbelt the size of the Canadian Province of Prince Edward Island. (It is not alone -- by 1999, over 100 U.S. cities and counties have established growth boundaries, and state-wide mandates exist in at least three states – Oregon, Washington, and Tennessee)

This strategy does have some virtues, particularly in those relatively few urban environments which have large agglomerations of high uncertainty quaternary functions which are unusually dependent on face-to-face contact -- such as one finds in downtown New York, London's "City", San Francisco, and the core of Toronto. Here, it is reasonable to encourage housing in and adjacent to the C.B.D. It is both efficient and more interesting, for as Jane Jacob's once said "a Central Business District which lives up to its name is a dud". Also, in such cities, centralization does positively affect modal split.

The rhetoric promoting the reinvented industrial mass-transit city is familiar. Advocates of this vision cite liveability, invoking the images of Paris's Left Bank (forgetting that city's northeast), Greenwich
Village (forgetting the "Alphabet Streets"), San Francisco's Russian Hill (forgetting West Oakland) and the morphology of small towns (forgetting the fact of their low densities and the single family character of their housing). Agricultural land is to be saved; nature is to be preserved and made accessible to the urban populace; energy consumption is to be reduced. What is usually overlooked, but is probably the most telling as an element encouraging containment and growth controls on urban development is the fact that containment is also beneficial to speculators in residential real estate -- witness the role of real estate interests in the implementation of growth control strategies in many of the towns and cities of California (Dowall and Landis, 1982).

The proponents of the containment / densification argument often ignore the implications for land use planning of important advances in this century's technology -- advances such as those in telecommunications, plant genetics, food transportation and storage, and methods of birth control -- even where they may be consistent with sustainable development. The revived Malthusian positions regarding agricultural land are now, and are likely to continue to be, hard to sustain in the face of massive world food overproduction, shifts away from animal and animal feed crops, and the spreading global demographic transition.

Advocates of this argument also propose solutions to problems in the urban environment which were, at least in part, rooted in previous applications of these very same solutions. For example, proponents of containment / densification, propose as a solution to the problems of our suburbs, which they cite as being so sterile and repelling, greater planning control, more containment, and higher densities. In doing so, they overlook the fact that these objectives were central elements in the planning strategies which produced these areas in the first place. While arguing for increased levels of control, these proponents overlook the fact that these places are, more than any other extensive urban environment in North America, the product of strategic land use planning.

Also much of the thrust of the argument promoting "sustainability" pays scant attention to the clear preferences -- made evident in both the market and in William Michelson's exhaustive survey -- for the low to moderate density single family house. Unfortunately, barring dramatic controls on population movement, segments of the urban population and industry will leapfrog the contained / densified city, thereby negating the proposed solution. The proposals for urban sustainability are often too narrowly focussed on the immediate metropolitan area rather than the urban system as a whole.

Most importantly, many of the policy conclusions of the containment and densification school are premised on an urban paradigm which is both inappropriate in the modern city, and conducive to the production of sterile dependent suburban communities devoid of both the urbane and the charm of the traditional small town and yet one in which an increasing preponderance of our population are scheduled to live.

Moreover, this strategy may be less sustainable than the option of a "city of realms" comprised of moderate densities with a preponderance of single family housing, with compact metropolitan town centers, all built with the design wisdom of the builders of our late nineteenth century small-towns. While the model of the 19th century city may still have applicability to the inner reaches of those few large scale metropolitan areas dominated by finance and other information intensive activities -- even here the optional paradigm of the "city of realms" will likely be both the most liveable and the most sustainable.

Urban Problem Perception and Paradigm Dependency:

The traditional monocentric urban paradigm requires little elaboration. It is the city of Burgess and Hoyt, of the traditional land consumption-accessibility models, the city of declining population densities, the core and suburb, centralization and decentralization, centripetal and centrifical processes. In Canada it is still the city which permeates our high school text books, our newspaper editorials and political debate. In Canadian urban planning it is only since the mid-nineteen seventies, in Toronto and Vancouver in particular, that there has developed an appreciation of the potential of an alternative form -- the polynucleate city. (Ironically this is the form of city which evolved in the unconstrained "sprawling" cities of the American south and southwest such as the San Francisco Bay metropolis.) This appreciation did not go far enough, however, for the paradigm of what
Vance called the "City of Realms" entails much more than a repository of unwanted back offices clustered around sterile shopping mechanisms, all posing no threat to the "sophisticated" metropolitan center. The authors of Toronto's "Central Area Plan" and "Metroplan" in the 1970's may have missed the full ramifications of their proposals to build their orderly equivalents of the American "edge cities", for they were promoting a model which required substantial rethinking of the impact of peripheral development on urban efficiency, and even essential parts of the logic behind densification and growth control.

Vance describes the urban realm as"... a largely self contained extensive area within which a mix of land uses is such that daily life can be carried on without normal resort to external locations in other realms. ...For most daily purposes, the realm is that self sufficient area that cares for an individual's needs". Increasingly, most residents of large metropolises do not make use of the entire urban area, save for exceptional needs; instead, they live and operate within a realm that is geographically confined enough to allow them to function relatively efficiently in spatial terms" (Vance, 1990). These realms often have distinctive social and economic characteristics, provide specialized retailing and consumer services appropriate to the residents of the realms. The relatively unconstrained American metropolis, may be made up of many realms (Vance estimated their threshold at between 175,000 to 200,000 population.)

Whether our perception of the ideal-typical is that of the traditional monocentric paradigm or the "city of realms" affects both our perception of urban sustainability and what we may view as appropriate planning policy. For example, development of the urban fringe in a monocentric city, inevitably, results in a lengthening of the average length of the journey-to-work and the journey-to-shop. Such fringe development will also necessitate restructuring access routes through the existing urban fabric. In this context, high density infilling is attractive for efficiency maximization and the shifting of modal split towards mass transit. In the city of realms, however, lateral expansion at reasonably compact residential densities (say 15-20 units per hectare) along with somewhat more efficient use of commercial and industrial space does not necessitate significant expansion of urban journeys. Employment, shopping and services appropriate to the cultural and economic makeup of the realm remain proximate to the populations.

Proximity to at least a quasi natural environment may even be best maintained in the realm cities. For example, in the "realms" of the San Francisco metropolis, positioned through a process of leapfrogging both the natural barriers and government established parks and preserves, there exists easy access to vast tracks of often wild open space even for those in the inner city. This can be more difficult to accomplish in a contained, higher density, centralized city.

The monocentric urban paradigm positions the center as the dominant focus of specialized retailing, services, and culture, and the place of interaction with other cities. But this emphasis can be seen as having encouraged the sterility of the suburban commercial landscape. What does it matter if the new centers do not act as the town center of old? The traditional urban "downtown" fulfils that role. The unfortunate truth is that in most Canadian metropolitan areas neither the traditional core, remote from an increasing majority of the population, or the ill conceived, often alienating, planned shopping centers provide meaningful foci for the dominant suburban population.

Housing Markets, Social Inequity, and Urban Sustainability:
It is a mistake to treat the idea of sustainability as solely involving natural systems to the exclusion of processes operative within society and its economy. Unstable systems within the physical environment are undesirable but so are those within the social and economic systems of the city, if for no other reason than unstable economic systems may negatively impact those of the natural environment. The most important of these latter processes are those of the housing markets, for these markets are notorious for inducing unexpected negative feedback. Ignoring the operation of the housing market in land use planning can have the effect of exacerbating the substantially inequitable redistribution of wealth resulting from housing hyperinflation (as happened in Toronto's major housing price bubbles of the early 1970's and the late 1980's). More important to the issue of "sustainability" is the impact of the imposition of strategies of recentralization, containment, and densification on urban housing markets, and the
As Martin Pauley pointed out in *Architecture Versus Housing*, housing can be seen in essentially two ways -- as a function of the individual and as a function of society (Pauley, 1971). The traditional planning model (now in the guise of sustainability) which emphasizes servicing efficiency, containment, growth controls, higher densities, and centralization is one which tends to emphasize housing as a function of society. In conditions of rapidly accelerating housing demand, it promotes rapid growth in land values, through planned containment and the consequent reduction in the availability of this key production factor. It also does this through administrative delays in the approval process.

The impact of containment and densification is particularly severe within the single family housing market, but the inflation within this market also puts demand pressure on the various forms of mass housing. Overall, there is a reduction in affordability and the need for an increased role of society in the provision of housing, usually in a collectivized form. This overall containment strategy helped establish "council housing" as the dominant residential form in pre-Thatcher Britain. This may help produce higher urban densities, but it is costly to the individual and to government. In the end, as a means of providing housing to substantial proportions of the Canadian urban population, it may well prove to be an unstable system, as it appears to have been in Europe.

In Canadian (and certainly American) society, there exists an impediment to the smooth application of the containment-densification strategy. The problem lies in the deep-seated preference of a strong majority of the Canadian population (along with those of many other countries) for the individually owned single family house which can at least begin to mirror the individual rather than some collective entity. This preference has been particularly well documented in the intensive research undertaken by William Michelson in Toronto and presented in his book *Environmental Choice, Human Behaviour and Residential Satisfaction* (1973). There, he documents the strength of this preference for the single family house and the corresponding rejection of mass housing as more than an interim residence. Whether it is suburban or central city, the single family house is chosen by an overwhelming majority as the closest approximation to their "conceptualization of the ideal". In these conclusions, Michelson’s work is consistent with evidence provided by the housing markets during Canada's post war housing bubbles. During these times, the higher rates of housing price escalation has been suggestive of a strong preference for the single family house and limited demand cross elasticity.

When, in the search for sustainability, containment strategies are adopted, the consequent housing price escalation results in substantial transfers of assets to those possessing property -- generally the more affluent -- from those who don't -- generally the young and the poor. Moreover, the consumer is unlikely to be as malleable as planners might hope for in the search for a closer approximation of the housing ideal. Many aspirants will leapfrog the containment to outlying locations at the outer range of the commuter shed and others will opt to reside in non-metropolitan centers, where densities are lower and consumption of land is, by definition, greater.

**The Price of Virtue:**
The containment/densification strategy, while superficially appealing as a tool promoting land use efficiency, entails considerable costs both in terms of social equity and even environmental impact. These costs may even prove more extensive than the alternative of accepting metropolitan areas in the form of polycentric cities of realms, the single family house on moderately sized lots, hopefully organized in a more liveable form suggestive of the small towns of earlier eras, as neo-traditional planners suggest.

The metropolitan containment / densification option combines not only a significant infringement of individual choice and ability to personalize the home but also social inequity through the considerable transfers of wealth to owners of housing and potential housing sites from those younger and poorer segments of the population aspiring for such property. This is something which the "realms metropolis", with its more open frontiers, would be less likely to produce. The constraints of the containment / densification strategy may be acceptable if there were indeed compelling empirical evidence favouring the widespread application of this strategy in Canada. But this evidence is dubious at best.
The Potential of Neo-Traditional Planning In A City of Realms:
The alternative is to accept and promote the city of realms -- a phenomenon which is a natural response to the preferences of the urban population, if not its inner-city elites. Equally necessary, is the acceptance of the single family house as the majority of the population's conception of the ideal, not just as the affluent's abode while they raise children. This does not have to entail quarter-acre lot subdivisions or inefficient use of commercial and industrial land, nor does the lateral expansion of the city of realms have to generate the kind of sterile, ugly places many Canadian suburbs have become. We should reject the view that low densities produce the impoverishment of the suburbs and confront the fact that the better parts of the late 19th century towns and small cities, which serve as an admirable model for much of today's neo-traditional planning, had densities which were lower than those existing in the modern Canadian suburb and much less than many being promoted today. New development in "urban realms" could be not only aesthetic, but also a reasonable compromise between efficiency and liveability. They will be the most stable, and in the end the most sustainable.

References

Abstracts of Additional Papers Presented at the Conference
The New International Population Order

Joseph Chamie, Director (retired), United Nations Population Division

The unprecedented growth of world population in the 20th century has altered the course of all life on this planet. World population nearly quadrupled during the past century, with revolutionary changes in human survival, child bearing, ageing, and urbanization. With increasing globalization, population trends and demographic differences are having greater significance and consequences than in the past. Rapid rates of population growth in some regions, population decline in others, population aging, the historic shift in the world’s urban-rural composition and other critical demographic trends are ushering in a New International Population Order. An appreciation of these critical population trends and transformations are essential and indeed among the underpinnings for understanding the world of today as well as tomorrow.

Forest Sustainability along Rural Urban Interfaces

David N. Wear
USDA Forest Service
Southern Research Station

Forest sustainability can mean many things to many people, but at its core it has to do with managing changes in forested landscapes to provide a desired flow of benefits over the long run. In many parts of the United States, including the Southeast, the great challenges to sustaining forests have shifted over the past twenty five years, away from rural timber management issues and toward the issues raised by exurban population growth and the evolving footprint of human settlement and occupation. Our focus on a rural-urban interface suggests new patterns of development that are neither essentially urban nor essentially rural but define an intersection of social systems and ecosystems. In this interface, the “human world” and the “natural world” overlap at increasingly broad scales and challenge our ability to fashion a workable coexistence—i.e., a sustainable future. The interactions between people and nature are bi-directional and complex and the resulting feedbacks can lead to a cascade of effects that change the quality of the human experience and the flow of ecosystem services. An understanding of how human systems and ecosystems interact is the necessary foundation for finding a sustainable trajectory of change. Solutions demand innovative interdisciplinary research programs focused on understanding and forecasting the human-ecosystem template and the flow of ecosystem services at meaningful scales, and developing institutions and tools for planning, policy, and management designed for the landscapes of the 21st century.
Household Dynamics in Space and Time: Implications for Urbanization and the Environment

Jianguo (Jack) Liu, Rachel Carson Chair in Ecological Sustainability and Director, Center for Systems Integration and Sustainability, Michigan State University

Aggregate demographic statistics such as human population size and growth rate are common indicators of human impacts on the environment and urbanization. However, environmental impacts of households (the basic socioeconomic units) are largely ignored. Globally, the number of households has been increasing much faster than population size as a result of the continuous reduction in household size. Even in areas where population size declined, the number of households still increased substantially. In the future, households will continue to proliferate as more countries are becoming industrialized. A rapid increase in household numbers, often manifested as urban sprawl, and resultant higher per capita resource consumption in smaller households, pose big threats to the environment. Household proliferation leads to landscape fragmentation, road network expansion, increased complexity of natural resource management, and rapid land use change. In this talk, I will present household dynamics across the world over time (for some countries over several centuries), highlight impacts of household proliferation on urbanization and the environment, and address challenges and opportunities facing society and the scientific community.

The Bio-Geo-Socio-Chemistry of Urban Watersheds

Peter Groffman, Institute for Ecosystem Studies

Increases in impervious surface associated with urbanization lead to development of an “urban stream syndrome” with physical degradation of the stream and riparian zone, declines in water quality and changes in biota. This degradation motivates a variety of human responses ranging from regulation to address pollutant delivery to receiving waters (e.g. Chesapeake Bay), to the formation of neighborhood groups concerned about children playing in polluted streams. These groups can serve as catalysts for social cohesion and community action that can foster ecological and socio-economic revitalization of underserved neighborhoods. In the Baltimore Ecosystem Study, one of two urban long-term ecological research (LTER) projects funded by the U.S. National Science Foundation, we are using “the watershed approach” to integrate ecological, physical and social sciences. Watersheds are a natural (and well-used) physical unit for ecological research and can also function as a focus for human-environment interactions. In this talk I review 1) how urbanization results in degradation of water quality, stream and riparian ecosystems; 2) how this degradation can motivate human action and 3) how restoration can serve as a catalyst for environmental and socio-economic revitalization of underserved areas. Using examples ranging from nitrate dynamics in riparian zones, to the role of urban trees as absorbers of air pollution, to the creation of a trail along a historic stream corridor, I will illustrate how changes in highly visible components of the environment (streams) can be used as a tool for integrating different academic disciplines along the urban/rural interface.
Blurring the Boundaries: The Urban-Rural Interface and the Need for Cultural Change in Ecology, Planning, and Management

Clifford S. Duke, Director of Science Programs, Ecological Society of America

The urban-rural interface constitutes not just a boundary between contiguous areas on a map, but a complex web of interactions among places and people, some geographically adjacent, some not defined by geography at all. Traditional geographic boundaries still exist, with urban cores transitioning to suburbs, and suburbs to small towns, farms, ranches, and “natural” places. But global commerce and global environmental impacts mean that beef served in a New York restaurant may have come from Argentina and the tractor on a Nebraska farm may have come from Japan, while carbon dioxide emissions in Los Angeles and China contribute to climate change impacts in the South Pacific and the Canadian Arctic. Responding to this ineluctable, largely unintentional blurring of geographic and environmental impact boundaries requires a parallel, deliberate blurring of the cultural boundaries among ecologists, planners, and managers. These boundaries need to be blurred by new means and forms of collaboration among disciplines and sectors (academic, government, non-governmental organizations, private) and by fundamental changes within disciplines. That is, we need to change what it means to be an ecologist, a city planner, a natural resource manager. Only by breaking down and blurring human and disciplinary boundaries can we begin to address the global problems associated with the blurring of geographic boundaries. The Ecological Society of America’s Ecological Visions project (www.esa.org/ecovisions) recommends just such a transformation in the ecological science community. This presentation extends that recommendation to all concerned with problems at the urban-rural interface.

Defining the Interface: What is it? Where is it?

Wayne C. Zipperer, USDA Forest Service

Questions commonly asked of individuals studying urbanization effects on rural systems are: what is the interface, where is it, and why is it important to define it? Often the interface is defined in geographical terms—e.g., interface, intermix, and occluded. These terms provide a spatial context of development with other land uses. Similarly, the interface often is described from a fire or economic perspective. Yet, the interface is more than a single measurement or context. It is a composite of multiple factors that converge to form a set of conditions, which defines a landscape in space and time. Thus, the interface is not a location, but rather a condition defined by changes to the physical, biological and social components of a landscape caused by urbanization. But, what are these changes and how are they related? Conceptually, physical, biological, and social components of a landscape can be viewed in a n-dimensional space with elements of the various components serving as axes. This hypervolume is much like the hypervolume of niche theory. By mapping the physical, social and ecological elements, the interface condition of a landscape can be defined. Linking a temporal element enables us to examine how the landscape is changing and what are the rates of change. From a planning and management perspective, this information provides an insight into factors creating the interface, the extent of the interface, and how it is changing. Each are critical pieces of information for effective land-use decisions and formulating land-use policy.
Canyon Frags and the City: The Nature of Nature in San Diego

Alicia Cox, San Diego State University

The eastward expansion of San Diego between 1900 and 1930 forced real estate speculators to contend with the area’s natural topography. Building inside canyons was neither safe nor financially feasible, so the grid pattern of development applied to the mesa top communities skipped over the canyons. By keeping the canyons intact, pockets of open space were wrapped into the urban landscape of central San Diego. More than eighty years have passed since the canyons and residential communities became intertwined, however, and conflicts exist between the two. Conflicts between canyons and surrounding land uses are most evident in the “frags” which develop in the mouths of canyons. Coined by Grady Clay, frags are fragments of space cause by errors in geographic design of cities. The patches of undefined space between the built environment and open space canyons, referred to here as canyon frags, are the subject of this paper. Canyon frags are the transitional spaces between residential neighborhoods and open space where no single land use is defined. They are seen in the eye of the beholder: an informal pathway to one person; a future park to another; and a site for affordable housing to still another. Some of the primary problems occurring at canyon frags are trash dumping and graffiti. This paper explores the juxtaposition of canyon frags between rural and urban environments and the nature-culture hybridity they represent. This is the story of two canyon frags in San Diego.

Development and Assessment of a Fire Model for Forest Park, Portland, Oregon

David Kuhn, Portland State University

The goal of the research is to develop a fire simulation model that can be used by city officials to predict the behavior and probability of fire in Forest Park under various forest, weather, and threat conditions. Forest Park consists of 2,025 hectares of forest in the northwest quadrant of the city of Portland, Oregon. Since Euro-American settlement in the 1850s, the forest has been harvested and numerous fires have burned many areas leading to multi-aged and mixed stand development. The fire regime of the region suggests a fire return interval of over 200 years, but this standard may be not accurate for Forest Park given its use and proximity to a large urban center. In 1951 a high-intensity crown fire swept over 25% of the park and provides a known break in the successional pattern. Using USFS Firemon standards six monitoring plots have been established within and adjacent to the 1951 fire zone. Tree crown and fuel sampling methods were employed at each plot for the development of a fuel model. A network of weather stations provides wind data to generate a three-dimensional wind field simulation using a computational fluid dynamics model. Ignition potential will be identified through the analysis of development intensity adjacent to the park and human-forest interaction points and patterns. Ignition threat points representing the highest probability scores will become ignition points in the fire simulation model. The ignition point of the 1951 fire is known which enables the fire model to be tested using historic weather data and the estimated forest stand structure.
The Front Range Fuels Treatment Partnership - A Multi-Agency Response to a Growing Problem


The Front Range of Colorado includes a complex and potentially explosive combination of hazardous forest fuel conditions and the urban-wildland interface. The 2002 wildfire season was the most damaging and costly in Colorado's history. The Hayman Fire alone burned 139,000 acres of the front range including many interface acres. The forested acres are increasing in fuel densities while more and more people move into the interface. Federal, State and local governments have acknowledged this ever increasing problem and have formed the Front Range Fuels Treatment Partnership to reduce wildland fire risk through sustained fuels treatment along Colorado's front range. The challenges are many and the logistics are complicated but there is great interest by the agencies, governments and many other stakeholders to make the partnership successful. A total of 510,000 acres need to be treated over the next decade, a goal that will take inter-agency cooperation, new technology, focused energy and funding, and buy-in from every level of government.

Collective Action to Reduce Risk of Catastrophic Wildfire in the WUI: Theory and Empirical Evidence

D. Evan Mercer and Toddi Steelman, USDA Forest Service and North Carolina State University

A variety of initiatives at all levels of government have been proposed to reduce the risk of catastrophic damages to communities from wildfire. Yet, little is known why some communities manage to foster effective responses to wildfire threats while others fail to do so. The actions to control wildfire risks exercised by one landowner (private or government) have implications for the risks faced by her neighbors so that the sum of individual landowner decisions affects the expected risk faced by the entire community. Therefore, wildfire risk reduction can be viewed as a public good, the provision of which will depend on a combination of individual, collective and cooperative actions. Since private landowners have the liberty to adopt or not adopt risk reducing strategies, policy makers need to consider these responses when choosing the optimal amount of public mitigation and suppression resources. Understanding the decision whether or not to cooperate through voluntary contributions to a public good is a central problem in economic and social theory. In this paper we will compare economic and social theories of cooperation and collective action and develop a conceptual framework for analyzing cooperative and collective actions to reduce the risk of catastrophic wildfire. Then we will use the results of case studies of community responses to wildfire threats in New Mexico, Colorado, and Arizona to examine the implications of the theory for designing optimal public policies and research programs for wildfire risk reduction.
Restoring Community Spirit after Wildfire: An Example

Alix Rogstad, Cooperative Extension, University of Arizona

The village of Summerhaven is located on a sky island at approximately 7,800 feet elevation on Mt. Lemmon in the Santa Catalina Mountains in southeastern Arizona. Between 17 June and 15 July 2003, the Aspen Fire burned over 84,000 acres in the Coronado National Forest and adjacent private property. Much of the resulting landscape in Summerhaven now consists of a mosaic of moonscape, where no plants or trees remain, and areas that are still overgrown and in need of fuels reduction. After the fire, about 150 structures survived out of approximately 500, and the community spirit was at an all-time low. Disturbed landscapes have a higher potential for the establishment of invasive species. Therefore, there is a concern about natural re-establishment of native vegetation within the burned areas. The University of Arizona Cooperative Extension – Fire Education Program partnered with Trees for Mt. Lemmon to develop a seed mixture of indigenous plants that were distributed to landowners for fire-impacted properties. The seed mixture was developed using native plant species, which will help to maintain the genetic integrity of the area. The seed mix included a variety of 13 species, including grasses, legumes, and forbs. Property owners receiving seed packets were able to become personally involved with and contribute to Summerhaven’s vegetation recovery. Additionally, by educating landowners about the implications and consequences of planting non-native plant species in the area, the probability of invasive plants becoming established will be reduced.

Interface Fire Mitigation

Dolores D. Funk, Malaspina University-College

In the summer of 2003 the province of British Columbia witnessed one of the worst firestorms in its history. There were 2500 fire starts and interface fires were at an all time high. 3 lives were lost, 45,000 people were evacuated, 300 homes were destroyed, many businesses were destroyed, and it cost 700 million dollars to fight. This disaster has caused the people of British Columbia to take note. The result has been that all concerned have begun to take a serious look at the current forestry practices, land-use practices and firefighting abilities. Many questions have arisen about current fires suppression practices, the increasing push of urbanites settling in interface areas, and also questions about our abilities to protect both lives and residences of those who dwell in these areas. The purpose of this paper is to provide an overview of the steps that can be taken to better prepare for the possibility of wildfire at the urban/rural interface. This report will cover provincial government initiatives, planning tools that are available to regional planners, engineering tools, fire fighting and prevention guidelines, public education as well as fire hazard mapping.
Quantifying and Ranking the Flammability of Ornamental Shrubs Used in the Southern United States

University of Florida, USDA Forest Service, USDC National Institute of Standards and Technology

Thirty-four southern shrub species were tested for flammability at the Building and Fire Research Laboratory of the National Institute of Standards and Technology, Gaithersburg, Maryland. Peak heat release rate, total energy released, mass loss, plant density loss, ignition time, maximum flame height, temperature, and heat flux were quantified for four individuals of each species tested. In addition, height, canopy volume, foliar moisture content, and foliar energy content were measured. Height to lowest foliage and foliar moisture content were inversely related to flammability, whereas foliar energy content was directly related flammability. Peak heat release rate and the total energy released accounted for 97.6% of the variation in a principal component analysis. A cluster analysis revealed three categories of flammability with *Ilex glabra* (gallberry), *Kalmia latifolia* (mountain laurel), *Ilex vomitoria* (yaupon holly), and *Juniperus chinensis* (Chinese juniper) being the most flammable and *Hydrangea quercifolia* (oakleaf hydrangea), *Hydrangea macrophylla* (bigleaf hydrangea), and *Yucca filamentosa* (Adam’s needle) being the least flammable species. Overall, twenty-two species were ranked with low flammability and may be appropriate for firewise landscaping. Results contributed to developing a diagnostic key for determining firewise species to use in residential landscaping.

A Comparison of Housing Growth Hotspots in the Midwestern and Northeastern U.S from 1940-2000

Christopher A. Lepczyk1, Roger B. Hammer2, Volker C. Radeloff1, Susan I. Stewart3
1Department of Forest Ecology and Management, University of Wisconsin-Madison; 2Department of Rural Sociology, University of Wisconsin-Madison; 3USDA Forest Service, North Central Research Station, Evanston, IL

Sprawl is one of the major causes of landscape change in the United States as well as worldwide. In the both the Midwest and Northeast United States recent housing growth has been rampant at the outlying fringe of metropolitan areas and in remote regions with attractive recreational and aesthetic amenities. Our goal was to identify hotspots of housing growth as both an absolute and a percent measure in both regions, analyze their spatial patterns, and compare hotspots so that policy, planning, and management efforts can be focused, and suitable areas identified for detailed examination of underlying causal factors. Using a set of fine scale (mean size < 400 ha) housing data we measured decadal housing growth hotspots from 1940 to 2000 separately for the entire Midwest and Northeast U.S. Hotspots were estimated using the G-star statistic, a local indicator of spatial autocorrelation, based on neighborhood sizes from 5 to 50 km. In the Midwest the number of hotspots increased continuously over the 60-year period, whereas in the Northeast they increased until the 1970s and subsequently decreased. Similarly, the total area of hotspots increased in the Midwest, but peaked in the 1970s in the Northeast. In both regions mean hotspot size decreased as a function of percent growth and showed either a positive or static trend for absolute growth. Hotspot locations moved away from metropolitan areas towards rural locations, many of which are rich in natural amenities and potentially sensitive to environmental change. Our results highlight a continuing trend of decentralizing housing growth and the need to target specific locations in future management efforts.
Emerging Exurbia: A Comparative Analysis of Exurban Settlement Patterns Across the U.S.

Jill Clark, Elena Irwin, and Ron McChesney, Exurban Change Program, Ohio State University

As US urban land consumption grows, even greater than our population grows, to make informed policy and planning decisions it is critical that the pattern of this growth is well understood. So often the discussion of growth focuses on studies that are either based on already urbanized areas (a problem of scope) or on course level data that does not disaggregate so that emerging settlement patterns can be studied (a problem of scale). This research turns the focus to the region that lies between the rural-urban fringe and rural areas, often referred to as exurbia. This area transcends the traditional dichotomy of urban versus rural and metropolitan versus non-metropolitan. Previously, data limitations have prevented a systematic study of exurban areas across the US. We use a population database that is at a relatively fine spatial scale (each cell approximately 0.67 km square). The objectives of our research are three-fold: to estimate and compare the amount of land and people in different exurban settlement patterns; to analyze socioeconomic, landscape and geographic characteristics of settlement patterns by region; and, to draw conclusions as to the policy and planning implications. Preliminary results show the total amount of land in exurbia and urbanized areas is roughly the same and that exurban settlement patterns vary widely across the country. Furthermore, we find that factors, such as percent employment in the central business district, household income, and road networks, are highly and significantly correlated with this type of pattern and its increasing presence on the landscape.

Land Development, Human Land Use, and Urban Sprawl in Puerto Rico – An Island-wide Approach from Geotechnologies

S. Martinuzzi 1,2, W.A. Gould 2, and O.M. Ramos-Gonzales 2
1Universidad Nacional de La Plata - LISEA, Argentina; 2USDA Forest Service International Institute of Tropical Forestry

Urbanization is a subject of frequent attention in Puerto Rico, especially as it refers to sprawl, degradation of natural resources like forests, wetlands, and watersheds, and reduction of agricultural lands. Puerto Rico, with 9000 square kilometers and close to 4 million people, is one of the most densely populated countries in the world. It is also a “biodiversity hotspot”. Island-wide analyses of urban development provide an opportunity for a comprehensive visualization and interpretation of the human-use of the landscape. We make use of geotechnologies and population census data, mapping the urban areas of the island, analyzing patterns of development and their relationships with topographic variables, identifying areas of urban-use and rural-use, and analyzing how people are distributed in the lands they occupy as an input for evaluating land consumption and urban sprawl. We found that 6% of the island is covered by high-density developments and 5% by low-density. While high-density occurs typically in the plains and at lowers elevations, low-density is distributed in a wider range of physiographic units, including plains, hills, and mountains. Urban-use areas, including developed and non-developed lands within urban centers, encompass 16% of the island. Two classes of Rural-use areas are reported: high and low rural population densities, representing 36% and 48% of the island respectively. We finally integrated population from the census at fine resolution, categorizing the urban cover in 5 levels of “degree of sprawl”. We found that 50% of the urban areas of Puerto Rico are suffering from high levels of sprawl.
Large-Scale Land Transformations in China Estimated with Satellite Data: Urbanization and its Potential Consequences

Hanqin Tian1, Mingliang Liu1, Jiyuan Liu2, Siqing Chen1, Shufen Pan1, Wei Ren2, and Dafang Zhuang2

1School of Forestry and Wildlife Sciences, Auburn University, Auburn, AL 36849, USA
2Institute of Geographical Sciences and Natural Resources Research, Chinese Academy of Sciences, Beijing 100101, China

China, the third largest country of the world, is in transition from a largely rural society to a predominantly urban one. Two decades ago, fewer than 20% of China’s people lived in urban areas; today it is 36%; and by 2020 it is expected to be 60%. Here we use an analysis of remotely sensed data gathered between 1980 and 2000, to map the magnitude and pattern of changes such as the conversion of grasslands and forests to croplands and the loss of cropland to urban expansion. With high-resolution imagery from Landsat MSS, TM and ETM for the entire country, we show that between 1980 and 2000 the urban areas increased by 3,014 million hectares at the expenses of cropland and grassland. In northern China, large areas of woodlands, grasslands and wetlands were converted to croplands, while in southern China large areas of croplands were converted to urban areas. The land-cover products presented here give the Chinese government and international community, for the first time, an unambiguous understanding of the degree to which the nation’s landscape is being altered. Documentation of these changes in a reliable and spatially explicit way forms the foundation for management of China’s environment over the coming decades. Economic development, population growth and land use policy are the primary controls over large-scale land transformation in China. This rapid urbanization has important implications for cycles of carbon, nitrogen and water at regional and global scales.

Four Legs Good, Two Legs Bad? Re-Examining the Ecology of Rural-Residential Growth

Peter A. Walker (with Sarah J. Marvin and Patrick T. Hurley), Department of Geography, University of Oregon

Many formerly resource-dependent areas are today being transformed to primarily rural-residential use by "exurban" migrants. A great deal of concern about this transformation has emerged, and many scholars of the "cows-versus-condos" debate have concluded that rural-residential development represents a major threat to rural ecosystems. This paper will present recent results from a three-year study of one community in the exurban Sierra Nevada that call into question some of the assumptions that have emerged about rural-residential land use. The research presented in this paper was conducted using an integrated, multi-method longitudinal social and ecological analysis. Using time-series remotely-sensed images, changes on over 140 parcels that underwent the transition from agricultural to rural-residential land use between 1957 and 2003 were examined using a GIS classification system that tracked changes in vegetation over time. Results suggest that the effects of urbanization on formerly agricultural land vary widely. In contrast to much of the current ecological literature on rural-residential growth, some changes in our study site (particularly in riparian areas) suggest significant ecological improvements. We conducted social surveys and interviews with the owners of these parcels and found that the statistically most important variable associated with positive land-use impacts is landowner ideological values about the land. This suggests that common assumptions about the ecological impacts of residential growth in rural areas need to be re-examined. Importantly, this also suggests possible avenues for using an improved understanding of landowner ideologies and land-use practices to make all-but-inevitable rural-residential growth more ecologically sustainable.
Analyzing Tree Cover in South Carolina’s Rapidly Urbanizing I-85 Corridor

Christopher Post, Donald Ham, Patricia Layton, Donald Lipscomb, and David Nowak, Department of Forestry and Natural Resources, Clemson University, USDA Forest Service Northeastern Research Station

The Interstate 85 corridor in South Carolina has experienced explosive growth over the past 20 years. During that period, the urban population has increased approximately 40% while the rate of land conversion to urban uses has been greater than 200 percent. The most rapidly urbanizing area, Greenville County, has the same population that Atlanta had in 1950. An analysis of tree cover for 1981, 1989, and 1999 using aerial photography, Landsat imagery, and permanent field inventory plots has been conducted for 750 square miles of the area to estimate the impact of urbanization on natural resources. Aerial photographs were orthorectified and used to classify Landsat imagery for percent tree canopy cover. One hundred randomly selected permanent, tenth-acre plots were established to collect data on urban forest structure and to provide inputs for the dry deposition pollution module of the Urban Forest Effects (UFORE) model. Plots were identified by GPS coordinates and two photographs were taken of each plot. Results show a 4.1% loss in tree canopy cover between 1989 and 1999 for the study area, with a loss of 10.1% within a one mile corridor of Interstate 85. Impacts of urban forest on air pollution will be discussed.

Riparian Forest Diversity and Structure Along an Urbanization Gradient in West Georgia, USA

Michele L Burton and Lisa J Samuelson, School of Forestry and Wildlife Sciences, Auburn University

Changes in riparian woody plant assemblages are anticipated in the southeastern United States due to increases in urbanization rates. Because riparian forests serve important roles in maintaining water quality and biodiversity, understanding how they respond to urbanization is crucial. The objective of this study is to examine forest structure (leaf area index, tree density, diameter distribution, basal area) and vegetation diversity indices such as importance values, Shannon-Wiener diversity (H’) and evenness (J’) of riparian woody plant species in response to an urbanization gradient in West Georgia, USA. In each riparian community (17), woody vegetation (>2.54cm DBH) within a 3.5 ha plot was sampled. Structure and diversity of woody plant regeneration was also examined as important components of forest sustainability. Measures of forest structure and diversity were compared to measures of urbanization and land cover within each watershed. Although *Liquidambar styaciflua* and *Quercus nigra* were dominant species in the forest stand and regeneration layer for all riparian communities, the invasive, non-native shrub *Ligustrum sinense* was the most dominant species observed in the regeneration layer for urban, developing, and agriculture communities. The proportion of non-native species in the forest stand and regeneration layer decreased and Shannon diversity of the regeneration layer increased with increasing distance from the urban center. Shifts in diversity may be related to anthropogenic disturbance, which might subdue the ability of diverse communities to maintain stability, productivity, and resistance to biological invasions.
The Changing Social Fabric of Private Forest Landscapes in Missouri

Bernard J. Lewis and K. Julie Richter, University of Missouri -- Department of Forestry

The past decade in Missouri has witnessed a continuing expansion of big city suburbs as well as a surge of people moving to the Missouri Ozarks. More than three-fifths of this latter group has been settling outside of incorporated places. Such processes are reflected in land tenure patterns, the changing characteristics of Missouri's nonindustrial private forest (NIPF) landowners (who collectively own about 83% of the state's 14 million forested acres) and, ultimately, the overall integrity of the state's forest ecosystems. A recent study has focused on better understanding NIPF landowners and their decision-making processes and examining how these affect the forest ecosystems of the region. The study combines quantitative and qualitative methods to try and better understand landowner attitudes and motivations for land ownership and management. A random sample of 800 landowners in the Black and St. Francis River watersheds of southeastern Missouri was surveyed to provide the basis for establishing a motivational typology of landowners. A set of 30 qualitative interviews with selected landowners from the above sample amplified a number of themes hinted at in survey responses and revealed additional concerns as well. Among many other factors, differences in cost of living and quality of life are two key reasons stimulating migration patterns. This paper summarizes interview and survey results characterizing the changing fabric of forestland ownership in Missouri, including the early stages of typology refinement, and looks at implications for key ecological phenomena such as forest fragmentation and ecosystem integrity.


John J. Librett, Michael Pratt, and Thomas L. Schmid, Centers for Disease Control and Prevention

Chronic diseases such as obesity and diabetes have risen commensurate with the acceleration of urbanization. To address this, scientists and practitioners in public health, urban planning, and ecology have partnered to study the effect of the natural and built environment on the public's health. This partnership is based on the hypothesis that better community design and access to natural resources will result in increased levels of physical activity.

As part of this effort the Centers for Disease Control and Prevention are actively working with partners such as the US Forest Service, US Fish and Wildlife Service, National Parks Service, Trust for Public Lands, and the Robert Wood Johnson Foundation. These partnerships have resulted in the development of a sustained research, evaluation, and policy agenda specifically addressing socioeconomic and ecological aspects of the built and natural environment. Through this work a compelling perspective has developed linking the natural and build environment to public health outcomes.

Governments and corporations worldwide are recognizing the value of a triple bottom line approach which combines the importance of social, economic, and environmental capital. Commensurate with this, leadership in urban planning, ecology, and public health have found an alliance that also creates a powerful win-win-win triad. Drawing from examples of the social-ecological model this presentation covers a global perspective on successes achieved, gaps being addressed, and opportunities still yet to be explored. Case studies from Brazil, Colombia, Australia, and the U.S. will highlight successful projects that have combined the ecological, urban planning, and public health perspective.
A Protective Role for Avian Diversity in the United States West Nile Virus Epidemic

Brian F. Allan1 Wade A. Ryberg1 Rachael Katz1 Nicholas Griffin1 R. Brian Langerhans1 Kristina N. Smyth2 Brad Oberle1 Michele Schutzenhofer2 William J. Landesman3 Kevin R. Crooks4 Richard S. Ostfeld5 and Jonathan M. Chase1

1Department of Biology, Washington University - St. Louis, 2Biology Department, Saint Louis University; 3Department of Ecology and Evolution, Rutgers University; 4Department of Fishery and Wildlife Biology, Colorado State University; 5Institute of Ecosystem Studies, Millbrook, NY 12545

In 1999, a mosquito-borne flavivirus called West Nile Virus (WNV) entered the U.S.A. and in five years has swept across the continent causing over 14,000 diagnosed human cases. An established paradigm in the ecology of WNV is that human incidence is higher in urban areas due to high abundances of vector competent mosquitoes in these areas. An alternative explanation is that the diversity and community composition of birds may determine WNV incidence, as several North American bird species that are tolerant of human disturbance have been implicated as highly competent reservoirs for WNV. Factors that reduce bird diversity are likely to increase the incidence of WNV by increasing the proportion of vector blood-meals taken from reservoir competent bird species, consistent with a hypothesis known as the dilution effect. Thus we hypothesized that human incidence of WNV is negatively related to bird diversity. We established three, 64 kilometer-long transects originating in the urban center of St. Louis and extending to the south and west into the Missouri Ozarks. Along each transect we established five sampling sites in forested areas approximately 16 kilometers apart. At each site we measured bird and mosquito community composition and infection rate in mosquitoes. Our results support both the established paradigm that there is higher vector abundance in urban areas and the novel hypothesis that low bird diversity contributes to high incidence of WNV. These data suggest that an important service to humans of biodiversity is the dilution of disease risk.

The Relationship of Forest Fragmentation to Lyme Disease in Rapidly Urbanizing Maryland

Laura Jackson and Elizabeth Hilborn, U.S. Environmental Protection Agency

It is well-established that expansion of the urban-rural interface is detrimental to the ecological condition of forests and other natural resources. Research now indicates that low-density development patterns can also adversely affect human health. Asthma, animal-transmitted diseases, obesity, diabetes, heart disease, and depression are all on the rise and relate in part to patterns of development. Our study sought to quantify the relationship of development pattern to Lyme disease. We analyzed 514 landscapes across twelve Maryland counties for the years 1996 – 2000, regressing disease rate against measures of forest fragmentation. We used major roads to delineate landscapes, which ranged in size from 0.01 to 580 km2. Statistical relationships remained remarkably stable across this range of spatial scales. The parameter that explained the most variation in case rate is the percent of all land-cover edges represented by the adjacency of forest and herbaceous cover. Herbaceous cover refers to pasture, row crops, and grass on low-density developed land with less than 20% impervious surface. Also highly significant was percent of the landscape in forest cover, which exhibits a quadratic relationship with disease rate. These results begin to quantify landscape design parameters that may reduce casual contact between humans and wildlife involved in transmitting disease. Our model indicates that such contact is facilitated in landscapes with high forest-herbaceous interspersion as opposed to clustered forest and herbaceous cover. By extension, landscapes with sufficient high-density development to preclude a large percentage of forest-herbaceous edge would also limit exposure to disease.
Fragile Population Segments in Georgia, USA

Frank H. Millard

A demographic segmentation analysis produced eighteen population segments in Georgia. The analysis included age structure, education level, housing value and income, among other variables. These segments were used as grouping variables in an analysis with adverse health outcomes (e.g., infant mortality, low birth weight and premature mortality), which suggested several conclusions: (1) the poorest population segments had shares of adverse health outcomes greater than two time the most affluent segments, (2) the spatial correlation of adverse health outcomes and population segments indicates the urban poor are more fragile than other population segments.

Identification of Lands Important for Protecting Water Quality and Watershed Integrity in the Chesapeake Bay Watershed

Albert Todd1, Stephanie Painton-Orndorff2, and Carin Bisland3

1 USDA Forest Service, Northeastern Area State and Private Forestry, 2Nature Conservancy, and 3 U.S. Environmental Protection Agency

Restoring the Chesapeake Bay is an enormous challenge. Aggressive efforts are underway to restore critical areas and reduce or mitigate pollution sources. The Chesapeake 2000 Agreement offered a new blueprint for restoration that brought unprecedented focus on the need for conservation of valuable lands in order to meet long-term water quality and living resource goals. Resource lands (forests, farms, and wetlands) are under stress from both land use change and environment conditions. The Chesapeake Bay Program was charged with identifying the resource lands in the Chesapeake Bay watershed that have the highest water quality, habitat, cultural and economic values and are the most vulnerable to loss.

To identify the forests and wetlands most important for protecting and maintaining water quality and watershed integrity, a GIS-based model was developed to integrate various data sources (e.g., slope, soils, floodplains, potential wetland function, impervious surface, etc.), map the coincident areas that are directly or indirectly related to protecting or maintaining water quality (e.g., steep slopes, highly erodible soils, etc.), and highlight the areas that are a priority for conservation management. A total of 12 variables were mapped and assessed in this model, with seven being analyzed at a 30 meter cell resolution and four being summarized by 11-digit watershed. The variables were broken down into classes based on their influence on water quality and weighted for emphasis. All variables were summed and mapped, highlighting important lands to conserve for the protection of water quality and maintenance of watershed integrity in the Chesapeake Bay watershed. Vulnerability was determined using a combination of housing unit and impervious surface change extended by relative commuting distance from nodes or “hot spots” of change.
Lot Size Regulations and Water Quality Protection: The Case for Large Lots in Rural Areas

Eric Olson and Paul McGinley, University of Wisconsin - Stevens Point

Development at the rural – urban interface has many consequences for the natural environment. In areas rich with surface water resources such as lakes and streams, the urbanization of the landscape can dramatically transform the natural hydrology and threaten high quality water resources. This paper examines the relationships between parcelization, development, impervious surfaces, stormwater runoff and surface water quality in the urban – rural interface. We focus on the impacts of impervious surfaces and developed pervious surfaces (lawns) on stormwater infiltration. Drawing on existing research, we develop a new model to quantify the nutrient loading that is associated with various lot sizes. We then apply this model to a rural watershed experiencing exurban development pressure. The model indicates that without requiring landowners to implement stormwater management best management practices, the continuing division of land into smaller parcels and subsequent development will most likely result in water quality degradation. These results have significant implications for local, state, and national policy makers seeking to manage development in ways that ensures the long-term sustainability of critical freshwater resources. They suggest that large lot requirements may be necessary in the short term in order to manage the increase in impervious surfaces. These results potentially contradict development and stormwater policy recommendations derived from more urban contexts.

Alternative Wastewater Treatment Systems: Systems, Location, and Site Character in Tennessee

Kendrick J. Curtis, University of Tennessee, Geography Department

In densely populated urban and suburban areas, domestic and commercial wastewater service is provided via a central collection and treatment system. In sparsely populated areas, centralized systems are cost prohibitive. Developments removed from a centralized system must utilize an onsite treatment system. Traditionally, individual septic tank and drain field systems have been the preferred onsite method. However, land developers have increasingly turned to alternative onsite systems to service residential developments on the urban/rural fringe. In Tennessee, development densities have been indirectly controlled by the type of wastewater service utilized. To ensure public health and safety, area requirements to site a septic system on a lot have effectively prohibited high densities removed from centralized systems. Alternative technologies, such as the sand filter, are being installed in areas that previously would not have permitted onsite sewage-based development. This research seeks to identify the types of alternative systems utilized in Tennessee and their distribution. A second objective is to determine soil conditions inherent in the physical setting of sites served by alternative systems. Sites in select counties serve as case studies to indicate whether or not alternative systems are utilized because of the inability to site a conventional septic system due to soil constraints or other environmental limitations.
Gait Transition: A Promising New Approach for Establishing Culvert Water Velocity Guidelines

Alison Jane Johnson, University of New Brunswick

Urbanization of an area often involves the construction of roads and inevitably a method for crossing pre-existing waterways. Culverts or bridges are almost always used and have become a common fixture in our landscape. Improperly designed and installed culverts can pose barriers for fish spawning, migration and feeding in a number of ways: they may become blocked by debris; be elevated relative to the river bed; have insufficient water depth or elevated water velocities. The latter is of particular importance to this paper. Current culvert water velocity guidelines are historically based on swimming performance experiments but there has been evidence to suggest potential problems in the methods used to gain this data. This paper examines a new and potentially more accurate method of establishing culvert water velocity guidelines using gait transition. Like us, fish employ a variety of gaits which use different types of muscle in an effort to maximize efficiency. As with humans, gait transition in fish is automatic with changes in speed. It is for this reason that gait transition data is potentially more accurate for basing culvert water velocities than prior methods using swimming performance.

An Economic Analysis of Costs of Bioretention Cells and Stormwater Ponds

Ritu Sharma1, Scott R. Templeton1, Charles Privette1 John C. Hayes1 and William F. Hunt2
1Clemson University and 2North Carolina State University

The degradation caused by urban stormwater runoff is serious. Changes in land use that increase impervious cover lead to flooding, erosion, habitat degradation, and water quality impairment. Best management practices are used to reduce these damages. Bioretention cells and stormwater ponds are two such practices used to clean and control the stormwater runoff. Bioretention cells fit into small urbanized land pockets whereas stormwater ponds need more open space. To analyze the cost of both these practices data were collected from two different sources; the Center for Watershed Protection and University of North Carolina’s Water Resource Research Institute. Cost of bioretention cells and stormwater ponds were adjusted for purchasing-power differences in time and space. Factors, other than water-quality or water-quantity volume, affecting real costs were estimated. A comparative study of the volume-to-cost relationship is presented for the two practices. The volume of water-quality is calculated below which a bioretention cells is cost effective compared to the stormwater pond. Results indicated economies of water-quantity size for both the practices. There were also significant regional differences in the cost of bioretention cells.
The Etowah Habitat Conservation Plan: Watershed Planning Along an Urban-Rural Interface

Laurie Fowler1, Bud Freeman1, Curt Gervich2
1University of Georgia, 2Etowah Habitat Conservation Plan

The Etowah River flows along the northern fringe of the Atlanta, Georgia metropolitan region. The Etowah drains 11 counties including three of the fastest growing in the United States. Three of its fish species are listed as threatened or endangered under the federal Endangered Species Act. To prevent their extirpation, the University of Georgia, US Fish and Wildlife Service, local governments and diverse stakeholders are working to create a regional habitat conservation plan (HCP). The Etowah HCP will provide protection through land use planning and development regulations, a water supply planning framework and permanent protection of high priority watersheds. Several complexities make the Etowah HCP planning process particularly noteworthy. For example, scientific research has shown that cumulative impacts of development across the watershed may have as much or more impact on imperiled species than development adjacent to streams. Educating the general public about these kinds of indirect and cumulative effects as well as identifying and selecting the management strategies that are most applicable to a given jurisdiction are key elements of the HCP. This presentation will emphasize the research, governance and decision making structures of the HCP, and the outreach program developed to increase local participation in the planning process. Together, the HCP’s locally based steering and technical committees are addressing the complex political, ecological and community issues involved in watershed planning. These committees are developing policy based on scientific data that meets the ever-changing needs of local communities and residents in this rapidly developing landscape.

Comparison of Watershed Planning Strategies for the Lake Sunapee Protective Association

Laura M. Weit, Lake Sunapee Protective Association & Antioch New England Graduate School

As Lake Sunapee’s shoreline is quickly being converted into multimillion-dollar homes, planners, developers, and environmentalists are all faced with the economic, environmental, and social changes that can occur within a watershed. Pervious surfaces become impervious, additional sediments are transported into waterways to reduce water clarity and wreck havoc on aquatic habitats, and middle-income families or retirees are pushed out of the watershed, since they can no longer afford the property taxes. While keeping these considerations in mind, along with many others, a comparison between both the positive and negative affects of effective watershed planning techniques was developed.

Methodologies of five watershed plans were analyzed based on overall cost, effectiveness (to address the problems the strategy was meant to solve), ease of implementation, use of existing coalitions, and how well the strategy met the community’s need. A rating on a scale of one to ten (one being the highest, ten being the lowest) was created for each strategy. Using this rating system, recommendations and suggestions were generated for the Lake Sunapee Protective Association to determine the best strategies for future watershed planning efforts. Over the next few years, these strategies will be implemented in the towns of Goshen, Newbury, New London, Springfield, Sunapee, and Sutton all located in Southwestern New Hampshire.
The Baldwin County Wetland Conservation Plan: Development and Implementation

Cara Stallman and Ken McIlwain, Baldwin County (Alabama) Commission

The objective of the Baldwin County Wetland Conservation Plan (BCWCP) is to provide local decision-makers the best tools possible to make wise land-use decisions regarding Baldwin County’s wetland resources. There were four major tasks of this project. First, the development of a Wetland Protection Overlay District (WPOD) was incorporated into the Baldwin County Zoning Regulations. Second, the development of a GIS wetland data layer containing information on wetland locations, types and functional capacity for wetlands throughout Baldwin County. Third, this project developed a wetland education/outreach program for area stakeholders. Finally, wetland restoration/construction projects were designed and implemented at selected sites throughout the County. In order to assess the functions of each wetland area throughout the County, a remote functional assessment model was developed using GIS software through the integration of other remotely sensed data layers such as flood zones, National Wetland Inventory data, and endangered species, among others. The model was written, executed and calibrated with the support of an interagency Technical Advisory Committee. The results categorized all of Baldwin County’s wetlands as suitable for conservation, enhancement, or restoration. The resulting data is available to local stakeholders in digital and hard copy format. The results provide watershed-based wetland restoration strategies for Baldwin County’s wetlands. The majority of wetlands were categorized as wetlands suitable for conservation.

Agroforestry Solutions for Integrated Watershed Management

Greg Ruark, USDA National Agroforestry Center

Rural and urban residents need to view themselves as partners in watershed management to effectively address water quality issues. They need to better understand how their land-use decisions affect one another and how they might work together to achieve common goals. When communities construct buildings, sidewalks, and paved parking lots, the covered soil can no longer absorb large quantities of rainwater. The conventional approach is to use concrete to divert untreated runoff into storm drains, where it concentrates and eventually discharges into rivers and streams. These massive discharges into natural streams cause bank erosion, channel cutting, and downstream flooding of other communities and rural lands, while producing a general disruption in the ecological function and integrity of our waterways. Research in agroforestry has lead to the design of riparian forest buffers that can handle large quantities of runoff from agricultural lands and also reduce the input of sediments, pesticides, fertilizers, and animal wastes into surface waters. Many of these same practices are low cost and they can be modified to help communities use vegetative approaches to treating stormwater runoff.
Whose Land Market? The Political Ecology of Land Conservation in the Sierra Nevada

Patrick T. Hurley, Nelson A. Rockefeller Center, Dartmouth College

Conservation scientists have described the increase of residential development in formerly rural places as a major threat to the loss of biodiversity and natural resources in many rural parts of the United States. Many of these same scientists are calling for the development of new and innovative land-use planning approaches and policies to stem the decline of biodiversity and potential loss of areas of resource production. This paper uses a comparative study of two contiguous counties in the Sierra Nevada of California and their respective experiences with developing land conservation programs designed to integrate principles of conservation science into county planning. More specifically, the paper investigates the politics of conservation associated with Natural Heritage 2020 in Nevada County and Placer Legacy in Placer County. In Nevada County, the development industry largely resisted efforts by the county government to develop new conservation areas, while the development community in Placer County has worked with the county to actively delineate and create new conservation areas. This research explores the differential responses by developers and landowners in the two counties to understand the failure of Natural Heritage 2020 in Nevada County and the apparent success of the Placer County’s Placer Legacy program. The experiences of these counties with conservation and development emphasizes the importance of paying attention to historical land development patterns and local political histories, while suggesting a need to better understand a differentiated development industry and the variable political responses that emerge in response to conservation interventions in rapidly urbanizing rural places.

An Integrated Analysis of Private Land Conservation Initiatives in Larimer County, Colorado

George Wallace, Katherine King and Tawnya Ernst, Department of Natural Resources, Recreation and Tourism, Colorado State University

In response to rapid growth, a variety of programs have been created in Larimer County, Colorado to protect private land open space, natural areas and working lands at or near the urban interface. A variety of voluntary, incentive-based or quasi-regulatory conservation programs are underway but tend to operate independently. These programs and individual landowners utilize conservation easements, development agreements or restrictive covenants to preclude/limit urban or exurban development on private land. To date, little is known about the social and ecological benefits being provided by the different approaches or their long-term viability, even though in most cases, limited public resources are used to acquire, transfer or retire development rights and to help with management and monitoring at the parcel level. Colorado State University, USDA (NRI grants) and local officials are collaborating on a suite of studies that will create a comprehensive county-wide database and analysis of these private land conservation efforts. We describe the comprehensive list of potential benefits derived to expedite the analysis, the typology of conservation programs and the lands they protect, and the emerging spatial pattern of both private and public land conservation efforts. We then explain how we are evaluating the effectiveness and long-term viability of these conservation efforts, including an analysis of management plans, preliminary results from surveys and interviews with officials, landowners, and new residents of conservation developments (clusters with protected residual lands).
Alternative Futures for Utah’s Wasatch Front: Conservation of Open Space

Richard E. Toth, Thomas C. Edwards, Jr., Robert J. Lilieholm, David L. Bell and Erin R. Buteau, Department of Environment and Society, Utah State University

Faculty and graduate students in the Bioregional Planning Program in the Department of Environment and Society at Utah State University have focused on various land use studies related to the urban/wildland interface of the Salt Lake City Region. These studies have included two major regional planning units: 1) the Wasatch Front Regional Council – Salt Lake, Davis, Morgan, Weber, and Tooele Counties, and 2) the Mountainland Association of Governments – Utah, Wasatch, and Summit Counties. These two planning units represent approximately 22,000 square miles of north central Utah. The projected time frame for growth and development is the year 2030. The central question being addressed in these studies is how an open space system can better integrate and direct land use development while at the same time contributing to quality-of-life issues for the general population of the region. The open space system is measured against a number of alternative growth scenarios which vary from conventional urban sprawl up to proposed locations for new communities of 40,000-50,000 residents. These scenarios also include proposals to maximize the protection of major environmental issues e.g. protection of surface and subsurface water, conservation of prime agricultural land, the maintenance of biodiversity, and visual quality. The development of the alternative growth scenarios as well as the environmental assessment models take into account the various socio/demographic, economic, and biophysical characteristics of the region. To date these studies have been presented to federal, state, and local agencies within the two planning units.

National Survey of County Open Space Protection Efforts

Karen Mumford and Margaret Myszewski, Department of Environmental and Occupational Health, Rollins School of Public Health, Emory University; Carl Vinson Institute of Government, University of Georgia

Loss of open space is of growing concern among citizens and governmental officials across the United States. While many studies have been conducted about efforts on the state level to protect open space, little is known about county-level efforts. With this in mind, a nation-wide survey of county planners was designed to examine the various tools and strategies employed by counties to protect open space and to consider some of the challenges facing counties as they engage in these efforts. To examine whether open space protection efforts varied across regions of the country or by population density, states were classified into four geographic regions and counties were divided into rural or urban groups based on their inclusion in a Metropolitan Statistical Area, according to the 2000 U.S. Census results. Planners were asked a variety of questions including: types and the amounts of open space land protected within their counties over the last 10 years; revenue sources and tools used to acquire or create open space; barriers faced by counties in their efforts to acquire or create open space; and anticipated future open space protection efforts. These preliminary results represent the first broad picture of county-level open space protection efforts. The authors hope these findings may be of use to policy makers and land-use planners involved in or expanding county-level efforts to protect open space.
Conservation Subdivisions: What's Being Conserved?

James R. Miller, Department of Landscape Architecture and Department of Natural Resource Ecology and Management, Iowa State University

In the United States, hundreds of thousands of hectares are converted annually to suburbs, shopping malls, and parking lots. The amount of developed land in this country is projected to increase by nearly 80% over the next 25 years, with disproportionate impacts on environmentally sensitive areas that are already stressed by human activities. There are a variety of policy-based instruments intended to mitigate the adverse consequences of sprawl. One such technique is the conservation subdivision. Conservation subdivisions differ from conventional developments in at least two ways; building density is higher but limited to part of a given site, thus preserving a substantial proportion as open space. Proponents argue that this approach is in many ways an attractive alternative to regulatory policies and to other incentive-based tools. Here, I examine the conservation design framework underlying this form of development and the ways that it is actually being implemented, based on the results of a recent survey. I then discuss the potential of conservation subdivisions to contribute to the preservation of biodiversity at local and regional scales, as well as contributions at the “scale of human experience”.

Urban “Green” Developments and Natural Resource Conservation: Can We Truly Create Sustainable Communities?

Mark Hostetler and Kara Youngentob, Department of Wildlife Ecology & Conservation, University of Florida

“Green” or Neo-traditional developments are being built throughout the United States with goals to conserve natural resources and to promote a sense of community. Ultimately, decisions made by homeowners determine whether a community functions as a sustainable community. We conducted a mail survey of middle class homeowners in Gainesville, Florida to determine if there were differences in sense of community and environmental attitudes, behavior, and knowledge among residents from three development types (Traditional, Post-WWII, and Neo-traditional). The Neo-traditional community had the strongest sense of community between the development types, but in terms of environmental attitudes, knowledge, and behavior, it did not differ from Post-WWII communities and was generally lower than the traditional community. However, Neo-traditional homeowners did have greater knowledge about the legal status of the Gopher Tortoise. This was due to a local conservation Gopher Tortoise program in the Neo-traditional development. Results demonstrate that conservation biologists need to partner with developers and residents to produce on-site education programs that help communities understand and conserve natural resources. We will discuss how a unique educational package consisting of interpretive signs, a Web site, and brochure can be used to increase environmental awareness and action within a neighborhood.
The Big "Green" Chill: An Assessment of the Recently Announced Crackdown on Conservation Easements by the IRS

Richard W. Hall, Forest Policy Center, Auburn University

In the spring of 2004, the IRS announced that it would begin a major crackdown on individuals and organizations associated with conservation easements that do not fully comply with the Federal Tax Code. This presentation will identify and summarize those portions of the tax code that deal with conservation easements, the motivation behind the recent IRS crackdown and the potential impacts this crackdown will have on the preservation of rural farm and timberland within the wildland urban interface.

Examining Linkages Between Urban Spatial Patterns and Ecological and Social Processes in Sydney, Australia

Matthew Beaty1, Andrew Huggett1, Amy Griffin2 and Michael Doherty1
1CSIRO Sustainable Ecosystems; 2University of New South Wales-ADFA

Examining linkages between changing urban spatial patterns and ecological and social processes is a key starting point in understanding cities and urbanizing landscapes as functioning ecosystems. In this presentation, we provide an overview and preliminary results from a multidisciplinary research project focused on understanding linkages between urban landscape heterogeneity and two important components of the urban ecosystem: human health and urban biodiversity. This project has three major components. First, urban patch characteristics (e.g., urban form, land use connectivity, intensity and heterogeneity) were identified and mapped using a novel classification system based on combination of environmental and social characteristics identified from socioeconomic and biophysical datasets and high-resolution satellite imagery. Second, linkages among urban patterns and the ecological characteristics of urban remnant native vegetation, managed greenspace, and selected fauna were then assessed based on variation in the abundance, composition, and distribution of selected avifauna and flora identified from field survey data and high-resolution satellite imagery. Third, spatial variability in patterns of human health, as measured through human physical activity (an indicator of risk for a range of diseases and other medical problems) was assessed with a physical activity questionnaire and structured observation of neighborhoods, urban parks, and recreational areas. Results from the first two components of this work and the implications of these findings for urban design and sustainable urban development will be discussed.
**Characterization of Land Use and Land Cover Changes at the Urban-Rural Interface of West Georgia by Using a Time Series of Satellite Imagery**

Hanqin Tian, Shufen Pan, Chi Zhang, Guangsheng Chen, Siqing Chen, Hua Chen, and Mingliang Liu, Auburn University

Characterization of land use and land cover changes in spatially-explicit way is essential for quantifying impacts of land use and urbanization on ecosystem function and services. In this study, we have used a time series of satellite imagery to characterize spatial and temporal patterns of land use and land cover at the urban-rural interface in the northeast of Columbus, the third largest city in Georgia, for the past 30 years. We have also used aerial photo at a resolution of 1 meter to analyze uncertainty in the estimates of land cover area due to spatial scale. This paper describes a suite of techniques that have been used to develop an operational approach, which will ensure high accuracy and compatibility in image process from multi-date, multi-scale, and multi-sensors of remote sensing data. Based on population size and distance to an urban center (Columbus), we have chosen twenty-five watersheds across the three counties (Muscogee, Harris and Meriwether) along the urban-rural interface to address the effects of urbanization on water quality, biodiversity, and ecosystem processes. The first product of impervious surfaces derived through a multi-scale, multi-data and multi-sensor approach has been broadly adopted by our interdisciplinary team members. Our analysis reveals that the urban-rural interface has been experiencing three major land transformations including urban sprawl, forest loss and agricultural abandonment.

**A GIS-Based Approach to Assessing Development Impacts on Private Forests**

Susan M. Stein, Ronald E. McRoberts, Mark D. Nelson, David M. Theobald, Mike Eley, and Mike Dechter USDA Forest Service

The private working land base of America’s forests, farms and ranches is being converted at the rate of nearly 4,000 acres per day with tremendous economic, ecological, and social service impacts. The USDA Forest Service is sponsoring the “Forests on the Edge” project as a means of developing a better understanding of the contributions of America’s private forests to timber, wildlife, and water resources and the pressures exerted on these resources from development, fire, air pollution, insects and disease. The project uses GIS techniques to construct a series of maps depicting pressures and opportunities on America’s private forests in the lower 48 states. Phase I of the project identifies fourth-level watersheds with private forests that are projected to experience increased housing density by 2030. The majority of these watersheds are in the eastern United States, although some that are projected to experience the greatest percent change are in the West. The methodology, results, and planned uses of Phase I products are presented, as are examples of the potential impacts of increased housing density on forest attributes such as wildlife, timber and water.
Land-use and Marine Spatial Planning in Hong Kong and Southern China
Kerrie L MacPherson, Centre of Urban Planning and Environmental Management, University of Hong Kong

How to secure Hong Kong’s future as “Asia’s world city” has been hotly debated by politicians, policy makers, government planners and entrepreneurs, with an increasing awareness that the SAR’s growth and sustainability depend on developing comprehensive plans for the conservation and management of its marine environment. In 1995, after years of agitation by marine scientists and international and local conservation groups, The Marine Parks Ordinance was passed into law, providing for the designation, protection and management of ecologically important marine environments. Today there are four marine parks and one marine reserve protecting 1.46% of the total sea surface of surrounding waters. However laudable such legislation may be, Hong Kong’s 6.8 million people inhabiting a highly urbanized area of 1 650 sq km, share a fragile ecosystem strained by industrial and urban development, pollution, land fills and reclamations all of which impact negatively on marine habitats. Furthermore after the inception of China’s open door policy in 1978-79, and the rapid economic, industrial and urban development in south China, human pressures on marine resources and the environment are unprecedented. Hong Kong, situated at the gateway to south China’s maritime frontier, has had a long history of human interaction with the sea. What problems in marine ecology can be identified within these long-term patterns? How has rapid economic and industrial development in Hong Kong and south China led to increasing marine degradation? With the retrocession of Hong Kong to China’s sovereignty in 1997, what policies and planning initiatives could be developed to solve these problems of a common ecosystem?

Explaining the Spatial Distribution of Second Homes: An Integrated Approach
Ryan Bidwell, Michelle Kondo, Rebeca Rivera and Stan Rullman, Urban Ecology Program, Departments of Anthropology, Urban Design & Planning, and College of Forest Resources, University of Washington

The impacts of urbanization extend far beyond the traditional boundaries of ‘urban’ and ‘suburban’ areas. By many accounts, land conversion in rural and “exurban” areas has become the United State’s dominant mode of land development. Development in exurban areas has profound impacts on ecological processes, particularly as many exurban areas abut public lands and other ecological reserves. One form of land conversion within exurban areas has been the development of occasional-use or second homes, which represent more than one-half of all homes in some areas. Although previous research has focused on natural amenities as drivers of second home development, cultural drivers are also important. Using a mixed methods approach, this research will describe the patterns of second home development in Washington State, and also explore the underlying physical and cultural drivers that produce this landscape mosaic. Quantitative analysis will be conducted using a Geographic Information System (GIS), to explain the distribution of second homes relative to physical characteristics of the landscape. Expanding on this one-dimensional perspective, qualitative interviews with second home owners will investigate the social values and motivations that underlie individual’s land-use decisions. Integrating qualitative and quantitative findings will provide a more comprehensive explanation of second home development in Washington. Understanding both the landscape pattern and the underlying drivers of exurban land conversion will help communities, scientists, and planners predict and mitigate for future impacts of second home development.
A New Scorecard Method for Rapid Assessment of the Sustainability of Ecosystem Functions Within Urban and Rural Forest Stands

S. L. Madson and D. Markewitz, D. B. Warnell School of Forest Resources, University of Georgia

Sustainability has been recognized globally as a valuable guiding paradigm for environmental and economic policies. Despite many national and international efforts, the concept has been difficult to operationalize due to its nature as a societal construct and due to incomplete scientific information. Ecologically, we are concerned with the ability of forests within urban/rural interfaces to continue to deliver ecosystem services, such as water quality or nutrient cycling. We have developed a cost-effective, rapid assessment protocol for monitoring the state of ecosystem functions within forest stands, which can be utilized by multiple stakeholders, similar to the use of the index of biological integrity (IBI) technique used in aquatic systems. We have completed an extensive literature review, from which we have identified 10 key functional indicators. We have developed these into a functional indicators scorecard (FIS) to utilize as a rapid assessment of functional sustainability within forest stand types across the United States. We present here the FIS, the FIS field protocol, an example of the scorecard method applied to southeastern pine and hardwood forests, and the results of initial field trials. The FIS can be utilized as an early warning system to detect stands with impacted forest functions, as a triage method for allocating monitoring and management resources, and as an educational tool to increase public awareness of the services provided by urban and rural forests. The FIS will also provide quantitative information to forest managers and policymakers in pursuit of sustainable management of forests within the urban/rural interface.

Urbanization and Forest Dynamics

C.E. Tripler, M. M. Carreiro and C. D. Canham, University of Louisville and Institute of Ecosystem Studies

Urbanization impacts on sapling recruitment and growth dynamics were examined for the city of Louisville, Kentucky. We conducted a study of sapling distributions for eight major tree species in an oak-dominated urban and rural forest within the “Knobs”. We established permanent quadrats along transects inside of mapped forest stands. We found that the number (1860 vs. 990) and density (3.9 vs. 2.0 m2) of saplings was significantly higher in the rural site than the urban site ($\chi^2 = 204.8, P < 0.001$). Basal area did not adequately explain sapling number differences between the urban and rural sites (correspondence analysis; $\chi^2 = 2.0, P = 0.157$). At the community level, we found a correlation between a site’s pooled individual species basal area and sapling number (rural $r^2 = 0.920$, urban $r^2 = 0.996$). In general, basal area relationships with stand level sapling populations, on a per species basis, should not differ if environmental conditions are essentially equivalent. Yet, the predicted slope of the relationship for the rural site was 37% greater than the urban. We also found that Sugar Maple ($Acer saccharum$) and White Ash ($Fraxinus americana$) had comparatively higher radial growth in the urban forest ($\Delta AICc > 7$). American beech ($Fagus grandifolia$), Chestnut Oak ($Quercus rubra$), and Shagbark Hickory ($Carya glabra$) had increased radial growth in the rural forests ($\Delta AICc > 4$). Shifts in shade-tolerance competitive rank order in the urban forest suggest long-term changes in these forests composition and structure.
Ecosystem Integrity Versus Urban Growth in the Southeast: Connecting the Dots to Support Quality of Life

Rick Durbrow, Cory Berish, and John Richardson, US Environmental Protection Agency, Region 4

The southeastern United States has large areas of unique ecological character. Agricultural, silvicultural, and road development practices are fragmenting the landscape; resulting in adverse impacts on ecological function. More devastating practices associated with economic progress or “urban sprawl” are quickly eclipsing old threats to the ecological function across intact ecosystems across the country. Currently natural ecosystems show trends for high losses of several ecosystem types, such as long leaf pine forests and wetlands. These ecosystems support processes that protect water and air quality, provide habitat for species and support recreational opportunities that enhance the quality of life for a rapidly growing region. Unmanaged growth in the southeast is placing significant stress on the remaining intact natural ecosystem. The resulting impact on the environment is a fragmentation of ecosystem processes. The impacts on the population are increased costs required to meet air and water quality standards as well as a diminished quality of life.

In order to safeguard the functionality of large ecosystem processes providing environmental services and protecting human health, threats to ecological function and conflicts in resource protection need to be identified and prioritized. Effective protection measures must be established to minimize environmental degradation from ecosystem fragmentation. The delineation of an ecological framework in the southeast provides an opportunity to take a proactive approach to protecting ecological processes that support air and water quality. Utilizing a regional framework as an organizing principle for ecosystem protection provides the business community with unique opportunities to work with federal, state and local governments, community groups and nonprofit organizations to leverage scarce government resources to meet broad environmental goals through specific on-the-ground projects.

Development of Urban Forestry in China

Chunjian Liu (1), Yaoqi Zhang (2), Xiaohui Shen (1), Pisheng Zhou (1), and Jun Zhao (1), (1) Dept. of Landscape Science and Engineering, Shanghai Jiao Tong University, P. R. China and (2) School of Forestry and Wildlife Sciences, Auburn University

Urban forestry has been practised since ancient China, at least Tang Dynasty (618-907 A.D.). It has been evolving along with the changes in socio-economic circumstances and the Chinese attitudes towards and understanding the trees and vegetation with human living environment. Urban forestry has received particular attention since the People’ Republic of China established in 1949. The economic reforms and rapid urbanization since the 1980s have dramatically changed the urban forestry administration and management. While investigating the long history of urban forestry development in China, this paper will emphasize the most recent emerging issues and problems. Some recommendation to facilitate urban forest program will be presented as well.
Demand for Residentially Located Trees in the Southeastern U.S.

Tymur Sydor, David Newman and Mike Bowker, Warnell School of Forest Resources, University of Georgia

Residentially located trees, a private environmental resource provide urban residents with a number of benefits. The value of these benefits is difficult to measure since they are typically bundled with residential property and no separate market for them exists. A shadow value for this resource was estimated in the first-stage hedonic model from residential property transactions. Box-Cox functional form was used to obtain a complex marginal bid function for trees from characteristics and prices paid for the property in two counties in North Carolina - Wake and Forsyth and a Clarke County in Georgia. In the second stage, the marginal bid function for tree coverage was regressed against endogenous characteristics of residential agents in three counties to estimate demand for tree coverage on residential property. Demand for trees is further establishes the benefit transfer for this environmental resource for various counties and cities in Southeast.

Effect of Canopy Cover on the Volume of Rain Throughfall

Jeff Cochran, Shirley E. Clark, and Melinda M. Lalor, University of Alabama at Birmingham

This study was performed to establish the extent to which post-development rain throughfall, and resulting runoff, could be reduced by leaving canopy cover in place. The study compared the volume and intensity of rain that reached the ground in an open area (no canopy cover) versus two areas with intact canopy covers. Rain gauges were placed in a parking lot, a homeowner’s yard (minimal canopy removal during construction), and an undeveloped wooded lot in an environmentally-friendly development (where canopy removal was minimized) in Shelby County, Alabama. Rain was measured for a period of twelve consecutive months and rain throughfall was compared between the sites by season (Spring/Summer vs. Fall/Winter) and by rainfall depth. The sites were sufficiently close to each other to assume that the rainfall characteristics were the same between the sites in terms of the intensity and the variation of intensity and volume during the storm. The hypothesis tested was that the areas with canopy cover would have a lower total throughfall amount than the parking lot (i.e., that interception by the canopy would be statistically significant). The summer season had a total of 83 events for comparison with rainfall depths ranging from less than 0.25 cm to approximately 7.5 cm). Investigation of the relationship between the amount of throughfall on an area without canopy cover and with canopy showed that, for these sites, even in an area with high rainfall intensities, canopy cover could be expected to reduce the total throughfall by approximately 13.5%. No significant results were seen for intensity but this evaluation was limited by the study techniques.
Agency Protocols for Wildlife Information Transfer: The Challenges and Opportunities of Serving an Urban Population

Kieran J. Lindsey, Texas A&M University

A self-administered questionnaire was developed to assess how information about wildlife, beyond traditional hunting and fishing issues, is transferred to the public by state wildlife management agencies, the U.S. Fish and Wildlife Service, USDA Wildlife Services, the Cooperative State Research, Education and Extension Service; and the U.S. Forest Service. The questionnaire addressed agency mission and record-keeping, as well as public demand for information and agency response regarding non-traditional wildlife issues, including: conflicts between humans and wildlife; human health and safety; attracting wildlife; viewing wildlife; general curiosity; and wildlife in distress (i.e., injured, diseased, and “orphaned ”). Several factors may prevent effective transfer of information about non-traditional wildlife issues to the public, particularly urban and suburban residents, including the historic emphasis on consumptive users. Collaborative efforts between governmental and non-governmental organizations may, however, provide effective ways to respond to public demand.

Birds, Bugs, and Dangerous Animals: Children’s Acquisition of Environmental Knowledge in the Sonoran Desert

Colleen M. O'Brien, Department of Anthropology, University of Georgia

Increased development in formerly rural areas of the Sonoran Desert affects the region’s culture as well as the ecology. Modernization and acculturation has contributed to a loss of environmental knowledge by eroding former cultural connections to the land and its resources. As a consequence, children today are more removed from nature than previous generations, learning more from TV or books than from personal experiences. This has prompted researchers to inquire whether changes in how we learn about nature affect what we know about the natural environment. The majority of research on children’s environmental learning has been conducted in urban areas, where children often have limited contact with the natural environment. However, as development and environmental degradation spread from urban areas, rural children are experiencing a similar disconnect from nature as their urban counterparts. Ethnographic research was conducted in southern Arizona to determine how rural children learn about the desert environment, and to record what cultural knowledge children have retained about desert plants and animals. Findings indicate that children have varying perceptions of what constitutes learning, and the animals that are most culturally salient are those found close to the home, suggesting that more informal learning is occurring than was previously considered. This research has applicability for developing future environmental education programs and school curriculum development in the region.
Connecting Local Environmental Knowledge and Land Use Practices: A Human Ecosystem Approach to Urbanization in West Georgia

Josh McDaniel and Kelly Alley, School of Forestry & Wildlife Sciences, Auburn University

Issues of urban sprawl and migration of exurban residents into the surrounding countryside of metropolitan areas have generated considerable debate across the US. These debates often revolve around the ecological footprint of urban areas and the erosion of quality of life indicators associated with rapid expansion of urban and residential areas. Although there has been much research done on the environmental and socioeconomic impacts of urbanization, little attention has been given to cultural impacts. This paper focuses specifically on the role of local environmental knowledge as an important resource in human ecosystems, and looks at the implications of environmental knowledge loss associated with urbanization and its related demographic changes. We compared environmental knowledge among rural, urban, and developing watersheds in western Georgia, and also look at relationships between local environmental knowledge and variables such as gender, education, income, and participation in outdoor recreational activities. We then explored how variations in environmental knowledge affected land use practices at the household level. The mean knowledge scores of residents in all three classifications of rural watersheds were higher than those living in developing and urban watersheds. We found residents of managed pine watersheds possessed the highest mean scores (p=0.006), while urban watershed residents were the lowest. We also found that local environmental knowledge was influenced by active participation in outdoor recreation, with active bird-watchers having the highest environmental knowledge scores. However, we found less influence of factors such as education and income on environmental knowledge. We also found a clear connection between local environmental knowledge and land management practices. Timber owners scored higher than non-timber owners (p=0.099), and landowners who constructed streamside management zones (SMZs) scored higher than those who did not (p=0.034).

Rapid Identification of Biological Elements in the Urban/Rural Interface

Don Hamilton, Ed Brown, Julian Beckwith, David Barber and Sherri Clark, University of Georgia

The urban/rural interface often places people unfamiliar with rural and wild lands, in contact with significant elements of those areas. Threatened or endangered plants and animals may be impacted negatively by human encroachment into their habitats. Contact with certain animals and plants can threaten human health and safety. Rapid identification of unknown flora and fauna can reduce risks of negative impacts and health or safety threats.

The College of Agricultural and Environmental Sciences at The University of Georgia, has given County Extension Agents throughout Georgia, a tool to facilitate rapid identification of unknown plants and animals. Digital cameras provided County agents, allow them to collect images of possibly rare or toxic plants and strange or poisonous animals. An online Web form makes possible the automatic submission of information and digital images to appropriate expert diagnosticians. E-mail notification of sample submission and Web access to sample images and information, make it possible for diagnosticians to respond wherever Internet connectivity is available. Upon sample evaluation, automatic notification of the diagnosis with recommendations and comments, is accomplished by e-mail to the sample submitter.

This Distance Diagnostics through Digital Imaging system has been available for nearly seven years in Georgia. By constant addition of new features, it has matured into a system providing archival records of samples submitted, as well as recoverable educational information and images. Its value has been demonstrated in various ways, such as through rapid identification of toxic plants and animals threatening human health, and also through quick discovery of threats to agricultural and horticultural crops.
Biodiversity and its Health in Urbanizing Landscapes

W. Douglas Robinson, Department of Fisheries and Wildlife, Oregon State University

It is widely known that numbers of native species decline as humans urbanize landscapes. The causes underlying reduced species richness are many. An emerging issue is health of biodiversity, which also declines in many species living in urbanizing landscapes. Stream-dwelling fish show higher rates of disease, including lesions and tumors, as water quality declines in urban streams. Some birds exhibit conjunctivitis and other diseases more frequently. Some of this decline in biodiversity’s health is associated directly with degradation of the physical environment, but other declines result from biotic imbalances caused by unnatural associations of co-occurring species. Whether these declines in health of biodiversity foretell declines in human health is a pivotal question. Human health may suffer as disruptions in natural biotic interactions lead to greater exposure to zoonotic diseases. The increase of Lyme disease cases in northeastern landscapes has probably occurred because forest fragmentation and urbanization have increased the abundance of competent disease reservoir species relative to incompetent ones. At urban-rural interfaces, contact between carnivorous mammals and humans or their pets increases the chances of rabies transmission. Health of biodiversity, how landscape transformation affects that health, and the consequences for humans of biodiversity with declining health deserve further study. Advances in molecular techniques make such studies relatively feasible. I will review examples of biodiversity and its health in urbanizing landscapes and propose some directions that future investigations might take.

Effects of Land-Use Intensity on Bird Communities in Puerto Rico

Marcela Suarez-Rubio and John R. Thomlinson, University of Puerto Rico, Institute for Tropical Ecosystem Studies

Human population continues to increase, expand and urbanize, and this process may have the greatest local effect on wildlife due to its persistence on the landscape and its dissimilarity to natural land cover. An accelerating pattern of rural development and deforestation is one of the most important factors affecting bird populations in Puerto Rico. Only 1.2% of the lowland moist seasonal evergreen forests on the island are protected. Generally, these forests occur at the lowest elevations where rates of land-cover conversion to urban and developed areas are highest. Additionally, rural development is one of the most important factors contributing to the increasing loss of biodiversity. For this reason, Puerto Rico provides a unique opportunity to assess how the spatial arrangement of remnant forest patches influences the bird community within a range of urbanization intensity. Bird assemblages differed along the urban-suburban gradient in Puerto Rico: some species were relatively unaffected by urbanization, while several increased in abundance with increased urbanization and some were sensitive to even minor disturbances by urban development. It is important to understand the sensitivity of particular bird species to habitat degradation in the urban-rural interface, areas that in Puerto Rico are used by both endemic and neotropical migrant species. Identifying the importance of forest patches for these groups of birds will greatly aid in their conservation. In addition, we are identifying those species that are particularly sensitive to fragmentation, so that these can be used as bio-indicators of environmental health.
Densities of Neotropical Migrant Songbirds Along a Southeastern U.S. Urban-Rural Gradient

J.A. Stratford and W. D. Robinson, Center for Forest Sustainability, Auburn University

Birds are ideal study subjects to study the landscape-scale ecological consequences of urbanization. We modeled the densities of fourteen species of neo-tropical migrant birds along an urban-rural gradient associated with Columbus, GA and surrounding areas using land-use parameters as covariates. Zero-inflated Poisson regression was used to create density models that account for extra zeros. In all but two cases, extra zeros could be accounted for by including large-scale urban cover. The extra zeros in Brown-headed Cowbird, a potential brood parasite of neo-tropical migrants, and Yellow-billed Cuckoo were accounted for with medium-scale urban cover. The Poisson covariates were associated with known primary habitats and, for seven species, in combination with urban cover. This indicates that, in urban settings, neo-tropical migrants may not be found even if the local habitat is appropriate. Moreover, the abundance of birds is influenced by urban cover even when the percentage of urban cover is small. Priority, therefore, should be given to forested lands where urban cover is absent or minimal.

Animal Behavior in Urban Ecosystems: Modifications Due to Human-Induced Stress

Sarah T. Saalfeld and Stephen S. Ditchkoff, School of Forestry & Wildlife Sciences, Auburn University

Once considered to be unsuitable habitat for most wildlife species, urban/suburban areas now maintain a wide array of wildlife populations, many of which were previously restricted to rural or undisturbed habitats. The presence of some wildlife species in close proximity to human populations can create conflict, forcing resource managers to address issues relating to urban wildlife. However, evidence suggests that wildlife residing in urban areas may not exhibit the same life history traits as their rural counterparts because of adaptations to new or human-induced stresses (i.e. changes in predator composition or increased vehicular traffic). These adaptations can create difficulty for biologists or managers that must address problems associated with urban wildlife. Population control or mitigation efforts aimed at urban wildlife require detailed knowledge of the habits of wildlife populations in urban areas. Essentially we may need to relearn the biology of these species in order to effectively manage them in these new environments. This paper provides examples of wildlife populations that have modified their behavior as an adaptation to urban stresses, presents preliminary data concerning white-tailed deer fawn survival and mortality rates in suburban areas, and discusses the challenges that resource managers face when dealing with urban wildlife.
A Different Urban Gradient: Human Socioeconomic Predictors of Avian Diversity

Paige Warren, Ann Kinzig, and Chris Martin, University of Massachusetts at Amherst

Contemporary approaches to understanding biodiversity patterns in human-dominated landscapes have included species-area relationships and urban-to-rural gradient indices. These tools are assumed to capture certain landscape or habitat characteristics such as degree of disturbance or extent of available habitat. However, they incorporate very little of the rich information on cultural, economic, and demographic characteristics of humans inhabiting cities. The social-science literature suggests such characteristics are associated with both peoples’ preferences for and ability to realize different landscapes, with subsequent impact on other organisms dwelling within the urban matrix. We therefore hypothesized that human socioeconomic factors could serve as an important indices—capturing variation in factors such as habitat, resource, and predator availability and hence predicting avian community structure across the urban matrix. In small, neighborhood parks in Phoenix, Arizona, we found that the number of native bird species was positively correlated with the surrounding neighborhood socioeconomic status (SES) even when accounting for features of the park such as age, size, and vegetation structure. Overall, bird communities in the high SES neighborhoods in this study resembled native desert communities more than those in lower SES neighborhoods. I will explore some of the potential mechanisms mediating this relationship, as well as potential implications for understanding patterns of biodiversity more generally and for equitable access to ecological amenities for citizens of urban areas.

Addressing the Problem of Urban Moose-Related Vehicular Collisions in Prince George, British Columbia

Roy V. Rea, Ecosystem Science and Management Program, University of Northern British Columbia

Moose-related vehicular collisions are on the rise throughout much of the range of moose and are occurring within townships where moose are distributed. Several moose are killed each year within the city limits of Prince George, British Columbia, Canada. Recently, an interagency group was formed in Prince George to specifically address the problem of moose-related vehicular collisions (MRVC’s) within the city in response to what appears to be an increasing trend in urban moose-vehicle encounters. Our research team assessed what agencies in the Prince George area keep records on Moose-Related Vehicular Collisions (MRVC’s). We obtained access to records that were available and used these records to plot collision hotspots. We inventoried countermeasures currently in use and reviewed the literature on ungulate-related collisions in an effort to determine appropriate countermeasures for addressing collisions in an urban/suburban landscape. Our findings indicate that approximately 15-30 MRVC’s are likely occurring in the city limits annually, and that most of these are occurring in areas adjacent to greenbelts where speed limits are higher and street lighting limited. Most collisions appear to occur in June and December and, according to the literature, likely to occur between dusk and dawn. Moose warning signage is the only countermeasure currently employed in Prince George and, according to limited data, improperly placed. We recommend the development of a GIS web-based record-keeping system but suggest that improved moose warning signage and reduced night-time speed limits be implemented as an interim measure in areas where MRVC’s are recurrent.
Nutritive Quality of Native, Warm-Season Grasses Exposed to Tropospheric Ozone

John S. Lewis, Stephen S. Ditchkoff, John Lin, Russell B. Muntifering, and Arthur H. Chappelka, School of Forestry and Wildlife Sciences, Auburn University

We examined the effects of tropospheric ozone (O3) on two native, warm-season grasses, eastern gamagrass (EGG; *Tripsacum dactyloides*) and big bluestem (BBS; *Andropogon gerardii*), in June – Sept., 2003. We fumigated plants with three levels of O3 in a randomized block experiment with three replicates for each treatment. Treatments were carbon-filtered (CF), which removed approximately half of the ambient O3; non-filtered (NF), representing conditions in Auburn, AL; and double the ambient concentration (2X), simulating an urban environment. Because forage quality can be just as important as quantity, we chose to investigate effects on nutritive quality parameters in addition to biomass yield. Mean daytime O3 concentrations were 14, 29, and 61 ppb for CF, NF, and 2X treatments, respectively. Ozone concentrations were lower than expected for our study period, and BBS showed little response to our treatments. However, we generally observed decreased nutritive quality as evidenced by increases in concentrations of structural carbohydrates and lignin and decreases in concentration of N as exposure time progressed for EGG. Re-growth of both species showed no treatment effects, which emphasizes the importance of timing between acute O3 exposures and physiological stage of plant development. Our study indicates that scientists must become aware of how O3 affects nutritive quality of forages irrespective of effects on above-ground biomass production. The decreases in nutritive quality parameters observed for EGG may have implications affecting plant selection by herbivores. Considering that the urban-rural interface is increasingly serving as habitat for both wild and domestic herbivores, an understanding of how urban activities influence nutrition of forage populations is critical.

Conservation of the Avifauna of the Juan Fernández Islands, Chile

Erin Hagen, Peter Hodum and Michelle Wainstein, College of Forest Resources, University of Washington

Growing human populations and truly global activities increase anthropogenic pressures that can negatively impact all levels of biodiversity. Fragile species often decline due to habitat degradation frequently driven by human activities (exotic species introductions, unsustainable resource harvests, encroachment). Habitat degradation is especially worrisome in areas of unique species assemblages. The Juan Fernández Islands, Chile, are characterized by isolated plant and animal communities that exhibit high degrees of endemism. The archipelago has received international recognition for its biological uniqueness, as well as for the plight of its endangered natural systems. The bird community is rich in endemic species and subspecies, many of which have been accorded threatened status. The threatened avi-fauna have small populations restricted in geographic range. Therefore, human mediated changes in local environments have catastrophic impacts on these fragile species. In response to growing concerns for native avifauna, a program of science-based conservation was initiated in active collaboration with local residents. Successful and lasting conservation requires ongoing scientific research and the integration of the community in conservation science. A strong conservation ethic among local residents is encouraged by increasing local understanding of intact native systems, species of concern and threats to their survival. Residents are trained and employed as research assistants and teens serve as stewards of threatened seabirds in a recently established reserve. Community efforts include invasive plant control to protect critical habitat of endangered hummingbirds, meetings and initiatives to address exotic species and sprawl, as well as active education in the classroom and in the field.
Planning Housing Developments for Biodiversity Conservation

Roarke Donnelly and John M. Marzluff, Department of Biology, Oglethorpe University

Most plans to conserve biodiversity in urbanizing areas focus entirely on fragments of native habitat. They attempt to maximize fragment size and minimize fragment isolation based on an equilibrium theory of island biogeography. Where development pressure is high and most of the landscape will eventually be developed, such plans will not be sufficient. Conservation biologists must supply urban planners with descriptions of development styles that are less detrimental to biodiversity conservation. These descriptions should focus on the land use type that will dominate the developed area, must focus on environmental variables that planners can influence, and must describe clear thresholds with respect to the environmental variables. We describe a study of breeding songbirds from the Seattle metropolitan area that achieves all of these goals, in part through a novel application of nestedness analysis. We use 54 -1 km² landscapes to test whether single family residential development has conservation value and the relative effect of habitat quantity, pattern, and quality on songbird conservation. Bird species richness was high and many native species were retained in abundance in developments where urban land cover was <52%, forest was >64% aggregated, and tree density (especially that of evergreens) remained >9.8 trees/ha in settlement. These patterns suggest that managing residential development can benefit conservation and provide environmental thresholds amenable to urban planning.

Managing Disease in Elk on the National Elk Refuge: Competing Claims and Common Goals

Mark Neff, Environmental Studies Program, University of Oregon

Situated at the southern end of the Greater Yellowstone Ecosystem, Jackson, Wyoming is a community undergoing constant change. The region is now dominated by year round tourism whereas it was formerly a ranching economy. The changing economy has led to competing claims over the region’s remaining wildlife resources. Elk are fed to maintain large and visible herds despite diminished winter habitat, creating conditions that encourage wildlife disease on the National Elk Refuge (NER) as well as on other local feedgrounds. The bacterial disease brucellosis abounds in feedground-associated elk (Cervus elaphus) in western Wyoming but is not found in elk that are not fed. The disease does not significantly affect elk population viability, but does present an economic threat to local cattle ranchers who fear that their livestock may contract the disease. The local economy is dependent on the elk for hunting and tourism purposes, but is also dependent on ranching. Competing claims on elk have led to a series of lawsuits between the state of Wyoming and the federal government over the right to make brucellosis management decisions. In early 2003 the state began vaccinating elk on the NER with a cattle vaccine that the state insists is efficacious, but which is deemed by the USFWS to be only marginally effective in elk. The recent decision to begin vaccinating elk on the NER is a political compromise between government agencies with competing constituencies. This paper presents ongoing research into pertinent political structures and the limitations they impose on management options.
The Changing Landscape of Wildlife Management

Clark E. Adams, Kieran J. Lindsey, and Sara J. Ash, Texas A&M University and Cumberland College

This paper begins by identifying the demographic factors that set the stage for the need for urban wildlife management. The relevant issues to be discussed include: 1) how urbanization has intensified a separation of people and wildlife, 2) those factors that illustrate a need for wildlife management in urban areas, 3) the degree to which the urban public is informed about the wildlife around them, 4) how the urban public is attempting to reconnect with the natural world, and 5) the outcomes of human/wildlife encounters in urban communities. The magnitude of urban wildlife problems is illustrated using a national data base maintained by USDA-APHIS Wildlife Services (WS). This data base consists of 10 years of accumulated records (national and regional) of the number of public requests for assistance; identification of nuisance species; and economic losses resulting from damage caused by all species in four damage categories; e.g., agriculture, human health and safety, property loss, and natural resource loss. Urban wildlife management is only in the formulation stage of the policy life cycle. A national study of land grant universities that offer at least a B.S. degree in wildlife management and state departments of natural resources revealed that the infrastructure for urban wildlife management is missing. The needed changes required to enhance the relevance of urban wildlife management in the policy and decision-making process are discussed in terms of academic recognition and curricula changes, agency recognition and commitment, and public education.

Analysis of Deer -Vehicle Crashes (DVCs) in Alabama: A Wildlife Management Perspective

James B. Armstrong and Anwar Hussain, School of Forestry & Wildlife Sciences, Auburn University

The average annual rate of animal related accidents in Alabama has been about 3000 since 1994. This rate has been steady except in 1997 when there was a surge in accidents due to a change in the maximum speed limit from 65 mph to 70 mph. Categorizing these crashes by type of animal, 90 percent or more of these animal related crashes would be due to deer, and while findings regarding costs associated with deer vehicle crashes have varied quite dramatically, they all estimate that costs are in billions of dollars. Increasingly, researchers are learning that deer vehicle crashes are not a random phenomena but rather follow a systematic pattern. This is an important finding as this allows us to target high risk areas and focus on critical aspects of the problem. The current study assesses the role of wildlife habitat in causing deer vehicle crashes and identifies cost effective and practical ways of mitigating deer vehicle crashes (DVCs) in Alabama. Using conditional fixed effects negative binomial count modeling, the probability of crashes as well as their number is estimated. The estimated model is used to characterize road fragments with relatively higher probability of deer vehicle crashes (DVCs), and evaluate the role of deer habitat in relation to the pattern and frequency of accidents.
Constructing Greenbelt to Contain Urban Sprawl-Its Success and Failure in Beijing, China

Jun Yang and Joe McBride, Department of Environmental Science, Policy and Management, University of California, Berkeley

The greenbelt construction has been proposed as a measure to stop the urban sprawl by urban planners in Beijing, the capital of China. This paper examines that proposal. It is based on the analyses of satellite images, documents, and field surveys to establish the structure of the greenbelt and its development in Beijing. The results showed that the current greenbelt failed to contain the expansion of the city. The enormous demand for land and the high cost for relocating farmers are two main reasons for this failure. The effectiveness of another greenbelt planned by government to contain the urban sprawl of Beijing in the future was discussed. I suggested preserving the current open spaces by providing financial incentives to its owners and enhancing the implementation of laws and regulations on land resource could be more effective in slowing down urban sprawl than constructing greenbelt.

Redefining the Boundaries of Metro Manila, Philippines: The Handicap of “Legalistic” Boundaries in an Ever-Changing Rural/Urban Interface

Maria Aileen Leah G. Guzman and Jude Anthony N. Estiva, College of Environmental Science, State University of New York and Aparri & Associates, Hackensack, New Jersey

Metro Manila serves as the main financial, commercial and political hub of the Philippines. Metro Manila was formed as a result of legislation that defined its boundary and composition thus, requiring the Philippine Government to gear its plans, programs and policies towards the rapid development of Metro Manila. However, as a contiguous urban area, Metro Manila continues to extend its boundaries beyond its “legal boundary”, invading its resource shed in the process. As a result, Metro Manila’s “urban/rural interface” is pushed further into the resource shed. Growing urban population (including migration), demand for cheap land, demand for abundant water supply, and other socio-economic factors contributes towards the cycle of urban expansion towards the resource shed and the creation of new rural/urban interface as well as the eventual conversion of the interface into a “new urban area”. This paper examines the limits of Metro Manila’s “urban expansion” from 1970-2003 and its impacts to its resource shed. Satellite images, maps and other data will be used to determine the extent of the changing urban/rural physical interface. Socio-economic factors will also be examined and related to the changing interface.
The Costs and Benefits of Urban Containment: The Case of Seoul's Greenbelt Policy

David N. Bengston and Youn Yeo-Chang, USFS, NC Research Station; Seoul National University, Seoul, Korea

Countries around the world have responded to the problems associated with rapid urban growth and increasingly land-consumptive development patterns by creating a wide range of policy instruments designed to manage urban growth. Out of the array of growth management techniques, urban containment policies are considered by some to be a promising approach. This paper focuses on greenbelts, the most restrictive form of urban containment policy. The long-standing greenbelt of Seoul, South Korea is examined as a case study. Seoul’s greenbelt has generated both significant social costs and benefits. Costs include higher land and housing prices in the urban area surrounded by the greenbelt, additional costs incurred by commuters who live beyond the greenbelt and work in Seoul, and increased congestion and related quality of life impacts. Benefits include the amenity value of living near the greenbelt, recreational resources, bequest and heritage value, fiscal savings due to increased efficiency in the provision of public services and infrastructure, and a wide range of ecosystem services. After standing virtually unchanged for almost three decades, Korea’s greenbelt policy is currently being revised and weakened, largely due to pressure from greenbelt landowners and developers. While there is no definitive answer to the question of whether Seoul would be a more or less “sustainable city” today without the greenbelt, it is certain that in the absence of the greenbelt Seoul would have lost much of its rich natural heritage and essential ecosystem services.

Connecting on the Urban-Rural Margins: How One Community Used Public Dialogue and Collaboration to Create a Plan for Responsible Development

Patrick McNamara, University of Nebraska at Omaha

Omaha By Design (OBD) is an innovative approach to community planning that explicitly addresses the issues of how to preserve the farmland, wetlands and green spaces that surround the city while encouraging environmentally responsible development within it. Public dialogues included two tracks: first, a thirty-member Working Review Committee with representatives from environmental organizations, neighborhood groups, elected officials, government agencies, and developers; and second, a series of six well-attended community meetings where citizens provided input on the three areas of the plan (Green Omaha, Civic Omaha, Neighborhood Omaha). The result of this year-long public deliberation process was a new Urban Design Element and major amendments to the Land-Use Element of Omaha’s Master Plan (for more information on these see www.omahabydesign.org). Many of the details in these documents address how to mitigate the negative effects of sprawl and preserve the community’s natural resources as development takes place on the fringes of the city. Initial findings from this research support the need for significant citizen involvement from the beginning of a planning process, leadership from the public, private and nonprofit sector all endorsing the process and supporting, or at least not obstructing, the plan that emerges, and the preference for a regional approach to planning especially when natural resources such as ground water and floodways do not conform to municipal boundaries.
Conditions for Sustainable Community Forests: Evidence From 17 Village Groves in Korea

Inae Kim and Yeo-Chang Youn, Department of Forest Science, Seoul National University, Korea

There were many villages where groves were established and managed by the villagers for a special purpose, usually forming an element of the society’s culture. While nearly every village seemed to have groves as commons in Korea in the past, many of them have been disappearing due to various reasons. This study aims to identify the main factors influencing the disappearance of these village groves.

For empirical analysis, seventeen villages with religious function were selected from the villages listed in the report by Korea Research Institute (1938). Among them there are still some villages conserving their groves while the others cleared the groves to other land use. We interviewed the villagers and collected information on the social, economic, cultural and ecological aspects of the villages. The main factors influencing the loss or conservation of village groves were identified based on the result of Boolean algebra using data on social, economic, cultural and ecological changes of the villages.

The most important factors supporting the conservation of village groves were found to be social and cultural institutions. The social institution governing village grove management and religious values of the villagers are critical for the conservation of grove. In the most villages with their groves remaining, the forest are designated and protected as a cultural heritage by the state or local government. The functions of village groves have also been changed. The spiritual values of villages once believed as a holy place by villagers have been replaced by recreational and educational values of the forest. In conclusion, the sustainability of community forests in Korea should be understood in a social, cultural and economic context rather than ecological terms.

Community-Based Landscape Assessment in Western Interface Areas

Tamara Shapiro, Utah State University

In the western United States, the wildland-urban interface typically describes increasingly populated areas at particular risk to damage from wildfire. However, other critical issues in the interface arise from the effects of landscape change on natural and cultural resources. Management of these resources in interface areas is further complicated by conflicts between multiple ownerships and jurisdictions at the federal, state, and local levels. The CEDAR method of landscape inventory provides a framework for the identification of critical lands, conflicts, and policy contradictions within specified areas. The purpose of this project is to test the "CEDAR" method as a means to identify management conflicts between development and natural resource patterns that occur at a variety of scales and timeframes within representative interface areas. The “CEDAR” method of landscape characterizes open spaces in terms of their Cultural, Environmental, Developmental, Agricultural, and Recreational resources. Its process emphasizes community input and involvement in the identification of unique community resources in addition to traditional data acquisition via agency personnel. The identification of critical landscapes within interface areas can help communities and agencies avoid or effectively mitigate for environmental degradation as growth continues. Through an audit of planning documents, including forest management plans, county comprehensive plans and zoning ordinances we identify conflicts and inconsistencies in policy and implementation that could result in inefficient development and conservation strategies in interface areas. This work provides a framework for on-going planning research addressing natural resource management and landscape change in the western wildland-urban interface areas.
Preliminary Findings of a Stakeholder Analysis for the Black Warrior and Cahaba Watersheds

J. Patrick Carter-North, Department of Agricultural Economics and Rural Sociology, Auburn University

Urban growth is dependent on environmental amenities and resources often provided by surrounding rural areas. Water availability is a key constraint affecting urban growth in cities like Birmingham, Alabama. Preliminary results will be presented of a stakeholder analysis regarding two watersheds (Black Warrior and Cahaba) upon which the city of Birmingham, AL depends for drinking water. The Cahaba River is nationally recognized for its rich biological diversity, scenic beauty, endangered species and is the longest free-flowing river in Alabama while the once pristine Black Warrior River is characterized as a working river with a series of locks and dams to facilitate commerce and industrial activity. The upper portions of both the Black Warrior and Cahaba watersheds are located around the highly urbanized Birmingham area, while much of the middle and lower portions of both watersheds remain largely rural. Special emphasis will be placed on the dynamics between urban and rural stakeholders, along with differences in stakeholder opinions, perspectives, and interests between the two respective watersheds. Stakeholders interviewed include elected officials, business and industry representatives, watershed/environmental advocacy and conservation organization representatives, developers and non-industrial private landowners.

Grassroots Solution to Urban Tensions

Robert G. Hoyt, EcoLogix Group, Inc., and Katrina Jones, Maryland Department of Transportation

Over the past three centuries, the vast industrial complex that makes up the Port of Baltimore has brought its share of urban prosperity as well as urban conflict. This is especially true in the 21st century as heavy industry declines and gentrification of older blue collar neighborhoods takes hold. A long history of shipbuilding, ship breaking, chrome production, and steelmaking have left legacy contamination problems along parts of Baltimore Harbor. Because of the history of adversarial relationships between the MPA and some citizen groups, the MPA hired EcoLogix Group, a policy and outreach consulting firm, to facilitate an entirely new process. Rather than presenting the citizens with MPA’s proposed projects, EcoLogix asked the citizens to first present their ideas on how to solve the industrialization problems in ways that served their neighborhoods. The team of citizens included local government representatives from the 3 jurisdictions bordering Baltimore Harbor, as well as representatives of port industries, and key non-government organizations. The Team made recommendations that not only address the Port’s long-term dredged material placement needs, but also help with the Port’s need for land to accommodate a growing seaport trade. The outcome has been viewed as a huge success by the Port community, which now has multiple placement options under evaluation. Just two years ago, the Port had no new options for meeting long-term dredged material management needs for harbor sediments. The American Association of Port Authorities recently gave Maryland an award for this citizen-oriented process. The Harbor Team was successful because it embraced citizen input from the start and in a very unique way. This approach and the lessons learned from it should serve as a model for solving other urban and rural issues.
Community-Based Water Quality Programs in Prince William County, Virginia

David D. Close, Gregory K. Eaton, Patricia M. Reilly, Virginia Tech Department of Horticulture & Virginia Cooperative Extension

For more than 10 years Prince William County, Virginia has proactively tackled the water quality concerns of rapid urbanization. The Prince William Department of Public Works partners with Virginia Cooperative Extension (VCE) to provide storm water education and outreach programs to local businesses, non-profit organizations, and residents to increase awareness and reduce the harmful effects of urban and suburban storm water run-off. As an incentive to attend these annual programs, businesses and non-profits are offered a 10% rebate on their previous year’s storm water utility fee. Consistently, there are 40 participants per educational program. An estimated value of tax rebates, the total number of participating businesses, and a summary of business types will be expounded. The Prince William Extension office also runs a water quality educational program for homeowners. The GreatScapes program has existed for 12 years. Homeowners are charged a minimal fee to have the square footage of their turf measured and a soil sample analyzed. They are given pre and post surveys to assess their lawn care practices. Participating homeowners are also eligible to attend nutrient management classes and field days. VCE Master Gardener volunteers assist in developing customized nutrient management plans for program participants. During fiscal year 2004, 173 management plans were written for homeowners and 1.63 million square feet or 37.42 acres of turf came under nutrient management. An additional 45,000 square feet of turf outside Prince William County, but within the watershed, also came under management. Their proactive approach to working with businesses and homeowners demonstrates a balanced and thoughtful tactic of reducing surface water contamination. These two programs serve as models for mitigating water quality through effective educational programs.

Changing Land Use and the Environment (CLUE)

J.C. Hayes, S.J. Klaine, J. Smink, R. English, S. Templeton, M. Schlautman, R. English, C. Post, and J. Morse, Departments of Biological Sciences, Forestry and Natural Resources, Entomology, Soils and Plant Sciences, School of the Environment, Public Services and Agriculture, and the Clemson Institute of Environmental Toxicology, Clemson University

Changing land use is essential for development to satisfy the needs of a growing population. South Carolina and the southeastern U.S. Are projected to have substantial population growth rates during the next thirty years. In order to facilitate this development, it is critical to understand both on-site consequences and off-site impacts of land-use change. This presentation focuses on the Changing Land Use and the Environment program which seeks to characterize on-site consequences of land use change, estimate the off-site impacts of land use change, and develop strategies to facilitate land use change while preserving critical natural resources. To achieve the goals of this comprehensive program, interdisciplinary teams of experts are focusing research to produce a science-based process by which the impacts of land use change can be evaluated and minimized.

Comprehensive water quality sampling was established in two sub-basins (one developed and another undergoing development) to characterize changes in storm water and receiving water quality and quantity as a function of land use. Information from such sub-basins enables efficacy of BMPs to be compared with reported values and model predictions. Further development of model relationships for other BMPs will also be presented. Another aspect of the project has been to identify installation and maintenance issues that impact BMP effectiveness. In many cases, these issues play a dominant role in whether the practice actually works. Results of this research help to quantitatively answer questions posed by stakeholders, policy and decision-makers, developers and planners concerning land use alternatives.
Response of Macroinvertebrates to Land Use Change in a Small Watershed

William R. English, J. A. Smink, J. W. Pike, M. A. Goddard, S. J. Klaine C. J. Post, M. A. Schlautman, T. Karanfil, J. M. Hur, B. A. Powell, J. C. Morse, J. C. Hayes, Departments of Biological Sciences, Forestry and Natural Resources, Entomology, Soils and Plant Sciences, School of the Environment, Public Services and Agriculture, and the Clemson Institute of Environmental Toxicology, Clemson University

The Greenville, South Carolina metropolitan area is one of the fastest developing areas in the United States. An objective of the Changing Land Use and Environment (CLUE) project is to characterize water quality impacted by land-use change in the Saluda and Ready River watersheds of Greenville, South Carolina. The CLUE project focuses on impacts common to urban development. In our poster, we address the impacts due to 1. Sedimentation from construction sites, 2. Alteration of discharge due to increased impervious surfaces. 3. We provide the response of macroinvertebrate communities due to sedimentation and habitat alteration and, 4. Linkages between sediment and microbial contamination.

Results: We found that mean streambed particle size was reduced in developing areas. Stream cross-sectional areas enlarged in areas with high percentages of impervious surfaces. Sedimentation and altered discharge resulted in the benthic macroinvertebrate community showing a general reduction in biotic integrity below urbanized reaches and that undisturbed tributaries had the highest biotic integrity values. Fecal coliform levels were higher for both surface water and bottom sediments in and below the urbanized area during base flows. Levels of fecal coliform in samples collected during storm flows were significantly higher than in base flows, and were correlated with high sediment loads.

Impacts of Urbanized and Non-urbanized Land Use On a Downstream Impoundment

Mark Schlautman, J. A. Smink, J. W. Pike, M. A. Goddard, W. R. English, C. J. Post, S. J. Klaine, T. Karanfil, J. M. Hur, B. A. Powell, J. C. Morse, J. C. Hayes, Departments of Biological Sciences, Forestry and Natural Resources, Entomology, Soils and Plant Sciences, School of the Environment, Public Services and Agriculture, and the Clemson Institute of Environmental Toxicology, Clemson University

The Reedy River drains the rapidly urbanizing basin that holds the City of Greenville, SC. The adjacent basin, drained by the Saluda River, is relatively rural and composed predominantly of agricultural and forestry land use. Both rivers empty into a highly eutrophic reservoir, Lake Greenwood. In addition to being used for recreation, Lake Greenwood is the drinking water supply for the City of Greenwood. This research attempted to characterize the land use and hydrologic conditions that controlled nutrient migration in the Reedy and Saluda basins that comprise this watershed. The Reedy River water quality and quantity is controlled predominantly by point source discharges, particularly POTW effluents. Nonpoint source pollutants, on the other hand, control the Saluda River. Lake Greenwood receives approximately the same nutrient load from both rivers. Results suggest that, contrary to public opinion, POTW effluents on the Reedy River are not the major source of nutrients entering Lake Greenwood.
Downstream Impacts of Urbanization in Small Watersheds

Stephen J. Klaine, J. A. Smink, J. W. Pike, M. A. Goddard, W. R. English, C. J. Post, M. A. Schlautman, T. Karanfil, J. M. Hur, B. A. Powell, J. C. Morse, J. C. Hayes, Departments of Biological Sciences, Forestry and Natural Resources, Entomology, Soils and Plant Sciences, School of the Environment, Public Services and Agriculture, and the Clemson Institute of Environmental Toxicology, Clemson University

Morphological and biological characteristics of drainage systems are continuously influenced by land-use changes and associated practices. Water quality and hydrology in receiving streams can also change substantially as a consequence of urbanization within the watershed. It follows that stream networks in these areas are in constant threat of alteration due to loss of riparian vegetation, in-channel erosion, increased temperatures, increased storm runoff, increased mobility of suspended sediments, and aquatic habitat degradation. In order to quantify the impact of urbanization on aquatic habitat, a paired basin study was performed in a small watershed in the Piedmont region of South Carolina. Peak discharge during storm events increased more than 2-fold in the urbanizing basin after only 6% of the basin had been developed. Total suspended solids, however, increased by an order of magnitude. These hydrologic and particulate changes had significant impacts on the biological communities in the urbanizing basin. Benthic invertebrate taxa richness dropped from 38 to 20 while EPT richness dropped from 9 to 1. The habitat score also dropped from 199 to 150. These results suggest that small changes in land use cause dramatic changes in the aquatic ecosystems that drain them.

Urbanization as a Driver of Distant, Rural Land-Use and Land-Cover Change: Environmental Dependency in Chihuahua, Mexico

Nate Currit, Department of Geography and Land Studies, Central Washington University

Contemporary patterns of global interconnectedness facilitate the emergence of patterns of dependency between urban and rural places that result in socio-economic and environmental change. The thesis of this article is that globalization has a measurable, significant effect on local land-cover change in distant rural places – that a global process is a significant driver of local environmental change that can be distinguished from purely local processes. In the case of Chihuahua, Mexico, globalization patterns and processes are most readily evident in Ciudad Juarez – a large urban center that has long attracted some of Mexico’s largest industrial establishments (i.e., maquiladoras). The hypothesized process by which growth in the maquiladora industry affects local environmental change in distant rural places is tested by 1) linking growth in the maquiladora industry with the spatial concentration of population and income, and 2) linking spatial concentration with local land-cover changes, measured via the classification of remotely sensed imagery. Results show that maquiladoras are concentrated in Ciudad Juarez; that population is concentrating in Ciudad Juarez and simultaneously deconcentrating in distant places; and that significant relationships exist between rural population deconcentration and changes in local land-cover types in rural places. The findings indicate emergent socio-economic and environmental dependencies where urban patterns and processes drive land-use and land-cover changes in rural places distant from the foci of increased global interconnectedness. The implications of these findings are that emergent patterns of urban-rural dependency must be taken into account for effective system management and to maintain system resilience.
Trend and Development of Farmland Use in the United States: Who Gains and Who Loses

Harjanto Djunaidi and Warren L. Anderson, School of Agribusiness and Agriscience, Middle Tennessee State University

Land is an important natural resource in the U.S. agricultural food and fiber industry. While farming will not be possible without land in any part of the world, recent developments in land conversion use to non agricultural purposes have reached an alarming level in the U.S. (Southeast Farm Press, March 3, 1999). Concerns have been raised by many scholars and population experts on the speed of farmland conversion to other non agricultural uses, particularly for housing projects in effort to accommodate a rapid increase of urban population. In order to meet an ever increasing demand for housing and other public space due to increasing population, more farmland in the U.S. has been converted to non agricultural uses. The conversion of farmland for non agricultural purposes has direct impacts on the ability of the country to produce enough food to satisfy a growing food demand due to increasing population. So far, the United States has been able to keep up with the growth of food demand through technology advancements and food imports. The application of the latest technology such as biotechnology has increased the productivity of farmland use. The acreage of farmland has declined but the growth of food production in the U.S. is still positive or favorable. The question is how long this situation can be sustained? Theoretically, at one point, one can not hold the above relationship forever due to the law of diminishing marginal productivity. This study examines recent trends and development of farmland use in the U.S. using most recent available data (1998-2002). Preliminary statistical results showed that some states did experience farmland loss and the rate of the change could reach as high as 150 percent per year. The analysis also showed many states in the U.S. are showing an increase in farmland acres.

American Idle: The Effects of Urbanization on Farmland and Farm Structure in the United States

Eric B. Jensen and Douglas Jackson-Smith, Department of Sociology, Social Work, and Anthropology, Utah State University

Among the most critical emerging ecological consequences of urbanization is the conversion of productive agricultural land to residential and commercial uses. Often overlooked in the discussion of urbanization is the simultaneous intensification of surviving agricultural operations who seek to maximize their income per acre to justify their continued use for food and fiber production. This paper uses county-level data from the continental United States between 1987-2002 to examine how urban proximity affects the size, scope, and character of farming systems. We focus on a range of agricultural trends that have ecological significance, including: the sheer loss of farmland, the concentration of livestock production, the intensification of crop production, the rapid growth in hobby farming and ‘consumptive farming,’ and participation in the federal Conservation Reserve Program. The analysis also recognizes a difference between trends in agriculturally important counties (both metropolitan and nonmetropolitan) where a critical mass of commercial agriculture has persisted, and those places where agriculture is a relatively marginal productive activity.
Fundamental Long-Term Changes in Alabama Agriculture
Claude E. Boyd and Mike Polioudakis, Department of Fisheries, Auburn University

Changes in agricultural and rural life are part of the bedrock background against which we have to understand the modern urban-rural interface. This paper explains changes in Alabama agriculture since 1950. These changes indicate the situation not only in Alabama but in most of the Southeast and in other areas of the U.S. where traditional agriculture has not thrived, and so these changes have general significance. Among other changes, from 1950 to the 1990s, total farm acreage has declined (21,300,000 to 9,800,000); the number of farms has declined (220,000 to 40,000); average farm size has increased (97 acres to 245 acres); forestry and new agricultural crops have arisen (broilers now are nearly a 2 billion dollar industry); 8% of farmers now produce about 82% of the crops; and farmers have become a minority in the countryside (less than 2% of the rural population). The paper explains how these changes stem from the fact that crops can be grown in Alabama but cannot be grown to compete with other regions of the U.S. such as the Midwest and California. Proposed responses to improve agriculture and rural life include development of niche crops and new markets. These solutions will continue to change agricultural and rural life and will strongly condition the nature of the urban-rural interface.

Modeling How Land Use Affects Nutrient Budget in the Guayas Basin, Ecuador:
Ecological and Economic Implications
Mercy J. Borbor-Cordova, William H. McDowell, Charles A. Hall, Elizabeth W. Boyer, Municipio de Guayaquil - Ecuador

We examined some ecologic and economic relations between land use and the nutrient budget of the Guayas Basin-Ecuador. In the Guayas Basin extensive agriculture activities upstream interact with an intense urbanization process downstream. This study embraces the complexity of understanding the interactions between biophysical and human systems using the fluxes of nutrients as the main indicator. In this study we developed a spatial land use nutrient budget model that estimates the nutrient inputs into the Guayas Basin. These spatial fluxes (N, P) are then coupled to the seasonal budgets of nutrients of the Guayas estuary in the Gulf of Guayaquil. Subsequently, we apply a tradeoff analysis of three agricultural technology scenarios to explore how different agricultural land use and management practices can alter the nutrient balance and fluxes within the basin and the coastal zone. Overall, we found that fertilizer input is the main source of N and P into the Guayas Basin and the main output is the export crops. We used the nutrient balance as an index of agricultural sustainability; where a negative balance of N or P indicates nutrient depletion and subsequent decrease in soil fertility, agricultural yield, and ultimately economic profitability. We found that there are negative balances at the sub watershed level suggesting nutrient depletion. Our analysis pointed out that the Guayas Basin is a N-limiting system and that agricultural and urbanization activities increase this N limitation downstream. If the current agricultural land use management practices persist this research suggests that there will be a steady increase of N and P into the system, with a progressive decline in the N:P ratio leading to eutrophic conditions. The tradeoff analysis reveals that under current agricultural practices there is a positive relation between profit and nutrient depletion. While technology is available to improve the agriculture productivity and reduce nutrient depletion there are economic and socio-cultural barriers that prevent the implementation of such technology. These results suggest that there is a need to create incentives to implement an integrated management plan for coastal watersheds.
**Urban Pressure and Soil Degradation in the Rural-Urban Interface: How Sustainable is the Soil in the Kano Close-settled Zone, Nigeria?**

Roy Maconachie, Dept. of Geography, University of Sussex, United Kingdom

In Nigeria, Africa’s most populous country, peri-urban livelihood strategies have become important survival mechanisms for a wide range of actors, but the sustainability of these strategies remains largely unexplored. Based on field research which adopts methods from both the natural and social sciences, this paper examines the social, economic, and cultural contexts of soil degradation in peri-urban areas, with specific reference to recent developments in and around the burgeoning city of Kano in northern Nigeria. Extensive discussions with land-users, living and working in Kano's urban periphery, reveal that links between urban areas and the countryside play an important role in the process of rural, urban and peri-urban change. Particular issues of concern include the competition for key resources and its impact on soil fertility, together with related implications for levels of poverty, livelihoods and the sustainability of food production systems. The paper also draws on quantitative approaches, including the chemical analyses of soil, water and plant samples, and in the process of working across the divide between the physical and social sciences, the methodological complexities of assessing soil degradation are revealed. It becomes apparent that positivist interpretations of the soil must not be viewed in isolation of local knowledge of environment, livelihood diversity and change. Since the concept of soil degradation is a social construction and has different meanings for different individuals, a more critical evaluation of how the knowledge, understanding and perceptions of local actors drive behaviour and affect land-use decisions at the micro-level is essential, if viable and sustainable environmental policies are to be initiated in the future.

**The Impact of Urbanization on Forest Ownership Dynamics in the Northeastern United States**

Brett J. Butler, USDA Forest Service

The fate of America’s forests lies largely in the hands of the families, individuals, corporations, and other private groups who own 57 percent of the nation’s forestland. The area of private forestland has stayed relatively constant over the past decade, but there have been significant changes in ownership patterns. The area of forestland owned by timber investment management organizations and non-industrial forest owners has increased simultaneously with decreases in the area owned by traditional forest industry companies. Details of ownership dynamics in the northeastern United States and the causes and consequences of these changes will be examined using data from the U.S. Forest Service’s Forest Inventory and Analysis forest inventory and landowner survey programs and the U.S. Census Bureau. Over the past 50 years, the population in the northeastern United States has increased by 38 percent with much of this increase occurring along major transportation corridors. Concurrently there were significant changes in forestland and forestland ownership patterns. For example, the area of forestland along the I-95 corridor decreased by 15 percent and the area outside this sub-region increased by 9 percent. The characteristics of the owners are also shifting with the number of owners with smaller parcels increasing. Privacy and owning land as part of a home remain important objectives, family legacy and land investment are increasing in relative importance and timber production is decreasing. Forest ownership patterns will continue to change as many landowners intend to transfer landholdings in the near future.
Cost Analysis of Mechanical Thinning Treatments in Small Stands at the Wildland Urban Interface

Bruno Folegatti, Mathew Smidt, and Ed Loewenstein, School of Forestry and Wildlife Sciences, Auburn University

Mechanically treating small parcels at the Wildland Urban Interface requires careful economic analysis of the practices. The economy of tract size, wood products extracted, and removal volume, are decisive points in harvesting profitability. We compared three variations of commercial thinning treatments: conventional (16m²/ha), heavy (9m²/ha), and strip cutting plus thinning (11.5m²/ha). Productivity and harvesting costs were compared across three sites and three stand sizes (4, 8, and 12 hectares). The sites represented a range in loblolly pine first thinning conditions. Overall skidder productivity set production rates and harvest costs. Stand size and treatments that lead to larger removal volumes lowered per unit fixed harvest costs. Greater volume per stem from the sites lowered harvesting cost and was associated with increased wood value. Treatment differences were most important for the 4ha stand where the heavy cut increased revenue by US$3.10/m³ in comparison to the conventional cut. The difference is economically significant and represents about 20% of total harvest cost and 48% of stumpage prices. Alternative treatments that increase removal volume per hectare have the potential to address harvest marketability and feasibility and may make harvesting small stands more attractive to landowners and buyers.

The Challenges in Building RSim, a Comprehensive Resource Management Model

Michael E. Chang, Virginia H. Dale, Tom Ashwood, Latha Baskaran, Rebecca Efroymson, Chuck Garten, Lisa Olsen, Michael W. Berry, Matthew Aldridge, and Catherine Stewart, School of Earth & Atmospheric Sciences, Georgia Institute of Technology; Environmental Sciences Division, Oak Ridge National Laboratory; Department of Computer Science, University of Tennessee; and U.S. Army for Health Promotion and Preventive Medicine, Aberdeen Proving Ground

The Regional Simulation Model (RSim) is being designed by a team of ecologists, biologists, computer scientists, and atmospheric scientists to allow resource planners and managers to explore multiple environmental effects associated with change in land use, cover, and intensity at military bases and surrounding areas. Effects to be considered include changes in air and water quality, noise conditions, and habitats for game, threatened, and endangered species. The RSim model is being developed for the region around Fort Benning, Georgia because of the large amount of data available for the installation and surrounding region, and the cooperation offered by the base in developing and testing the model. The need for applying ecosystem management approaches to military lands and regions that contain them is critical because of unique resources on these lands and the fact that conservation issues may jeopardize military missions if not appropriately managed. The RSim model addresses this critical need by enabling application of ecosystem management approaches to military lands and surrounding regions. In building the model however, the team has encountered and endeavored to solve numerous issues associated with conflicts in ecosystem management goals, temporal and spatial scales, and complicated feedback loops. The team has also struggled simply to coordinate the interfaces between the various environmental modules that comprise the model system. Herein, we provide a report on the challenges faced by the team and provide specific examples related to developing the air quality module within the context of the RSim as a whole.
Impacts and Social Transformations Generated by the Forest Activities in Uruguay: Case Study of Three Rural Towns

Matias Carambula Pareja, Universidad de la Republica - Uruguay

In Uruguay by means of the Law Nº 15939 (1987) forest plantations with species of fast growth were promoted. They were implanted on grounds of low productivity, replacing mainly the cattle production extensive characteristic of the country. In 1990 the surface occupied by commercial plantations included 70.529Ha. (0.4% of the farming surface), whereas by 2000 it covered 659.803Ha. (4.0% of the farming surface). The study explores the impacts and social transformations that this forest production has generated on three towns with different degrees of involvement in the activity: Red stones, town of forest history; Step de la Cruz, new forest town and Sarandi of Navarrese, cattle town, witness previous to the forestall activities. It is sustained theoretically from the territorial approach and approaches the following subjects: dynamic population, changes on the services and infrastructure, "new" societies forest, the use, and the economic activities. The "forest towns" register important population increases, the services and infrastructure have improved. Also they would present/display minors indices of unemployment in comparison with other regions of the country, but, the little resources and labor unmannerliness are very important, which would explain the high observed levels of poverty. Red stones and Step de la Cruz have differences. First with a model based on the investment of national firms and with a strong industrial component, presents/displays some indicators that would allow us to it a model of integrative development. The second, with the presence of multinational firms, oriented the industry of the cellulose without an industrialization process, presents/displays indicators of a fragmented society, with important problems of social nature.

Modeling the Causes and Consequences of Forest Fragmentation in the Raleigh-Durham Area

Robert McDonald, Harvard University

Land-cover and land-use change modeling have become increasingly common, and myriad different modeling techniques are now available. Many techniques assume that the rules of landscape change are the same everywhere within the study area, an assumption that contrasts with reality in many municipal regions, which have spatially varying development restrictions. In this talk, we provide a case study from the Raleigh-Durham area of North Carolina (USA) showing the consequences of using a model with a spatially homogeneous form when the rules of landscape change are spatially heterogeneous. We also present a synopsis of field research into the effects of the forest fragmentation concurrent with development on forest ecosystems, and discuss briefly the spatially heterogeneous affect of open space on housing prices in the Raleigh-Durham area.
Modeling Forest Change and Its Ecological Consequences in the Southern Cumberland Plateau

Robert Gottfried, Douglass Williams, Matthew Lane, Christopher Butler, Derek Lemoine and Kevin Willis
Department of Economics and Sewanee Landscape Laboratory, The University of the South

This paper reports on the results to date of a US EPA-funded study of land use change in a rapidly changing, highly biodiverse region of the southern US. The paper develops and tests a model to predict the conversion of native forest over time to pine plantations, and to low density permanent and second homes in a seven county area on the southern Cumberland Plateau of Tennessee. The theoretical framework explores how the interaction between different buyer and landowner types affects the probability of forest conversion, particularly when knowledge of market conditions and land use options is imperfect. The spatial diffusion of information across the landscape plays a central role in the model, as does land use on nearby parcels. Utilizing probit analysis to examine GIS data on land use change for the period 1980-2003, along with spatially explicit tax data, the paper discusses land use transition probabilities for parcels of varying characteristics. The paper then discusses the link between conversion to pine and bird populations, and the extent of streamside buffers of these land uses provide depending upon landowner type. The discussion ends with a discussion of how the results will provide the basis for an ecological and economic GIS simulation model of change model for the study area.

The Effects of Social Networks in Natural Resource Product Development, Marketing and Distribution in Rural Vermont

Curt Gervich, Etowah Habitat Conservation Plan

The economic and cultural systems of rural Vermont have largely been built on natural resource industries such as forestry and agriculture. Milltown, Vermont is one such rural, resource dependent community. Many of Milltown’s residents rely on the forests surrounding the community for sources of primary or secondary income. Residents hold jobs at the local timber mills, tap maple trees for syrup production, grow Christmas trees, gather mushrooms, berries and forest herbs, and work in nature-based tourism. This research examines how Milltown’s resource dependent business owners utilize social networks as they produce, distribute and market their products and services. Qualitative methods such as snowball sampling and participant observation were used to identify forest dependent industries and business owners in the host community. In-depth and structured interviews were used to document business practices and social networks used by 22 local forest-dependent business owners to complete five business phases. This presentation focuses on unique social network types and themes important to forest dependent business owners in Milltown. The themes corresponded, generally, to the importance of family; friends; industry professionals; and the larger community in forest dependent businesses. This research made six general conclusions regarding social networks and forest dependency in the host community and concludes with a discussion of the roles that forest dependent firms play in creating and strengthening community in Vermont.
Urban-Peri-Urban/Rural Interface: Food Quality Assurances A Study of Haryana and Uttar Pradesh – 2 States of India

Neela Mukherjee and Meera Jayaswal, Private Consultancy, New Delhi, India

Though seldom recognized and under-researched, the peri-urban farmers in India play a critical role in the food chain for supply of food to those residing in cities and towns of India. Livelihoods of poor households in the peri-urban India are strongly dependent on growing vegetables and cereals and producing milk and selling them in nearby towns and cities. They constitute the backbone of a city’s food supply system, in this case Delhi – a mega city and the capital city of India and the city of Varanasi – a major business hub and tourist attraction in the State of Uttar Pradesh. It is in this context that participatory action research was undertaken in 15 peri-urban villages in the two Indian States of Haryana and Uttar Pradesh located in the North to study the peri-urban-urban/rural interface in terms of providing goods and services. The study funded by DFID, UK was based on listening and learning from the voices of the poor producers and consumers of food from the peri-urban/rural areas of India during the period 2000-03. Field inquiry was located in different peri-urban/rural sites near industrial hubs.

Specific objectives of the fieldwork:

To understand the urban-peri-urban/rural interface and the role of selected horticultural produces (Spinach, Cauliflower and okra) in the livelihood strategies of peri-urban/rural poor. To understand the existing advice, support and information, which are available to the peri-urban/rural producers and consumers in the context of the urban-peri-urban/rural interface. To arrive at appropriate policy recommendations in this context especially for the poor and marginalized groups.

No Land under our Feet: Urbanisation, Land and the Poor in Peri-Urban Kumasi, Ghana.

Daniel K. B. Inkoom, Kwame Nkrumah University of Science and Technology, Department of Planning

Ghanaian cities, like most other African cities, currently face two major structural issues. The first is their limited capacity to provide employment and accommodation to a rapidly increasing population and prevent environmental degradation, and the second is how to remain competitive in the face of global economic transformation processes that have drastically altered the country’s competitive advantages, notably cheap labour and agricultural raw materials.

According to the ideological roots and attributes of urban management, policies should be pursued by government to ensure effective urban planning and management in order to bring about positive change in the lives of poor urban residents. This paper addresses three key questions: (1) What happens to rural land owners as the city expands? (2) How does the peculiar land tenure system shape the nature of urban development in the process of city expansion, and (3) What management approaches ensure that the poor (urban and rural) survive in the city? These questions are examined in the light of the critical issues of employment and accommodation, within the context of Kumasi, seat of the Ashanti kingdom and Ghana’s second largest city. The key issues the paper raises relate to how the poor are able to deal with all these complexities and still survive in the city environment. The paper explores the networks and support systems they draw on to enable this to happen. The paper also tests the assumption that in the face of great challenges, governments’ urban management policies are key to ensuring orderly development of the urban environment.
Celebrating Rural Traditions in increasingly Urban Contexts: Fiestas and Kitchenspaces in the House-lot Garden in Central Mexico

Maria Elisa Christie, University of Indianapolis

This paper explores human and gendered dimensions of urban-rural interfaces in Central Mexico with a focus on traditional fiestas and food preparation in the house-lot garden. The goal of my research was to understand how women in Xochimilco and Ocotepec—on the outskirts of Mexico City and Cuernavaca—interact with the natural environment in their everyday lives. With a feminist political ecology approach, I explored the gendered spaces associated with food gathering and preparation using qualitative methodologies. My research took place primarily in kitchenspace, which I define as the place where food is prepared, whether indoors or out, including ritual celebrations in the house-lot garden. It is a privileged and gendered site of social and cultural reproduction and provides a unique perspective on a society’s changing relationship with the natural environment. This and other gendered spaces are often neglected in academic research, in part because of their inaccessibility to male researchers. In an overwhelmingly urban world, scholars and policy makers alike will have to grapple with new dimensions of human interaction with the natural environment and the fact that in developing countries, “urban” populations often retain many aspects—and spaces—of non-urban culture. This research may provide insights into comparable Latin American contexts where people of traditional and mestizo cultures face new challenges upon migrating to urban centers, or when la mancha urbana [the urban stain] transforms their communities into suburbs, bedroom communities, or peri-urban areas.

Federally Managed Public Lands and Issues of Environmental Justice

Uttiyo Raychaudhuri and Michael A. Tarrant, University of Georgia

The purpose of this study is to examine potential inequities in the distribution of federally managed public lands in the contiguous United States with respect to socio-economic characteristics of residents of areas proximate (versus distant) to these lands for issues of environmental justice. As people are moving towards the exurbia, there is an emerging trend of areas on the public land-urban interface becoming settlement grounds. This exurbanization pattern and increasing human settlement on lands proximate to public land boundaries are resulting in changing economics of land use, land costs, transportation, infrastructure (sewer, water, power) and other service provisions (schools, hospitals, police). Geographical Information Systems (GIS) is used to elucidate the effects of this phenomenon and provide guidance for future research. Data analyzed in a temporal and spatial scale establishes potential inequities in the distribution of federal lands and consequent issues of environmental justice with respect to socio-economic distribution of people who inhabit these fringe areas and who benefits from their proximity to federal lands. The distribution of federal lands and consequent settlement of people in and around their boundaries have given rise to issues of social and economic justice. Environmental benefits which are inherent with federal lands are magnets which propel these settlement patterns. Environmentalism is now equated with social justice and civil rights. Implications of how environmental justice issues are intertwined with land-use planning and decision models that incorporate human and ecological health concerns and involve mainstream environmentalists and social justice groups are discussed.
Ethics and Ecology on the Urban Frontier

Robert Kirkman, School of Public Policy, Georgia Institute of Technology

I argue that emerging efforts toward an ethics of the built environment call for a more sophisticated relationship to ecology than has been typical of environmental ethics in the past. As it has developed since the 1970s, environmental ethics has largely been preoccupied with wild nature, ecosystems that have not yet been significantly altered by human activity, as the standard against which human decisions are to be measured. Along the way, environmental ethicists have sought to ally themselves with ecology, often drawing out what they take to be the metaphysical and normative implications of emerging scientific theory. There are exceptions to this pattern, of course, as a number of environmental ethicists have turned their attention to agricultural landscapes, and a few have even begun to consider more intensively built environments – cities and suburbs – as suitable places for normative inquiry. Making this turn toward the built environment introduces a number of complications, however. For one, the norms established by conventional environmental ethics do not seem to apply very readily to environments in which nature and culture intertwine, so that it is no longer so easy to determine what is “natural” or “wild” and what is merely “tame.” More importantly, ethicists who would look for inspiration and insight in ecology must be more careful in drawing conclusions from what they find there: ecology can illuminate some critical features of the built environment, but by no means all of them.

The Rural-Urban Split and the Course of Democracy in Africa

John Murungi, Department of Philosophy, Towson University

For any serious student of African political affairs, the course of democracy in Africa is remarkably rocky. This paper demonstrates this state of affairs by examining the rural-Urban split. In conventional wisdom, democracy is supposed to be a government of the people by the people for the people. Since not everybody in any country makes the decision as to how the country is to be run, it is the majority of the people whose decision matters in carrying out a democratic project. Since the majority of people in African countries live in the rural area, it would tend follow that it is this majority that should determine how African countries are to be run. Unfortunately, this is not the case. It is in the urban area that political and economic powers are located. It is the center of higher and technical education. It is where health and transportation services are concentrated. It is the center of international transactions. It is the showcase of whatever development there is in the country. Development has largely come to mean the development of a minority in the urban area of the country. One of the consequences of the concentration of power in the urban area is that those who reside in the rural area have become disenfranchised and the areas they inhabit have become desolate. This state of affairs is reinforced by international forces in the country since they too are concentrated in the urban area. Abuse of power and systemic corruption is centered in the urban area. To the majority of many Africans, the urban area is more or a curse than a blessing. The so-called decentralization in African countries has not contributed to democracy. It has largely benefited urban dwellers -a few of them. The rural area is the sad face of Africa, and the glittering of the urban area in terms of current rural/urban divide cannot erase this sadness. Although Cambodianization was not and cannot be a solution for the problem of democracy in Africa, there needs to be a revolution that brings about substantive attention to the rural condition.
Saigon's Edge: Conflicts Between Ideal Representation and the Social Organization of Space on Ho Chi Minh City’s Rural-Urban Fringe

Erik Harms, Cornell University

This paper offers an ethnographic depiction of the operation of power and dogma in Late Socialist Ho Chi Minh City from the perspective of contested time and space on the Rural-Urban fringe. Field-work on the edge peers beyond the ideological edifices of "rural Vietnam" and "urban Vietnam" by looking through the cracks that form in a system of cultural Ideals when they confront actual social life. Saigon's Edge is neither rural nor urban, but uncomfortably both. Focusing specifically on competing social constructions of time and space in an area undergoing rapid urban development, the work provides an empirical basis from which to describe the social effects of the turn towards 'market socialism' and the celebration of urbanization. On Saigon's Edge the political and cultural fissures created by competing temporal orientations range from how people relate to historical commemoration and ritual time, to labor time and "family time", as well as changing orientations to tradition, modernity, and development projects. The contest over space includes land disputes and an emerging real estate market (in a country without a legal recognition of private property), the politics of city planning, land appropriation and compensation, as well as on-the-ground changes in spatial orientation played out in the home, the family and in public space. Combining ethnographic description of different orientations to time and space with an analysis of texts and representations leads to a powerful critique of essentialist state mythologies that depend on pure rural and pure urban social types that simply do not exist.

Urban-rural Interface Issues in a Predominantly Rural State: Some Experiences from Arkansas

Sayeed R. Mehmood and Philip A. Tappe, School of Forest Resources, Arkansas Forest Resource Center, University of Arkansas

Aply called the “Natural State”, Arkansas is one of the most rural states in the nation. The Bureau of the Census estimates that 46.5 percent of the state’s population is classified as “rural”. The National Association of Counties classifies 62 of the state’s 75 counties as “rural”. Activities traditionally associated with rural areas, such as agriculture, forestry, and hunting, have always been important for the state’s economy. However, some areas in Arkansas are experiencing rapid population growth and urbanization. For example, a metropolitan area in northwest Arkansas experienced a 47.5% increase in population within the last decade. Such rapid urbanization in predominantly rural areas gives rise to a host of urban-rural interface issues such as forest fragmentation, loss in forest and agricultural production, alteration of wildlife habitat and associated reduction in game populations, and human-wildlife conflicts. This paper will present Arkansas data collected from a variety of sources to demonstrate the rise in urban-rural interface issues in rapidly urbanizing areas of the state. Results of research conducted at the Arkansas Forest Resources Center on human-wildlife conflicts will also be presented as a case study.
Regional Convergence Toward Sustainability in Northeastern Ohio

Joe Konen1, Ben Stinner2, Bill Grunkemeyer1, Myra Moss3
1Ohio State University Extension Center at Wooster; 2Ohio Agricultural Research and Development Center; 3Ohio State University Extension Center at Lima

In Northeastern Ohio 4.5 million people live in both highly urbanized areas and counties with significant agricultural communities. Insignificant population growth, loss of manufacturing jobs, and a struggling agricultural sector at the urban fringe mark the region’s struggling economy. This presentation will discuss a comprehensive program to address regional sustainability for the area. The program has two phases: an assessment phase and an action phase. Presenters will profile the social, environmental and economic pressures on the region and describe major regional initiatives toward sustainability including: the unique geo-spatial, soil and water assets of the region; land-use planning opportunities to reverse sprawl and plan for sustainability; local food projects and other entrepreneurial agricultural opportunities in the region; coordinated and targeted economic development and business attraction plans; regional planning for educational excellence; and environmental sustainability for communities and watersheds. Presenters will discuss their plans for the second, action phase, which will help catalyze change to move the region forward in sustainable development and produce a model system that could be transferred to other regions.

Place and Rural Change: A Case Study of a ‘Restructuring’ Community in the City’s Countryside

Jeffrey R. Masuda and Theresa D. Garvin, University of Alberta

In Canada, there are no less than six “official” definitions of rural using primarily economic data from the federal census categorizations. However, ‘rural life’ often does not coincide with official definitions, which makes for difficult, and at worst inappropriate policy-making. The purpose of this research is to understand the impacts of social and cultural dimensions of change in a region undergoing what has been termed ‘rural restructuring’. The presentation reports the results of a case study of rural restructuring in a community located near Edmonton, Alberta, Canada. A municipal proposal for an industrial park called the Alberta’s Industrial Heartland has been both a driving force and consequence of rural social, economic, and cultural volatility in the region. We conducted individual and group interviews with local residents, government officials, industry representatives, and media to understand what this volatility means to the everyday lives of the local community. Results show that people are dealing with rural change in ways that have implications for local economy, community, environment, and governance.
Rural and Urban in the Brazilian Amazon and the “Fate of the Forest”

Alvaro O. D'Antona, Andrea D. Siqueira, and Leah K. VanWey, Indiana University

Due to rapid occupation and landscape transformations in the last forty years, defining what is “rural and urban” in the Brazilian Amazon region is not a simple task. There is great variation within the region. At the extremes, there are municipalities with more than 90% of their land in forested conservation units and indigenous areas and municipalities that are considered 100% urban. Between these two extremes lie the vast majority of municipalities. For these areas, the discrete definitions of “rural and urban” settings are often blurred. More often than not, urban and rural are unified systems where people, goods and ideas circulate. The proposal of this paper is twofold. First, we will present the urban and rural criteria used by the Brazilian national statistical agency (IBGE) and compare these criteria to conceptual approaches proposed by Brazilian researchers studying rural - urban interconnections. Second, we will evaluate the applicability of these concepts for the Brazilian Amazon region, addressing the “fate of the forest” within these classifications. In other words, what is the place of forest and the meaning of forest in these classification systems? Are forests doomed to disappear in the rural settings where they are considered areas to be domesticated and transformed in productive areas? Are forests in urban centers predominantly sources of services? We will address these topics by drawing on a diversity of municipal situations, from municipalities that are predominantly rural to municipalities that are predominantly urban, in four states: Acre, Amapá, Amazonas and Pará.

Do Certain Features Attract Certain People to a New Urban Community? Testing the Differences Between Homebuyers in a New Urban Community with Those in a Conventional Suburban Development

Neil Wieloch, Department of Sociology, Social Work and Anthropology, Utah State University

In addition to providing solutions to the problems of urban sprawl, new urbanist planning strategies hold the promise of creating a “sense of community” through the built environment. Such features as shared public spaces, pedestrian friendly streets, historic-looking houses with front porches, accessible town centers and recreation areas, and aesthetically-pleasing civic buildings are meant to bring people together in ways that conventional suburban developments do not. The effectiveness of these practices in achieving their goals has been debated by researchers of urban planning. But one avenue that has not been studied is the degree to which new urban planned communities actually attract a unique population. If new urban communities do, in fact work – that is effectively create a sense of commonality and neighborly interaction among their residents, how much of their ability to do so is a result of the type of individuals that choose to move there? This research explores the question of whether it is the built environment or the people that make a community by comparing various community-oriented characteristics and outlooks of home buyers moving into a developing new urban community with home buyers moving into a conventional development.
A Trans-Disciplinary Research Approach Providing a Platform for Improved Urban Design, Quality of Life and Biodiverse Urban Ecosystems

C.T. Eason1, J. Dixon 2, M. van Roon2
1 Landcare Research, Auckland, New Zealand; 2 University of Auckland, New Zealand

This paper outlines a platform for trans-disciplinary urban research approach underpinned by a literature review on low impact urban design and development (LIUDD) and preliminary results from working with six key stakeholder groups: consumers, Maori, community, developers and regional and city councils. Conventional development practices lead to adverse effects from stormwater runoff in urban areas and contribute to escalating costs of infrastructure. LIUDD comprises design and development practices that utilize natural systems and new low impact technologies to avoid, minimize and mitigate environmental damage, reduce energy requirements and waste. However, there are major constraints: consumer and practitioner behaviour, deficient pricing of resources such as water, conflicts between stakeholder groups, and variable quality of planning instruments. Significant practical work and research is required to overcome obstacles to broadscale uptake of LIUDD. With this in mind we have implemented a 4 pronged research programme that provides information on i) the performance of LIUDD at the development site and catchment scale, ii) the economics of conventional versus LIUDD, and iii) the potential for integration amongst different types of instruments (district plans and codes of practice) that will be a pre-requisite for the development of a rational set of incentives for developers. Fourthly, through a participatory research approach we will facilitate uptake of LIUDD by the range of professionals and consumers. The programme commenced in October 2003 and is planned to run for 6 years. It will allow for the assessment of the different development processes and alternative urban design and form. We aim to demonstrate LIUDD’s technical and ecological benefits; to strengthen and rationalize plans and regulations. We are currently working on case study sites in Auckland and other main centres with rapid development.

Urban Regeneration in the Pacific Northwest: Portland’s Pearl District Comes of Age

Barbara E. Cates, Department of Geography, University of Oregon

Portland, Oregon is experiencing a geographic transition that is characteristic of a larger trend occurring in many aging cities nationwide. Downtown re-investment not only reworks space, but it poses an especially welcome geographic shift for innovative, proactive cities grappling with growth management legislation and sustainability practices in an increasingly global world. My micro-scale analysis examines the urban phenomenon of revitalization as exemplified by a mixed-use district located in one of Portland’s classified urban renewal zones, in order to gain insight into a pattern that may well represent the future of inner city landscapes across the United States. In viewing the Pearl District as the direct outcome of a self-imposed urban growth boundary, this paper will provide a spatial, cultural and socioeconomic analysis of urban change, including the impacts that land use management has had on the return to the core of one of America’s most visionary cities.
Inspiration from the Landscape – Creativity Meets the Challenge of the Urban/Rural Interface

John Peine, USGS Southern Appalachian Field Lab, University of Tennessee

Great Smoky Mountains National Park is at the heart of one of the most revered landscapes in the world as noted by its status as an International Biosphere Reserve and World Heritage Site. This landscape has inspired numerous examples of the utilization of science and innovative policy to establish functional best sustainability practice (BSP) in the southern Appalachian highlands. This presentation will highlight a sample of these BSPs from various dimensions of the landscape that are documented on the Best Sustainability Practices Website (http://www.nbii.gov/datainfo/bestpractices/appalachia/index.html). The common thread of these best practices is that the environmental setting inspired them.

Black Belt Housing Rehabilitation

Patrick Kennealy, Department of Agricultural Economics & Rural Sociology, Auburn University

Urban and rural housing assistance programs were compared during 2004 through a qualitative review of government and non-governmental low-income housing rehabilitation programs in rural West Alabama Black Belt counties and urban Tuscaloosa County. Private and public urban housing assistance programs in urban areas benefit from the availability of social and financial capital resources missing in rural areas. Non-governmental Tuscaloosa-based housing service providers are able to draw on financial and human capital lacking in the rural Black Belt. The public services of the federal government (USDA Rural Development and HUD) also face challenges of providing home ownership assistance services in the Black Belt area. Potential solutions are identified.
The Nature and Impacts of Tourism in the Urban Coastal Zone

Yehuda Klein, Jeffrey Osleeb and Lee Hachadoorian, Graduate Center of the City University of New York

Over the past thirty years, the coastal counties have shifted from traditional maritime activities such as fishing and boating, to a more service-oriented, and tourism-dependent economy. The key to economic growth in the coastal states has been the strength of the travel and tourist industry. This study links a regional model of tourism-generated earnings to a GIS model to quantify the relationship between the relative size of the travel and tourism sector in each county and the county’s proximity to the coast. We find that tourism-related earnings, as a percent of total earnings, is concentrated in counties that lie within forty km (25 miles) of the Atlantic, Gulf and Pacific coasts of the United States. In contrast, the share of earnings attributable to tourism is not sensitive to distance from the coast for counties that are further than forty km (25 miles) inland. An exploratory spatial analysis of United States coastal zone suggests that the size of the travel and tourism sector is highly dependent on both the degree of urbanization and on proximity to recreational beaches. Key unanswered questions are: 1, the importance of beach quality to the tourism industry, relative to other amenities such as weather and the presence of cultural attractions; and 2, the degree to which a common set of causes explains migration patterns, tourism, and economic development in the coastal zone.

Sustaining Forestland In Urbanizing Areas.

Robert E. Bardon and Mark Megalos, Department of Forestry and Environmental Resources, North Carolina State University and Division of Forest Resources, Department of Environment and Natural Resources, Raleigh, NC

In North Carolina forests within the urban matrix can no longer provide habitat for specialized wildlife. Dwindling forest tract size threatens the viability of the land to support traditional uses. Since 1991, North Carolina has lost over 1 million acres of commercial forestland to residential development and other uses. Efforts are needed to sustain large, contiguous tracts of managed forestland to maintain biodiversity and other benefits. It is becoming increasingly evident that publicly funded acquisition of lands or conservation rights cannot alone insure the long-term sustainability of forestland. Two forestry summits were held in 2004 for forest landowners and other interested stakeholders to promote the sustainability of North Carolina’s forest community. Participants were surveyed about the factors required to sustain North Carolina’s forests. Forty two percent of the participants identified urbanization and development as the greatest threat to the sustainability of North Carolina’s forests. Sixty three percent of the participants indicated that financial incentives, reduced taxes, and education are key to the sustainability of North Carolina’s forestland. The authors promote several educational programs and forest sustainability policies based on the survey results and insights from the forestry summits. Relevant solutions and implications for sustaining forestland in urbanizing areas are discussed.
Storm Surge Forecasting For New York Harbor

Frank Buonaiuto, Hunter College, City University of New York

With the growing awareness of sea level rise and increased flood potential of Lower Manhattan a storm surge modeling system for New York Harbor and the surrounding metropolitan region has been developed. The modeling system combines a regional meso-scale weather model with a model of tidal hydrodynamics. The meteorological model MM5 provides a time series of wind and pressure fields to the hydrodynamic model ADCIRC, developed by the US Army Corps of Engineers. Stresses associated with the wind and pressure, are incorporated into the momentum equations enabling the prediction of storm surges as well as wind induced setup. The system was verified using historical storms which include Hurricane Floyd, a 100 year rainfall event, and the 1992 Northeaster, a storm in which many of the low lying coastal regions of NY and NJ were flooded. Model predictions matched observation data collected at several sites located within the harbor, Raritan Bay and Long Island Sound. In addition the system was used to analyze changes in water levels associated with the operation of hypothetical storm surge barriers around New York Harbor. The system is now operating in a forecast mode where 60 hour MM5 wind and pressure fields, updated twice daily are used to drive the surge model. The forecasts are automatically posted on the web once the predicted water levels and atmospheric conditions have been compared to a network of real time observation data collected by NOAA and USGS.
Poster Abstracts
The Transformation in Irrigated Land in the Spanish Valley of the Ebro: The Case of the Rioja Region

Mohamed Amir Bouzaida
Dpto. de Geografía y Ordenación del Territorio
Universidad de Zaragoza

Irrigations projects are very important in the dry areas of Spanish agriculture. The present study analyses the socio-economic and environmental aspect of the irrigation project in the north of Spain. The study begins describing the area physical characteristic and the irrigation project feature. Next, the human recourses in the irrigation and surrounding areas are examined, in order to know the availability of labor supply for the project. Based in the information obtained from experts, and surveys to farmers, cooperatives and companies, the following points have been analyzed: i) farms characteristics in the irrigation project area (with many examples); ii) which are more profitable crops to plan in the new irrigated land; and iii) manufacturing potential in the area to process the raw products. The study concludes identifying the environmental effects of irrigation on the area. The results show that there are enough human resources to cover the employment induced by the irrigation development, and also the importance of irrigation to improve the loss of the population problem. The extensive type crops (corn, alfalfa, barley), the pocketed late peach and the olive tree, are very important crops in the irrigated farms. The industries in the area have enough processing capacity to absorb the increase in the raw products supply, and have planned new production activities. Finally, the negative effects of the irrigation project on vegetation and fauna are described, and some correcting measures and proposed.

Zion Lodge Landscape: Holding On to the Past and Preparing for the Future

Rick Heflebower and Lisa Ogden
Utah State University and Zion National Park

Things are changing at Zion National Park and have been since it was dedicated as a national park in 1919. Managing 2.5 million visitors a year and keeping human impact to a minimum is challenging, to say the least. The Zion Lodge complex was developed around 1928 to accommodate visitors. The original lodge included some rustic style cabins, swimming pool, bathhouse, cactus garden, and a native grass lawn area. By 1931, the landscape was more formalized by the addition of bluegrass, a designated walkway, and an extended main road to give the public better access. One old cottonwood tree (circa~1890-1910) sits in the middle of the “lawn area” located in front of the lodge and has become a gathering place for visitors.

In 2003, an irrigation audit was performed on the lawn area as well under the old cottonwood tree. Five straight years with below normal precipitation had park officials worried that the area may not be receiving enough water. It was also apparent that irrigation applied near some of the cabins was adversely affecting the foundations causing settling to occur. Findings from the irrigation audit showed that the tree and turf areas were being under watered. Changing the irrigation schedule and replacing some of the old fixtures corrected this problem. It was decided that irrigation near the cabins would be discontinued to protect the foundations. Long-range plans include selecting more drought tolerant plants for the cabin area and Putting them on drip irrigation.
Participatory Process and Sustainability Assessment Tools for Appropriate Design and Equity in Suburban Stormwater Management

B. Kirk, A. Voinov, J. Todd, T. White, A. Hackman, B. Bowden, A. McIntosh, University of Vermont

Stormwater is rarely a direct concern of most suburban residents, but as stormwater regulations tighten, the cost and aesthetic impacts of improving existing stormwater infrastructure is raising the attention of otherwise uninterested homeowners. While regulators and officials negotiate methods to address suburban stormwater issues, a grassroots approach to developing stormwater management solutions has the opportunity to emerge. Shared learning, participatory design, sustainability assessment, and multi-criteria decision making offer opportunities to engage citizens to choose stormwater management options which are more ecologically, economically, and socially appropriate for their communities. It was hypothesized that a four part process of participatory education, design, evaluation, and decision-making would result in an outcome which is more appropriate from the combined city, citizen, regulatory, and environmentalist perspectives than would have been otherwise dictated top-down from a city stormwater utility. The appropriateness of a citizen-selected solution is compared to the default top-down approach most likely to be implemented in the absence of proactive citizen participation, using a mixed methods analysis approach. The two-part evaluation includes a comparison of the degree to which the two solutions find concordance between the values of the most critical stakeholders over criteria which indicate the solutions’ sustainability. Secondly, the equity of the process and the degree of helpfulness of the component parts of the decision making process is assessed through interviews with citizen stakeholders.

Honey, What's for Dinner? An Exploration of the Effects of Garden Plants on the Pollination and Reproductive Success of Native Wildflowers

Khrystina N. Smyth (a,b), Tiffany M. Knight (b), and Jonathan M. Chase (b)
(a) Saint Louis University, (b) Washington University

A better understanding of human influences on natural systems is vital to conservation endeavors in urban and suburban regions. Urban gardening with cultivated plant species is very common, and usually thought to be beneficial to native pollinators. However, these cultivated plants could either compete with or facilitate native plant species. In this study, we examined how pollination and reproductive success of a native plant species (Purple Coneflower, Echinacea purpurea) is affected by the presence of a cultivated showy, fragrant garden species (Butterfly Bush, Buddleia davidii). Three possible relationships are: facilitation, the garden plants attract pollinators and native plants benefit from overflow; competition, pollinators are limited and the garden plant is preferentially visited; or no effect. We manipulated two experimental factors, density of native plant (single vs. four) and presence of garden plant (present vs. absent) to give us four treatment combinations; we replicated each treatment 5 times for a total of 20 experimental plots. Pollinator visitations were recorded for twenty minute periods at least three times at each plot during the months of June, July, and August. Additionally, we recorded seed set of Echinacea purpurea to determine differences in reproduction between treatments. Our preliminary results suggest that both density of flowers and the presence of Buddleia davidii affect pollinator behavior. High density plots were visited by more pollinators overall and the presence of Buddleia davidii attracted more butterfly visitors to plots.
Housing Growth over Time: The Influence of Human Settlement on the Landscape

Roger B. Hammer1, Susan I. Stewart2, Christopher A. Lepczyk3, and Volker C. Radeloff2
1Department of Rural Sociology, University of Wisconsin-Madison; 2Department of Forest Ecology and Management, University of Wisconsin-Madison; 3USDA Forest Service, North Central Research Station, Evanston, IL

Human development, especially housing growth, is a major cause of land use change in the United States. While population growth in the U.S. is substantial, housing growth outpaces the rate of population growth due to declining family size and the increasing popularity of second homes among other factors. A team of ecologists and social scientists at the University of Wisconsin-Madison and the U.S. Forest Service North Central Research Station is currently studying the patterns of past housing growth, forecasting future growth trends and estimating the effects of sprawl on forested ecosystems. We developed methods to backcast housing density based on the 2000 Census of Housing for every decade since 1940 resulting in fine-resolution housing change maps for the conterminous U.S. Human settlement is dispersing, with housing growth occurring more slowly in urban areas and more rapidly in suburban and exurban areas, and even in select rural areas with rich amenity resources. Housing development in or near wildland vegetation is of particular concern for forest managers, and we have mapped the 2000 Wildland Urban Interface across the U.S. In-depth studies that are largely focused on the U.S. Midwest show that past sprawl had substantial effects on forest productivity, road development, avian species diversity, and forest fragmentation.

Biogeochemistry of a Suburban Basin


Urbanization and intensive agriculture have been shown to have negative impacts on water quality, but the impacts of suburbanization are less well known. In New England, the pressure of suburbanization is large and land use patterns are often rapidly changing with interspersed agriculture, active forest management and human habitation. To address the effects of suburbanization on water quality, we established a long-term study of the Lamprey River basin (479 km2) in SE New Hampshire in 1999. We are examining the influence of ecosystem properties, land use patterns, human population density, and property values on water quality by examining differences in water quality among sub-basins. We are also addressing long-term changes in water quality associated with changes in these watershed attributes over time in the entire Lamprey River basin. Results to date show a strong influence of population density on nitrate in stream water, but no effect on phosphate or dissolved organic matter. Property values also affect nitrate levels, with higher property value per ha associated with higher nitrate concentration and flux. Projects under way include measuring total nitrogen inputs and outputs to the basin, in-stream changes in nitrogen along the main stem, changes in nitrogen in the riparian zone of small tributaries and examination of linkages between the quality of groundwater, surface water and landscape characteristics. Initial results show that there is a large amount of nitrogen retention in the Lamprey River basin and that increased groundwater nitrate concentrations are associated with increased population density.
Effects of Landscape Context and Recreational Use on Carnivores in Regional Protected Areas

Sarah E. Reed, Department of Environmental Science, Policy & Management, University of California - Berkeley

Protected areas in urban landscapes – including state and regional parks, wildlife refuges, and open space preserves – are amenities for people as well as the biological resources they are designed to protect. Surveys of residential location choice and housing prices indicate that people value proximity and easy access to protected areas. However, public affinity for protected areas may limit their effectiveness for conservation. Recreational use and the configuration of land uses surrounding a protected area – its landscape context – may have negative impacts on wildlife populations. My research uses the distribution and relative density of mammalian carnivores as indicators of the impacts of human disturbances on the conservation effectiveness of protected areas in developing landscapes. In pilot season surveys, I found significant effects of landscape context and recreational use on native carnivore densities in protected areas in Northern California. Native carnivore densities were significantly higher in protected areas adjacent to exurban residential and agricultural land uses than in protected areas adjacent to suburban residential land uses. In addition, native carnivore densities were significantly lower in protected areas that permit recreation than those that do not, and preliminary recreational user surveys indicate a negative relationship between the intensity of recreational use and native carnivore density. The results of this research will be integrated in predictive models of the impacts of human disturbances to aid in conservation planning and management of regional protected areas.

An Analysis of Social and Economic Aspects of Suburban Subdivision Development

Troy Bowman, Jan Thompson, Joe Colletti and Lois Morton, Iowa State University

As urban populations expand, suburban development places increased pressure on environmentally sensitive areas. Consequently, planners and other groups are exploring ways to protect vulnerable areas while maintaining housing densities. Conservation subdivision design and low impact design are approaches commonly discussed, but only recently has there been research on its social and economics effects. This study examined the social and economic aspects of low impact development. Residents of three conservation subdivisions and three traditional subdivisions along the urban/rural interface in Cedar Rapids, Iowa were surveyed to assess sense of community, quality of life, organizational participation, attitudes on and willingness-to-pay for open space features. Results suggest that residents in conservation subdivisions have a stronger sense of community, express greater satisfaction with their quality of life, and have a higher stated willingness-to-pay for open space features. Overall, residents exhibited a desire for more open spaces. In addition, face-to-face interviews and a mail survey of subdivision developers across Iowa were conducted to examine attitudes toward low impact design, current practices, and willingness-to-accept costs of low impact development. Results suggest that developers have a strong aversion to risk, and are constrained by both a perceived lack of interest from the public and the inflexibility of urban planners. However, developers exhibited willingness-to-accept some costs of low impact development. Overall, findings imply that low impact design has social and economic benefits to residents and developers, but adoption is hindered by differing perceptions of residents, developers, and urban planners.
**Urbanization and Infectious Disease Risk in Wild Songbirds**

Catherine A. Bradley and Sonia M. Altizer, Emory University

Urbanization and land use development are major causes of species endangerment, driven in part by habitat fragmentation and loss, the impacts of non-native species, and pollutants, including toxins and other waste that act as wildlife stressors. Mechanisms associated with host susceptibility and immune function, disease transmission dynamics, and impacts of pathogens on host fitness are likely to be affected by human activities and environmental changes associated with urban development. For example, wild animals in urban areas may be more susceptible to parasitic diseases as a result of stress from crowding, pollution or habitat degradation. Several studies examining the impact of urban development on biodiversity have found that species richness and diversity indices are negatively correlated with housing density, road density, and exotic vegetation (Green and Baker, 2002; Haire et al. 2000). Although these studies provide important information concerning the effect of urbanization on biodiversity, they do not compare the condition, reproduction, and survival of individuals inhabiting urban areas to that of those inhabiting less developed habitats, nor do they examine susceptibility to and transmission of parasitic diseases. Focusing on wild songbirds, my work uses observational, experimental, and modeling approaches to examine how environmental changes linked with urbanization influence host-pathogen interactions. Here we discuss applicable theories of wildlife disease ecology, data from the 2004 field season and future study plans.

**Support for and Opposition to Stricter Environmental Regulations**

Rooney Elizabeth Patterson, Department of Political Science, Auburn University

This poster will examine the constituencies that support and oppose environmental regulations using data from the 2000 National Election Survey or NES conducted by the University of Michigan, which is one of the two principal sources of national data on U.S. public opinion. Preliminary analysis illustrates that there is very little correlation between attitudes on environmental regulations and either social class or traditional values. In contrast, views about the national economy, support for government activism, urban-rural residence, gender, and race all exert a significant impact on whether Americans support or oppose environmental regulations.
Wetlands from the Literary, Biological, Mathematic and Economic Perspectives

P.R. Fernandes, M.E. Bellanca, M.R. Bacon, C.A. West, and J.F. Logue, University of South Carolina - Sumter

At USC Sumter we are developing two linked courses studying “Wetlands from the Literary, Biological, Mathematic and Economic Perspectives”. The objectives are: 1) Develop a learning community composed of ENGL 102 where the students will study literature pertaining to natural history and wetlands, and ENVR 101 with a special focus on southeastern wetlands issues. 2) Help students develop interconnections among academic disciplines pertaining to the environment and involving civic engagement. Literature of southeastern wetlands will be offered as a special section of English 102, which deals with Composition and Literature. By reading selected short fiction, poetry, and nonfiction relating to nature and the environment, students will articulate, analyze, and compare the diversity of human interactions with, and attitudes toward, southeastern wetlands. ENVR 101 will emphasize physical parameters used to delineate wetlands and use the biological and ecological structure and function of wetlands as a bridge to connect broader ecological issues of regional, national and global importance. Case studies will be used that involve or have connection to communities around the university as a point of departure for discussion of broader environmental issues. The mathematics component will introduce students to mathematics in the context of the civil and environmental components of the course. Quantitative reasoning skills of mathematics will be introduced as a practical means of perceiving and solving problems. By the end of the semester we hope that students will better understand the interdependence between society and the environment, and how economic decisions made by humans can impact the environment.

A Study to Evaluate Impact of Urbanization on Local Air Quality: Differences Seen in Large Urban, Small Urban and Rural Ozone

Kari L. Maxwell-Meier and Michael E. Chang, School of Earth & Atmospheric Sciences, Georgia Institute of Technology

This study provides evidence of possible chemical and physical differences in properties that contribute to ozone for large urban, small urban and rural areas. Measurements from 58 sites in and around Georgia are used. The time series are separated using a Komorogov-Zurbenko (KZ) Filter to isolate intra-day, diurnal, synoptic, seasonal and long term trends within the series. The isolated trends are then used to compare the relative importance of each component to the overall variability in ozone for selected sites. A correlation analysis is also conducted on the synoptic scale, since sites affected by the same weather patterns will be connected spatially on this scale. The correlation with distance is used to define spheres of influence for the selected sites. Further analysis of these sites focuses on the relative differences in the photochemical precursors and products of the distinct airsheds. The differences exhibited over these communities should be considered in policy discussions of the effectiveness of current air quality control of small urbanized areas.
Regional Vulnerability Analysis of Air Toxics Impacts on Ecological Resources and Human Health in EPA Region 4

Latoya Miller, United States Environmental Protection Agency

Available air, water, and soil data, as well as other land use, ecological, and demographic data will be assimilated to present a multi-media characterization of potential ecosystems and human health vulnerabilities to toxic air pollutants (primarily Clean Air Act hazardous air pollutants or CAA HAPs) in EPA Region 4. The primary tool for this analysis is the Regional Vulnerability Analysis (ReVA) methodology. Specifically, this project will evaluate ecological and human health endpoints to predict potential vulnerabilities to HAPs and other non-criteria pollutant air toxics, through both direct (i.e., chemical deposition with subsequent contact) and indirect (i.e., inhalation) exposure pathways. Chemicals to be evaluated include airborne releases of CAA HAPs and Toxics Release Inventory (TRI) chemicals. The analysis will consider the potential impact of airborne releases of chemicals that persist for relatively long periods of time in the environment, which are removed from the air (commonly by deposition), and may also bioaccumulate/biomagnify. These chemicals are a combination of PB-HAPs (persistent, bioaccumulative and hazardous air pollutants) and other PBT chemicals reported to the TRI. Ambient air concentration modeling as used in the 1999 National-scale Air Toxics Assessment and the Risk Screening Environmental Indicators Model will be used to indicate atmospheric dispersion. The ReVA tool will assist in evaluating the extensiveness of co-location of sensitive ecological resources and human populations to these chemical stressors. The results will provide a coarse-scale filter that highlights locations where more in-depth analysis of air toxics impacts would be most useful to protect human health and ecological resources.

Species Composition and Quality of Forests in Preserved, Managed, and Developed Areas Near Cedar Rapids, Iowa

Michaeleen E. Gerken, Jan R. Thompson, and Cathy M. Mabry, Iowa State University

Growth and expansion of urban areas place pressures on remnant natural areas. To add to our understanding of the effects of development on forest fragments, we examined these ecosystems in settings subject to different levels of human disturbance. We assessed species richness, diversity of functional groups according to life history pattern, percent native species, mean coefficient of conservatism, and floristic quality along a rural-urban gradient of preserved, managed, and developed forests near Cedar Rapids, Iowa. Species present in 20m x 20m plots along this gradient were catalogued throughout the growing season in April, June, and August. Differences between plots located in preserved, managed, and developed forests were less significant than differences between plots located in upland, sideslope, and bottomland landscape positions. This study will provide baseline data for future efforts to monitor changes in floristic composition in a rapidly urbanizing area. Typical species composition lists and values for richness and floristic quality measures will allow for comparison of other fragments and aid in assessment of natural area quality in an urban setting.
One of the most prominent issues in the Wildland Urban Interface today is fire. Fire in the wildland-urban interface is of unique concern because of special issues that differentiate it from other wildland fires - particularly in the Southeast. The South’s wildland areas are distinct from wildlands in other regions of the United States. Private landowners control most of the forested land in the South; vegetation growth- and associated fuel accumulation- is particularly high in the South because of higher rates of rainfall and longer growing seasons; and fire return intervals tend to be shorter in the South. Because of these and other unique qualities, the Southern WUI is particularly threatened by unwanted fire- 95% of fires in the Southeast potentially involve the Wildland Urban Interface (WUI). This condition creates a critical need to mitigate fire hazards and reduce risks in the WUI zone. To address these issues, land managers, land owners, policy makers, and the public increasingly need improved access to fire research that is thoroughly organized, condensed, and presented in a form that is useful for problem solving. While a growing body of information is available on fire and fuels management in the interface, this information is not always in a form that is easy to locate and easy to use. The Encyclopedia of Southern Fire Science (ESFS; [http://fire.forestencyclopedia.net](http://fire.forestencyclopedia.net)) addresses this problem by organizing and synthesizing this large body of fire science and translating it into an Internet-based encyclopedia system. ESFS is a cooperative effort between the USDA Forest Service, the Southern Regional Forestry Extension Office, and more than 10 research institutions and land management agencies across the South. In addition to addressing fire in the WUI, the ESFS compiles original syntheses of a broad range of topics including: fuels management and fire behavior; fire effects on air, water, soil, plants, and animals; ecology and management of fire-influenced communities; economic and health impacts.

### The Effect of Impervious Surface Area and Forested Riparian Buffer Width on Stream Salamanders in Wake County, NC.

Jennifer Miller, North Carolina State University

The United States is becoming increasingly urbanized, resulting in an increase in impervious surface area. Increased impervious surface area has been demonstrated to significantly alter stream hydrology and stream habitats. To help mitigate the impacts of impervious surface, forested riparian buffers are commonly used. Salamanders are a major component of stream habitats and sensitive to environmental changes. This study investigates how stream salamander abundance changes with impervious surface area and forested buffer width. Forty-four streams from across Wake County, North Carolina were selected to represent a range of impervious surface areas and forested buffer widths. The streams were sampled in April, May, and November of 2004. Results are expected in the spring of 2005.
**Agrarian Landscapes in Transition: a Timeline of the Salt River Valley of Central Arizona Utilizing a Socioecological Systems Approach**

Steven Kent Metzger, School of Life Sciences, Arizona State University

The purpose of this research is to explore a socioecological systems approach to the analysis of historical agrarian landscape transition in the Salt River Valley of Central Arizona. The socioecological systems approach is a robust framework for linking human dimensions and ecological aspects within a system of study. Interactions between the human and ecological components include land use, land cover, production, consumption and disposal. This system of study focuses on the highly productive irrigated Salt River Valley area of Central Arizona, and the rural/urban interfaces of the metropolitan Phoenix area. A timeline presents important events and transitional processes. The farmer’s perspective is utilized to identify and analyze these events and processes, and to define major time periods, or eras. This study is a first step in analyzing, from the farmer’s perspective, the complexities of agrarian landscape transition at rural/urban interfaces in this system of study. Further research will delve into greater details within each era. It is hoped that this narrative study will inform future planning efforts, and encourage productive dialogue between stakeholders.

**Rural-Urban Food Flows: Key Issues and Themes for sub-Saharan Africa**

Kenneth Lynch, School of Earth Sciences & Geography, Kingston University, UK

The study of food flows between urban and rural areas involves a range of broader social and economic as well as geographical processes. Cities are usually areas of considerable food deficit and can serve to focus food distribution in the same way as it serves as an economic and political focus. Food chains can act as a conduit through which relations between urban and rural areas are articulated. This poster illustrates some of the key issues in rural-urban food flows in developing countries, based on research in Tanzania and Nigeria, and proposes food has been neglected as a key element in considering urban planning and management and research on rural-urban linkages relative to other flows.
The Center for Forest Sustainability’s WEST GEORGIA PROJECT:
Uncertainty in Estimation of Impervious Surface Based on Multi-Scale Remote Sensing Data: Scale Effect

Shufen Pan, Hanqin Tian, Siqing Chen and Guangsheng Chen, Center for Forest Sustainability, School of Forestry and Wildlife Sciences, Auburn University

Multi-scale remote sensing data have been used for estimating impervious surface, a key index for urbanization and associated environmental problems. To determine the explicit amount and spatial distribution of impervious surface cover on the landscape is a key step for the study of urbanization and its effect on such cross-cutting ecosystem services as water quality. This study is to evaluate uncertainty involved in scale-related estimation of impervious surface by using four types of remotely sensed data, which cover a spectrum of spatial resolution including aerial photo (1m), IKONOS (4m), SPOT (10m) and Landsat TM (30m). We have chosen three watersheds along an urban-rural interface in West Georgia, where urbanization in the past decades has been a major concern. Our preliminary analyses indicate that the areas of impervious surfaces as estimated by remotely sensed data varied from fine to coarse resolution for all three kinds of watersheds. To accurately estimate impervious surface and its effects on ecosystem services, we need to explore ways to scale up observations at a fine resolution to a large area.

Development of a GIS-based Integrated Information System (GIIS) for Interdisciplinary Research at Urban-rural Interface

Shufen Pan and Hanqin Tian, Center for Forest Sustainability, School of Forestry and Wildlife Sciences, Auburn University

To support integrated system modeling research and meet both ongoing research objectives as well as future needs in the Center for Forest Sustainability, we are developing a GIS-based Integrated Information System (GIIS), a core infrastructure for our interdisciplinary research. The GIIS allows project participants to access, navigate and manipulate information typically used in integrated projects to support the decision-making process during various project phases in an integrated environment. The GIIS serves as a spatial modeling and analysis framework for broad applications and provide a spatial environment for linking models of ecosystem, hydrological and economic/policy processes, and for storing data from field measurements in both aquatic and terrestrial environments as well as remotely sensed data. In essence, The GIIS serves as a data gathering and clearing house for the project. The GIIS being developed in three stages: 1) Incorporation and assessment all spatial data bases included within components of the Integration Model (water quality, biodiversity, carbon sequestration, land use change, socio-economic factors); 2) Establishment of an infrastructure that coalesces these databases under a single coherent GIS; and 3) Creation of a modeling framework and systems approach used in developing a decision-support system. To make databases accessible to all beneficiaries, we also plan to develop a web-based GIS that will allow investigators to access data sets through the internet. This will also improve the efficiency of the linkage between GIS and sub-models including implementing various database management strategies and interfaces within a GIS environment.
Redbreast Sunfishes and Rip-Rap: Does Stream Fish Diet Change in Response to Increased Watershed Urbanization?

Nathan W. Tubbs, Brian S. Helms, and Jack W. Feminella, Department of Biological Sciences, Auburn University

We investigated the relationship between watershed urbanization and fish feeding ecology, by examining fish diets from streams along an urbanization gradient in western Georgia, USA. Fishes were collected from multiple piedmont streams draining watersheds (500-2500 ha) of strongly contrasting urbanization. Although fish diversity and richness decreased with urbanization, redbreast sunfish (Lepomis auritis) was common in all study streams irrespective of watershed land use or differences in overall diversity. The ubiquitous nature of this fish in study streams made it a good species for quantifying the degree of dietary shifts, if any, along a gradient. We removed sunfish stomachs and identified macroinvertebrate items to the lowest possible taxonomic level. Preliminary data indicated that sunfish have a broader breadth of diet (more prey species) in streams from forested watersheds than fish from urbanized watersheds, which largely reflected higher macroinvertebrate prey abundance in forested vs. urbanized streams. In addition, the proportion of sunfish diet as terrestrial invertebrates was higher in urbanized than forested streams. These data suggest that redbreast sunfish relies more heavily on allochthonous (outside) inputs in urbanized streams as available autochthonous (instream) resources decrease. The ability of redbreast sunfish to effectively exploit aquatic and terrestrial resources explains, at least in part, this species’ widespread distribution in streams of strongly contrasting water quality conditions.

Effects of Forest Regrowth and Urbanization on Ecosystem Carbon Storage in a Rural-Urban Gradient in the Southeast US

Chi Zhang1 Hanqin Tian1 Shufen Pan1 Graeme Lockaby1 Erik B. Schilling1 & John Stanturf2
1School of Forestry and Wildlife Sciences, Auburn University, 2USDA Forest Service, Southern Research Station, Athens, GA

While we have a qualitative sense that forest recovery after cropland abandonment and rapid urbanization in recent decades are two counteracting processes that have affected the capability of carbon sequestration by terrestrial ecosystem in the Southeast US, our challenge now is to quantify exactly how these processes have contributed to the carbon balance of the terrestrial ecosystems in this region. Along an urban-rural gradient in Georgia, we have analyzed changes in the types and spatial patterns of land use/cover and their effects on ecosystem carbon storage in this study. Based on Landsat imagery data over four years (1974, 1992, 1998 and 2002) and agricultural census records, we have developed an annual grid data set of land use change in three counties (Muscogee, Harris and Meriwether) from 1974 to 2002. This data set has been used as the input of the Terrestrial Ecosystem Model to simulate land use effects on carbon fluxes and storage in the study region. Our results indicate that, from 1974 to 2002, urban area has increased more than 160%. About 80% of new urban areas were converted from forests. Forest areas remained unchanged in the past 28 years, but forests in 2002 seem to be much younger than forests three decades ago due to large scale land-use change. Our simulations suggest that ecosystem carbon storage decreased 11.5% due to land-use change since 1974. Although forest regrowth after cropland abandonment has led to a carbon uptake, urbanization has caused a carbon loss and dominated this region. A large loss of carbon from terrestrial ecosystems has occurred since the early 1990s as a result of rapid urbanization. The spatial pattern of carbon release induced by deforestation in both the 1980s and 1990s matched the urbanization gradient, with the lowest carbon release in Meriwether County, and the highest carbon release in Muscogee County. The most intensive carbon loss was located at the periphery of the largest urban areas. Balancing urban development and forest protection is of critical importance to maintaining sustainable ecosystem carbon storage.
Sediment and Hydrologic Relationships Along an Urban-Rural Gradient in the Lower Piedmont

Jon E. Schoonover, B. Graeme Lockaby, and Brian S. Helms, Center for Forest Sustainability, Auburn University

The Southeast United States is experiencing rapid urban development. Consequently, Georgia’s streams are experiencing morphological and hydrologic alterations from extensive development and from other land uses such as livestock grazing and silviculture. A multiyear study was developed to assess sediment movement and hydrology within 18 watersheds ranging in size from 500-2500 ha. Stream hydrology was monitored using InSitu pressure transducers, while biweekly grab samples and stacked-pole samplers were used to determine in-stream total suspended solid (TSS) and total dissolved solid (TDS) concentrations during baseflow and stormflow. Also, multiple headwater cross-sections and sediment grids were measured routinely and following storm events to assess streambed stability within the watersheds. Preliminary results have shown higher TSS loads in non-urban watersheds during baseflow conditions, while TDS concentrations and loads were consistently higher in urban watersheds during baseflow and stormflow. TSS loads increased significantly during stormflow within watersheds having greater than 10% impervious surface cover and watersheds that have experienced extensive silvicultural activity. Additionally, urban watersheds portrayed flashy hydrology and were experiencing active downcutting in headwater reaches. Within these watersheds, grid analyses suggested that sediments were accumulating near the watershed outlets. In summary, this assessment will clarify the influence of land development on channel morphology and hydrology across a mixed land use gradient.

Urbanization Effects on Forest Health in the Vicinity of Columbus, Georgia

Diane M. Styers and Arthur H. Chappelka, School of Forestry and Wildlife Sciences, Auburn University

Rapid population growth in the southern US has recently initiated one of the largest urbanization movements in recent history, resulting in an immense reduction of forested land. Conversion of natural lands in rural areas to impervious urban surfaces has the most direct adverse effect on the composition, structure, and function of forests in the South. Vegetation in developing and rural areas is exposed to many sources of air pollutants (i.e., SO2, O3, NOX, heavy metals) as a consequence of increased human presence, and thus may be subject to higher rates of injury. The purpose of this study is to determine effects of land use change (urbanization) on forest condition, particularly those effects related to increased air pollutant exposure. Indicators of forest health, including crown condition, presence or absence of lichens, ozone-induced foliar injury on sensitive plants, levels of trace metals in tree rings and soils, and insect or disease problems, will be measured and quantified along a rural to urban gradient near Columbus, Georgia. Historical and field data will be combined and incorporated into a regression model to predict future changes along this gradient. Upon completion of this research, these data will be used for computer-simulation model calibrations to predict the effects of various problems associated with air pollutants relative to changes in land use patterns. In addition, these permanent plots can be re-sampled in the future to provide data pertaining to shifts in the urban-rural interface and subsequent changes in forest condition as a result of human disturbance.
Alterations of Floodplain Ecosystem Processes as a Result of Chinese Privet (Ligustrum sinense Lour.) Invasion Across an Urban Gradient

Eve F. Brantley, Jennifer D. Mitchell, and B. Graeme Lockaby, School of Forestry and Wildlife Sciences, Auburn University

Chinese privet (Ligustrum sinense Lour.) is an aggressive, nonnative shrub predominantly found in areas where natural or man-made disturbance to ecosystems has occurred. Shifting land uses have contributed to its invasion of sensitive ecological areas such as riparian floodplains. However, research has not previously been conducted to evaluate its impact on ecosystem processes. This research will focus on privet impacts to above- and belowground productivity, leaf litter decomposition, regeneration, and nutrient dynamics. Study sites are located in the southern Piedmont near Columbus, GA. The sites encompass an urban land use gradient that includes forest, pasture, developing, and urban lands. Preliminary research has revealed significant differences in land use and nutrient P foliar concentrations for privet and sweetgum (Liquidambar styraciflua). Additionally, variations in N:P ratios of sweetgum and privet foliar nutrient composition suggest a P deficiency occurs for privet on these sites or that nutrient requirements are different for privet than other species. Differences in nutrient dynamics of privet may enable it to better compete and survive in wide ranging environmental settings. We intend to clarify relationships related to changing land use patterns, presence of Chinese privet and resulting alterations in riparian biogeochemical cycling.

Evaluating Hydrology and Stream Biotic Integrity Across a Gradient of Urbanization

Brian Helms1, Jon Schoonover2, and Jack Feminella1
1Department of Biological Sciences, Auburn University, 2School of Forestry and Wildlife Sciences, Auburn University

In 2002, we began a multiyear study designed to determine the effects of changing land use on stream biotic integrity. Of particular interest was the influence of altered hydrologic regimes associated with urbanization on fish and benthic macroinvertebrate communities. We studied 18 watersheds (500-2500 ha, Lower Piedmont ecoregion) along an urbanization gradient north of Columbus, Georgia, USA. We monitored stream hydrology continuously (every 15 min) with the aid of pressure-transducers, and quantified biota and their habitat seasonally in a representative 100-m reach in each watershed. We assessed stream hydrological patterns by calculating 54 different discharge variables, each categorized as a Magnitude, Duration, Frequency, or Predictability measure. Preliminary results suggest that macroinvertebrate diversity, fish species richness, and the number of lithophilic spawners (sensitive fish guild) decreased with increasing frequency of spate flows. The proportion of the fish assemblage as centrarchid species and overall number of fish caught, however, increased with the frequency of spate flows, indicating that hydrologically altered streams were inhabited by high abundances of tolerant species, especially Lepomis macrochirus and L. auritus. Overall, our data suggest a functional connection between land use change, altered stream hydrology and geomorphology, and concomitant shifts on biotic assemblages.