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# Growth through greening: developing and assessing alternative economic development programmes

J.D. Gatrell \*, R.R. Jensen

*Department of Geography, Geology and Anthropology, Indiana State University, Terre Haute, IN 47809, USA*

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## Abstract

The paper articulates how communities can capitalize on the specific benefits of urban forestry and assesses the outcomes of urban forestry efforts. To accomplish this, the paper defines the context of local economic development and urban forestry; outlines the economic, aesthetic, and ecological benefits of a smart-growth agenda that includes urban forestry; and presents two brief case studies that empirically assess the viability of urban forestry policy by measuring the dynamics of the urban canopy. The research methodology presented here can be used by policy-makers to assess policy outcomes and the overall success of smarter and greener economic development strategies.

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Planners, applied geographers and economic development practitioners all seek to create liveable spaces that enrich the daily lives of residents. For this reason, this paper examines one collection of local amenities – *forest amenities* – that contribute to a locality's overall quality of life. This paper is a comparative study of urban forestry efforts in two Florida cities, Gainesville and Ocala, and reviews the policies of each community and assesses their urban canopy dynamics. In one case, a community has closely linked growth to a comprehensive urban forestry initiative. In

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\* Corresponding author. Tel: +1-812-237-2256; fax: +1-812-237-8029.

*E-mail address:* gejdg@scifac.indstate.edu (J.D. Gatrell).

the other, there are less stringent tree protection, planting and design policies, which exempt key land-use types and are not linked to new growth *per se*. In the first case, urban forestry positively reinforces the community's smart-growth strategy. In the second, urban forestry has not been coupled with economic development.

### Local economic development

Localities develop and implement economic development plans to preserve and improve the material conditions of everyday life (Cox, 1995). This is accomplished through the maintenance and expansion of local infrastructures, such as roads, schools and environmental features. The global competition for inherently limited resources has resulted in uneven development and, to lure new development, localities have crafted an almost infinite array of local economic development strategies. In the process, the competition for investment has also contributed to the design and implementation of a variety of land-use policies.

Because strategies for economic development and land-use planning vary from jurisdiction to jurisdiction, a confusing patchwork of urban growth strategies and land uses characterizes American cities. In general terms, American growth strategies exist within a continuum that ranges from the much-derided conditions of uncontrolled growth and urban sprawl to the adoption of new smart-growth plans (Weitz, 1999). While smart growth is linked to the lofty ideals of a new urbanism and neo-traditional town planning (see Brown & Bonifay, 2001), it has emerged as a pragmatic alternative to the polarizing land-use policies that have created two basic and opposing constituencies – pro-growth and no-growth. Mindful of the conflict between these groups, smart-growth advocates co-opt existing no-growth and pro-growth constituencies by creating a new centrist, or pragmatic, smart-growth programme that balances the sometimes competing interests of the environment, the economy, and quality of life. Ostensibly, smart growth achieves this goal by emphasizing the overall liveability of the locality and the importance of sense of place (English, 1999). In theory, proponents of alternative economic development approaches believe 'more liveable' spaces thrive and are able to minimize the inherent realities of uneven capital investment across space and over time. In the process, smart growth mitigates the negative externalities of uncontrolled growth by placing controls on it. Because of new controls, the overall quality of economic development improves, the quality-of-life indicators rise, and the whole local system is inherently more sustainable (Calavita & Caves, 1994; English, 1999; Weitz, 1999).

In this study, we focus on urban forestry efforts because the debate over sprawl and smart growth often includes language lamenting the loss of green space, or worse, the 'paving of America'. Moreover, urban forestry and green space efforts have emerged as a pragmatic policy initiative that enables pro-growth, no-growth and smart-growth advocates to collaborate and improve the overall quality of life (e.g. *New York Times*, 2001). By narrowly focusing on urban forestry, the paper presents a competitive and 'greener' economic development agenda that is consistent with contemporary politics and enables single communities to successfully compete for inward capital investment.

## Urban forestry as smart growth

Today, new local environmental movements have emerged to address key economic development issues. Under the banners of ‘no growth’, ‘slow growth’ and ‘farmland preservation’, grassroots initiatives are aggressively being institutionalized around the USA through a variety of political, bureaucratic or electoral mechanisms that are intended to control the scale and scope of urban growth (Freilich, 1999; Ross, 2001; Weitz, 1999). While these ideas are sometimes radical, the widening acceptance of a common environmental ethos has yielded pragmatic results. For example, ‘American-style’ economic development is no longer exclusively expansionist. Indeed, environmental themes and language are increasingly used to describe new ‘smart’ projects that align economic, environmental and quality-of-life interests. One of the more prominent components of the smart-growth movement has been urban forestry and related environmental concerns, such as green space.

## Urban forestry

Urban forestry – the sustained planning, planting and protection of trees, residential tree lines and forests in urban areas (Blouin & Comeau, 1993) – has a long tradition in the civic life of small towns, cities and suburbs across America. Indeed, community organizations have undertaken tree planting and other ecologically minded projects for decades. Yet these local efforts are not necessarily examples of urban forestry *per se*. In most cases, community organizations – like the Green Space Coalition of Morgantown, West Virginia or LA’s Tree People (2000) – focus narrowly on preserving wooded lots, revitalizing forgotten parks and reclaiming brown-fields. In contrast, urban forestry refers to a comprehensive arboricultural regime that includes encouraged, discouraged and mandated activities associated with trees and other components of the urban canopy.

Despite a long grassroots history, the urban forestry movement is less than 30 years old. In fact, the dynamics of urban forestry efforts began to change only in the 1970s when local, state and federal governments became major funding sources and active partners in local programmes.<sup>1</sup> As monies grew, so did the scale of urban forestry. While grassroots groups are still key constituencies within localities and often provide necessary volunteer labour, urban forestry requires the ‘sustained planning, planting, protection, maintenance, and care of trees, greenspace, and related resources in and around cities and communities for economic, environmental, social, and public health benefits’ (Blouin & Comeau, 1993) that only a full-time staff, government agencies and sustained funding can provide (Environmental Protection Agency, 1992).

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<sup>1</sup> While tree planting efforts can be dated back to the 1970s and the Society of Municipal Arborists was formed in 1964, the comprehensive characteristics of urban forestry (ecology, economics and aesthetics) date only from the early 1990s.

Given the vast spatial, temporal and economic commitment required, the urban forestry movement has silently persuaded cities to implement invisibly components of the urban forestry regime using a variety of public, private and public–private partnerships over the past few decades. Fortunately, funding is now more readily available than before. Today, grants-in-aid programmes for urban forestry are administered by most states and the federal government. The greater availability of funds enables local governments, public–private partnerships and other networks of community organizations to design and implement local urban forestry plans. However, there are many obstacles to their successful implementation. Besides a lack of financial resources, these programmes must overcome the inherent mistrust between the various constituencies associated with urban forestry that are unable to appreciate fully the motivation of participating actors. Similarly, inter- and intra-governmental turf issues often threaten the successful implementation of comprehensive projects (Environmental Protection Agency, 1992). Consequently, urban forestry professionals must cultivate new constituencies through educational outreach programmes at local arboretums and similar facilities while maintaining fragile political (and economic) coalitions in an era where environmental advocacy is often considered as no-growth and organization structures vary from city to city (Summit & Sommers, 1998).

While the political and economic costs of urban forestry are an inherent barrier, proponents of smarter and greener economic development can overcome the resistance by clearly articulating the combined symbolic and material benefits to the entire community (pro-growth and no-growth constituencies alike). In particular, the benefits of urban forestry can be examined along three axes: economic, ecological and aesthetic.

### *Economic benefits*

Trees and forested areas contribute to appreciably lower utility costs and increased property value (Anderson & Cordell, 1985; Jensen, 2000). In terms of the overall economic benefits of comprehensive programmes, the Sacramento Municipal Utility District's shade tree programme was the first major programme to produce reductions in energy consumption and lowered utility costs (McPherson, Scott, & Simpson, 1998). The immediate economic benefits of urban forestry are reduced energy consumption associated with an overall reduction in the 'heat island' effect (Larson & Carnahan, 1997; Quattorchi & Luvall, 1999). The energy savings associated with urban forestry are important for several reasons. First, the benefits of a reduced heat-island effect positively impact all residents. Benefits are gained through the altered albedo of the urban environment, increased transpiration, reduced latent heat, and general space condition benefits associated with shade trees (Simpson, 1998; Simpson & McPherson, 1998). While the benefits of shade and decreased air temperature are most easily accrued in air-conditioning-intensive regions, like the Sunbelt, energy savings can also be attributed to urban forestry in more moderate and temperate climates through reduced air speeds throughout the year. In these regions, the economic savings are gained through reduced 'heating load' (USDA Forest Service,

2001). Finally, energy savings can also be applied to the supply side of the equation as energy generation costs are reduced.

In addition to utility savings, the other major economic benefit associated with urban forests is increased property values. For example, a recent Finnish study (Tyrvainen & Miettinen, 2000) demonstrates that property values are higher in areas with access to urban forest amenities, which increase the value of homes by roughly 4.5–5%; this reinforces the earlier findings of Anderson and Cordell (1985). Consequently, the direct (energy savings and property value) economic benefits are real and available to all residents.

In addition to reduced energy costs, energy supply benefits and property values, urban forestry initiatives may have other long-term economic (if somewhat indirect) benefits. These include reduced costs in several areas: road maintenance, health care, flood control, water treatment and a community's overall water consumption. While not immediate, these cost savings are significant. In a similar fashion, the negative externalities of non-green land uses, such as air pollution, heat load and energy consumption, and their economic costs, should be considered.

### *Ecological benefits*

Urban forestry efforts have had a number of ecological benefits:

- reducing airborne and water-soluble pollutants through both leaf and root surfaces;
- achieving significant 'water savings' because well-placed native trees consume less water than many grasses and other vegetation cover;
- reducing dependence on fossil fuels for heating and cooling by providing shade, transpiration and wind shielding;
- fixing carbon dioxide from the atmosphere through photosynthesis, and
- providing a net gain in habitat for urban wildlife, thus increasing urban biodiversity and reducing habitat fragmentation (Kato, Yokohari, & Brown, 1997; McPherson, Scott & Simpson, 1998).

In concert, the ecological benefits of urban forestry are both economic and non-economic. Likewise, the ecological benefits have potentially positive outcomes for individuals and for the whole community.

### *Aesthetic benefits: improving the liveability of cities*

The popularity of various 'Places-Rated' reports and town rankings demonstrate that quality of life 'matters' – so much so that non-economic factors are often important considerations when shaping and forming new land-use policies in urban areas. For this reason, some communities are explicitly developing growth projects that link a range of quality-of-life factors (such as parks, air quality, water quality, greenway and other issues) together to promote inward investment. Because urban forestry efforts are an integral component of many quality-of-life indicators, it has the potential to become an effective mechanism to promote (and sustain) growth.

Forests can improve quality of life in two ways. First, they provide residents and visitors with additional recreation and wildlife protection areas. Secondly, trees and green space provide significant advantages in terms of psychological and physical well-being. In general, open, green and forested spaces decrease stress, enable residents to cope with daily life, and in very real terms make cities more liveable (Flores, Pickett, Zipperer, Pouyat, & Pirani, 1998; Ridd & Liu, 1998; Tyrvaainen & Vaananen, 1998). Similarly, green environments have been credited with mediating the everyday stress associated with poverty, blight and 'urban stress' (Kuo, 2001). Likewise, the inherent air-quality benefits improve the overall quality of life for individuals and the community.

While the concept of aesthetic value of urban forests may be 'fuzzy', the popular and academic literature demonstrates that quality-of-life indicators and local amenities are of great significance to *would-be* investors. In fact, the liveability of cities (as measured by amenities packages and other quality-of-life indicators) is often cited as a key determinant of contemporary industrial location (Daniels, 1985; O'Farrell, Moffat, & Hitchens, 1993; Glasmeier & Howland, 1994; Gatrell, 1999). In this context, the qualitative nature of urban forest amenities and 'psychic capital' of green space should not be discounted simply because the fuzzy nature of environmental issues cannot be directly correlated to economic outcomes. This is true of many economic development strategies.

While the economic, aesthetic and ecological benefits of greening urban environments have been well established by planners and landscape ecologists (Environmental Protection Agency, 1992; Kato, Yokohari & Brown, 1997), the dynamics of uneven development have not enabled economic development specialists (*as a class of professionals distinct from planners*) to leverage the region-wide benefits of green economic development. That is, the environmental values that have informed the planning process cannot necessarily address the wider concerns of uneven development and its associated politics. Because of this, environmental concerns have long been considered a threat to growth. This is especially the case in communities that are required focus on 'growth', in isolation, if uneven development concerns are acute. As a result, environmental issues may not be given a high priority by economic development professionals. As the case studies below demonstrate, communities focusing on meeting the demands of growth, as opposed to those that focus on making communities liveable, have very different policies and outcomes.

### **Urban forests in two north central Florida cities**

The case study discussed here reviews two Florida communities. The primary research objective was to determine the extent of urban forest cover in Gainesville and Ocala and identify the potential economic benefits (in energy savings) associated with it. Non-economic benefits are also discussed. The two communities are comparable insofar as they are geographically close, have similar climates, populations and relative 'ages', and exhibit – in broad terms – similar population growth (Table 1). In terms of geology, both are situated along Florida's central ridge in the southeastern

Table 1  
 Characteristics of the two study communities

Characteristic	Gainesville	Ocala
Population (2000)		
City	95 447	45 943
County	217 955	258 916
Percentage change, 1990-2000		
City	12.2	9.3
County	20.0	32.9
Area (square miles)		
City	45	38
County	874	1579
Density per square mile (2000)		
City	2121	1202
County	249	164
Mean monthly unemployment (2001)		
MSA (%)	2.4	4.6
Air quality index	76	74
Leisure index	8	6
Utility cost index	95.1	90.00
Home appreciation rate (%)	20	10.1

Source: Bureau of Labor Statistics (2002); *Money Magazine* (2001); US Census, (2002); for further information about the two communities, see the relevant websites: [www.state.fl.us/gll/](http://www.state.fl.us/gll/) (Gainesville) and [www.ocalafl.org/](http://www.ocalafl.org/) (Ocala).

coastal plain (Fig. 1). As the following discussion demonstrates, however, the two communities are quantitatively and qualitatively different. While the core values that have shaped both urban forestry initiatives are similar, the exact design, implementation, specific ordinance regime, site exemptions and outcomes of each city's programme have differed.

### *Case-study communities*

#### *Gainesville*

Located in Alachua County and founded in 1854, Gainesville's politics, like those of many university towns, are often considered progressive, in relative terms, compared to the surrounding region. In fact, the University of Florida – its faculty, staff and students – are credited as the driving force behind Gainesville's alternative development practices, environmental awareness and long history of land-use planning, dating back to the 1940s (Shea, 1998). Moreover, the University of Florida and its health care network are the community's largest employers and help to anchor the

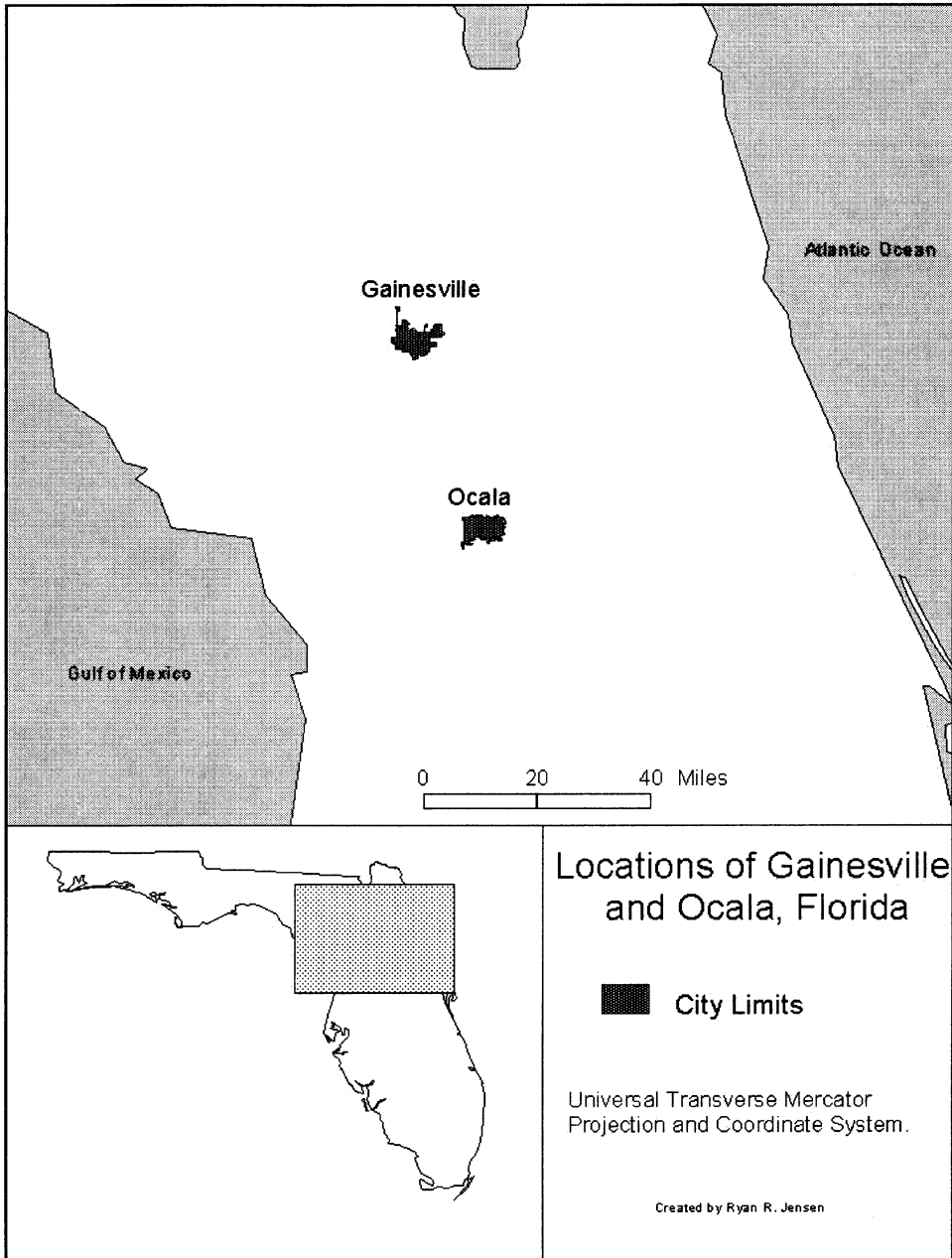


Fig. 1. The study area.

economy. As a result, Gainesville's robust local economy has long been characterized by a solid professional labour market and low unemployment. Because of these factors, its economic development policies have not focused solely on job growth, industrial recruitment, or downtown revitalization; rather, it has adopted a holistic strategy that emphasizes the overall sustainability of the economy, environment and quality of life (Shea, 1998). Indeed, Gainesville and its residents have had the opportunity (or perhaps luxury) to recast economic development as a community-building process instead of 'growth'.

In Gainesville, urban forestry is a high priority for citizens and government alike (Table 2). For example, the city's FY 00–01 work plan (City of Gainesville, Office of Management & Budget, 2001b) has a clear environmental focus that transcends department units as natural resource management issues are addressed within and between unit boundaries. Similarly, the work plan focuses explicitly on tree protection, anti-sprawl, open space and land conservation, recreation and culture, and clean initiatives that would directly benefit from urban forestry efforts. Based on the topics outlined in the work plan, it is evident that Gainesville has sizeable and influential pro-growth and no-growth constituencies. Beyond the city's work plan, public support for urban forestry initiatives is clearly evident: through a 1999 survey and a follow-up survey in 2000, city officials found clear and consistent support for the city's urban forestry effort, residents strongly supporting the high priority placed on maintaining the urban canopy (City of Gainesville, Office of Management & Budget, 2000, 2001a).

Table 2  
Gainesville citizen opinion survey results (%)

	Excellent	Good	Important	Somewhat important	Not important
<i>Quality of city maintenance of the tree canopy</i>					
1999	20	56			
2000	20	58			
<i>Quality of nature parks and greenways</i>					
1999	20	56			
2000	24	53			
<i>Importance of city maintaining the canopy</i>					
1999			55	35	10
2000			60	36	4
<i>Importance of nature parks and greenways</i>					
1999			49	41	10
2000			56	38	6

Source: City of Gainesville, Office of Management & Budget (2000, 2001a).

### Ocala

Located in Marion County just 64 km south of Gainesville, Ocala's political culture and local traditions are less clear. Like Gainesville and most other Florida communities, Ocala has experienced significant growth over the last 20–30 years, its overall population having grown at a faster pace than Gainesville's since 1990. Between 1990 and 2000, the city grew by over 9% and the county by roughly 33%. This growing population will pose significant problems as net migration to Ocala and Marion county will out-pace job growth rate in both the short and long term (P. Howell, City of Ocala, Planning Department, personal communication, 10 June 2002; Ocala Economic Development Corporation, 2002). Unlike Gainesville's vibrant university district, Ocala faces the challenge of city-centre revitalization, urban sprawl, improving the community's economic base, and providing expanded services to meet the demands of an ever-growing population. As a result, the growth strategy that has evolved is inherently different as the community focuses on basic issues like job growth or unmet housing needs. Because of these concerns, the responsibilities of local government in Ocala are inherently different from those of Gainesville.

At a more personal level, the pace of Ocala's economic development has commonly been characterized as slow; so much so that the local newspaper – *The Star Banner* – includes references from both residents and outsiders to Ocala as 'Slocala' (Thompson & Frazier, 2001). In fact, this perception permeates much of the region and has been used to describe community development in not only *Star Banner* editorials but also in the nearby *Gainesville Sun*. In concrete terms, the local economy is more heavily dependent upon traditional industries and lower-level service employers than the more affluent and professional Gainesville (Tables 3 and 4). Currently, Ocala faces the daunting reality of population growth outpacing job growth and an unemployment rate that is consistently one and a half to two times that of Gainesville (Bureau of Labor Statistics, 2002). It is thus not surprising that residents affectionately (or not so affectionately) refer to the city as 'Slocala'.

Table 3

Employment by selected industrial sectors, Marion County and Alachua County, 1999

Sector	Marion County		Alachua County	
	No.	%	No.	%
Manufacturing	9 420	13.18	5 109	6.47
Retail	13 599	19.02	13 401	16.98
Food services	5 881	8.23	7 898	10.01
Health care	10 583	14.80	16 699	21.16
Information industries	1 023	1.43	3 056	3.87
Professional scientific and technical services	2 439	3.41	4 854	6.15

Source: US Census, Count Business Patterns (2002)

Table 4  
Employment by top employers, Gainesville and Ocala, 2001

Ocala-Marion County	No.	Gainesville–Alachua County	No.
Marion County School Board	4 908	University of Florida	18 000
State of Florida (all depts)	2 100	UF-Shands Health Care	7 500
Marion County government	1 751	Alachua County School Board	4 400
City of Ocala	1 111	City of Gainesville	2 200
Munroe Regional Medical Center	2 100	Florida Department of Children and Families	2 100
Emergency One Inc.	1 600	Malcolm Randall VA Medical Center	1 700
Ocala Regional Medical Center	1 300	North Florida Regional Medical Center	1 500
Publix Supermarkets	1 300	Publix Supermarkets	1 400
Clairson International	950	Santa Fe Community College	1 300
Winn-Dixie Supermarkets	911	AvMed Health Plan	1 200
K-Mart Corporation	812	Nationwide Insurance	1 150
Mark IV Automotive-Dayco Ocala	800	Gainesville Regional Utilities	750
Mark III Industries Inc.	750	Alachua County	725
Lockheed-Martin	700	Wal-Mart	580
Wal-Mart	700	Taco Bell	575

Source: Data from Ocala–Marion County Chamber of Commerce and Gainesville Area Chamber of Commerce, 2002.

At a basic level, the perceptually ‘less progressive’ politics of Ocala underscore the city’s more conservative nature and traditional approach to regional development. Yet, Ocala has demonstrated a commitment to urban forestry and the belief that trees ‘enhance the natural beauty of our community and the quality of life for residents of Ocala and Marion County; increase property values; and improve our standard of living’ (City of Ocala Planning Department, 2002). While the city seeks to accrue some of the key benefits of urban forestry, the importance of urban forestry to the community is unclear. Unlike Gainesville, the city does not regularly conduct resident surveys (S. Allen, personal communication, City Managers Office, Ocala, 22 March 2001; P. Howell, City of Ocala, Planning Department, personal communication, 10 June, 2002) so no reliable data are available with respect to citizen support for urban forestry efforts. Additionally, the planning department – the administrative unit responsible for the tree ordinance – has not performed any surveys or organized focus groups that directly or indirectly gauge public perception of, or support for, the urban forestry programme (P. Howell, City of Ocala, Planning Department, personal communication, 10 June, 2002).<sup>2</sup>

<sup>2</sup> Currently, the 10 person planning staff oversees the implementation of the tree protection ordinance. Additionally, the department manages historic preservation efforts, prepares the comprehensive plan, and provides other land information services. In contrast, Gainesville’s policies are administered primarily by a dedicated staff that includes a full-time arborist and tree crew.

### Urban forestry policies

In both communities, tree policies and ordinances exist (Table 5). However, the efforts of Gainesville more accurately reflect the scale and scope of urban forestry associated with, and as defined by, professional urban foresters (or arborists). The following paragraphs outline the key differences observed between the two cities in the specific area of urban forestry and observed forest amenities.

The most noticeable symbol of comprehensive and successful urban forestry efforts has long been a community's designation as a 'Tree City USA'. Such a designation is not only a symbolic gesture but is a recognition that communities place a high priority on city forests. Indeed, the commitment to urban forests must be demonstrated through following the National Arbor Day Foundation's (NADF) four standards:

1. establish a legal governing body to oversee urban forestry efforts;
2. design, implement, and enforce a tree ordinance that includes the charging of a

Table 5  
Urban forestry policies: Gainesville and Ocala

Rule	Gainesville	Ocala
<i>Protection rules<sup>a</sup></i>		
Removal		
Residential property	Permit required	Permit required with exemption for R-1 parcels less than 3 acres
Non-residential property	Permit required	Permit required
Replanting		
Residential property	Replacement required	Replacement required
Non-residential property	Replacement required	Replacement required
<i>Design rules<sup>a</sup></i>		
Size/species list classes	Small/medium/large	Shade/ornamental
Native species requirement	75% of plantings	Not explicitly required
Landscape plans	Required	Required of non-exempted sites
Sq. footage requirements	Y (2850)	Y (3000)
Installation standards	Y	N
<i>Other issues</i>		
Full-time city arborist <sup>b,c</sup>	Y	N
Administrative unit <sup>c</sup>	Parks Division Tree Crew	Planning Department staff
Disincentives <sup>a</sup>	Fines	Fines

*Note:* The tree protection/canopy ordinances can be viewed at the Municipal Code Corporation's homepage: [www.municode.com](http://www.municode.com)

<sup>a</sup> City of Gainesville (2002); City of Ocala (2002).

<sup>b</sup> National Arbor Day Foundation (2002).

<sup>c</sup> Personal communications with city planners and managers in 2001 and 2002.

- tree board or city unit with writing and implementing an annual urban forest work plan that deals with tree planting and removal in public places;<sup>3</sup>
3. budget at least \$2 per capita to urban forestry efforts, and
  4. observe Arbor Day through city proclamation.

For the past 14 years, Gainesville has consistently had the distinction of being named a 'Tree City USA' by the NADF. Over the 24-year lifetime of the Tree City programme, it has been named a tree city 18 times, while Ocala has been recognized as a Tree City 11 times. In addition to Tree City USA guidelines, Gainesville's city-owned utility has participated in a new NADF programme, Tree Line USA, for the past three years. This enlists local utilities to participate in a comprehensive forest management initiative similar to the groundbreaking SMUD project of the 1980s. In Ocala, by contrast, the city-owned electric utility, Ocala Electric, does not participate in this project. To more closely understand the systemic policy differences that have contributed to the creation of existing forest amenities, the policies of each city are examined below.

### *Gainesville*

Beyond Tree City USA efforts that are targeted specifically at public spaces, Gainesville has explicitly linked tree planting with growth – all growth (see Table 5). It continues to green by growing because all growth results in additional trees. Its ordinance-based strategy requires landowners and developers to submit landscaping plans for all construction projects, requires extensive permitting to remove or cut trees, includes square footage requirements, and mandates the replacement of removed trees with new ones. In addition to mandating replanting, the city management regimes require that developers plant *native* trees. This is important, because appropriate tree selection – particularly native trees – provides the most direct and valuable ecological benefits. The specific ordinance requires that tree planting efforts be based on the easily calculated formula of one tree per 2850 ft<sup>2</sup> of area developed. Additionally, the Land Development Code requires proper tree installation (planting, staking and watering) for all new plantings to increase the survival rate.

In practice, this policy has resulted in a significant increase in tree plantings. In 1998, development plans called for the removal of roughly 2700 trees; this was balanced by subsequent developments that resulted in the planting of over 3075 trees by developers. Similarly, the city removed over 300 trees in parks and along the tree lines and replanted over 1000 in their place in 1998. In addition to planting requirements, Gainesville's Land Development Code also contains property design principles that encourage tree preservation and inhibit tree destruction.

Most importantly, the Land Development Code's forestry management approach is site specific and ecologically sound. To maximize both economic and non-economic

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<sup>3</sup> In previous years, Tree City USA guidelines indicated that city ordinances include an annual work plan that provided for a full-time arborist. However, present guidelines state local work plans and ordinances should 'be flexible enough to fit the needs and circumstances of the particular community' (NADF, 2002).

benefits, the ordinance regime's design standards are explicit. For example, if trees are planted along roads, the Land Development Code separates different types of trees into large, medium and small categories. Each tree type serves a specific structural, aesthetic and environmental purpose. Large trees require a linear spacing of 15 m and include live oak (*Quercus hemisphaerica*), southern magnolia (*Magnolia grandiflora*), sweetgum (*Liquidambar styraciflua*) and winged elm (*Ulmus alata*) to provide the maximum possible benefits and assure the accrual of future large species benefits. This is especially important, as large species require a major spatial commitment to the urban forest. Medium trees are used for streets with a right of way of <25m and require a linear spacing of 11m. They include blackgum (*Nyssa sylvatica*), bald cypress (*Taxodium distichum*), spruce pine (*Pinus glabra*) and red maple (*Acer rubrum*). Finally, small trees are generally used under power lines and consist of crape myrtle (*Lagerstromia indica*), holly (*Ilex* spp.), hop hornbeam (*Ostrya virginiana*) and ash magnolia (*Magnolia ashei*). By deliberately encouraging species selection, the city reduces potential costs (trimming, hardscape damage, etc.) and maximizes benefits. Finally, Gainesville employs (and enforces) the common practice of tree removal–tree replacement. In sum, Gainesville's urban forestry initiative is the result of a relatively activist ordinance scheme that empowers the city to *manage* the local forest.

### *Ocala*

Like Gainesville, Ocala has an ordinance-based strategy that discourages tree destruction, encourages planting, and includes site design elements. However, the totality of the programme is less comprehensive, explicit and activist. In particular, Ocala has a less stringent tree removal permitting process and it exempts a key land use type: parcels smaller than 3 acres that are zoned R-1 (single family residential) are not required to obtain a permit to remove a tree. By exempting small landowners, Ocala has no control over much of the city's urban canopy, since few parcels are larger than 3 acres. Beyond protection, the language of the site design and related replacement guidelines are less detailed, prescriptive and extensive than those of Gainesville. For example, the square footage, species, and other planting requirements of the Ocala ordinance are either less stringent or non-existent (see Table 5). The ordinance structure of Ocala thus limits the city's ability to effectively regulate the urban canopy.

In addition to less stringent rules, the city of Ocala has not consistently devoted resources or personnel to urban forestry. Indeed, the implementation of the tree plan and ordinances lies with the planning department's small and overburdened staff of non-specialists. In concert, staffing concerns, the exempted land use class, and less prescriptive site design rules are key differences between the two cities and one would expect these to lead to different policy outcomes. The next section does this by assessing the extent (spatial extent) and intensity (density) of the urban canopy in both Ocala and Gainesville using remote sensing technologies.

## Assessing the outcome of urban forestry policies

### *Methods*

The policy outcomes associated with each community's very different greening approach is assessed by observing the forest canopy of each community to assess its relative status. This approach was chosen because it was judged to be the clearest indicator of the spatial extent of urban forests and can be used to assess – in absolute and relative terms – the potential benefits of urban forestry. In the process, it also sketches the environmental character and associated quality of life in each community. Despite its inherent limitations, the canopy analysis is useful for determining the scale and scope of urban forestry efforts in empirical terms.

The urban canopy coverage was calculated using the leaf area index (LAI), defined as  $\text{m}^2$  of leaves per  $\text{m}^2$  of ground. Unlike previous urban forestry research, this project assesses the intensity and extent of urban forests beyond the micro-scale by using remotely sensed data. This is more able to accurately capture the overall spatial implications of urban forestry on a community-wide basis. Upon completion of the canopy analysis, local energy consumption data were used to measure – in relative terms – the potential economic benefits that might be accrued through aggressive urban forestry efforts.

Using data acquired from the LANDSAT Thematic Mapper sensor, a LAI surface map was generated for each city using a combination of fieldwork, digital image processing techniques and artificial neural network processing (ANN) (see Jensen, 2000). These LAI maps show clear differences between the two cities (Figs 2 and 3).

### *Results*

Forty random LAI point estimates were extracted from the LAI surface map in each city using a geographic information system (GIS). Based on these, Gainesville's urban forest had a mean LAI of 4.61 (s.d. = 1.27). In contrast, Ocala's urban forest LAI (mean = 2.13, s.d. = 1.20) suggests both a spatially less extensive and less intensively developed urban canopy. More importantly, the study shows that the observed difference in the estimated LAI for the two cities was statistically significant ( $t = 10.17$ ;  $p < 0.00001$ ). In short, Gainesville's efforts have resulted in a dense urban canopy that can be statistically differentiated from Ocala's less developed urban forestry efforts. This result is even more significant given Gainesville's larger population and higher density.

It may be concluded that the Gainesville tree ordinance has not only contributed to making Gainesville attractive from a pedestrian perspective, but has also helped to alleviate some of the urban heat island effects and pollution problems. For example, households in Gainesville use an average of 935 kWh a month (R. Bauldree, Gainesville Regional Utility, personal communication, 2000). Conversely, Ocala households use an average of 1075 kWh per month (J. Henning, Ocala Electric Utility, personal communication, 2000). Using the average rate of  $\$0.07524 \text{ kWh}^{-1}$ , households in Gainesville are achieving annual savings of  $\$126.40$  per household. In general terms,

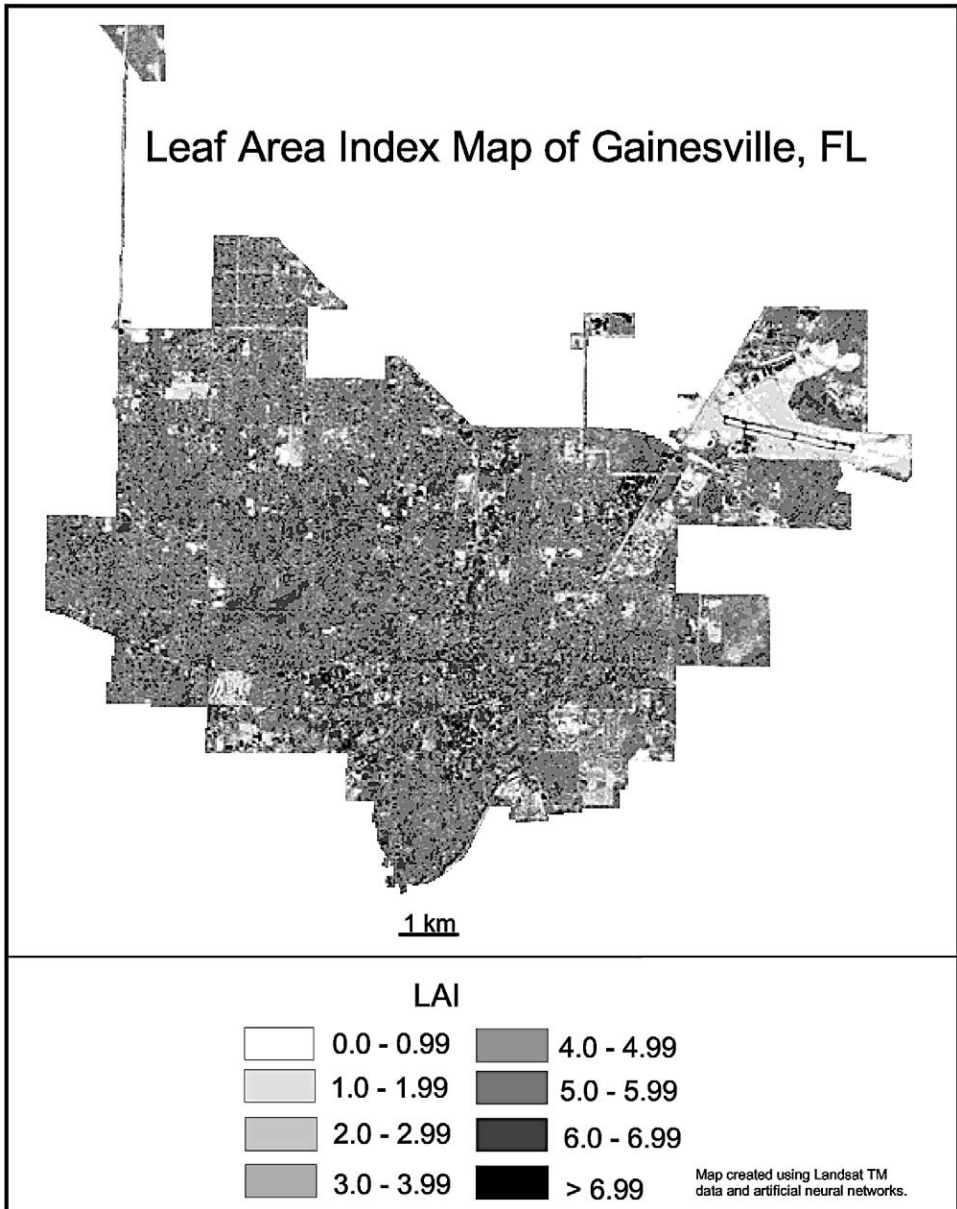


Fig. 2. Leaf area index map of Gainesville, Florida, derived from ANN.

the distinctiveness of each community's tree canopy and the observed differences in energy consumption rates is consistent with the findings of other research at more micro-scales. Moreover, the relative consumption rates and resulting cost savings are all the more impressive when it is considered that Gainesville's overall utility

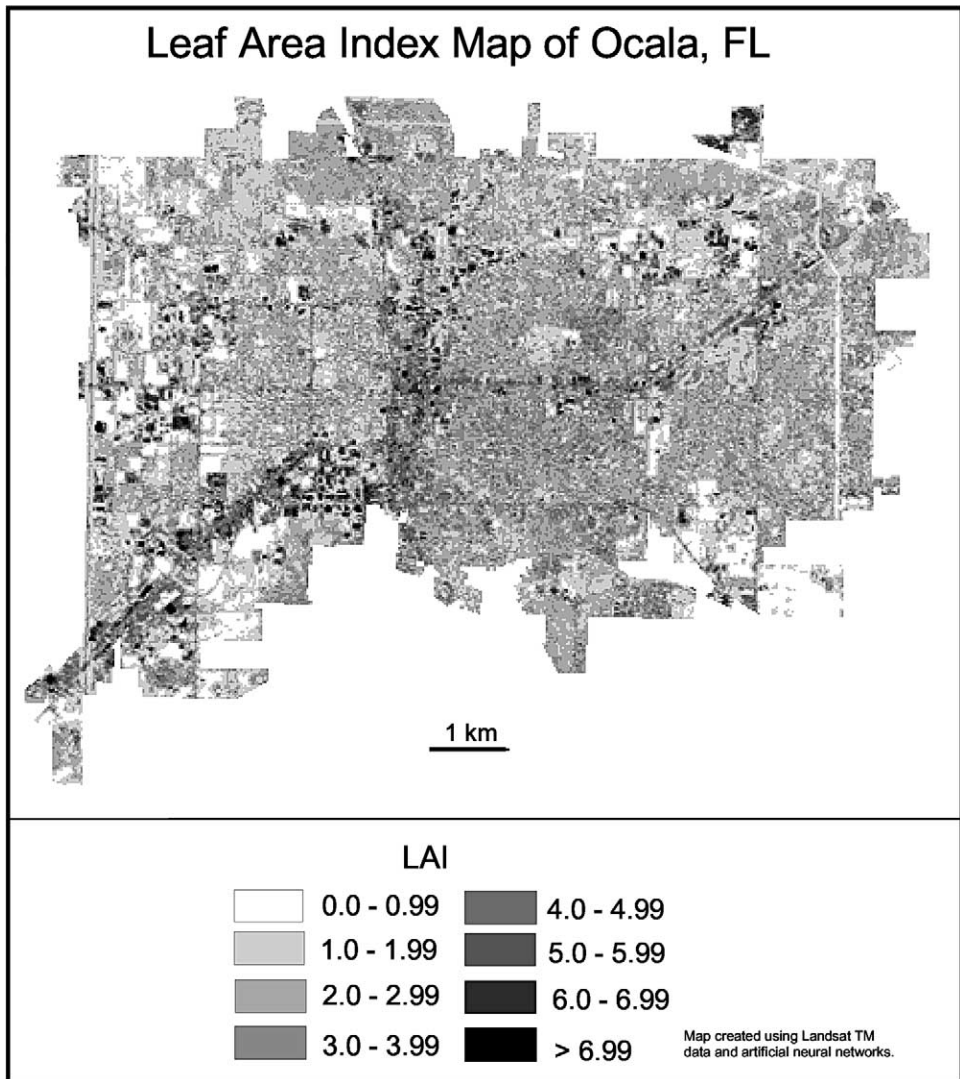


Fig. 3. Leaf area index map of Ocala, Florida, derived from ANN.

index is higher than that of Ocala (see Table 1). Finally, the overall appreciation rate of real property is much greater in Gainesville than that found in Ocala.

Perhaps more importantly though, the study underscores the economic, ecological and aesthetic outcomes associated with comprehensive and community-wide policy implementation efforts. Gainesville’s ‘green strategy’ has contributed to a positive perception of the community’s liveability. The community survey showed that citizens clearly support the effort and believe it is an important contribution to the community. In addition, analyses published in the popular press have consistently

ranked Gainesville higher on numerous counts than nearby Ocala (Best Places.net, 2001; *Money Magazine*, 2001), especially on quality of life and air quality. While this study (indeed no study) can reasonably control for the myriad of systematic and structural differences that exist between (as well as within) cities, research findings reinforce the findings and assertions of the professional urban forestry community.

## Conclusion

In recent years, attempts to establish 'environmental' spaces within the context of region-wide planning and economic development have met with mixed results (see Calavita, 1992, 1997). Yet we believe the possibility exists for communities to develop environmental policies that enable them to remain not only attractive but also competitive. For example, Gainesville, like many communities, has struggled with the benefits and costs of growth and development (see Vogel & Swanson, 1989). Eventually, however, it adopted a 'greener' economic development approach that controls growth and arguably improves the overall quality (quantitatively and qualitatively) of economic development. By institutionalizing the principles of urban forestry, the efforts and interests of pro-growth and no-growth groups in Gainesville coalesce and overlap. Within this context, the case studies have demonstrated how urban forestry efforts can be leveraged to meet the desired policy outcomes and economic returns necessary to satisfy the needs of the entire community. In Gainesville, current growth continues the expansion of the urban canopy. As a result, Gainesville has emerged as one of Florida's 'most sustainable cities' and one of its most liveable (Shea, 1998; *Money Magazine*, 2001). In contrast, Ocala's policy of exempting key land use types has led to uncertainty about the overall sustainability of the canopy.

In this analysis, the empirical evidence has shown that local strategies and contingencies have resulted in significantly different urban forests. It has illustrated how comprehensive canopy regulation can be effective without discouraging – and even encouraging – new growth. The paper has also demonstrated that remote sensing technologies can be used to assess the overall effectiveness of smart-growth strategies like those employed here. Specifically, the derived Leaf Area Index can be used to benchmark the status of an urban canopy in order to detect future change. The research has demonstrated how qualitative policy differences have resulted in observable differences in the tree canopy and demonstrated that remote sensing technologies are an effective assessment tool for charting and quantitatively assessing such outcomes.

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