Measuring the Adoption of Local Sprawl
Reduction Planning Policies in Florida

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Abstract

While sprawling growth patterns have become a major issue for planners and environmental managers, little empirical research has been conducted on the adoption of sprawl-reduction policies in local plans. The authors systematically evaluate the comprehensive plans of forty-six local jurisdictions in southern Florida for the presence of five sprawl-reduction planning policies (SRPPs) using plan-evaluation techniques. Results indicate a clear statistical and spatial pattern of SRPPs across the study area and show that specific socioeconomic and demographic characteristics influence the adoption of SRPPs in comprehensive plans.

Keywords: *sprawl; Geographic Information Systems; plan quality*

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The issue of sprawl has become a major focus for planning researchers and practitioners and often underlies the debate on creating sustainable communities. Rising dependence on the automobile, rapid population growth, and migration out of existing urban centers in search of affordable housing are some of the factors that have reshaped the American landscape into a pattern of low-density, sprawling residential developments (Mieszkowski and Mills 1993; Beatley and Manning 1997; Burchell et al. 1998). For years, planners have argued (and sometimes documented) that sprawling urban and suburban development patterns are creating negative impacts including habitat fragmentation, water and air pollution, increasing tax bases and infrastructure costs, inequality, and social stagnation (Ewing 1997; Porter 2000; Squires 2002). While the triggers for and adverse effects of sprawl are well articulated, little empirical research has been conducted on the factors influencing communities to actually reduce sprawl through local planning policies.

This study focuses on the adoption of sprawl-reduction planning policies (SRPPs) by local jurisdictions in southern Florida. Despite a strong state-planning mandate intended to manage growth and limit adverse impacts from sprawl, ecological systems are being threatened by sprawling development patterns, particularly in southern Florida where natural amenities provide an ideal location for second homes and seasonal tourism. Specifically, we address the issue of mitigating sprawl and its environmental consequences by evaluating the local comprehensive plans of forty-six jurisdictions in southern Florida. Using plan evaluation, Geographical Information Systems (GIS), and quantitative analytical techniques, this study (1) examines the presence (or absence) of environmental SRPPs in a region with a history of sprawling development patterns, (2) analyzes the spatial pattern of sprawl-reduction planning strategies across the study area, and (3) identifies the major environmental, socioeconomic, and demographic factors influencing communities to adopt SRPPs. Using ordinary least squares (OLS) multiple regression analysis, we test several hypotheses on what motivates local jurisdictions to adopt policies aimed at reducing sprawling growth patterns. Based on the results, we discuss the planning implications for incorporating SRPPs into local planning frameworks as a proactive approach to reducing the adverse impacts of sprawl.

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► The Environmental Impacts of Sprawl

There is no universally accepted definition of sprawling land development; however, there are several common characteristics pervading the literature: (1) low-density, often single-family dwellings; (2) automobile dependency even for short trips; (3) spiraling growth outward from existing urban centers; (4) leapfrogging patterns of development; (5) separation of land uses; and (6) an undefined edge between urban and rural areas (Ewing 1997; Burchell et al. 1998; Duany, Plater-Zyberk, and Speck 2000; Galster et al. 2001; Heimlich and Anderson 2001; Hess et al. 2001; Gillham 2002). While the literature identifies various social (Freilich and Peshoff 1997; Berry-Cullen and Levitt 1999; Bullard, Johnson, and Torres 2000; Putnam 2000; Wiewel and Schaffer 2001; Ewing et al. 2003) and economic (Bank of America 1995; Leinberger 2000; Heimlich and Anderson 2001; Carruthers and Ulfarsson 2003) consequences associated with urban sprawl, this article focuses on the mitigation of environmental impacts. Environmental problems receive perhaps the most attention in discussions of the adverse effects of sprawl, particularly in southern Florida where the Everglades ecosystem has been negatively affected by rapid coastal development. These negative impacts include, among others, air pollution resulting from automobile dependency; water pollution caused in part by increases in impervious surfaces; loss or disruption of environmentally sensitive areas, such as critical natural habitats (e.g., wetlands, wildlife corridors, etc.); reductions in open space; increased flood risks; and overall reductions in quality of life (Arnold and Gibbons 1996; Benfield, Raimi, and Chen 1999; Kenworthy and Laube 1999; Hirschhorn 2001; Kahn 2001).

More specifically, the reliance on automobiles (attributed partly by landscapes defined by low-density patterns of development and a lack of comprehensive public-transit options) has contributed to reductions in air and water quality as well as the accelerated depletion of fossil fuels (Kenworthy and Laube 1999). In the United States, the number of motor vehicles is growing more than three times faster than the nation's population growth, and car owners are driving longer distances than ever before (Dunphy et al. 1997). Land is being consumed at a faster rate as populations shift from urban areas to suburban fringes (Porter 2000; Kahn 2000; Dwyer and Childs 2004). For example, between 1950 and 1995, the population of Chicago grew by 48 percent while land coverage increased by 165 percent (Openlands Project 1998). Similarly, in the sprawling region southeast of Boston, more land has been developed in the past 40 years than in the preceding 330 years (Southeastern Regional Planning and Economic Development District 1999). Sprawl associated with rapid population growth is nowhere more apparent than in south Florida where the percentage change in urbanized land is among the highest in the country (Fulton et al. 2001). For example, Lang (2003) reported that out of thirteen large U.S. office markets, South Florida has the lowest percentage of its office space in its major downtown (Miami). Only 13 percent of South Florida's office space is located in its central business district (CBD), compared with a median of nearly 30 percent for all thirteen markets.

Development expanding outward from urban centers often reduces open space, fragments wildlife habitats, and compromises the integrity and function of ecological systems. For example, the development of wetlands can result in negative impacts on migratory bird nesting sites, aquatic habitats, and hydrological system function. Buildings, pavement, parking lots, and other impervious surfaces prevent rainwater from infiltrating the soil, dramatically increasing nutrient-laden runoff into creeks and rivers (Arnold and Gibbons 1996; Beatley and Manning 1997; Benfield, Raimi, and Chen 1999). Along these lines, Hasse and Lathorp (2003) suggest that indicators of wetland loss increased impervious surfaces and that population density can actually provide a useful quantitative measure for the impact of sprawl on critical natural resources.

Finally, subdividing large natural areas into smaller spatial units can inhibit wildlife movement across the landscape (Peck 1998; Cieslewicz 2002). Leapfrog development patterns further fragment natural landscapes by leaving patches of open land intermingled with built-up areas. Roadways, fences, and other abrupt human-defined edges can act as barriers to wide-ranging species (Noss 1991). Blocking or disrupting natural corridors can (1) reduce the area of habitat available to species, (2) increase the likelihood of population extinction by limiting immigration, and (3) exacerbate genetic problems resulting from inbreeding (Dramstead, Olson, and Forman 1996; Duerksen et al. 1997; Peck 1998). Urban and suburban sprawl can thus lead to changes in ecological processes that alter the overall biodiversity, genetic diversity, and connectivity of keystone species (van Lier and Cook 1994; Noss and Cooperrider 1994; Forman 1995; Dramstead, Olson, and Forman 1996).

► The Role of SRPPs

In response to increasing adverse environmental impacts linked to sprawling development patterns, planning scholars and practitioners are advocating the adoption of sprawl-reduction policies in local plans (Pendall 1990; Bengston, Fletcher, and Nelson 2004). While there are multiple planning techniques suggested in the literature, this study focuses on the presence of the following five key SRPPs: transfer of

development rights, conservation easements, clustering, environmental mitigation/restoration, and density bonuses. These policies are often highlighted in the planning literature because, on a regional scale, they help concentrate growth within targeted areas, restrain development from sprawling uncontrollably into rural areas, and protect or restore a region's natural resource base. Several terms are used to identify this type of development, including *smart growth*, *compact development*, and sometimes *new urbanism* (for more information, see Knaap and Talen 2005; Ye, Mandpes, and Meyer 2005).

Transfer of Development Rights

The transfer of development rights (TDRs) has long been used for mitigating sprawling development by promoting a dense urban core (Costonis 1974). This land-use planning strategy allows development rights to be transferred away from ecologically valuable areas to areas that are less sensitive and therefore more appropriate for intense growth (Strong 1987; Porter 1997). Designated transfer areas are usually located in rural settings containing critical natural resources (e.g., wetlands, wildlife habitat, biological diversity, etc.), while receiving areas are located in nearby urban centers. The receiving areas selected for growth are usually determined by local planning authorities to promote infill and redevelopment or to guide growth toward certain city areas. Although establishing TDRs can be an arduous process because it relies on the coordination between municipalities, developers, and landowners, it is considered an effective planning tool for concentrating growth, promoting a well-defined urban-rural boundary, and maintaining the integrity of ecological systems.

Conservation Easements

A conservation easement is a "legally binding agreement that permanently restricts the development and future use of the land to ensure protection of its conservation values" (Gustanski and Squires 2000, 9). This planning technique involves a set of restrictions that a landowner voluntarily places on his or her property to maintain its conservation values, prevent future development, and reduce an heir's inheritance-tax liability (Strong 1983; Wright 1993). Easements essentially allow local governments to pay landowners to forgo certain land-development rights in exchange for tax reductions. Easements are usually conveyed by a qualified government agency or nonprofit organization. The specificity of the contract between the landowner and the agency becomes the binding and enforceable document for land protection (Boyd and Simpson 1999). Common stipulations for a conservation easement include prohibitions on road construction, subdivision of the land, mining, timber production, and so on.

Conservation easements can be powerful deterrents to sprawl because they buffer or prevent growth from occurring in ecologically sensitive areas (habitat being a type of sensitive area) or areas on the fringe of urban centers. In an extensive evaluation of conservation easements in the United States, Gustanski and Squires (2000) note that this planning policy has been effective in protecting rural areas and could be used as a "supplement to countywide growth management efforts" (p. 167). Florida has several programs in place to acquire ecologically sensitive lands such as the Preservation 2000 Initiative and the Florida Forever program, which use a documentary stamp tax to generate $300 million annually for acquisition of conservation lands through easements and other planning techniques (Beatley 2000). Since 2001, Florida has acquired over 7,000 acres of conservation land through Florida Forever (Florida Department of Environmental Protection 2002).

Environmental Mitigation/Restoration

Policies associated with environmental mitigation and restoration are fairly widespread among local jurisdictions in Florida. When implemented on a regional scale, these planning tools can help reduce sprawling development patterns. Mitigation is a popular alternative in part because it allows development to proceed as long as adverse impacts are offset by creating habitats such as wetlands elsewhere. For example, allowing wetland development in urban areas if these fragmented wetlands can be replaced off-site can encourage infill and more compact forms of development. Also, large mitigation sites (e.g., mitigation banks) can act as protected areas that steer growth toward more densely developed areas. Most states, such as Florida, have mitigation programs that require destroyed wetlands to be replaced by creating new wetlands or restoring previously degraded wetlands (Salvesen 1990). Imposed replacement ratios can vary across local jurisdictions ranging from two to five acres of wetlands created for every one acre destroyed (Hoehna, Lupia, and Kaplowitzb 2003). Florida also has a state-level wetland mitigation banking program where restoration takes place off-site in an approved location. "Mitigation banking involves the off-site restoration, enhancement, and/or construction of wetlands to compensate for unavoidable adverse wetland impacts associated with proposed developments" (Weems and Canter 1995, 199). In theory, this mitigation project should be executed in a landscape position similar to the original wetland, morphology

should resemble the original wetland as closely as possible, and water should be contained in the system (Marsh et al. 1996).

While the efficacy of mitigation has been brought into question (see, among others, Zedler 1991), if applied comprehensively at a jurisdictional level, it can help reduce sprawling development, particularly in suburban areas (Beatley 2000). Incorporating mitigation measures (from wetland replacement ratios to restoration of specific natural areas) into local planning frameworks is one approach to increase the likelihood that programs are implemented (particularly in Florida where comprehensive plans are legally binding). On-site mitigation can discourage growth or guide growth away from ecologically sensitive areas. For example, if properly sited, large mitigation banks can essentially act as protected areas that buffer sprawling residential developments at the fringe of urban areas and help maintain higher densities within an urban core. Mitigation, then, can be more ecologically meaningful than simply a piecemeal approach for enabling development and achieving "no net loss" of wetlands. If applied strategically with the ecological system in mind, local mitigation policies can provide a powerful planning tool that not only protects critical habitats and natural areas but also helps restrain sprawling growth patterns.

Clustering

Clustering development is another planning policy that when applied at the jurisdictional level, can help mitigate sprawling patterns of growth. Clustering involves targeting development density in a specific area to protect critical habitat and other natural areas (Arendt 1997). On a regional scale, clustered development patterns help contain growth within an urban core and protect critical habitats (although Audirac and Shermyen [1990] argue that compact forms of development can actually exacerbate environmental impacts and run counter to residential preferences for low-density lifestyles). At the parcel level, cluster zoning allows high-density development in one area of a parcel while leaving the remaining land undeveloped. This planning policy is widely used to contain local growth and set aside sensitive areas such as wetlands and wildlife habitats (Beatley and Manning 1997). While the overall development density is the same across the region or site, increasing the permissible density in less sensitive areas can promote a more compact style of growth, thus reducing the threat of sprawl. Clustered development may be the most effective tool for mitigating sprawl in part due to its direct and easily recognizable benefits: creating more compact forms of development while protecting significant areas of natural habitat without negatively impacting land values.

Density Bonuses

A common form of incentive that can mitigate sprawl is the application of development density bonuses. This policy allows landowners to increase the density of commercial or residential development on their property if they take certain actions to protect critical natural resources or provide other public benefits (Seyfried 1991). Required actions can include locating development outside of significant habitat areas, planting specific vegetation that attracts wildlife, and maintaining riparian corridors. Similar to clustering, this planning tool can help focus growth in designated areas while avoiding negative impacts on sensitive natural resources. Density bonuses are commonly in the range of 25 to 50 percent (larger bonuses may create adverse development impacts) but will vary depending on the specific landowner's situation (Duerksen et al. 1997).

► Factors Influencing the Adoption of Sprawl-Reduction Policies

While there is little, if any, empirical research on the factors contributing to the adoption of local sprawl-reduction policies, there is a strong literature base explaining the variation in plan quality associated with comprehensive plans. *Plan quality* refers to the overall strength of a plan in terms of its ability to attain its stated objectives. Kaiser, Godschalk, and Chapin (1995) first identified and defined the core characteristics of plan quality: fact base, goals, and policies. A strong factual basis, clearly articulated goals, and appropriately directed polices are considered the central elements of a high-quality plan. The ability to code and measure indicators within a plan has made it a widely used instrument with which to quantitatively assess the quality of management efforts (for more information, see Berke and French 1994; Berke et al. 1996; Brody 2003b, 2003c).

Past research on plan quality and plan evaluation can thus inform a conceptual model for explaining the presence of sprawl-reduction policies in local plans and help us derive several testable hypotheses (listed below) on what factors influence local jurisdictions to adopt SRPPs in their comprehensive plans. For example, existing environmental conditions and human impacts are thought to stimulate planners to adopt environmental policies in local plans. Jurisdictions with high levels of biodiversity should, in theory, be interested in safeguarding critical ecological components with directed goals and policies that mitigate sprawling development patterns. However, where there are low levels of biodiversity resulting from human disturbances, planners and planning participants

may feel an urgency to protect natural resources, which will, in turn, increase the presence of sprawl-reduction policies in plans. Brody (2003a) and Brody, Carrasco, and Highfield (2004) found that levels of biodiversity within a jurisdiction are not related to the quality of plans, but instead, the degree of human disturbance (e.g., pavement, agriculture, exotic species, etc.) significantly increases the quality of a jurisdiction's plan to effectively manage ecological systems. We believe a similar behavioral and resulting statistical pattern will emerge with respect to adopting policies to reduce sprawl.

Hypothesis 1: Increasing levels of human disturbance associated with physical development within a jurisdiction will increase the likelihood the adopted plan will contain SRPPs.

Previous studies have also tested the impacts of socioeconomic and demographic variables on plan-quality scores. Berke et al. (1996) examined the positive influence of wealth on plan quality associated with natural hazards. Jurisdictions with wealthier populations usually have more financial resources to devote to planning staffs and plan development. On the other hand, wealthy populations are often associated with rapidly expanding urban areas and suburban areas where there is less emphasis or political will to adopt policies to reduce sprawl. Although high levels of wealth are often correlated with education, more educated populations may increase the presence and strength of SRPPs in a plan. Highly educated residents tend to have stronger environmental values (see, among others, Van Liere and Dunlap 1980; Scott and Willets 1994; Fransson and Garling 1999) and are more likely to support policies that involve protecting open space and critical natural habitats.

Hypothesis 2: Increasing levels of wealth will decrease the likelihood that an adopted local plan will contain SRPPs.

Hypothesis 3: Increasing levels of education will increase the likelihood that an adopted local plan will contain SRPPs.

Past research on the relationship between population density and plan quality is mixed. A number of studies suggest that as communities become more densely developed, land-use policies to mitigate the impacts of natural hazards and related environmental issues become less likely (Burby and French 1981; Burby and Dalton 1994; Dalton and Burby 1994). In these cases, the authors theorized that land-use solutions are less feasible for jurisdictions with a reduced amount of available space for growth and development. In contrast, Berke et al. (1996) found that development density has no effect on plan quality for hazard mitigation.

From a sprawl perspective, however, population density should have a profound effect on plan quality. Local jurisdictions with high population density have already been able to maintain a dense urban core and reduce the incidence of sprawl. These jurisdictions may therefore have less interest or need to adopt land-use strategies that protect open space and reduce sprawling development. It is important to note that in this study, population density and human disturbance are not the same measure. A highly disturbed jurisdiction can be impacted over a broad area, whereas a jurisdiction with high population density can reflect a compact development pattern, which is one of the principles of smart growth.

Hypothesis 4: Increasing population density will decrease the likelihood that an adopted local plan will contain SRPPs.

Finally, Burby and May (1998) examined the significance of planning capacity as a contextual control variable in a study on plan quality associated with natural hazards. *Planning capacity* refers to the number of planners that contribute to the development of the comprehensive plan. The higher the planning capacity for a given jurisdiction, the more technical expertise and personnel are devoted to producing the plan. Generally, the more personnel devoted to drafting a plan, the stronger it tends to be.

Hypothesis 5: High levels of planning-agency capacity will increase the likelihood that an adopted local plan will contain SRPPs.

▶ Research Method

Study Area

We selected the southern portion of Florida to study SRPPs at the local level in part because the state requires each local community to prepare a legally binding comprehensive plan. City and county comprehensive plans in Florida stem from the 1985 Local Government Comprehensive Planning and Land Development Act, which mandated that new local comprehensive plans be written for each local jurisdiction and required that they be consistent with goals of the state plan. Comprehensive plans provided an ideal unit of analysis for evaluation because they follow a consistent format (in terms of production, element types, and review/updating processes), are an institutionalized policy instrument, and most important, provide a basis for city and county environmental, land-use, and growth-management decisions. Rule 9J-5, adopted by the Department of Community Affairs in 1986, requires that specific elements be included in local plans and prescribes methods local governments must use in preparing and submitting plans. These plans must look within and beyond jurisdictional boundaries, drive collaborative efforts with other jurisdictions or organizations, and contain policies that seek to guide growth and development in a sustainable manner.

A second rationale for selecting southern Florida as a study site is that the region is experiencing high levels of sprawling development and has one of the fastest growing populations in the United States. Despite the growth-management mandates described above, rapid population increases and escalating demands for development outside of urban centers have forced the Everglades ecosystem and associated biodiversity into a state of decline. Florida has been identified as having some of the highest natural amenities of any state in the country (USDA Economic Research Service 2005). The growth of Florida's resident and tourist populations, as well as its agricultural industry, has contributed to a dramatic loss of forest and wetland communities, water pollution from nutrient runoff, and fragmentation of wildlife corridors used by the Florida panther, bobcat, and other wide-ranging keystone species. Such a rapidly growing region offers an ideal study site within which to examine the variation of SRPP adoption within local comprehensive plans.

Finally, the fact that Florida has in place several statewide programs related to growth management that can help reduce sprawling development patterns makes it an ideal state to study the variation in sprawl-reduction strategies at the local level. For example, one of the major provisions of the 1985 Growth Management Act required local governments to insure that the public facilities and services that are necessary to support development be available and "concurrent" with the impacts of development. All new development must be located where existing services are available or where there are plans and funds to provide these services. In 1992, legislation was passed authorizing the creation of Transportation Concurrency Management Areas (TCMA). The purpose of a TCMA is to "promote infill development or redevelopment within selected portions of urban areas in a manner that supports the provision of more efficient mobility alternatives, including public transit" (Steiner 2001). Florida's concurrency principles have been criticized for their ineffectiveness in reducing uncontrolled, sprawling growth (Downs 2003).

Another statewide program intended to reduce the negative aspects of sprawling development patterns is the creation of regional planning councils. These councils (eleven total and five within the study area) assist member units of local government in responding to statutory planning requirements, which include technical assistance, local plan review, dispute resolution/facilitation, and GIS mapping support. Each council also drafts a Strategic Regional Policy Plan that is intended to serve as a long-range guide for physical, economic, and social development of a region through identified goals and policies. While the authority of these councils has been greatly reduced in recent years, they are still active organizations working to ensure that growth is consistent at the regional level (Catlin 1997).

While often criticized for their lack of effectiveness in managing growth, the presence of these planning programs demonstrates existing capacity for and a commitment to sustainable patterns of growth. We would, therefore, expect local jurisdictions in Florida to be more likely to adopt sprawl-reduction policies in their comprehensive plans.

Sample Selection

Thirty adjacent counties covering the southern portion of Florida and the Everglades ecosystem plus the sixteen largest cities in land area were selected for analysis (Figure 1). Since the goal is to achieve the greatest level of spatial coverage, cities were selected based on area rather than population. Cities selected by land area were essentially the same as if they were selected by population size (the rank order differs), but the rationale is important since one of the goals of the study is to assess the spatial distribution of policies. Selecting forty-six adjacent local jurisdictions provided the opportunity to map and graphically analyze the mosaic of SRPPs across a contiguous area and maintain a regional-level focus where sprawl tends to be most easily identified.

The most recent comprehensive plans for counties and cities in the sample were evaluated for the presence or absence of the five SRPPs to determine their overall potential to mitigate the adverse environmental impacts of sprawl. Two trained coders working independently of each other evaluated the sample of plans. An "intercoder reliability score" was computed equal to the number of coder agreements for indicators divided by the total number of indicators. We calculated a score of 97 percent. The literature suggests that an intercoder reliability score in the range of 80 percent is generally considered acceptable (Miles and Huberman 1994).

Concept Measurement

The dependent variable, sprawl-reduction plan quality, was measured by evaluating the comprehensive plan for each jurisdiction in the sample against the five SRPPs: transfer of development rights, conservation easements, clustering, environmental mitigation, and density bonuses. Each policy was measured on a 0 to 2 ordinal scale, where 0 is *not identified or mentioned*, 1 is *suggested or identified but not detailed*, and 2 is *fully detailed or mandatory* in the plan. One limitation of this study is that it evaluates plans as guides for future development as

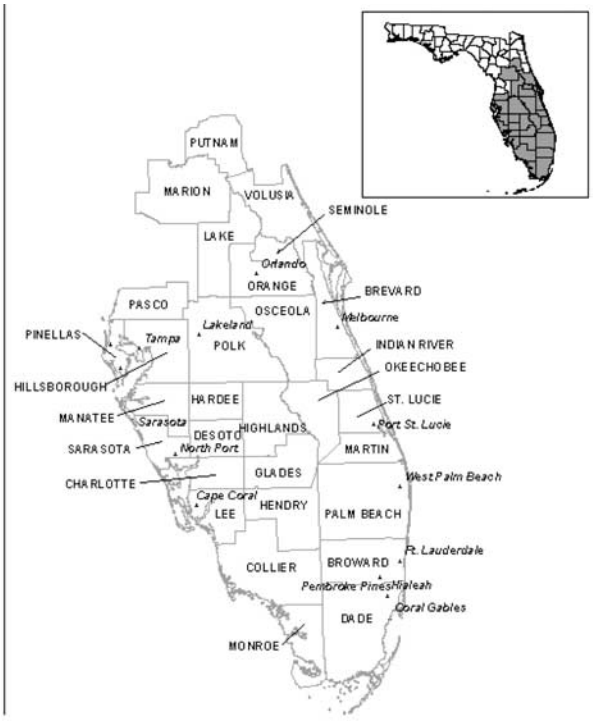

Figure 1. *Study area and sample of jurisdictions.*

opposed to determining how these policies are implemented after the plans are adopted. Even if a policy is present and mandatory in a plan, there is no guarantee this policy is implemented as a regulation and enforced by the local jurisdiction. However, we can assume that higher-scoring plans have a greater likelihood of being implemented, because local comprehensive plans in Florida are legally binding instruments. In fact, jurisdictions in Florida have been sued by the state when their plans were found to be in noncompliance.

A measure of total sprawl-reduction plan quality was calculated for each jurisdiction by (1) summing across all policies for a given jurisdiction's plan, (2) normalizing this score by dividing by the total number of indicators, and (3) multiplying the fractional score by 10 to place the variable on a 0 to 10 scale (as previously done by Berke et al. 1996; Berke et al. 1998; Brody, Carrasco, and Highfield 2004). That is,

$$SRPP_j = \frac{10}{2m_j} \sum_{i=1}^{m_j} I_i, \qquad (1)$$

where $SRPP_j$ is the SRPP index for the jth jurisdiction and m_j is the number of policies within the jth jurisdiction.

We measured environmental variables using satellite images of land cover generated by the Florida Fish and Wildlife Conservation Commission (FFWCC), which predict species overlap and identify "hot spots" of biodiversity. Areas of biodiversity based on the overlap of forty-four focal species (identified by the FFWCC) were selected for final analysis. These focal species serve as umbrella or indicator species of overall biodiversity in Florida (Cox et al. 1994). Each pixel in the raster-based data layer was assigned a value on a scale of 1 to 3 depending on the number of species overlap. We calculated the amount of biodiversity by calculating the area of all values (1-3) and dividing that value by the total area of a jurisdiction. The amount of disturbance was calculated in a similar manner based on the same land-cover image developed by the FFWCC. Areas interpreted as disturbed land cover (grassland and agriculture, shrub and brush, barren and urban, and exotic species) were summed in a rasterized coverage and then divided by the area of a jurisdiction, creating a disturbance variable on a scale of 0 to 1.

We measured socioeconomic and demographic independent variables with data obtained from the 2000 U.S. Census. Socioeconomic variables used in the regression analysis included the following: population density (population per square mile), education (percentage of the population with a high school degree), and wealth (median home value). For education and wealth data, we used the square root to reduce skewness and potentially biased results. We also included a measure of planning-agency capacity. Information on planning capacity was obtained by contacting each planning department in the sample and was measured based on the number of staff devoted to writing the comprehensive plan. Generally, the more personnel devoted to drafting a plan, the stronger it tends to be. For more detail on concept measurement, see Appendix A.

Data Analysis

The data were analyzed in two phases. First, we examined the presence (or absence) of each SRPP for every jurisdiction in the sample. Results in this phase were reported using both descriptive statistics and GIS mapping techniques to visually assess the distribution of SRPPs across the study area. Mapping policies enabled us to more easily identify locations in southern Florida where sprawl-reduction policies are lacking and to isolate inconsistencies in policy adoption among adjacent jurisdictions. In the second phase, we conducted OLS regression analysis to explain the effects of socioeconomic, demographic, and environmental variables on the strength of the overall sprawl-reduction measure. This analysis allowed us to test specific hypotheses on the major factors influencing a

jurisdiction to adopt SRPPs and provided insight on how other communities can effectively adopt such policies in the future.

Tests for model specification, multicollinearity, and spatial autocorrelation revealed no violation of OLS regression assumptions. The threat of spatial autocorrelation was of particular importance since our sample consisted of adjacent jurisdictions as opposed to a randomly selected sample. A Global Moran's I statistic and a local indicator of spatial autocorrelation found no significant results that would violate regression assumptions. However, a Cook and Weisberg test for heteroskedasticity was statistically significant at the .05 level, prompting us to use robust standard errors in the regression analysis. In addition, a series of diagnostics were performed to test for influential data points or outliers because influential data points may have a significant impact in a sample as small as forty-six. No influential data points were discovered.

► Results

Statistical and Spatial Distribution of SRPPs

The overall statistical and spatial distribution of SRPPs varies widely across the study area. For example, while almost 70 percent contains some type of policy for TDRs (Table 1), as shown in Figure 2, there are notable spatial gaps in several areas. Mandatory policies for TDRs are located in jurisdictions primarily in the north and northwest portions of the study area. Extensive spatial coverage exists for the Tampa Bay watershed encompassing Hillsborough, Pinellas, and Pasco counties (see Pinellas County Comprehensive Plan, http://www.pinellascounty.org/Plan/default.htm and http://www.pinellascounty.org/Penny/default.htm). Adjacent jurisdictions in the eastern portion of the study area from Indian River south to Palm Beach County also contain mandatory TDR policies. In contrast, jurisdictions encompassing the urban corridor from Miami to Fort Lauderdale have not adopted TDR policies in their comprehensive plans. It should be noted that this corridor has undergone rapid growth over the past several decades where sprawling residential development has spread west toward the Everglades National Park boundary.

While the same percentage of jurisdictions has adopted conservation-easement policies (either suggested or mandatory) in their local plans, the intensity of these policies and their spatial distribution is quite different from TDRs. First, there seems to be a comparative lack of commitment for implementing conservation easements that protect critical habitats, because this policy is suggested rather than mandated for more jurisdictions (only half of the sample contains mandatory policies). This difference is noteworthy because it is often assumed that weaker language in a plan will reduce the likelihood of implementation. In terms of the spatial pattern of conservation-easement policies, the majority of mandatory coverage lies in the north and northwest portions of the study area (Figure 3). In contrast, most of the southern tip of Florida and areas north of Lake Okeechobee surrounding the city of Orlando did not have conservation easements in local plans at the time of this study. Figure 3 also shows that jurisdictions in the central portions of the study area do not emphasize conservation easements in their plans. Interestingly, these areas have experienced lower rates of population growth and development compared with coastal cities.

All but four of the jurisdictions sampled have adopted some type of environmental mitigation/restoration policy in their comprehensive plans. This result is expected since mitigation is our broadest indicator of sprawl and is required for wetland alteration by the state of Florida. Nevertheless, as shown in Figure 4, there are several jurisdictions with no mitigation policy, all of which are cities, including Fort Lauderdale, Orlando, and Sarasota. Also, the neighboring counties of Osceola and Okeechobee, which are situated along the Kissimmee River, have only suggested mitigation polices in their comprehensive plans.

Over 60 percent of the sample contains policies for clustering development to protect critical habitats. Notable absences include the entire southeast portion of the study area from West Palm Beach to the south of Coral Gables and counties to the north of Lake Okeechobee (Figure 5). Density bonuses, the final sprawl-reduction policy evaluated, appear the least in the sample of plans. Only 26 percent of the jurisdictions sampled has adopted a density-bonus policy to maintain a dense urban center and reduce sprawling growth patterns (Table 1). Except for Palm Beach County, this SRPP is absent for the entire area south of Lake Okeechobee where sprawling commercial and residential development patterns have been a central issue for planners (Figure 6).

The total measure of sprawl-reduction plan quality (sprawl index) is perhaps the most useful indicator to analyze, because effective sprawl-mitigation programs rely not on a single technique but on a combination of policies exerting a cumulative effect. The average SRPP index score is 5.76 (on a scale of 0-10), signifying a relatively weak local commitment to mitigating sprawl in a region that is undergoing rapid growth and development. Figure 7 shows that the strongest overall sprawl-reduction measures occur in jurisdictions in the very north and northwest portions of the study area. Hillsborough, Lake, Marion, Highlands, and Volusia counties all receive the

Table 1.
Presence and intensity of SRPPs by jurisdiction.

	TDRs	*Conservation Easements*	*Environmental Mitigation*	*Clustering Growth*	*Density Bonuses*	*SRPP Index*
County Jurisdictions						
Brevard	0	0	2	0	0	2
Broward	1	1	2	1	0	5
Charlotte	2	1	2	0	0	5
Collier	2	2	2	2	0	8
Dade	0	0	2	1	0	3
De Soto	0	2	2	2	0	6
Glades	1	0	2	2	0	5
Hardee	0	0	2	2	0	4
Hendry	0	1	2	2	0	5
Highlands	2	2	2	2	2	10
Hillsborough	2	2	2	2	2	10
Indian River	2	2	2	2	0	8
Lake	2	2	2	2	2	10
Lee	1	2	2	2	0	7
Manatee	2	2	1	2	1	8
Marion	2	2	2	2	2	10
Martin	2	0	2	2	1	7
Monroe	2	0	2	2	0	6
Okeechobee	0	1	1	1	0	3
Orange	2	0	2	2	2	8
Osceola	1	1	1	1	1	5
Palm Beach	2	2	2	0	2	8
Pasco	2	2	2	2	1	9
Pinellas	2	2	2	0	2	8
Polk	2	0	2	0	0	4
Putnam	2	0	2	0	0	4
Sarasota	2	2	2	2	0	8
Seminole	0	2	2	2	0	6
St. Lucie	2	2	2	2	0	8
Volusia	2	2	2	2	2	10
City Jurisdictions						
Cape Coral	0	0	0	0	0	0
Clearwater	2	2	2	0	0	6
Coral Gables	0	0	1	0	0	1
Ft. Lauderdale	1	1	0	0	0	2
Hialeah	0	0	0	0	0	0
Lakeland	0	1	2	2	0	5
Melbourne	2	1	2	0	0	5
Miami	0	0	2	1	0	3
North Port	2	2	2	0	0	6
Orlando	2	2	2	2	0	8
Pembroke Pines	0	2	2	0	0	4
Port St. Lucie	2	2	2	0	0	6
Sarasota	0	0	0	0	0	0
St. Petersburg	2	2	1	0	0	5
Tampa	2	1	2	2	0	7
West Palm Beach	2	2	1	2	0	7
Average	0.690	0.690	0.91	0.630	0.260	5.761

Note: SRPP = Sprawl-reduction planning policy; TDR = Transfer of development rights.

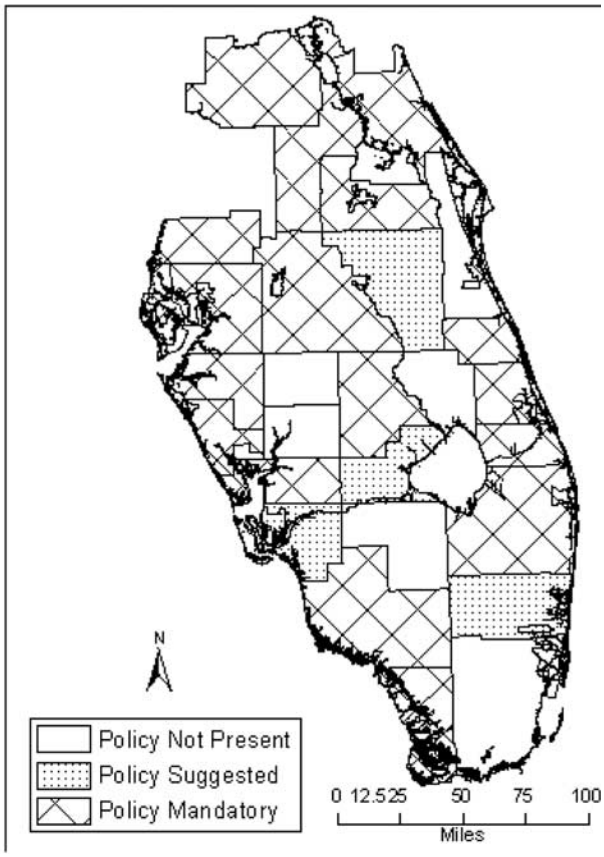

Figure 2. *Spatial distribution of transfer of development rights.*

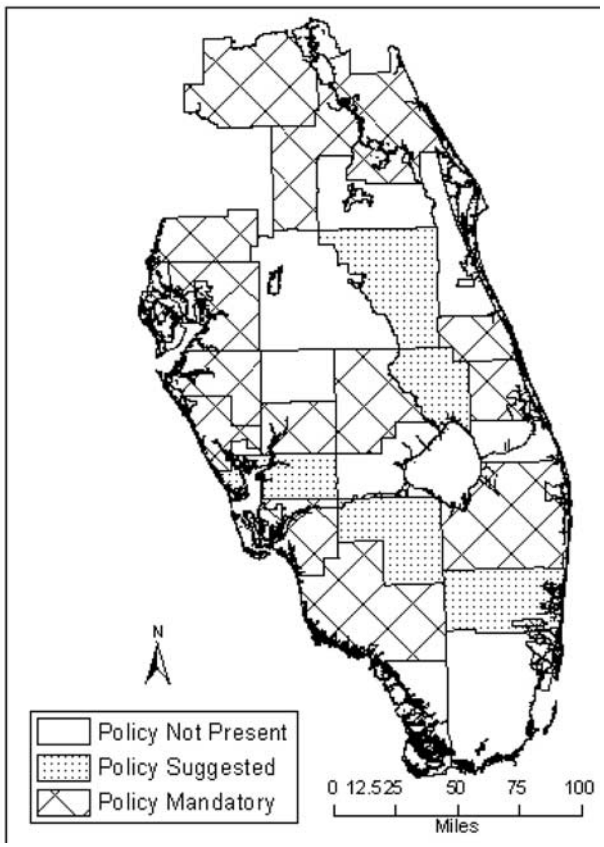

Figure 3. *Spatial distribution of conservation-easement policies.*

highest possible total SRPP score, indicating that these jurisdictions are dedicated to proactive approaches to mitigating the adverse environmental impacts of sprawl.

For example, in 2000, Volusia County initiated two local land-acquisition programs: Volusia Forever and ECHO (see Volusia County Government, http://volusiaforever-echo.com/inside.htm). Volusia Forever, consisting of an ad valorem tax, will provide $4 million a year exclusively for the purchase of environmentally sensitive lands, water-resource protection, and outdoor recreation lands. Over a twenty-year period, the initiative is projected to raise an estimated $99 million. Similarly, the Volusia ECHO program will finance the acquisition, restoration, construction, and improvement of ecological, cultural, historic, and outdoor recreation facilities for public use. The initiative is expected to raise an estimated $80 million over a twenty-year period. The weakest set of policies occurs in the southeast portion adjacent to the Everglades National Park and the north central areas near Orlando. Another important observation is that on average, counties score much higher than cities (a mean score of 6.6 vs. 4.0). Also, high-scoring counties tend to surround low-scoring cities. For example, while Sarasota County scored an 8, the city of Sarasota scored a 0.

Explaining the Variation in Sprawl-Reduction Plan Quality

Multiple regression analysis allowed us to identify some of the major factors contributing to the adoption of SRPPs in local plans (Table 2). Increasing population density significantly ($p < .05$) reduces the number and strength of sprawl-mitigation measures, confirming previous results based on modeling plan quality (Burby and French 1981; Burby and Dalton 1994; Dalton and Burby 1994). This result suggests that jurisdictions with high population concentrations or dense urban cores have little motivation to adopt land-use strategies that protect open space and reduce sprawling development.

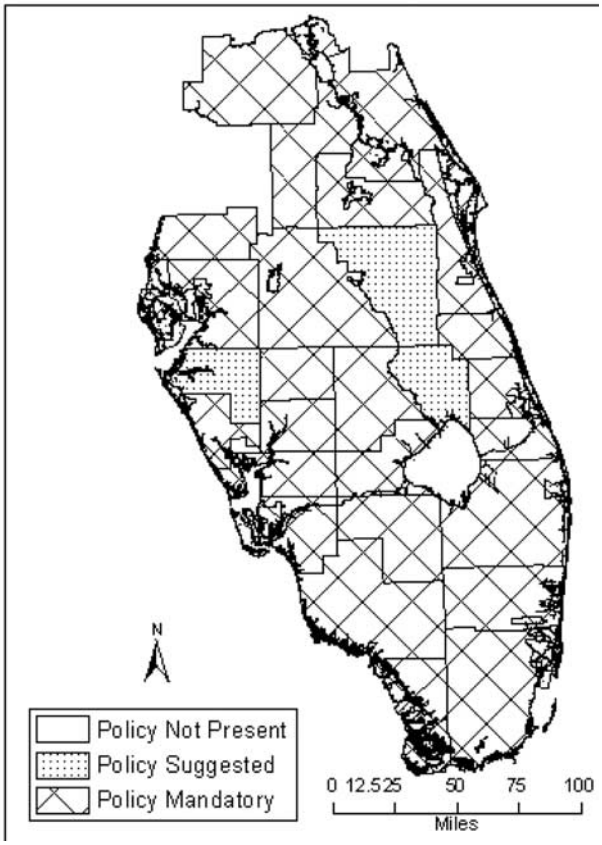

Figure 4. *Spatial distribution of environmental-mitigation/restoration policies.*

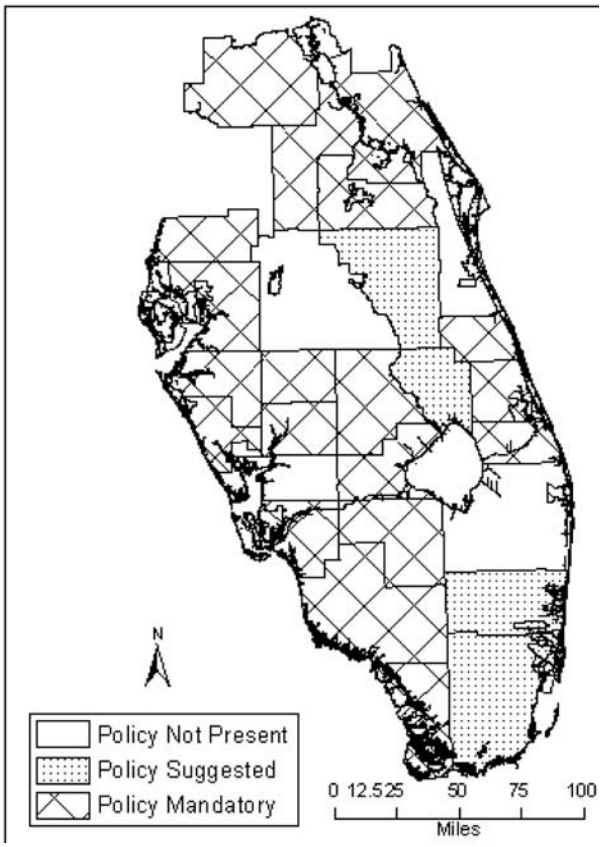

Figure 5. *Spatial distribution of clustering-development policies.*

Similarly, jurisdictions with wealthy populations on average have significantly lower SRPP scores. In contrast, education has a significant positive effect on the adoption of sprawl-reduction policies. Communities with high levels of education, and perhaps awareness of the environmental impacts of sprawl, consistently include sprawl-mitigation measures in their comprehensive plans.

Local planning-agency capacity also significantly increases the degree of sprawl-reduction policies adopted by local jurisdictions. That is, as the number of professional planners working on a comprehensive plan increases, the likelihood that SRPPs will be approved also increases. While past research has shown a significant relationship between the levels of biodiversity, human disturbance, and the environmental aspects of plan quality (Brody 2003a; Brody, Carrasco, and Highfield 2004), this study found no such evidence. While no serious multicollinearity was observed in the model, it is important to note that disturbance and population density are highly correlated, possibly contributing to a diminished statistical effect on the dependent variable (Appendix B).

► Discussion and Planning Implications

Visual and statistical analyses of the data indicate that local plans in southern Florida vary in their potential to mitigate sprawling growth patterns through the adoption of five selected land-use policies. This variation shows a clear spatial trend within the study area: jurisdictions to the north of Lake Okeechobee and those in the southeast urban corridor extending from Fort Lauderdale to Coral Gables are lacking policies believed to reduce the adverse effects of sprawl. It may come as no surprise that these same areas are experiencing or are slated to experience rapid growth and development extending outward from traditional urban areas. For example, Polk and Osceola counties, which lie to the south of Orlando, have begun to be affected by sprawling growth partly emanating from tourism development in the Orlando area. Between 2000 and 2003, Osceola County gained more than 33,000 new residents, making it, percentage-wise, the second fastest growing county in Florida and eighteenth in the United States (2000 U.S. Census Bureau). High growth areas such as this are

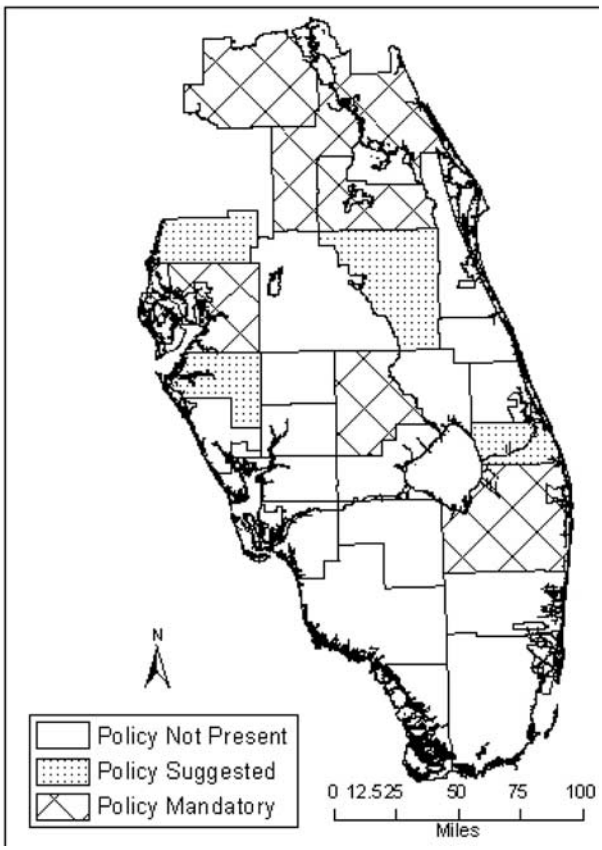

Figure 6. *Spatial distribution of density-bonus policies.*

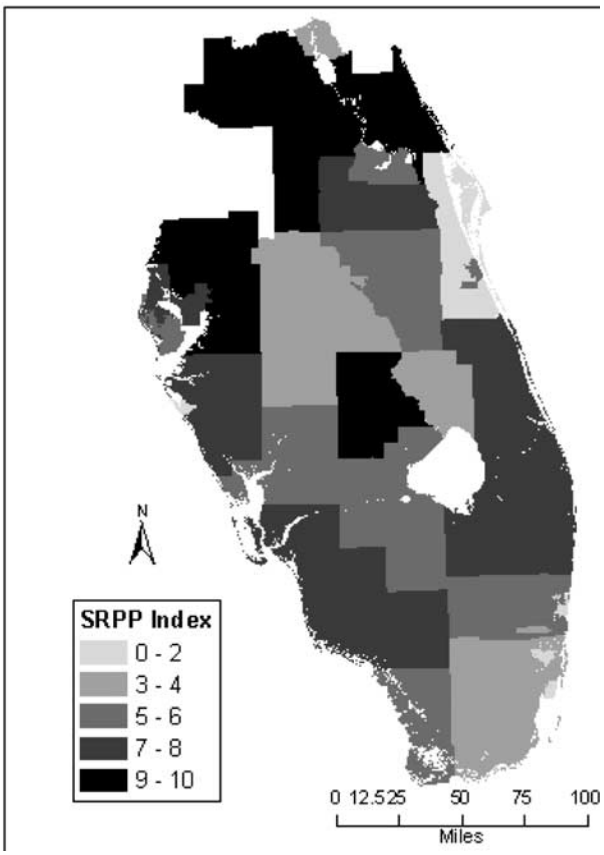

Figure 7. *Sprawl-reduction planning policies index.*

Table 2.
Explaining the adoption of sprawl-reduction planning policies.

	Coefficient	*Robust Standard Error*	t-*Value*	*Significance*
Population density	–1423.370	586.381	–2.43	0.020
Median home value	–0.013	0.005	–2.30	0.027
Education	1.664	0.756	2.20	0.034
Planning capacity	0.051	0.025	2.08	0.044
Biodiversity	3.248	2.733	1.19	0.242
Disturbance	3.070	3.752	0.82	0.418
Constant	–7.488	7.869	–0.95	0.347
n	46			
F-ratio (6, 39)	6.59			
Significance	0.0001			
R^2	0.3191			
Root mean square error	2.445			

particularly vulnerable to the negative environmental impacts of sprawl without proper land-use policies in place.

Conditions differ in the southeast part of the study area where SRPPs are also lacking in comprehensive plans. In this area, extensive development has already taken place to the point where there is a continuous urban corridor along the coast, particularly between Miami and Fort Lauderdale. However, rapid development continues to persist in the form of commercial and residential sprawl. Despite state efforts to contain growth, office and housing developments are pushing west, impeded only by the boundaries of the Everglades National Park. For example, virtually all office growth in Miami-Dade County in the past fifteen years has occurred outside of Miami's downtown. From 1987 to 2002, Miami-Dade's non-CBD market grew 60.3 percent to include nearly 30 million square feet of office space. In contrast, office space in Miami's CBD increased just 4.7 percent over this same period (Lang 2003). The cumulative impacts from development adjacent to the Everglades ecosystem stress an already-declining natural system. While sprawl is occurring in several jurisdictions lacking SRPPs, this article does not suggest that local planning frameworks alone are determinants of sprawl. Additional research is needed to further measure the incidence of sprawl (which this study does not attempt to do) and examine the relationships between sprawl and plan-quality measures.

Aside from the apparent spatial pattern of SRPPs across the study area, results also suggest an overall weak level of commitment from local jurisdictions to mitigate the threat of sprawl. In a state with multiple environmental and antisprawl programs and a strong local planning mandate, one might expect to observe a greater degree of sprawl-reduction strategies in local plans, particularly as measured through five common land-use policies. However, the incidence of sprawl is often considered a regional phenomenon, and we believe that low average SRPP scores can be explained by an attitude among local communities and planners that the problem is the responsibility of state and federal officials. While the state's Eastward Ho! Initiative and Sustainable Communities Demonstration Project have made some progress toward reducing the prevalence of sprawling development, sprawl cannot be effectively mitigated unless the problem is also addressed by local plans and planning frameworks.

A lack of regional thinking may also partly explain why cities in the sample scored so much lower than counties. One explanation could be that because the cities evaluated in this study are almost entirely built out, there is little room to grow and little reason to adopt land-use strategies requiring existing open space, such as density bonuses or clustering of development. This rationalization is supported by the regression analysis in which overall population density significantly decreases SRPP scores. Another explanation, as mentioned above, is that sprawl is consistently viewed as a regional problem and therefore not the responsibility of a city jurisdiction or its plan. In fact, cities in Florida often look to their respective county for guidance on hazard mitigation, environmental management, and other seemingly regional issues (Godschalk, Brody, and Burby 2003). While sprawl is indeed a regional problem, it is manifested at the local level with growth spiraling away from existing urban cores into adjacent jurisdictions. Thus, cities such as Sarasota and Fort Lauderdale must coordinate with adjacent counties and integrate sprawl-reduction strategies into their comprehensive plans to effectively mitigate the problem. Still, another explanation for the apparent lack of planning interest to reduce sprawl in cities is the power of local developers and others with material interest in sprawling growth patterns to impede the implementation of plans. While it is beyond the scope of this study to examine political-economy factors, it is important to note the influence of the development community to shape growth patterns when market conditions provide the opportunity for financial gain.

Some of the results from multiple regression analysis also have important local planning implications because they help explain why communities are adopting sprawl-reduction, land-use policies. First, jurisdictions with wealthier populations have significantly lower instances of SRPPs in their plans. In Florida, the preferences of wealthy retirees and second homeowners fuel the development of residential subdivisions and segregated gated communities. Few prospective buyers tend to live in dense urban areas or new urbanist communities but instead prefer large single-family houses in a suburban setting. As a principal driver of sprawl, this trend needs to be addressed by local planning agencies, developers, and property owners.

Second, jurisdictions with higher levels of education adopt significantly more sprawl-mitigation policies in their comprehensive plans. Higher education can be associated with greater environmental awareness and concern for community livability standards. Through its mandated public-participation process, citizens have the opportunity to impact the content and quality of a final plan (Brody, Godschalk, and Burby 2003; Brody 2003b). Educated participants thus may be influencing the types of issues addressed in the planning process as well as the specific policies adopted. While planning organizations cannot influence the level of residents' formal education, they can use educational techniques to improve their plans' quality. Brochures, workshops, seminars, Internet learning modules, and other efforts can be effective techniques for raising the

public consciousness about the adverse impacts of sprawl and, ultimately, for strengthening local plans to reduce the occurrence of sprawl.

Third, greater planning-agency capacity leads to stronger sprawl-mitigation measures within local comprehensive plans. A larger number of professional planners working on a plan can translate into increased technical expertise and training associated with sustainable growth and environmental management. The challenge for planning organizations, however, will be to anticipate future rapid growth and fortify planning staffs accordingly before sprawl takes place. Small rural communities with limited planning staff can be overwhelmed by explosive regional development projects. Yet matching planning-agency capacity with the level of expected regional growth could help trigger the adoption of SRPPs before adverse environmental impacts take place. Increasing the authority and activeness of regional planning councils may also help boost the capacity of multiple neighboring jurisdictions to plan more effectively for sprawl reduction. Larger planning staffs will not alone reduce sprawl in Florida, but taking proactive measures to anticipate and appropriately accommodate rapid growth is an important course of action that may result in positive effects.

► Conclusion

While the majority of research on sprawl focuses on how communities' growth-management decisions can exacerbate sprawl and result in negative impacts, this study examines how and why local jurisdictions take measures to mitigate sprawling development patterns. Evaluating the presence and intensity of five sprawl-reduction policies enabled us to identify which jurisdictions in the study area are committed to sustainable growth through local planning. Mapping and graphically analyzing sprawl-reduction policies allowed us to see precisely where SRPPs are in place among multiple jurisdictions and to isolate gaps in a regional mosaic of growth management. Finally, statistically modeling the variation in SRPPs provided insight into what is stimulating communities to adopt smart growth measures and how they can more effectively use local planning instruments to reduce sprawl in the future.

While this study provides some useful results, it should be considered only a starting point for empirically examining the topic of sprawl-reduction techniques. Additional research is needed before any conclusions can be made about how or why local jurisdictions adopt antisprawl measures. First, a sample of forty-six jurisdictions lacks statistical power, and these results should be considered preliminary. Larger sample sizes covering broader, more diverse regions and multiple states will allow for more advanced analytical techniques and confidence in interpreting the results. Second, a more comprehensive measure of sprawl-reduction plan quality is needed to thoroughly explore the topic. The five policies evaluated in this study should be considered only a starting point for developing a more detailed instrument with which to evaluate plans. Third, case-study analysis of specific jurisdictions would complement statistical analyses and provide a more detailed contextual picture of how and why communities are adopting antisprawl techniques in local plans and the impact of political-economy factors on the pattern of regional development. Fourth, more work should be done to understand the relationship between plan quality and the occurrence of sprawl. Before this can be accomplished, an accurate spatial measure of sprawl or nonconforming development must be developed that can systematically be applied to large regions. Fifth, measuring the degree to which the state mandate on concurrency is affecting the development patterns of local jurisdictions would provide important information on the effectiveness of such programs. Finally, the implementation of sprawl-reduction policies should be studied in more detail. A high-quality plan does not necessarily translate into strong implementation of policies even if the plan is a legally binding instrument. Until we can adequately describe and explain the quality of implementation associated with growth-management strategies, our understanding of how to mitigate sprawl will be incomplete (for more detail, see Brody and Highfield 2005). As suggested in the results section, the amount of funding invested in a particular strategy could indicate the level of commitment and the degree of implementation associated with reducing sprawl.

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▶ Appendix A: Concept Measurement

Variable	*Type*	*Measurement*	*Scale*	*Source*	*Mean*	*Standard Deviation*
Sprawl-reduction plan quality (SRPP index)	Dependent	Sum of five SRPPs (normalized and standardized)	Interval (0-10)	Sample of plans	5.76	2.76
Area of biodiversity	Independent	Percent of jurisdiction with high levels of biodiversity based on the overlap of 44 focal species	Interval	GIS calculation from FFWCC data layer	0.27	0.21
Area of jurisdiction that is disturbed	Independent	Percent of jurisdiction with disturbed areas	Interval	GIS calculation from FFWCC data layer	0.53	0.18
Planning-agency capacity	Independent	Number of planners devoted to drafting the plan	Continuous	Survey	17	13.21
Educational attainment	Independent	Percentage of the population with a high school degree	Interval	2000 U.S. Census	78.73	8.80
Population density	Independent	Population per square kilometer of each jurisdiction	Interval	GIS calculation and 2000 U.S. Census	479.54	618.19
Wealth	Independent	Median home value	Interval	2000 U.S. Census	108,804	46,790.14

Note: FFWCC = Florida Fish and Wildlife Conservation Commission; GIS = Geographic Information Systems; SRPP = Sprawl-reduction planning policy.

▶ Appendix B: Correlation Matrix

Variables	*Plan Quality*	*Population Density*	*Wealth*	*Education*	*Planning Capacity*	*Disturbance*	*Biodiversity*
Plan quality	1.000						
Population density	–0.351**	1.000					
Wealth	–0.199	0.159	1.000				
Education	0.215	–0.046	0.438***	1.000			
Planning capacity	0.217	0.231	0.115	0.232	1.000		
Disturbance	–0.135	0.552***	–0.330**	–0.270*	0.096	1.000	
		0.000	0.025				
Biodiversity	0.232	–0.557***	0.119	0.009	–0.059	–0.753***	1.000

*$p < 0.1$. **$p < 0.05$. ***$p < 0.01$.

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