Implementing the Principles of Ecosystem Management Through Local Land Use Planning

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While ecosystem approaches to management focus on broad spatial scales, decision makers increasingly recognize that implementation must occur at the local level with local land use decisions. This article examines the ability of local comprehensive plans in Florida to incorporate the principles of ecosystem management. It seeks to understand how comprehensive plans can effectively contribute to the management of ecological systems by systematically evaluating local plans against a conceptual model of what makes for a high quality ecosystem plan. Results measure the relative strengths and weaknesses of local plans to achieve the objectives of ecosystem management and provide direction on how communities can improve their environmental frameworks.

KEY WORDS: ecosystem management; comprehensive planning; plan quality; Florida.

INTRODUCTION

In response to the increasing decline of critical natural resources across the United States, public decision makers are abandoning the traditional species by species approach to regulation and instead are embracing ecosystem approaches to management. Ecosystem management represents a departure from traditional management approaches by addressing the interaction between biotic and abiotic components within a land or seascape, while at the same time incorporating human concerns (Grumbine, 1994;

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Szaro et al., 1998). In this approach, entire ecological systems, and the ecological processes within them, become the framework for management efforts. Both academics and policy makers have proposed ecosystem management as a new "paradigm" of management and an improved framework for protecting resources over the long term (Christensen et al., 1996; Cortner and Moote, 1999). At least 18 federal agencies have committed to the principles of ecosystem management and are exploring how this concept can be incorporated into their present day activities (Haeubner, 1998). The most recent survey identified over 600 ecosystem management projects ranging from the Greater Yellowstone Ecosystem (GYE) and the Everglades Ecosystem to the Chesapeake Bay and the Gulf of Maine (GOM) (Yaffee et al., 1996).

Planners and managers increasingly recognize that while ecosystem management requires looking beyond specific jurisdictions and focusing on broad spatial scales, the approach will in part be implemented at the local level with local land use decisions. Furthermore, ecosystem approaches to management may not be realized solely by structural or engineering approaches to management, but by the coordination of local plans and policies across larger landscapes (Kirklin, 1995; Beatley, 2000). Local level planning therefore must be considered along with other spatial and jurisdictional scales when it comes to managing entire ecological systems. The factors causing ecosystem decline, such as rapid urban development and habitat fragmentation occur at the local level and are generated by local land use decisions (Noss and Scott, 1997). The vast majority of these decisions affecting large ecosystems will be made at a smaller scale where they make the largest impact on the natural environment (Endter-Wada, 1998; McGinnis et al., 1999). As a result, some of the most powerful tools that threaten or protect natural habitat are in the hands of county commissioners, city councils, town boards, and local planning staff. Thoughtful policies and actions at the local level can often protect critical habitats of regional significance more effectively and less expensively than the best intentioned state or federal protection schemes (Duerksen et al., 1997). The importance of local ecosystem-based planning is further highlighted by the declining role of the federal government in the protection of habitat and associated ecological systems over the past 10 years, and a future political climate that suggests giving more control to local jurisdictions when it comes to making resource use decisions.

While much research has been geared toward instituting the broad principles of managing natural systems, comparatively little work has been done to evaluate the specific tools and strategies involved in implementing ecosystem management. To date, little or no research has been conducted

to determine how local jurisdictions can incorporate the principles of ecosystem management into their planning and regulatory frameworks. Ecosystem management was derived from federal-level thinking, but effective implementation will be achieved at the local level with sound planning efforts. Long-term success of ecosystem approaches to resource management thus rests on understanding how local plans effectively capture their key principles and practices.

I conducted this study in recognition of the problems facing ecosystem management in the United States and the general lack of applied research in addressing these problems. My primary objective was to examine the ability of local comprehensive plans in Florida to embody and implement the principles of ecosystem management. While ecosystem approaches to management take place at a variety of geographical scales and jurisdictional levels, this article focuses on the role of local jurisdictions comprised of a mosaic of private and public land ownership. Understanding the degree to which local communities incorporate the principles of ecosystem management into their comprehensive plans can provide important insights into how ecosystems and their components can be strategically managed in the future. It is important to note that this study examines the quality of plans, not the quality or extent of the plans' implementation. Overall, results indicate that while certain components of plans support the principles of ecosystem management, local jurisdictions in Florida are ill-equipped to manage sustainably natural systems despite a strong regional and state emphasis on such an approach.

The following section derives a conceptual definition of ecosystem plan quality by adding ecological considerations to existing conceptions of what make a high quality plan. From this discussion a plan coding protocol for evaluating local plans is presented. Sample selection and data analysis procedures are then described. Next, statistical results are presented for plan components as well as each issue within a component. Finally, I suggest planning recommendations based on the results to improve the ability of local jurisdictions to manage broader ecological systems in Florida and in other states.

CONCEPTUALIZING ECOSYSTEM PLAN QUALITY

Researchers increasingly use plan quality both as an outcome variable for assessing the planning process, and as a causal variable for assessing the plan implementation process. The ability to code and measure indicators within a plan has made plan quality a widely used instrument with

which to quantitatively assess the quality of management efforts. While previous research provides a conceptual and methodological basis for determining the quality of a plan, no study to date has linked plan quality to achieving the principles of ecosystem management. Furthermore, no scholar has thoroughly explored how the ecological and social components of ecosystem management can be captured and measured in a local land use plan. The remainder of this section builds upon the theories and practices of both ecosystem management and plan quality to conceptualize the dependent variable of the study, ecosystem plan quality.

The first major step in developing a definition of ecosystem plan quality is to extend established planning theory and practice by adding ecosystem considerations to existing conceptions of what constitutes a high quality plan. This study builds on and extends previous conceptions of plan quality, which identify factual basis, goals, and policies as its core components (Kaiser et al., 1995) by adding the two additional plan components of inter-organizational coordination & capabilities and implementation. The first additional component captures more accurately the aspects of collaboration and conflict management often required with ecosystem approaches to management. The implementation component measures how likely the goals, objectives, and policies in the plan are to be put in place (not if implementation actually occurred). This component captures, among other issues, the concepts of ecological monitoring, enforcement, and a commitment to put the adopted plan in place. The addition of these components to original conceptions enables the definition of plan quality to more effectively capture the principles of ecosystem management. Plan quality is thus conceptualized (and measured) through the following five components: Factual Basis; Goals and Objectives; Inter-organizational Coordination and Capabilities; Policies, Tools and Strategies; and Implementation. Together these five plan components constitute the ability of a local plan to manage and protect the integrity of ecological systems. As mentioned above, the five plan components by themselves constitute the basis of a high quality plan but have never been considered with respect to ecosystem approaches to management. This study makes its strongest contribution to the existing planning literature by linking generic plan quality components to the principles of ecosystem management.

Indicators (or items) within each plan component further "unpack" the conceptions of plan quality. A "plan coding protocol" listing each plan component and indicator is provided in Table 1. I used this protocol to evaluate and measure plan quality for a random sample of local comprehensive plans in Florida. Each plan component in the protocol is described below in more detail.

TABLE 1

Ecosystem Plan Coding Protocol

Factual Basis		
	1. Resource Inventory	
Ecosystem boundaries/ edges	Ecological zones/habitat types	Ecological functions
Species ranges	Habitat corridors	Distributions of vertebrate species
Areas with high biodiversity/species richness	Vegetation classified	Wildlife classified
Vegetation cover mapped	Threatened & endangered species	Invasive/exotic species
Indicator/keystone species	Soils classified	Wetlands mapped
Climate described	Other water resources	Surface hydrology
Marine resources	Graphic representation of transboundary resources	Other prominent landscapes
	2. Ownership Patterns	
Conservation lands mapped	Management status identified for conservation lands	Network of conservation lands mapped
Distribution of species within network of conservation lands		
	3. Human Impacts	
Population growth	Road density	Fragmentation of habitat
Wetlands development	Nutrient loading	Water pollution
Loss of fisheries/marine habitat	Alteration of waterways	Other factors/impacts
Value of biodiversity identified	Existing environmental regulations described	Carrying capacity measured
Incorporation of Gap Analysis data		
	Goals and Objectives	
Protect integrity of ecosystem	Protect natural processes/ functions	Protect high biodiversity
Maintain intact patches of native species	Establish priorities for native species/habitat protection	Protect rare/unique landscape elements
Protect rare/endangered species	Maintain connection among wildlife habitats	Represent native species within protected areas

TABLE 1 (*Continued*)

Goals and Objectives		
Maintain intergenerational sustainability of ecosystems	Balance human use with maintaining viable wildlife populations	Restore ecosystems/critical habitat
Other goals to protect ecosystems	Goals are clearly specified	Presence of measurable objectives
Inter-Organizational Coordination & Capabilities for Ecosystem Management		
Other organizations/stakeholders identified	Coordination with other organizations/jurisdictions specified	Coordination within jurisdiction specified
Intergovernmental bodies specified	Joint database production	Coordination with private sector
Information sharing	Links between science and policy specified	Position of jurisdiction within bioregion specified
Intergovernmental agreements	Conflict management processes	Commitment of financial resources
Integration with other plans/policies	Other forms of coordination	
Policies, Tools, & Strategies		
A. Regulatory Tools		
Resource use restrictions	Density restrictions	Restrictions on native vegetation removal
Removal of exotic/invasive species	Buffer requirements	Fencing controls
Public or vehicular access restrictions	Phasing of development	Controls on construction
Conservation zones/overlay districts	Performance zoning	Subdivision standards
Protected areas/sanctuaries	Urban growth boundaries to exclude habitat	Targeted growth away from habitat
Capital improvements programming	Site plan review	Habitat restoration actions
Actions to protect resources in other jurisdictions	Other regulatory tools	
B. Incentive-Based Tools		
Density bonuses	Clustering away from habitats	Transfer of development rights
Preferential tax treatments	Mitigation banking	Other incentive-based tools

TABLE 1 (*Continued*)

Policies, Tools, & Strategies		
C. Land Acquisition Programs		
Fee simple purchase	Conservation easements	Other land acquisition techniques
D. Other Policies		
Designation of Special Taxing Districts for Acquisition Funding	Control of Public Investments and Projects	Public Education Programs
Monitoring of Ecological Health and Human Impacts		
Implementation		
Designation of responsibility	Provision of technical assistance	Identification of costs or funding
Provision of sanctions	Clear timetable for implementation	Regular plan updates and assessments
Enforcement specified	Monitoring for plan effectiveness and response to new information	

Factual Basis

The factual basis of a plan in general assesses existing and projected conditions, identifies problems associated with these conditions, and provides an informational base upon which goals and policies rely. The factual basis of an ecosystem plan is an inventory of existing resource issues, environmental policies, and stakeholders' interests within the ecosystem. It takes both a written and visual form, and serves as the factual and descriptive basis on which policy decisions within the plan are made. The foundation for the factual basis is a resource inventory of critical natural resources, which should draw explicitly from the literature on ecosystem science and landscape ecology. The level of understanding of the boundaries and functions of ecological systems captured in the plan not only is essential to physically managing the landscape, but demonstrates the geographic level of focus and sense of place inherent in the community. Identifying the adverse impacts to existing natural resources demonstrates the degree to which planners and community members are aware of environmental problems and indicates their desire to improve existing conditions. The factual

basis also supports and often drives the other components comprising ecosystem plan quality.

Items within the factual basis plan component are grouped into three categories. First, the resource inventory category includes indicators such as mapping ecosystems and habitat boundaries, describing ecological functions, and being able to classify wildlife and vegetation. To protect the ecological infrastructure of a landscape, planners also must identify critical habitat, areas of high biodiversity, and most importantly corridors that facilitate the movements and migration of key species. Second, the human ownership category characterizes the existing management of critical habitats and areas of high biodiversity. To identify new lands for protection, a planner must begin by identifying the existing network of protected areas. The resource inventory combined with the human ownership category can provide the basis for a gap analysis that can greatly aid planners in generating plans that seek to manage ecological systems. Human impacts, the third and final category of the factual basis component of a plan deals with identifying resource problems stemming from human development. Indicators in this category include human population growth, the development of wetlands, and water pollution, and habitat fragmentation.

Goals and Objectives

The goals and objectives component of a plan sets a future condition to which a local community aspires. These statements can be either broad expressions of civic values or specific measurable objectives that become catalysts for action. In any case, goals and objectives help prioritize issues and problems facing a community.

In this study, goals and objectives guide the implementation of ecosystem management. They contain both general statements of long-term goals regarding clarity and consistency, as well as specific measurable objectives, such as a 40 percent reduction in nutrient runoff to reduce impacts on an estuarine system. The goals and objectives plan component reflects the values of a community and its desire to protect regionally significant habitats and the integrity of ecological systems.

Goals must be clearly specified and objectives must be measurable in order to provide benchmarks of success. Spatially specific and prescriptive goals generated through effective planning provide more detail than vague commitments of ecosystem protection. They penetrate into the meaning of ecosystem management derived from ecosystem science by seeking to maintain large intact communities of native species, connections among significant habitats, and intergenerational sustainability of natural systems.

Furthermore, they aim to protect both the functionality of the ecosystem, as well as its unique landscapes and rare species.

Inter-Organizational Coordination and Capabilities

The inter-organizational coordination and capabilities plan component identifies the need to coordinate with other jurisdictions, landowners, and organizations to generate an effective land use plan. It recognizes that planning problems often extend beyond the designated planning area or the domain of a single organization and that collaboration is a necessity to achieve commonly held resource management goals.

Ecosystem management is a human boundary-spanning problem (Grumbine, 1994; Wondolleck & Yaffe, 2000). Ecological systems, particularly large watersheds and estuaries, extend across multiple jurisdictions and organizational lines, making sustainable management of the entire system a difficult prospect (Kirklin, 1995). Because ecosystems do not adhere to what has become a "crazy quilt" of land ownership, organization, and governance, environmental management goals are not being reached (Daniels et al., 1996). While natural systems often intricately connect over broad spatial and temporal scales, land use decision frameworks remain limited to local jurisdictions and suffer from limited input from regional planning councils. Uncoordinated local land use decisions have a cumulative negative impact on the system as a whole. Collaboration across jurisdictional lines and among multiple organizations thus can become imperative if approaches to ecosystem management are to be attained (Daniels & Walker, 1996; Randolph & Bauer, 1999).

The inter-organizational coordination and capabilities plan component captures the ability of a local jurisdiction to collaborate with neighboring jurisdictions and organizations to manage what are often transboundary[1] natural resources. It represents a key component in defining local ecosystem plan quality because it measures to what degree a local community is able to recognize the transboundary nature of natural systems in Florida and coordinate with other parties both within and outside of its jurisdictional lines. The state of Florida requires a general intergovernmental coordination plan element (i.e. not environmentally specific) for all local city and county plans, but there is wide variation among plans when it comes to policies focused on protecting natural systems. This plan quality component addresses the critical factors necessary to foster collaboration which include, among other indicators, joint fact finding, information sharing, inter-governmental agreements, and integration with other plans in the region (e.g. Ecosystem Management Area plan, National Estuary Program).

Policies

The policy component of a plan sets forth specific principles of land use design or development management (Kaiser et al., 1995). Policies derive from goals and objectives, but focus more directly on government action. Policies represent the heart of a plan because they actualize community goals and objectives by setting forth actions to protect critical habitats and related natural systems. Strong policies draw heavily on the environmental and land-use planning literatures to identify tools that effectively protect ecological systems. Policies fall into four broad categories: regulatory, incentive, land acquisition, and other. Regulatory tools include items such as land use or density restrictions, restrictions on native vegetation removal, and buffer requirements. Incentive-based tools deal with strategies to encourage landowners to protect critical ecological components as opposed to making them do so. Incentives include clustering, density bonuses, the transfer of development rights (TDRs), preferential tax treatments, and mitigation banking.

Land acquisition programs form another important category within the plan protocol because they indicate the ability of jurisdictions to fund the purchase of critical habitats and sensitive lands. Florida leads in acquisitions efforts across the country. Under its Preservation 2000 Initiative, the state generated $300 million per year for 10 years to fund the acquisition of sensitive lands (Beatley, 2000). However, leadership at the state level has not necessarily translated into local initiatives to acquire areas containing critical habitat.

The 'other policies' category in the policies plan component deals with items that do not easily fall into land use or environmental tools, but are important in implementing the principles of ecosystem management. In particular, educational programs that focus on the importance of protecting significant habitats and ecosystems can be considered a vital strategy in effecting resource use behavior at the local level.

Implementation

The Implementation component involves articulating how a plan can, after adoption, become an enduring instrument that is carried forth through regulations and collective action. This component conceptualizes a commitment to implementing the final plan in the future, not how well the plan actually is implemented once adopted. For comprehensive plans to be effective, implementation must be clearly defined and laid out for all affected parties. Implementation depends not only on the ability of a commu-

nity to implement its plan in a timely fashion, but also to designate responsibility for actions, enforce adopted standards, and sanction those who fail to comply. This plan component also focuses on monitoring both ecological conditions and program effectiveness so that a community can adapt to changing conditions by setting updated standards to most effectively obtain stated goals and objectives.

DATA AND METHODS

Since Florida hosts both strong ecosystem management and local growth management programs, the state provides an ideal institutional and biogeographical setting in which to conduct the study. Specifically, the growing emphasis on ecosystem management and planning makes Florida a well-suited location for the following reasons. First, Florida contains some of the most biologically diverse and valued ecosystems in the country. The state is widely recognized as one of North America's most important reservoirs of biological diversity (Cox et al., 1994). Second, Florida has a well-established framework for ecosystem management to ensure a level of consistency in the way the concept is understood and carried out. Local communities across the state seeking to protect broader ecosystems thus have a model on which to base their specific programs. In 1993, Florida's Department of Environmental Protection (DEP) recognized that traditional approaches to management could not adequately protect biodiversity and thus decided to reorient the state's environmental programs around an ecosystem approach to management (now termed regional watershed management). Under this approach, DEP moved away from media-based management, which addresses water, air, and land separately, and toward an integrated understanding of problems and solutions based on natural boundaries rather than those defined by humans. Third, Florida requires that each local community 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 new local comprehensive plans to be written and required that they be consistent with goals of the state plan.

My study principally relies on local city and county comprehensive plans as the unit of analysis. These plans serve as the basis for measuring ecosystem protection. While there are many different types of resource management plans in Florida, comprehensive plans follow a consistent format (in terms of production, element types, and review/updating processes),

are an institutionalized policy instrument, and most importantly provide a basis for city and county land use and resource management decisions. Because these plans need to look beyond jurisdictional boundaries, drive collaborative efforts with other jurisdictions or organizations, and contain policies that seek to protect critical habitats comprising broader ecosystems, they act as strong gauges of how well local jurisdictions will manage ecosystems over the long term. In this sense, comprehensive plans are an important tool for accomplishing many of the goals of ecosystem management because they mark the starting point for specific ordinances, land development codes, and environmental policies. They also often incorporate and implement more regional environmental activities, such as National Estuary Programs (NEP) and other agreements on transboundary resource management.

I based the study population on local jurisdictions (cities and counties) in Florida that have completed under the state mandate recent updates of their comprehensive plans. A sampling frame was obtained through a list of local jurisdictions in the state and was subjected to the following sampling strategy. 1) The sample included only those jurisdictions with a population of 2,500 or more to make certain the sample was not skewed toward small communities (Berke & French, 1994). 2) The sample excluded large cities, such as Miami because these jurisdictions have very different contextual factors that may skew the sample (Berke et al., 1996). 3) The sample used only coastal jurisdictions to maintain a degree of consistency and comparability in terms of the types of ecosystems assessed. From the sampling frame, a random sample of 30 jurisdictions was drawn and evaluated against the plan quality protocol.

The study used issue-based indicators or items within each component to define and measure the quality of a comprehensive plan. Each item was measured on a 0–2 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. In the factual basis component of the protocol, most items have more than one indicator. For example, habitats can be either mapped, catalogued or both. An item index was created in these cases by taking the total score and dividing it by the number of sub-indicators (i.e., an item that receives a 1 for mapping and 1 for cataloging received an overall issue score of 1). This procedure assured that all plan quality items remained on a 0–2 scale, while at the same time recognizing that a strong fact base relies on both textual and graphic description. Together, these indicators capture the principles of effective ecosystem management and translate them into elements that can be identified, measured, and compared across each plan.

Once plans were coded using the ecosystem plan protocol (Table 1), two phases of analysis were conducted. First, an overall measure of ecosystem plan quality was derived by creating indices for each plan component and overall plan quality (as done by Berke et al. (1996) and Berke et al. (1998). Indices were constructed for each plan component based on three steps. First, the actual scores for each indicator were summed within each plan component. Second, the sum of the actual scores was divided by the total possible score for each plan component. Third, this fractional score was multiplied by 10, placing each plan component on a 0–10 scale. Adding the scores of each component (factual basis; goals and objectives; interorganizational coordination and capabilities; policies; and implementation) resulted in a total plan quality score. Thus, the maximum score for each plan is 50.

Second, to further unpack the results from evaluating plans against the planning protocol, the author used several additional measures based primarily on the techniques used in Godschalk et al. (1999). These measures look at each issue-based indicator in the protocol from three perspectives: their presence, their quality, and a total quality issue score.

1. Item breadth score = # of plans that address item/# plans in sample (0–1 scale)
2. Item quality score = total score of all plans that addressed an item/# plans that addressed the issue (0–2 scale, converted to 0–1 scale)
3. Total item score = item breadth + item quality (0–2 scale)

The second phase of analysis aimed to provide a sharper lens of focus with which to identify in greater detail the ability of local plans to integrate the principles of ecosystem management. Item breadth measures the percentage of the sample that includes an item in the planning protocol. Item quality measures not only if the item was included in the plan, but its level of detail or the strength of a particular policy (mandatory versus suggested). The total item score combines the previous two measures to provide insights into the overall quality of an item. The significance of an item that is not often included in a plan, but is done so with high quality can thus be determined.

RESULTS

Evaluating the sample of plans against the ecosystem plan quality protocol leads to a better understanding of the relative strengths and weaknesses of the ability of local jurisdictions in Florida to achieve ecosystem approaches to management. Results expose opportunities to strengthen lo-

cal planning frameworks in future plan updates. In addition to assessing total plan quality and plan component scores, in this section I further unpack ecosystem plan quality by examining item-based descriptive statistics (item breadth, item quality, total item scores) for the sample of plans.

Overview of Ecosystem Plan Quality

Results from the first phase of analysis provide an overall assessment of how well local jurisdictions in Florida are incorporating the principles of ecosystem management into their comprehensive plans. As shown in Table 2, the mean score for total ecosystem plan quality is 20.62, which on a scale of 0–50, indicates a relatively weak effort to manage ecological systems at the local level. Mean scores for all plan components (scale of 0–10) register fairly low despite a strong state program on ecosystem management and a clear local planning mandate to protect critical habitats and ecological functions.

Factual basis is the lowest scoring plan component, demonstrating a lack of knowledge regarding the existing level of critical natural resources within a jurisdiction. In contrast, the inter-organizational coordination and capabilities plan component scores fairly high with a mean of over 5.0 (on a scale of 0 to 10). A high score for this component suggests that jurisdictions recognize the transboundary nature of ecosystems and are willing to collaborate with other jurisdictions to manage these natural resources over the long term. The score, however, may simply reflect the fact that a general inter-governmental coordination element is required in all plans. Specific scores for each plan component are discussed in more detail in the subsequent sections.

TABLE 2

Descriptive Plan Quality Scores for Each Plan Component

Plan Component[a]	Mean	Standard Deviation
Factual Basis	2.25	2.03
Goals and Objectives	3.63	2.25
Inter-Organizational Coordination	5.14	1.92
Tools, Policies, Strategies	4.35	1.57
Implementation	5.00	2.30
Total Ecosystem Plan Quality[b]	20.62	7.76

[a]Maximum score by plan component is 10.00.
[b]Maximum score for total ecosystem plan quality is 50.00.

Analyzing Plan Component and Item Scores

Results from the second phase of analysis provide a more detailed examination of local jurisdictions' ability to incorporate the principles of ecosystem management by unpacking the results from the plan coding protocol item by item.

Factual Basis

In the *Resource Inventory* category (Table 3), a relatively low percentage of plans inventory ecosystem boundaries, ecological functions, areas of high biodiversity, or natural resources that extended beyond the local jurisdiction. These issues form the building blocks for identifying and managing ecosystems. Instead, the majority of plans concentrate on traditional environmental components within jurisdictions, such as soil types, wetlands, and surface water features. Other important elements for understanding ecosystem processes, such as identification of species ranges, keystone species, and exotic or invasive species receive some of the lowest scores in terms of breadth. Habitat corridors between wildlands, an essential part of maintaining the landscape mosaic because they allow for natural movements of species, are not mapped or described by any of the plans sampled. Vegetation mapping and classification is more likely to be included over vertebrate species since land cover is more easily identified and modeled graphically across landscapes. Only a few jurisdictions, such as Pinellas County and the city of Bradenton use GIS to generate maps of resources or biodiversity, despite the fact that these data are readily available from the state.

While most of the plans do not tend to focus on ecosystem-based environmental factors, when they do descriptions are done in detail, resulting in high item quality scores (as opposed to overall plan component scores). This result suggests that when local jurisdictions make the commitment to move beyond the standard for inventorying critical natural resources (soils, wetlands, surface water, etc.), they ensure a high quality result. This phenomenon causes the total item scores for ecosystem-based environmental issues to be relatively higher. For example, only just over half of the plans sampled describe the ecological functions for habitat type or ecological zones, but this item receives the second highest total item score (1.41) in the *Resource Inventory* category. Similarly, only 47 percent of the sample mapped their land cover, but did so with such high quality that the total item scores for this indicator 1.29, ranking it among the highest in its category.

TABLE 3

Issue-Based Scores for the Factual Basis Plan Component

Indicator	Issue Breadth	Issue Quality	Total Issue Quality
Resource Inventory			
Ecosystem boundaries	.33	.53	0.86
Ecological zones/habitats	.67	.66	1.33
Ecological functions	.53	.88	1.41
Species ranges	.23	.50	0.73
Habitat corridors	.00	.00	0.00
Vertebrate species	.17	.80	0.97
Biodiversity/species richness	.33	.63	0.96
Vegetation classified	.57	.62	1.18
Wildlife classified	.47	.50	0.97
Land cover mapped	.47	.82	1.29
Threatened/endangered species	.53	.52	1.05
Exotic species	.17	.50	0.67
Keystone species	.13	.56	0.70
Soil types/associations	.90	.77	1.67
Wetlands mapped/described	.80	.59	1.39
Climate	.30	.89	1.19
Groundwater resources	.70	.60	1.30
Surface hydrology	.73	.66	1.39
Marine resources	.67	.41	1.08
Representation of transboundary resources	.23	.61	0.84
Other prominent landscapes	.43	.44	0.88
Ownership Patterns			
Conservation Lands mapped	.43	.38	0.82
Management status for conservation lands identified	.17	.50	0.67
Network of conservation lands mapped	.23	.79	1.02
Distribution of species within network of conservation lands identified	.00	.00	0.00
Human Impacts			
Human Population Growth	.30	.83	1.13
Road density	.03	.50	0.53
Fragmentation of habitat	.23	.71	0.95
Wetlands development	.10	.50	0.60
Nutrient Loading	.50	.87	1.37
Water Pollution	.63	.87	1.50
Loss of fisheries/marine habitat	.20	.75	0.95
Alteration of Waterways	.33	.75	1.08
Other impacts/loss of biodiversity	.63	.79	1.42

Human impacts listed and described in the sample of plans concentrate primarily on typical urban environmental problems, such as water pollution (63 percent of the sample) and nutrient loading (50%). Federal water quality monitoring regulations and obvious environmental disturbances, such as eutrophication easily identify these impacts. In contrast, relatively few plans address the most pertinent issues related to habitat degradation and ecosystem decline in Florida and other states, such as habitat fragmentation, loss of wetlands, or an increase in road density. Experts cite these issues as having the greatest adverse impacts on ecosystems and the decline of biodiversity across the state (Cox et al., 1994; Noss & Cooperrider, 1994; Beatley, 2000). Most items in this category are discussed in detail and receive relatively high quality scores. Scores are of particularly high quality in instances where monitoring programs are in place or information is available at the state level, such as for water pollution and nutrient loading.

Goals and Objectives

Table 4 reports the number of times a goal or objective in the ecosystem planning protocol is reported by plans in the sample (quality scores were not reported for this plan component to simplify the interpretation of

TABLE 4

Issue-Based Scores for the Goals and Objectives Plan Component

Indicator	Issue Breadth
Protect ecosystem integrity	.80
Protect natural processes/functions	.83
Protect high biodiversity	.23
Maintain intact patches of native species	.37
Establish priorities for native species/habitat protection	.50
Protect rare/endangered landscape elements	.50
Protect rare/endangered species	.80
Maintain connections among wildlife habitats	.27
Represent native species within protected areas	.10
Maintain intergenerational sustainability of ecosystems	.23
Balance human use with maintenance of viable wildlife populations	.40
Restore ecosystems/critical habitat	.70
Other goals to protect ecosystems	.53
Presence of measurable objectives	.70

the data). The majority of plans include broad goals to protect the integrity, natural functions, and processes of ecosystems. However, comparatively few plans cite more specific objectives involved in managing ecological systems, such as protecting biodiversity hotspots (23%), maintaining large intact patches of native species (37%), or maintaining wildlife corridors (27%). These results suggest that while plans frequently state general (and often vague) goals related to ecosystem management, they are unable to incorporate specific objectives that could drive precise land use tools and policies. For example, protecting representative examples of ecosystem types or natural communities is an important aspect of maintaining the landscape mosaic and helps actualize the broader goals of protecting ecosystem integrity. Only 10% of the jurisdictions sampled mention this goal.

Protecting rare and endangered species is one of the most frequently stated goals in the sample (80%), driven mostly by interest in protecting characteristic megafauna, such as the manatee or Florida panther. (Need to provide the scientific names of the manatee and the Florida panther in parentheses following the common names) Planners and planning participants often are well aware of the decline of single species (usually large mammals), but are unable to relate the protection of these species to protecting networks of habitat or areas of high biodiversity. Perhaps this result stems from the historic focus on single species in the United States through the Endangered Species Act (ESA), rather than protecting connected habitats or entire ecosystems. Finally, the majority of plans mention restoration goals and objectives, reflecting the degraded state of many urban areas included in the sample. Most jurisdictions have little remaining viable habitat to protect due to rapid urban development in the 1970s and early 1980s, and instead must focus on goals to restore badly degraded natural systems.

Inter-Organizational Coordination and Capabilities

Overall, results for this category of the planning protocol reveal a strong commitment toward collaborating both within a jurisdiction and with neighboring communities. As shown in Table 5, almost all of the jurisdictions sampled mention in detail coordinating with other organizations to protect resources within their boundaries as well as those that cross several administrative lines. Furthermore, most of the jurisdictions (83%) express a commitment to integrating other environmental plans or policies in the region into their local planning frameworks. Incorporating regional environmental efforts, such as Water Management District Plans or National Estuary Program plans remains an essential part of achieving ecosystem approaches to management at the local level. Not only do the majority of organizations include language

TABLE 5

Issue-Based Scores for the Inter-Organizational Coordination & Capabilities Plan Component

Indicator	Issue Breadth	Issue Quality	Total Issue Quality
Other organizations/stakeholders identified	.87	.83	1.69
Coordination to protect transboundary resources	1.00	.97	1.97
Coordination within jurisdiction to protect ecosystems	.97	.90	1.86
Intergovernmental bodies specified	.43	.85	1.28
Joint database production specified	.43	.85	1.28
Information sharing	.70	.79	1.49
Links between science and policy identified	.23	.71	.95
Position of jurisdiction within bioregion specified	.43	.65	1.09
Intergovernmental agreements (IGA) designated	.57	.74	1.30
Integration with other environmental plans/ policies	.83	.86	1.69
Conflict management process outlined	.50	.87	1.37
Commitment of financial resources	.20	.75	.95
Other forms of coordination	.80	.85	1.65

to collaborate to manage ecological systems, but these policies are almost always mandatory, raising their item quality scores.

Item scores are not as strong when it comes to describing the specifics of inter-organizational coordination. Less than half of the sample designates intergovernmental bodies to protect transboundary resources or engage in joint database production. Half of the plans outline conflict management processes to resolve resource conflicts prevalent in ecosystem management. Finally, 20 percent of the plans actually commit financial resources necessary to bring together various parties to manage ecological systems. Although the breadth of these items is low, their item quality is comparatively high. In other words, when an item is included in the plan, jurisdictions generally show a strong commitment to carry it out, which is reflected in the strength of the total item scores.

Policies, Tools, and Strategies

Results for this component demonstrate that plans in the sample tend to favor traditional environmental policies, such as resource use restrictions

in and around critical habitats, restrictions on removal of native vegetation, and conservation zones to protect sensitive lands (Table 6). Other regulations, such as fencing controls to permit natural movement of native species (e.g., Florida panther), phasing of development to reduce wildlife disturbance, or setting urban growth boundaries that do not include critical habitats, are less represented. While mainstream policies play an important role in ecosystem approaches to management, the evidence increasingly shows that less commonly used growth management tools focusing on both overall growth patterns (e.g. targeted growth areas) and specific site-related regulations (e.g., subdivision standards) may allow for significant gains in protecting regionally significant habitats (Duerksen et al., 1997). Notably, however, when a policy is stated, it is almost always mandatory, contributing to high item quality scores for indicators within this component. Overall, traditional environmental policies, such as resource use restrictions, native vegetation removal restrictions, and conservation zones, however, receive the highest total item scores in the regulatory category.

Despite their effectiveness in protecting critical habitats and ecological systems (Duerksen et al., 1997; Peck, 1998; Beatley, 2000), incentive-based policies enjoy far less representation than regulatory techniques. The most widely used tool is transfer of development rights (47%) to protect primarily wetland habitat. Only 20 percent of the sample cited mitigation banking, despite a strong state-level program and regulatory framework allowing for the practice. When a plan includes incentive-based tools, the policies are almost always mandatory, causing the item quality scores to be extremely high in this section. Low breadth scores account for comparatively low total issue scores for these items.

Seventy-one percent of the sample mentioned land acquisition programs, where localities include specific policies to acquire land for conservation to protect critical habitats. This high score might reflect a state level emphasis on the policy, such as the Preservation 2000 initiative, where the state sold bonds sufficient to generate $3 billion over a ten-year period (Beatley, 2000). Land acquisition techniques get incorporated into plans primarily in the form of fee simple purchases.

Other non-regulatory techniques are also important indicators of determining ecosystem plan quality. For example, most plans (87%) contain the policy of monitoring ecological processes and human impacts, an essential component of adaptive management. Monitoring policies primarily are associated with water quality issues, but several jurisdictions also include policies for specific species, wetlands habitats, and other ecosystem components. Finally, 50 percent of the plans include educational programs on the importance of protecting habitat and ecological systems. Although the

TABLE 6

Issue-Based Scores for the Policies, Tools, and Plan Component

Indicator	Issue Breadth	Issue Quality	Total Issue Quality
Regulatory Tools			
Resource use restrictions	.83	.96	1.81
Density restrictions	.53	.94	1.47
Restrictions on native vegetation removal	.97	1.00	1.97
Exotic species controls	.60	1.00	1.60
Buffer requirements	.60	.97	1.57
Fencing controls to allow species movement	.10	1.00	1.10
Public or vehicular access controls	.60	.97	1.57
Phasing of development to protect habitat	.03	1.00	1.03
Controls on construction to protect habitat	.93	1.00	1.93
Conservation zones/overlay districts	.87	1.00	1.87
Performance zoning to protect habitat	.20	1.00	1.20
Subdivision standards to protect habitat	.13	1.00	1.13
Protected areas/sanctuaries	.57	1.00	1.57
Urban growth boundaries to protect ecosystems	.03	1.00	1.03
Targeted growth areas to protect habitat	.30	.94	1.24
Capital improvements programming	.27	.94	1.20
Site plan review to protect habitat	.67	.98	1.64
Habitat restoration	.83	1.00	1.83
Actions to protect resources in other jurisdictions	.90	1.00	1.90
Other regulatory tools	.83	1.00	1.83
Incentive-Based Tools			
Density bonuses	.37	.86	1.23
Clustering development away from critical habitat	.40	.92	1.32
Transfer of development rights	.47	.93	1.40
Preferential tax treatments	.10	.67	.77
Mitigation banking	.20	.92	1.12
Other incentive-based tools	.17	.77	.93
Land Acquisition Programs	.70	.63	1.33
Other Policies, Tools, & Strategies			
Designation of special taxing districts	.07	1.00	1.07
Control of public investments and projects	.53	.94	1.47
Public education programs	.50	1.00	1.50
Monitoring ecological health and human impacts	.87	.79	1.66

environmental planning arena largely overlooks educating the public, policies can build an understanding of ecological problems and commitment to protecting ecological systems over the long term. When included, polices in this section of the planning protocol are almost always mandatory and the item quality scores thus rate extremely high.

Implementation

Compared to other plan components, Implementation scores are strong in both breadth and quality (Table 7). Results measure a jurisdiction's future ability to implement its plan, not if the plan was actually implemented after adoption. The majority of jurisdictions incorporate the essentials of implementing a plan, such as accountability, a clear timetable, and regular updates or assessments (although one might expect even higher breadth scores given the state mandate to implement a plan). Experts also frequently rely upon monitoring plan effectiveness and incorporating new information into updates essential to effective ecosystem management (Holling, 1987; Lee, 1993). The implementation component may score relatively high in part due to the high item quality scores in the plans. For example, when a policy is stated, it is almost always mandatory. Jurisdictions do not cite identification of funding for implementation and sanctions for failure to implement policies as frequently as one might expect. These issues, along with enforcement measures, ensure that policies and projects required in the plan actually come to fruition and are adhered to by the public.

TABLE 7

Issue-Based Scores for the Implementation Plan Component

Indicator	Issue Breadth	Issue Quality	Total Issue Quality
Designation of responsibility	.80	.88	1.68
Provision of technical assistance	.30	.94	1.24
Identification of costs or funding	.33	.85	1.18
Provision of sanctions for failure to comply	.10	1.00	1.10
Clear timetable for implementation	.77	.98	1.74
Regular plan updates and assessments	.67	.98	1.64
Enforcement specified	.67	1.00	1.67
Monitoring for plan effectiveness and response to new information	.77	.75	1.52

DISCUSSION

Based on the results above, one can infer that local jurisdictions in Florida have not been able to effectively incorporate the principles of ecosystem management into their planning frameworks. While strong interest in ecosystem management exists at the state and regional levels, this commitment has not entirely filtered down to the local level or local jurisdictions have been unable to effectively convert the principles of ecosystem management into their land use planning instruments: comprehensive plans.

Overall, the factual basis for the sample lacks detail and fails to address many of the issues associated with managing ecological systems. Some jurisdictions (Longboat Key, Cocoa, etc.) do not even have a Factual Basis incorporated in their plans and instead rely on separate (often outdated) documents that are neither part of the legal plan nor circulated to the public.

In general, plans reveal a commitment to the broad notions supporting ecosystem protection, but do not include clear and concise goals, which are needed to implement effective ecosystem policies. When goals are stated, they usually are vague and unfocused in their intent. Furthermore, while the majority of plans include measurable objectives to achieve stated goals, these objectives are almost always limited to maintaining a no net loss of wetlands and do not extend to specific measures, such as water quality levels or acreage of protected habitat. More specific objectives to actualize broad statements are needed to strengthen the ability of local plans to manage ecological systems.

While the basic intent to coordinate beyond jurisdictional and organizational boundaries is strong, the plans lack the building blocks of coordination. More specific collaboration techniques and detailed descriptions perhaps would foster more directed coordination necessary to protect transboundary resources. Nevertheless, this plan component is particularly strong compared to others in the ecosystem planning protocol. These results may be caused by a recognition that managing coastal resources requires collaboration that does not necessarily adhere to human defined boundaries together with the State's requirements of an intergovernmental coordination plan component.

Overall, the policies, tools, and strategies plan component focuses primarily on a narrow set of traditional regulatory land use tools. A greater reliance on more innovative practices, particularly those based on incentives rather than strict regulation, would allow communities to expand their growth management toolbox, increase the quality of their plans, and more

effectively manage ecological systems. Finally, the Implementation plan component falls short when it comes to making the policies "stick." One of the most frequently vocalized criticisms of plans in Florida is that they are not fully implemented after adoption.

The results of my study suggest how and where ecosystem management can most effectively be incorporated into local level resource planning decisions. The findings provide guidance for both local and regional planners on how to set future land use policies to reduce the decline of biological diversity and prevent the loss of critical natural habitats. By understanding the degree to which plans protect ecosystems, decision-makers can be more precise and efficient in their efforts to promote ecologically sustainable approaches to development. First, developing a conceptual and measurable model of a local ecosystem management plan moves the field of environmental planning away from qualitative assessments of plan quality toward an evaluative technique that is more precise, defensible, and comparable across multiple jurisdictions. Understanding exactly what makes a strong local ecosystem management plan provides practitioners with a model against which to test the effectiveness of existing plans and policies. Second, demonstrating the extent to which local jurisdictions are managing natural systems in Florida provides insight into how to strengthen existing local planning frameworks. Identifying the relative strengths and weaknesses in local management across the state helps planners improve plans and policies that seek to more effectively protect the state's critical natural resources over the long term.

Enhancing the ability of local plans to manage ecological systems also can compliment other planning goals of local communities in Florida. Since the concept of sustainability lies at the core of ecosystem management, this management approach supports other related aspects of planning, such as smart growth, natural hazard mitigation, and even economic development. With increasing emphasis on planning for social and natural systems at a landscape level, the principles of ecosystem management in most cases fit comfortably into a broader matrix of government action and private market forces.

PLANNING RECOMMENDATIONS

The following recommendations, based on the results of the study, may assist planners in Florida and other states to incorporate the principles of ecosystem management into local plans and policy instruments. These recommendations aim to facilitate a proactive approach to natural resource

management, rather than to institute policies long after adverse human impacts have taken place. Most importantly, they provide direction to planners on how, from a spatially bottom-up perspective, the integrity, functions, and processes of ecological systems can be protected over the long term.

Improve Factual Basis of the Plans

The first step in increasing the overall quality of a local plan is to improve its factual basis by conducting a more thorough resource inventory and incorporating available data on existing natural resource conditions. A strong factual basis helps a community understand what resources are being adversely impacted or are in need of further protection. With a greater understanding of existing critical resources, planners and planning participants may be more likely to incorporate ecosystem management policies at the outset of adverse human impacts.

As previously mentioned, the factual basis rank as the lowest scoring plan component in the study and leaves the most room for improvement. Incorporation of ecosystem components, such as identification of keystone species, areas of high biodiversity, and habitat corridors will help a community implement the principles of ecosystem management. For example, jurisdictions can make use of the Florida Fish and Wildlife Conservation Commission's digital maps of focal species, areas of high biodiversity, and habitat conservation areas. These maps could be analyzed in combination with existing land use patterns to identify conservation zones.

Increase the Use of Geographic Information Systems

Geographic Information Systems (GIS) technology is a powerful tool to both display and analyze natural resource data. It helps planners not only understand precisely where critical habitats exist but the degree to which they are in need of protection. As an analytical tool, GIS helps project the future and enables planners to make proactive choices about the management of existing natural resources. GIS also can serve an educational function by explaining complex problems to planning participants who are not technically oriented. There are hundreds of GIS data layers available to local jurisdictions throughout Florida ranging from watershed boundaries to vegetation cover. However, only a few communities in the sample take advantage of the large amounts of free existing data and the analytical power of this technology in making ecologically sustainable planning choices. For example, only 7 percent of the sample in the study incorpo-

rated Gap Analysis data layers in their plans. Planning offices do not need to hire technical personnel or purchase expensive equipment to successfully use GIS in planning. Data layers easily can be downloaded in several formats from state or regional organizations.

Increase Monitoring Activities

It important not only to identify existing natural resources but also to understand how baseline conditions change over time. Monitoring ecological processes, critical habitats, and the impacts to these resources from human activities plays an essential role in anticipating the decline of ecosystems and setting preventative policies. Managers must be able to react to constantly changing ecological systems, sudden shifts in interests and objectives, and a continuous barrage of new and often ambiguous information. A strong local monitoring program can provide a powerful informational lever for identifying adverse impacts to biodiversity before they become irreversible.

The majority of the jurisdictions studied designated monitoring programs, primarily related to water quality. However, it is unclear how data from monitoring will be fed back into the decision making process and enable the plan to be a flexible policy instrument. Through monitoring, jurisdictions can most effectively practice adaptive management, a continuous process of action-based planning, monitoring, researching, and adjusting with the objective of improving future management actions (Holling, 1995; Endter-Wada et al., 1998). For example, jurisdictions can initiate a community based water-monitoring program for coastal estuaries. Changes in nutrient levels can be reported to the local planning or environmental agency, which can take action before major declines in water quality threaten to fisheries or recreational areas.

Generate More Specific Goals and Policies

One of the major weaknesses of the plans examined in the study is their lack clear directives and specific ecosystem management goals and policies. Descriptions of programs or specific actions often are overly vague and diffuse. Plans need more specifics, particularly for goals, to guide the implementation of ecosystem management initiatives. Clear and detailed goals often have timelines when they must be accomplished. Strong objectives can be measured or have measurable targets (i.e., a 40 percent reduction in nitrogen run off). For example, the goal "to protect natural systems" comes across as vague and difficult to interpret. On the contrary, the goal

"manage and enhance viable native ecological communities to protect the functions of natural systems and the diversity of native plants, animals, and fisheries, particularly those endangered or threatened" is much more specific and effective at generating strong policies.

Expand the Planner's Toolbox

The plans examined in the study concentrate primarily on a narrow set of regulatory actions, such as land use restrictions or conservation zoning. However, the use of incentive-based policies in plans, such as density bonuses, transfer of development rights, and preferential tax treatments can be effective in achieving the goals of ecosystem management at the local level. Most importantly, such policies encourage rather than force parties to protect critical habitats and areas of high biodiversity. For example, allowing increased densities for residential developments in exchange for the protection of critical wetland habitat enables developers to meet their objectives while instilling motivation to protect important ecological components. Efforts to protect ecosystems become more proactive when landholders act because they want to, not because they have to.

Planners can also use education-based policies to expand their repertoire to help change behavior and generate proactive ecosystem management practices. Local outreach programs can build public awareness on the importance of protecting the value of critical natural resources and maintaining ecological integrity. Educational strategies include informational workshops, information dissemination (print and electronic), presentations, and community programs such as monitoring or waste cleanup.

Although the findings and recommendations of this study provide some insight into how local communities can incorporate the principles of ecosystem approaches to management into their land use plans, the reader should exercise caution when applying the results to areas outside of Florida. Florida has a strong top-down planning mandate at the state level, as well as a well-defined ecosystem management program. The plan quality of other states without such strong local planning requirements and interest in ecosystem management may be somewhat different.

Furthermore, while this study provides a greater understanding of how to implement the principles of ecosystem management at the local level, it provides only a starting point for exploring the topic. Further research is needed to determine what factors drive the quality of local plans, such as environmental features, human impacts, and socioeconomic factors. The quality of local plans also should be related to the ecosystem itself, which often is the ultimate target for management efforts. Understanding how sev-

eral local jurisdictions together protect the integrity of the ecosystem in which they lie may be the only way to truly measure the degree to which an ecosystem is being managed over the long term. In addition, more empirical research on how the planning process, specifically stakeholder participation, impacts the quality of management plans would provide important information to planning agencies interested in attaining the goals of ecosystem management and sustainable development in general. Finally, investigation into the relationship between plan quality and plan implementation with regard to managing critical natural systems would further provide insights into how policy and knowledge can successfully be converted into action.

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ENDNOTE

1. The term transboundary is defined for this study as a management approach that focuses beyond a single human boundary, such as a local jurisdiction or some line of human ownership.

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