Green Infrastructure Plan Evaluation Frameworks

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Abstract

The rising rate of land consumption and fragmentation in the United States has prompted land use planners to consider a strategic approach to conservation and development that channels urban growth and preserved lands into more suitable locations. Green infrastructure planning represents a strategic approach to conservation that combines the efforts of previous conservation planning methodologies and practices in the United States into a systematic framework that can encompass larger landscapes and broader planning goals. Green infrastructure is defined as the interconnected network of waterways, wetlands, woodlands, wildlife habitats, and other natural areas; greenways, parks, and other conservation lands; working farms, ranches and forests; and wilderness and other open spaces that support native species, maintain natural ecological processes, sustain air and water resources and contribute to health and quality of life. This paper serves to provide 1) a more structured definition for green infrastructure plans, 2) “best practice” guidelines for green infrastructure planning, as well as 3) a framework for evaluating green infrastructure plans for different scales of planning. The paper proposes plan evaluation frameworks at regional and local scales that can be used by planners in the future as a guideline or checklist of best practices for developing green infrastructure plans, as well as a standard means for evaluating plans.

INTRODUCTION

The rising rate of land consumption and fragmentation in the United States has prompted land use and conservation planners to consider a strategic approach to conservation and development that channels urban growth and preserved lands into more suitable locations. Conservation organizations and agencies have historically responded to development pressures by preserving land on a parcel-by-parcel, opportunity-driven basis. Study after study has linked the degradation and loss of natural functions not only to haphazard development practices, but also to haphazard conservation efforts (Beatley, 2000, Noss, 1987). Like sprawling development, these domestically focused conservation efforts traditionally have been fragmented, site-specific, and narrow in focus (Benedict and McMahon, 2002). While successful at conserving open space, conservation efforts of this sort have not been led by larger landscape-scale goals and thus have typically fallen short of protecting even the minimum amount of contiguous lands to ensure viable ecological systems (Noss, 1987). Due to the growing body of work on the effects of land fragmentation, as well as advancements in environmental planning and geographic information systems, the need for landscape scale planning has become increasingly more apparent (Ewing, 1996). This is evidenced by the literature authored in recent years that provides guidance and instruction to conservation planners implementing regional biodiversity networks (Conservation Measures Partnership, 2004, Groves, 2003, Margules and Pressey, 2000 and Soule, 1991).

Taking a landscape-scale focus for conservation planning is the foundation for green infrastructure planning, a strategic conservation planning approach that builds on conservation

planning approaches of recent years. The planning and scientific analysis that has served as a foundation for regional biodiversity networks, often called "reserves," are the roots of the green infrastructure approach. Green infrastructure advances these current methods of conservation planning by providing a solution for continued land fragmentation and the resulting degradation of natural systems that incorporates goals for biodiversity, as well as the conservation of lands for human uses, such as working landscapes and recreational open spaces. Green infrastructure planning provides an interconnected blueprint for conservation and development opportunities that can be utilized by both ecologists and land use planners alike. Planning for an area's "green infrastructure" provides a landscape-scale framework for evaluating conservation priorities. Moreover, it provides communities with a broad, unifying vision of the future and helps provide conservation certainty for regions and communities facing dramatic, growth-related changes (Benedict and Bjornlund, 2002). Green infrastructure is defined as the interconnected network of:

> "waterways, wetlands, woodlands, wildlife habitats, and other natural areas; greenways, parks, and other conservation lands; working farms, ranches and forests; and wilderness and other open spaces that support native species, maintain natural ecological processes, sustain air and water resources and contribute to the health and quality of life for America's communities and people (The Conservation Fund, 2004)."

Since the term "green infrastructure" was first used in planning efforts, green infrastructure plans have been developed in a variety of ways and have served a variety of purposes. This term has become more widely used in land-use and conservation plans within the last few years. As it has been used freely in describing conservation planning efforts, this paper serves to provide 1) a more structured definition for green infrastructure plans, 2) "best practice" guidelines for green infrastructure planning, as well as 3) a framework for evaluating green infrastructure plans for different scales of planning. The paper will propose plan evaluation frameworks that can be used by planners in the future as a guideline or checklist of best practices for developing green infrastructure plans, as well as a standard means for evaluating plans.

The term green infrastructure has multiple meanings as it relates to conservation efforts. Just as gray infrastructure describes the functional support system of urbanized areas, green infrastructure the "noun" refers to nature's life support system (Benedict and Bjornlund, 2002). This term describes all of the natural features of a place – its wetlands and wildlands, parks and open spaces, wildlife habitat and ecological systems. More and more conservation planners are beginning to understand the importance of planning for green infrastructure. Green infrastructure the "adjective" refers to an approach to conservation planning that is landscape-scale, driven by a broad-reaching public process, and results in an implementation strategy to protect an ecological network of conservation lands.

One of the factors that distinguishes green infrastructure plans from other conservation plans is that the primary objective is to identify suitable lands for conservation in the context of current and future developed lands. Green infrastructure planning can assist the traditional land use planning process, delineating lands for protection before the allocation of lands for new development. This not only ensures that important natural systems are not fragmented by urbanization, but it also provides a framework for locating new development. Green infrastructure's comprehensive network design gives conservationists and developers the certainty of knowing which lands are available for development, and which are conservation priorities. Moreover, conservation efforts are much more effective when they are coordinated with growth management and smart growth efforts.

Numerous types of conservation-based plans have arisen over the course of the last few decades. In the early days, plans originated out of a specific threat to natural lands, such as the need for recreational trails and parklands, concern over fragmented habitats or the need to protect precious water resources. Even though conservation plans focus on providing

guidance for conservation efforts, these plans can serve numerous functions. In his exploration of land conservation efforts over the last three decades, John Randolph outlined four types of local conservation planning efforts. Beginning with parks and recreation planning and arriving at present day green infrastructure planning, Randolph depicts an increasing complexity in planning efforts, as well as a tendency over the years to incorporate a broader, landscape scale focus (see Table 1). Randolph's use of the word "planning" instead of "plans" may be due to the fact that conservation plans have not always been named according to their primary objectives. In other words, a plan that is probably considered an "open space" plan by its content may sometimes be labeled a "greenways" plan, and vice versa.

Table 1. Evolving Nature of Local Government Land Conservation in the United States (Randolph, 2004)

Period	Type	Conservation Tools	Primary Objectives
<1980	Parks and Recreation Planning	Land acquisition; park planning and management	Active recreation, scenic amenity
1980s	Open Space Planning	Land acquisition and easement; park planning and management	Active recreation, scenic amenity, farmland protection, urban forestry
1990s	Greenways and Open Space Planning	Land acquisition, easement, floodplain zoning, park and greenway planning and management	Active and passive recreation, scenic amenity, farmland protection, urban forestry, urban wildlife
2000	Green Infrastructure	Land acquisition, easement, floodplain management, Smart Growth Management tools, conservation land development, partnerships with landowners, land trusts	Hubs and links for active and passive recreation, scenic amenity, farmland protection, urban forestry, urban wildlife, regional and state ecological systems, integration of conservation and growth management

Most types of conservation plans are highly similar and not easily distinguishable. As most conservation plans are not standardized, save those developed for regulatory requirements, distinctive frameworks for plan types do not exist. This creates both a range of plan formats and methodologies within a specific plan "taxonomy," as well as similarities between plan taxonomies.

As conservation planning is moving towards the incorporation of multiple goals within a single planning effort (Noss et al, 2002), the lines between plan types are becoming even more blurred. It is quite common today to find hybrid plans that incorporate elements of different plan types, for example watershed plans now often incorporate conservation goals for habitat protection. While a highly conventional structure for plan taxonomies is probably not useful considering the wide variability in planning efforts, differentiating the core plan taxonomies is useful in gaining an understanding of what plan elements and approaches exist. This clarification can provide conservation planners with a more universally defined language pertaining to conservation planning options.

Exploring examples of conservation plans can begin to get at the core differences between the taxonomies. Defining and differentiating between plans can clarify the purpose of different conservation plans, highlight the differences between plans and provide a more solid basis for establishing evaluation efforts. This not only provides a general foundation for differentiating plan types, but it also sheds light on the opportunities for improving plans.

GREEN INFRASTRUCTURE PLAN ELEMENTS

It is important to note that there is no "one-size-fits-all" blueprint for green infrastructure plans, but the green infrastructure approach does suggest a basic framework for plan development. Inclusion of some elements distinguishes green infrastructure plans from the other plan types outlined in Table 1. These elements, common to most plan types, are organized into four main steps: goal setting, analysis, synthesis and implementation. Time and funding constraints will likely prevent most planning efforts from including this "ideal" set of plan elements outlined below. However, the elements and the evaluation criteria outlined later in the

paper can assist planners with adapting the framework for their particular needs and constraints.

Goal Setting

A leadership forum or advisory committee should direct green infrastructure plan development. This forum or committee may take many forms depending upon the project's scope and budget, but they generally should be composed of a diversity of stakeholders found within the study area. Bringing together a diversity of perspectives, backgrounds and expertise will provide a strong basis for developing the goals that will lead planning efforts. As green infrastructure plans seek to achieve healthy ecological systems, as well as working landscapes and human environmental needs, a diversity of stakeholders can provide necessary input to ensure that these needs are met within plan goals. They can also serve to garner public support for green infrastructure planning efforts and ensure that plan goals are politically defensible. This plan element is similar to other plans, but nonetheless crucial in importance. As stated by Flink and Searns in their 1993 guide for greenways planning, “greenways almost always begin with two key elements: an outstanding natural or cultural feature and committed visionary leadership.” The same need for a visionary leadership is crucial for green infrastructure plans. Goal setting is one of the most important functions of the advisory body and is essential to a unified green infrastructure vision.

At their core, green infrastructure plans must include goals for the protection of ecological functions and processes, as well as protection of working lands, and open space for human benefit. These are factors that have been covered in other plan types, but typically not included all within one plan. Just as the term “green infrastructure” connotes an area’s natural life support system, so should green infrastructure plans incorporate all of the natural elements of an area. These goals will be determined by the landscapes and land uses within a given planning area and the corresponding threats to these human and natural environments. It should be noted that not all areas will include all possible conservation objectives, but a plan should still be considered a green infrastructure plan if it incorporates and balances all salient conservation goals for the area.

As green infrastructure plans incorporate ecosystem and land-use components and processes over space and time, green infrastructure plans must focus on landscape-scale approaches to conservation planning. So what exactly is a landscape-scale approach? A landscape-scale approach considers how an area’s resources “contribute to, interact with, and are influenced by the ecosystems of surrounding areas” (Benedict and Bjornlund, 2002). This goes beyond an accounting of flora and fauna content and looks at the larger *context* within which endangered habitats and other critical natural areas are situated. Ecosystems are dynamic entities and planning efforts that are focused on protecting natural systems need to take into account the changing spatial and temporal factors involved in ecosystem conservation. Drawing upon landscape ecology and conservation biology theories and practices within an environmental planning framework can ensure that green infrastructure plans integrate and account for all of these factors.

Different landscapes, human needs and threats to conservation will require different goals and planning efforts. What is critical is that the leadership forum focuses on balancing these three green infrastructure goals (i.e. landscape processes, working lands and open space for human benefit) by utilizing a landscape-scale approach. These three plan elements provide the basic plan foundations for green infrastructure plans.

Analysis

The goal of a network design is to delineate an interconnected green infrastructure system that incorporates both benefits to nature and to people. Network design criteria should be developed and based on ecological and land-use planning theories and utilize an integrated landscape-scale approach. The basic application of these theories include:

1. Linking components and processes of the ecosystem,
2. Identifying ecologically valuable areas as well as areas in need of restoration, and
3. Considering the distribution and relationship of landscape features and processes over time, and the interaction of these features with the human built environment (Benedict and Bjornlund, 2002).

Analysts use these theories to devise a set of criteria for assessing the most valuable lands within a given planning area. Systems of criteria often include weighting some conservation values more than others and should be based on the goals set forth by the leadership forum. All plan efforts should utilize agreed upon criteria to formulate a spatial network of conservation lands for their study area. Creating a unifying network vision would allow for conservation efforts within a region to be more coordinated and strategic as local governments can work from the same defined spatial goals, while also maintaining the flexibility for setting local conservation priorities within the larger network design.

The network design should be created by conducting a suitability analysis or using a similar method (based on determined network criteria) to calculate a range of resource values for the study area. This analysis will typically focus on a range of goals for the planning area. This is often conducted individually for each independent green infrastructure goal or "attribute" and then later compiled to define the entire network. A "coarse-scale" evaluation identifies the larger landscape values for the plan area and the relative ranking of these lands. A "fine-scale" evaluation will look within the ranked resource areas and take a more acute and smaller-scale evaluation within the larger context. This approach is similar to The Nature Conservancy's conservation planning framework that incorporates ecoregional and site-level planning (The Nature Conservancy, 2000). The key difference between these planning methodologies is that The Nature Conservancy's approach is primarily based upon biodiversity conservation principles. The green infrastructure "top-down" approach ensures that landscape scale functions and processes are the foundation of the network design as well as the more local and smaller scale lands that will constitute the larger network.

The network design should utilize a hub/corridor framework and incorporate a diversity of land uses. These network components ensure that important resource areas are protected and linked to provide the optimal environment for an area's ecological systems. Efforts to design ecological networks should look beyond linkage goals and include empirical scientific evidence that supports the size and shape of the network components for the given planning area. As most network analysis will be conducted by technical and scientific experts and not by the leadership forum, it is important to elicit feedback on the preliminary green infrastructure network design from the leadership group. Herein lies an interesting tension between scientific analysis and human environmental values. While scientists may argue that the most effective network systems are based on the best available science, conservation of the network will never be implemented if it lacks public support. Education can help bridge the gap between the best available science and public support, and the involvement of the leadership forum can help balance scientific and political goals to ensure a network design that is both ecologically viable and politically executable.

Synthesis

The protection status of green infrastructure network lands should be identified and incorporated into the analysis model. This is a key characteristic of all conservation plans. For example, lands that are unprotected will rank higher than those that are protected temporarily, dependent upon the resource value of the lands. This information is crucial for delivering a structured system that determines conservation priorities.

The network analysis should be able to identify gaps in the network, allowing planners to ascertain significant areas that are prime for restoration efforts. Restoring hub and linkage gaps is a crucial component to any green infrastructure plan, as most network designs will contain "holes" in the form of developed or degraded lands. As green infrastructure network design is based upon ecological frameworks and not simply open space, many lands identified within a given framework may not currently be in a natural and/or fully functioning state. For example, a network design may include natural areas, a greenway system, agricultural lands and possibly brownfield sites – comprising a diversity of land uses. The network should include all of these lands and identify any areas in which restoration efforts should be undertaken to strengthen the network and their relative importance. Brownfield sites are an example of how developed areas may be part of a green infrastructure network, emphasizing the importance of assessing linkages of the entirety of lands within a planning area, not only those lands that are currently undeveloped.

The final plan should included a geographic representation (i.e. map) of the final network design. This map will communicate the larger goals to plan users and provide a common basis for implementation efforts. Additional maps, which designate specific implementation efforts for specific areas within the network design, may also be included. This information advances conservation implementation efforts to specify opportunities for protection efforts.

Implementation

A system for prioritizing protection opportunities – a decision-support tool - is another green infrastructure plan requirement. The network design should be evaluated against the protection status of lands and other factors identified through the goal setting process to produce a prioritization system that ranks conservation opportunities. Without this system, the plan serves only as a blueprint of conservation lands – not a framework for assessing priorities.

A key function of the decision-support tool is that it should result in a land protection strategy that can guide plan implementation efforts. If local planners cannot utilize the decision-support tool, it serves only to prepare a spatial design that does not provide meaningful information for assessing future conservation opportunities and strategies for action. The decision-support tool must provide users with essential attribute information about the network design that can assist with future efforts. As choices have to be made between conservation opportunities, local governments can use a decision-support tool to ensure that they are making the most of their conservation dollars when weighing competing choices.

Green infrastructure plans should not only identify a green infrastructure network design, but they also should provide a list of the mechanisms and tools for land protection as well as viable funding programs for reaching plan goals. This implementation strategy provided within a green infrastructure plan should highlight opportunities for utilizing existing regulatory and non-regulatory land use tools for protecting important network lands. This may also include suggesting new tools that have yet to be utilized in a given planning area. Likewise, all available funding resources, including federal, state, local and private funding sources should be documented in the plan and include a description of the funding opportunities that each supply.

A good green infrastructure plan will outline a patchwork "quilt" of protection strategies that match implementation tools to the different spatial areas outlined in the green infrastructure network design. This implementation strategy will include a diversity of land uses, as designated by the network design. As most green infrastructure plans will be conducted from a regional context, it may be difficult to outline a highly specific implementation plan, however, local governments will reap the benefits of a coordinated strategy that aligns opportunities and funding efforts so that the most important priorities are protected, hopefully resulting in a lessening of competition between localities.

FRAMEWORKS FOR EVALUATING GREEN INFRASTRUCTURE PLANS

William C. Baer asserts that "the appropriate criteria to evaluate a plan are implicit in the concept that the plan embodies. Moreover, in reciprocal fashion, the plan's concept is clarified only by considering the criteria to judge it" (Baer, 1997). Developing green infrastructure criteria and applying these criteria to conservation plans can clarify the mission and purpose of green infrastructure plans and assist planners with developing conservation plans that are highly effective.

For the purpose of developing specific criteria for evaluating green infrastructure plans, plan evaluation frameworks for regional and local scales were developed. A site scale plan framework, more specific to landowners and developers, also has been developed but is not addressed in this paper. These frameworks focus on different spatial scales that represent the geo-political boundaries under which most planning efforts are conducted. The frameworks outline the specific criteria for green infrastructure plans at each respective scale. As the regional and local scale frameworks are highly similar, they are displayed as one framework in Tables 2-5, and are differentiated by "R"-regional or "L"-located in the last column. It is assumed that the regional and local planning can be undertaken by a host of different entities, including public agencies and conservation organizations.

It is important to note that the key to effective green infrastructure planning is to link and coordinate planning and implementation across these three spatial scales. However, it is also important to differentiate planning for the purpose of highlighting the distinct plan functions and implementation efforts at each level. Moreover, not all local and site-scale planning efforts will be conducted in the context of a regional-scale green infrastructure plan. Each of the three frameworks was designed to work within the hierarchy and independently.

Regional scale plans include multi-state, statewide, ecoregional, or larger watershed-scale planning efforts. This is typically the largest scale of planning that will define the landscape context of the green infrastructure network design for smaller planning scales, and lays the framework for more localized planning efforts. Regional scale plans cover large swaths of land and thus typically incorporate a multitude of landowners. As such, regional plans do not tend to have highly specific implementation plans focused at the parcel level, but provide a regional goal and a means for coordination between conservation efforts.

Local scale plans include multi-county, county, city or even small watershed planning efforts. This scale is typically multi-jurisdictional, but represents a smaller sub-area within the larger landscape context. Local scale planning is most effective when coordinated with regional green infrastructure planning efforts. However, local planning efforts conducted outside of a regional green infrastructure planning context are still viable and recommended. Plans undertaken at this scale tend to have more land-use governing jurisdiction to make specific parcel-level recommendations and develop specific plans of action. Local planning efforts may include numerous landowners, but typically fewer than the regional scale.

Site scale plans include small-scale conservation or conservation development plans. These are often called "site plans" or "small area plans" and may often focus on balancing development and conservation efforts at the parcel level. This level of planning is where most on-the-ground implementation efforts take place and thus they provide highly specific conservation action plans. For these plans to be highly effective and to ensure the integrity of the larger network design, they should be linked to regional and local scale plans.

Green Infrastructure Plan Evaluation Frameworks

The frameworks were derived from the principles of the green infrastructure planning approach and review of several green infrastructure plans. The frameworks are broken down into four main plan elements:

1. *Goal setting* – "Goal setting" or direction setting provides a clear, relevant basis for developing plans and later for decision-making and evaluation (Kaiser et al, 1995). This plan element represents the first stages of plan development, where issues are identified, a process for plan development is outlined and plan goals are derived. This plan element consists of three main types of criteria: plan foundations, stakeholder involvement and conservation goals.

Plan Foundations evaluate the basic elements and purposes for plan development. These include the incorporation and documentation of comprehensive green infrastructure elements and a discussion of the threats to those elements; the nature of the planning effort, including the focus on landscape systems; any regulatory and/or policy requirements that play a role in the planning effort; any larger scale green infrastructure planning efforts that may provide a larger scale framework for plan development; and finally the goals, objectives and strategies that will lead the plan development process.

Stakeholder Involvement assesses the means for identifying stakeholders that should be involved in plan development, any leadership entity that provides advisory guidance to the process and approves planning activities, and the inclusion of a broad array of organizations and professional disciplines.

Conservation Vision identifies and evaluates the specific conservation goals that led green infrastructure planning efforts.

2. *Analysis* - The "Analysis" element provides the factual, scientific basis for the green infrastructure network design model. Based in theories and practices from ecological and environmental sciences and land use planning, this part of the plan serves to translate the plan's goals and objectives into the green infrastructure network design model by utilizing a suitability analysis or similar methodology. Analysis consists of two main criteria: network design criteria and network suitability analysis.

Network Design Criteria evaluate the process by which the green infrastructure network design is delineated. This includes assessing the experts involved in the design process, the data incorporated in spatial modeling and the scientific thresholds utilized.

Network Suitability Analysis considers the results of the spatial modeling analysis. Specifically it evaluates the nature of the network, the incorporation of a range of scales and land uses into the model, and the ability to replicate the analysis.

3. Synthesis - The "Synthesis" plan element includes the assessment of the green infrastructure network design model in terms of vulnerability factors, the status of land protection and other feasibility factors. This assessment leads to the identification of priorities for implementation. This element consists of three main criteria: network design model enhancements, identifying priorities, and relationship to plan goals.

Network Design Model Enhancements evaluate the additional factors fed into the network design model that strengthen the design. These include land protection status, threat or stressor factors related to green infrastructure components, on-the-ground "fact checking" to determine that network design model is appropriate for real world needs, and stakeholder assessments that may include additional factors into network design.

Identifying Priorities evaluates the process by which identified green infrastructure lands are classified and ranked. Classification efforts are evaluated for their ability to delineate a specific system for prioritizing parcels by conservation value.

Relationship to Plan Goals evaluates the final design's ability to meet plan goals and to potentially link into larger green infrastructure planning networks.

4. *Implementation* - The “Implementation” element provides a strategic framework for achieving established green infrastructure plan goals by integrating conservation priorities with implementation tools and funding sources. The main themes within the implementation element are the decision-support tool, implementation tools, conservation funding, conservation strategies and defining development opportunities.
Decision-Support Tool criteria assess the plan’s ability to provide a quantitative mechanism for ranking the conservation value of protection opportunities.
Implementation Tools evaluates the documentation and assessment of potential conservation tools that can be used to protect lands within the green infrastructure network. This includes existing and new policies, programs, and market-based approaches for enacting conservation.
Conservation Funding assesses the inventory of various funding mechanisms documented within the plan, as well as providing support for permanent funding programs devoted to protecting network lands.
Conservation Strategies criteria evaluate the plan’s ability to develop a strategic effort that links implementation tools and funding sources to actual lands within the green infrastructure network, and to mandate or recommend additional efforts aimed at restoration and conservation management, as well as garnering further support for plan goals.
Defining Development Opportunities evaluates the plan’s ability to identify development opportunities that complement and fit within the context of the green infrastructure network.

Each of these elements includes numerous criteria specific to the geo-political scale of the plan. These criteria not only serve as a means for evaluating green infrastructure plans, but they also serve as a guiding framework for plan development. Each of the four plan elements can be scored using the simple point system included. Some of the criteria are weighted more heavily than other criteria, as determined by relative importance for strengthening plans. The primary goal of the scoring system is to provide a comprehensive checklist for plan development efforts. Time and funding constraints will dictate how many of the elements can be realistically included, but the framework provides a "ideal" scenario toward which the planning effort can strive to achieve.

Best Practices for Plan Development: As these three frameworks are specific to green infrastructure plan evaluation, they do not necessarily include “best practice” plan criteria that are attributable to the universe of plans. In revising their latest edition of *Urban Land Use Planning,* authors David Godschalk and Philip Berke have developed a comprehensive *Plan Quality Evaluation Protocol* that evaluates internal and external plan elements for all plan types. It is highly recommended that this plan protocol be followed when developing conservation plans or any other type of plan. As some best practice criteria are rather important for green infrastructure plans, they have been included within these frameworks. However, several important criteria that are not mentioned are:

1. Including an assessment of emerging conditions and future forecasts;
2. Consistency with other related plans and acknowledgement of other related planning efforts;
3. Identification of parties responsible for implementation efforts;
4. Inclusion of a provision for regular plan updating;
5. Inclusion of monitoring, and evaluation provisions; and
6. Inclusion of a provision for financing implementation, monitoring, evaluation and plan revising efforts.

Likewise, there are many sources available that address the project management and monitoring side of conservation planning. A noteworthy example is the recent publication, *Open*

Standards for the Practice of Conservation by the Conservation Measures Partnership (2004). These planning guidance documents should be reviewed when developing any comprehensive conservation planning initiative.

TABLE 2. Regional/Local Plan Element 1 – Goal Setting

R = Regional Plan
L = Local Plan

1.1	Plan Foundations	Possible Points	Applicable Plan
1.1.1	Were plan parameters identified geographically, temporally and/or other?	1	R,L
1.1.2	Were the planning area's comprehensive "green infrastructure" components and threats to those components documented?	3	R,L
1.1.3	Did the plan call for coordination with adjacent areas regarding efforts that extended beyond jurisdictional boundaries?	3	R,L
1.1.4	Was the plan based on an integrated landscape analysis that focused on the protection of functional landscape components?	5*	R,L
1.1.5	Were federal, state, county or local planning mandates or policy recommendations addressed and incorporated into the plan?	1	R,L
1.1.6	Was the plan supported by a legislative body or executive office by means of a formal resolution?	1	R,L
1.1.7	Did the plan incorporate results from a statewide or regional green infrastructure plan?	3	L
1.1.8	Was the plan led by a vision, formal plan goals, and strategies for guiding plan development?	5*	R,L
1.2	Stakeholder Involvement		
1.2.1	Did a leadership forum or advisory committee provide leadership and generate momentum for the planning effort?	5*	R,L
1.2.2	Did the leadership forum/advisory committee include a diversity of professional disciplines and represent multiple sectors?	3	R,L
1.2.3	Did the plan include documentation of a stakeholder analysis to identify stakeholders included within the plan parameters?	1	R,L
1.2.4	Did the planning process include an "adequate" public engagement process that provided stakeholders with ample opportunities to weigh in on plan development?	3	R,L
1.2.5	Were county and local governments engaged in plan development?	1	R,L
1.2.6	Were federal or state agencies engaged in plan development?	1	R,L
1.2.7	Were area non-governmental organizations, land trusts or other conservation organizations engaged in plan development?	1	R,L
1.3	Conservation Vision		

1.3.1	Was plan development led by goal(s) to protect ecological processes and functions?	5*	R,L
1.3.2	Did the plan include goal(s) for working lands protection (i.e. farming, forestry, ranching)?	3	R,L
1.3.3	Did the plan include goal(s) for hazard mitigation?	3	R,L
1.3.4	Did the plan include goal(s) for watershed protection?	3	R,L
1.3.5	Did the plan include goal(s) for open space and its associated human benefits (i.e. passive recreation, aesthetic quality)?	3	R,L
1.3.6	Did the plan include goal(s) for the preservation of cultural and historic resources?	1	R,L
1.3.7	Did the plan include goal(s) for eco-tourism and other economic development activities that utilize conservation lands?	1	R,L
1.3.8	Did the plan include goal(s) for growth management?	1	R,L
1.3.9	Did the plan include other conservation-related goals?	1	R,L

**Denotes a required criteria that plans must include.*

TABLE 3. Regional/Local Plan Element 2 – Analysis

2.1	Network Design Criteria	Possible Points	Applicable Plan
2.1.1	Did the plan include a comprehensive assessment of landscapes and landscape features within plan parameters? (e.g. biological, hydrological, geological, human-dominated)	3	R,L
2.1.2	Were spatially explicit data sets that contain attribute information for landscape features, gathered and compiled?	3	R,L
2.1.3	Did data sets include information for human-dominated landscape features (agriculture, development, etc.), as well as natural landscape features?	1	R,L
2.1.4	Were baseline maps prepared to identify individual green infrastructure components (i.e. forestlands, working lands, wildlife habitat, parklands, etc.)	1	R,L
2.1.5	Did network design criteria for hubs and corridors incorporate ecological thresholds and other conservation parameters? (ex. minimum dynamic areas, size of migration corridors, natural disturbance regimes, edge effects, important riparian zones, etc.)	5*	R,L
2.1.6	Were corridors identified using least-cost path analysis or a similar methodology?	3	R,L
2.1.7	Were network design criteria documented?	1	R,L
2.1.8	Were ecologists and other natural areas specialists involved in producing the network design criteria and weighting systems?	3	R,L
2.1.9	Were network design criteria based on current biological and ecological theories and best practices? (i.e. hubs/corridors, contiguous lands, connectivity, etc.)	5*	R,L
2.1.10	Do the network design criteria incorporate all of the plan's goals?	3	R,L

2.2	Network Suitability Analysis		
2.2.1	Was a suitability analysis or similar land suitability method (that incorporated the network design criteria) utilized to calculate and classify the range of conservation values for the study area?	5*	R,L
2.2.2	Were conservation values assessed for a range of spatial scales, including smaller parcel-level analysis?	1	R,L
2.2.3	Did the final network design (i.e. results from suitability analysis) result in an ecologically connected framework?	5*	R,L
2.2.4	Did the network design incorporate a diversity of land uses (i.e. working lands, open space, parklands, habitat)?	5*	R,L
2.2.5	Are specific hubs and corridors delineated in the plan?	3	R,L
2.2.6	If a regional plan was developed, were new target hubs and corridors revealed at the local-scale analysis?	1	L
2.2.7	Were gaps in the network (both in hubs and corridors) identified?	5*	R,L
2.2.8	Did the plan include a clear and coherent graphic representation of the final network design?	5*	R,L
2.2.9	Was the suitability analysis model (or similar model) replicable?	1	R,L

**Denotes a required criteria that plans must include.*

TABLE 4. Regional/Local Plan Element 3 – Synthesis

3.1	Network Design Model Enhancements	Possible Points	Applicable Plan
3.1.1	Was feedback from a stakeholder assessment of the network design incorporated into the model?	1	R,L
3.1.2	Was an ecological "ground-truthing" assessment of the network design incorporated into the model?	3	R,L
3.1.3	Were risk and vulnerability factors (i.e. risk for development or fragmentation) for network segments assessed and incorporated into the model?	3	R,L
3.1.4	Was the protection status of green infrastructure network lands identified and incorporated into the model?	5*	R,L
3.1.5	If it is not feasible to connect hubs using the corridors identified in the original network design, are alternative corridors identified?	3	L
3.2	Identifying Priorities		
3.2.1	Were the systems for prioritizing and ranking hubs and corridors based on the results of the suitability analysis, vulnerability factors and status of land protection?	5*	R,L
3.2.2	Were hubs and corridors ranked within each different type of landscape?	1	R,L
3.2.3	Were hubs and corridors ranked at a coarse, regional scale?	1	R
3.2.4	Were hubs and corridors ranked at a finer, local scale?	1	R,L
3.2.5	Was a system for prioritizing restoration and enhancement opportunities developed?	3	R,L
3.2.6	Were specific priorities identified in this plan?	5*	R,L
3.2.7	Were ranking systems combined to create a comprehensive system for ranking lands within the green infrastructure network?	3	R,L
3.3	Relationship to Plan Goals		
3.3.1	Were the final conservation priorities evaluated against the original design criteria?	1	R,L
3.3.2	Did the final conservation priorities meet plan goals?	1	R,L
3.3.3	Does the local plan integrate the network design into a larger, regional network design?	3	L

**Denotes a required criteria that plans must include.*

TABLE 5. Regional/Local Plan Element 4 – Implementation

4.1	Decision-Support Tool	Potential Points	Applicable Plan
4.1.1	Did the plan include a decision-support tool (i.e. mechanism for quantitatively ranking conservation opportunities based on the network design and other important factors)?	5*	R,L
4.1.2	Does the decision-support tool allow for the incorporation of new data as it becomes available?	3	R,L
4.1.3	Can the decision-support tool help guide local and site-level implementation efforts?	5*	R,L
4.1.4	Was the methodology for developing the decision-support tool documented?	1	R,L
4.2	Implementation Tools		
4.2.1	Does the plan identify available mechanisms and tools for land protection (i.e. acquisition, easement, TDR, other)?	5*	R,L
4.2.2	Does the plan assess the feasibility and effectiveness of utilizing available tools for land protection?	1	R,L
4.2.3	Does the plan recommend new conservation tools?	1	R,L
4.2.4	Were implementation tools matched with sites based on their ability to handle the threats that were identified in those areas?	3	R,L
4.2.5	Did the plan provide useful and effective ways to integrate the green infrastructure network implementation efforts into county/city regulation, planning, capital improvement programs, and/or development review procedures?	1	L
4.2.6	Did the plan call for specific “small area plans” or similar small-scale plans to guide the conservation of target areas?	1	L
4.3	Conservation Funding		
4.3.1	Does the plan identify federal, state, local and/or private conservation funding opportunities?	5*	R,L
4.3.2	Did the plan document strategies for leveraging existing funding sources to generate new sources?	1	R,L
4.3.3	Does the plan document the need for a recurring or revolving funding source?	1	R,L
4.4	Conservation Strategies		
4.4.1	Was information pertaining to related environmental protection, natural resource conservation, green space planning and other similar efforts assessed in terms of implementation opportunities?	3	R,L
4.4.2	Does the plan outline specific implementation strategies for state and regional agencies?	5*	R
4.4.3	Does the plan outline specific implementation strategies for county, local governments and private landowners?	3	R,L
4.4.4	Does the plan identify relative priorities for implementation	3	R,L

	strategies?		
4.4.5	Does the combination of all identified implementation strategies encompass a diversity of land uses?	5*	R,L
4.4.6	Are implementation strategies spatially matched to create an “implementation quilt” across the network?	3	R,L
4.4.7	Was a coordinating body or task force established to oversee and coordinate implementation efforts?	1	R,L
4.4.8	Does the plan identify necessary stewardship and management activities to restore, monitor and maintain green infrastructure network resources over time?	3	R,L
4.4.9	Does the plan outline a marketing and public outreach strategy to garner further support for plan goals?	1	R,L
4.5	Defining Development Opportunities		
4.5.1	Did the plan discuss opportunities for development within the context of the green infrastructure network?	1	R,L
4.5.2	Did the plan identify a range of land uses to buffer priority protection areas from current or future development?	1	R,L
4.5.3	Did the plan recommend the use of conservation development or limited development for developing lands within the context of the green infrastructure network?	1	R,L
4.5.4	Were implementation strategies coordinated with state or local growth management efforts?	3	R,L

**Denotes a required criteria that plans must include.*

Regional and Local Plan Evaluations: The four plans evaluated were chosen based on a preliminary review that identified them as meeting all plan criteria – two for regional evaluation and two for local evaluation. These plans represent diverse methods for developing green infrastructure plans. The following synopses describe the plans reviewed and highlight results from the evaluation. The scoring system was not applied to these plans, as they were completed before this evaluation system was developed. However, the framework was utilized as the foundation for evaluating the plans.

Sonoran Desert Conservation Plan (Huckleberry, 2000; Huckleberry, 2001) – Regional Plan Review: As a response to the increasing degradation of habitat for vulnerable species and a rising need for growth management policies to curb haphazard sprawl, Pima County, Arizona initiated a highly advanced model for conservation planning in 1998. Working under the three plan objectives of creating a science-based conservation plan, producing an update to the comprehensive land use plan, and obtaining federal regulation compliance for the protection of endangered species through a multiple species conservation plan, the *Sonoran Desert Conservation Plan* combined traditional growth management and conservation planning into a single comprehensive planning initiative. This initiative was led by goals to protect biological diversity and vulnerable species habitat, ensure the protection of critical riparian areas in the desert region, identify and preserve cultural and historic resources, ensure the future viability of ranchlands and ranching, and connect the numerous public parks and preserves into a linked landscape system.

Including more than 400 public workshops and education meetings, this planning effort sought to balance a highly scientific land classification process with a robust public

engagement component. The steering committee and supportive technical advisory teams included citizens, scientific experts, and representatives from nonprofits, federal agencies, and planning advisors. The planning process included a short-term component focused on the immediate protection and enhancement of natural resources and the environment, and a long-range planning component to ensure that natural and urban environments not only coexist, but also reinforce each other's success for the long term. Throughout the process, short-term goals such as identifying and designating new public parklands and obtaining conservation funding in the form of general obligation bonds were achieved.

The Sonoran Desert Conservation Plan does not consist of one single plan, but a combination of plans including numerous supplementary plans to reinforce and advance specific elements. These include a federal Environmental Impact Statement, a regional Multi-Species Conservation Plan, an adaptive management plan, an implementing agreement and an update to the County Comprehensive Land Use Plan. At the time of this review, planners had completed the *Preliminary Sonoran Desert Conservation Plan* and a draft of the *Multi-Species Habitat Conservation Plan.* The review is based on these documents and other supporting materials. As the county planning area included over 5.9 million acres, it was deemed appropriate to evaluate this plan using the regional green infrastructure framework criteria. This is also supported by the regional nature of the habitat conservation plan and the numerous cooperative agreements with adjacent governing jurisdictions. What follows are several key points that came though during the plan evaluation.

1. The process is exceptional in terms of the numerous stakeholders that have been engaged. From engaging citizens and technical experts to lead the planning process, to securing cooperative agreements with neighboring jurisdictions and with federal agency partners, to enlisting private conservation organizations to assist with the analysis and development of prioritization systems, this effort serves as a model for collaborative conservation planning.
2. The process extended beyond regulatory requirements of the Federal Endangered Species Act to enact a broader comprehensive planning process that linked growth management, land use and conservation planning. The plan was highly effective in defining development regulations that corresponded to the ecological network design. The county comprehensive plan reflected the goals of the planning process and established formal county policies to regulate land use related to priority conservation lands.
3. Although it was created through a highly scientific and iterative process, the network design did not incorporate all of the goals of the plan. The network was specific to ecological hubs and corridors, as this component was necessary for applying for a Section 10 incidental take permit. This will probably change in the long run, but the plan at this point in time does not identify the process for incorporating other plan goals, such as cultural and historic resources, into the design.
4. The final plan will incorporate a decision support tool and currently includes in-depth recommendations for establishing institutional changes to further plan goals. Some parcel-specific implementation measures have already been established through the county's Acquisition Master Plan.

Florida Greenways and Trails Plan (Florida DEP, 1998; GeoPlan Center, 1998) – Regional Plan Evaluation: Due to the increasing loss of natural habitat and ecological lands, two private conservation organizations initiated efforts in 1991 to create the Florida Greenways Program, which was focused on building a statewide constituency for greenways. As a key outcome of this effort, the Governor of Florida established a 40-member Greenways Commission to develop a coordinated approach for protecting,

enhancing and managing a statewide greenways and trails system. The work of the commission resulted in the establishment of a Greenways Coordinating Council that worked with the State's Department of Environmental Protection to develop a 5-year implementation plan for the proposed network. The GeoPlan Center at the University of Florida was contracted to delineate the physical network design that would augment the implementation report, and to assist with general greenways planning.

The network design model was based on the development of a joint system that included ecologically significant lands and a cultural-historic trail network. Combined, these two networks created a comprehensive statewide system that linked and integrated ecologically significant sites, and corridors for trail and recreational uses.

The implementation plan introduced the statewide greenway and trail network model and provided seven recommendations for implementing the system, including the development of a system for prioritizing network features, developing a process for "designating" greenway and trail network lands, stimulating awareness of the network and educating landowners on the benefits for developing greenways and trails, and providing assistance and financial support for state, regional, local and private sector greenway implementation, maintenance and management efforts.

Like the Sonoran Desert Conservation Plan, the Florida Greenways and Trails Plan was the culmination of a lengthy planning process that resulted in an ecologically based network design. This plan was one of the first statewide efforts to create a spatial framework for guiding land conservation efforts. What follows are a few of the highlights that arose through the plan evaluation.

1. The plan had strong political support and approval from the Governor and from the state legislature. This aided the funding and implementation of the plan; however this level of support may not be entirely sustainable through administration changes. The plan included policies that respond to statutory requirements, creating a more binding framework for future efforts.
2. The statewide plan focused solely on lands of national or statewide significance; however, the implementation plan did call for the development of a prioritization process to aid county and local governments in developing conservation strategies. The idea was to create a statewide network and then delineate local level strategies that would provide the building blocks for the network.
3. Following preliminary analysis and development of the greenways and trails network design, the model was taken to a series of meetings for comment and review by the general public and by landowners. This process resulted in a modification of the design to reflect their input, specifically allowing landowners to withdraw their lands from the network design. From a political standpoint, excluding lands of landowners who were unwilling to designate their properties as part of the greenways network was probably a smart move. However, it should be noted that the network design was slightly altered based on this feedback.
4. The plan included a comprehensive implementation element comprised of 1) a list of land conservation tools approved by the state, as well as a list of state-level funding sources, 2) suggestions to adopt a new statewide public conservation program to replace an older program that had timed out, and 3) the creation of a new coordinating body that would promote the program and advise the State's Department of Environmental Protection on administration and management of the greenways and trails program.

Talbot County Green Infrastructure Plan (The Conservation Fund, 2004) – Local Plan Evaluation: Located on the Eastern Shore of the Chesapeake Bay, Talbot County Maryland is receiving increasing development pressure from the greater Washington D.C.-Baltimore region. This county is home to many rural communities and acres of

farmlands. Combining the unique Chesapeake Bay setting and a significant acreage of unprotected agricultural lands makes Talbot County vulnerable to a real estate development boom.

Following an update to their county comprehensive plan in 2004, Talbot County Maryland undertook a countywide planning effort to identify green infrastructure resources and form strategies to protect these resources. This effort was bolstered by the State of Maryland's GreenPrint and Smart Growth programs and other state and federal programs related to the protection of lands within the Chesapeake Bay Watershed. The County Planning Department contracted The Conservation Fund, a national land and water conservation organization, to conduct the green infrastructure assessment, propose implementation strategies and develop a decision-support tool that would enable the county to effectively respond to and prioritize different conservation opportunities, and customize assessments to conservation funding opportunities that may arise. The green infrastructure plan goals aligned with the goals of the updated County Comprehensive Plan, as well as a resolution that the County signed, in conjunction with five other Eastern Shore counties, in which they committed to preserve 50% of the County's land by 2010.

Taking from the goals of the comprehensive plan, the Talbot County Green Infrastructure Plan focused on the identification of lands that had outstanding ecological value, lands that had a potential for high agricultural productivity, lands that provided critical protection of aquatic resources in riverine systems and lands that served to protect the Chesapeake Bay Watershed. The Conservation Fund assessed these conservation objectives using a suitability analysis and developed a comprehensive county wide green infrastructure network design from these assessments.

The local level analysis was built upon the Maryland Green Infrastructure Assessment, a statewide green infrastructure study conducted by the Maryland Department of Natural Resources. The county level analysis proved effective at identifying parcel level conservation priorities that supported the statewide network design, as well as identifying additional lands that were not identified in the statewide analysis. Ten "hubs" or conservation priorities were identified through these assessments.

As the plan was developed by a private organization, implementation strategies were not mandated by the plan; however, specific action items were proposed. The plan included a review of current federal and state funding sources, recommendations for local funding opportunities and a plan for garnering public support for future conservation efforts. What follows are a few highlights from the plan review.

1. The plan incorporated a comprehensive mix of conservation objectives within the planning effort and the final network design - more so than the other plans reviewed. It also incorporated statewide growth management and conservation program objectives into the plan goals and was developed within a larger statewide green infrastructure framework.
2. The plan did not include a full-fledged public involvement component. As the plan was developed based upon recommendations taken from the County's Comprehensive Land Use Plan, it incorporated the goals derived from that plan's public process.
3. The plan identified current programs and options for additional funding sources utilized in other locations (i.e. general obligation debt, tax levy, land conservation bank) and discussed the potential effectiveness of implementing these tools within the county.

4. Even though the plan was developed under the supervision of the county planning office, the plan was not formally adopted and did not carry the political support of a publicly vetted plan.

Anne Arundel County, Maryland Greenways Master Plan (Anne Arundel County, 2002) – Local Plan Evaluation: Like Talbot County, Anne Arundel County, Maryland has attracted development from the greater Baltimore-Washington region. As a response to decreasing open space in the county, several county planning efforts, including the General Development Plan, recommendations from 12 small area plans, and recommendations from the County Land Preservation and Recreation Plan, proposed the protection of a network of linked conservation lands within the county. These efforts were further supported by the State's Green Print program and the Maryland Green Infrastructure Assessment effort, which resulted in a statewide green infrastructure network design.

Led by the Greenways Master Plan Technical Advisory Team of federal, state and county agency representatives, a planning effort to identify a network of green infrastructure lands began in 2000. The plan took a 50-year outlook and included a modest public involvement component. The plan was led by one goal to

> *"Create an interconnected network of greenways in Anne Arundel County that protects ecologically valuable lands for present and future generations and provides open space, recreational and transportation benefits and opportunities for people."*

Using habitat data on three indicator species located in the county, and analysis results from the statewide green infrastructure assessment, five network criteria were analyzed to develop a network of hubs and corridors. This network incorporated 27% of lands in the county, 51% of which were already in some form of permanent or temporary protection status. The plan called for the development of individual implementation/management plans for each of the 41 greenway segments, and as a result the plan was not very specific in developing conservation priorities or a detailed implementation plan. However, the plan did call for the creation of a new Greenways program to be headed by a program manager, establishment of a revolving fund for public land acquisition projects, development of a public education and outreach program to garner support for the plan and a creation of a program to educate landowners on private land conservation opportunities. While the plan did not document the method for ranking and prioritizing greenway segments based upon critical needs for protection and management, the plan does identify six priority greenway segments that are in need of immediate action.

This plan serves as a good example for how the green infrastructure planning approach is permeating other plan taxonomies. While primarily focused on developing a linked network of trails and greenways, the analysis for the network design was based upon ecological criteria and assessments. Moreover, the greenways network was designed to enhance and improve upon the existing statewide green infrastructure network at the local level. What follows are a few highlights from the plan review.

1. The plan did not include critical ecological lands that are incorporated in other planning efforts, thus the greenway and trail county network is not ecologically comprehensive for the county. The plan could have included additional conservation objectives in analysis, including critical watersheds, farming and forestlands, Maryland Critical Areas, or other important conservation lands.

2. The Technical Advisory Team included members from the county planning office, Maryland State natural resource agencies, and one member from the National Park Service, constituting a good blend of conservation and planning expertise.
3. The final design resulted in a greenways network that was complementary to the state network model and identified additional "critical connections" which require restoration to ensure wildlife movement at a county scale.
4. The plan included a short summary of the analysis conducted to delineate the greenway network. Specific metrics and the methodology for analysis were not included in this plan and made it difficult to understand the process undertaken to design the network.
5. The plan recommended amendments to county planning documents and processes to factor the network design into other land use planning activities.

CONCLUSION

Decades of conservation planning have resulted in several plan taxonomies that are no longer easily differentiated. It has become increasingly difficult to articulate the differences between greenway, open space, green infrastructure and other types of conservation plans as planning efforts have evolved and now produce plans that look more like hybrids. Distilling the core components and purposes of conservation plan taxonomies, as this paper has demonstrated, can help create a common language for conservation planners and shed light on the advancements that have been made in the field of conservation planning. Green infrastructure planning represents a strategic conservation approach that combines the efforts of previous conservation planning methodologies and practices into a systematic framework that can encompass larger landscapes and broader planning goals.

Green infrastructure planning – an approach to conservation planning that focuses on landscape scale conservation efforts – has been influenced by advancements in ecological sciences and land use planning practices and methodologies that have developed over the last 150 years. This comprehensive approach can be attributed to the progression of numerous fields, such as landscape ecology and environmental planning and the work of many experts such as Frederick Law Olmsted, Warren Manning, and Eugene Odum. Green infrastructure planning differs from other types of conservation planning as it focuses on the identification and protection of critical ecological functions and processes and other open spaces, links public planning processes and scientific analysis to delineate a linked network design comprised of ecological hubs and corridors, and provides a blueprint for future land conservation and development efforts.

Although the green infrastructure planning approach has been permeating conservation efforts across the nation in recent years, a specific framework for creating green infrastructure plans has not been developed until now. Designed to better define green infrastructure plans and provide guidance for green infrastructure planning efforts as well as criteria for evaluating plans, the plan frameworks introduced in this paper can be implemented at any planning scale and by any planning entity. Applying these green infrastructure plan frameworks can guide future conservation planning efforts.

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