Proceedings of the Fábos Conference on Landscape and Greenway Planning

Volume 4
Issue 1 *Pathways to Sustainability*

Article 31

2013

Synthesizing an Integrated Green Infrastructure - Establishing a Conceptual Planning Framework in the Western United State's Urbanizing Communities

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Introduction

Planning methodologies in the United States have continually evolved and adapted to address the myriad of environmental and social issues faced by contemporary culture (e.g., Thompson and Steiner, 1997; Calthorpe, 1993), but few have provided the framework to successfully address these subjects simultaneously and comprehensively, and fewer effectively meet the evolving demands society places on human and ecological systems, especially in urbanizing areas, where ecological fragmentation and land use conflict predominates.

Currently, most spatial planning frameworks assess ecological-based and social-based systems as separate entities (Weber et al., 2006; Daniels, 2009), and our understanding of the interrelationships between these systems is incomplete (Wu, 2006). In the United States's continually transmuting landscapes, planning practices must modify and expand (Armitage et al., 2009) to support an integrated approach to solve modern society's complex temporal and socio-spatial problems (Berkes et al., 2003; Waltner-Toews et al., 2003). In 2009, Termorshuizen and colleagues indicated the absence of such an integrated planning methodology, and to date (2013) this has not been accomplished. A crucial first step in contributing to such an approach is the initiation of a clear and consistent conceptual planning framework. This paper will provide such a framework.

Context

Social concerns and ecological functions were effectively combined as early as 1857 with the work of Frederick Law Olmsted in New York's Central and Prospect Park as well as Boston's Emerald Necklace (Daniels, 2009). Ebenezer Howard's early work for Garden Cities (1902) in the United Kingdom built upon Olmsted's concepts (Daniels, 2009) to include greenbelts to facilitate balanced urban growth and "a steady state of green and service infrastructures to support the communities that reside there" (Mell, 2007).

Though Ian McHarg did contribute an influential model for analyzing and combining "social values" of the landscape in the late 1960's (McHarg, 1969), this early approach was broad, vague, and analyzed the situation with respect to the "costs to society" from an environmentally-exclusionary perspective. McHarg's overlay technique (e.g. social values and hazardous areas concurrently) promoted a rationalist, spatially-explicit land use planning technique which directed the location of the social and ecological systems, and did not integrate them.

Though current practice and research now frame these early pioneering concepts within contemporary landscape and urban planning, this multi-functional landscape ideal has been

largely forgotten, particularly through the conservation and preservation priorities prevalent in the United States, isolating large tracts of land with limited management cohesion and disconnect from the broader ecological network and systems (Miller and Hobbs, 2002).
Since the mid 1990s, ecosystem theory has broadened to incorporate humans not just as outside disturbances but as integrated with other biological and physical processes and their structures (e.g., McDonnell and Pickett, 1993; Alberti, 2008). However, spatial planning paradigms in the United States perpetuate the independence of sociological systems and ecological systems.

This ideological division between the social sciences and the natural sciences regards each as autonomous systems (Koomen et al., 2008) where the human or sociological-based systems view all processes internally without external or ecological impacts (Berkes et al., 2003) and the natural or ecological-based systems consider humans and their actions as external or segregated from the ecosystems (Liu et al., 2009). As interrelated systems thinking has increased within the discipline of spatial planning and landscape architecture, so too has the need for improved theory and concepts.

Green infrastructure, a relatively new methodology in spatial planning, utilizes systems theory and presents a compelling approach to resolve many of contemporary society's land use concerns and merits further examination. The term 'green infrastructure' was first developed by Mark Benedict and Ed McMahon (2002) of The Conservation Fund (TCF) in the early part of this century and is defined as follows:

> *Green infrastructure is an 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 (American) communities and people. (p. 6)*

Though this definition goes beyond traditional environmental planning concepts to incorporate human livability while maintaining natural-system importance (Kambites and Owen, 2007), its focus on ecological processes misses a more inclusive framework for applying systems thinking and interconnected strategies to a broader range of elements beyond ecological systems to include cultural, social, historical, economic, and political resources, among others.

Green infrastructure practices in the United States primarily focus on ecological and natural system conservation (e.g., The Conservation Fund, 2007; The Trust for Public Land, 2010; Weber et al., 2006) and emphasize analyses and critical land protection that support biodiversity and conservation biology (Weber et al., 2006). Though Benedict and McMahon's definition of green infrastructure provides an anthropological approach (i.e. ecosystem services), the fluid integration of nature-centered and human-centered strategies is not yet fully represented in current United States based spatial planning practices (Kambites and Owen, 2007). Evidence that green infrastructure planning can successfully transcend an ecological framework is evident outside the United States, particularly in Western Europe and the United Kingdom, where green infrastructure planning is being practiced comprehensively (e.g., Science for Environment Policy, 2012; GIFT-T, 2012; Cambridgeshire Horizons, 2011), but only as an integrated outcome (i.e. benefits for humans *and* people), not the methodology itself.

While the idea of identification of ecological resources is a vital part of any spatial planning effort, acknowledgement of the validity in including human-based, or sociological, considerations in green infrastructure planning is predominately relegated to economic valuations of ecosystem services (Costanza et al., 1997), or the benefits people obtain from ecosystems (e.g., Paetzold et al., 2010, de Groot et al., 2002). This shift in approaches from a preservation and conservation emphasis towards ecosystem services and multifunctional benefits presents a strategy to evaluate resources in terms of how they support human well-being (Paetzold et al., 2010), but researchers must not limit the values to strictly economic or ecological measurements.

Green infrastructure can potentially provide a wide range of social, economic and ecological benefits (e.g., Kambites and Owen, 2007; Benedict and McMahon, 2006), but it is the merit of the comprehensive planning concept itself, not just the benefits, which must be acknowledged to structure a revised methodology. The challenge is to bring together socio-ecological systems in a comprehensible, replicable and integrated framework. Through the assimilation of broader typologies within green infrastructure's ecologically-based planning matrix, a more complete interconnected systems approach that allows for richer ecological analysis (Mell, 2008), socio-cultural-based resource acknowledgement, and increased understanding of contemporary urbanizing society can be achieved.

Goals and Objectives

The goal of this paper is: 1) to validate the need for a more integrated spatial planning framework in urbanizing landscapes, 2) to show how a case study did produce such an integrated framework, 3) to critically analyze the case study's strengths and weaknesses, and 4) to provide a discourse to improve future frameworks to incorporate socio-ecological systems.

The objective of this paper is to illustrate a conceptual framework which recognizes the importance of ecosystem services, landscape integrity, and stewardship in urbanizing landscapes of the western United States.

The paper illustrates through a case study examination how to successfully acknowledge, document, and synthesize a comprehensive system of resources, placing what have been traditionally disparate approaches (i.e. anthropological-based and ecological-based resources) within the context of a proven yet expanded green infrastructure methodology.

Case Study Introduction

A new approach to land use planning was essential to prepare for the projected 2.3 million residents (WFRC, 2012) who will occupy the Wasatch Front by 2040, most of whom will reside along the region's urban corridor (Ogden-Salt Lake City-Provo). *(re)connect: The Wasatch Front Green Infrastructure Plan* (2012) is currently undergoing implementation in the Salt Lake City Metropolitan Region by the Wasatch Front Regional Council; a 60 city, 5 county planning organization promoting cooperative problem resolution and planning coordination among local governments (WFRC, 2012). It must be noted that the author of this paper was also the lead consultant for the case study. In the case study presented, social and ecological-based resource frameworks were merged into a single green infrastructure planning approach in northern Utah, one of the most rapidly expanding areas within the United States.

This case study review does not to discuss the data, rationale, or criteria in determining the green infrastructure networks themselves, but does emphasize that these steps provided a methodology to facilitate comprehensive green infrastructure planning. Separate sets of criteria determining the highest quality green infrastructure resources were used to identify and map the green infrastructure networks – their cores, hubs, and corridors - traditional green infrastructure components. The primary spatial modeling tool used in (re)connect to complete the mapping process was ArcGIS ArcMap 10.

(re)connect incorporated sociological resources in its spatial planning framework for two reasons: First, (re)connect's asset-based approach to green infrastructure intended to be as thorough as possible in the identification of landscape resources that provided benefits and services to the region's residents. There were many ecological as well as socio-cultural resources that provide recreational, psychological, economic, and public health benefits (Paetzold et al., 2010, de Groot et al., 2002) which this methodology endeavored to denote.

Second, (re)connect promoted the understanding that socio-cultural systems need not be viewed as inherently separate from natural systems. Human land-use patterns often conflict with natural systems (e.g., Lyle, 1999; Turner et al., 1990) which is why human-affected landscapes are so ubiquitously regarded as distinct from the surrounding "natural landscapes" (Steiner, 2002) in planning disciplines. This notion of separation perpetuates in the dissociated development patterns and fragmentation of landscapes (Tzoulas et al., 2007) throughout the western United States. Socio-ecological systems, as supported by Berkes and Folke (2003), are interrelated and in flux; this viewpoint also positions humans as part of nature and the authors consider the separate characterization of these two systems to be assumed, culturally induced and inconstant.

Each green infrastructure project requires a slightly different planning approach based on its objectives and the regional differences in green infrastructure resources. The Conservation Fund has used an array of methodologies. (re)connect selected from, and slightly modified, those strategies to arrive at a green infrastructure network approach that accounted for the specific context of the Wasatch Front. This case study demonstrates how an integrated socio-ecological network might be developed and utilized by planners in making proactive, sustainable decisions.

Case Study Framework Development

Ecological-based resources are important components of any green infrastructure planning approach, but they were only one of five resource categories examined; (re)connect developed a unique methodology to enable the assessment of sociological landscape benefits and community resources in addition to the more commonly evaluated natural-based resources.

(re)connect viewed the Wasatch Front's resources from an asset-based perspective, not the common reactive or 'fear of loss' position. This approach first identified the service-providing socio-ecological systems, or comprehensive green infrastructure resources, then discerned ways to strengthen them through stewardship actions, spatial connection, planning recommendations, and land use strategies, the latter of which is not discussed in this paper but important to the context of the methodology.

The following steps outline the integrated green infrastructure methodology utilized in (re)connect:

Step 1: Development of the Socio-Ecological Green Infrastructure Typology Spectrum

(re)connect's integrated methodology represented resources from across the spectrum between natural-based and social-based typologies (figure 1). These resources were not mutually exclusive, and did not always conflict with one another. Conversely, these had the capacity to strengthen one another (e.g. mountain trails and water quality), particularly when recognized through the conception of ecosystem services and stewardship.

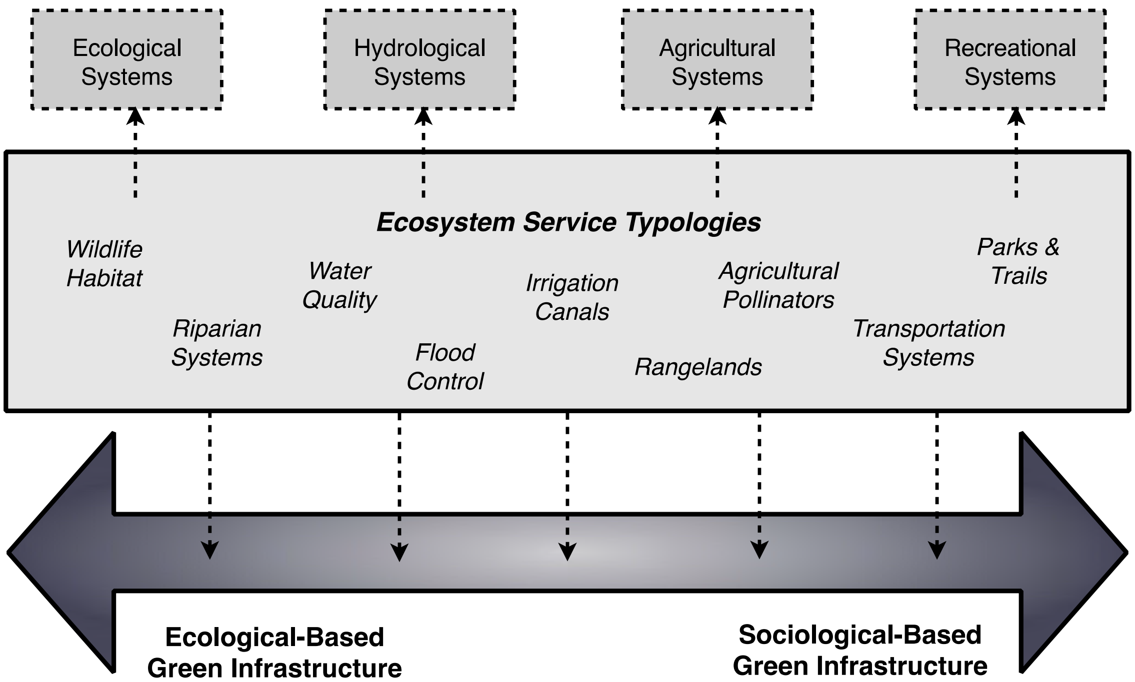

Figure 1: Socio-Ecological Green Infrastructure Typology Spectrum Diagram
The ecosystem services listed on the far left were important for ecological-based (natural) system performance. Those on the far right were beneficial to sociological-based (human) system functionality, and those in the middle were of value to both natural and social systems.

Ecosystem services, or benefits that people derive from ecosystems (Daily, 1999), provided this planning methodology with a means to initiate the social green infrastructure framework, and was similar to that of the natural, or traditional, green infrastructure approach.

Step 2: Definition of the Asset Network Typologies

(re)connect's methodology identified the predominant resource priorities and goals held in common by the many and diverse stakeholders. These collective planning considerations were organized into five (5) asset network typologies or categories (figure 2, top) as defined through the resource system typology spectrum (figure 1, top)

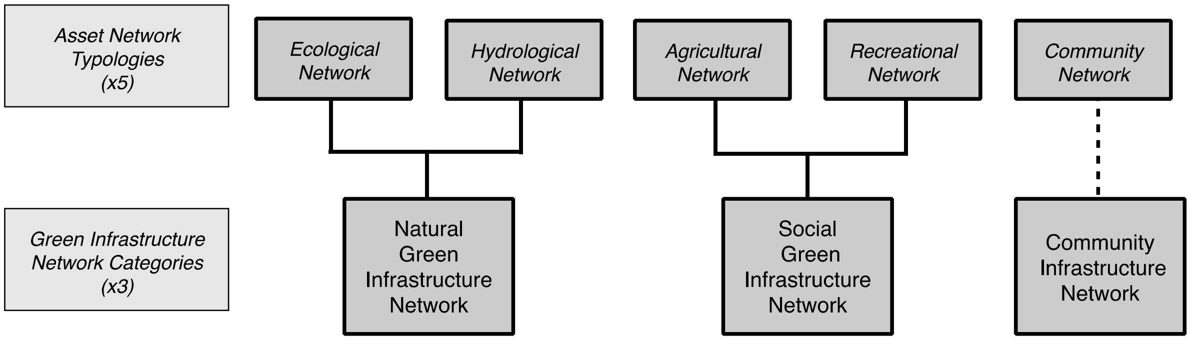

Figure 2: Asset Network Typologies and Green Infrastructure Network Categories

Step 3: Aggregation of the Asset Network Typologies into Infrastructure Network Categories

A set of composite, or combined, infrastructure networks were synthesized to better assess the interrelations of the individual asset network typologies (figure 2, bottom). Being aware of the foundational contradiction between ecosystem integrity and human land uses (Forman, 1995), the five (5) asset networks were combined into two (2) final green infrastructure networks rather than one (1) overall network, and one (1) community infrastructure network. For the purposes of this paper, ecological integrity is defined as the ability of an ecological system to support and maintain a functional community of organisms and hold resilience to disturbances (Parrish et al., 2003).

The natural green infrastructure network synthesized the ecological and hydrological assets. Since recreational and agricultural or working lands assets represent human benefits, and cultural land uses contrast natural processes (Forman, 1995), they were combined into the social green infrastructure network. The community asset network, comprised predominately of built infrastructure, was not incorporated into these two composite green infrastructure networks, but was simply renamed the community infrastructure network and is utilized later in the methodology's process. Though this last network was not given the 'green infrastructure' nomenclature, it does retain the concept of interconnected and service-providing 'infrastructure' and the network's composition applied the same criteria and componentry as the others to the best extent possible.

Step 4: Establishment of the Socio-Ecological Green Infrastructure Network

Through an additive process, the social and green infrastructure networks were combined to create the socio-ecological green infrastructure network (figure 3). This composite network exemplified an important tenet of (re)connect's interrelated green infrastructure approach: landscape integrity.

Figure 3: The Socio-Ecological Green Infrastructure Network

Step 5: Incorporation of the Community Infrastructure Network

The community infrastructure network (see step 1 & figure 2) consisted of built landscapes and systems that contributed to the community livability and economic vitality of the region. These resources, such as public and private institutions (e.g. libraries, schools, hospitals), transit centers, and other cultural features, are valued by humans only, and had the capacity to impact green infrastructure networks far beyond a region's physical borders.

Step 6: Synthesis of the Areas of Stewardship Opportunity

To better understand the interconnectivity of the two (2) green infrastructure and community networks, another composite network was generated which illustrated the areas of spatial overlap between: 1) the community infrastructure network and the natural green infrastructure network, and 2) the community infrastructure network and the social green infrastructure network. This was referred to as areas of stewardship opportunity (figure 4).

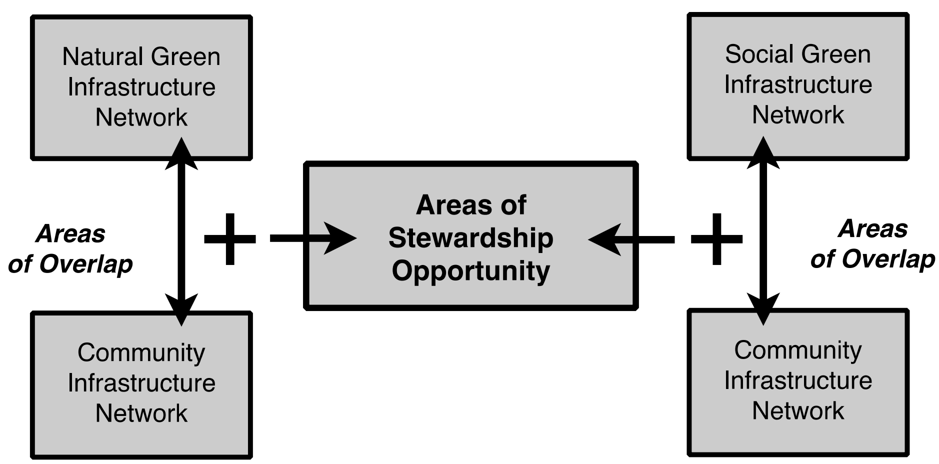

Figure 4: Areas of Stewardship Opportunity

This combined diagram simply illustrated the areas where community infrastructure resources were concurrent spatially with green infrastructure resources. These were areas where community systems may potentially have significant impacts, positive or negative, upon green infrastructure systems. As such, the network can be viewed as potential areas of opportunity for stewardship actions.

Case Study Summary

(re)connect: The Wasatch Front Green Infrastructure Plan has illustrated a comprehensive methodology for analyzing and integrating two disparate frameworks into a conceptual planning approach which acknowledges their distinction yet interrelatedness. The purpose of this green infrastructure planning framework was to first identify then synthesize the highest quality ecosystem service providing resources into various networks which provide the basis to make proactive spatial planning decisions.

This case study has promoted an inclusive understanding of the Wasatch Front's resources which enabled the recognition of not only the natural systems, but also the built, designed, and sociological systems of the region; and it provides a characterization of how these systems contribute to the region's economic vitality, social livability, and regional sustainability. The many distinct systems (figure 1, top) that intermix and connect communities are the foundation for this methodology. These networks of resources and systems perform a wide range of functions and deliver many services. Augmenting green infrastructure in the Wasatch Front, a process which will require stewardship, provides an opportunity to accomplish many planning goals held in common by the varied stakeholders.

There were significant findings from the development of this case study's framework. The traditional green infrastructure planning approach (Benedict and McMahon, 2002; TCF, 2006) is based on landscape ecology principles and green infrastructure planning projects completed to date (2012) in the United States have been in largely undeveloped, natural areas. The Wasatch Front region and Salt Lake metropolitan area is heavily developed and urbanized yet surrounded by dense pockets and large tracts of unimproved, wilderness expanses. The principles of green infrastructure as developed by The Conservation Fund had to be slightly modified to work within the context of the region's urbanized landscape. As shown, this challenge was met by separating the green infrastructure networks into social-based and natural-based resources.

Discussion of Results

(re)connect: The Wasatch Front Green Infrastructure Plan demonstrated an alternative approach to spatial planning in the western United State's urbanizing regions. Though there is a breadth of literature advocating socio-ecological network interrelationships, planning disciplines have not yet fully facilitated an approach to address these systems concurrently and completely. This paper summarizes such a framework; however there are both advantages and disadvantages to this conceptual planning framework.

As shown, this new approach to spatial planning provided pragmatic insight and theoretical relation to important emerging planning principles: community infrastructure, stewardship, ecosystems services, and landscape integrity.

Community systems interrelated with the green infrastructure networks through the concept of stewardship (figure 4). Worrell and Appleby's (2000) ethical and practical definition of stewardship supports this comprehensive socio-ecological framework (figure 3); it recognizes ecological health, a long-term perspective, and the integrated societal interests including private and economic concerns in the responsible utilization of natural resources.

Stewardship is critical to maintaining diverse capacities and benefits and the delineation of areas of stewardship opportunity (figure 4) is a key knowledge tool for planners. Through stewardship of the natural green infrastructure network, communities received improved ecosystem services (figure 1 - left). Likewise, enhanced regional and community identity, public health, as well as increased landscape productivity (figure 1 - right) resulted from the stewardship of the sociological green infrastructure network.

A comprehensive green infrastructure approach can provide a more integrated framework for applying systems thinking and interconnected strategies to a broader range of resources than ecological. Spatial planning frameworks that look beyond traditional ecological components and conservation priorities to apply a green infrastructure methodology that includes sociological and community typologies capitalize on the multifunctional benefits an interconnected system inherently provides (Lovell and Johnston, 2009).

The connectivity and performance of landscapes, whether built or natural, are key concepts that make the green infrastructure approach an important part of spatial planning in the expanding urbanizations of the United States, particularly when the definition of ecosystem services is continually expanding (e.g., Bolund and Hunhammar, 1999; Carpenter and Folke, 2006).

The term 'landscape integrity' has been primarily discussed within landscape ecological disciplines often to refer to 'ecological integrity' or 'ecological health' and frequently disregards the sociological context of the conjoined anthropological systems (Hellmund and Smith, 2006). As interrelated systems thinking has increased within the discipline of landscape architecture and spatial planning, the concept of landscape integrity has advanced to consider ecological and sociological functions within the landscape as an indicator of overall health or quality (Hellmund and Smith, 2006).

But this conceptual planning framework is not without its points of contention. Though this integrated conceptual planning framework does account for oft-omitted typologies and benefits (see figure 1), it is still limited to bio-physical elements and does not completely account for the phenomenological or ecopsychological benefits of socio-ecological networks. Furthermore, it is not known if the goal of landscape integrity can be realized through the foundation of an ecological-based methodology.

Additionally, the integration of sociological and ecological systems may not provide the outcome desired. Ecologists have warned that merging the two systems may result in undesired outcomes such as habitat and species loss (Agrawal and Gibson, 1999). Sociologists cite the lack of demand for a more integrated form of green space planning and design (Bowman and Thompson, 2009), such as new urbanism.

Notwithstanding, both humans and nature benefit when these resources are perceived and planned as an interconnected network (figure 3), whether directly or indirectly (Lovell and Johnston, 2009). Green infrastructure planning provides the foremost framework to understand these concepts within the larger context of the fields of natural sciences and social sciences. It is through this evolving integrated socio-ecological framework in spatial planning that the numerous and diverse benefits and services to humans and nature (e.g., de Groot et al., 2002; Benedict and McMahon, 2002) can be further studied and acknowledged.

Conclusion

Spatial planning practices must evolve to consider the social, cultural, and economic benefits a community receives from its landscapes, which in turn must maintain their saliency and productiveness in both their natural (ecological) and anthropological (social) frameworks, particularly in urbanizing areas.

The conceptual approach presented is a fundamental shift from traditional green infrastructure planning in the United States and supports a paradigm shift towards integrated systems thinking in the planning disciplines. Researchers have noted the lack of innovative planning approaches that integrate ecological and social frameworks in planning models (Groves, 2008). Broadening the concept of green infrastructure provides a valuable planning methodology to the service and application of resources. The issues contemporary society faces today are socio-ecological (e.g. resource consumption, population and housing, food production) and the solutions must then be socio-ecological based. Continued exploration, analysis, and discourse is needed; this paper adds to the increasing mix of planning theory and is a step towards the needed coalescence.

References

Agrawal, A., and Gibson, C. (1999). Enchantment and disenchantment: The role of community in natural resource conservation. World Development 27(4), 629-649.

Alberti, M. (2008). Advances in urban ecology: Integrating humans and ecological processes in urban ecosystems. Springer Science + Business Media, LLC, NY.

Armitage, D. R., *et al.* (2009). Adaptive co-management for social and ecological complexity. Frontiers in Ecology and the Environment 7(2), 95-102.

Benedict, M.A. & McMahon, E.D. (2002). Green Infrastructure: Smart conservation for the 21st century. Renewable Resources Journal, Autumn Edition, 12-17.

Berkes, F., Folke C., and Colding J. (2003). Navigating social–ecological systems: building resilience for complexity and change. Cambridge, UK: Cambridge University Press

Bolund, P., and S. Hunhammar, (1999). Ecosystem services in urban areas. Ecological Economics 29, 293–301.

Bowman, T. and Thompson, J. (2009). Barriers to implementation of low-impact and cons,ervation subdivision design: Developer perceptions and resident demand. Landscape and Urban Planning 92, 96-105.

Calthorpe, P. (1993). The next American metropolis: Ecology, community, and the american dream. Princeton Architectural Press, New York.

Cambridgeshire Horizons, 2011. The Green Infrastructure Strategy for Cambridgeshire. Retrieved from http://www.cambridgeshirehorizons.co.uk/our_challenge/GIS.aspx

Carpenter, S. and Folke, C. (2006). Ecology for transformation. Trends in Ecology and Evolution 21, 309–315.

Costanza, R., R. d'Arge, R. de Groot, S. Farber, M. Grasso, B. Hannon, K. Limburg, S. Naeem, R. V. O'Neill, J. Paruelo, R. G. Raskin, R. Sutton, and M. van den Belt. (1997). The value of the world's ecosystem services and natural capital. Nature 387, 253–260.

Daily, G. C. (1999). Developing a scientific basis for managing earth's life support systems.

Conservation Ecology 3(2), 14
Daniels, T. (2009). A trail across time: American environmental planning from city beautiful to sustainability. Journal of the American Planning Association, 75(2), 178-192.
de Groot, R.S., Wilson, M.A., and Boumans, R.M.J. (2002). A typology for the classification, description and valuation of ecosystem functions, goods and services. Ecological Economics, 41(3), 393-408.
Forman, Richard T.T., (1995). Land mosaics: The ecology of landscapes and regions. Cambridge University Press.
GIFT-T, (2012). Retrieved from http://www.gift-t.eu
Groves, C. (2008). The conservation biologist's toolbox for planners: Advances, challenges, and opportunities. Landscape Journal. 27(1), 81-96.
Hellmund, P., and Smith, D. (2006). Designing Greenways. Washington, D.C.: Island Press.
Kambites, C. & Owen, S. (2007). Renewed prospects for green infrastructure planning in the UK. Planning Practice and Research, 21(4), 483-496.
Koomen, E., Dekkers, J., and van Dijk, T. (2008). Open-space preservation in the Netherlands: Planning, practice and prospects. Land Use Policy 25(3): 361-377.
Liu, J.; Dietz, Thomas; Carpenter, Stephen R.; Folke, Carl; Alberti, Marina; Redman, Charles L.; Schneider, Stephen H.; Ostrom, Elinor et al. (2009). "Coupled human and natural systems". AMBIO: A Journal of the Human Environment 36(8), 639–649
Lovell, S. T., and Johnston, D. M. (2009). Designing landscapes for performance based on emerging principles in landscape ecology. Ecology and Society 14(1), 44.
Lyle, J. T. (1999) Design for human ecosystems: Landscape, land use, and natural resources. Island Press, Washington D.C.
McDonnell, M., and Steward, P. (1993). Humans as components of ecosystems: the ecology of subtle human effects and populated areas. Springer Science + Business Media, NY.
McHarg Ian L. (1969) Design with nature. Natural History Press. New York
Mell, I.C. (2007). Green Infrastructure planning: What are the costs for health and well- being? Journal of Environment, Culture, Economic and Social Sustainability, 3(5), 117-124.
Mell, I.C. (2008). Green Infrastructure: Concepts and planning. FORUM Ejournal 8, 69-80. Newcastle University.
Miller, J.R., and Hobbs, R.J. (2002). Conservation where people live and work. Conservation Biology, 16, 330-337.
Paetzold, A., Warren, P.H., and Maltby, L.L. (2010). A framework for assessing ecological quality based on ecosystem services. Ecological Complexity, 7, 273-281.
Parrish, J. D., Braun, D. P., and Unnasch, R. S. (2003). Are we conserving what we say we are? Measuring ecological integrity within protected areas. BioScience, 53(9), 851-860
Science for Environment Policy, (2012). Retrieved from http://ec.europa.eu/environment/index_en.htm
Steiner, F.R. (2002). Human ecology: Following nature's lead. Island Press, Washington, D.C.
Termorshuizen, J.W., and Opdam, P. (2009). Landscape services as a bridge between landscape ecology and sustainable development. Landscape Ecology, 24, 1037-1052.
The Conservation Fund. (2006). Retrieved from www.conservationfund.org
The Trust for Public Land. (2010). Retrieved from www.tpl.org
Thompson, G.F. and Steiner, F.R. (1997). Ecological design and planning. John Wiley & Sons, Inc., New York.
Turner, B.L. II, Clark, W.C., Kates, R.W., Richards, J.F., Mathews, J.T., and Meyer, W.B.

(Eds.), (1990). The earth as transformed by human action: Global and regional changes in the niosphere over the past 300 years. Cambridge Univ. Press, Cambridge

Tzoulas, K, Korpella, K., Venn, S., Yli-Pelkonen, V., Kazmierczak, A., Niemela, J., and James, P. (2007). Promoting ecosystem and human health in urban areas using green infrastructure: A literature review. Landscape and Urban Planning, 81, 167-178.

Waltner-Toews D, Kay J, Neudoerffer C, and Gitau T. (2003). Perspective changes everything: Managing ecosystems from the inside out. Frontiers in Ecology and the Environment, Vol 1, 23–30.

The Wasatch Front Regional Council, (2012). Retrieved from http://www.wfrc.org

Weber, T., Sloan, A., and Wolf, J. (2006). Maryland's green infrastructure assessment: Development of a comprehensive approach to land conservation. Landscape and Urban Planning, 77(1-2), 94–110.

Worrell, R., and Appleby, M.C. (2000). Stewardship of natural resources: Definition, ethical and practical aspects. Journal of Agricultural and Environmental Ethics, 12, 263-277

Wu, J. (2006). Landscape ecology, cross-disciplinarity, and sustainability science. Landscape Ecology, 21, 1-4.