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The Nature and Health Connection: Social Capital and Urban Greening Ecosystems

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Abstract: Urban greening is a general term that includes all the ecological, cultural, and engineered green spaces within cities and towns, and includes (but is not limited to) parks, open spaces, community gardens, and the urban forest. Ecosystem services is a term that describes the materials, services, and processes that people and their settlements are absolutely dependent upon for survival and well being. Decades of research confirms that green sites and systems provide many environmental services within cities through design and management, including cleaner air and water, reduced stormwater, and energy savings. In addition, research across a range of disciplines (such as psychology, urban planning, public health, and geography) demonstrates a broad array of health and well-being cultural services associated with the human experience of nature in cities. A technology transfer project has collected the research publications, synthesized findings into topics or themes, and provides summary materials useful for multiple public audiences. The science delivery web site (*www.greenhealth.washington.edu*) presents concise summaries derived from more than 2,100 empirical articles. The research evidence about the beneficial aspects of the human response to urban forestry and urban greening is profoundly important. The knowledge supported by the research findings has broad implications, from support of individuals, to community cohesion, to economic costs and benefits. The research base indicates that urban forestry and associated green spaces contribute not only natural capital, but are also essential for sustaining human and social capital development. The article develops the idea of human health and well-being as a neglected aspect of cultural ecosystem services. Then proposals about collaboration opportunities are presented, including activity across the urban to rural landscape gradient. Future research that will continue to expand this ecosystem services outlook, and help sustain quality of life and health for millions of people.

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The interdependence of landscape and human systems is gaining greater attention. Communities have come to realize that we are dependent on nature to support necessary, everyday human needs and quality of life. *Ecosystem services* is the term that describes the full scope of nature's contributions to human health and welfare. Ecosystem services are defined as those conditions and processes through which natural ecosystems, and the species that inhabit them, sustain and fulfill human life. Specifically, ecosystem services are defined by their contribution to human well-being, since they are end products of various ecosystem functions (Daily, 1997a). In turn, ecosystems can only remain healthy and functioning if people and organizations sustain natural systems through conservation and restoration efforts.

Natural assets, such as forests, agricultural lands, shorelines, and seas, have been the sources of essential and economically valuable goods and services throughout human history. More recently, the concept of ecosystem services has expanded to include additional sources of direct or indirect benefits and their economic consequences, such as flood protection, pollinator activity, natural filtering of potable water, and climate stability (Costanza et al., 1997; Daily, 1997b; de Groot et al., 2002). Generally, ecosystem services arise from broad systems of ecological components, processes, and functions, but the term specifically signifies aspects of ecosystems that are valued by people (Boyd, 2007; USEPA, 2009).

Ecosystem Services Classifications

Much of our understanding of ecosystem services has been informed by studies that focus on a specific ecosystem or resource type (such as upland forests or wetlands). As these studies accumulate a published review may itemize the character and extent of a particular service. Other authors then collect and sort the revealed sets of ecosystem services. Several classification systems have been proposed. Each system sorts and defines derivations of natural capital, summarizing across decades of scientific evidence. Each classification recognizes material, non-material, and experiential benefits that people derive from natural systems, clarifying the role of environment in human and social capital.

A classification was prepared for the Millennium Ecosystem Assessment (MEA) (2005) that has since become widely used in scientific and popular communications. The resulting classification system identifies four main ecosystem service types having 30 sub-categories: 1) provisioning (e.g., food, raw materials, medicine, water supplies), 2) regulating (e.g., climate, water, soil retention, flood retention), 3) supporting (e.g., soil formation, nutrient cycling, decomposition), and 4) cultural (e.g., science and education, artistic, spiritual).

Classification systems can be useful descriptive tools as they efficiently describe complex ideas and relationships. If proposed and generally accepted, a classification can also become the basis of policy and management decisions concerning ecological systems and natural resources. A comprehensive and coherent framework of ecosystem services definitions may underpin the deliberate, planned use of resources, by focusing decisions and supporting valuations and accounting based on actual benefits (Wallace, 2007, 2008). As classifications move from knowledge summaries to planning and management tools, it becomes ever more important to specify and aggregate all potential services.

It seems that current ecosystem services frameworks recognize the conserved and preserved landscapes of the past, but fail to fully acknowledge urbanized landscapes as potential ecosystem services sources. Within cities urban residents derive extensive intangible, indirect benefits from

even the smallest slivers of nearby nature. These are the nearby services of built landscapes. The relative absence of discourse about urban-based ecosystem services may reflect the historic rural and wildland anchoring of ecological studies, the fairly rapid transition of the United States (and other nations) to having majority urban human populations, or perhaps, even the landscape origins of ecological scientists' upbringing or early education. Whatever the reason for limited attention to urban-based ecology and ecosystem services, heightened interest in urbanism and urban sustainability indicates ever-greater possibility of expanded benefits and functions classifications.

Urban Environmental Services

Ecosystem services classifications generally focus on larger, naturalistic landscapes in structure, hierarchy, and management intention. Yet, research of recent decades with focus on urban forestry and urban ecology has yielded important insights about the functions of biota and biophysical systems that are *in* the city. The soils, fauna, and vegetation of green spaces can mitigate environmental impacts from site to regional landscape scales.

When measured cumulatively across a metropolitan area the positive benefit/cost implications of such biotechnologies are substantial (Chen and Jim, 2008; Nowak, 2006; McPherson et al., 2005). For instance, modifications of local microclimate can include changes in solar radiation, wind speed, air temperature, relative humidity, and terrestrial re-radiation. Urban greening also improves air quality, as plant foliage enables beneficial gaseous exchange and intercepts polluting particles. Urban vegetation positively affects water quantity and quality, as the pervious soils of planted areas allow infiltration of precipitation, reducing runoff and increasing groundwater recharge. Soils and vegetation can also retain water pollutants, thus improving water quality by mitigating nonpoint source pollution. Climate and energy effects are additional benefits. Strategically placed trees within residential areas can reduce heat gain thus reducing household energy consumption. Scaling up, areas of substantial tree canopy across a city can produce an 'oasis effect' in hot climates, contributing to mitigation of urban heat island effect, perhaps a more immediate threat in some cities than climate change.

Other service functions are receiving increased attention. For instance, while most agriculture still occurs in more rural lands, public interest in local foods and improved nutrition in underserved urban communities is promoting increased efforts to recover and conserve urban soil fertility. Natural landscapes are needed to harbor pollinators needed for productive urban farms and gardens.

Metro Nature and Social Capital

Many of the studies of environmental services have focused on benefits provided by actual or planned levels of canopy cover over cities. Within pristine forests canopy is important but not the sole ecosystem element; a healthy forest has diverse structure and species biodiversity. Metro nature is used here to indicate the diversity of landscape expressions within cities, and can be regarded as the structural diversity of urban ecosystems. Metro nature is interspersed within the places where people live, work, learn and play in cities, providing green backdrops for the daily routines of millions of people. Included are naturalistic patches, such as urban forests, greenbelts, conserved open spaces, and riparian corridors. Metro nature also includes constructed nature such as parks, streetscapes, community gardens, pocket parks, and recreation paths. Metro nature can be fragmented and diverse in content and character, unless the intentions of green infrastructure, sustainability design, or other principles are applied.

The diversity of structure and biota of urban greening also support a diversity of ecosystem services. Scientific and empirical evidence are the expected underpinnings of ecosystem services classifications and valuations. In addition to the science of environmental benefits there is a surprisingly rich literature about the relationships of urban nature and human health and well-being. Yet this body of study is rarely included in the discussions about ecosystem services. Perhaps this is because the scholarly contributions are distributed across a wide array of disciplines (such as psychology, sociology, anthropology and geography) and the scholarly sources of allied professionals (such as urban planning, public health, landscape architecture, and urban forestry), making publications difficult to discover and acquire.

The USDA Forest Service has sponsored a project to provide better access to this knowledge base for scientists as well as practitioners. The website *Green Cities: Good Health* represents a collection of more than 2,100 scholarly works that have been sorted into topical themes. Each theme is presented as a web page summarizing up to 300 articles. Each web page presents bullet points of findings highlights, a summary essay that is extensively cited, and ends with a complete list of references should a page visitor wish to locate a source publication. The project goal is to provide an accessible research literature portal for urban greening professionals, local leaders, and concerned citizens. Table 1 presents the thematic breakdown of published sources; information about each of these topics can be found at *www.greenhealth.washington.edu*.

Each of the themes is supported by hundreds of scholarly publications, and most are peer-reviewed. The entire collection, as well as the thematic emphasis, is an evidence-based expression of the many dimensions of social capital that are supported by urban greening planning and management. The themes address the range of social scales from individual response, to person-to-person interactions, to neighborhoods, to organizations, to various types of communities. The studies document how nature contributes to human performance and functioning in everyday life, as well as within the institutions and social systems that are the underpinnings of vibrant cities.

Cultural Services and Social Capital

Generally, cultural services are nonmaterial benefits people obtain from ecosystems through spiritual enrichment, cognitive development, reflection, recreation, innate physiological response, and aesthetic experiences. Ecosystem services classification models are intended to be comprehensive presentations of the full array of human benefits provided by ecological systems. The classifications claim to address social and cultural benefits, but subsequent descriptions and applications rarely treat psychosocial dimensions in the same level of detail as biophysical components. Attention to and measures of the social capital services of ecosystems generally lag behind the quantitative assessments of provisioning, supporting, and regulating services.

Yet social scientists have greatly expanded the scope and characterization of nature's functions in cities (Sanesi et al., 2011; Campbell and Wiesen, 2009; Wolf, 2008). There has been a surge of research activity in the past decade concerning the human health and well-being benefits provided by the human experience of nature in cities. *Active living*, for instance, has received extensive attention and includes the role of parks and open space in addressing obesity-related public health concerns, particularly opportunities for moderate physical activity. One could frame such studies as being about recreation, per current ecosystem services classifications, but studies indicate more complex interactions of activity opportunity and facilities, personal motivations, contemporary lifestyles, and health systems.

Table 1: *Green Cities: Good Health* literature review themes

Benefit Theme	Description
Community Economics	Valuation methods are used to convert intangible benefits to dollar sums. Nonmarket valuations can support local decision-making regarding the urban forest.
Community Building	People interact while spending time in city parks, gardens, and open spaces. These social dynamics can help build social capital, even resilience.
Culture & Equity	There is some variability in how people respond to nature based on ethnic background, and there are inequalities in the distribution of nature across cities.
Active Living	Obesity is a major public health issue. The presence and character of green spaces in a neighborhood affects residents' rates of physical activity.
Crime & Fear	Law enforcement officials may regard vegetation as a contributor to social disorder and crime. Research tells a different story when people work together to restore their community.
Safe Streets	City streets are thoroughfares for motor vehicles, and can also serve as public spaces. A quality streetscape may be safer, as vegetation and mixed-use transportation effects crash rates.
Place Attachment & Meaning	Place attachment and meaning are person-to-place bonds that evolve through emotion and cognition of a specific place and/or features of a place.
Wellness & Physiology	Scientific measures of stress response (such as heart rate and blood pressure) can improve quickly when one views nature, leading to better long-term health.
Healing & Therapy	Gardens and restorative settings are becoming standard features in health treatment and recovery settings. The experience of nature promotes healing.
Mental Health & Function	Our busy lives make many demands on our ability to pay attention and process information. Brief respites in natural settings help one to recover the ability to concentrate and focus.
Work & Learning	Little attention is given to how one's environment affects the places where we spend many hours each day. Green offices and classrooms appear to boost work productivity and education performance.
Reduced Risk	The built environment concentrates certain conditions that can affect one's health. Urban vegetation can reduce the health risks of excessive noise, heat, and other stressors.
Lifecycle & Gender	There are a few differences in the human response to nature, with some based on a person's age and/or whether one is male or female.

Cultural Services – An Expanded View

Few studies have intentionally extended the understanding of cultural services, and most portrayals of this category differ little from the earliest ecosystem services classifications. It is surprising that cultural services of cities remain so poorly understood or investigated (Elmqvist et al., 2004). For

instance, the i-Tree suite of tools, developed and supported by the USDA Forest Service, enables city forestry professionals to quantitatively document the benefits and value of the urban forest primarily in terms of environmental services. Despite extensive evidence, the analytic tools now only represent cultural services using hedonic property valuation.

Several papers have addressed the issue. Wallace (2007) acknowledged that further work is still required to resolve particular issues in the classification of socio-cultural services. Dobbs et al. (2011) offered a framework for developing a comprehensive set of indicators for groups of ecosystem services associated with urban forests. The authors acknowledged that the relationship between the urban forest and human well-being in terms of psychological and social values is critical, but did not explicitly include many of the specific services represented by the terms of Recreation and Aesthetics in a broader model for quantifying ecosystem services, goods, and disservices.

Vejre et al. (2010) noted that intangible services should be acknowledged along with tangible services (the biophysical realm) in order to achieve sustainable development. The authors' analysis of a peri-urban green space restoration lead to an observation that the intangible social services may rival (or even dominate) the tangible in valuations of open space in some areas around larger cities.

Collaboration and Cultural Services

The breadth, depth, and extent of the *Green Cities: Good Health* literature review suggests several opportunities for collaboration within cities of the U.S. and across the world. At one level the parcels or sites that offer ecosystem services can be functionally collaborative in achieving multiple purposes. On another level urban foresters and urban greening managers can reach out to non-traditional communities of practice for collaborative partnerships. And thirdly, we can begin to envision the collaborative linkage of ecosystem services across the entire landscape gradient.

The term infrastructure brings to mind roads, pipes, and power lines. Generally, infrastructure systems are systematically planned built structures that source and deliver crucial services or products throughout human communities, such as road or water systems. Yet, natural systems are the fundamental sources of human sustenance and livelihood. A practical integration of built and natural systems is the concept of *green infrastructure* (Benedict and McMahon, 2006).

An ecological infrastructure incorporates all the natural, semi-natural and artificial networks of multifunctional ecological systems within, around, and between urban areas, at all spatial scales (Tzoulas et al., 2007). Green infrastructure upgrades parks and open space to a coherent planning scheme having differently scaled landscape units with functional linkages (Sandström, 2002). Successful implementation includes not only construction of specific green spaces for key services but also strategic designation and conservation of existing parcels that provide the highest levels of services.

Any particular unit of a green infrastructure system can generate or deliver multiple services. Innovative urban nature systems are becoming ever more multi-functional. In an urban ecosystems assessment done over a decade ago seven systems types were identified: street trees, lawn/parks; urban forests; cultivated land; wetlands; lakes/sea; and streams (Bolund and Hunhammar, 1999). Most of the systems were discrete land units containing biota at the ground surface that were separated from built land uses either in function or by legal boundaries. In today's cities natural elements or parcels are no longer simply set asides for recreation or aesthetics. Trees, parks, open

space, and other green infrastructure features are now multi-tasking, and potentially can deliver multiple environmental and cultural services. Local governments promote innovative integrations of nature in engineered systems that serve multiple purposes (Young, 2010). For instance green roofs are installed to manage on-site stormwater and reduce building energy use, but also serve as small parks and offer wildlife habitat (Oberndorfer et al., 2007). Urban farms address concerns of food security and children's nutrition, can aid stormwater management, and can provide green industry job training.

In a second approach to collaboration urban greening professionals can align with the leadership of other professional groups. The cultural ecosystem services of urban greening address some of the most urgent issues of contemporary society, such as education quality, public health costs, therapy for emotional and physical disabilities (such as those experienced by veterans returning from deployment), and mental functioning of the growing elderly population. While the experience of nature is not a panacea for the ills of society the extensive psychosocial research findings suggest that natural settings enable positive response, better functioning, and healing. In the most general sense urban greening is profoundly important for health human habitat.

Such evidence can (and should) be the basis for reaching out to key professional organizations and communities of practice. Collaborative alliances can seek to plan, implement, and continue to study how nature can augment or even supplant interventions that can be quite expensive (and perhaps even harmful in the long term) when treating individuals and communities. Partnerships with public health, medical, education, law enforcement, and other professionals can be pursued to further fine tune, through design and monitoring, how nature can be integrated with social services delivery systems.

Finally, as ecosystem services become the basis of landscape planning it is important to address the integrated (and collaborative) services transitions across the entire wildland to urban landscape gradient (McDonnell et al, 1997). The services potential of wildland and rural areas have received considerable scientific and land management attention, as large tracts of native and managed vegetation are notably important for water quality protection, food production, biodiversity, and other services that support urban populations that may be either proximate or some distance away. With increased densification of human populations the composition of available ecosystem services changes, as large-scale environmental services decline (Tratalos et al., 2007). The ecosystem services provided by more built landscapes become more contextual. The large landscapes of more rural areas give way to parsed landscapes providing services to local, nearby human consumers. Nature becomes an affiliate with human systems and gray infrastructure to address close-at-hand needs, such as stormwater management and microclimate control.

Figure 1 depicts general land use patterns across the landscape gradient. The character and quantity of ecosystem services is different at all locations within the gradient. For instance, rural areas generate greater quantities of provisioning services, such as the agricultural and wood products of working landscapes. Urban areas will provide higher levels of cultural services, yet sites can be designed to simultaneously provide spaces of respite and food production. Recent analyses of services 'bundling' and 'stacking' begin to address services synergies and trade-offs, and have implications for ecosystem services valuation and land management practices (LaRocco and Deal, 2011). Multiple services assessments are important to not only capture the contributions of any land

Figure 1: Urban to Rural Landscape Gradient (credit Topografis PC, Chicago)

parcel, but to also address services cohorts at different locations across the entire landscape gradient (Raudsepp-Hearne et al., 2010). Also needed is research that aims to understand the relationships among multiple ecosystem services so that land management can be based on better understanding of the interactions between services (Bennett et al, 2009).

Conclusions

Landscapes and design elements that generate ecosystem services should include urban forestry, but include other structural elements ranging in scale from the green roofs and green walls of buildings, to courtyards within clustered housing, to street trees, to roadside bioswales, to riparian networks, to regional green space systems (Beatley, 2010). As urbanization increases and natural environments are increasingly fragmented, the importance of these heterogeneous urban green spaces increases. For instance, private gardens can provide considerable benefits if planning practices encourage the formation of interconnected networks, perhaps even landscape ecology frameworks (Goddard et al., 2010; Loram et al., 2007). While an individual garden may be much smaller than the unit of management needed to generate a substantial level of services, planning can encourage the construction and management of collections of gardens across scales from neighborhood to the city. Gardens (or other small nature elements, such as street trees) can serve as an important resource based on cumulative cover across an urbanized area.

Public discussions of ecosystem services will probably continue to focus on the services potential of rural reserves and working landscapes, including market values. Yet services in urban settings indicate how higher density living can be a satisfying and more sustainable alternative than sprawl development (Glaeser, 2011; Owen, 2009; Frumkin et al., 2004). Nearly forty years of research demonstrates that the human response to nature in cities is much richer than aesthetics and beautification, indeed that these terms are but proxies for deep and meaningful contributions to social capital. Active planning and design to enhance ecosystem services, particularly in urban areas, can create places that are better human habitat and attract future home-buyers. Assessments of ecosystem services across the entire landscape gradient provides a data set to underpin land use policy and trade-offs, and also helps decision makers create communities that offer a high quality of life and support many aspects of human welfare.

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