Urbanizing Habitat Conservation Planning Using Landscape Ecological Interventions: An Ecosystem Approach

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Urban ecologists are recognizing the need to erase the false distinctions we have been accustomed to make, between the natural and the human world. Efforts to see cities as integrated with nature, rather than distinct from it, are taking shape. Environmental planning needs to similarly reconceptualize how we think of urban regions, taking them to be a part of nature.

Nature conservation in urbanizing regions has predominantly relied on Habitat Conservation Plans (HCPs) in recent decades. HCPs depend almost exclusively on the critical habitat designation clause of the US Endangered Species Act for their legitimacy, and rest most centrally on the setting aside of lands into designated nature reserves for the conservation of endangered species, in exchange of permission to harm ("take") the same endangered species elsewhere in other parts of the target region during the process of urban development. California's Natural Community Conservation Plans (NCCPs) are a move toward ecosystem management, dealing with entire ecoregions, and attempting to manage whole landscapes in pursuit of conservation goals. But, by

and large, habitat conservation planning is taken to exclude urban and suburban development.

However, I would argue that neither the HCP nor the NCCP approach can deal effectively with nature conservation in urbanizing regions, nor actually operationalize an ecosystem management approach to regional planning, as long as metropolitan areas are excluded from their purview. Habitat conservation planning must begin to urbanize itself, and urban land use planning must begin to ecologize itself, so that they begin to better integrate at the regional level.

In one sense, this is a call to transcend the Endangered Species Act, and get beyond a species-oriented approach to an ecosystem ecology-based and truly habitat-oriented "Endangered Ecosystems Act" sort of approach, which is concerned most with the management of "keystone" ecological processes and functions [Mills et al., 1993; Stone, 1995; De Leo & Levin, 1997].

Institutionalizing the use of native vegetation and the application of strategically appropriate impervious surface mitigation techniques across urban and suburban zones would improve the ecological plasticity and resilience of whole ecosystems, enhancing regional habitat for native wildlife, while at the same time improving the health of soils, and helping to deal more effectively with storm water runoff and ground water recharge by mitigating the adverse impacts of impervious surface proliferation in such metropolitan regions.

Endangered Species and Set-aside Nature Reserves As A Primary Basis for Conventional Conservation Planning

Contemporary conservation planning in North America has been shaped almost entirely by the Endangered Species Act (ESA), with its quite incidental provision that "critical habitat" deemed necessary for the survival of endangered species be designated and set aside to ensure the recovery and continued good health of those endangered species. This "critical habitat" designation requirement of the law evolved into the creation of Habitat Conservation Plans (HCPs), with their requirement for setting aside "nature reserves" sufficient in ecological suitability and in geographic magnitude for the biological recovery and persistence of populations of endangered species. When the procedural difficulties of establishing separate HCPs for each and every species designated as endangered began to be recognized, particularly in regions where many such species were found to coexist in the same locations, these HCPs morphed into what came to be called Multi-Species Habitat Conservation Plans (MSHCPs).

HCPs and MSHCPs are based on a quid pro quo arrangement with land owners and developers, in that they are allowed to "take" (that is to say, to kill or cause to be killed) a certain proportion of species that the ESA process has designated to be endangered (and thus to be protected from further harm), in exchange for the cumulative setting aside of sufficient space to ensure the survival of those same threatened or endangered species for the next one hundred years.

In 1991, as the practice of conservation planning began to gain in implementation experience, it was recognized that the whole human land use planning enterprise needed to be linked to habitat conservation planning. Thus California innovated the HCP process into a consideration for the anticipatory conservation of entire ecological communities associated with species that *may* be at risk of future endangerment, in its Natural Community Conservation Plan (NCCP) process. “The primary objective of the NCCP program is to conserve natural communities at the ecosystem scale while accommodating compatible land use. The program seeks to anticipate and prevent the controversies and gridlock caused by species' listings by focusing on the long-term stability of wildlife and plant communities and including key interests in the process” [DFG, 2006]. This NCCP process is the closest we have come, until now, to capturing the imperatives emergent from a process-function based scale-hierarchic ecosystem approach for an integrative and adaptive nature management protocol.

It is only recently that endangered species and habitat conservation policy has formally begun to take note of the two ideas of ecosystem management and adaptive management, deriving from the science of ecosystem ecology. However, environmental planning has not had any resounding success in operationalizing the concept of an adaptive ecosystem management in its efforts to actually implement such an approach to conservation planning [McLain & Lee, 1996; Schreiber et al., 2004; Prato, 2005]. This lack of success might be traced equally to the assertion that planning has not yet found a robust way of

incorporating complexity theory into its everyday practices [Wilhere, 2002], and also to an inherent tension between the American ideation of a private property-based land use planning regime and the ecological need to plan using multiple criteria and at multiple levels of organization—not merely at the level of the individual and the human community, as we do currently. Scale hierarchic ecosystem ecology, or process-function ecology, provides specific techniques and tools useful in understanding how environmental planning might concretely move toward an ecosystem approach to adaptive nature management.

In a process-function world-view, the world is taken as manifesting three significant ecological aspects—*structure, pattern*, and *process*. These are somewhat, though only crudely, analogous to our ideas of species assemblages, landscape morphologies, and matter-energy-information flows. In such an approach, ecological phenomena are conceptualized as showing a scale-hierarchic arrangement into nested levels of organization, levels that are purposively defined and that are sensitive to scale and to perspectival position in their depiction [Vasishth, 2006].

However, as pointed out previously, habitat conservation planning has emerged primarily from a confluence of species protection legislation (the ESA) and land use management regulations (HCPs, MSHCPs, and, in the case of California, NCCPs), which roughly approximate the ecological concepts of *structure* and *pattern*. Species protection science (biological ecology) and "critical habitat" designations (land use planning) remain the effective extent of the knowledge base upon which environmental planning has sought to act in the

case of habitat conservation planning. But no explicit place has yet been made for the third descriptive aspect—ecological *process*—which Grimm et al. [2000] define as "a general term referring to the suite of processes, such as primary production, ecosystem respirations, biogeochemical transformations, information transfer, and material transport, that occur within ecosystems and link the structural components."

A key implication of this neglect is the overt and exclusive prioritization of organisms and landscape elements as necessary and sufficient proxies for the telling of nature. This incomplete conceptualization of ecological phenomena may be one reason environmental planning has lagged in operationalizing an effective ecosystem approach to nature management. If environmental planning is to realize such an evolutionarily holistic approach, we will need to incorporate all three aspects of ecological phenomena—that is to say, structure, pattern *and* process—into our description protocols.[1]

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[1] The important point here is that the argument from process-function ecology is not for a *displacement* of the organismic and landscape world-views in conventional ecology, but rather are a call for the *expansion* of the way we think about nature, to include processes and functions in our thinking about structure and pattern.

Process-Function Ecology and Ecosystem Management

Habitat conservation planning in the US represents a crude and jerry-rigged patching-together of multiple fixes to two existing traditions in environmental planning—endangered species legislation, and land use planning. As a contender for an ecosystem approach, the track record of habitat conservation planning is spotty at best, and even where the process has evolved some degree of sophistication, such as in the Southern California Coastal Sage Scrub Natural Community Conservation Plan (CSS-NCCP), it is fraught with controversy and contention.

In part, at least, this contention is inherent in “wicked” problems, or ecological phenomena which defy simple, singularizing resolution [Rittel & Webber, 1973]. And in part it is because the habitat conservation planning process itself is not the outcome of forethought design but rather a shaky structure reactively cobbled together in fits and starts. The process is largely an outcome of chance decisions and piece-meal, make-shift, tack-on adjustments, driven far more by issues of legislation design and litigability, or by the ebb and flow of political forces and interest groups, rather than by any consistent, systematic, proactive application of knowledge and judgment based on the best contemporary understandings in ecosystem ecology. Because of its particular historical development, habitat conservation planning is almost exclusively

concerned with only two elements of this triple hierarchy—species and land use—and without regard to ecological processes and functions.[2]

Process-function ecologists would argue that ecosystem managers do not manage the system itself but rather the processes—including human processes—which generate the system [Allen & Hoekstra, 1992:256-281]. Of course, most such processes are intangible, and we have an understandable bias toward the objective and organismic aspects of the world. Being less tangible, however, these processes can matter in ways that are not always obvious [Melillo et al., 2003:7-8].

For instance, there is the case of nitrogen deposition in Riverside County, driven by atmospheric pollution within the South Coast Air Basin and primarily from increases in vehicular activity in Los Angeles County. Nitrogen, being a fertilizer, is giving “weedy” exotic and invasive species a competitive edge over the more native but slower-growing Southern California Coastal Sage Scrub vegetation endemic to the broader region. This is driving habitat change within Riverside County, which is also the site of the relatively high-priority effort to implement the Western Riverside MSHCP, and, in very real ways, is undermining the progress being made in habitat conservation [Allen et al., 1993; Cione et al., 2002; Edgerton-Warburton & Allen, 2000; Padgett & Allen, 1999]. Thus,

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[2] This restrictive view of ecological phenomena in planning is further distorted by reducing the idea of species to a typology, erasing functional and practical meaning from the concept of species [Rojas, 1992; Vasishth, 2006].

increases in vehicle ownership and in vehicle miles traveled by residents of Los Angeles County are forcing vegetation changes onto the residents of Riverside County. A conservation planning protocol that is not founded upon nutrient-flows of this sort, and on other processes and functions revealed by biogeochemistry and hydrology, is likely to fail by not having taken account of actual and formatively occurrant ecological realities.

The rapid urbanization of landscapes in the Southern California region is driving significant changes in ecological processes and functions as well. The emerging field of urban biogeochemistry [for instance, see: Groffman et al., 2002; 2003; 2004; Kaye et al., 2006; Shochat et al., 2006; and Pouyat et al., 2007] is beginning to show us that the ecosystem context of urban areas can prove significant as a determinant of the ecological health of landscapes. Increases in impervious surfaces begin to influence hydrology and meteorology in ways that habitat conservation cannot afford to ignore any longer. A conservation approach based almost exclusively on the design and implementation of set-aside nature reserves, intended primarily to ensure the survival of some minimal population of a threatened or endangered species, does not stand up to the clearer light of scientific knowledge deriving from scale-hierarchic and urban ecosystem ecology.

Ecosystem Management and Habitat Conservation Planning

One of the most significant influences of human activity on habitat structures, patterns and processes is a rescaling of their spatial and temporal

dimensions—creating patches, dividing up, slowing down, speeding up. The modification of ecological context, in short. The immediate consequences of this rescaling are seen in the modification of a variety of processes and functions. By recognizing the role of processes, habitat conservation planning can begin to manage for alterations and impediments to process and function. And ecosystem management is concerned with compensating for the modification or erasure of ecological context, rather than merely manipulating the tangible and morphological aspects of populations and habitat [Urban et al., 1987; Allen & Hoekstra, 1992; Pickett et al., 1995].

Land use planners are most concerned with dividing up the landscape within the plan area into sections that will be "managed" or protected, and those that will be "left" to human use. But this is not how ecological phenomena are organized, nor does it reflect how they actually occur. Irrespective of land use allocations, the management of ecosystems must follow functional processes, where ever they might lead us. The rescaling of land, taken as change in ecological context, may well demand that proper management practices be most concerned with a commensurate and compensatory rescaling of ecological structures and functions—including those more directly under the control of human populations. For instance, in the case of fire suppression around human settlements, the significant changes are in the frequency with which burns occur naturally, and in the spatial size of contiguous landscape left available to absorb (or, quite literally, to "incorporate") fire—to turn it from disaster or disturbance into a stabilizing and creative process. These are the consequences of fire

suppression that must be mitigated by any ecosystem approach to nature management [Allen & Wyleto, 1983; Urban et al., 1987]. In the final analysis, ecosystem management is about the management of processes, not just the management of tangible objects and entities.

More directly, in the case of habitat conservation planning and using the examples of the Western Riverside County Multispecies Habitat Conservation Plan (WRC-MSHCP) and the Southern California Coastal Sage Scrub Natural Community Conservation Plan (CSS-NCCP), at least some of the problems of conflict between species-oriented habitat conservation and human-oriented land use allocation may stem from the absence of a process-function perspective and its attendant conception of scale hierarchic levels of organization. In both the WRC-MSHCP and the CSS-NCCP, the key players are environmental consultants supported by conservation biologists and land use planners, ensuring that the ecological elements of structure and pattern receive appropriate consideration. Conservation biologists are most often, and quite properly, concerned with population and meta-population level issues, such as determining "minimum viable population" (MVP) estimates to derive probabilistic single species habitat requirements for 50, 100 or 150 year persistence [Burke et al., 1991]. Land use planners then make an effort to match these needs with existing land use patterns in the area, so as to create some feasible, unobjectionable subdivision of the area covered by the MSHCP or the NCCP—the approval of which, it is hoped, will relieve local actors of the restrictions on private property development imposed by the Endangered

Species Act (ESA). This concern with deriving MVP and its subsequent refinements is driven partly by the need to meet the legislative requirements for delimiting critical habitat under the ESA. But more importantly, these ideas of MVP and reserve habitat requirements derive from the dominant paradigm in conservation biology—island biogeography [Simberloff, 1988; Rojas, 1992].

MacArthur and Wilson's [1967] island biogeography theory and its later transformations have provided the foundation for much of the theory and practice of reserve design. Nature reserves are, after all, habitat islands (surrounded by a sea of culturally-transformed human-appropriated landscapes). Or, at least, they may be treated as such—if one is concerned particularly and primarily with species and population dynamics. In its simplest formulation, island biogeography theory suggests that the number of species that will inhabit an island under equilibrium conditions is determined by the rates of in-migration and the rates of extinction—where in-migration rates are determined by the degree of isolation from potential colonizers, and extinction rates, in the absence of natural or human disturbance, are controlled most by the relation of species population size to land area [Diamond & May, 1976; Pickett & Thompson, 1978]. It is this postulation of a knowable species-area curve in population dynamics which, at least conceptually, drives reserve design criteria [Gilpin & Soulé, 1986; Wilcox, 1984; Simberloff, 1988; Woodruff, 1989].

Population and meta-population concerns such as minimum viable population (MVP), minimum viable density (MVD), or population viability analysis (PVA), have formed the center-piece of most efforts to design reserves, or

systems of reserves and corridors, within habitat conservation plans.[3] The focus is on the *structural* elements of species and populations, and on the generation of land use *patterns* to divide the plan area into reserves and non-reserves. Again, the incorporation of a process-function view would enable significantly different sorts of descriptions. For instance, the consideration of landscape level processes such as disturbance regimes and patch dynamics would demand a quite different conception of reserve design—one focused more on valuing ecosystem resilience, and based on an adaptive management scheme that proactively moves across levels of organization by recognizing the scalar and perspectival multiplicity of observed reality in how the world actually happens.

The descriptions generated by such an expanded view of natural organization and occurrence would move the planning process away from any simple species-area basis for reserve design. Once ecological processes and functions are allowed standing in the planning process, it becomes evident that reserves must have instead what Pickett and Thompson [1978] had called "minimum dynamic area." Disturbance and succession, in their interaction, are then seen as significant processes which generate landscape mosaics. Diversity across these mosaics, generated partly by patch dynamics, is necessary for the stability of the wider ecosystem level of organization [Pickett, 1985]. Such a

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[3] For a useful discussion of the limitations of population viability analysis and suggestions on effective ways to incorporate PVA into conservation planning, see Reed et al. [2002].

process-driven design would be based on natural disturbance regimes taken along with the area required by different taxa to maintain their internal recolonization dynamics at levels which prevent extinction.

A scale-hierarchic view which recognizes structure, pattern, and process in ecological phenomena leads us to place significant emphasis on the management of processes to assure functional integrity and the system's ability to respond creatively to supra-system shocks. Or, as Urban et al. [1987:124] put it: "...a disturbance regime that can be incorporated is not disturbing at all."

Ecologizing Urban Agglomerations

Pickett et al. [2001] make a useful distinction between two ideas—"ecology in the city" and the "ecology of the city." Simplistically, ecology *in* the city is concerned with the study of bits of nature that happen to be located within the boundaries of some city. Ecology *of* the city, however, is the study of cities as ecological entities in themselves, seen to present structures, patterns and processes that integrate across human and natural systems.

From within such a process-functional view, urbanization processes can be seen to affect their ecological context most in two ways—by laying down copious amounts of impervious surfaces, and by the wholesale replacement of native vegetation with species that more closely affiliate themselves with the human occupation of nature—plants and vegetation that *we* choose to grow, for reasons of our own preference.

The extent to which urban development lays out impervious surfaces matters enormously. Not only do impervious surfaces reduce groundwater recharge, increase urban runoff and add to the pollution burden carried by stormwater discharges [Arnold & Gibbons, 1996; Barnes et al., 2000; Brabec et al., 2002], but the paving over of land also adversely affects the organic health of soils.

Although soil is quite commonly considered inert, it is in fact alive with microbial life and active in a wide variety of biogeochemical processes and cycles necessary to the maintenance of life [Pouyat et al., 2002; Crawford et al., 2005; Kaye et al., 2006; Pouyat et al., 2007]. It can be hard, however, to keep in mind that soil might best be treated as a metabolism. And that, like all metabolisms, soils demonstrate thresholds and tipping points. Urban soils are, of course, heavily impacted by anthropogenic activity, but even so, it is meaningful to speak both of soil diversity and of microbial diversity as significant environmental quality indicators within the city [Amundson et al., 2003; Garbeva et al., 2004]. It should be noted, however, that Porazinska et al. [2003] find that there is little relation between plant community traits (native versus exotics, homogeneous versus heterogeneous stands, and so on) and any of the biotic or abiotic soil variables. One implication of this may be that types of vegetation make little difference to below-ground biotic diversity or soil health.

A second set of significant ecological impacts from urbanization arise from the laying of lawns upon the land. A distinction should be made between the idea of the lawn and the idea of the garden. A garden is a place where we grow

a diverse variety of plants and vegetation. Lawns, on the other hand, are expanses of mono-cultural turf grass, most often non-native and outside the ecological vernacular, and which more often than not require copious amounts of chemical and water inputs to maintain their synthetically lush character [Robbins & Sharp, 2003].

The American home owner, particularly in the case of detached single family homes, appears drawn inexorably toward the ideal of such lush, “weed”-free expanses of manicured green turf. Some have argued that this affinity can be traced to our primordial origins from the African savannah. Steinberg [2006] says:

> The United States is far and away the world's leader in cultivating perfect, weed-free, ultra-trim, supergreen grass. How did the greening of America come to pass?
>
> The leading theory, mentioned in news reports, rests on genetic predisposition. According to the "savanna thesis," human beings are attracted to grassy open expanses because we evolved as a species in Africa. "We spent 98% of our evolutionary history in those savanna-like environments," the ecologist John Falk once explained. "Our habitat preference for short grass and scattered trees seems to be a vestige of that history."

Robbins & Sharp [2003: 425] argue that, in part at least, there is a “moral economy” of the American lawn, in which “the lawn-chemical industry has implemented new and innovative styles of marketing that … help to produce an association of community, family, and environmental health with intensive turf-grass aesthetics.”

However, it may as well be that our obsession with emerald green landscapes derives as much from an Anglo-Saxon heritage that harkens to

rolling country estates and the imagined ideal of luxurious country living. As Breuste [2004] has it, we show a low tolerance for accepting indigenous vegetation, especially when we find ourselves in dry, semi-arid ecosystems. It seems our idea of a “good” nature is a green and irrigated one. Besides, we are accustomed to the idea that “cultivation improves nature” [Breuste, 2004: 444]—at least in the sense of making it more directly useful to us.

But in any case, the American lawn is a fixture that begs displacement, if we are to take seriously the call to ecologize our cities. We would substantially reduce the pressure we place on our ecological context if we were to instead rely more directly on nature to provide us with attractive and local alternative landscapes to enjoy on a day-to-day basis.

Engaging Existing Fragmentation

One source of potential paralysis for ecological planners is the recognition of the extent to which “damage” has already been done to our regional landscapes. It is difficult, at least, to not feel overwhelmed by an observation of the extreme degree to which we have already fragmented the terrain upon which we currently dwell. Every city and suburb appears archetypal of what we seek to avoid. What is the point, we feel, of talking about complementary land uses and alternative forms of ecologized urbanization when the vast majority of our built environment is already in place, and that in ways which we know to be simply wrong-headed?

To borrow from Omar Khayyam, if we could, would we not shatter it to bits and remold it closer to our hearts desire? Of course we would. But, that not being a realistic option, what seems to be the point of changing how we do things today when we cannot redo the past? Behaving intelligently from here on in will hardly begin to undo the damage already done, it would surely seem to us.

Well, this turns out not really to be the impediment it appears at first glance. In many, if not in most, cases, habitat quality trumps habitat connectivity. We may be better off having a overly fragmented but high quality habitat landscape than having a well connected but low quality habitat landscape! Angold et al. [2006: 196] point out that “dispersal for most of our urban species is not a limiting factor in population persistence.” While it is true that some few species are dependent on greenways and wildlife corridors, and that these should indeed be part of any effort to ecologize a region, most species can get by quite well without these connectivities.

What this means, of course, is that we don’t need to worry too much about fragmentation—at least, not to the point of paralysis—provided we can upgrade existing open spaces to high-quality habitat. Snep et al. [2006: 345] argue that larger peri-urban habitat does indeed provide some degree of support for inner-city fragments. While habitat connectivity is important, and while larger habitat patches are better than smaller ones, it is at least the case that “(b)y providing a range of different habitats, from inner city up to peri-urban area, moderately mobile habitat specialists could better compete against the small set of successful habitat generalists that are increasing in urban environments all over

the world." And where we do need to strain to carve out wildlife connectors and greenways, we should bear in mind that these are "a chain of different habitat" in their own right, and provide valuable ecosystem services to many different species [Angold et al., 2006: 196].

For instance, neo-tropical migrant birds, among the species that are most drastically displaced by conventional patterns of urbanization, might thrive in well-designed and forested greenways [Mason et al., 2007: 153]. In urbanizing areas, even at exurban and suburban densities, native bird species begin to decline sharply, and more opportunistic "weedy" species, better suited to a scavenging urban life, begin to take over. Mason et al. [2007: 153] suggest that "Landscape and urban planners can facilitate conservation of development-sensitive birds in greenways by minimizing the width of the train and the associated mowed and landscaped surfaces adjacent to the trail, locating trails near the edge of greenway forest corridors, and giving priority to the protection of greenway corridors at least 100m wide with low levels of impervious surfaces (pavement, buildings) and bare earth in the adjacent landscape."

Urbanizing Habitat Conservation Planning

Urban ecology, as the study of biogeochemical processes and functions in an urban setting, is currently taking shape as a coherent field. Work at the Baltimore and the Central Arizona-Phoenix Long Term Ecological Research (LTER) sites is starting to produce results that will prove useful to urban

ecological planners [for instance, see: Groffman et al., 2002; 2003; 2004; Kaye et al., 2006; Shochat et al., 2006; Pouyat et al., 2007; and Pickett et al., 2008].

Of course, there are the more directly self-serving reasons why we must care about our ecological context. We are, after all, materially dependent on nature to provide us with a whole host of ecosystem services. Folke et al. [1997] have shown that cities typically lay claim to hundreds of times more land, as "ecosystem support areas," than that contained within their administrative boundaries. Over and above our dependence on a more distant nature, both as a source of raw materials and as a sink for our wastes, Bolund & Hunhammar [1999] maintain that cities are also more directly dependent on many of the bits of nature within their boundaries. We rely on a slew of locally generated ecosystem services such as air filtering, microclimate regulation, noise reduction, rainwater drainage, sewage treatment, and for recreation and cultural activities. Very often, we take these for granted, and, at times don't even recognize that their degradation or absence is imposing additional costs upon us, until this is forcefully brought to our attention.[4]

But in the meanwhile, there are landscape-level changes that we can begin to make to bring habitat conservation planning into our cities, and so to

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[4] Hence the ever-present and urgent need to point out the consequences of inattention—degraded urban forest canopies, exacerbated urban heat island effects, degraded streams and ground water, the high costs of untended pollution, and so on.

better integrate our cities with nature. Colding [2007: 47] has argued for attention to the "synergistic effects that different land-uses may have in terms of supporting processes essential for biodiversity," and for the provision of "land-use configurations that more optimally support ecosystem processes that promote resilience in urban settings."

There are two important points embedded here. First, the notion that it is ecosystem processes which need our attention, rather than merely events, objects and entities [Vasishth, 2008]. And second, that promoting resilience is, in itself, the greater good that we can bring from an ecosystem approach to urban management. Holling [1973] has shown that the until-recently dominant view (and still persistent one) of nature as exhibiting some singular stable equilibrium state to which it repeatedly tries to revert itself must be replaced instead by a view of multiple and evolutionarily shifting equilibrium states. One significant implication of this move is the prioritization of resilience—the ability to find some new state of equilibrium after disturbance or disruption—as a primary objective in ecosystem (and hence urban) management [Pickett et al., 2004; Folke, 2006].[5]

One way in which planners might effectively look to enhance the resilience of urban and suburban agglomerations is through the use of what Colding [2007] calls "ecological land-use complementation." That is to say, the arrangement of

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[5] It may be useful, here, to make a distinction between common ideas of "recovery"—as a return to normalcy—and the less intuitive notion of adaptation to a changed circumstance—a renormalization, if you will.

landscape structures and elements in ways such that complementary land-uses are able to reinforce the processes and functions necessary to the improved maintenance of biodiversity (such as the movement of species populations, the delivery of pollination services, and effective seed dispersal) in urban and suburban areas. The proximate location of residential gardens and city parks, the tight clustering of built-up areas in ways that leave larger contiguous habitat spaces available for nature, the strategic location of urban functions that often support large swaths of open land (cemeteries, universities, stadia, and ceremonial institutional structures), and, radically, the giving over of conventional lawnscapes to more wildlife habitat-oriented landscapes.

Promoting the use of native and (in the case of Southern California) Xeriscape-kinds of drought-resistant vegetation in urban landscaping and as replacements of conventional manicured residential lawns, pushing for the replacement of impervious surfaces with permeable materials [Scholz & Grabowiecki, 2007], and creating programs that push much more aggressively for the plantation of native, ecologically appropriate trees in urban and community forestry projects, are all measures that would reduce the ecological footprint of our cities while more fully integrating our urban and suburban complexes with their ecological context. This would, in turn, effectively increase the carrying capacity of the land upon which our cities are located, and, not trivially, would reduce as well our expenditures on grey infrastructure needed both to import water and energy resources and to deal with the waste and pollution generated by urban and suburban living. In a very real way, we can

bring habitat conservation planning into our cities, using native ecologies and vernacular landscapes to generate multiple environmental benefits. For ourselves. Taken as a part of nature.

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