Building an Arc: Architecture, Biodiversity and the City (Notes on a Methodology for Integrating Habitat in Urban Development)

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INTRODUCTION

This paper speculates as to how the built environment can support biodiversity, for the benefit of human and non-human species alike. It is grounded in the conviction that designers have a tremendous opportunity to engage in projects in our cities that contribute to local, regional and global ecological enrichment. It describes a preliminary methodology by which teams of designers and ecologists might approach the integration of habitat within site and building scale developments in urban environments, with an emphasis on comprehensive ecological assessment and study as part of the architectural design process.

The methodology set forth is viewed as a preliminary step in the generation of a more rigorous set of protocols for evaluating compatibilities between habitat need and development type, one that would both translate across contexts and that would enable identification of ecological conditions of particular design settings. The paper concludes with a consideration of how the methodology might be evaluated and what steps would be necessary to ensure its effectiveness.

1.0 ARCHITECTURE AND BIODIVERSITY

> "The first step is to pose environmental problems as problems of cooperative behavior within human communities." –Bryan Norton[1]

> "Urban biodiversity exists at a crucial nexus of ecological and social interactions, linking local, regional and global scales" –Cynthia Rosenzweig and William D. Solecki [2]

Sprawl and poorly planned development are the primary contributors to habitat loss in America.[3] One of the most troubling aspects of this trend is evidence that losses of habitats beget further losses of species, and that the downward spiral of ecological simplification and impoverishment is accelerating. Given the importance of biodiversity to the quality of life of future generations – that the great variety and volume of biota creates the conditions that perpetuate life - we must work through all channels (public and private) in all environments (rural or urban) and at all scales (regional, site and local) to avert this trend.[4] Architects and other design professionals have an important role to play in this effort, by virtue of the projects they take on and the design processes they embrace.

1.1 THE IMPORTANCE OF COLLABORATION BETWEEN DESIGNERS AND ENVIRONMENTAL SCIENTISTS

The environmental philosopher Byran Norton argues,

> "Changes in natural systems attendant upon human population and technological expansion represent a series of more and more irreversible experiments in reducing the complexity and diversity of the plant's life and cultural practices. Natural systems, as well as conventional cultural practices, are undergoing constant 'disturbance' at every level and on every scale. What we need is a new way of talking about and evaluating rapid, often irreversible changes that will result from continued economic and technological growth."[5]

The architecture of cities represents a form of economic and technological growth par excellence, and the authors of this essay argue that collaborations between architects, ecologists, landscape architects and others elicit important ways of talking about, evaluating and acting to minimize such "irreversible" change. To put it more positively, designers in collaboration with the environmental science community have an enormous opportunity to engage in projects that both support the needs and aspirations of humans and that can help ensure the preservation, and when necessary, the reestablishment of individual non-human species, if not entire ecological communities. The urgency of this imperative is made apparent when we consider that "annual global spending on ecosystem protection (including acquisition) is just over $3 billion (the price of two B-2 bombers)."[6] What this means is that public investment alone is unlikely halt current trends, and therefore we must seek creative approaches to private urban development in order to address effectively habitat protection and creation, at the regional, site and building scales.

1.2 ECOLOGICAL INNOVATION IS LAGGING IN A MOVEMENT TOWARD REGENERATIVE DESIGN

For the purposes of this paper, one definition of sustainability may be that of sustaining site and landscape ecologies, and, given increased urbanization, sustaining human/nature connectivity for the physical and psychological health of urban inhabitants. But our goal ought to be to move beyond sustainability, to chart the path from low impact to sustainable to regenerative design, with the latter focused less on minimizing adverse effects and more on adding value (for example, rather than designing buildings that consume less energy, we should be designing buildings that produce energy). Environmentally friendly water and energy systems, material assemblies, and cohesive community-based design strategies have all advanced dramatically in recent years, and are moving closer toward a regenerative threshold. However, truly ecological design – where design professionals are working meaningfully with ecological dynamics so that these are strengthened as a result of project development – has made comparatively little progress. Perhaps it is not surprising that the built form has evolved relatively independently of site ecologies, given the complexity of working with living systems. Yet when considering the current state of ecological health, and the recognition of the importance of environmental quality for an increasingly urban population, the authors believe the time has come to rethink what we mean by urban fabric, such that it becomes organic and fecund, and quite literally, alive.

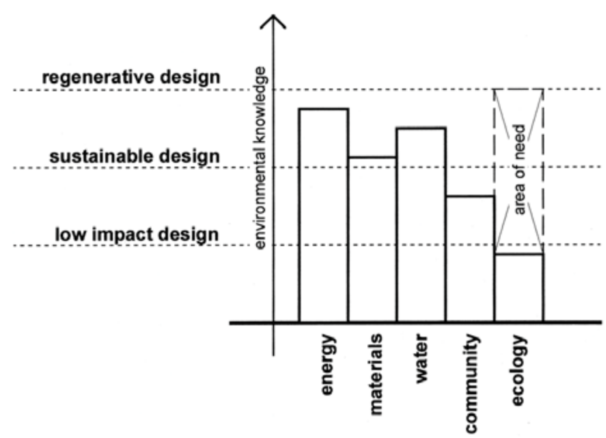

figure 1: the ecological knowledge gap in an overall trend towards regenerative design

1.3 HOW ARCHITECTURAL UNDERTAKINGS WITHIN CITIES CAN CONTRIBUTE TO BIODIVERSITY

Strategies to ensure the continued viability of species are being proposed or tested at a range of scales, from the North American Wildlands Project that is continental in scope to more modest site restoration efforts.[7] Central to such proposals are goals of landscape connectivity, preservation and restoration of core habitat for specialist species, appropriate bufferage for core habitat, etc.[8] While the more ambitious of these look as far as 100 years into the future, for many species the extent and rate of habitat loss suggest the need for more immediate action. Because larger scale projects involving public lands require extensive planning, consensus building through open processes of participation, significant resources for implementation, etc., the value of coupling planning/design projects on a more immediate (say 2-8 year) timescale with the needs of species at risk (i.e. whose habitats have been compromised) becomes apparent. Private urban development might be viewed as providing ancillary support for public open space networks that form the backbone for working landscape ecologies in urban environments. The poltical scientist Stephen Meyer suggests, "Perhaps they can help us to maintain viable populations of still-plentiful relicts (species) for the next 100 years as we try to put in place larger-scale landscape protection."[9] By "they" Meyer means a range of strategies; our "take" is more specific, that the concept of "Building an Arc" refers to a literal stocking of urban environments with working, functioning, and visible ecologies. Urban architectures become more than places of human activity, they also provide important habitat "architectures" for species, within a carefully planned context of development pattern and form.

1.4 THE NEED FOR A METHODOLOGY FOR INTEGRATING ECOLOGY AND ARCHITECTURE IN THE CITY

We can look to a limited number of precedents where attempts were made to create viable ecological matrices as part of urban development projects, for example Paul Kephart's "ecosabatoge" work on such projects as Renzo Piano's California Academy of Sciences and on William McDonough's Gap Headquarters in San Bruno, CA, two of the largest living roof projects in the world (these are being used as nurseries to generate seed stock for endangered grasses and flowering plants).[10] Yet no comprehensive effort has yet been undertaken to facilitate means for architecture and urban development to support biodiversity. What are the underpinnings of potentially valuable interactions between the built/urban and natural environment? How do designers identify opportunities to retain or create habitat as part of design efforts? How do designers know which species, guilds and biological communities to plan for? Given already formidable demands of design professionals, how is it possbile to gain access to relevant ecological knowledge efficiently? And lastly, how do we arrive at a greater level of certainty that what is planned and built functions as intended, that it actually serves desired ecological purposes?

For the remainder of this paper, and in an attempt to begin to systematically address these questions, the authors describe a preliminary methodology by which architects, ecologists and others might approach the integration of ecology and architectural development, so for example migration and foraging patterns, habitat needs and life cycle histories of targeted species might be more likely to be included in design decisions. This paper is viewed as a preliminary step, a mission statement of sorts, in the development of more rigorous protocols for use by design professionals concerned about long-term ecological health and stability and who are working on projects in our cities.

2.0 DRAFT METHODOLOGY FOR INTEGRATING ECOLOGY AND ARCHITECTURE

While the methodology would ideally provide designers the tools necessary to facilitate habitat integration in their projects, it is important to acknowledge the importance of developing working relationships with experts outside the architectural discipline. It is unlikely that an architectural firm would have the expertise, time or budget to conduct surveys of critical ecosystem types in the vicinity of a project, and here collaborations with those concerned and knowledgeable about local ecological conditions become important. For example, municipal or county governments can provide assistance by offering ecological classification information of a project vicinity. Additionally, partnerships with ecological specialists will better position designers to understand which habitat elements would be viable for intregration into a site and/or building design.

2.1 REGIONAL ECOLOGIES INFORMING SITE AND BUILDING DESIGN THINKING

Every system operates at varying resolutions or scales. Successful designs begin with concepts that are considered and responded-to at each of these resolutions throughout the process. Scale-sensitive design thinking results in outcomes or design products where the operative concept has penetrated each of these scales, such that ordering across each is apparent, consistent and supportive. In many ways the design concept is a lens, a portal that can be stopped down from scale to scale to provide clarity and acuity so structural links are identified across each level of resolution.

Human and ecological systems both have this "design at all scales" mechanism of ordering. From a purely functional standpoint:

1) Parts are effective and supportive of other parts
2) Smaller scales are supported by larger framework scale systems that allow them to function
3) Energy and material inputs, be they solar energy for ecosystems or fossil fuels (today anyway) for people, are processed, converted, and distributed so that they are distributed effectively and efficiently
4) The system is (ideally) self-supportive, self-healing, and maintains long-term growth and economy for the system as a whole

From the standpoint of integrating ecological concerns in architectural design, a preliminary consideration of the regional context can help the designer identify the habitat community types present, the macro-ecological dynamics of these communities, and the likely site ecologies in close proximity to the development site (that an ecologically regenerative development might respond to). This survey, typically not a component of the architectural design process, yet perhaps analagous to a review of building and planning codes at the outset of a design investigation, will also enable the generation of specific *inhabitant profiles*. In much the same way inhabitant profiles define design requirements for target human dwellers, habitats within the urban ecological context have their own profiles, determined through assessments of the structure and composition of occupying species guilds, the spatial patterning of species activity, the life cycle histories and habitat needs of individual species, and an undertsanding of which species are the most threatened and the most robust.

2.2 IDENTIFYING COMPATIBILITIES BETWEEN SPECIES, HABITAT AND DEVELOPMENT

With a range of local habitat types, species inhabitants and species life-history needs identified, the designer in consultation with a project ecologist can begin to consider which species (and habitats) to incorporate into the design, and also begin to speculate as to building configurations that would support ecological goals. In effect what we are advocating is the augmentation of building development programs/briefs that include inventory and assessment of human client/user needs with the indentification of target species (candidate "clients") and their habitat needs.

Below we offer preliminary criteria that can assist in deciding which habitats and species might be planned for in a development project. It is important to note that the criteria will not lead to a "correct" choice of species, but rather the ability to make more informed decisions. Some of the criteria may in fact prove inconsistent or suggest different choices. For example, we might wish to support a sensitive species within a development context, yet its very status as sensitive may be due to its lack of tolerance to disturbance, so that it would be unlikely to colonize a building or other element in an urban development.

Species Contribution to Larger Ecosystem Functioning

Particular "lynchpin" species are extremely valuable in that they provide habitat components for numerous other species. This „richness" of a given species in supporting the life histories of other species, and providing synergistic benefits to the greater ecology, ought to be factored in ecologically minded development planning.

Species Disturbance/Edge Tolerance

The biosphere reserve concept, developed by the UNESCO Man and Biosphere program, is intended help facilitate human and nature interaction so as to conserve biodiversity, encourage ecological and economically sustainable development, and to provide a structure for studying conservation and development issues.[11] Central to the concept is a three zone organizational system consisting of (1) the *core* as the critical habitat area for biodiversity conservation, within which the majority of human activities are limited, (2) the *buffer zone* to protect and link cores, and (3) the *transition* zone that mediates between the buffer and the surrounding region, with the majority of human activity occurring in this zone.[12] We hypothesize that these zones can be applied at a variety of scales from the regional to the building scale.

Relating the bioreserve concept to the layout of a building, a designer may identify core areas such as roofs that would be off limits to humans and that could potentially be utilized by more sensitive species. Additionally there could be buffer zones where limited interaction between human and ecological entities could take place. Designers might also consider potential project cores in relation to any nearby cores and buffer zone linkages (existing or potential), as many species that might occupy habitats within a development would be unlikely to be able to fulfill their full lifecycle needs within the development area alone.

Careful investigation of species sensitivity to disturbance in relation to project type will also be necessary, in particular the consequences of the "edge effect." Such investigations in combination with traditional building program assessments may result not only in the added constraints but creative design opportunities. Temporal segregation, as one example, may be identified as a means to enable greater spatial overlap between "people" spaces and non-human spaces than would at first seem permissible: spaces within a building may be used only during certain parts of the day (or night), and sensitive species may be able to occupy adjacent habitat if their patterns of dormancy/inactivity for example coincide with the architectural spaces' non-use times.

Congruence Between Configuration of Development Feature and Desired Habitat

The ecologist Robert MacArthur argues that the diversity of bird species in a given area "is largely determined by the structural features of the habitat" (regardless of the number of plant species present).[13] Subsequent urban ecological research suggests that the structure and function of a place often determines which species inhabitat it. Dr. Jeremy Lundholm, a biologist and plant ecologist, refers to this phenomenon as a *habitat template*, where the spatial qualities of a habitat type govern which species will use it, regardless of location.[14] With this knowledge, designers in collaboration with ecologists might identify "microhabitat" opportunities for a project in question, beginning with those elements they anticipate will be incorporated in the project regardless of ecological goals, and evaluating what minimum modifications to typical (cost effective) building assemblies might be possible in order to create habitat.

Critical Need: Health and Population of Species

When possible and viable, we would attempt to conserve and/or create habitat for those native plant and animal species that are the most at-risk. As the environmental philosopher Bryan Norton argues, in almost all instances we lack knowledge as to the long-term value of species for ecosystem functioning. A prudent approach would therefore be to assume all species have high potential value and work to minimize species extinctions.

Species Expressive and Formal Qualities

Certain high profile or "flagship" species appeal to people, generating emotive response. If these are incorporated in a given development scenario, inhabitants in regular contact with them may be more inclined to support further initiatives in integrating ecology and urban architecture/development. Additionally, certain species have formal, structural and spatial qualities that are akin to architecture and that might inspire thoughtful design response. An example is Oregon white oak in the Pacific Northwest. Designers have an opportunity to translate the visual and experiential characteristics of such species into built forms in response to functional needs, so as to generate richly dynamic spatial settings. It is hypothesized that expression of these forms can in turn produce demonstrable amenity value for people who utilize these spaces.

2.3 ECOLOGICAL SURVEYS AND OTHER STUDIES

In addition to regional ecological assessments and compatibillity studies described above, specific species surveys and other studies could be undertaken to increase the likelihood that efforts to integrate habitat in design are successful. As examples, studies corresponding to an upcoming, pilot university-level design studio led by the authors and focusing on issues of urban ecology and biodiversity might include:

Plant/Pollinator Community Studies

A study of plant bloom times would be useful in determining "gaps" (e.g. far fewer flowers in August in comparison with historical conditions) in regional and local flowering. This could be used to design temporally robust foraging habitat for native pollinators, or in identifying and locating new honeybee hives.

Oak/Forager Communities

Native squirrels and other oak mast (acorn) foragers can be highly tolerant of people in oak woodland environments and therefore would be appropriate design study species. Design students could work with environmental studies students to do actual surveys in the neighborhood of the project site and determine what responses in the built environment might support population behaviors.

Forest-Cavity Nester Communities

Many cavity nesters are year–round residents, and there is great potential to execute surveys to determine populations and distributions locally. Additionally, spatial parameters for designing for cavity nesting species could be undertaken (for example for acorn woodpecker communities that thrive in Santa Barbara County, California, a region where human ecologies also thrive).

2.4 ACCOUNTING FOR BIODIVERSITY IN ARCHITECTURAL DESIGN EXPLORATIONS

With regional ecological dynamics, target species, and potential building configurations in mind, and with data associated with surveys and other studies of targeted species, designers are now equipped to incorporate ecological concerns in their graphic explorations, to document what has been learned so far, and to speculate as to the specifics of architectural configurations. Although there is no specific set of graphic/design conventions that we would advocate for all projects, some conventions that would likely to be useful in most situations include:

Ecological Context Diagrams

In additional to more traditional "vicinity" plans, ecological context plans/diagrams would be useful in describing the network of communities and species (existing or potential) that could support and be supported by project scale habitat development.

Section Underlay Studies

Designers could develop separate sectional studies of the same architectural location/condition, one with a goal to optimize functionality and spatial richness for humans ("inside out" approach) and another with a goal to optimize habitat conservation/creation and suite of ecological interactions ("outside in" approach). Hybrid section studies could be generated from these "underlays" in an attempt to optimize both. Sections are seen as particularly useful in their capacity to describe trophic levels and vertical relationships, where stacking of value becomes apparent.

Space-Over-Time Studies

Whether plan, section, isometric or other mode of graphic representation, site and building scale drawings that document or project patterns of movement of species over time could be especially useful in understanding and communciating how architecture can support the life histories of nonhuman species.

3.0 TRAJECTORIES: IMPLEMENTING AND TESTING THE METHODOLOGY

The draft methodology described above will be introduced to students in an upcoming thesis level studio that will focus on a particular design problem in a particular urban ecological context. Through documentation of studio work and surveys of students focusing on the usefulness of the methodology, the authors anticipate considerable further development. In parallel to this effort, the authors will evaluate methods of sucessful ecological restoration projects – adaptive management strategies and monitoring systems for example – in order to ensure specific and appropriate goals for ecosystem/building intergration. Ultimately the intention is to utilize this methodology on an actual architectural undertaking, so that "on the ground" evaluations of specific ecological benefits in a realized project can be conducted and learned from.

A final note born of humility: while the authors believe a systematic approach to aligning urban ecologies and urban architectures is valuable, we recognize the extraordinary complexity of ecological systems and consequently the obstacles to developing a relatively simplified methodology for their integration in urban environments. However, given the magnitude of the problem we face, we believe this is an important and potentially critical endeavor, one that can improve environmental quality for all inhabitants of our cities. As the ecologist Jeremy Jackson suggests, "Ecosystem deterioration…needs to be addressed by a series of bold experiments to test the success of integrated management."[15]

ENDNOTES

1. Norton, Bryan G., *Sustainability: A Philosophy of Adaptive Ecosystem Management*, Chicago: University of Chicago Press, 2005, p. 575

2. Rosenzweig, Cynthia, and Solecki, William D., "Biodiversity, Biosphere Reserves, and the Big Apple: A Study of the New York Metropolitan Region" in *Annals of the New York Academy of Sciences*, 1023: 2004, 105-124, p. 106

3. Audubon, *Solving Sprawl: 1999 Sierra Club Sprawl Report* (http://www.sierraclub.org/sprawl/report99/openspace.asp#intro)

4. A comprehensive argument for the need to support biodiversity is well beyond the scope of this effort. If the reader is interested in more comprehensive treatment of this topic the authors recommend: Bryan G. Norton's *Why Preserve Natural Variety?* (Princeton, NJ: Princeton University Press, 1987), Stephen M. Meyer's *The End of the Wild* (Cambridge, MA: MIT Press, 2006), and Stephen R. Kellert's *Building for Life: Designing and Understanding the Human-Nature Connection* (Washington, DC: Island Press, 2005)

5. Norton, Bryan G., *Sustainability: A Philosophy of Adaptive Ecosystem Management*, p. 199

6. Meyer, Stephen M., *The End of the Wild*, Cambridge, MA: MIT Press, 2006, p. 86

7. For a treatment of the North American Wildlands Project see Dave Foreman's *Rewilding North America: A Vision for Conservation in the 21st Century* (Washington, DC: Island Press, 2004)

8. Such concerns are central to the discipline of landscape ecology. See for example Richard T.T. Forman & Michel Godron's *Landscape Ecology* (New York: John Wiley & Sons, 1986)

9. Meyer, Stephen M., *The End of the Wild*, pp. 87-88

10. For these and other examples of Paul Kephart's work, see http://www.ranacreek.com/

11. See Cynthia Rosenzweig and William D. Solecki's "Biodiversity, Biosphere Reserves, and the Big Apple: A Study of the New York Metropolitan Region;" also see Kwi-Gon Kim's "The Application of the Biosphere Reserve Concept to Urban Areas: The Case of Green Rooftops for Habitat Network in Seoul" in *Annals of the New York Academy of Sciences*, 1023: 2004, 187-214

12. See Peter Dogse's "Toward Urban Biosphere Reserves," in *Annals of the New York Academy of Sciences*, 1023: 2004, 10-48

13. Bryan G. Norton, *Why Preserve Natural Variety?*, p. 54

14. See Jeremy T. Lundholm's "Green Roofs and Facades: A Habitat Template Approach," *Urban Habitats*, Vol 4:1 (12/2006) 1-15

15. See Jeremy B.B. Jackson, et. al., "Historical Overfishing and the Recent Collapse of Coastal Ecosystems," *Science*, Volume 293 No. 5530 (July 27, 2001), pp. 629-638