Conservation Where People Live and Work

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Abstract: *Effective conservation planning requires information from well-designed studies across a spectrum of land uses, ranging from wildlands to highly modified production landscapes and large cities. There is currently a lack of such information about human settlement, even though this is a major source of land-use change with serious implications for biodiversity. Fewer than 6% of the papers in recent volumes of* Conservation Biology *described work conducted in urban, suburban, or exurban areas or studies in which human settlement was considered explicitly. For a variety of reasons, conservation has tended to focus on lands with a relatively small human presence, often dominated by resource extraction and agriculture. Urbanization is occurring in numerous biodiversity hotspots worldwide, however, and has been identified as a primary cause of declines in many threatened and endangered species. Suburban and exurban growth are affecting biodiversity in many places once thought of as too remote to attract such levels of development. Conservation biologists must address the issue of human settlement to enhance the habitat value of unreserved lands for native species, to increase landscape connectivity between reserves, and to mitigate adverse influences on reserves from adjacent lands. Conservation and restoration of native habitats in densely settled areas also have social and educational value. We therefore suggest a more balanced approach in conservation biology to addressing the effects of human land use through increased attention to areas where people live and work.*

Conservación donde la Gente Vive y Trabaja da planeación eficaz de la conservación

Resumen: *La planeación de una eficaz conservación requiere de información que provenga de estudios bien diseñados a lo largo de un amplio espectro de usos del suelo que se enfiende desde tierras silvestres hasta paisajes de producción altamente modificados y ciudades grandes. Actualmente, existe una carencia de información en lo referente a los asentamientos humanos, a pesar de que este factor constitúya una fuente importante de cambio del uso del suelo con implicaciones serias para la biodiversidad. Menos de un 6% de los documentos escritos en volúmenes recientes de* Conservación Biológica *han descrito trabajos realizados en áreas urbanas, suburbanas y exurbanas, o son estudios en los cuales los asentamientos humanos fueron considerados explícitamente. Por una variedad de razones, la conservación ha tendido a enfocarse en tierras con relativamente poca presencia humana, frecuentemente dominada por la extracción de recursos y la agricultura. Sin embargo, la urbanización está ocurriendo en numerosos sitios importantes para la biodiversidad a nivel mundial y ha sido identificada como la principal causa de disminuciones de muchas especies amenazadas y en peligro de extinción. El crecimiento suburbano y exurbano está afectando la biodiversidad en muchos lugares que anteriormente eran considerados muy remotos como para que atrajeran estos niveles de desarrollo. Los biólogos de la conservación deben enfrentar el tema de los asentamientos humanos para resaltar el valor del hábitat de áreas fuera de reservas para especies nativas, para incrementar la conectividad del paisaje entre reservas y mitigar las influencias adversas de zonas aledañas a las reservas. La conservación y restauración de hábitats nativos en áreas densamente pobladas también tienen un valor social y educativo. Por lo tanto sugerimos una aproximación más balanceada de la conservacián biológica para atacar los efectos del uso humano del suelo poniendo una mayor atención en las áreas donde la gente vive y trabaja.*

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To build a better motor we tap the uttermost power of the human brain; to build a better countryside we throw dice.

Aldo Leopold (1933*a*)

Introduction

No one has argued more forcefully or eloquently for wilderness preservation than Aldo Leopold. He played a pivotal role in formulating the wilderness concept in the United States, and his efforts resulted in the establishment of the first wilderness area. Yet, during the last two decades of his life, Leopold focused on small farmsteads in human-dominated landscapes and ". . .the oldest task in human history: to live on a piece of land without spoiling it" (Leopold 1991: 254). He recognized the critical importance of large protected areas kept free of development, but realized that these alone were not sufficient for conservation.

Today, conservation biologists arrive at this same conclusion, for many of the same reasons. There is no substitute, in terms of preserving biodiversity, for protecting extensive tracts of wild land (Redford & Richter 1999). But such areas are too few and far between, do not adequately represent the world's ecosystems, and are usually too small to prevent the loss of at least some species (Grumbine 1990; McNeely et al. 1994; Newmark 1995). These realizations have given rise to a broader focus in conservation planning that encompasses protected areas, smaller reserves, and unprotected lands (Jongman 1995; Saunders et al. 1995; Soulé & Terborgh 1999). There are formidable difficulties in establishing and managing reserves, especially if they are small, but figuring out ways to inhabit and use unreserved lands in a manner compatible with biodiversity conservation has been a particularly vexing problem (Callicott & Mumford 1997).

To be effective, conservation planning must be based on information derived from well-designed studies along the entire spectrum of land uses, from wild lands to the places where people live and work (Dale et al. 2000). The need for such studies is especially acute in areas of human settlement. Human settlement is a prevailing source of land-use change worldwide (United Nations Centre for Human Settlements 1996) with serious implications for biodiversity (McDonnell & Pickett 1993; Marzluff et al. 2001). We suggest that because relatively few studies have focused on settled areas, there is meager basis for making recommendations on ways to mitigate the adverse effects of urban, suburban, and exurban development on native species. We consider various factors that have caused conservation biologists to focus greater attention on other forms of land use, and we contend that there are numerous incentives for rectifying this situation. We discuss these incentives in terms of improving the scientific basis for meeting conservation challenges and in terms of societal and educational benefits.

Conservation Biology and Human Settlement

Nearly a decade ago, Pickett et al. (1992:78) observed that the threats to biodiversity posed by urban sprawl and the spread of suburban and exurban development were ". . . clearly. . .a rich area for exploration by conservation biologists." How have conservation biologists responded to this appraisal? One way to assess the degree to which various topics have been addressed within a scientific discipline is to survey the published work of its practitioners (e.g., Wiens 1992; Hobbs 1997). We reviewed papers published in *Conservation Biology* from 1995 through 1999 (volumes 9–13) to gauge the amount of attention afforded to different land types across the spectrum from wildlands to urban areas. Our review is limited to terrestrial field studies, which we categorized according to the type of land use in or near the study area and the extent to which human settlement was considered. We realize, of course, that conservation biologists publish their work elsewhere, so for this reason we do not suggest that our survey is comprehensive. Given the preeminence of this journal in the discipline, however, such a review may serve as a useful index.

Of the studies that we reviewed (n = 217), 21% occurred in places where there were few or no permanent settlements, such as national parks or wilderness areas. Approximately 63% were conducted in landscapes characterized by relatively low human densities and dominated by either agricultural activities (n = 42) or extractive resource use (n = 95), especially timber harvest. Effects related to patterns or types of settlement were not addressed in the design or analyses of these studies. Fewer than 6% of the papers described work conducted in urban, suburban, or exurban areas, or research in which human settlement was considered explicitly–exurban development in a forest-dominated landscape, for example. We were unable to determine the intensity of human settlement in or near the study area for the remaining 10% of these investigations.

Our survey supports the contention that conservation biologists have placed relatively little emphasis on human settlements per se. We believe that this pattern may stem, in part, from deep-rooted traditions in conservation and ecology. The philosophical underpinnings of both fields have been strongly influenced by the writings of George Perkins Marsh (Botkin 1990). Marsh (1864) held people as separate from nature and viewed natural systems, undisturbed by humans, as balanced. Historically, conservationists focused on protection from human activities and the preservation of nature's intrinsic balance, whereas ecologists conducted research in remote areas so as to understand the structure and function of "undisturbed" or "balanced" ecosystems (Botkin 1990; Pickett et al. 1992; Pickett & McDonnell 1993). In both cases, value was accorded to ecological systems in proportion to the perceived absence of anthropogenic influences.

There are, of course, less esoteric reasons to focus conservation efforts in places that are far removed from human population centers. Large reserves where human activities are greatly restricted, or "core areas" (Noss et al. 1999), are often advocated by conservationists because many of the species most in need of protection do not fare well in landscapes dominated by people (Knight & Clark 1998; Groom et al. 1999). For terrestrial vertebrates, human settlement presents numerous barriers to movement; this is especially true for wide-ranging mammals that come into conflict with people. Moreover, residential development presents political obstacles to the restoration of historical variability in ecological processes, such as fires or floods, on which elements of biodiversity may depend (Landres et al. 1999). Human settlement may also act as a source of exotic or domesticated species that compete with or prey upon native plants and animals. By making reserves as large as possible, conservationists hope that sufficient area is provided for large animals, a variety of habitats are protected to accommodate smaller or less mobile species, and the negative effects emanating from human settlements are mitigated.

Given the size limitations of even the largest reserves, the preferred conceptual model for extending conservation efforts to surrounding unreserved lands consists of concentric buffer zones of increasing human use projecting out from a protected core area (United Nations Educational, Scientific, and Cultural Organization 1974; Harris 1984). Ideally, only low-impact human activities, such as backpacking, would be permitted in the inner buffers (Noss & Harris 1986), and more intensive yet sustainable land uses would occur in the intermediate zones. The best examples of ecologically sustainable land use to date tend to involve resource extraction, such as selective timber harvest or certain types of agriculture (Callicott & Mumford 1997). Low-density residential development would be relegated to the outermost zones in the core/buffer model (Noss & Harris 1986); more densely populated areas, such as cities and suburbs, would presumably be located as far away as possible from the core.

Urban and suburban environments are synonymous with extreme habitat fragmentation and exemplify the biotic homogenization occurring across the globe (Hobbs & Mooney 1997). Angermeier (2000:375) gives voice to a commonly held view when he asserts that cities ". . .are distinct from the rest of nature and support strikingly little biotic diversity." The few native species that remain are often characterized as widespread generalists of little conservation value. Urban areas thus represent an extreme on the continuum of desirable environmental conditions, the endpoint we are trying to avoid in managing ecosystems (Hunter 1996; McIntyre & Hobbs 1999). There appears to be widespread agreement that the battle has already been lost in settled areas and that conservation efforts are better spent elsewhere.

It is likely that additional factors have contributed to the patterns in our survey results. Resource extraction may be perceived as more amenable to study with a simple treatment-effect approach, whereas the environmental effects of settlement can be complex and involve numerous confounding factors (McDonnell & Pickett 1993). Moreover, many of the traditional funding sources for conservation research are linked to natural resources on state or federal lands, properties generally managed by a single government agency. Because settled landscapes are under multiple jurisdictions and include many private holdings, large logistical hurdles must be overcome when research is conducted in these areas, and financial support may be more difficult to acquire. There are probably other equally plausible explanations, but whatever has caused the lack of attention to human settlement in conservation biology, there are compelling reasons to rectify the situation.

Biodiversity and Human Settlement

Although we might prefer biologically important areas to be buffered from human settlement, reality often dictates otherwise. The world's biodiversity hotspots (Myers 1988, 1990; Mittermeier et al. 2000) tend to have higher-than-average human population densities and growth rates, and most of these regions are rapidly urbanizing. There are 146 major cities presently located in or directly adjacent to a hotspot (Cincotta & Engelman 2000). Urban and suburban sprawl are rapidly transforming critical habitats and threatening biodiversity in the Atlantic Forest Region of Brazil and Paraguay, the Cape of South Africa, coastal Central America, and southwest Australia (Cincotta & Engelman 2000; Myers et al. 2000).

In the United States, urbanization has been identified as a primary cause, singly or in association with other factors, for declines in more than half of the species listed as threatened or endangered under the U.S. Endangered Species Act (Czech et al. 2000). Similar numbers are reported by Wilcove et al. (1998) in a more thorough assessment that includes 700 "imperiled" species that are not federally listed. More than 50% of the species endangered by urbanization occur in three states: California, Florida, and Texas (Czech et al. 2000). These are places that we associate with sprawling metropolitan areas and large, rapidly growing human populations, but exurban and rural development are also affecting biodiversity in many areas that just a few decades ago were thought of as too remote to attract much attention from builders.

Exurban growth and the spread of rural subdivisions are driven by increases in per capita income and factors that allow greater separation between home and the conventional workplace. Because properties near public lands are especially attractive to homeowners (Nelson 1992; Beatley 1994; Power 1996), residential develop-

ment now occurs on the boundaries of many important conservation sites in the United States, including some of the nation's largest nature reserves (Knight & Landres 1998). The counties surrounding Yellowstone National Park, for example, are among the fastest growing in the country (Stohlgren 1996). Large reserves are thus increasingly subjected to external threats (Janzen 1983, 1986) associated with human settlement in the surrounding landscape. Moreover, because large protected areas often were established on relatively unproductive lands, some of the most valuable sites in terms of biodiversity may occur outside reserve boundaries, coincident with the properties being targeted by developers (Hansen & Rotella 1999). As an example again, in the Greater Yellowstone Ecosystem, many key wildlife habitats in the areas adjacent to the park have been directly affected by the sprawl of development (Glick & Clark 1998).

The effects of human settlement in the surrounding landscape are likely to become more acute as reserve size decreases (Saunders et al. 1991), and small reserves are often all that exist in productive, economically important regions. Furthermore, real-estate values in these areas may preclude the future acquisition of any but relatively small parcels, especially in urbanizing regions (Schwartz 1999). "Bigger is better" has become a rule of thumb in conservation biology with regard to reserve size, but small reserves also serve a useful function in protecting biodiversity (Shafer 1995; Schwartz & van Mantgem 1997). Small reserves have value as components of regional conservation networks because they provide habitat for some species that are not adequately protected in large reserves (Faulkner & Stohlgren 1997; Schwartz 1999), especially when species turnover is high (Hopper 1992; Hopper et al. 1996). Moreover, small reserves may serve as the base around which restoration efforts can be focused in highly fragmented landscapes (Herkert 1997).

Small reserves and habitat remnants in urban and suburban areas are often subject to profound environmental stresses and invasions. Although the flora and fauna of cities are poorly documented (Niemela 1999), the few comprehensive surveys that have been undertaken have resulted in surprisingly long species lists, for the most part comprised of non-natives (Kloor 1999). Nevertheless, a remarkable amount of native diversity is also known to persist in some of the world's largest metropolitan areas (Jonsson 1995). Examples include remnants of Mata Atlantica forests in Rio de Janeiro (Monteiro & Kaz 1992), the Singapore Botanic Garden (Tinsley 1983), the Ridge Forest in New Delhi (Kalpavriksh 1991), and urban green space in Calcutta (Ghosh 1989). Forest Park, a 4000-ha forested area just a few kilometers from the urban center of Portland, Oregon, has nearly the full complement of plants and animals found in larger forests outside the urban center (Jonsson 1995). There are also studies that describe diverse avifaunas of predominantly native species in cities (Gotfryd & Hansell 1986; Recher & Serventy 1991; Wood 1993; Danaid 1994; Hadidian et al. 1997; Briffett et al. 2000). These examples suggest that even densely settled environments contain elements of biodiversity that deserve the attention of conservationists.

Conservation in settled areas must be grounded in good science. The addition of two urban sites to the U.S. Long-Term Ecological Research (LTER) network shows great promise for enhancing our understanding of the ecology of cities and our ability to solve environmental problems (Parlange 1998). The establishment of these sites is also an encouraging sign that the attitudes of funding bodies toward research in areas of human settlement are changing. The systems-based research in Phoenix and Baltimore has thus far tended to focus on the urban end of the urban-rural gradient (Grimm et al. 2000). Conservation scientists can extend these efforts by emphasizing organism-centered investigations in a wider range of biomes and landscapes, particularly exurban areas and the rural-wildland interface (Miller et al. 2001). Relatively little is known about the effects of human settlement on most plants and animals, and there is much to be learned even about the best-studied species (Marzluff et al. 1998).

Indeed, there is a pressing need among resource managers, land-use planners, developers, and private landowners for information on a variety of conservation-related topics regarding settlement. To make useful recommendations, conservation biologists must go beyond general guidelines derived from the theory of island biogeography or extrapolated from research conducted in the context of other land uses (Soulé 1991; Duerkson et al. 1997) and begin to address specific questions directly related to settlement. For example, what are the ecological footprints or effect zones of the various components of the built environment? How do these vary within and among taxa? How do the effects of residential areas compare to those of commercial development? What are the relative effects of different spatial patterns of development, such as clustered versus dispersed? How are important centers of biodiversity, such as riparian areas, affected by urban or suburban growth in the surrounding landscape? Where are the key wildlife movement corridors in a given landscape, and how might they be buffered from settlement? Are there ways to channel wildlife movement through low-density developments so as to minimize conflict with humans? Which species of native plants and animals remain competitive in the face of challenges by exotic species, and what are the life-history or ecological traits that allow them to do so? What are the sociological and economic factors that determine which habitats are likely to be affected by development? How can conservation biologists effectively bring their science to bear on land-use policy decisions?

This list is, of course, intended to be illustrative, not exhaustive. The point is that a wide range of issues must

be addressed if we are to mitigate the adverse effects of human settlement on reserves from adjacent lands, increase landscape connectivity between reserves, and enhance the habitat value of unreserved lands for native species.

Social and Educational Assets

Ultimately, the success of biodiversity conservation depends on broad-based public support. Generating support among landowners for species protection on private lands, where most threatened species occur, entails a shift from strict top-down command-and-control regulation (Holling & Meffe 1996) to a more expansive set of conservation tools that includes a range of economic incentives (Bean & Wilcove 1997; Knight 1999; Main et al. 1999). In a broader sense, building public support depends on reaching a wider, more diverse audience with a message that conveys the importance of biodiversity and its relevance to individual lives—something that conservationists have, in large measure, failed to do (Nabhan 1995).

We believe that the failure to communicate the importance and relevance of biodiversity stems, at least in part, from what is emphasized in conservation. From the perspective of someone who lives in a city or suburb, conservation is too often something that happens somewhere else—in a national park, wilderness area, or rainforest—and is experienced second-hand (if at all) on television or in a magazine. The importance attached to biodiversity thus becomes commensurate with its entertainment value. But a sole focus on distant lands and species most people will rarely see is limited in its ability to engender a genuine appreciation for nature close at hand (Orr 1993). Conservationists have come to appreciate the necessity of considering multiple scales, from landscapes to continents, but need to place greater emphasis on "the scale of personal experience" (Karasov 1997). It is important to communicate that many of the same ecological processes taking place in television nature shows also occur, with perhaps less charismatic players, in one's own backyard. As Leopold (1949:174) observed, "The weeds in a city lot convey the same lesson as the redwoods. . . ." An appreciation for the natural environment in one's neighborhood or hometown can lead to a broader ecological understanding (Sauer 1998) and may even act as a catalyst for involvement in local conservation issues.

Because many land-use decisions are made at the base of the government hierarchy by county officials, city administrators, and landowners (Miller et al. 2001), habitat protection may often be better achieved by compassionate and informed members of the local community than through command-and-control regulation (Shutkin 2000). For example, there is widespread opinion in Australia that community-based projects there offer the best hope of preserving the remaining native biota in extensively fragmented agricultural landscapes (Dilworth et al. 2000). With this same perspective, The Nature Conservancy is moving away from a strict emphasis on acquiring and protecting reserves in the United States to a program that also includes community-based conservation built on cooperation and partnerships in rural areas (Knight 1999). The Chicago Wilderness Project is an example of this approach in a more densely settled area, and includes over 60 public and private organizations allied in a common effort to protect and restore ecosystems and biotic communities in the region (Brawn & Stotz 2001). Community-based efforts establish a positive-feedback loop as they draw on local support and, in turn, foster even greater interest in local conservation issues. The Chicago Wilderness Project, in addition to the important work of identifying conservation priorities and implementing management plans, has made great strides in community involvement through education and outreach (Brawn & Stotz 2001). A scaled-down example is found in the restoration of the North Woods of Central Park, New York City, which has done much to improve a degraded system and to educate and rally the local population (Sauer 1998). Participation in such activities may equip future generations with the skills and values to address issues beyond their neighborhoods or hometowns (Cheskey 1993).

Conservation research conducted in populated areas has this same potential for community integration, as exemplified by the Baltimore and Phoenix LTER sites. Projects at both sites set a high priority on the involvement of local residents, especially primary and secondary students (Parlange 1998). There are numerous benefits to this approach: scientists are provided with a large cadre of field workers, a window is opened for the public on the research process and its importance, and a two-way dialogue is established between ecologists and the local community. Overall, such efforts can do much to address the contention that scientists spend too much time talking to other scientists, whereas they should communicate more with the other elements of society if they want their research to be relevant and have an impact (Dunbar 1995; Saunders et al. 1995; Ehrlich & Ehrlich 1996; Wills & Hobbs 1998).

Finally, conservation and restoration in highly developed areas are essential to the preservation of biodiversity, even if urban habitats rarely harbor the species most in need of protection. The benefits of retaining nature in cities, in terms of enhancing the quality of life of urban residents, have long been recognized (Worster 1973): ultimately, the key to stemming the exodus of city dwellers to exurban and rural areas is to make cities more livable (Shutkin 2000). As Box and Harrison (1994:11) note, "if the contribution of urban green spaces to future generations is to be justified solely in terms of their

contribution to the stock of environmental assets, then urban environmental assets will always be deemed to be poor substitutes for their rural counterparts. On the other hand, if urban green space policies acknowledge the social and educational assets of accessible natural green spaces, then the inheritance value of these areas is unrivaled."

Conclusion

Aldo Leopold observed that "conservation is not merely a thing to be enshrined in outdoor museums, but a way of living on the land" (Meine 1988:310). With this in mind, he sought to provide farmers with the tools necessary to improve conditions for wildlife on their properties (Leopold 1933*b*) and, in so doing, improve the quality of their own lives. Conservation biologists must likewise provide the tools necessary to living better on the land by addressing the issue of human settlement, from urban areas to rural subdivisions.

Development will continue, with or without input from conservation scientists. Without it, unplanned growth will continue to replace native habitats and threaten biodiversity. In the United States, a recent survey showed that sprawl has become a major issue among voters, equal in magnitude to such traditional concerns as crime, education, and the economy (PEW Center for Civic Journalism 2000). Discontent with current patterns of development and a desire for alternatives are also evidenced by the growing number of ballot initiatives related to land use and by increases in the number of tax dollars allocated to the preservation of open space. Still, even planned growth with no scientific context is, at best, a missed opportunity. Now is the time for conservation biologists to work with the public to design a better future through development that minimizes adverse effects on native habitats and open-space protection that achieves conservation goals.

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