

**Human Geography and the "New Ecology": The Prospect and Promise of Integration**



Karl S. Zimmerer

*Annals of the Association of American Geographers*, Vol. 84, No. 1 (Mar., 1994),  
108-125.

Stable URL:

<http://links.jstor.org/sici?sici=0004-5608%28199403%2984%3A1%3C108%3AHGAT%22E%3E2.0.CO%3B2-M>

*Annals of the Association of American Geographers* is currently published by Association of American Geographers.

---

Your use of the JSTOR archive indicates your acceptance of JSTOR's Terms and Conditions of Use, available at <http://www.jstor.org/about/terms.html>. JSTOR's Terms and Conditions of Use provides, in part, that unless you have obtained prior permission, you may not download an entire issue of a journal or multiple copies of articles, and you may use content in the JSTOR archive only for your personal, non-commercial use.

Please contact the publisher regarding any further use of this work. Publisher contact information may be obtained at <http://www.jstor.org/journals/aag.html>.

Each copy of any part of a JSTOR transmission must contain the same copyright notice that appears on the screen or printed page of such transmission.

---

JSTOR is an independent not-for-profit organization dedicated to creating and preserving a digital archive of scholarly journals. For more information regarding JSTOR, please contact [jstor-info@umich.edu](mailto:jstor-info@umich.edu).

# Human Geography and the "New Ecology": The Prospect and Promise of Integration

Karl S. Zimmerer

Department of Geography, University of Wisconsin-Madison

Ecologists are in a period of retrenchment, soul searching, 'extraordinary introspection,' . . . This follows on nearly three decades of heady belief on the part of some ecologists . . . that communities are structured in an orderly predictable manner, and of others that information theory, systems analysis, and mathematical models would transform ecology into a 'hard' science. (Robert McIntosh 1987:321)

I think that in this vast empirical stew [social life and the empirical reality surrounding it], if you'll pardon the expression, where disorder reigns, are scattered small islands of organization. (Claude Levi-Strauss and Didier Eribon 1991:102)

**T**he "new ecology" offers a sort of shorthand for a significant reorientation that has occurred in the field of biological ecology (Botkin 1990; Colwell 1984; 1985; 1992; McIntosh 1987). The "new ecology" accents disequilibria, instability, and even chaotic fluctuations in biophysical environments, both "natural" and human-impacted (for example, Botkin 1990; McIntosh 1987; 1991; Mooney and Godron 1983; Roughgarden et al. 1989; Vale 1982; Worster 1990). This emphasis on the volatility of environmental change tests the conventional ecological wisdom that depicts nature as tending toward stability or near-constant balance. The "new ecology" thus challenges the major premises of biological ecology *qua* systems ecology as practiced during the 1960s and the 1970s. Whereas systems ecology regards environments at various scales as systems tending toward equilibrium and homeostasis (Laszlo 1972; Margalef 1968; E.P. Odum 1969; 1971; H. Odum 1983), the "new ecology" proclaims opposition to the idea of persistent stability in environmental systems.

For geographers who have long been interested in human modifications of nature (for

example, Kates 1987; Parsons 1971; C.O. Sauer 1967; Simmons 1993; B.L. Turner 1989), the "new ecology" amplifies these vital geographical traditions. In this regard, the biophysical attributes of environmental modification are of especial interest to the various ecological subfields in human geography—cultural ecology (Butzer 1989; Kates 1987; Turner 1989), the cultural ecology of development (Grossman 1981; 1984; Nietschmann 1973), political ecology (Blaikie and Brookfield 1987; Bryant 1992; Redclift 1987), and kindred approaches such as human ecology (Whyte 1986) and adaptive dynamics ecology (Knapp 1991), among others (Brookfield 1964; Butzer 1989; Denevan 1983; Ellen 1982; 1988; Entrikin 1980; Grossman 1977; 1981; Kates 1987; Knapp 1987; 1991; Leighly 1987; Parsons 1971; Porter 1978; Stoddart 1965; B.L. Turner 1989; Whyte 1986; Zimmerer nd.). But if the geographical literature on ecological relations is ample, it is also remiss for its negligence of the "new ecology's" insights on the dynamics of biophysical environments.

Our efforts in human geography to date have scarcely touched the profound re-interpretation of biophysical environments that has emerged through the perspectives of the "new ecology."<sup>1</sup> To be sure the "new ecology" has already inspired rethinking in the realm of human-environment relations (Denevan 1983; Knapp 1981; 1987; 1991; Smith 1984; Winterhalder 1980), but human geography's interpretation of biophysical environments awaits enlightenment. Shoring up the ecological foundations of human geography will require reconsideration of our assumptions and perspectives on biophysical environments. Toward that end, this paper begins with a discussion of major findings from the "new ecology." The two en-

suming sections revise existing ecological concepts and reformulate certain ecological postulates that have been deployed by human geographers since the 1970s. I examine three of these postulates in greater detail: (1) generalized carrying capacity; (2) area-biodiversity relations, that is, biological diversity as a function of geographical area and isolation; and (3) biodiversity-stability relations, that is, biological diversity confers ecological stability.

These ecological postulates derive from disproven assumptions and dubious principles of systems ecology. Each depends on unwarranted, and often unstated, assumptions about temporal and spatial regularities in biophysical environments. Given these alleged regularities, the postulates proffer accounts of such ecological features as the distribution and diversity of organisms via intermediate-level processes of "competitive exclusion" and "niche specialization." The "new ecology" casts doubt on the applicability of these intermediate-level processes and it proposes reformulations that promise to strengthen human geography's contribution to current research issues (Butzer 1989; Kates 1987; B.L. Turner 1989).

But the integration of the "new ecology" into human geography will not be seamless. The third section of the paper assesses the obstacles to our efforts. The first of these is the decline of predictive capacity and analytical certainty (in contrast to systems ecology) and the ensuing erosion in scientific claims on behalf of environmental conservation (Botkin 1990). The second is the prospect that non-equilibrium conditions might be construed as justification for the human-induced deterioration of environments (Worster 1990). Although each of the difficulties poses real problems, neither should preclude human geography's consideration of the "new ecology," provided, of course, that these perspectives improve our understanding of biophysical environments. Indeed, I will argue that environmental conservation has much to gain through the adoption of these perspectives and that the contributions of landscape ecology and agroecology offer cases in point.

Whereas our third section deals with the constraints on geography's adoption of "new ecology" principles, section four focuses on the conditions that enable integration. Most important are three perspectives shared by the

"new ecology" and human geography—the importance of history, spatial scale, and subjectivity. Both perspectives pay careful attention to historical (non-cyclical) time; to the function of spatial scale (scale dependency); and to differential perceptions of environments and environmental change. These shared orientations of the "new ecology" and human geography point in turn to a conclusion that elaborates several integrative research themes that are especially pertinent to the problems of environmental conservation and economic development.

Geography's longstanding interest in these problems (C.O. Sauer 1956) has been renewed by the introduction of new ideas and concepts—sustainable development (Redclift 1987), sustainable resource management (Friedmann 1992:119–124), conservation-with-development (Stocking and Perkin 1992), and sustainable agriculture for development (Conway and Barbier 1990). This renewal, I maintain, may be hastened through the integration of the "new ecology's" perspectives into human geography. These perspectives call for flexible environmental management strategies that accommodate at once change, risk, complexity, and development based on local participation. Indeed, geographical notions of participatory development (Bebbington 1991; Carney 1991; Friedmann 1992; Nietschmann 1991; Porter 1979; Richards 1985; Thrupp 1989; Zimmerer 1994) dovetail nicely with the perspectives of the "new ecology" and fill a niche in the research agenda on environmental conservation and economic development.

## "New Ecology"

The term "new ecology" has been used since the 1980s to describe a major theoretical shift in the field of biological ecology (Colwell 1984; 1985; 1992). Others prefer more evocative expressions such as "dynamic ecology," the "ecology of chaos" (Worster 1990), "discordant nature" (Botkin 1990), and "ineluctably contingent nature" (May and Seger 1986). But whatever the term, this new perspective calls attention to the instability, disequilibria, and chaotic fluctuations that characterize many environmental systems as it challenges the primordial assumption of systems ecology,

namely that nature tends toward equilibrium and homeostasis (Laszlo 1972; Margalef 1968; E.P. Odum 1969; 1971; H. Odum 1983). While the various conceptual orientations of the "new ecology" may not yet constitute a theoretical shift in the sense of a complete replacement of Kuhnian scientific paradigms (McIntosh 1987), they nonetheless acknowledge the shared direction among discrete perspectives on the ecological properties of biophysical environments.

The emergence of the "new ecology" may be traced to empirical and theoretical advances and the rise of new metaphors. Field studies have been especially important in cases where the results could not be reconciled with a systems ecology view of nature. Closely-monitored fluctuations in wildlife populations that had been impacted by human management and exploitation, for instance, contradicted the predictions of systems ecology (Botkin 1990; Botkin and Keller 1982). Economic species such as elephants in East Africa and anchovies off the Peruvian coast exhibited sharp fluctuations in population size that could not be explained satisfactorily by equilibrium-based principles. Theory has also contributed to the disaffection for equilibrium models. Theoretical constructs drawn from chaos theory (Malanson et al. 1990; Schaffer 1985) and mathematical modelling (May and Seger 1986) challenged the analytical basis of much of systems ecology. And lastly, fresh metaphors, borrowed in part from computing sciences, have aided in the "new ecology's" reinterpretation of nature (Botkin 1990). Parallel computer processing conveys a metaphor for the conditionalities (or contingencies) of ecological processes in a diversely organized natural world.

The "new ecology" also involves a new conception of time. Historical time with its emphasis on the irregular periodicity of environmental variations and ecological functioning has displaced the cyclical time of systems ecology. Natural disturbances thus occur more frequently and over larger areas than previously thought (Christensen 1989; Connell 1978; Loucks 1970; Mooney and Godron 1983; Pickett et al. 1989; Pickett and White 1985; Vale 1982; Veblen 1985; White 1979).<sup>2</sup> Disturbances such as fire, wind, drought, pest outbreaks, disease epidemics, volcanic eruptions, and landslides take place relentlessly across a

wide range of biotic and biophysical landscapes. To be sure, geographers have long paid attention to natural and human disturbances (Frederic Clements' mechanistic doctrine of cyclical succession notwithstanding, Parsons 1981; C.O. Sauer 1967; Watt 1947; cf. Clements 1935),<sup>3</sup> but empirical and conceptual inquiry accelerated during the 1980s. New interests have emerged to address how the irregular temporal variation of ecological processes and so-called "site histories" structure the foundations of environmental systems; how, for example, organism dispersal establishes important time-dependent conditions for ensuing changes in biophysical environments.

The "new ecology" also deploys spatial scale in its redefinition of the ecological processes that shape biophysical environments (Allen and Hoekstra 1991; Allen and Starr 1982; Baker 1989; M.G. Turner 1989; Remmert 1991; Vale 1982). Spatial scale differentiates the function and exchange of energy, material, and organisms. "Hierarchy theory" places the scale-dependency of ecological functions at the center of a comprehensive conceptual framework (Allen and Starr 1982). In real environments, of course, these spatial and temporal contingencies commonly combine. Consider the approach of the "new ecology" with regard to landscapes that contain "disturbance patches," that is, non-contiguous areas of disturbed habitat. These landscapes pose a fundamental question: do the disturbance patches constitute a scale-dependent steady state of mosaics (the "shifting-mosaic steady state" described by Bormann and Likens 1981) or a portion of systems that are unstable even at the largest spatial scales (Baker 1989).<sup>4</sup> This question, of course, strikes at the heart of our conceptions of time and space.

The "new ecology" also broaches the delicate issue of "subjectivity." In ecology, subjectivity refers to the differential capacity of non-human organisms for adjustment and evolutionary adaptation as these organisms encounter environmental variation in time and space (Kolasa and Pickett 1991). Insofar as the equilibrium principles of systems ecology posited the regularity of environmental variation, ecologists had little interest in the subjectivity of non-human organisms. "New ecology's" emphasis on markedly uneven environments, in contrast, vigorously renews inquiry into the behavioral and biological capacities of organ-

isms. The "new ecology" thus turns toward evolutionary and organismal biology and away from ahistorical systems ecology; toward individual organisms, species, and populations (or direct linkages, such as in symbiotic systems) and away from undifferentiated ecosystems (Colwell 1985; 1992; Futuyma 1979).

The consolidation of "new ecology" perspectives in biological ecology and biogeography has not been uneventful. Critics have attacked the "new ecology's" theoretical framework and the implications of that framework for research design. The first criticism charges that the pluralism and the contingency of the "new ecology" is atheoretical at worst and a dangerous deviation from unified models of explanation at best (McIntosh 1987). If, runs the latter charge, all practitioners of biological ecology and biogeography were to adopt the "new ecology," then they forsake the compelling prospect of a unified ecology. The second criticism of the "new ecology" declares that all of the emphasis on contingency and complexity discourages the investigation of larger complex research problems in favor of smaller and more tractable ones (May 1984). Few generalizations, they argue, will issue forth from the "new ecology." What these criticisms fail to do, however, is to attack forthrightly the truth-claims of the "new ecology."

Conversely, the "new ecology" has trenchantly criticized the assumptions and principles of systems ecology. Predicated on the merger of the biological ecosystem concept (Tansley 1935) and systems theory (Stoddart 1965), systems ecology has tended to view nature in terms of mechanical regularity. These assumptions of temporal and spatial homogeneity, as the "new ecology" points out, are rarely satisfied (Allen and Starr 1982; Connell 1978; Forman and Godron 1986; Kolasa and Pickett 1991; Pickett and White 1985; Schaffer 1985; White 1979). Accordingly, the numerous principles of systems ecology that are based on the assumption of environmental homogeneity require reexamination.<sup>5</sup> Consider the erroneous principle that alleges the prevalence of competitive exclusion among organisms (E.P. Odum 1971), a function that presumably orders the distribution and diversity of organisms. Systems ecologists hold that pervasive competitive exclusion is responsible for the evolutionary process of niche specialization, in which diverse organisms evolve adaptations to

specific, non-overlapping habitats and thus embody unique ecological roles. The governing role of competitive exclusion is founded, however, on unwarranted assumptions of temporal and spatial homogeneity. Given nonequilibrium conditions, the "new ecology" has proven convincingly that the principle of competitive exclusion is limited in its application (Allen and Starr 1982; Connell 1978; Forman and Godron 1986; Kolasa and Pickett 1991; Pickett and White 1985; Schaffer 1985; White 1979).

The assumptions of systems ecology—the pervasiveness of competitive exclusion, niche specialization, and environmental homogeneity—nonetheless endure in the various ecological postulates that are applied by human geographers, and it is to these that I now turn.

## Ecological Concepts: Old Orientations and New

Ecological concepts in human geography have been used to interpret two types of relations between organisms and the environment. The first addresses human relations to biophysical environments; the second, the nature of these biophysical environments.<sup>6</sup> In the case of human-environment relations, the ideas of "adjustment" and "adaptation" have been widespread since Harlan Barrows declared "man's adjustment to the environment" as the basis for a geographical human ecology (Barrows 1923). Pioneered in the early twentieth century in the Department of Geography at the University of Chicago (Martin 1987; see also Goodland 1975; Worster 1977; White 1945), the ecological concept of organismal adjustment served as the foundation for subsequent interpretations of human behavior in the natural-hazards tradition (Burton, Kates, and White 1968; 1978; Burton and Hewitt 1974; Kates 1971; White 1974; Whyte 1986). In human geography's version of systems ecology, the notion of adaptation or "adaptedness" considered human practices and, in some cases, beliefs as ecosystem functions (Nietschmann 1973:1–10; see also Rappaport 1968:1–7).<sup>7</sup> In cultural ecology, trajectories of human adaptation, sometimes labelled as "coping behaviors," served as the basis for understanding adaptive dynamics (Bennett 1976; Denevan 1983; Knapp 1991; Richards 1985; Waddell 1975; 1977).

Explanations of human behavior based primarily, or entirely, on ecological concepts of adjustment and adaptation invited, however, theoretical and historical critique.<sup>8</sup> Application of simple adjustment concepts, for instance, frequently overlooked the roles of ethnicity and power in shaping human behavior (Hewitt 1983; Love 1983; Orlove 1980; Waddell 1977; Watts 1983b; Whyte 1986; Wolf 1972; 1982:ix-x). Similarly, the initial concept of adaptation favored the continuity of homeostasis over the dynamics of change. In this fashion, adaptation became essentially teleological, change could not be explained, and the whole concept was bereft of historical meaning (Ellen 1982:236-251; Friedman 1974; Hames and Vickers 1983; Knapp 1987:129-132; Orlove 1980; Watts 1983a). Concepts of adaptation in human-environment relations thus require reformulation, and a handful of human geographers have begun that task by acknowledging the importance of ethnicity and social and political power (Denevan 1983; Knapp 1991).

But if human geographers have begun to rethink human-environment relations, they have made less progress in their reconsideration of the nature of biophysical environments. And it is on that score that "new ecology" perspectives offer some much-needed assistance. Our rethinking begins with three conventional ecological postulates: (1) the calculation of carrying capacity based on data at coarse spatial and temporal scales (generalized carrying capacity postulate); (2) the relationship between the spatial characteristics of environments and the diversity of non-human organisms (the area-biodiversity postulate); and (3) the relationship between the temporal characteristics of environments and the diversity of non-human organisms (the stability-biodiversity postulate). In each case, these postulates assume temporal and spatial homogeneity and the pervasiveness of niche specialization and competitive exclusion. These, of course, are the assumptions of systems ecology. That they are flawed is dawning upon geography and related fields and that realization is drawing them toward the revisionist insights of the "new ecology."

### Generalized Carrying Capacity

The postulate of generalized carrying capacity holds that a given biophysical environment

exists in equilibrium with a certain population of organisms. First established in laboratory experiments with cultured microorganisms during the nineteenth century, this postulate has been widely applied, discussed, and criticized in human geography (Bernard 1985; Bernard et al. 1989; Brush and Turner 1987; Campbell 1986; Denevan 1987; Redclift 1987; Simmons 1981; Street 1969; B.L. Turner 1983:22-26). Human geography's applications are of two sorts: human carrying capacity and animal carrying capacity. The two applications often intertwine, of course, because human populations frequently depend on game and livestock. Although human geographers have critically assessed the postulate of generalized carrying capacity for human populations (Denevan 1987; Street 1969; see Brush 1977 for the cultural ecology critique of an anthropologist), they have not paid similar attention to the analogous postulate for animal groups, and it is here that the "new ecology" perspective may be helpful.

The "new ecology" points out two problems with the postulate of generalized carrying capacity as applied to animal populations.<sup>9</sup> First, the postulate typically assumes a specific and regular pattern of demographic growth. As derived from the nineteenth-century laboratory experiments mentioned above, growth is described by an S-shaped curve (sigmoid) that levels off at an upper asymptote (E.P. Odum 1971:183-195; Whittaker 1975:14-20). This upper value, typically designated *K*, is taken to measure the generalized carrying capacity. In wildlife ecology and rangeland management, where the postulate of generalized carrying capacity has been used most extensively, population numbers are assumed to fluctuate regularly around the *K* value. These assumptions of regularity do not correspond to biophysical reality, however (Botkin 1990; Botkin and Keller 1982). The empirical evidence demonstrates instead a remarkable lack of temporal homogeneity in biophysical environments owing to the prevalence of unpredictable ecological disturbances such as drought. The assumption of a "continuing steady-state basis" embedded in the definition of carrying capacity (Whittaker 1975:17) is simply unwarranted.

The second problem with the postulate of generalized carrying capacity is the assumption of the spatial homogeneity of environments, that is, environmental differences are either in-

significant or regular in their occurrence. Note how the assumptions of spatial homogeneity and temporal homogeneity are related. By assuming regularity in temporal variation, spatial evenness may be posited. These assumptions are in turn embedded in calculations of livestock carrying capacity, as evidenced by studies of East African rangelands (Bernard 1985; Bernard et al. 1989; Campbell 1986). While some of these studies have acknowledged that significant environmental variations are ignored in calculating livestock carrying capacity (Bernard 1985:69; Campbell 1986:50–51), recent studies demonstrate that the effects are often so substantial that they greatly alter carrying capacity estimates. Within a small area (260 km<sup>2</sup>) in Burkina Faso, for example, forage yields among environmental patches differ by a factor of more than twenty-five (De Leeuw and Tothill 1990:7–8).

Thus, the postulate of generalized carrying capacity must be reformulated in order to account for the temporal and spatial heterogeneity of environments. And in that reformulation, the "new ecology" offers some guidance. On the outset, we must recognize the important roles of temporal disturbance and spatial variation in environments. In the case of livestock carrying capacity, we begin by delimiting the spatial unevenness of crucial resources (food, water, shelter) that constrain, singularly or together, livestock numbers. Recent studies in Zimbabwe and South Africa demonstrate the virtues of such an approach (Abel and Blaikie 1990; De Leeuw and Tothill 1990; Scoones 1989). In Zimbabwe, for example, livestock carrying capacity depends on the spatial distribution of "key resources" (e.g., drainage lines, river banks, contour ridges) that provide crucial forage during the dry season. Assessing the spatial and temporal variations in these "key resource" sites significantly improves our estimates of livestock carrying capacity.

### Area-Biodiversity Relations

A second postulate of systems ecology—the claim of a direct association between area and biodiversity—is equally seductive for human geographers who are interested in environmental conservation and, more particularly, in the roles of indigenous and peasant peoples in the conservation of biodiversity (Girod and

Nietschmann 1992; Hecht and Cockburn 1990; Herlihy 1989; 1990; Nietschmann 1991; Redclift 1987; Stevens 1993) and for anthropologists and scholars in environmental studies (Batisse 1982; Chapin 1992; Clay 1985). Their interest in biodiversity converges on the numerous biosphere reserves that are inhabited by indigenous and peasant peoples with territorial rights over their reserve areas ("parks with people"). Research on biosphere reserves (established or proposed) in the Central American countries of Panama, Costa Rica, Nicaragua, and Honduras and elsewhere seeks to promote designs and plans that effectively conserve biodiversity while protecting the territorial sovereignty of local inhabitants.

It comes as no surprise that the designers of biosphere reserves have sought biological guidelines, nor that they have found these in the literature of applied island biogeography (Batisse 1982; Clay 1985; for major statements on applied island biogeography, see Diamond 1975 and Miller 1978). This literature asserts that biodiversity is a direct function of area ("island size") and of isolation with respect to similar habitats (the area-biodiversity postulate). When this postulate is applied to biosphere reserves, area becomes the key predictor of biodiversity: the larger the area, the better. The area-biodiversity postulate also implies certain recommendations on reserve shape. If the biological diversity of reserves diminishes, *ceteris paribus*, with exposure to boundary or "edge" habitats, then circular reserves are preferable to other shapes (Diamond 1975). Indeed, several studies present diagrammatic models of circular reserves and one of these describes the circular unit as "a typical biosphere reserve" (Redclift 1987:138; see also Batisse 1982; Clay 1985).

But in most cases, area and isolation offer poor estimates of the extent of biodiversity, and the poverty of these estimates can be traced back to the unwarranted assumptions of applied island biogeography and systems ecology. They begin by assuming the pervasiveness of competitive exclusion and niche specialization and the regularity of environmental conditions (spatial and temporal homogeneity). Given these assumptions, it follows that area together with isolation (a proxy used to determine colonization rates) constitute the sole parameters for determining biodiversity. The problem is that environmental conditions are

not invariantly regular in time and space, and that fact invalidates the use of homogeneity-based ecological principles in the planning of optimal reserve size and shape. The "new ecology," by contrast, offers a number of principles that are more appropriate for reserve design (Forman and Godron 1986; Forman 1990).

"New ecology" highlights environmental complexity; it acknowledges the role of a variety of factors—regional biogeography, environmental heterogeneity, and differential migration capacities among organisms—in shaping biodiversity; and it insists that designers of biosphere reserves accommodate these factors. Clearly, recommendations of circular-reserve designs based solely on area and isolation parameters are unwarranted. But the contribution of the "new ecology" extends well beyond parochial notions of reserve design to a full-blown critique of applied island biogeography. A case in point is recent research on the impact of fragmented landscape patches on biodiversity (Forman 1990). In addition to the parameters of size and isolation, this research considers landscape configuration—the connection and juxtaposition of patches, for example. The results are providing useful insights for the design of biosphere reserves in the Caribbean lowlands of Central America. In eastern Honduras and to the south in eastern Nicaragua, for example, a serpentine-like series of habitat patches has been proposed as the basis for the Tawahka Reserve inhabited by the indigenous Tawahka Sumu (Herlihy 1990:32).

### **Biodiversity-Stability Relations**

Systems ecologists assume that the relations of biological diversity and temporal stability are inextricable and determinate (Laszlo 1972; Margalef 1968; H. Odum 1983). In human geography, Harris's interpretation of agricultural species diversity among the Yanamamo people ("Waika") in the upper Orinoco rain forest of southern Venezuela illustrates the dangers in applying the biodiversity-stability postulate (Harris 1971). Harris assumed that less diverse fields containing maize were more recent in origin and less stable than more diverse swidden plots (Harris 1971:481–482). But Harris's supposition has been countered by evidence documenting the antiquity of maize cultivation

in the upper Orinoco and nearby Amazon basins (Roosevelt 1980).

Misgivings about the biodiversity-stability postulate date back at least to the late 1970s (Connell 1978; Goudie 1981:280–283; May and Seger 1986; Pimm 1984). The "new ecology" challenges the postulate's underlying assumptions, namely that stable biophysical environments are dominated by competitive exclusion and niche specialization and that these, in turn, are responsible for biological diversity. It also challenges the equally erroneous reasoning that regards the presence of biodiversity as evidence of ecological specialization and the stable temporal conditions that would have permitted it. The "new ecology," in contrast, offers an alternative and more nuanced view of the relations between biodiversity and the temporal attributes of environments. Natural ecological disturbance in this view is a determinant that in many cases enhances biological variety (Connell 1978; Christensen 1989; White 1979). Drawing on "new ecology" concepts, recent research in biogeography has shown how ecological disturbance may underlay biodiversity patterns (Beatty 1991; Vale 1988; Veblen 1985).

A corollary of the biodiversity-stability postulate, and one that has been especially common in human geography, is the assumption that biodiversity reflects "adapted" niche specialization of agricultural plants. Geographers have deployed this assumption in their interpretations of biodiversity (either species diversity or cultivar diversity) in the cropping systems of peasant and indigenous farmers (Knapp 1991:11; B.L. Turner 1983:111; see also related work in cultural ecology by anthropologists, for example Brush and Guillet 1985:24; Webster 1973:119).<sup>10</sup> In a review of crop diversity in the Central Andes of South America, Brush and Guillet (1985:24) assume that "selection [of crop types] matches agronomic qualities to microenvironmental conditions." Their assumption that specialized environmental niches are occupied by a specific suite of diverse crop types seems unwarranted, however, in light of "new ecology" findings. Niche specialization is not somehow immutable and given; its properties must be demonstrated rather than assumed.

Recent research in human geography has spawned a reinterpretation of the role of the environment in the distribution of agricultural



biodiversity (Zimmerer 1991a; 1991b; for earlier work on this topic in human geography, see Chang 1977; Clawson 1985; Gade 1975; C.O. Sauer 1952). These studies of the unrivalled diversity of potatoes in the Andes mountains address the extent to which distribution of crop diversity reflects ecological specialization to environments. A test of cultural ecology's hypothesis that distribution patterns of Andean potatoes are primarily or exclusively an adaptive function of elevation-related microenvironments (Brush and Guillet 1985:24; Webster 1973:119) reveals a paucity of finely-tuned adaptations to microenvironments (Zimmerer 1991a; 1991b). More critical in explaining the distribution of agricultural biodiversity is the role of dispersal ("migration" to biogeographers and ecologists). These findings, oddly enough, are consistent with the newer perspectives of the "new ecology" (Botkin 1990; Forman and Godron 1986) and the older ones of a more traditional biogeography (J.D. Sauer 1988).

### **Integrating "New Ecology" and Human Geography: Difficulties and Examples**

Integrating the "new ecology's" interpretation of nature into human geography will not be easy. Among the many obstacles to integration, two are particularly notable for their potential to mitigate contributions on environmental conservation. First, the "new ecology" offers modest predictions by comparison to the general, or "global," predictions of systems ecology. The latter's predictive capacity is based on the assumption that environments tend toward equilibrium and that the steady-state (the equilibrium state or states) provides a benchmark for assessing human impacts (Redclift 1987:18). The predictive capacity of the "new ecology" is weaker, by contrast, owing to the intervention of natural disturbances and non-equilibrium conditions in many environments. All of which makes the establishment of guidelines for environmental conservation more problematic. A second obstacle to integration is that the "new ecology" might provide an unintended apologia for environmental degradation (Worster 1990). To the extent that environmental disturbances are com-

monplace, human-induced degradation might be justified in the name of science by interests opposed to environmental conservation.

These difficulties are cause for concern, but they do not in themselves vitiate the integration of the "new ecology's" perspectives on biophysical environments and human geography. My contention gains point when we take a closer look at successful applications of the "new ecology" in research fields descended, in part, from geography.

The perception that the predictive capacity of the "new ecology" is less than could be attained under the assumption of homeostatic environmental systems (McIntosh 1987) is nullified by a series of qualifications. First, many of the ecological processes highlighted in "new ecology" are partially determinate (rather than stochastic) and thus prediction remains feasible. Even certain chaotic processes can be predicted within ranges of certainty (Hastings and Powell 1992; Malanson et al. 1990). Second, many of the major processes of environmental change that are important to ecological human geography (soil erosion, for example) are composed primarily of determinate processes. And third, the ecological predictions of the "new ecology," based as they are on actual environmental conditions, are more realistic than the high degree of certainty proclaimed by equilibrium-based ecological models. The hubris of unwarranted certainty, it turns out, has been responsible for numerous cases of environmental mismanagement (Botkin 1990:15–25, 75–89; Botkin and Keller 1982:73–79).

Concern that the concepts of the "new ecology" will subvert environmental conservation is predicated on the fact that ecology, like other forms of knowledge, is socially constructed (Haraway 1988; Harding 1987; 1991; Kloppenborg 1991; Merchant 1980; Worster 1977; 1990). Because ecology occupies a unique and privileged place in the scientific interpretation of biophysical environments, it might empower certain social interests and groups at the expense of others and of nature as well. These critics of scientific knowledge caution that interpretations of nature arising from the "new ecology" could justify environmental deterioration by humans generally and by certain social interests in particular. A scientific ecology that presupposes the absence of long-term equilibria and the prevalence of disturbances, it might be suspected, may also be responding

to bureaucratic realities which often require arguments that are scientifically credible. Whether the ascent of the "new ecology" during the 1970s and the 1980s has legitimated human-induced environmental deterioration has not yet been examined. But in any event, the dangers of the legitimation of environmental damage wrought by humans will have less to do with the ideas of the "new ecology" and more to do with their manipulation in planning and policy-making processes.

On this point, consider the generally positive experiences of landscape ecology and agroecology (Altieri 1983; 1987; Altieri and Hecht 1990; Forman and Godron 1986; Gliessman 1990a; M.G. Turner 1989; Naveh and Lieberman 1984). Landscape ecology and agroecology have integrated "new ecology" concepts while continuing to offer useful contributions on environmental conservation. Neither has justified environmental damage by humans. Although both fields depended at one time on systems ecology frameworks, each has rejected systems ecology assumptions of temporal and spatial homogeneity in favor of "new ecology" perspectives. Integration has not provided a scientific rationale for environmental mismanagement, but it has ensured the utility and viability of landscape ecology and agroecology.

Recent inquiry in landscape ecology emphasizes three main themes: landscape structure, landscape function, and landscape change (Forman and Godron 1986; M.G. Turner 1989; Naveh and Lieberman 1984). These themes trace their origins to landscape studies in geography (Risser et al. 1984; Troll 1939; 1966; 1988). At a later date, the field superimposed various principles of systems ecology (Naveh and Lieberman 1984:26–65). But since the mid-1980s, studies in landscape ecology have benefitted from the infusion of conceptual rigor, theoretical sophistication, and topical breadth via the "new ecology." Concurrently, landscape ecologists have examined topics such as the nature of ecological disturbance, spatial fragmentation, and biodiversity through the methodological and conceptual inclusion of landscape features in addition to area and isolation (Forman and Godron 1986). With respect to biodiversity, recent research in landscape ecology has elucidated the roles of environmental heterogeneity, landscape pattern, and landscape shape as determinants of the

magnitude and spatial patterning of diversity (Forman 1990; M.G. Turner 1989).

Contrary to the fears of some, the adoption of "new ecology" concepts by landscape ecologists has not resulted in the legitimation of environmental deterioration. In fact, research on topics such as disturbance and spatial fragmentation has been quite explicit about distinguishing their effects in natural and human-modified ecological systems (Forman and Godron 1986; Mooney and Godron 1983; Whitney 1987; for related work in geography, see Baker 1992; Vale 1982; 1988). And these distinctions offer crucial insights for environmental conservation. Many human-induced ecological disturbances, for instance, differ from natural ones in frequency, magnitude, and degree. Comparisons between natural and human disturbances also raise far-reaching research questions for environmental conservation (Botkin 1990:153–167; Forman and Godron 1986:9–10, 117–119; see also Vale 1988). One of these is how human impacts can be brought to resemble natural regimes of disturbance. Another is whether disturbance-related concepts such as ecological resilience and sensitivity can be sufficiently refined to offer useful insights for conservation planning.

Agroecology has also benefitted from an infusion of ideas from the "new ecology." This ecological approach to the study of agriculture (Altieri 1983; 1987; Cox and Atkins 1979; Gliessman 1990b) has longstanding ties with human geography via the study of the farm practices of peasant and indigenous cultivators (Klee 1980; Hecht 1987; B.L. Turner 1989). At one time, however, agroecology drew heavily upon the ecosystem models of systems ecology (Conway 1986; Loucks 1977; Lowrance et al. 1984; E.P. Odum 1984). Indeed, the diversity-stability postulate and the assumption of closed systems were embedded in agroecology until the mid-1980s. Thereafter, however, the conceptual outlook shifted significantly in favor of "new ecology" perspectives. The closed ecosystems assumed by systems ecology were displaced by ecological systems open to external, as well as internal, exchanges of materials, energy, and organisms (Altieri 1987; Gliessman 1990b; Knapp 1987:129–132).<sup>11</sup>

But agroecology's integration of the "new ecology" has not undermined concerns about environmental conservation. Research on eco-

logical structure and functions of intercropping offers a case in point (Altieri and Hecht 1990; Gliessman 1990a; Letourneau 1990; Vandermeer 1988; Vandermeer and Schultz 1990). At first, agroecology *qua* systems ecology deployed the diversity-stability postulate as the ecological *modus operandi* for intercropping (Altieri 1983). Recent work in agroecology, however, demonstrates that the relationship between biodiversity and temporal stability is not invariant. Their relations are possible rather than necessary. Consequently, agroecological research has taken a new turn as it investigates the parameters that ensure (or at least promote) biodiversity and stability—parameters such as the time-based dynamics of organismal populations (Gliessman 1990b; Letourneau 1990; Vandermeer and Schultz 1990).

The examples of landscape ecology and agroecology suggest that the concepts of the "new ecology" can be effectively integrated into human geography without imperiling either scientific usefulness or conservationist objectives. Indeed, the prospects for rapprochement may be even better in human geography since our sub-fields dealing with human-environment relations already incorporate perspectives that parallel the "new ecology."

### **"New Ecology" and Human Geography: Similar Orientations**

In pointing out the resemblances between human geography's analysis of human-environment relations and the "new ecology," I do not wish to imply an exclusively ecological interpretation of human behavior or society. Indeed, one of the virtues of recent work in human geography is the use of different epistemologies for the examination of human behavior and social organization (related to human-environment relations), on the one hand, and biophysical environments, on the other (Blaikie 1985; Blaikie and Brookfield 1987; B.L. Turner 1990).<sup>12</sup> While the blend of these epistemologies is not always smooth, they share nonetheless Toffler's opinion that "science and humanity [are] back in a world in which *ceteris parabis* is a myth" (Toffler 1984:xv). In a world in which variation matters greatly, ecological human geography and the "new ecology"

share three environmental orientations—the importance of time (history), spatial scale, and subjectivity.

In the case of temporality, historical (non-cyclical) time has acquired renewed importance in the geography of human-environment relations. Disturbances once dismissed as mere shocks for an equilibrating ecosystem are now imbued with the potential of irreversibility. Such an orientation is especially useful for analysis of environmental modifications that are molded, as often as not, by contingent rather than deterministic circumstances (Blaikie and Brookfield 1987; B.L. Turner 1990). Even current environmental modifications are contingent on precedent historical processes. And when assessments of environmental modification and conservation omit historical inquiry, they run the risk of oversights as serious as the myopic accounts of deforestation in the mountains of Nepal (Blaikie and Brookfield 1987; Ives and Messerli 1989) or of American environmental history (Cronon 1983; Worster 1988:293). In these cases, the history of nature's complexity clearly matters insofar as it embraces political economy and human attitudes, values, and beliefs.

Refinements in the concept of spatial scale have also helped to clarify human-environment relations. Recent research on multiple spatial scales (Butzer 1990; Meyer et al. 1992; Kates 1987; Turner et al. 1990) is redressing the critique that ecological human geography focuses too narrowly on the microscale decisions of local inhabitants at the expense of their social, economic, and political relations within broader contexts. Recent studies have highlighted a medley of spatial scales involving communities, regions, states, and world systems (Blaikie 1985; Kates 1987; Ives and Messerli 1989; Lewis 1992; Meyer et al. 1992; Schmink and Wood 1987; Sheridan 1988; Watts 1983a). The attention to multiple scales is now *de rigueur*; it is more explicit, more expected, and more expounded than heretofore. Ecological human geography thus interrogates the interconnections between local and extra-local spatial scales entrained in the processes of environmental modification.

And lastly, human geographers are applying concepts of subjectivity to human beings as well as to non-human organisms. Their meanings differ, however. In the "new ecology," subjectivity refers to the unequal capacities of or-

ganisms as they respond to environmental heterogeneity. In human geography, subjectivity refers to the self-conscious awareness of humans. These differences notwithstanding, the subjectivities of the "new ecology" and human geography appear to be broadly similar. Indeed, when human geographers declare that individuals and social groups are characterized by different capacities to respond to environmental modification (Bryant 1992), we are on the edges of analogue. These differential capacities often arise, of course, from unequal access to material resources and from divergent attitudes, values, and beliefs (ideology) (Blaikie 1985; Blaikie and Brookfield 1987; Bryant 1992; Watts 1983a).

### **Conclusion: Implications and Future Research Involving the Integration of "New Ecology" into Human Geography**

The "new ecology" is rife with implications for human geography and other disciplines in the social sciences and humanities that are concerned with biophysical environments. Human geography seems especially well-positioned for probing the multi-faceted ideas of the "new ecology." Particularly promising is the application of the "new ecology" to the burgeoning study of environmental conservation and economic development (sometimes referred to as "conservation-with-development") (Adams 1990; Bryant 1992; Conway and Barbier 1990; Emel and Peet 1989; Friedmann 1992:119–124; Redclift 1987; Schmink and Wood 1987; Sheridan 1988; Stocking and Perkin 1992). Ecological frameworks are prerequisite for understanding the role of resources in "conservation-with-development" study (Anderson 1981; Botkin and Keller 1982; Holling 1973; 1978; Park 1980; B.L. Turner 1990), and the "new ecology" can help in furnishing this framework as it advances human geography's explanatory capacity, its scientific credibility, and its policy contributions to "conservation-with-development."

Two of the central themes for "conservation-with-development" converge in the "new ecology." The first theme deals with the provision of management guidelines for environmental conservation. "New ecology" findings offer fresh insights on the importance of het-

erogeneous conditions in time and space for environmental management. Change, risk, and uncertainty emerge as major considerations for effective environmental management (Botkin 1990; Forman 1990). The effective management of change must incorporate regimes of natural disturbance and compare these with the effects of human activities. The effective management of risk involves assessments of the relative riskiness of various conservation options and of the advantages of flexibility whereby action plans may be altered in order to minimize possible environmental degradation. Managing for uncertainty includes evaluating the limits within which natural processes and human interventions are likely to produce a certain result (as opposed to asserting the certainty of single values and ironclad outcomes).

These conservation goals (management for change, risk, and uncertainty), albeit inspired by the "new ecology," hold special promise for human geographers interested in economic development and social change and, more particularly, in the motif of economic development based on the active participation of local people (on "local participatory development" see Bebbington 1991; Carney 1991; Friedmann 1992; Herlihy 1989; Nietschmann 1991; Porter 1979; Richards 1985; Thrupp 1989; Zimmerer 1994). Having recognized the limitations of top-down development models, human geographers are examining anew the socioeconomic empowerment of local people through democratic participation, decentralized decision-making, and economic growth based on local resources, skills, and knowledge. And when local participatory development is united with environmental conservation under the management guidelines of the "new ecology," local inhabitants are, in many cases, most able to identify the spatial and temporal heterogeneities of their biophysical environments and to help plan accordingly.

The convergence of local participatory development and the "new ecology" can prove fruitful for research in human geography on environmental conservation. By comparing environmental modifications of local land use with natural disturbances, human geographers can gauge the ecological impacts of resource management (that is, managing for change). By studying the technical and social knowledge of local inhabitants, human geographers can aid in the delimitation, implementation, and en-

forcement of protected areas (that is, managing for risk). And by conducting studies of livestock carrying capacity that make use of local inhabitants' recognition of environmental variation, human geographers may aid in the estimation of the range of likely values (that is, managing for uncertainty). Integrating the perspectives of the "new ecology," in sum, will advance human geography's capacity for contributions to transdisciplinary understandings of environmental conservation and its relation to economic development.

## Acknowledgments

The Graduate School of the University of Wisconsin—Madison supported library research during 1990 and 1991. I am grateful for the comments of Thomas Bassett, James Burt, William M. Denevan, Nicholas Entrikin, Sally Horn, Gregory Knapp, Martin Lewis, Robert Sack, Melissa Savage, Yi-Fu Tuan, B.L. Turner II, Thomas Vale, and Bruce Winterhalder.

## Notes

1. The implications of "new ecology" are significant for various disciplines in the social sciences and humanities. Implications for the humanities will be explored by leading ecological thinkers under the direction of visiting environmental historian William Cronon in a special faculty seminar to be held in 1994 at the University of California-Irvine.
2. A disturbance is defined as "any relatively discrete event in time that disrupts ecosystem, community, or population structure and changes resources, substrate availability, or the physical environment" (Pickett and White 1985:7).
3. C.O. Sauer and biogeographer Watt (1947) were notable opponents of Clements's overly deterministic concept of ecological succession. For Sauer, history was central to understanding nature and the modification of it. In writing on "Man in the Ecology of Tropical America," for instance, he cautioned that even in the "natural" landscape the distribution of organisms could not be explained solely as a consequence of succession and vegetation climax; scholars also needed to account for the historically-contingent processes of disturbance and dispersal (C.O. Sauer 1967).
4. The "new ecology" suggests that stability is absent in certain environments (Baker 1989), a finding at odds with the assumption of single or multiple stable states. The assumption of multiple stable states in human geography (Kates 1987:530; see also Holling 1973) thus needs to be reexamined. This realization has been accompanied by a notable change in ecological terminology. Recent work in biological ecology and biogeography thus seeks to describe and define nonequilibrium "heterogeneity," both spatial and temporal (Kolasa and Rollo 1991; McIntosh 1991).
5. Treatments of a few topics in ecological human geography, such as carrying capacity, indicate a shift toward a nonequilibrium interpretation of biophysical environments (for example, Simmons 1993:110; cf. Simmons 1981:24–25). But the sources, significance, and implications of this shift in the interpretation of nature have not yet been examined.
6. Although many environment-development studies strive to examine human-environment *inner*-actions (Watts 1983a, emphasis in original), this concern does not obviate the distinction between the two types of relations identified here. At its core, this distinction is epistemological; human-environment relations are subject to one (or more) epistemological vantage point and the nature of biophysical environments to another. By highlighting this distinction, I do disagree with the need for a single framework of inneractions. The distinction is nonetheless necessary in order to clarify the role for human geography of ecological thought in general and the "new ecology" in particular.
7. Some systems ecology research in human geography also used the adaptation concept to explain relations among humans, such as reciprocal arrangements for the exchange of labor and food-gifts (Nietschmann 1973).
8. It is worth noting that such criticisms reflect a wide array of vantage points, including non-Marxist and Marxist ones. My intent is not to offer a review of these critiques but rather to delimit the contributions of "new ecology" in understanding the nature of biophysical environments.
9. Studies of the carrying capacity of human populations anticipated several of the "new ecology's" criticisms of animal carrying capacity. These studies pointed out that spatial and temporal heterogeneities in the food-procurement systems of human populations limited the usefulness of carrying capacity (Brush 1977; Brush and Turner 1987; Denevan 1987; Street 1969).
10. The studies of Knapp (1991:11) and B.L. Turner (1983:111) assume that crop diversity is adapted to specialized environmental niches, and thus they overlook the implications of "new ecology" perspectives on biophysical environments. Conversely, these two scholars explicitly avoid the assumption of adaptation in human-environment relations and Knapp (1991), paradoxically, goes on to show the lack of niche specialization in crop diversity.
11. In human geography, assumptions of closed ecological systems in local areas and their vulnerability to perturbation (Grossman 1981:222) have not been fully critiqued by a "new ecology" perspective. "New ecology" holds not only that such systems are open (a critique made by Knapp 1987:129–132), but also that exchanges may not be perturbing.
12. This divergence is critical because ecological concepts have long been used to consider both human-environment relations as well as the nature of biophysical environments (Worster 1977;

1988). But the prospect of unity promised in ecology has waned as ecology's attempts to embrace human-environment relations were rebuffed by widespread evidence that nonfunctionalist human behavior and social organization shape environmental modification in important ways (Zimmerer nd.). The nature of biophysical environments, by contrast, has remained solidly within ecology's explanatory scope.

## References

- Abel, N. O. J., and Blaikie, P. M. 1990. Land Degradation, Stocking Rates, and Conservation Policies in the Communal Rangeland of Botswana and Zimbabwe. *Pastoral Development Network*. Overseas Development Institute, Paper 29a.
- Adams, W. M. 1990. *Green Development: Environment and Sustainability in the Third World*. London: Routledge.
- Allen, T. F. H., and Hoekstra, T. W. 1991. Role of Heterogeneity in Scaling of Ecological Systems Under Analysis. In *Ecological Heterogeneity*, ed. T. F. H. Allen and T. W. Hoekstra, pp. 47–68. Berlin: Springer-Verlag.
- Allen, T. F. H., and Starr, T. B. 1982. *Hierarchy: Perspectives for Ecological Complexity*. Chicago: University of Chicago Press.
- Altieri, M. A. 1983. *Agroecology: The Scientific Basis of Alternative Agriculture*. Berkeley, California: Division of Biological Control.
- . 1987. *Agroecology: The Scientific Basis of Alternative Agriculture*. Boulder, Colorado: Westview Press.
- Altieri, M. A., and Hecht, S. B., eds. 1990. *Agroecology and Small-Farm Development*. Boca Raton, Florida: CRC Press.
- Anderson, J. M. 1981. *Ecology for Environmental Sciences*. New York: J. Wiley.
- Baker, W. L. 1989. Landscape Ecology and Nature Reserve Design in the Boundary Waters Canoe Area, Minnesota. *Ecology* 70(1):23–35.
- . 1992. Effects of Settlement and Fire Suppression on Landscape Structure. *Ecology* 73(5):1879–1887.
- Barrows, H. H. 1923. Geography as Human Ecology. *Annals of the Association of American Geographers* 13(1):1–14.
- Batisse, M. 1982. The Biosphere Reserve: A Tool for Environmental Conservation and Management. *Environmental Conservation* 9(2):101–111.
- Beatty, S. W. 1991. Colonization Dynamics in a Mosaic Landscape: The Buried Seed Pool. *Journal of Biogeography* 18(5):553–563.
- Bebbington, A. 1991. Indigenous Agricultural Knowledge Systems, Human Interests, and Critical Analysis: Reflections on Farmer Organization in Ecuador. *Agriculture and Human Values* 8(1–2):14–24.
- Bennett, J. W. 1976. *The Ecological Transition: Cultural Anthropology and Human Adaptation*. New York: Pergamon.
- Bernard, F. E. 1985. Planning and Environmental Risk in Kenyan Drylands. *Geographical Review* 75(1):58–70.
- Bernard, F. E., Campbell, D. J., and Thom, D. J. 1989. Carrying Capacity of the Eastern Ecological Gradient of Kenya. *National Geographic Research* 5(4):399–421.
- Blaikie, P. 1985. *The Political Economy of Soil Erosion in Developing Countries*. London: Longman.
- Blaikie, P., and Brookfield, H., eds. 1987. *Land Degradation and Society*. London: Methuen.
- Bormann, F. H., and Likens, G. E. 1981. *Pattern and Process in a Forested Ecosystem*. Berlin: Springer-Verlag.
- Botkin, D. B. 1990. *Discordant Harmonies: A New Ecology for the Twenty-first Century*. New York: Oxford University Press.
- Botkin, D. B., and Keller, E. 1982. *Environmental Studies: The Earth as a Living Planet*. Columbus: Merrill.
- Brookfield, H. C. 1964. Questions on the Human Frontiers of Geography. *Economic Geography* 40(4):283–303.
- Brush, S. B. 1977. The Concept of Carrying Capacity for Systems of Shifting Cultivation. *American Anthropologist* 77(1):799–811.
- Brush, S. B., and Guillet, D. W. 1985. Small-Scale Agro-Pastoral Production in the Central Andes. *Mountain Research and Development* 5(1):19–30.
- Brush, S. B., and Turner, B. L., II. 1987. The Nature of Farming Systems and Views of their Change. In *Comparative Farming Systems*, ed. B. L. Turner, II and S. B. Brush, pp. 11–48. New York: Guilford.
- Bryant, R. L. 1992. Political Ecology: An Emerging Research Agenda in Third-World Studies. *Political Geography* 11(1):12–36.
- Burton, I., and Hewitt, K. 1974. Ecological Dimensions of Environmental Hazards. In *Human Ecology*, ed. F. Sargent, II, pp. 253–284. New York: American Elsevier.
- Burton, I., Kates, R. W., and White, G. F. 1968. The Human Ecology of Extreme Geophysical Events. Working Paper No. 1, Department of Geography. Toronto: University of Toronto.
- , ———, and ———. 1978. *The Environment as Hazard*. New York: Oxford University Press.
- Butzer, K. W. 1989. Cultural Ecology. In *Geography in America*, ed. G. L. Gaile and C. J. Willmott, pp. 192–208. Columbus: Merrill.
- . 1990. The Realm of Cultural-Human Ecology: Adaptation and Change in Historical Perspective. In *The Earth as Transformed by Human Action*, ed. B. L. Turner, II, W. C. Clark, R. W. Kates, J. F. Richards, J. T. Mathews, and W. B.

- Meyer, pp. 685–702. New York: Cambridge University Press.
- Campbell, D. J. 1986. The Prospect for Desertification in Kajaido District, Kenya. *Geographical Journal* 152(1):44–55.
- Carney, J. 1991. Indigenous Soil and Water Management in Senegambian Rice Farming Systems. *Agriculture and Human Values* 8(1–2):37–48.
- Chang, J. 1977. Tropical Agriculture: Crop Diversity and Crop Yields. *Economic Geography* 53:241.
- Chapin, M. 1992. The Coexistence of Indigenous Peoples and the Natural Environment in Central America. *Research and Exploration* 8(2), Map Supplement.
- Christensen, Norman L. 1989. Landscape History and Ecological Change. *Journal of Forest History* 33:116–125.
- Clawson, D. L. 1985. Harvest Security and Intraspecific Diversity in Traditional Food Agriculture. *Economic Botany* 39(1):56–67.
- Clay, J. 1985. Introduction—Parks and People. *Cultural Survival Quarterly* 9(1):2–5.
- Clements, F. C. 1935. *Plant Succession: An Analysis of the Development of Vegetation*. Carnegie Institute of Washington Publication 242. Washington, D.C.: Carnegie Institute of Washington.
- Colwell, R. K. 1984. What's New? Community Ecology Discovers Biology. In *A New Ecology: Novel Approaches to Interactive Systems*, ed. P.W. Price, C. N. Slobodchikoff, and W. S. Gaud, pp. 387–396. New York: Wiley.
- . 1985. The Evolution of Ecology. *American Zoologist* 25:771–777.
- . 1992. Making Sense of Ecological Complexity: A Personal and Conceptual Retrospective. *Biotrópica* 24(2b):226–232.
- Connell, J. H. 1978. Diversity in Tropical Rain Forests and Coral Reefs. *Science* 199:1302–1309.
- Conway, G. R. 1986. *Agroecosystem Analysis for Research and Development*. Bangkok: Winrock International Institute.
- Conway, G. R., and Barbier, E. B. 1990. *After the Green Revolution: Sustainable Agriculture and Development*. London: Earthscan.
- Cox, G. W., and Atkins, M. D. 1979. *Agricultural Ecology*. San Francisco: W. H. Freeman.
- Cronon, W. 1983. *Changes in the Land: Indians, Colonists, and the Ecology of New England*. New York: Hill and Wang.
- De Leeuw, P. N., and Tothill, J. C. 1990. The Concept of Rangeland Carrying Capacity in Sub-Saharan Africa—Myth or Reality. *Pastoral Development Network*. Overseas Development Institute, Paper 29b.
- Denevan, W. M. 1983. Adaptation, Variation, and Cultural Geography. *Professional Geographer* 35:399–407.
- . 1987. Review of *Human Carrying Capacity of the Brazilian Rainforest*. *Geographical Review* 77(4):479–481.
- Diamond, J. M. 1975. The Island Dilemma: Lessons of Modern Biogeographic Studies for the Design of Natural Reserves. *Biological Conservation* 7:129–146.
- Ellen, R. 1982. *Environment, Subsistence, and System: The Ecology of Small-Scale Social Formations*. Cambridge: Cambridge University Press.
- . 1988. Persistence and Change in the Relationship Between Anthropology and Human Geography. *Progress in Human Geography* 12(2):229–262.
- Emel, J., and Peet, R. 1989. Resource Management and Natural Hazards. In *New Models in Geography: The Political Economy Perspective*, Vol. 1, ed. R. Peet and N. Thrift, pp. 49–76. London: Unwin Hyman.
- Entikin, J. N. 1980. Robert Park's Human Ecology and Human Geography. *Annals of the Association of American Geographers* 70(1):43–58.
- Forman, R. T. T. 1990. Ecologically Sustainable Landscapes: The Role of Spatial Configuration. In *Changing Landscapes: An Ecological Perspective*, ed. I. S. Zonneveld and R. T. T. Forman, pp. 261–278. Berlin: Springer-Verlag.
- Forman, R. T. T., and Godron, M. 1986. *Landscape Ecology*. New York: Wiley.
- Friedman, J. 1974. Marxism, Structuralism and Vulgar Materialism. *Man* 9:444–469.
- Friedmann, J. 1992. *Empowerment: The Politics of Alternative Development*. Oxford: Blackwell.
- Futuyma, D. J. 1979. *Evolutionary Biology*. Sunderland, Massachusetts: Sinauer.
- Gade, D. W. 1975. *Plants, Man, and the Land in the Vilcanota Valley of Peru*. The Hague: D.W. Junk.
- Girof, P. O., and Nietschmann, B. Q. 1992. The Geopolitics and Ecopolitics of the Río San Juan. *Research and Exploration* 8(1):52–63.
- Gliessman, S. R., ed. 1990a. *Agroecology: Researching the Ecological Basis for Sustainable Agriculture*. Berlin: Springer-Verlag.
- . 1990b. Agroecology: Researching the Ecological Basis for Sustainable Agriculture. In *Agroecology: Researching the Ecological Basis for Sustainable Agriculture*, ed. S. R. Gliessman, pp. 3–10. Berlin: Springer-Verlag.
- Goodland, R. 1975. History of "Ecology." *Science* 188:313.
- Goudie, A. 1981. *The Human Impact: Man's Role in Environmental Change*. Oxford: Basil Blackwell.
- Grossman, L. 1977. Man-Environment Relationships in Anthropology and Geography. *Annals of the Association of American Geographers* 67(1):126–144.
- . 1981. The Cultural Ecology of Economic Development. *Annals of the Association of American Geographers* 71(2):220–236.
- . 1984. *Peasants, Subsistence Ecology, and*

- Development in the Highlands of Papua New Guinea*. Princeton, New Jersey: Princeton University Press.
- Hames, R. B., and Vickers, W. T. 1983. Introduction. In *Adaptive Responses of Native Amazonians*, ed. R. B. Hames and W. T. Vickers, pp. 1–28. New York: Academic.
- Haraway, D. 1988. The Science Question in Feminism and the Privilege of Partial Perspective. *Feminist Studies* 14(3):575–599.
- Harding, S. 1987. *The Science Question in Feminism*. Ithaca: Cornell University.
- . 1991. *Whose Science? Whose Knowledge? Thinking from Women's Lives*. Ithaca: Cornell University.
- Harris, D. R. 1971. The Ecology of Swidden Cultivation in the Upper Orinoco Rain Forest, Venezuela. *Geographical Review* 61:475–495.
- Hastings, A., and Powell, T. 1992. Chaos in a Three-Species Food Chain. *Ecology* 72(3):896–903.
- Hecht, S. B. 1987. The Evolution of Agroecological Thought. In *Agroecology: The Scientific Basis of Alternative Agriculture*, ed. M. A. Altieri, pp. 1–20. Boulder, Colorado: Westview Press.
- Hecht, S., and Cockburn, A. 1990. *The Fate of the Forest: Developers, Destroyers, and Defenders of the Amazon*. New York: Harper Collins.
- Herlihy, P. H. 1989. Panama's Quiet Revolution: Comarca Homelands and Indian Rights. *Cultural Survival Quarterly* 13(3):17–24.
- . 1990. "Wildlands" Conservation in Central America During the 1980s: A Geographical Perspective. *Conference of Latin Americanist Geographers* 17/18:31–43.
- Hewitt, K. 1983. The Idea of Calamity in a Technocratic Age. In *Interpretations of Calamity*, ed. K. Hewitt, pp. 3–32. Boston: Allen and Unwin.
- Holling, C. S. 1973. Resilience and Stability of Ecological Systems. *Annual Review of Ecology and Systematics* 4:1–23.
- . 1978. *Adaptive Environmental Assessment and Management*. New York: John Wiley and Sons.
- Ives, Jack D., and Messerli, B. 1989. *The Himalayan Dilemma: Reconciling Development and Conservation*. London: Routledge.
- Kates, R. 1971. Natural Hazard in Human Ecological Perspective: Hypotheses and Models. *Economic Geography* 47(3):438–451.
- . 1987. The Human Environment: The Road not Taken, the Road Still Beckoning. *Annals of the Association of American Geographers* 77(4):525–534.
- Klee, G., ed. 1980. *World Systems of Traditional Resource Management*. New York: Halsted Press.
- Kloppenburg, J., Jr. 1991. Social Theory and the De/reconstruction of Agricultural Science: Local Knowledge for an Alternative Agriculture. *Rural Sociology* 56(4):519–548.
- Knapp, G. 1981. The Full Extent of the Field: A Commentary on the 'New Cultural Geography' in Latin America. *Proceedings of the Conference of Latin Americanist Geographers* 8:217–224.
- . 1987. Introduction. In *Human Impact on Mountains*, ed. N. J. R. Allan, G. W. Knapp, and C. Stadel, pp. 129–132. Totowa, New Jersey: Rowman and Littlefield.
- . 1991. *Andean Ecology: Adaptive Dynamics in Ecuador*. Boulder, Colorado: Westview Press.
- Kolasa, J., and Pickett, S. T. A., eds. 1991. *Ecological Heterogeneity*. Ecological Studies 86. Berlin: Springer-Verlag.
- Kolasa, J., and Rollo, C. D. 1991. Introduction: The Heterogeneity of Heterogeneity: A Glossary. In *Ecological Heterogeneity*, ed. J. Kolasa and S. T. A. Pickett, pp. 1–23. Ecological Studies 86. Berlin: Springer-Verlag.
- Laszlo, E. 1972. The Systems View of Nature. In *The Systems View of the World*, ed. E. Laszlo, pp. 19–46. New York: George Braziller.
- Leighly, J. 1987. Ecology as Metaphor: Carl Sauer and Human Ecology. *Professional Geographer* 39(4):405–412.
- Letourneau, D. K. 1990. Two Examples of Natural Enemy Augmentation: A Consequence of Crop Diversification. In *Agroecology: Researching the Ecological Basis for Sustainable Agriculture*, ed. S. R. Gliessman, pp. 11–29. Berlin: Springer-Verlag.
- Levi-Strauss, D. and Eribon, D. 1991. *Conversations with Claude Levi-Strauss*. Chicago: University of Chicago Press.
- Lewis, M. W. 1992. *Wagering the Land: Ritual, Capital, and Environmental Degradation in the Cordillera of Northern Luzon, 1900–1986*. Berkeley: University of California.
- Loucks, O. L. 1970. Evolution of Diversity, Efficiency, and Community Stability. *American Zoologist* 10:17–25.
- . 1977. Emergence of Research on Agro-Ecosystems. *Annual Review of Ecology and Systematics* 8:173–192.
- Love, T. 1983. To What are Humans Adapting? *Reviews in Anthropology* 10(1):1–8.
- Lowrance, R., Stinner, B. R., and House, G. J. 1984. *Agricultural Ecosystems: Unifying Concepts*. New York: Wiley.
- Malanson, G. P., Butler, D. R., and Walsh, S. J. 1990. Chaos Theory in Physical Geography. *Physical Geography* 11(4):293–304.
- Margalef, R. 1968. *Perspectives in Ecological Theory*. Chicago: University of Chicago Press.
- Martin, G. J. 1987. The Ecologic Tradition in American Geography 1895–1925. *Canadian Geographer* 31:74–77.
- May, R. M. 1984. An Overview: Real and Apparent Patterns in Community Structure. In *Ecologi-*



- cal Communities: Conceptual Issues and the Evidence*, ed. D. R. Strong, Jr., D. Simberloff, L. G. Abele, and A. B. Thistle, pp. 3–16. Princeton, New Jersey: Princeton University Press.
- May, R. M., and Seger, J. 1986. Ideas in Ecology. *American Scientist* 74:257–267.
- McIntosh, R. P. 1987. Pluralism in Ecology. *Annual Review of Ecology and Systematics* 18:321–341.
- . 1991. Concept and Terminology of Homogeneity and Heterogeneity in Ecology. In *Ecological Heterogeneity*, ed. J. Kolasa and S. T. A. Pickett, pp. 24–46. Ecological Studies 86. Berlin: Springer-Verlag.
- Merchant, C. 1980. *The Death of Nature: Women, Ecology, and the Scientific Revolution*. San Francisco: Harper and Row.
- Meyer, W. B., Gregory, D., Turner, B. L., II, and McDowell, P. F. 1992. The Local-Global Continuum. In *Geography's Inner Worlds*, ed. R. F. Abler, M. G. Marcus, and J. M. Olson, pp. 255–279. New Brunswick, New Jersey: Rutgers University Press.
- Miller, R. E. 1978. Applying Island Biogeographic Theory to an East African Reserve. *Environmental Conservation* 5(3):191–195.
- Mooney, H. A., and Godron, M., eds. 1983. *Disturbance and Ecosystems: Components of Response*. Ecological Studies 44. New York: Springer-Verlag.
- Naveh, Z., and Lieberman, A. S. 1984. *Landscape Ecology: Theory and Applications*. New York: Springer-Verlag.
- Nietschmann, B. 1973. *Between Land and Water: The Subsistence Ecology of the Miskito Indians, Eastern Nicaragua*. New York: Seminar.
- . 1991. Conservation by Self-Determination. *National Geographic Research and Exploration* 7(3):372–373.
- Odum, E. P. 1969. The Strategy of Ecosystem Development. *Science* 164:262–270.
- . 1971. *Fundamentals of Ecology*. Third Edition. Philadelphia: W.B. Saunders.
- . 1984. Properties of Agroecosystems. In *Agricultural Ecosystems: Unifying Concepts*, ed. R. Lowrance, B. R. Stinner, and G. J. House, pp. 5–12. New York: Wiley.
- Odum, H. 1983. *Systems Ecology*. New York: Wiley.
- Orlove, B. S. 1980. Ecological Anthropology. *Annual Review of Anthropology* 9:235–273.
- Park, C. 1980. *Ecology and Environmental Management: A Geographical Perspective*. Boulder, Colorado: Westview Press.
- Parsons, J. J. 1971. Ecological Problems and Approaches in Latin American Geography. In *Geographic Research on Latin America, Benchmark 1970*, ed. B. Lentek, R. L. Carmin, and T. L. Martinson, pp. 13–32. Muncie, Indiana: Ball State University.
- . 1981. The Ecological Dimension—Ten Years Later. In *Geographic Research on Latin America, Benchmark 1980*, ed. T. L. Martinson and G. S. Elbow, pp. 22–33. Muncie, Indiana: Ball State University.
- Pickett, S. T. A., and White, P. S., eds. 1985. *The Ecology of Natural Disturbance and Patch Dynamics*. New York: Academic.
- Pickett, S. T. A., Kolasa, J., Armesto, J. J., and Collins, S. L. 1989. The Ecological Concept of Disturbance and its Expression at Various Hierarchical Levels. *Oikos* 54:129–136.
- Pimm, S. L. 1984. The Complexity and Stability of Ecosystems. *Nature* 307(26):321–326.
- Porter, P. W. 1978. Geography as Human Ecology. *American Behavioral Scientist* 22(1):15–39.
- . 1979. *Food and Development in the Semi-Arid Zone of East Africa*. Foreign and Comparative Studies/African Series XXXII. Syracuse, New York: Syracuse University.
- Rappaport, R. A. 1968. *Pigs for the Ancestors: Ritual in the Ecology of a New Guinea People*. New Haven: Yale University Press.
- Redclift, M. 1987. *Sustainable Development: Exploring the Contradictions*. London: Methuen.
- Remmert, H., ed. 1991. *The Mosaic-Cycle Concept of Ecosystems*. Ecological Studies 85. New York: Springer-Verlag.
- Richards, P. 1985. *Indigenous Agricultural Revolution: Ecology and Food Production in West Africa*. London: Unwin Hyman.
- Risser, P. G., Karr, J. R., and Forman, R. T. T. 1984. *Landscape Ecology: Directions and Approaches*. Illinois Natural History Survey Special Publication Number 2. Champaign, Illinois: Illinois Natural History Survey.
- Roosevelt, A. 1980. *Paraná: Prehistoric Maize and Manioc Subsistence Along the Amazon and Orinoco*. New York: Academic.
- Roughgarden, J., May, R. M., and Levin, S. A. eds. 1989. *Perspectives in Ecological Theory*. Princeton, New Jersey: Princeton University Press.
- Sauer, C. O. 1952. *Agricultural Origins and Dispersals*. New York: American Geographical Society.
- . 1956. The Agency of Man on the Earth. In *Man's Role in Changing the Face of the Earth*, Vol. 1, ed. W. L. Thomas, Jr., pp. 49–69. Chicago: University of Chicago Press.
- . 1967[1958]. Man in the Ecology of Tropical America. In *Land and Life*, ed. J. Leighly, pp. 182–193. Berkeley: University of California.
- Sauer, J. D. 1988. *Plant Migration: The Dynamics of Geographic Patterning in Seed Plant Species*. Berkeley: University of California.
- Schaffer, W. M. 1985. Order and Chaos in Ecological Systems. *Ecology* 66(1):93–106.
- Schmink, M., and Wood, C. H. 1987. The "Political

- Ecology" of Amazonia. In *Lands at Risk in the Third World: Local Level Perspectives*, ed. P. D. Little and M. H. Horowitz, pp. 38–57. Boulder, Colorado: Westview Press.
- Scoones, I. 1989. Patch Use by Cattle in Dryland Zimbabwe: Farmer Knowledge and Ecological Theory. *Pastoral Development Network*. Overseas Development Institute, Paper 28b.
- Sheridan, T. E. 1988. *Where the Dove Calls: The Political Ecology of a Peasant Corporate Community in Northwestern Mexico*. Tucson: University of Arizona Press.
- Simmons, I. G. 1981. *The Ecology of Natural Resources*. London: Edward Arnold.
- . 1993. Human Societies and Environmental Change: The Long View. In *The Challenge for Geography: A Changing World: A Changing Discipline*, ed. R.J. Johnston, pp. 100–116. Oxford: Blackwell.
- Smith, E. A. 1984. Anthropology, Evolutionary Ecology, and the Explanatory Limitations of the Ecosystem Concept. In *The Ecosystem Concept in Anthropology*, ed. E. F. Moran, pp. 51–86. Boulder, Colorado: Westview Press.
- Stevens, S. 1993. *Claiming the High Ground: Sherpas, Subsistence, and Environmental Change in the Highest Himalaya*. Berkeley: University of California.
- Stocking, M., and Perkin, S. 1992. Conservation-with-Development: An Application of the Concept in the Usambara Mountains, Tanzania. *Transactions of the Institute of British Geographers* 17:337–349.
- Stoddart, D. R. 1965. Geography and the Ecological Approach: The Ecosystem as a Geographic Principle and Method. *Geography* 53(3):242–251.
- Street, J. M. 1969. An Evaluation of the Concept of Carrying Capacity. *Professional Geographer* 21(2):104–107.
- Tansley, A. G. 1935. The Use and Abuse of Vegetation Concepts and Terms. *Journal of Ecology* 2:194–202.
- Thrupp, L. A. 1989. Legitimizing Local Knowledge: "Scientitized Packages" or Empowerment for Third World People. In *Indigenous Knowledge Systems: Implications for Agriculture and International Development*, ed. D. M. Warren, L. J. Slikkerveer, and S. Oguntunji Titilola. Studies in Technology and Social Change, No. 11. Ames, Iowa: Iowa State University.
- Toffler, A. 1984. Science and Change. Foreword to *Order Out of Chaos: Man's New Dialogue with Nature*, ed. I. Prigogine and I. Stengers, pp. i–xxvi. New York: Bantam Books.
- Troll, C. 1939. Luftbildplan und Oekologische Bodenforschung. *Zeitschrift der Gesellschaft für Erdkunde* (Berlin) 74:241–298.
- . 1966. *Landscape Ecology*. Delft, Netherlands: ITC-UNESCO.
- . 1988. Comparative Geography of High Mountains of the World in the View of Landscape Ecology: A Development of Three and a Half Decades of Research and Organization. In *Human Impact on Mountains*, ed. N. J. R. Allan, G.W. Knapp, and C. Stadel, pp. 36–56. Totowa, New Jersey: Rowman and Littlefield.
- Turner, B. L., II. 1983. *Once Beneath the Forest: Prehistoric Terracing in the Río Bec Region of the Maya Lowlands*. Dellplain Latin American Studies No. 13. Boulder, Colorado: Westview Press.
- . 1989. The Specialist-Synthesis Approach to the Revival of Geography: The Case of Cultural Ecology. *Annals of the Association of American Geographers* 79(1):88–100.
- , ed. 1990. *The Earth as Transformed by Human Action*. New York: Cambridge University.
- Turner, B. L., II, Kasperson, R. E., Meyer, W. B., Dow, K. M., Golding, D., Kasperson, J. X., Mitchell, R. C., and Ratick, S. J. 1990. Two Types of Global Environmental Change: Definitional and Spatial-Scale Issues in their Human Dimensions. *Global Environmental Change* 1:14–22.
- Turner, M. G. 1989. Landscape Ecology: The Effect of Pattern on Process. *Annual Review of Ecology and Systematics* 20:171–197.
- Vale, T. R. 1982. *Plants and People: Vegetation Change in North America*. Washington, D.C.: Association of American Geographers.
- . 1988. Clearcut Logging, Vegetation Dynamics, and Human Wisdom. *Geographical Review* 78(4):375–386.
- Vandermeer, J. H. 1988. *The Ecology of Intercropping*. New York: Cambridge University Press.
- Vandermeer, J., and Schultz, B. 1990. Variability, Stability, and Risk in Intercropping: Some Theoretical Explorations. In *Agroecology: Researching the Ecological Basis for Sustainable Agriculture*, ed. S. R. Gliessman, pp. 205–229. Berlin: Springer-Verlag.
- Veblen, T. T. 1985. Stand Dynamics in Chilean Nothofagus Forests. In *The Ecology of Natural Disturbance and Patch Dynamics*, ed. S. T. A. Pickett and P. S. White, pp. 35–51. New York: Academic.
- Waddell, E. 1975. How the Enga Cope with Frost: Responses to Climatic Perturbations in the Central Highlands of New Guinea. *Human Ecology* 3(4):249–273.
- . 1977. The Hazards of Scientism: A Review Article. *Human Ecology* 5(1):59–76.
- Watt, A. S. 1947. Pattern and Process in the Plant Community. *Journal of Ecology* 35:1–22.
- Watts, M. 1983a. On the Poverty of Theory: Natural Hazards Research in Context. In *Interpretations of Calamity*, ed. K. Hewitt, pp. 231–262. Boston: Allen and Unwin.
- . 1983b. Good Try, Mr. Paul: Populism and Politics of African Land Use. *African Studies Review* 26(2):73–84.

- Webster, S. 1973. Native Pastoralism in the South Andes. *Ethnology* 12(2):115–134.
- White, G. F. 1945. *Human Adjustment to Floods*. Department of Geography Research Paper No. 29. Chicago: University of Chicago.
- , ed. 1974. *Natural Hazards: Local, National, Global*. New York: Oxford University Press.
- White, P. S. 1979. Pattern, Process, and Natural Disturbance in Vegetation. *The Botanical Review* 45(3):229–299.
- Whitney, G. G. 1987. An Ecological History of the Great Lakes Forest of Michigan. *Journal of Ecology* 75:667–684.
- Whittaker, R. H. 1975. *Communities and Ecosystems*. New York: MacMillan.
- Whyte, A. V. T. 1986. From Hazard Perception to Human Ecology. In *Geography, Resources, and Environment*, Volume 2, ed. R. W. Kates and I. Burton, pp. 240–271. Chicago: University of Chicago Press.
- Winterhalder, B. 1980. Environmental Analysis in Human Evolution and Adaptation Research. *Human Ecology* 8(2):135–170.
- Wolf, E. 1972. Ownership and Political Ecology. *Anthropological Quarterly* 45(3):201–205.
- . 1982. *Europe and the People Without History*. Berkeley: University of California.
- Worster, D. 1977. *Nature's Economy: The Roots of Ecology*. San Francisco: Sierra Club.
- , ed. 1988. *The Ends of the Earth: Perspectives on Modern Environmental History*. Cambridge: Cambridge University.
- . 1990. The Ecology of Order and Chaos. *Environmental History Review* 14(1–2):1–18.
- Zimmerer, K. S. 1991a. The Regional Biogeography of Native Potato Cultivars in Highland Peru. *Journal of Biogeography* 18:165–178.
- . 1991b. Managing Diversity in Potato and Maize Fields in the Peruvian Andes. *Journal of Ethnobiology* 11(1):23–49.
- . 1994. Local Soil Knowledge and Development: Some Answers to Basic Questions from Highland Bolivia. *Journal of Soil and Water Conservation* 49(1):29–34.
- . nd. Ecology as Cornerstone and Chimera in Human Geography. Forthcoming in *Conceptual Thinking in Human Geography*, ed. C. Earle and M. Kenzer. London: Rowman & Littlefield.

Submitted 5/92, Revised 12/92, 4/93, 8/93, Accepted 8/93.

Zimmerer, Karl S. 1994. Human Geography and the "New Ecology": The Prospect and Promise of Integration. *Annals of the Association of American Geographers* 84(1):108–125. Abstract.

The "new ecology" underscores the role of nonequilibrium conditions in biophysical environments, a reorientation of biological ecology based in part on biogeography. This paper describes the contributions of the "new ecology" and examines their implications for the analysis of biophysical environments in human geography, the most notable of which is a reformulation of certain key ecological postulates (generalized carrying capacity, area-biodiversity postulate, biodiversity-stability postulate). The irony of these reformulations is that our advanced understandings of biophysical environments come at the expense of the perceived certainty of prediction and possible justification for human-induced environmental degradation. These difficulties are not insuperable, however, as is readily demonstrated by the applications of the "new ecology" in landscape ecology and agroecology. Their example may prove instructive as geographers integrate the "new ecology's" perspectives on biophysical environments and interpret the relations between environmental conservation and economic development. **Key Words:** ecology, environmental thought, philosophy of human geography, human-nature theory, cultural ecology.