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Even Conservation Rules Are Made to Be Broken: Implications for Biodiversity

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ABSTRACT / Despite efforts to enclose and control conservation zones around the world, direct human impacts in conservation areas continue, often resulting from clandestine violations of conservation rules through outright poaching, strategic agricultural encroachment, or noncompliance. Nevertheless, next to nothing is actually known about the spatially and temporally explicit patterns of anthropogenic disturbance resulting from such noncompliance. This article reviews current understandings of ecological disturbance and conservation noncompliance, concluding that differing forms of noncompliance hold differing implications for diversity. The authors suggest that forms of anthropogenic patchy disturbance resulting from violation may maintain, if not enhance, floral diversity. They therefore argue for extended empirical investigation of such activities and call for conservation biologists to work with social scientists to assess this conservation reality by analyzing how and when incomplete enforcement and rule-breaking drive ecological change.

The increase in conservation activity during recent decades can be considered nothing short of an epochal conservation boom (Zimmerer 2000). Between 1990 and 2000 alone, the number of The World Conservation Union (IUCN)-recognized protected areas worldwide quadrupled from 6,931 to 28,442, and the total coverage of protected areas and biosphere reserves expanded from 803 million hectares to 1,115 million hectares (World Resources Institute 2005). The majority of these designations were established under an ecosystem-based paradigm in which biodiversity maximization rather than single species protection was the main goal (Myers and others 2000). Most of the designations were explicitly designed to reduce human impacts on threatened ecosystems through entry or zoning prohibitions or other means.

But as innumerable studies have now shown, conservation actions are uneven and incomplete. Rules are difficult to enforce; political struggles sometimes make governance unstable; and the needs of impoverished communities often conflict directly with conservation mandates. In short, direct human impacts on conservation landscapes continue, often resulting from clandestine violations of conservation rules, including outright poaching, strategic agricultural encroachment, or everyday noncompliance. These incursions may differ in impact from the threats that originally led

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to park protection. For example, clandestine agriculture within a designated conservation zone may be considerably more patchy than the forest-clearing agricultural front that catalyzed park designation. The question, therefore, is whether conservation restrictions actually are inhibiting human impacts on designated landscapes, or whether they are, in effect, only altering the *pattern* of human impact? If so, what are the implications for biodiversity?

This article briefly addresses these questions with an emphasis on the links between human impacts and plant diversity (and by implication, faunal habitat) in protected areas. We first review current knowledge concerning the links between floristic diversity and human disturbance. Then, we review how and why human impacts persist in areas set aside for conservation. We argue for an increased research engagement with the biodiversity implications of clandestine human activities in conservation areas and contend that the current emphasis on reducing these impacts must be complemented by serious assessment of their ongoing spatial pattern and associated effects on biodiversity. We allow for the possibilities that ''rule-breaking'' in protected areas is likely to remain the norm for some time to come and that the clandestine nature of these activities may result in a dynamic landscape mosaic wherein landscape heterogeneity and concomitant floristic biodiversity actually are maintained. Because biodiversity maintenance and enhancement are, after all, explicit goals of most conservation actions, we ultimately submit that unsanctioned and clandestine resource use by people within protected areas may not conflict with conservation mandates, depending on the context and character of the human action.

Disturbance and Floristic Diversity

Biodiversity in a given area is shaped in part by the intensity and frequency of biotic or abiotic disturbance. For example, the high diversity of neotropical forests at local and landscape scales has been attributed to disturbances such as tree-fall gaps and periodic hurricanes, respectively (Vandermeer and Granzow de la Cerda 2004; Wright 2002). Other examples include ungulate-grazed grasslands, which generally contain more species than proximate ungrazed grasslands (Hickman and others 2004). Similarly, periodic fires in western forests open serotinous cones and canopy gaps to facilitate the coexistence of more species (Agee 1993; see Laska (2001) for reviews of additional examples).

Despite this growing body of evidence, however, pinning the relationship between biodiversity and disturbance down to a single mechanism has proved elusive. The intermediate disturbance hypothesis (Connell 1978) identified the intensity and frequency of disturbance as an important predictor of biodiversity, with the relationship hypothesized to be hump-shaped. Hobbs and Huenneke (1992) subsequently questioned the definition and assessment of ''intermediate,'' and a recent review suggests that the diversity–disturbance relationship is not always strong and hump-shaped (Mackey and Currie 2001; Sheil and Burslem 2003; but see Lawton and others 1998). Ecologists have since argued for greater attention to scalar contingencies in disturbance–biodiversity relationships (e.g., Allcock and Hik 2003; Bissonette and Storch 2002; Chase and Leibold 2002). For example, logged sites may contain more species than unlogged sites at a small scale, but this inequality can be reversed at a larger scale (Hamer and Hill 2000). Indeed, the inherent complexity of integrated ecological systems at larger scales has so far impeded the development of a satisfactory formal theory for the diversity–disturbance relationship (Whittaker and others 2001).

Although no one theory can yet account for all patterns, there is consensus among ecologists that disturbance, however defined, plays a key role in the maintenance of biodiversity (Laska 2001). A significant practical implication of this consensus is that for landscapes in which biodiversity conservation is an explicit goal, humans may need to allow or mimic natural disturbance (e.g., wildfire) to achieve that end (e.g., Dombeck and others 2004).

Anthropogenic Disturbance

We know, of course, that not all anthropogenic perturbations of wild ecosystems have positive environmental impacts. Toward one end of the spectrum are human activities that cause excessive disturbance and drive native plant species to extinction (Curran and others 2004; Seabloom and others 2002). Toward the other end of the spectrum are human activities that suppress ecogenic disturbances and imperil species-rich assemblages adapted to more frequent disturbance. If disturbances are too rare or mild, competitive exclusion may result in the dominance of a single species. From a conservation perspective, all these outcomes are undesirable. The preferred outcome would be a landscape-level disturbance regime that allows for the coexistence of multiple native species in communities resistant to invasion by nonnative biota. Superficially, this outcome could be accomplished if human activities in a given landscape tended to catalyze intermediate dis-

turbance, whether by accident or design (Hobbs and Huenneke 1992).

Such outcomes, however, are extremely difficult to produce intentionally, even under the best-controlled conditions. Land and resource managers are trying nonetheless. Their guide is the increasingly influential conceptual framework known as the ''shifting mosaic.'' This framework suggests that managers can maintain biodiversity by ensuring that within a given ecosystem, disturbance is sufficiently patchy and sporadic to create a landscape mosaic in which plant communities at multiple stages of ''recovery'' coexist.

Currently, the concept stands as a guiding principle in the international sustainable forestry movement (Emborg and others 2000; Gamborg and Larsen 2003). Foresters in pursuit of sustainable forests forego frontier-type clearings in favor of carefully designed harvesting patterns designed to create a pattern of diverse seral stages (May 1994; Sutherland 2002). In principle, the shifting mosaic approach can allow biodiversity to be maintained provided that the size, pattern, and contiguity of harvest patches allow localized harvest-induced extinctions to be offset by species dispersal from adjacent patches. Recent simulation studies have confirmed that fluctuating disturbance may promote coexistence of tree species with varying life history traits (Emborg and others 2000; Loehle 2000). Spatial simulation models (e.g., Rocky Mountain Landscape Simulator; see McGarigal and others 2005) may prove to be valuable tools for land managers. However, the generality and widespread applicability of the shifting mosaic concept remain largely untested as a land management tool (Ernoult and others 2003).

Although the shifting mosaic has yet to inform formal management policies beyond temperate timber contexts, the concept parallels (and to some degree is indebted to) traditional resource management systems worldwide. Cultivation patterns in tropical forests and grazing in grasslands have for millennia created disturbances at appropriate spatial scales, intensities, and patterns for a positive influence on plant diversity (Peters 2000). For example, in semitropical and tropical woodlands and savannas, researchers have shown that under seemingly ''unmanaged'' continuous grazing and browsing by livestock, biodiversity can be maintained if not enhanced (Behnke and others 1993; Blumler 1998; Fuhlendorf and Engle 2001; Huston 1994; Oba and others 2000; Turner 1998).

The Ubiquity of Resistance and Rule-Breaking

As much as traditional resource management regimes may have contributed to biodiversity, particularly within the tropics, such activities are severely restricted, if not completely banned, in most conservation landscapes. Most management plans, for example, explicitly prohibit grazing, clearing, or burning within core areas. Where enforced, the result has been a curtailment in these most visible forms of resource use by area residents. However, as innumerable studies show, sanctions on large-scale resource impacts in protected areas have not prevented unsanctioned and clandestine resource mobilization by local peoples. People extract from enclosures, overstock in buffer zones, and set fires in preserves with remarkable frequency.

The question then is asked: What if this unsanctioned use, this rule-breaking, is in effect producing a patchiness that inadvertently is highly congruent with shifting mosaic models of management? We rarely think of rule-breakers as positive ecological agents. Although most conservation actions recognize the need to respect local needs, they rarely consider poachers and clandestine farmers as integral to the maintenance of the very diversity that most conservation sites are set up to protect. Given that conservation budgets and resources are modest, particularly in developing countries that host vast coverage and a number of protected areas, it is likely that rule-breaking will continue well into the future. The time therefore appears right to investigate the potential for rule-breakers to play valuable ecological roles.

In this discussion, we show how any contemplation of rule-breakers as an ecological force must begin with a review of *why* people break conservation rules in the first place. This must be followed with a discussion of the particular land and resource use patterns that result from specific forms of violation. We draw primarily from the wealth of documentation on this topic by geographers and other researchers in the field of political ecology, a field that explicitly explores those myriad cases in which noncompliance is motivated and facilitated by need, resistance, or corruption.

Resistance to Conservation Actions

We define resistance as the violation of conservation institutions driven either by need or by deliberate distrust and hostility to what are commonly viewed as external and illegitimate authorities governing conservation territories (Robbins 2004). This may occur when individuals disobey conservation territory rules to gain access to resources necessary for survival. In parts of the world where conservation territories are carved from zones traditionally used for all or part of community livelihood, such violations are quite common indeed. Whether evident in the use of fire to create agricultural plots in restricted areas in Madagascar

(Kull 2002; Laney 2002), in the harvesting of fruit from ancestral fallows in Kalimantan (Peluso 1996), in noncompliance with rules of use in Nicaraguan biological reserves (Nygren 2004), in woodcutting in conserved forests in Michoacán, Mexico (Klooster 2002), or in breaches of land use restrictions in the wildlife zones of Kenya (Akama and others 1996), struggles for livelihood are frequently tied to human disturbance in conservation enclosures. Incursions of this kind typically create small-scale or diffuse disturbances. Most covert agricultural clearings rarely exceed one hectare, and may be hidden in locations far from roads or streams. Clandestine firewood or timber harvesters may operate in a deliberately extensive manner to ensure that their actions are less obvious to forest managers.

Not all resistance is driven by livelihood imperatives; some is more overtly political. That is, local peoples express their distrust and nonconfidence in management authority by subversive actions affecting the landscape. They do so because, despite much ''community-based'' conservation rhetoric, efforts to maintain many protected areas are resisted and resented by residents (Adams and others 2004; Anderson and Grove 1987; Campbell 2002; Few 2001; Lynagh and Urich 2002). The reasons for this resentment include the rigid territorial boundaries of conservation areas, failure to consider the complex social and political processes within and near conservation areas, poor consideration of the diversity between different places and among participants, forceful relocations, insufficient resource access for local communities, and general abuses of power among conservation managers (Brechin and others 2002; Neumann 1997; Zimmerer 2000), especially under conditions of political instability and violence more generally (Daniels and Bassett 2002). Whether in the incendiary responses of herders and farmers to the criminalization of burning in Madagascar as ''an infringement upon traditional, long-established rights'' (Kull 2002, 939), or in the foot-dragging of local Belizean fishers in conservation planning exercises (Few 2001), resistance to conservation authority by burning or harvesting is sometimes driven as much by strategic political motives as by need. Illegal use of resources often is tied to violent resistance in Filipino conservation territories (Lynagh and Urich 2002), as it also is in Costa Rican protected areas (Campbell 2002, 38). This is especially true when conservation efforts are driven by international conservation consortiums commonly viewed as illegitimate or even neocolonial by local producers (Chapin 2004). Unlike livelihood-driven incursions on protected areas, which are persistent and intended to go unnoticed, politically motivated resource use is more likely to take the form of a one-time, highly visible conservation infraction such as a large clearing.

Corruption in Conservation Areas

In contrast to resistance, corruption is rule-breaking that occurs with the assistance or collusion of local authorities. Although less well documented, it is also ubiquitous. Sometimes corruption occurs on a grand scale, as in large-scale timber extractions in places such as Honduras and Nicaragua (Richards and others 2003) or the Philippines (Kummer 1992). More commonly, extralegal extractions from conservation areas occur as part of a daily, local, and informal economy in which illicit grazing, woodcutting, grass collection, and bark stripping are enabled through piecemeal transactions between local officials, landholders, herders, and laborers (Robbins 2000a). Together with other violations, these form the ''regular'' and ubiquitous pattern of actual usage in conservation zones.

The ecological impacts of corruption are hard to anticipate, and have much to do with the nature and frequency of conservation monitoring and the personnel entrusted to the task. In the vastness of the Amazon, for example, widespread illegal mahogany extraction from indigenous reserves and protected areas has been extremely difficult to spot and therefore to address (Peres and Terborgh 1995). Furthermore, it may be widely recognized that the trade is enabled through collusion of authorities at all levels of government, as in Peru (Forero 2003).

Whether by resistance or corruption, then, it is clear that conservation rules are routinely broken. In response, a wealth of social science research has been directed toward understanding the institutional arrangements that engender rule-breaking, and toward seeking institutional, economic, and political solutions that reduce noncompliance in all its forms (see Gjertsen and Barrett 2004; Kritzer 2004; Ostrom 1990; Ostrom and others 1993).

Rule-Breaking and Biodiversity

As vital as such research is, the aforementioned examples show that rule-breakers must be taken seriously as ecological agents with potentially complex and possibly even beneficial implications for biodiversity. We urge conservation biologists to consider the rule-breakers less as undesirable anomalies than as semipermanent actors in conservation landscapes.

We suggest that violation-driven anthropogenic disturbance is ubiquitous and, for the foreseeable future,

inevitable. We further suggest that such violations commonly have a pattern. Specifically, the arrangements of these disturbances are by no means spatially or temporally random, and commonly have specific and somewhat predictable configurations. For example, where corruption leads to a formalized structure of payments for varying forest products, extractions occur in specific areas that represent a compromise between efficiency of harvest and distance from easy observation (Robbins 2000b). Elsewhere, encroachments for grazing have carved specific patches out of conservation areas, increasing overall biodiversity (Brower and Dennis 1998). In other cases, research has shown fragmentation to be the result of ecological trajectories that attend irregular enforcement and diverse institutions (Kepe and Scoones 1999; Robbins 1998).

In summary, illicit and extrainstitutional land uses in conservation territories have a tendency to be spatially coherent and patchy. Current ecological research suggests that such patterns, so prevalent in conservation zones around the world, may favor rather than disfavor the maintenance of biodiversity. This opens up the somewhat heretical possibility that the complex outcomes of irregular conservation enforcement may include the creation of an unintended, yet desirable, shifting mosaic of disturbance. Violations may not be anathema for biodiversity conservation after all.

Such outcomes need not *necessarily* be desirable. A shifting mosaic may favor the development of intra- and interpatch diversity. Simultaneously, however, the ecological resilience of sites could be compromised, particularly if anthropogenic disturbance poorly approximates the natural regime (Gunderson 2000; Holling 1973, Peterson 2002). That is, the ecosystem may be slower to rebound from disturbance. This compromised resilience could facilitate invasion by weedy species, which tend to thrive under disturbance regimes in which other species are in decline (Dhar and others 1997; Westman 1990). Thus, even if the net effect of anthropogenic disturbance were an increase in total species richness (e.g., McKinney 2002), it may come at the expense of ecosystem stability (i.e., resilience), an outcome incongruent with conservation goals.

Nevertheless, next to nothing is actually known about the spatially and temporally explicit patterns of anthropogenic disturbance resulting from such complex uses. We therefore call for conservation biologists to work with social scientists to assess this conservation reality by analyzing how and when incomplete enforcement and rule-breaking drive ecological change.

Research Mandate: Assessment of Conservation Reality

What would be required to take rule-breakers seriously? A research agenda following such a call would differ from current research in three important respects. First, it would require combining carefully formulated hypotheses concerning human impact with specifically selected indices of ecological impact such as measures of diversity within and between impacted areas. Such explicit ecological monitoring and hypothesis testing is currently absent from political ecological research in areas of rule-breaking and violation (Robbins 2004). Conversely, rigorous and well-defined diversity assessments by ecologists are rarely carried out in areas experiencing illicit resource use. Although permanent plots might be maintained for comparative purposes, data would have to be secured from *in situ* contexts of disturbance.

Second, this approach would require a dramatic increase in the spatial resolution of human impact analysis in conservation areas. Human disturbance needs to be mapped at ecologically meaningful scales, which would change the tools and methods of analysis. The scale of discrete patches and paths of disturbance often is well below the pixel size of typical remotely sensed images. Thus, Geographic Information Science (GIScience) approaches must be supplemented with ground-level analysis and appropriate sampling strategies.

Third, such *in situ* research at the site of conservation violations would require more careful integration of local knowledge and practice within conservation zones. This integration would require more than simple recording of ecological knowledge, but would further demand spatially explicit ecological data on people's activities and preferences (see Turner and Hiernaux 2002 for an excellent case example). It also would require patience, political savvy, and serious consideration of research ethics and human subjects protocols in project design because many recorded behaviors would be illegal.

Beyond these methodologic changes and refinements, we argue that this approach to conservation and disturbance would require researchers to change the way they think about unsanctioned human disturbances in protected areas worldwide. Such violations appear to be the rule and not the exception, and they may lead to unintended and even desirable outcomes. We must therefore see this kind of disturbance as a legitimate ecological phenomenon, with the potential to drive systems toward or away from the conservation goal.

This is not to argue that conservationists should sanction or endorse violations, of course, although it does suggest more openness in thinking about disturbance (Sutherland 2002). Nor do we deny the urgent need for expanded social science inquiry into the determinants of rule-breaking or compliance. But in the process, we must bear in mind that porous boundaries, management conflict, and outright violations will continue to lead to unintended outcomes in conservation practice. We cannot know *before the fact* the outcomes of such complex interactions. We physical and social scientists would do best to join forces to track and trace conservation reality, and to allow for the possibility that conservation failures, however undesirable, may hold ecological surprises for us all.

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