

Tropical Ecological and Biocultural Restoration

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THE INCREASINGLY VIGOROUS EFFORTS TO PROTECT SOME of the relatively intact portions of tropical nature come too late and too slow for well over half of the tropics—especially the half best suited to agriculture and animal husbandry. Its relatively intact habitats are gone. Its remaining wildlands are hardly more than scattered biotic debris. The only feasible next step is conservation of biodiversity by using the living biotic debris and inocula from nearby intact areas to restore habitats. If this step is not taken quickly, natural and anthropogenic perturbations will extinguish most of the habitat remnants, small population fragments, and the living dead—the organisms that are living out their physiological life spans, but are no longer members of persistent populations.

Rescue of tropical species and habitats through habitat restoration has abruptly become much more urgent. On the horizon are crop plants and animals genetically engineered explicitly to overcome the inhospitable conditions of currently marginal land in tropical agroecosystems. Agroecosystem inviability has always been the most powerful conservation force in the tropics. With the production of crops and livestock that flourish in tropical rain forest habitats, millions of free-lance farmers and entrepreneurs will push into rain forest. The biotic debris, the restorationist's biotic tools, will go first. A tropical brushy cattle pasture, ill kept and low grade, contains thousands of species of organisms that will be obliterated when that pasture is converted to a high-tech rice field.

Conservationists seeking relatively intact patches of forest still have some tropical regions from which to choose. However, this optimistic view implicitly assumes that the biodiversity of tropical habitats is interchangeable—that is to say, if 50% of a tropical country's forest is still uncut, then what is all the fuss about? The very fact that one habitat has been severely damaged and the other is still intact implies a significant biological difference between the two. The tropical wildlands that are still intact enough to attract a conservationist are almost always on extremely poor soils and steep slopes, are subject to fierce seasons and climate, are disease-ridden, are in political hinterlands, or all of these. The sites, though very interesting, do not represent what once was the full sweep and glory of tropical biodiversity. To redress this imbalance requires restoration of samples of the wild habitats that once occupied the lands that today support most tropical civilizations—dry forests, volcanic soils, riparian alluvia, coastal plains, islands, intermediate elevations, and so on.

Restriction of conservation to the few remaining relatively intact habitat patches automatically excludes more than 90% of tropical humanity from its direct benefits; restoration is most needed where people live. Intact habitats within successful agroecosystems are usually fragments of the tiny size (10 to 10,000 hectares) associated

with idiosyncratic ownership, civic toys, political wars, and displaced cultures. Restoration at such a habitat's margins is essential for its long-term survival. Even small bits of relatively intact tropical nature can partly recuperate if allowed to expand in area, restoring populations before an extinguishing perturbation arrives.

Can the Tropics Be Restored Ecologically?

Ecological restoration already occurs throughout the tropics. Succession on a landslide or in a tree-fall gap is natural ecological restoration. The fallow phase of traditional slash and burn farming is applied restoration ecology. At least half of Barro Colorado Island, Panama, is restored forest. The farmlands that once supported the Mayan civilizations of the Petén and Yucatan are today unintentionally restored *Manilkara* and *Brosimum* forest, albeit with many fewer species than were originally on the sites. If there is an adequate inoculum of plants and animals, and if it is permitted to invade and grow, tropical habitats can most certainly be restored. However, it is critical that the potential for restoration does not become yet another rationale for the obliteration of relatively intact tropical wildlands. An increasingly competent medical profession should not promote participation in potentially lethal acts.

Choose an appropriate site, obtain it, and hire some of the former users as live-in managers. Sort through the habitat remnants to see which can recover. Stop the biotic and physical challenges to those remnants. The challenge is to turn the farmer's skills at biomanipulation to work for the conservation of biodiversity. Explicit and public agreement on management goals is imperative. Is the goal a low-overhead zoo, botanical garden, gene bank, functioning watershed, teaching laboratory, or some combination of these and other goals? Agreement is particularly critical in freewheeling tropical frontier societies, where ownership and administrative responsibility for public goods are poorly defined.

As much or more space is required to restore a habitat as to preserve an intact habitat. The remnant (seed) populations and habitats are likely to be widely scattered over a large area. A large area is also needed for long-term survival of the restored habitat in its agroecosystem; humans need to be encouraged in nonharvest use of the area but the resultant damage can be tolerated only if the area is large enough to allow rotational and use zoning for tourists, researchers, and educational programs. Even cattle can hasten the return of pasture to forest by eating the saplings' competitors and the fire hazard, the grasses.

How good a copy of the original habitat will eventually appear in the restored habitat depends on what is still available—and on what is chosen to be viewed as the original habitat. The neotropics will always lack its gomphotheres and glyptodonts extinguished by Neotropical hunters 100 centuries ago. However, even if only a small fraction of the original species is present, some complex and interacting arrays of animals and plants will be sustained, just as they are sustained on species-poor tropical islands. Restored habitat facsimiles conserve far more biodiversity than do croplands. Conspicuous of locally extinguished species may also be returned from elsewhere, but their desirability will depend on management goals. How does one know what habitat to restore? The simplest thing to do is let the organisms decide; an almost infinite array of other possibilities depend on active management toward an explicit goal.

Time is an essential ingredient in tropical restoration. Results can be initially slow and inconspicuous. In general, a canopy of woody plants (and substantial faunas) will appear on a restoring site within one or two decades, mature-appearing forest will appear in one to five centuries, and truly pristine forest and faunal structure is a matter of millennia; these figures assume that relatively intact forest

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(a source of plants and animals) is zero to several hundred meters from the site. These rates of restoration depend on the path chosen to a given restoration end point, and with seasonality, soil type, and species richness of the site. However, if the budget allows people to become the dispersal agents, restoration processes can be greatly speeded up.

Accepting triage is perhaps the most painful requirement of tropical restoration; a thousand hectares of restored tropical forest will sustain thousands of species of insects, plants, and other small organisms but it will not sustain a white-lipped peccary population no matter how many times it is reintroduced. Triage is critical so as to get scarce resources focused on particular sites and not to ladle funds onto the living dead for nostalgic reasons.

Governmental ownership is also critical. Private owners change their minds and needs over the years. They are also not in a position to bear the unpredictable large costs of periodic assault from fire, pesticides, irrigation projects, new legislation, gold mining, squatters, log purchasers, new agricultural varieties, and so on.

Can the Tropics Be Bioculturally Restored?

The single most critical resource for tropical restoration (and for conservation as well) is social desire to build the wildland back into the agroecosystem's mind, heart, and pocketbook. The tropical conservationists' arena now includes grade school education, civil service administrations, local ecotourism, research-guided management plans, habitat restoration, political campaigns, and international debt.

Human culture evolved in mutualism and conflict with the natural world. The natural world is by far the most diverse and evocative intellectual stimulation known to humans. Tropical humans are experiencing nearly total loss of this integral part of their mental lives. It is as though they are losing their color vision and most of their hearing. Ten thousand acres of rice is one of the dullest habitats on earth. The level of human intellectual deprivation represented by the upcoming obliteration of tropical wildlands is the terminal step in what has been many consecutive generations of gradual biocultural loss to tropical humanity. It strands the school-children of a tropical town without either their predecessors' contract with the natural world or the cultural offerings of the large cities that are supported by their parents' agriculture. It is critical that diverse and imaginative education programs be taught within the restoring wildland, and local peoples be intellectually involved in the restoration and management process. To save what is restored, the doors of the library must be open very wide. Yes, some books will be stolen, lost, worn, incorrectly shelved, and unappreciated. That is the tax that a conserved wildland must pay for survival in tomorrow's tropics.

We have long been misled by the view that tropical peoples care only about their stomachs, not the "luxury" of baubles like national parks. Choose a community of 300 subsistence farms anywhere in the tropics, purchase three adjoining farms, turn them into a public conserved wildland, give it back to the community, and you will get 280 votes favoring its presence and permanence.

Problems

Tropical restoration is rich in pitfalls. Activities in one particular restoration project may be singularly inappropriate in another. Biocultural restoration through park-school education programs may be best here, and ecotourism best there. Grazing by cattle may be the fastest route to woody invasion of old pastures in tropical dry

forest and totally ineffective in pastures cut from tropical rain forest. Moreover, restoration conspicuously requires active and professional decisions from the outset, whereas the conservation of a relatively intact habitat may (erroneously) seem to require little more than a fence and a police force.

The early steps in restoration of a species-rich tropical forest will determine the kind of habitat obtained. For example, three totally different forest types will appear and dominate for many centuries if restoration of dry forest pasture begins with (i) wind-dispersed tree seeds, (ii) seeds defecated by animals, or (iii) hand-planted large-seeded forest trees. A restoration project can be especially fragile in its early years. For example, a single wildfire in a fuel-rich restoring forest-pasture mix can destroy both restoration gains and the inoculum that was present before restoration was initiated.

Genetic material introduced as part of a restoration process may swamp undiscovered remnant native populations, and may spread to nearby intact wildlands. Truly foreign organisms introduced as part of the restoration process may produce a very different wildland than was anticipated; a large area of secondary succession may inundate a small intact site with fast-growing propagules, thereby altering it as severely as would selective logging.

Restoration has been slow to appear on the tropical conservation scene. If tropical habitats are viewed as restorable, there is the fear that less urgency will be felt to preserve them. The slowness of restoration dampens the enthusiasm of its potential financial supporters. Restoration concepts are easily mislabeled as "colonial imperialist" by those whose personal interests they thwart. There is even objection to taking lands "out of production" by restoration; this is akin to protesting the revegetation of strip mine till. Habitats to be restored are almost invariably already occupied, giving them higher market values than those of intact habitats. Cash for purchase of unattractive land becomes critical. Restoration requires collaboration of economic and social forces; a national park service that has been built on the absolute expulsion of commercial agriculture from its parks cannot easily accept the use of cattle as biotic mowing machines to speed restoration. The increased understanding of human nature that comes about through restoration of biocultural understanding may be extremely disruptive to religious or business traditions. Finally, the improvement of rural intellectual life has never had high priority in tropical agricultural development programs.

In Closing

Foremost, tropical wildlands (restored or preserved) are intellectual bumps on a verdant agroscape. Wildlands play the same societal roles as do libraries, universities, museums, symphony halls, and newspapers. They must be integrated with the educational system just as are these other complex information storage and transfer systems. And their restoration and use can generate the same class of protective responsibility by their society.

The restoration and management process may easily be carried out by the adjacent agroecosystem as an exercise in biomanipulation. It will therefore be much better understood, less feared, and more desired as a neighbor than is often the case with initially intact wildland preserves. Study of the multiple routes back to a restored wildland will unquestionably yield information of very substantial value to the surrounding agroecosystem.

And all this is to say that humans have won the battle against nature. Humanity makes its living by preventing restoration. It is up to us to accept the responsibility of putting the vanquished back on their feet, paws, and roots. We can do it. Even defeated, tropical nature has too much to offer for us to accept a world without it. ■