The progressive loss of tropical forest cover has captured global attention for decades. The causes of this loss are multiple, geographically variable, and widely debated, but human poverty and overpopulation rank among those most commonly cited. Deforestation and land degradation in the Neotropics, for example, are often ascribed to the depredations of colonist “slash-and-burn” cultivators: As forest cover disappears along agricultural frontiers, the explanation seems unquestionably apparent in the person of the displaced campesino whose ax, fire, or chainsaw physically eliminates many trees. Resource policy based on this perception might logically seek legal protection of forests by barring the ax or banishing the landless intruder.

An investigation of changes in subtropical dry forest vegetation in one small area of the Dominican Republic demonstrated how mistaken such interpretations, and the consequent policies, can be. The study focused on the village of Jaiquí Picado, located in drought-ridden northern foothills of the island’s central mountain range.

**ABSTRACT**

As deforestation and habitat degradation proceed worldwide, the elaboration of realistic policies to protect and sustain forests assumes increasing urgency. Experience from one area of threatened tropical dry forest illustrates, however, that staunch environmental regulation based on partial understandings can have strikingly contradictory effects. In this study from the Dominican Republic, extensive dialogue and field observation with local residents offered a glimpse beyond the obvious proximal causes of forest loss—the subsistence farmers and charcoal makers regularly seen felling trees—to important influences of their socioeconomic and legal contexts.

**Keywords:** deforestation; Dominican Republic; international forestry; policy; sustainable forestry

Above: Who wields this machete? A pervasive focus on “slash-and-burn” agriculturalists distracts from more fundamental causes at work in scenes such as this one.
Over a period of two years in the mid-1990s, the project used an interdisciplinary array of methods to explore the interplay of natural and social influences on forest loss and change (Roth 1999; Roth in prep.). Sampling of vegetation and soils provided parts of the story; but direct observation of management practices and detailed interviews with a large cross-section of land users (n = 76, a randomly selected 54 percent of adult residents) lent insight unavailable from purely physical sources—and contributed notably counterintuitive findings.

One-fifth of the Dominican Republic once bore mature dry forest, now widely held to be the most endangered of tropical forest types (Murphy and Lugo 1986; Janzen 1988; Redford et al. 1990; Lerdau et al. 1991; Prance 1991); but close to 90 percent of this cover had disappeared before substantive environmental regulation began (Organización de los Estados Americanos 1967). During the century of agricultural settlement preceding this study, native dry forest cover in Jaiquí Picado had dwindled as most of the original stands were felled and a degraded scrub woodland emerged on land previously farmed (Roth 1999). Sparse, deciduous, thin-crowned, and open beneath, this persistent thorn scrub displayed markedly less complex structure and species composition than remnants of old-growth and retained fewer native and endemic trees (table 1). Years of clearing for subsistence agriculture and charcoal production in the area seemed to point unambiguously to the causes of forest decline.

A more intricate account of this process emerged through consideration of socioeconomic factors and attention to local people’s experience. It is not offered here as a generality, because conditions elsewhere are bound to differ. Nor is the intent to characterize the current situation in a country where two intervening turnovers in national administration have since brought substantially modified forest policies. Instead, the aim is to illustrate the complex and hidden causal pathways that can underlie seemingly manifest environmental processes.

### Societal Context

A succession of laws has regulated Dominican forest resources for well over a century, but the early legislation received negligible enforcement, and massive wood harvests in the mid-1900s failed to procure stand regeneration (Secretaría de Industria y Trabajo 1941; Olivo 1984). It was not until around 1960 that widespread deforestation, now seen as linked with the activities of shifting cultivators and charcoal makers, began to attract concerted government attention. New legislation soon placed severe restrictions on land clearing and tree cutting throughout the country, and by 1970 the Forest Service was incorporated into the Armed Forces, with armed guards serving as rangers. When Dominican forests continued to disappear at a disquieting pace (Hartshorn et al. 1981; Oficina Nacional de Planificación 1983; Russell and Fournier 1990–91), a militarized operation in 1986, much publicized as Selva Negra or “The Black Forest,” targeted charcoal makers and other small-scale woodcutters with jailings, confisca-

### Table 1. Selected characteristics of native dry forest versus degraded scrub woodland, Jaiquí Picado, Dominican Republic, 1993.

<table>
<thead>
<tr>
<th></th>
<th>Native dry forest</th>
<th>Scrub woodland</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Woody plant diversity</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Species richness (mean per 200-square-meter plot)</td>
<td>16</td>
<td>6</td>
</tr>
<tr>
<td>Concentration of dominance (Simpson index)</td>
<td>0.05</td>
<td>0.25</td>
</tr>
<tr>
<td>70 percent of individuals belong to minimum of:</td>
<td>15 native species in 12 families</td>
<td>Three species (two of them alien) in a single family: <em>Acacia macracantha, Haematoxylon campechianum,</em> and <em>Prosopis juliflora</em></td>
</tr>
<tr>
<td><strong>Species characteristics—percentage of woody plants</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Native to Hispaniola</td>
<td>99</td>
<td>75</td>
</tr>
<tr>
<td>Endemic to Hispaniola</td>
<td>11</td>
<td>4</td>
</tr>
<tr>
<td>Unique to this forest type</td>
<td>58</td>
<td>21</td>
</tr>
<tr>
<td>Deciduous</td>
<td>17</td>
<td>95</td>
</tr>
<tr>
<td>Thorn-bearing</td>
<td>6</td>
<td>75</td>
</tr>
<tr>
<td><strong>Forest structure</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Density (woody plants per hectare)</td>
<td>3,585</td>
<td>1,361</td>
</tr>
<tr>
<td>Basal area (square meters per hectare)</td>
<td>20</td>
<td>7</td>
</tr>
<tr>
<td>Coefficient of variation of tree heights (percent)</td>
<td>47.7</td>
<td>24.2</td>
</tr>
<tr>
<td>Coefficient of variation of tree diameters (percent)</td>
<td>68.2</td>
<td>39.9</td>
</tr>
<tr>
<td>Depth of litter layer (centimeters)</td>
<td>2.5</td>
<td>1.0</td>
</tr>
</tbody>
</table>

**NOTES:** Sample sizes (number of 200-square-meter plots): 31 in native forest and 57 in scrub. For comparisons with replication, **p < 0.01, ****p < 0.0001.

**SOURCE:** Roth (1999).
tions, and sometimes violent reprisals (Urbáez 1989).

For years, the theme of forest loss was aired untiringly by the media, the government, and numerous nongovernmental agencies, among whom the rural poor were often characterized as “enemies of the trees” having little understanding of forests or stake in their perpetuation; but the messages were often more stark than illuminating. Images of dry forest destruction—brush piles on steep hillsides going up in smoke, sinewy figures swinging machetes and hatchets at twisted trunks, small children on burros laden with bundles of firewood or sacks of charcoal—were etched deeply in the public consciousness by a steady stream of headlines and news footage (e.g., Estrella 1964). But detailed studies of the historical and social aspects of dry forest management were largely wanting.

In contrast to prevailing perceptions, subsistence farmers and charcoal makers in Jaiquí Picado demonstrated considerable ecological knowledge and active interest in the sound management of forests (Roth in prep.). However, the economic and legal forces impinging on such people’s lives often prevented environmental concerns from guiding their land-use decisions, or alternatively, allowed more encompassing developments to overshadow individual efforts at stewardship. Both of these limitations—the constraints on each farmer’s choices and the diminished relevance of individual choices within existing socioeconomic circumstances—wrought important effects on the landscape through the activities of land clearing, timber cutting, tree protection, charcoal production, and the management of fallows. One theme recurrent throughout these areas relates to the contradictory effects of laws ostensibly intended to prevent environmental degradation; another involves the more pervasive if less obvious role of wealth, rather than poverty, in occasioning forest decline.

**Land Clearing**

General accounts of deforestation in the Dominican Republic during recent decades (e.g., Ramm et al. 1987) have often highlighted hillslope agriculture and fuelwood harvests, implicating subsistence farmers and charcoal makers as major destroyers of forest. Direct observation of land-clearing activities in Jaiquí Picado did not dispel this impression, but a closer examination of economic and landholding structures revealed decisive effects at more distal points in the causal pathway.

Land ownership in the village was highly skewed (fig. 1). Most households owned virtually no cultivable land, while a very small percentage, some of them absentee, held large expanses. Although the majority of residents depended directly on products of the soil, their primary access to land was through sharecropping arrangements, such that most resource management in Jaiquí Picado was ultimately under the control of relatively few landowners.

The origins of this unequal land tenure resembled patterns historically common in the region (San Miguel 1997). Founding colonists had practiced swidden farming on largely communal land, fencing in only their ephemeral cultivated plots as protection against feral stock. Landholding arrangements were largely informal and locally respected through the early 1900s, but farmers lost access to substantial areas starting in mid-century, when outsiders able to purchase barbed wire and influence authorities literally staked their claims on the ground. Those fenced out, as well as newer arrivals who had lost land elsewhere, now divided their crops with landlords.

In interviews, proprietors of larger holdings often maintained that they treated the land better than their landless neighbors; but an inquiry into the history of local parcels confirmed these claims only to the extent that pasture provides protective soil cover. In recent decades, at least, the wealthy had caused the largest forest areas to be cleared, having not only more land and capital at their disposal but also the funds and influence necessary to bypass legal hurdles to clearing. Interviews and field surveys documented that subsistence farmers in the village cultivated an average of well under one hectare per household at any given time and together cleared some 22

![Figure 1. Distribution of land ownerships and aggregate land areas in Jaiquí Picado, 1993, according to the size range of individual holdings.](https://academic.oup.com/jof/article-lookup/10.1093/jof/99.10.20/4614276)
hectares per year; yet a single livestock owner once contracted to have 10 times that area of forest felled by ax and bulldozer to establish cattle pasture. Large projects of other wealthy proprietors had bared hillsides with slopes exceeding 60 percent and removed the last substantial stands of a number of old-growth species. Although highly visible and strictly illegal when undertaken, none of these larger clearings had been halted by authorities. The forest loss they occasioned was widespread and lasting: Farmers preferred to let their plots develop woody fallow after a year or so of cultivation, but pastures were kept clear of brush to prevent the forest from returning.

Despite their decisive influence on the removal of tree cover, large landholders were never to be observed personally wielding axes. Their pastures were typically opened by sharecroppers permitted a portion of the charcoal yield and a season or two of cultivation provided that the area be left planted to grass. Undeniably, subsistence farmers became the direct perpetrators of considerable forest loss; but less conspicuously, they were not singly or collectively in a position to halt it. Much of the same land would have continued to be cleared even if no poor farmers at all had resided in the area—as the sporadic use of machinery and the increasing activity of migrant workers on the larger properties attested.

Uneven distribution of land and wealth had not only predisposed those with larger holdings to clear disproportionately areas of forest; its less apparent effects also included destructive practices in which people with inadequate landholdings were obliged to engage. For example, the steepness of the land that subsistence farmers often cleared—probably the largest single influence on soil erosion—was seldom subject to their own choice. For the owners of large tracts who directed sharecroppers to clear steep slopes, however, there was a certain economic logic in doing so: Their holdings normally included flatter bottomlands where they situated their own semipermanent fields of cash crops, which stood to be fertilized by the runoff and sediment from the sloping areas above.

Because such slopes were to be kept indefinitely in nondemanding grass cover, soil conservation was of little relevance to their owners.

Even on lands belonging to the poor, the enterprise of their wealthier neighbors had produced indirect effects not easily amenable to observation. One of these involved the burning of slash cleared from prospective agricultural plots. Questioned about this practice, farmers conceded that they were aware of the harmful effects of burning on slopes but explained that the debris contained branches with formidable thorns. Many people had inadequate footwear, and children in particular often worked barefoot in the fields. People piled the slash before burning it, to confine the fires to small areas and protect the scant litter cover, but they refused to leave the spiny branches intact on the ground.

Interviews with residents confirmed the seriousness of this danger. With medical care generally inaccessible, serious injuries from thorns had incapacitated several adults and led to the deaths of two children in recent years. The spines considered most perilous were produced by two of the most common species in scrub vegetation, trees that had been virtually nonexistent in the area before conditions associated with pasture development allowed them to proliferate (Roth 1999). Causal pathways to degradation had taken distressingly ironic turns: Subsistence farmers were burning detrimentally on slopes to eliminate the dangerous thorns of species sown there by the cattle of the wealthy.

Precious Woods

The cutting of fine timber species or “precious woods” was another area in which the wealthy often appeared immune to legal restrictions. Dominican forest legislation had long given special consideration to such species, including several characteristic of native dry forest. Cutting regulations had stipulated their most appropriate uses, presumably those generating the products of highest market value, and current laws continued to prohibit their use for “the production of charcoal, firewood, fenceposts or crossties or any other end whose utility does not compensate for the destruction of said trees” (Consejo de Estado 1962).

These potentially merchantable species, popularly termed “useful” or “for fine works,” were considered off-limits by most residents of Jaiquí Picado. Hence, one farmer’s response when asked if people in the community engaged in practices harmful to
forests was, “No, because here people generally don’t cut the useful trees.” Many others stated that such species should not be cut “unless they have reached their useful size.” The irony embodied in such statements and in the law itself—that anyone would expend the effort to fell a tree that were not well worth cutting—suggested that the prominence of the harvester held greater weight in practice than the quality or size of the product. Although a few farmers admitted to having cut wood to make house repairs, newly felled poles of timber species were observed only on the property of the more prosperous residents. For decades, for example, few people appeared to have harvested mahogany; inventory plots totaling 1.76 hectares yielded just one stump of the species. Exorbitant costs and arbitrary denials of cutting permits, as well as the lengthy trips required to apply for them, were cited as effective barriers to the use of this prized wood. But ground-checked reports held that one unattended forest fragment had been sacked of its best mahogany and other valuable trees some years ago, reputedly with the participation of a well-connected member of the community and inattention or even compliance on the part of forest guards. A man with publicly avowed connections to the party in power was twice observed hauling newly cut trunks of valued species for construction uses. Another wealthy landowner was surprisingly frank in boasting of his own gifts of mahogany to police and high-ranking government officials. And cross-corroboration based on dozens of interviews documented that throughout the mid-1900s, prodigious quantities of logs of valuable native species had been removed from local old-growth forests by better-capitalized outsiders (Roth in prep.).

When the landless poor did engage in the harvest of semiprecious woods, the cattle of the wealthy once again figured elusively in the causal web: Posts for barbed-wire fencing were in constant demand by cattle ranchers, who paid others to cut them. Stump counts in the sampled forests indicated that nearly all specimens of valuable species that had been removed were of sizes, and in configurations, that pointed to the trees’ harvest for use as fenceposts rather than for charcoal, poles, or sawlogs (Roth in prep.).

Tree Stewardship

Another irony surrounding the strict ban on cutting of precious woods was its discouragement of investments in tree planting and forest stewardship that might otherwise have perpetuated populations of native timber species. Mahogany, for example, grew in some dooryards and public places; yet its seedlings were virtually absent from nearby vegetation, although said to appear around parent trees “in droves.” What was invisible in sampling plots became apparent in conversations with residents: Although some people repudiated such an attitude as ignorant and irresponsible, many had adopted the practice of destroying any mahogany seedling they found growing on their property, for fear of losing access to both tree and scarce land should the seedling prosper.

Reflecting concerns that have hampered plantation forestry generally in the Dominican Republic (Morell 1986), many residents had also refused to plant tree seedlings—even ones distributed for free by environmental agencies—assuming that anyone unable to pay large bribes would be denied productive use of the trees he or she nurtured. A large majority supported the concept of management involving selective thinning and compulsory replanting; but by denying people all rights to cut wood the forest laws had, in words heard continually in discussions of local forest resources, “turned us into enemies of the trees.” Legal provisions did exist for harvests in officially registered plantations, but people in Jaiquí Picado had limited contact with the agencies charged with issuing permits; and past seedling distributions had evidently aimed at permanent reforestation and thus neglected to inform people about questions of tree use and tenure. In any case, drafting and certification of the required management plan would have been daunting projects for a population that was mostly illiterate, unschooled in formal forest management, and unaccustomed to legal recognition of its rights, so the perception of absolute cutting prohibitions removed any inducement to cultivate trees.

This had not always been so, despite the long intervals required for seedlings
The arduous and hazardous work of charcoal production—from ax-cutting and stacking of hard, thorny woods through long days tending each hot, smoking furnace to the filling of sacks with the dusty chunks of coal—yields small gains even when the product can be sold without risk of seizure. Environmental laws criminalized this occupation, even though the wood used for charcoal is overwhelmingly from invasive scrub species that provide little in the way of soil protection or native habitat.

to reach marketable size. Valuable hardwoods had traditionally served Dominican farmers as a form of living bank whose funds could readily be liquidated for emergency use. When legal harvests still allowed for this economic cushion, visitors to one dry forest area found mahogany seedlings actively protected wherever they cropped up (Durland 1922).

Charcoal

Yet another contrary effect of seemingly protective legislation stemmed from the government’s indirect enforcement of the ban on charcoal production. Forest guards in Jaiquí Picado rarely patrolled the countryside to prevent tree cutting but stationed themselves instead along highways leading to the nearest urban markets, to stop and search vehicles capable of carrying sacks of charcoal. As reported by the offenders themselves, seizure of their goods in effect increased rather than reduced deforestation when they found themselves obliged to augment their production to substitute for the losses. Presumably, this contradictory and multiplicative result of enforcement was intensified by economic feedback effects of the flooding of the market by the confiscated charcoal—rumored to be sold by military officials for private gain—as well as by the increased cuts taken by intermediaries seeking to help cover their heavy risks.

Charcoal makers welcomed viable alternatives to an occupation they found grueling, hazardous, and only marginally profitable, and they were close to unanimous in their complaint that “forest” guards not only failed to prevent trees from being cut down but in fact clearly depended on the continued existence of this illegal activity to supply a portion of their own income in the form of bribes or the confiscated product. But most producers also viewed the law itself as misdirected, because the trees they cut for charcoal were of invasive scrub species that sprouted profusely, grew rapidly, and served for little other than fuel. Rather than let prohibition continue to foster contraband, they suggested such remedies as regulation through taxes along with permits to manage plantations of more widely useful trees.

Duration of Fallows

Interactions among laws, wealth, and livestock had also encouraged degradation by reducing the length of agricultural fallows. Subsistence farmers in Jaiquí Picado well understood the need to limit cropping periods to avoid “tiring” the soil. They also distinguished hillside plots, planted for an average of only one year, from flatter farmland, which might be cropped for several years’ time. Yet the fallowing periods they observed—averaging just three to five years—were scarcely adequate to restore soil fertility. Questioned about their choices, they acknowledged these periods to be unsatisfactory, noting it preferable to retire spent cropland for decades if possible. But they explained that such decisions belonged to the landowners, who generally opted for pasture conversion over keeping land in crops or fallow. As areas dedicated to grazing gradually disappeared from the pool of available farmland, increased pressure on the remainder restricted the length of time that any given plot could remain forested.

Legal restrictions exacerbated this pressure, particularly through the way that tree size was used as a guide in regulating the type of woody growth that could be cleared for agriculture. According to several residents, the forest service routinely granted permits to clear the trees of early secondary growth—those small enough to be felled using only machetes—but prohibited use of the axes essential for cutting larger trees, even if these were of prolific, invasive thorn species. The effect of this policy over time was that patches of early regrowth were kept indefinitely from returning to forest, as machetes were used to maintain pastures in an open state or to reopen recently abandoned swidden plots for agriculture, but existing forest could not be cleared.

Farmers recognized the agronomic implications of this approach: Beneath stands of saplings small enough for machete-felling, litter accumulation was never sufficient to have replenished the soil. Thus, these lands appeared destined to become highly degraded while others were kept from cultivation altogether. Although the restriction might potentially have helped to conserve patches of older forest, its value in protecting biological diversity was probably minimal. The pole-sized stands it
spared were dominated by the same abundant, rugged, largely exotic species as those found in young scrub growth, while remnants of old-growth forest—far richer in rare and endemic plants—had been preserved mainly by virtue of conditions, such as stones or precipitous slopes, that rendered them unsuitable for agriculture or grazing.

Resentment of the size limitation as unjust and misguided, together with a lack of reasonable alternatives, had induced some farmers to thwart it. One man admitted, for example, that when he expected to be denied a permit to fell older scrub he simply eliminated the larger trees surreptitiously and then waited for a year to request permission to cut the remaining stems.

**Perverse Protection and Root Causes**

Undue focus on the proximal steps in tropical deforestation can obscure important causal pathways contributing to depletion of forests, species, and soils. *Figure 2* tracks a number of these more distal effects, as discerned in one particular place and time, that were poorly accounted for in the explanations that had driven environmental policy there. The diagram highlights the extent to which prohibitions and their attendant sanctions can be ineffective, if not counterproductive, in providing protection. In a context of uneven access to resources and enforcement of laws, strict controls not only failed to encourage behavior protective of forests; they appeared in fact to aggravate degradation while contributing to a general contempt for environmental regulation. The quest for just and sustainable solutions to forest resource problems is nowhere easy, but it seems likely to benefit from greater attention to the insights of the very people maligned as the agents of destruction. As expressed by one farmer and charcoal

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**Figure 2. Environmentally counterproductive outcomes of environmental regulations, as evident in Jaiquí Picado during the mid-1990s; arrows indicate directions of causality.**
maker in Jaiquí Picado, “[The forest agency] has no respect for people, and people lose respect because they can’t obey the law, and then they stop respecting the trees as well. The law is against the law, I’d say.”

**Literature Cited**


