A New Look at Global Forest Histories of Land Clearing

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Annu. Rev. Environ. Resour. 2008. 33:345–67

First published online as a Review in Advance on August 19, 2008

The *Annual Review of Environment and Resources* is online at environ.annualreviews.org

This article's doi:
10.1146/annurev.environ.33.040307.093859

1543-5938/08/1121-0345$20.00

Key Words

contemporary deforestation, ethics of clearing, historical uncertainty, prehistoric clearing

Abstract

Uncertainty about historical evidence of forest clearing is highlighted; nevertheless, its longevity and basic importance for survival make an understanding of the process important. First, archaeological and paleobotanical evidence for clearing during late Mesolithic and Neolithic Europe is examined. A similar examination of the Americas during past millennia emphasizes the myth of a pristine precontact forest. Post-1950s deforestation is beset with similar problems of forest extent and loss, pathways and processes of change, and the rate of change. Recent literature also reflects concerns about past and present motives in clearing and management, emphasizing conflicts between traditional users and modern producers, North/South inequalities of consumption/production, and social confrontation. The cultural meaning of the forest is another current theme, developed through dominant "discourses." Finally, I argue that humans and the organic world are intimately entwined, and our expectations and ideas of the natural world actually mold the way we use and manipulate it.

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THE TASK OF THE ENVIRONMENTAL HISTORIAN

The evidence for histories of global forest clearing is a little like Charles Darwin's metaphorical description of the evidence of the geological record for his theory of the origin and evolution of species:

> I look at the geological record as a history of the world imperfectly kept, and written in a changing dialect; of this history we possess the last volume alone, relating to only two or three countries. Of this volume, only here and there a short chapter has been preserved; and of each page, only here and there a few lines (1, p. 166).

Similarly, the evidence for the history of global forest clearing cannot be other than fragmentary, and it is therefore also a history "imperfectly kept." We too look at odd volumes, separated chapters, and isolated lines, written in different dialects, in the hope that these fragments make some overall sense about the process. There are great gaps that cannot be filled, there is widespread ignorance of what does exist, and there are very few statistics that are wholly reliable. Much evidence is also highly prejudiced or used for purposes quite different from those for which it was written. Above all, in the past, clearing was regarded as the most natural thing in the world; it was the first step to improvement and agricultural expansion, and consequently, almost no one wrote about it or recorded statistics about it. Hence, our ignorance about the process is very great.

This review sets out to isolate some of those uncertainties and the new attempts to interpret the fragmentary and disparate evidence during two critical periods of uncertainty at the extreme ends of the spectrum of history—the prehistoric and the contemporary (post-1950). The third part looks at some of the new literature occurring during roughly the past decade, mainly since the author wrote *Deforesting the Earth* (2), a period that has seen the development of a more questioning discourse about the forest, which many perceive as the loci for some of the worst environmental problems in the world today—biodiversity loss, climate change, cultural elimination, and even the loss of the repository of myth and memory.

Never has the need to extend our searches of environmental change back into the farthest reaches of human time been so important or relevant as it is at present. At a time when we are beset by startling and even alarming accounts of environmental degradation, it is salutary to realize that some current changes are merely the latest manifestation (albeit at an accelerating rate) of an ever upward rising curve that began with the emergence of humans on Earth (3, 4). Environmental historians and historical geographers are well placed to provide both context and perspective; by bettering our understanding of human action in the past, then perhaps we are better able to look ahead. Nowhere is this truer than in the case of land clearing, which is not a modern phenomenon,

as is commonly supposed, but is as old as human occupation of Earth. It is one of the main processes for the modification and transformation of the physical environmental, biogeographical systems, climate, and the productivity of the planet. Controlled burning is probably coterminus with the emergence of *Homo erectus* some 0.5 million years ago.

THE REASONS FOR CLEARING

Clearing is part of the age-old quest of humanity for some of the basics of life—shelter, food, and warmth. Trees provide wood for the construction of shelter and for making a multitude of implements. Wood provides fuel to keep warm, to cook food and make it palatable, and also to melt metals and bake ceramics. The nuts and fruits of trees are useful for human foods, medicines, and dyes, and the roots, young shoots, and branches provide food for stock. Above all, cleared forest, frequently covered by a deep humus accumulation and initially rich in nutrients, provides land for growing crops. All these needs and benefits usually work in conjunction and result in cleared land.

Rising population has always put pressure on forest resources. In modern times, it has been of critical importance, with a near tripling of world population from 2.5 billion in 1950 to 6.7 billion in 2007, which is forecast to peak at ~8.4 billion by the end of the century. But numbers alone do not explain clearing. Additional local factors are lack of employment opportunities, inequality of the distribution of assets (particularly land), exploitive private enterprise, weak government control, misdirected past policies of aid agencies, national indebtedness, poverty, and the corruption of elite groups, who have economic and political control of society and accumulate profits through the extension of commercial logging. Eckholm wrote that usually uncontrolled clearing "is a symptom of society's inability to get a grip on other fundamental development issues" (5, p. 42).

Many empirical econometric studies have tried to isolate the main factors and their relationship with clearing, but with often contradictory results (6–9). Recently, Lambin et al. (10) have reviewed these exhaustively. Perhaps the last word lies with Guppy's penetrating and biting critique of exploding deforestation (11), which he likened to a "multi-layered cake," an early description of the contemporary division into proximate and underlying causes (12). On the surface are the obvious factors, e.g., population numbers, the need to raise capital for development, and others, but

> underneath are other layers—of social mores, of political expedients, of national and global economics, and of ideological conflict . . . [so that] . . . almost everywhere destroying rainforest is a means of *avoiding* tackling real problems by pursuing chimeras: a 'license to print money' which yields quick cash at the cost of ultimate catastrophe (11, p. 932).

Clearing is not a technological problem. In the past, humans with stone or flint axes needed only boundless energy to fell trees (13); in contrast, fire and browsing animals can wreak havoc in forested areas with little effort. The substitution of metal for stone axes ~3500 years ago (14), and for saws during the medieval period, eased the backbreaking toil of clearing and accelerated the rate of change and land-use transformation. Power saws, first introduced about 70 years ago, have had a catastrophic impact. One person can clear in a few days, or less, what before took 10–20 days.

THE PREHISTORIC FOREST

The term "prehistoric" is used here to denote a largely preliterate age that corresponds to prehistory, although its chronology is different for different parts of the world. Consequently, the unraveling of the history of forests in this "deep past" [i.e., many millennia before present (BP)] relies almost entirely on the results of fossil-pollen analysis by paleobotanists, the findings of archaeology, and the theorizing of anthropologists. Although we know that shifts in climatic phenomena since the end of the Ice Age (~10,000 years BP) have caused

BP: before present

shifts in tree taxa, the evidence for human initiation of changes during the past 6000 years is also clear. The evidence may be patchy, yet the conclusion is inescapable that humans were the primary engine of a change, which was far greater than suspected and greater than some would even care to admit.

Europe: A Forest Transformed

In Europe, forest clearing, cultivation, the cutting of sprouts and limbs for winter fodder, the localization and intensification of grazing, the use of fire, and the possible outbreak of selected arboreal pathogens all had their effect on opening up the forest canopy, thus creating opportunities for changes in its dominant structure, the extension or truncation of the range of taxa, and the invasion of weeds and ruderals.

Changes in forest structure are clearly indicated by the invasion of the early succession forest taxa such as fir (*Abies*), birch (*Betula*), and spruce (*Picae*), and in the south, the mediterranean pine (*Haploxylon Pinus*) (15, 16). The changing distribution of elm (*Ulmus* spp.) is an interesting and much investigated case. Its percentage representation in the pollen record dropped rapidly in southeastern Europe between 7000 and 6500 year BP, replaced by beech (*Fagus*) and hornbeam (*Carpinus*). A thousand years later (5400/5200 to 4470 years BP) elm declined dramatically in northern and northwestern Europe from over 25% of the total to a few percent, to exist only in fragments (17). The decline coincided with areas of middle Neolithic settlement on fertile loess soils, and one suggestion is that repeated cutting of branches and leaves for animal fodder was a cause for the decline. However, the fact that other tree taxa pollens stayed more or less constant suggests a curious selective clearing strategy (18–20), especially as the decline predates the appearance of the earliest domesticated animals. The most likely explanation is that the widespread use of fire to keep land open for grazing and the girdling of trees coincided with the onset of specific pathogens responsible for elm death.

Although the distribution of some trees waned, useful food trees were deliberately propagated. The walnut (*Juglans*), throughout central and western Europe, the pistachio (*Pistachia* spp.), and particularly the olive (*Olea europaea*), in southern Europe, are good examples of trees that have become naturalized beyond their native ranges, aided by grazing animals that kept down native competitors.

The third indicator of human interference is the spread of numerous vascular plants (weeds) and ruderals that accompanied cultivation. The range was enormous and depended on the type of land-use pursued. Winter wheat was usually accompanied by dock; summer cereals and root crops mainly by legumes and plantain (*Plantago)*; wet meadows and mown pastures by sedges, plantains, clover, and buttercups (*Ranunculaceae*); whereas pathways and human settlements abounded with nettles (*Urtica* spp.), sage (*Artemisia* spp.), chenopods, plantains, and knotweed (*Polygonum* spp.) (15, 16).

Recently a note of doubt about the nature of the "virgin forest" and the subsequent anthropogenic changes has been sounded by Vera (21), who has hypothesized that the openness that characterized the human-occupied landscape could have been created and maintained by large herbivores, such as several varieties of deer, aurochs, tarpan (primitive horses), bison, beaver, and wild boar, to produce a more park-like forest. The hypothesis has been tested rigorously by Kirby (22) and particularly by Mitchell (23), who compared pollen data for oak (*Quercus*) and hazel (*Corylus*) in Ireland, which was isolated in primeval times and did not support large herbivores, with sections of Europe and the eastern United States, which did support them. The results suggest that herbivores were not a factor in openness, but humans were.

The denial of the ability of humans to so completely alter the forests goes back a long way. In Europe, the mid-twentieth century paradigm was that indigenous, primitive hunter-gather Mesolithic cultures [circa (c.) 8000–5000 BC] were the primitive fag end of the Paleolithic (24), who were engulfed by successive waves of Neolithic

proto-agriculturalists who swept across central Europe from the Near East in a great colonizing wave (25). The subsequent primary Neolithics were labeled "primitive agriculturalists" who practiced only slash-and-burn clearing, which periodically exhausted the soil; provided the momentum for the overall movement; and were incapable of initiating systematic, permanent clearance and the formation of fields. (26, 27). This was bolstered by Iversen's classic landnam (or shifting cultivation) example from Denmark during the 1940s and 1950s and was later applied throughout northern Europe (28, 29). The subsequent academic popularity of the Bosrupian thesis in both archaeology and development studies that population pressure led to the intensification of agrarian systems seemed to support Iversen's work on landnam both factually and theoretically (30). The dominance of this orthodox discourse was remarkable, and it was not until the late 1970s and early 1980s that archaeology and paleobotany came together to tell a story that is much more complex and of profound significance to our understanding of prehistoric forest clearing.

First, Mesolithic culture was more sophisticated and of greater significance for forest clearing than was once thought. For example, in Britain, there is evidence of cultivation, clearing, and use of fire for game hunting. The tree line in the upland fringes of the Pennines, North York Moors, and Dartmoor is consistently below the altitude at which climatically it was possible for trees to grow, and in places, evidence of successive clearings is accompanied by the presence of pollens of light-demanding plants, such as sorrel and ribwort plantain, which could only flourish as a result of clearing (31, 32).

Second, Neolithic agriculture/settlement had far more spatial and chronological diversity than once thought. In particular, settlement and agriculture were stable in many locations. The significance of the timbered long houses found throughout Europe had been ignored, yet archaeological excavations during the 1970s showed that many had been occupied for many hundreds of (if not a thousand) years, which makes the universal slash-and-burn hypothesis unlikely (33, 34). The current view is that the Neolithics sought out gently shelving sites on the floodplain-lower interfluve slope zone and that settlements were strung out parallel to streams in lower parts of the catchments. Loess soils were usually favored because of their fertility, but they were often heavily timber covered (35). The trees were chopped down by flint and stone axes, and the floodplains were used for intensive garden cultivation and meadows. The Neolithic settlements would have been entirely recognizable to the modern farming eye.

Third, there is evidence that crop yields, particularly of cereals, were sustained for long periods on these soils and that shortfalls in diet were made up by a greater reliance on stock than has hitherto been thought possible. In particular, cattle supplied meat, blood, milk, and cheese, but sheep were also present, as were some pigs. Dairy products were particularly important and constituted what Sherratt (36–38) has called the "Secondary Products Revolution"; producing milk products was an advantageous way of using the rich pasture grasses that would have colonized abandoned fields. When the reproductive dynamics of domesticated herds and livestock generally are considered in detail, then the true significance of Neolithic pastoralism becomes evident. Quite large numbers were needed to make it economically feasible to extract milk, produce meat, and propagate breeding. Herds of between 10 and 20 are too small; 30–50 head are more realistic (39).

Put together, the evidence for Neolithic occupation over a space of some 3000 years is of a more stable, sedentary society and diversified economy than has been thought during the last few decades. It made intensive use of the predominant deciduous forest cover and its resources. Gregg (40), an anthropologist, has simulated nutritional requirements and optimal farming strategies to arrive at the needs and management of risks in a hypothetical village settlement. In her model, woodland is placed in a prime position. A typical six-household, 30-person settlement would have needed to plant 13.2 hectares (ha) of wheat and run a 40-head

herd of cattle along with 40 sheep/goats. The settlement would require 4.5 ha for houses, outbuildings, and garden plots, as well as a woodlot of 52.8 ha and an additional 4.8 ha for timber for construction purposes. The livestock would require 18.18 ha of pasture land (cleared forest?), 19.66 ha of natural meadows, and 2.56 km^2 for forest browse, which could be doubled to guard against overgrazing the forest resource in a locationally fixed settlement. Thus, each group of 30 persons needed a little over 6 km^2 of woodland to survive, a staggering 20 ha per person. Thousands of settlements of these dimensions have been found over the Europe plain, particularly on the loessic soils.

Undoubtedly, large areas of forests were cleared with flint and stone axes, which modern experiments show were capable of being used for forest felling (13, 39). Burning and animal grazing, if intensive enough, would have thinned and ultimately eliminated forest in other areas. The process continued unabated during the late Neolithic to early Bronze ages (c. 3000 to 1000 BC). Charcoal layers in peat deposits, and successive decreases in forest pollens, followed by increases in cereal and weed pollens, together with interbedded farming and clearing implements, leave one in no doubt about the sequence of events.

The cumulative effect of human alteration has been so pervasive and so great that the paleoecologist Faegri said recently that even in Scandinavia, often regarded as a wilderness outpost, a virgin landscape "was a fiction." Rather it was a "cultural landscape" in which "with some small and doubtful exceptions all vegetation types were created or modified by man" (41, p. 1), a judgment echoed by Peterken (42) for the whole of northern temperate Europe.

The Americas: A Forest Transforming

Whereas the Neolithic agriculturalists began significant forest clearing and established permanent settlements from roughly 4500 BC onward, it was not until about 1000 AD that comparable settlement took place in eastern North America. The alteration of all types of vegetation in the Western Hemisphere—from the tropical forests of the Amazon to the temperate forests and prairies of North America—was greater than is generally acknowledged. The idea of a "pristine landscape" or "First Eden" of untouched forest in equilibrium with nature, populated by inhabitants who were natural ecologists, so dearly loved by mid-nineteenth century romantics, contemporary ecologists/environmentalists, "wilderness" enthusiasts, and latter-day politically corrects, has too readily been accepted as a comforting generalization and benchmark against which to measure all subsequent change as well as a goal for future conservation practice. But the impacts were neither benign nor localized and ephemeral; nor were resources always used in a socially ecological way (43, 44). As far as forests are concerned, terms such as "presettlement" and "postsettlement" should be consigned to the intellectual trash can, and concepts like natural and equilibrium have probably not existed since the end of the Ice Age.

One crucial paradox in the traditional view has been the willful omission and even denial of the true magnitude and density of the population in the precontact forest while, at the same time, decrying the depopulation caused by disease introduced by the European newcomers. Rather than the 8–15 million native people present in all the Americas before 1492, as is conventionally thought, it is more likely to have been between 43 and 65 million, and the conservative estimate is 57. 9 million (45, 46); some even suggest double that figure (47). If that was so, then the density of population was approaching that of Western Europe at the same time, and such numbers must have meant extensive ecological transformations, something which was confirmed by the eyewitness settler accounts of well-ordered and prosperous settlements with surrounding fields.

Since the late 1980s, the conventional wisdom and discourse about the origin and nature of agriculture in the eastern woodlands have undergone a complete revolution. Formerly, eastern North America was perceived as being "a marginal, passive, and recipient far

northern fringe" under the influence of the "nuclear centers" of Meso-America, and even South America, and unable to supply the trilogy of basic domestic crops of maize, beans, and squash, which arrived circa AD 900, and then by some unknown diffusion process (48, 49, p. 7). But a different scenario has emerged, and the forests of eastern North America may have sustained an independent process of plant domestication. Three broad settlement episodes have been identified. From at least 5000 BC, if not much earlier, inhabitants of the numerous river bottomlands of the watercourses that traverse the woodland (e.g., the central Mississippi, lower Illinois, Ohio, lower Missouri, Tennessee, and Kentucky and their tributaries) domesticated a series of species, including sumpweed or marshelder *(Iva annua)*, sunflower *(Helianthus annus)*, ragweed (*Ambrosia* spp.), and chenopod *(Chenopodium berlandieri)*, and may even have independently developed a species of squash *(Cucurbita pepo)*. The river-bottom environments favored a coevolutionary process between humans and plants. The violent spring floods, constant channel changes, and annual soil enrichment and disturbance created varied and changing habitats that encouraged colonizing plants to develop attributes that preadapted them for manipulation, selection, and domestication. For example, in the Little Tennessee River valley, continuous Indian settlement is documented for at least 10,000 years, and the amount of disturbance on the surrounding terraces grew with the growth of population. There is evidence of abundant pollens of domesticated crops and progressive clearing and cultivation through the middle and late Holocene, together with lithic remains (50, 51).

With clearing and cultivation, the dominant structure of forest communities was changed, species were extended or truncated, old fields and settlements provided open areas for native ruderals to invade, and the amount of nonforest land increased, "creating a culturally maintained landscape mosaic" in which "the natural landscape was being transformed on a new scale . . . as a result of increasing clearance of canopy level trees" (51a, pp. 87 & 89). The fields provided a dependable, managed, and storable supply of food for the late winter and early spring, a buffer against food shortages when fishing, fowling, hunting, and foraging were impossible. Away from the rivers, the use of fire to facilitate hunting and promote the growth of desirable wild plants and herbage was widespread. It was a broad-spectrum agriculturalist-cum-forager economy, making the most of the marked seasonal abundance of plant and animal resources of the forest, often moving residence with the seasonal shift in resources (51, 52).

Then, between c. 250 BC and AD 200, Hopewellian farming societies emerged as fully fledged food production economies, with recognizable village-type settlements. These societies possibly added erect knotweed *(Polygonum erectum)*, maygrass *(Phalaris caroliniana)*, and little barley *(Hordeum pusillum)* to the four existing domesticated crops. Finally, between c. AD 800 and 1000, *Zea mays* was imported from the tropical areas. Initially, it was a minor crop in a well-established food regime, but suddenly it took off in a "rapid and widespread" (49, p. 292) explosion across the woodland from northern Florida to Ontario, playing a central role in the evolution of complex food-producing societies across the middle latitudes, usually on easily worked terrace soils. The late adoption of maize, and the six-century lag between introduction in AD 200 and the post-AD 800 takeoff is a mystery. Contrary to common perceptions, it is doubtful if even the settlements of the spectacular Hopewellian burial-mound cultures of the Middle Woodland times (0–AD 900) in Missouri practiced agriculture. It may initially have been a controlled ceremonial crop, but it is far more likely that the massive amount of forest clearing needed to grow it, and the maintenance of those clearings, stifled adoption until demographic pressures made the labor-cost-to-food-yield ratio more attractive. Then the forest suffered (49).

By the time Europeans landed in about 1600, fully fledged agriculture had only dominated as a way of life for perhaps 500 years or less on the eastern seaboard and possibly a little

longer further inland. The imprint of agriculture and settled life was unmistakable and locally quite intensive. Although enormous areas of natural forest remained, the land cover was not the vast silent, unbroken, impenetrable tangle of vegetation inhabited by ecologically minded humans, so beloved by many writers in their romantic accounts of the forest wilderness. Rather, it was a mosaic of fire-altered and human-selected species in different stages of succession, of clearings and cultivated fields around villages and houses, to say nothing of the innumerable earthworks, ditches, and route ways. The description by Hawkins (53) in 1798 of the density and complexity of clearings, fields, and villages in the forests, as he crossed and recrossed the numerous Creek settlements along the Chattahoochee and adjacent rivers in Georgia, is probably a reasonably accurate analogue of earlier conditions and represented the culmination of a near millennia of clearing.

Evidence for similar processes of early forest clearing is beginning to unfold for other parts of the Americas. For example, in tropical Latin America, some agricultural or pastoral activities, with associated clearing in the rainforest of equatorial upland areas, may date from at least the early Holocene. Throughout Amazonia, it is difficult not to find soils studded with charcoal (54), and ethnobotanists suggest that much of the Amazonian forest is a cultural artifact or is anthropogenic as native peoples have developed successive resource management strategies to cope with fluctuations in population dynamics and disturbances. Thus, it is a mosaic of different ages, compositions, and structures, made all the more complex by the propagation of useful tree crops, such as nuts, palms, and bamboo, and the diversity of plants has increased. Thus, even in areas where Indians have disappeared, the evidence of human manipulation and management may still be evident (55–57). Similar arguments can be made for the Maya lowlands and other parts of tropical Central America (58). It is estimated that at present up to 40% of the tropical forest in Amazonia is secondary forest, resulting from clearing, and that the remainder has suffered from some sort of modification. Simply "there are no virgin tropical forests today, nor were there in 1492" (43, p. 375).

Delcourt, writing about the Americas (59), has suggested that early humans, wherever they were, produced four major changes to the forest:

1. The increased frequency and magnitude of disturbance resulted in the expansion of nonforested patches or clearing.
2. The increasingly sedentary life style, the development of territorial control, and the high-energy investment in the cultivation of crops resulted in a new sort of disturbance in which large areas were kept in the early stages of succession, which allowed the invasion of subsequent weed populations.
3. The selective utilization of plants by humans and animals resulted in long-term changes in the dominant tree structures within forest communities.
4. There were substantial changes in the distributional limits of certain species.

Whether in Europe, the Americas, Africa, or Asia, the record is clear—the axe, together with dibble-and-hoe cultivation, and later the light plow, often integrated with pastoral activity in Old World situations, reduced the extent of the forest. Fire was particularly destructive in this process. It was not a pristine wilderness in which the indigenous inhabits were either incapable or unwilling to change anything. Everywhere, it was a far more altered world and forest than has been thought up to now.

THE MODERN ERA (POST-1950)

One might think reasonably that the uncertainties that characterized the deep past have been eliminated during the present, but nothing could be further from the truth. Although individual clearing episodes have been mapped and calibrated, for example, in Amazonia, Malaysia, and Thailand (60, 61), the overall picture is anything but clear. The uncertainties fall into four main categories and have to do with elements

of the calibration of (*a*) the extent of the global forest, which is often used as the base for calculating change; (*b*) the total amount cleared; (*c*) the processes or pathways of change; and (*d*) the rates of change. It is salutary to remember that, until the advent of satellite mapping of forest clearing during the late 1990s, historical data were the only source and that record is remarkably sketchy and not totally reliable.

Forest Extent

The extent of the global forest depends on what one regards as "forest." Obvious long time series sources, such as the Food and Agriculture Organization of the United Nations (FAO) (62), are notoriously variable and unreliable, and there are many quite conflicting definitions. Suffice it to say, most people make a broad distinction between a closed-canopy tree cover (forest), where tree crowns cover more than 20% of the area (many countries opt for a much higher figure of 30%–40%), and an open forest (sometimes called woodland), usually mixed forest/grasslands, with at least 10% tree cover. We cannot be more precise.

Originally, estimates of the extent of the modern (c. post-4000 BP) closed forest were pioneered by foresters and botanists from a disparate set of sources. Seminal was the 1923 calculation of the foresters Zon & Sparhawk (63) who estimated a figure of $\sim 42 \times 10^6$ km^2, which was then followed by at least 20 other estimates before 1980. After that time, climatic modelers led the field and analyzed sources digitally by creating files based on a grid of either $2^\circ \times 2^\circ$ or $1^\circ \times 1^\circ$ latitude and longitude or km^2 cells to get an objective quantitative measure for use in conjunction with global circulation models (GCMs) and other calculations, such as albedo, surface roughness, biomass, and others. In this way it was hoped that the problems inherent in qualitative maps would be overcome and statistical measures of the area and the change achieved. A notable pioneer attempt in this was by Matthews (64). However, the fact remains that, despite adopting an agreed vegetational classification (often the UNESCO hierarchical system based on life-form subdivided by variables such as density, altitude, and density), the data are still compiled from over 40 vegetation atlases, with all the problems inherent in that. Most recent calculations dispense with the mapping of forests and rely on crop estimates (reasonable since 1700) and project them backward and forward using complex calculations.

FAO: Food and Agriculture Organization of the United Nations

The lack of agreement in the estimates is startling but not surprising. The 28 calculations between 1923 and 2007 range from 63.5×10^6 km^2 to 23.9×10^6 km^2, distributed randomly around a mean 41.27×10^6 km^2 with a general firming up around the low 40s (2). The four latest estimates for 1999 (65), 2000 (66), 2002 (67), and 2006 (68) are for 43.27×10^6 km^2, 43.56×10^6 km^2, 45.40×10^6 km^2, and $40.5–42.2 \times 10^6$ km^2, respectively. However, it is noticeable that the most authoritative report to date on the world's forests by the Millennium Ecosystem Assessment (MEA) (69) shies away from making any independent assessment and instead uses the FAO's Forest Resources Assessment 2000 (FRA-2000) because it is the most globally comprehensive and consistent assessment. Nonetheless, the MEA is unusual among major reports in pointing out the inconsistencies of data in various estimates, owing to incompatible areas, compilations, and definitions, and even the FRA-2000 (which it uses) is not exempt. For example, FRA-2000 uses only 10% crown cover as a minimum threshold for forest for all countries, which conflicts with accepted "scientific definitions of 'forest' as a vegetation type as well as with traditional use and understanding of the term" (69, pp. 592–96). It is simply too low a figure. In addition, FRA-2000 uses remote sensing for only 10% of the tropical forests, focusing on 117 randomly selected sites, although it is known that deforestation occurs in quite specifically concentrated zones (e.g., along roads) and is anything but random (69, 70).

Because of these uncertainties, the reduction in forest extent over time cannot be used to estimate forest loss. In any case, once-forested areas do regrow with amazing rapidity if the ground is

UNEP: United Nations Environmental Programme

left uncultivated. Forests are dynamic entities, and whenever population pressures have been relaxed, they can regrow with amazing vigor. Examples include land after the Mayan population collapse c. 800 AD (71), after the Great Plague in Europe in the mid-fourteenth century when over a third of the population was wiped out (72, 73), after the initial European encounter with the Americas and the decimation of the native population by disease, and more recently after agricultural areas were abandoned after 1910 in the east and south of the United States as well as in Europe after 1980. Ramankutty & Foley (65) suggest that, between 1850 and 1992, global regrowth may have been on the order of 2.35×10^6 km^2.

Forest Loss

Because of the variation in the estimates of the extent of the forest, which is the base line for many calculations, the amount of forest cleared during historical and contemporary times is also open to various interpretations. Matthews (64) thought that preagricultural closed forest cover was 46×10^6 km^2 and more open woodland 15.23×10^6 km^2 and that there had been reductions by 7.01×10^6 km^2 and 2.13×10^6 km^2, respectively. Historical reconstructions by Williams (74, p. 179) on the basis of known clearing episodes and the potential rates of clearing using population numbers in the past support the general magnitude of change as being between approximately 7.44 and 8.05×10^6 km^2 (2, 74). Ramankutty & Foley (65) opted for a higher figure of 11.4×10^6 km^2, diminishing at least 1.5×10^6 km^2 with regrowth, which brings the total global loss down to 9.1×10^6 km^2, a figure not that dissimilar to the two previous estimates made under entirely different assumptions. The recent calculations of Hurtt et al. (68) are more complex, include shifting agriculture and wood harvesting in addition to clearing for agriculture, and suggest a total loss of between $12–15 \times 10^6$ km^2 of primary forest and $4–6 \times 10^6$ km^2 of secondary forest (possibly open woodland), although regrowth does not appear to be factored in.

Thus, the total area of the forest in the world has possibly decreased by between 19% and 22% in three cases and up to 29% to 36% in the latest case. This is a massive amount to be sure, but not, perhaps, the worldwide devastation that is commonly supposed. Further refinement of these figures is unlikely because, as Hurtt el al. (68, p. 1226) point out, their results "depend on uncertain inputs, and rely on simplifying assumptions," a qualification that could justifiably be made of all the above calculations.

Pathways and Processes of Change

The clearing of forest land is not a simple set of binary opposites of trees or no trees, but everything in between, especially in the tropical forests, which are the focus of current concerns. Often deforestation is qualified with words like clearance, conversion, modification, and disturbance. For example, in the FAO/United Nations Environmental Programme (UNEP) report (75), *deforestation* refers to the "complete clearing of tree formations," resulting in either a shifting cultivation cycle or permanently cleared land. Curiously, it did not include logging. Myers, in his report for the National Academy of Science in 1980 (76), said that *conversion* included any modification of the forest from "marginal modification to fundamental transformation," which could include permanent clearing, logging, and selective harvesting.

Equally as contentious as definitions and, indeed, part of the reason for the confusion is the role of logging. Some assert that selective logging does not lead to forest clearance and so does not constitute deforestation, whereas Myers (76) thinks that logging is crucial because, although it may only affect a small proportion of trees per hectare, it damages wide areas and is the precursor of penetration by the forest farmers. Thus, the "commercial logging/follow-on cultivator" combination is the "primary" cause of tropical forest conversion (76).

An even bigger problem lies in the role of rotational, shifting agriculture in causing either permanent forest change or merely disturbance, although ultimately both lead to

ecosystem change and degradation. Possibly only between 60% and 70% of land cleared for agriculture remains permanently without trees, the rest becoming fallow and returning to some form of forest. When one realizes that the number of shifting and shifted (displaced) agriculturalists might be 250–300 million and that they may be affecting as much as 190×10^6 ha, then their total impact on the forests is considerable.

One scenario of the pathway of change is that from a stock of untouched closed broadleaf forest, an annual amount of 70,000 km^2 is deforested annually, of which 51,000 km^2 is cleared totally and passes into the land-use category of permanently cleared forest and the remaining 19,000 km^2 goes into the category of fallow (shifting) closed forest (77). At the same time, there is some 34,000 km^2 of forest that is left fallow and open as a result of the annual cycle of shifting. But as population increases, cropland is overtaxed and fallows are shortened, so that 101,000 km^2 of that open forest is converted annually to permanently cleared land. In fact, the net reduction of the fallow forest category is only 82,000 km^2 because of the annual addition of 19,000 km^2 of newly disturbed nonfallow forest. If this pathway is correct, then a total of 152,000 km^2 is being cleared annually in the tropics, with 51,000 km^2 coming from the nonfallow forests and 101,000 km^2 coming from the fallow forests that were once a part of the shifting cultivation cycle. Similar calculations of pathways can be hypothesized on the basis of FAO/UNEP data (69, 78). Clearly then, with shifting cultivation, much forest must either become totally degraded or, more likely, become some form of open woodland or grassland. The internal dynamics of the pathways of change are critical to calculating rates of deforestation but are imperfectly understood.

Rates of Change

Just as the extent of the forest has been open to wide interpretation so has the rate of change. When Sommer (79) produced his pathbreaking inventory of tropical moist forests in 1976, along with an estimate of the rate of deforestation, it was to counter what he called the almost universal "euphoric belief" of the unlimited extent and growth of those forests. But thirty years later, we are probably no nearer to knowing the rough—let alone the exact—rate of deforestation over the globe. It is still a largely unresolved and contentious question.

After 1976, assessments continued to fluctuate widely, and most were based on interpolations of data from selected countries. Suffice it to say the rough parameters of magnitude (7.5 to an utter extreme of c. 20 million ha/yr) have been set, the lower figure being generally acknowledged to represent the complete removal of trees, the upper figure depending upon a wider definition of deforestation, which could include modification to some degree, so that an area equal to or even nearly double that destroyed could be severely disturbed or degraded. The latest and most authoritative assessment is that by Singh (80) for FAO, and it is based on a continuous monitoring record, using a combination of ground-level and remote-sensing data and Geographical Information Systems mapping for 90 countries. Between 1981 and 1990, the annual rate of deforestation (i.e., a change of land use with the depletion of the tree crown cover to less than 10%) was 15.4 million ha. However, a subsequent analysis of data for 1990 to 1997 puts the figure lower at 5.8 million ha $^+$/- 1.4 for humid tropical forests with an additional 2.3 million ha $^+$/- 0.7 visibly degraded (81).

In all this debate, it is salutary to realize that, between 1976 and 1998, only two primary sources of data have been produced—those made by FAO/UNEP and those made by Myers in 1980, one incorporating some objective satellite-measured data, the other relying on the expert assessment of an individual. All other estimates, including those made to date by the World Resources Institute, have been derived from these estimates, and their secondary nature makes them less reliable (82). Their variability depends on definitions of what is deforestation and what is conversion, the roles of logging and shifting agriculture, the types of forest considered (closed or open), and whether

they are specific measurements by remote sensing, or subjective judgments, or a combination of both. Some are extrapolations from sample areas, some are averages, some are actual, and some potential.

Thus, we are left with the knowledge that the exact magnitude, pace, and nature of one of the most important processes of the environmental change over large portions of Earth is largely unknown. This is not a purely academic question because, with the advent of global carbon emissions trading and the strong possibility that forest extent (and hence gain or loss) will be used to offset industrial emissions, untold millions of dollars will be transferred between countries on the basis of highly suspect data. In all this uncertainty, we can be sure of two things: The debate on the rate of clearing is not over, and the rate of change is constantly downward.

REPORTS AFTER 1995

Although the quantitative measures of forest clearing are now firmly in the hands of climatic modelers and satellite imagers, there has been no lack of qualitative, historical writing about clearing by environmental historians, political activists, and others. The flow of books and articles on the early modern and modern periods (c. 1750–1900, 1900–1950) has burgeoned in recent years in line with the growth of environmental history in academia. The literature contains a wealth of empirical material on the processes of clearing, although, as usual, often only obliquely and incidentally while considering other themes. Works published since 1996 are listed conveniently in the "Biblioscope" of the new journal *Environmental History* and in the articles and reviews in the European-based journal *Environment and History*, starting a year before (83). The majority of works are about the United States, which reflects the dominance and output of environmental history scholarship in that country, and about the forests of former colonial territories (particularly India), which reflects British and Indian scholarship. Another group deals with more general issues but with an emphasis on the environmental, aesthetic, cultural, and even religious implications of forests and their clearing.

But geographical locale aside, the interesting thing is that traditional writing about the forest is under siege as past practices are increasingly questioned (84). The past emphasis on the highly regulated forest, aimed at maximum high production, is more or less a thing of the past. Similarly, accounts about the development of forest conservation, corporations and prominent individuals, forest transport and machinery, labor, and unions have also largely stopped. These are all usually the preserve of the retiree forester and of those with a nostalgic view of the grandeur and romance of the old logging days. To the justifiable claim by the forest industry that it was the first real environmental movement, and has been in the forefront of conservation and stewardship with environmentally friendly practices of sustained yield and multipurpose management, has come the criticism that it has had too cosy a relationship with big business. In fact, the forest-based industries are the epitome of big business, and many have become the unacceptable face of giant transnational corporations and the enemy of native peoples.

Moreover, critics point out that high-level production is ecologically unsound as it entails the elimination of the natural canopy forest and its replacement with uniform stands of vigorously growing young trees that produced high annual increments of wood fiber, which also means a reduction of biodiversity. Old-growth forests, or ancient forests, are preserved only in national park and wilderness areas as monuments to the past and are of no value for the production-orientated forester. They are considered overmature and decadent and consequently are logged out (85). Even the ideal of sustained yield has been abandoned because it does not equate with a sustained stock of trees. In fact, they are polar opposites because a high level of perpetual sustained yield is obtained only when old growth is converted to vigorous and usually homogeneous stands of young timber. For ecocentricists, nothing in nature should be destroyed.

Many of these criticisms have been taken on board by practical foresters (86). Emphasis on regulation is being curbed and a concern for the global environment (including biodiversity; ecological system complexity; aesthetics; protection of natural fauna and flora; clean air and water; and carbon sequestration, among others) is being substituted. Production has not been abandoned, but it has certainly been played down in the light of economic prudence. This has meant a broadening of values away from fiber production, efficiency, and even conservation to include aesthetics and sustainability of natural ecological processes, common rights, and an innovative recognition of the complexity of the subject. It is no wonder that foresters today find that they "spend more time moderating human conflicts than measuring trees" (87, p. 27). The overwhelming fact is that the forest is no longer just about trees (even if it ever was), and there is a recognition that its connections to the wider economy, ecology, and culture are needed.

Nowhere in the natural world are nature/culture relationships more evident than in the forest, which is that part of nature that is alive, growing, and consequently, over long time spans, is open to adaptation, mutation, and change. Forests are dynamic and unstable and are not perfectly balanced systems, e.g., forests can undergo change and return to a similar, although not necessarily to exactly the same, state (88). For decades, ecologists have been arguing that this is so, but few environmental historians, and even environmentalists, have understood it until now and have clung, instead, to outmoded concepts of balance, stability, and equilibrium. However, new books on forest ecology, forest dynamics, and anthropogenic changes (89, 90) leave no place for misconceptions any more.

From all this debate has grown the realization that the history of the forest is also the history of forest policy, which brings us squarely into the realm of environmental concerns. There has been a reshuffling of the canonical feelings and values and the adoption of a new language and approach for a new discourse with reframing and reinterpreting being words frequently used. The unfolding of this discourse, as McQullian (91) aptly says, "puts flesh on the carbon-based bones of forest history."

Table 1 Frequently used words in recent titles on the history of forest clearing

Conflicts	Social Processes	Values
Contested	Justice	Inventing nature
War	Rights	Values
Conflicts	Power	Identity
Peril	Politics	Myth and legend
Action	Struggle	Memory, civilization

A flavor of the emphasis of recent works is given by the following list of some of the key words in titles of recent works. They fall into three broad themes, which are dealt with now (**Table 1**).

Conflicts

One of the unintended outcomes of reducing Northern Hemisphere high-volume production of forest products, and stemming the problems of regulation and science in the context of ever-expanding consumption, has been to obtain timber from elsewhere. The Japanese, age-old, dense forest cover is one of the earliest and best of examples of this (92), and the same has always been true, to a certain extent, of Western Europe's high consumption and importation of overseas timber, although the Baltic forests filled the gap until the mid-nineteenth century. But these countries are now joined by the United States, which used to be a major exporter (93, 94). Between 1900 and 1995, abandonment of marginal land, set-aside and land bank schemes, as well as environmental awareness of agricultural overcultivation have added greatly to the forest area while net clearing has been virtually nil. In the Southern Hemisphere, by contrast, clearing has been about 548×10^6 km^2, and some put it higher at 555×10^6 km^2 (2, 95). If we accept the estimate of Singh (80) of $\sim 15 \times 10^6$ km^2 cleared annually since 1995, then an additional 180×10^6 km^2

has been cleared from 1995 to 2006, making a total of 728 $\times$ 10^6 km^2. Carrere & Lohmann (95), in their provocative book *Pulping the South: Industrial Tree Plantations and the World Paper Economy*, call it the new "forestry imperialism"; more recently Jensen & Draffan think of it as being "strangely like war" (96). Of course, not all of that possible total of 728 $\times$ 10^6 km^2 has gone into supplying timber for the North. Millions of hectares are cleared because of individual peasant and government land clearing schemes, the latter in particular in Brazil, peninsular Malaysia, and Indonesia.

Reforestation is not the simple and beneficial answer that it seems at first sight, as quick-growing and high-yielding species like spruce, *Pinus radiata*, and eucalypts supplant native species, often with disastrous ecological effects and a loss of biodiversity. In Sweden, for example (97), productivity has increased as deciduous woods have been replaced by coniferous forests (deciduous woods down from 40% of southern forests in 1920 to 14% in 1977), spruce has replaced pine *(Pinus sylvestris)*, and more recently the high-yielding American lodgepole pine *(Pinus contorta)* is replacing all other trees. The forest is no longer a wilderness of old-growth mature timber but a manipulated stand of even-aged, even-spaced exotic trees, maintained by thinning and fertilizing and by disease and fire control. It is an almost totally managed human artifact.

Social Processes

It is probably true that most forests in the world have been at some time or other community property. In medieval Europe, for example, the forests were deeply embedded in the fabric of everyday life and provided peasants with land for clearings and pasturage as well as fuel wood and constructional timber (98). These rights were frequently embodied in a complex body of usages and customary laws. However, the monarchs were infatuated with the pomp of hunting and reserved large parts of the forest for their exclusive use, which led to demarcation, regulation, and even prohibition as territorial control was exercised and extended.

Similar arguments have been played out in the modern forests, especially those of the former colonial world, but not exclusively so, as witnessed by works about North America (99). Since the late eighteenth century, the nation state has replaced the autocratic monarch, and its officers have attempted to get total control of the forests in their aim to maximize production and state revenues, leading to ecological simplification (100). Taxation, statutory tenure codes, and the inevitable mapping in order to fix tenure have left the customary users powerless, unless they revolt. British management of the Indian forest pre-1945 was exemplary at one level, but exclusion of the native people and the consequent conflicts and struggles to establish rights were probably major causes of anticolonialism, and the problem of exclusion still exists in the modern Indian state (101–104). The same action is being replayed in Africa (105, 106) and throughout most of the tropical world. Hence, the titles of recent literature are sprinkled with the words justice, rights, power, politics, and struggle (107–109).

Shadows of the Forest

Forests hold a special place in the human imagination that frequently transcends the material conditions of state control, customary rights, regulation, production, and globalization and that affects our attitudes to clearing. Often the imagination is based on myth and legend, but these cannot be discounted as they evoke ideas, contribute to cultural and social practices, and contribute to visual images and text. Imagination becomes part of the repertoire by which we recognize the world around us.

Why are we attracted to trees and forests? Why do we care so much about them and get incensed at the felling of trees both individually and collectively? Why do the words "tropical deforestation" trigger such a reaction of concern? The answers to those questions, particularly the latter, have usually been provided in rational, scientific terms, such as biodiversity,

soil erosion, or even climatic change. Although all these have validity, it is suggested that beneath them lies a deeper sentiment or feeling of which most of us are dimly aware—that trees and forests have cultural meanings often embodied in religion, legend, myth, or even fairy tale and that these meanings transcend the objective reality of presence or loss (110–115). The endurance and universalism of these symbolic meanings link past and present, and widely different parts of the world.

Two recent works—Harrisons's *Forests: The Shadow of Civilization* (116) and Schama's *Landscape and Memory* (117)—reaffirm the power of symbolic myth and memory. Forests, Harrison suggests, have a central place in our cultural imagination. Because they have been so widespread in the Northern Hemisphere, western civilization has been defined by its forests, and it has literally "cleared its space in the midst of the forests" (116, p. xi). Moreover, clearing and cultivation defined the limits of the known and unknown world both physically and imaginatively. Many of the distinctions we make between light and dark, right and wrong, and even male and female are the basis of civilization. However, the forest has always upset these simple binary opposites. Forests have long been regarded as the place of evil and savagery (*savage* is derived from *sylva*, forest) and the abode of the wicked, the outlaw, and the lawless. Nevertheless, for some (e.g., early Christian saints and transcendentalists like John Muir), it was a sanctuary or paradise and place for spiritual contemplation. Forests upset, confuse, and destabilize civilization. But in the process of civilizing, the first and last victim has always been the forest. As civilization becomes center, the edge recedes so that forests move further away from habitation and the unknown, and that "edge of opacity" where the human abode "finds its limits on earth" (116, p. xi) (the wild, or wilderness, in other words) is gradually lost. Thus, the forest marks the edge of both the literal and imaginative domains, which we have lost; the outsideness is gone, the edge of exteriority vanishes, and the inside becomes emptier.

If the forest is the core of civilization for Harrison, then it is a major, if not the largest, part of terrestrial memory for Schama. It is our "shaping perception [that] makes the difference between raw matter and landscape," in which memory, especially social memory, binds both together, and which has had a surprising endurance through the centuries (117, p. 10). Below our conventional sight level are the veins of myth and memory, a complex and ancient heritage, which binds culture and nature together. Schama draws a positive conclusion from this store of memory, which he sees as a partial answer to our current environmental crisis. Rather than evoke what Oelschlaeger (118) calls new "creation myths" to heal the breach between materialist, urbanized culture, and the organic world of nature, we should draw sustenance from our existing inheritance of myth in order to realize the strengths of the links between them and what we stand to lose by continuing forest use and abuse. Consequently, memory is "less a recipe for action than an invitation for reflection" (117, p. 18). But whether the largely secular and atheistic society of the West can empathize with the sacred, and substitute faith for reason, seems problematical.

Both works are brilliant, provocative, yet frustrating because they are not by social scientists but by a literary theorist and a historian, mainly of western art. Harrison, in particular, contains unreflected presuppositions, is puzzling and difficult; the book's own irony occasionally becomes "a bit thick as in the word-plays and double inversions of meaning that have become an all-too-predictable part of postmodern literary criticism" (119). Schama's richly illustrated book, by contrast, is written with brio and is vivid, elaborate, unashamedly colorful, and informative, yet it does not depart from the evidence in any seriously misleading way. But its meandering length, with myth, faith, fable, and iconography breathlessly jumbled together, leaves the reader feeling that it dazzles more than it illuminates. These qualifications aside, both authors affirm that nature is a cultural product and that history matters

in the understanding of place, so that "nature without history has no being" (116, p. 242). The forest is still an enigma and a paradox; nonetheless, because of its cultural history, it still commands deep feelings in the contemporary world.

DREAMS, NIGHTMARES, AND MISREADINGS

Two books from the mid-1990s, more than any others, encapsulate the debates and discourses that run through the writing by environmental historians, social anthropologists, and environmental activists about the contemporary forest and its clearing; these are Langston's *Forest Dreams*, *Forest Nightmares: The Paradox of Old Growth in the Inland West* (120) and Fairhead & Leach's *Misreading the African Landscape: Society and Ecology in a Forest-Savanna Mosaic* (105).

Forest Dreams and Nightmares

Langston's study of the forests of the Blue Mountains of eastern Oregon and Washington begins when pioneers exploited the rivers, forests, and grass. Ponderosa pine was indiscriminately stripped out, nonfarmable cutover land covered large areas, and fires ravaged the rest. Cattle, and then later sheep, grazed-out the natural pastures, and wildlife was hunted and exterminated. By1906, the professional federal forest managers took over in order to save the Blues and applied their orthodox practices on the forest. The forests were withdrawn from the public domain and placed in the new forest reserve system. With the best possible motives, they set out to stem the corruption of land disposal and the greed of speculation and resource misuse. Their job was to achieve the conservation aim of "the greatest good of the greatest number for the longest time" in the face of a perceived timber famine of the interwar years. With selfless, enlightened scientific knowledge, they imposed a management system designed to maximize the yield of the forest and restore the grasslands of the mountains. Less productive old-growth timber (decadent and immature) was cut out and replaced by younger, faster-growing trees that ensured a supply of timber and protected the watersheds. They saw themselves as heroes in an almost epic struggle against big business, outsiders, insects, disease, even against the forest itself (120). But the Forest Service turned the forest dream into a forest nightmare, and by about 1980, the results of past practices were becoming evident. Light logging, with shorter and shorter cutting cycles of 30 years or less, smashed the ecology. The interests of fire management liquidated the ponderosa pines, but introduced firs. Insect infections became more frequent and more devastating, and wildlife collapsed.

At the heart of the problem was the age-old American propensity of seeing nature and people as separate entities (121). The Forestry Service is now mandated by Congress to return the forests to their presettlement structure. This means restoring all characteristics of the natural system, such as death, decay, and waste, as well as inefficiency, uncertainty, and redundancy. However much this is an improvement, it is still an attempt to control natural processes; in abandoning one discourse, forestry has adopted another.

Misreading the Forest

In the developing world, the break with the paradigms of the past has come less with the positive act of promoting tree growth (forestry) than with understanding the negative act of destroying trees (deforestation). Much of the tropical forest has been badly misread or misunderstood, and its inhabitants unjustly accused of either apathy or wanton destruction. Yet indigenous knowledge invariably rejects the nature/culture dichotomy and stresses the idea that "nature is culture" because the forests are manipulated by human practices that are an intelligent accommodation to the environment (122). If manipulation of the forest by native peoples is acknowledged, then the dominant discourse of the imperial and colonial political overlordship of the past has been that it had been mismanaged and should be

repressed and that western development and its science and organization should be applied (123, 124).

Nowhere has this been more amply demonstrated than in the grassy savanna-forest mosaic of western Africa (105, 125). The conventional wisdom has been that the landscape has been degraded and that the remaining patches of prominent forest—the "forest islands"—are relicts of a formerly extensive forest cover midst a sea of savanna. Ever since the first French occupation of the Kissingdougou landscapes of Guinea in 1893, and even into contemporary independence, administrators have been convinced that "savannaization" has been the result of repeated firing of the forest by the local inhabitants. So strong was this interpretation, that outsiders, including foresters, politicians, colonial civil servants, and modern-day aid agencies, sought to take resource control away from the local inhabitants, imposed repressive policies, and even criminalized certain forms of land use. In the 1970s, the setting of bush fires to promote grazing carried the death penalty. The dominant discourse was an exercise in power.

But the Kissingdougou landscape is one that is filling with forests, not emptying; the irrefutable evidence of satellite imagery shows that the forests are growing in size. The local inhabitants have an intimate relationship with the forest. Everyday activities, such as cattle keeping, thatch collection, gardening, defecation, and burning, contribute to the growth of forest islands, which are important in the daily lives of the inhabitants as sources of timber, fuelwood, food, and medicines. The system has been compromised by inappropriate outside interventions, significantly by environmentally conscious researchers who cynically see this supposed degrading environment as a way to gain money, justify budgets, and attract major international funding for rehabilitation.

This flawed discourse has had detrimental effects on local life. First, the locals have been impoverished by the imposition of taxes and fines on forest use, thus reducing their opportunities to benefit from their resources. Second, locals have been accused of wanton destruction, and their everyday activities criminalized, and they have been denied the technical validity of their ecological knowledge and development. Third, it goes without saying that they have been denied the value and credibility of their cultural forms, expressions, and even basis of morality, so that at times even their intelligence and consciousness have been denied. And fourth, the perspective of the dominantly urban-based postcolonial administrators toward the rural locals has been antagonistic. They are seen as incapable of responding to modernity, which reinforces ethnic stereotypes and differentiation. The general argument about the exaggeration of deforestation has been extended to a much wider area of West Africa (106), although it has been questioned, and to other areas of East Africa (125, 126).

CONCLUSION

If the record of global forest clearing can be said to be a "history. . . imperfectly kept" (1), it can also be said to be a history that is capable of endless interpretation and reinterpretation. The simple fact is that the relationship between humans and their environment is a two-way, reflexive process in which human knowledge, practices, and theory often produce that natural environment, which then becomes a human artifact and resource, and in turn affects human behavior. We have to be aware of the way our expectations and ideas of the natural world actually mold the way we use and manipulate it (127). Humans and nature are not binary and mutually exclusive opposites but are intimately entwined in the clearing, alteration, and preservation of forests.

Environmental historians and others with a similar interest in the forests of the past are attempting to expand our knowledge and fill in some of the gaps. Their continual evaluation of sources also helps us see more clearly some of the strengths and weaknesses of contemporary claims for forest change and helps us evaluate current orthodoxies. They certainly do not have all the answers about the extent of the

forest and the rate of deforestation, but they have heightened our awareness of the subtle interplay, both real and imagined, between people and their forests.

SUMMARY POINTS

1. Deforestation is as old as human occupation of Earth.
2. Tracing early forest change relies on paleobotanical and archaeological evidence.
3. Historical records of forest clearing are few and far between, and surrogate measures, such as land cultivated or population numbers, are frequently used to assess change.
4. Contemporary records are marred by uncertainties.
5. The uncertainties impact the fine-tuning of current and future political, economic, and social decisions to combat environmental change, especially climate change.
6. Environmental historians have attempted to clarify motives, conflicts, and values in forest clearing.
7. Forests and their disappearance have an emotive appeal and value that runs deep in many cultures.

FUTURE ISSUES

1. Greater cooperation of all disciplines is needed to understand the clearing of the forest of the past. History is an amalgam of all human knowledge.
2. All history is an interpretation of facts, and current environmental historians must be aware of natural ecological processes and varying interpretations of human actions when writing about the forest.
3. Current calculations of forest clearing can no longer rely on "eyeballing" accounts and must use the full technology of remote sensing.
4. Projections of future trends must be treated with caution, and it must be recognized that the basic data incorporate many uncertainties because of sampling and extrapolation.
5. Will carbon trading arrangements incorporate the positive effects of carbon sequestration by standing timber and count in the national and global totals, and therefore lead to less clearing?
6. Will the trend to clean biofuels mean more forest clearing as more land is cultivated for combustible crops? Since the beginning of 2008 "Food Poverty" through biofuel expansion has steadily risen to become a major new environmental issue.
7. If so, putting aside the environmental desirability of clean biofuels, their expanded use may depend on the global price of petroleum.

DISCLOSURE STATEMENT

The author is not aware of any biases that might be perceived as affecting the objectivity of this review.

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