Forest Plantations and a Vision for Restoring the Forests

By

David G. Victor[1]

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TOWARD SKINHEAD EARTH?

Eight thousand years ago, when humans played only bit parts in the world ecosystem, trees covered two-fifths of the land. Since then, humans have grown in number while thinning and shaving the forests to cook, keep warm, grow crops, plank ships, frame houses, and make paper. Fires, saws, and axes have cleared about half of the original forestland, and some analysts warn that within decades, the remaining natural forests will disappear altogether.

I don't need to convince this group that forests matter. A good deal of the planet's biological diversity lives in forests (mostly in the tropics), and this diversity diminishes as trees fall. Healthy forests protect watersheds and generate clean drinking water; they remove carbon dioxide (a greenhouse gas that traps heat in the atmosphere) from the air and thus help maintain the climate.

As the world ponders how to stem the loss of our forests, it is crucial to articulate visions of the future that are *feasible* and *desirable*. For forests, especially, change is slow. Goals are needed to help orient our actions today and to focus hope, where it merits, on the real levers that can spare and restore forests.

Here I report on one such vision that my colleague, Jesse Ausubel, and I have helped to articulate through a process of debate and analysis with a cross-section of the key players—from industry, environmental groups, indigenous peoples, and governments. We learned from experts of diverse backgrounds and we benefited, especially, from dialogue with the WWF/World Bank Forest Alliance.

Our thesis is that, fortunate for forests, the twentieth century witnessed the start of a "Great Restoration" of the world's forests. Efficient farmers and foresters are learning to spare forestland by growing more food and fiber in ever-smaller areas. Meanwhile, increased use of metals, plastics, and electricity has eased the need for timber. And recycling has cut the amount of virgin wood pulped into paper. Although the size and

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[1] *David G. Victor is Director of the Program on Energy and Sustainable Development at Stanford University and Adjunct Senior Fellow at the Council on Foreign Relations. This paper is based heavily on an essay by Victor and Jesse H. Ausubel, Director of the Program for the Human Environment at Rockefeller University. For the original see Victor and Ausubel, 2000, "Restoring the Forests,"* Foreign Affairs, *vol 76(6), November/December, pp. 127-144. That essay is based on the findings of a Council on Foreign Relations study group; for more information and copies of the background studies that inform this work, see http://greatrestoration.rockefeller.edu.*

wealth of the human population has shot up, the area of farm and forestland that must be dedicated to feed, heat, and house this population is shrinking. Slowly, trees can return to the liberated land.

In the United States, as in many countries, this Great Restoration began with a big stick. Horrified that farmers and loggers were stripping America of its trees five times faster than they were growing, and worried about the economic consequences of a "timber famine," President Theodore Roosevelt created the federal Forest Service and pushed landowners to start sustaining timber resources. Since about 1950, U.S. forest cover has increased -- despite the country's emergence as the world's bread and wood basket. Geographers have observed a transition from deforestation to reforestation in countries as distant as France and here in New Zealand, where new production methods have spared forests and regulation has locked the gains in place. Studies by forest experts in Finland reveal that by the 1980s, wooded areas were increasing in all major temperate and boreal forests. These mid- and high-latitude forests account for half the world's total and span some 60 countries. Such forests today are also healthier: the biomass (or total amount of living matter) per hectare (100 meters square, or about 2.5 acres) has increased even more rapidly than the size of the forests themselves.

But the Great Restoration is far from complete. Despite major gains in some areas, the world's sylvan balance sheet still bleeds trees, owing to widespread deforestation in the tropics. Yet even there, progress has begun to peek through. Preliminary satellite data suggest that the rate of tropical deforestation has slowed ten percent in the last decade. New studies in tropical western Africa reveal that deforestation in that region is only one-third the rate previously believed, and in some areas forests are rebounding. Brazil, for its part, is often in the forest press. Farmers' fires, cattle ranching, and timber cutting denude the Brazilian Amazon by perhaps half a percent each year, and the government seems powerless to stop it. By some estimates, four-fifths of Brazil's local wood consumption is illegally felled. Yet at the same time, Brazil has become a powerhouse in forest planting. Established on already degraded and abandoned land, eucalyptus and pine stands in Brazil supply a rising fraction of the world's lumber and paper and relieve the pressure on natural forests.

Yet still the world's forest estate dwindles because the forces of the great restoration have not spread rapidly or widely enough. What must be done to expand and accelerate the Great Restoration worldwide? To answer that question and build a vision of the potential for the “Great Restoration” we focus on agriculture and logging -- the two main threats to natural forests. We argue that these two industries must continue their transformation into modern, ultra-efficient industries. I will focus here on logging and, especially, on the role of high yielding plantation forests—the subject of this conference. But, if briefly, I also address the role of agriculture because it is the world’s largest land user; great efforts in the woods can be dashed on the fields of farmers.

Figure 1 summarizes our findings and illustrates the immense areas at stake. Two paths now stand open. Along one, leading to the "Skinhead Earth" scenario, quaint and inefficient agriculture and forestry will persevere. By 2050, forests will dwindle by 200 million hectares -- about five times the area of California -- and lumberjacks will regularly shave about 40 percent of forests. Along the other, however, farmers

and foresters will intensify production and shrink their footprint. Forests will spread anew to more than 200 million hectares, and only 12 percent of forestlands will hear cries of "timber." Our focus year of 2050 may seem distant, but trees grow slowly, and capital-intensive logging firms adjust their practices gradually. In one decade -- the time frame for most policies – little change can appear. Focusing attention on the global potential for high yield forestry—including forest plantations—requires explaining cumulative effects of trends that are just revealing their potential today. Five decades' work, with steady guidance, will make the restoration of the forests truly great.

SMART FOOD

Many different forces, including urban sprawl, pollution, and fire, can diminish forests. But around the world, agriculture and timber cutting do much of the clearing. Farmers are usually cited as forests' primary foes. As Time's millennial Earth Day issue lamented, "agriculture is the world's biggest cause of deforestation."

Just how much land is actually needed for agriculture integrates several variables: the size of the population, its income and diet, and the yield of crops grown. Already, growth in human numbers is slowing -- the present population growth rate of 1.3 percent per year has declined steadily from a peak of more than 2 percent around 1970. Still, by 2050, the total population will have increased, perhaps to as much as 8 or 10 billion. Taming population growth further will likely lessen the threat to forests, but protecting the forests seems only a marginal addition to the impetus for population reduction.

Rising income, meanwhile, has raised the population's demand for food, multiplying the effect of its growing numbers. The rich eat more than do the poor. But the main effect of income growth has been to add meat to many diets. And in terms of land used, eating animals that eat plants is less efficient than eating plants directly. As a rule of thumb, a vegetarian diet requires about 3,000 primary calories daily. Meat-eaters consume twice that amount. Vegetarian diets could therefore markedly reduce the land required to grow food. But foreign ministers and other politicians are unlikely to convince carnivores to switch from T-bones to tofu.

Given the difficulty in changing population and diet, the best way to reduce food's impact on forests will be to change the fourth factor: how farmers grow crops. Yield -- the amount of crops produced per hectare of land -- is the key indicator. Over the last quarter-century, average yields of cereal grains, including maize, rice, and wheat, rose 1.8 percent each year worldwide. Some countries achieved dismal results -- yields rose only 0.8 percent per year in developing Africa and actually declined in Angola, Malawi, and Zimbabwe. Other countries, big ones, outpaced the pack. Yields rose an average of 2.5 percent annually in Indonesia and more than 3 percent yearly in China. These gains allowed the worldwide food supply to nearly double, while cropland expanded less than ten percent. In India, rising yields almost entirely offset increasing demand for cropland, so the area under cultivation barely changed. The impact on land areas is the sum of these forces—Population, income, diet (food per unit income) and the yield. Figure 2 shows the averages for the world.

The conventional wisdom, the "skinhead earth" scenario, holds that as much as 200 million hectares of forest will be lost in the next decades as agriculture extends to feed larger and richer populations. Current trends, however, suggest not balding but regrowth. If farmers sustain the 1.8 percent annual yield improvement they have achieved in recent decades, they could meet the growing demand for primary calories while releasing 200 million hectares of cropland.

But farmers can do even better than that and offer even more land to the trees. Research by Jesse Ausubel and Paul Waggoner has shown that, with some extra effort, an increase in yield of two percent per year -- a plausible goal -- could spare a total of 400 million hectares. In other words, today's farmland could be cut by more than a quarter through smarter agricultural techniques. Sustaining a two percent rate of increase will not be easy, but history and technology suggest it can be done. Since sustained efforts to raise U.S. yields began in the 1940s, average yields for wheat and soybeans have almost tripled and corn yields have more than quadrupled. And farmers have hardly tapped the full potential. Champion American corn growers have lifted yields well above 20 tons per hectare without irrigation. Meanwhile, average U.S. corn yields stand at only 8 tons per hectare, and average world corn yields are a meager 4 tons (Figure 3).

How many of the hundreds of millions of hectares that farmers can spare will revert to trees? The amount depends on where cropland is abandoned and how people choose to use it. One and a half centuries ago, farmers had deforested two-thirds of Connecticut. Once they abandoned their farms to build guns and aircraft engines and sell insurance, however, the forests gradually recovered the landscape. But free land does not always become forest. In South Dakota, abandoned farms become grass prairies, not woodlands. Worldwide, no sure equation links the liberation of cropland to the return of trees. Guessing moderately, however, about half the land freed might eventually revert to forest -- say, 200 million hectares, or three times the size of Texas and four times the size of Spain.

FAST FORESTS

Farmers, if they continue the patterns that are already evident, May no longer pose much threat to forests. But what about lumberjacks? As with food, the area of land needed for wood is a multiple of population, income, "diet," and yield. The appropriate focus is on industrial wood -- logs cut for lumber, plywood, and pulp for paper. Although trees are also cut for fuel, most fuel wood is thinned from hedgerows, shrubs, and other open sources -- not forests.

Again, of the relevant factors, strategies to save the forests should not emphasize limiting population and income. Those government agencies and nongovernmental organizations (NGOS) most concerned with forests have little leverage over the number of people, and societies should aim to expand, not shrink, their incomes.

That leaves "diet" and yields. The wood "diet" required to nourish an economy is determined by the tastes and actions of consumers and by the efficiency with which millers transform virgin wood into useful products. Changing tastes and technological advances are already lightening pressure on forests. Concrete, steel, and plastics have

replaced much of the wood once used in railroad ties, house walls, and flooring. Genes, silicon, and even ceramics -- not boards -- are the growth materials for the new economy. Demand for lumber has become sluggish, and in the last decade, with the implosion of the wood-intensive Russian economy, world consumption of boards and plywood has actually declined. Figure 4 shows the total demand for wood, measured in billion cubic meters—with the Russian reversal clearly evident.

But the appetite for "pulpwood" -- logs that are chipped, softened into pulp, and then drawn into sheets of paper and board -- is still climbing, driven by the five percent annual rise in pulp consumption in developing countries. Pulpwood accounts for more than a quarter of industrial wood consumption. Paperwork proliferates in developing countries, and inside the glass and steel shells of the new economy, information machines still consume paper voraciously. Reliable electronic archives and electronic books will eventually quiet the taste for paper. So far, however, life still requires hard copy.

Meanwhile, more efficient lumber and paper milling is already carving more value from the trees we cut. Because waste is costly, the best mills -- operating under tight environmental regulations and the gaze of demanding shareholders -- already make use of nearly the entire log. In the United States, for example, leftovers from lumber mills account for more than a third of the wood chips that are turned into pulp and paper; what is still left after that is burned for power. And further improvements in management and technology will squeeze even higher value out of products and spare more virgin wood. In British Columbia, since the mid-1980s, sawmills have lifted the lumber obtained per cubic meter of log at an average rate of 1.2 percent per year. Worldwide, the pulp and paper industry is shifting a significant share of production from chemical to mechanical pulping, which cuts the wood required for a ton of useful pulp by half. And recycling has helped close leaks in the paper cycle. In 1970, consumers recycled less than one-fifth of their paper; today, the world average is double that.

New engineering has also helped decouple demand for virgin wood from the swelling population and economy. For example, floor systems built from engineered wooden I-beams use about one-quarter less fiber than traditional construction with solid rectangular ribs. And as a substitute for plywood, millers make oriented strand board (OSB) by gluing wood flakes in perpendicular layers. OSB can be manufactured from small trees, and it consumes the whole tree, except for bark and limbs. By contrast, plywood mills -- which peel timber into sheets and glue them together like cream cookies -- work only with larger trees and leave an unpeeled core at the center of every log.

As this suggests, the wood products industry has learned to increase its revenue while moderating its consumption of trees. This is not surprising, for efforts to lower trade barriers and improve management of forest resources are increasingly exposing millers worldwide to prices, competition, and consumer requirements that are spreading innovation and efficiency more widely. Large, capital-intensive pulp and paper mills are already responding -- their investors demand it. But in much of the world, sawmills thrive on remoteness, trade barriers, and artificially cheap logs that shield them from competition. By one estimate, 3,000 sawmills in Argentina function with an average input of only 1,000 cubic meters of wood per year. At such small

scales -- less than one-hundredth the size of the most modern sawmills -- millers can hardly implement the most efficient practices.

Demand for industrial wood, now about 1.5 billion cubic meters per year, has risen only one percent annually since 1960 while the world economy has multiplied at nearly four times that rate. In Figure 4, my colleague Rebecca Weiner and I have shown all major published scenarios for the future of world wood demand. Conventional wisdom lies in the middle and predicts that the total amount of wood harvested will reach 2.5 billion cubic meters in 2050. But the figure could be much lower if millers improve their efficiency, manufacturers deliver higher value through the better engineering of wood products, and consumers recycle and replace more. Together, these steps could shrink demand to about 2 billion cubic meters per year and thus reduce the area of forests cut for lumber and paper.

As with agriculture, yield -- cubic meters of wood grown per hectare of forest each year -- provides the largest leverage for change. Historically, forestry has been a classic primary industry; like fishers and hunters, foresters have exhausted local resources and then moved on, returning only if trees regenerated on their own. Most of the world's forests still deliver wood this way, with an average annual yield of perhaps two cubic meters of wood per hectare. If yield remains at that rate, as illustrated, by 2050 lumberjacks will regularly saw nearly half the world's forests. That is a dismal vision -- a chainsaw every other hectare.

Lifting yields, however, will spare more forests. Raising average yields 2 percent per year would lift growth over 5 cubic meters per hectare by 2050 and shrink production forests to just about 12 percent of all woodlands -- the Great Restoration.

Of course, industry has already taken big steps along the restoration path by sowing intensively managed "plantation" forests that act as wood farms. According to the U.N. Food and Agriculture Organization (FAO), one-quarter of industrial wood already comes from such farms, and the share is poised to soar once recently planted forests mature. At likely planting rates, at least one billion cubic meters of wood -- half the world's supply -- could come from plantations by the year 2050. Semi-natural forests -- for example, those that regenerate naturally but are thinned for higher yield -- could supply most of the rest. Small-scale traditional "community forestry" could also deliver a small fraction of industrial wood. Such arrangements, in which forest dwellers, often indigenous peoples, earn revenue from commercial timber, can provide essential protection to woodlands and their inhabitants.

Changes in both markets and regulation explain the shift toward high-yield, land-sparing forestry. Supply from "old-growth" forests -- mature natural forests dominated by large, old trees -- is tightening while the relative costs of trees from plantations are falling. In Oregon, for example, public pressure and laws to protect endangered species have reduced felling on federal lands by four-fifths since the mid-1980s. Offsetting that shrinking supply is rising production on private land in the southern United States -- where sunlight, moisture, and good soils for forests abound. Today, the American South -- which Bruce Zobel of North Carolina State University called the "wood basket of the world" -- supplies 15 percent of the world's industrial timber, at a sustainable average yield of about 5 cubic meters per hectare.

Outside the United States, diminished access to traditional sources of virgin wood and the need to control wood costs are also concentrating production. In British Columbia, where most forests are old growth, regulators have reduced the allowable cut by nearly a third over the last two decades, and more restrictions are likely. Clark Binkley, former dean of the University of British Columbia's School of Forestry, has argued that the province's logging can remain competitive only by shrinking its footprint and raising yields to twice or three times the current average annual yield of 2.2 cubic meters per hectare. In Brazil last year, the government and a coalition of 189 environmental groups scuttled a plan to open half the Amazon forest for potential clearing. Meanwhile, nearly all new Brazilian industrial wood comes from high-yielding plantations in the country's southeast, outside the Amazon region. China has reduced cutting of natural forests by a fifth since 1995. Malaysia and Indonesia, dominant exporters of tropical old-growth logs, have both announced reductions that could halve felling in their ancient forests by 2010. New plantations in those countries will not mature in time to fill the gap, but planted forests in New Zealand, Chile, and elsewhere stand ready to deliver. Chile alone will earn $3 billion in foreign exchange this year from forest products, nearly all grown on plantations that cover only 3 percent of Chilean territory. Trade is rationalizing world wood production toward the highest -- and most land-sparing -- yields.

With economics already favoring intensive production, foresters should be able to lift the average world yield in lumbered forests to 5 cubic meters per hectare by 2050. A recent study compiled by Wood Resources International, the World Bank, and the World Wildlife Fund (WWF) suggests that more than a fifth of the world's virgin wood is already produced from forests with yields above 7 cubic meters per hectare (Figure 5). And foresters have only begun to tap the potential for high growth. Roger Sedjo at Resources for the Future has documented that economically competitive plantations in Brazil, Chile, and New Zealand can sustain yearly growth of more than 20 cubic meters per hectare with pine trees. Aracruz Cellulose, Brazil's top planter of eucalyptus -- a hardwood good for some papers -- has invested heavily in forestry research that now delivers an extraordinary average of 43 cubic meters per hectare. In the Pacific Northwest and British Columbia, with plentiful rainfall, hybrid poplars deliver 50 cubic meters per hectare. And under extreme conditions -- with irrigation, fertilization, and intensive pest controls -- eucalyptus has been clocked at 100 cubic meters per hectare (or 20 times the goal of 5 cubic meters by 2050).

Foresters can push trees even faster. Today, the most advanced tree-breeding programs are only in their second, third, or fourth generations, since trees, unlike annual wheat and maize, are slow to reach sexual maturity. Modern biology can already speed breeding, however, by spotting the genes for superior performance early and then growing plants with those traits through traditional methods. Genetic engineering, now in its infancy, will be able to insert or delete selected genes directly and should gradually gain acceptance. Big tree planters are already placing large bets on biotechnology, which promises to boost the economic advantage of plantation forestry. Having spent heavily on state-of-the-art mills and to select and rejigger tree genes, the forest industry has come to prefer planted forests, which let it control what stock grows where.

At these rates, perhaps the strongest critique of this vision for the Great Restoration is that it is too modest. Average yields for wood production could be *much* higher than

5 cubic meters per hectare per year that we envision as a world average for 2050; as illustrated in a thought experiment that Roger Sedjo and Daniel Botkin published in *Environment* magazine in [1997], the area occupied by trees could be perhaps only 5%.

ARE FAST FORESTS SUSTAINABLE?

Actors in the wood drama can thus take three basic approaches to preserving and restoring the world's forests: lifting crop yields, choosing value over volume in making wood products, and concentrating forestry in fast-growing wood farms. Together, these measures can increase to 3 billion hectares the area of forests that are left for nature, the protection of watersheds and indigenous peoples, and other non-industrial uses. In contrast, the "skinhead earth" scenario will shrink these non-industrial forests to 1.8 billion hectares. This difference – 1.2 billion hectares – is almost twice the area of the Amazon basin.

Will plantation forests do their part? Answering that question requires looking especially closely at four issues: economics, goals, land-use planning, and certification.

First, will the fundamental economics of plantation forestry, on their own, ensure that this revolution spreads to every corner? Economists, environmentalists, and people who live in the woods have all raised warning flags about intensive industrial forestry. Some worry that plantation forestry is prone to fail because much of it depends on wasteful government subsidies. Indeed, public funds have helped establish viable land-sparing plantations -- just as they helped initiate other new waves of industry, including jet travel and the Internet. Three-quarters of South American plantations were planted after countries adopted incentive schemes, usually subsidies. Yet today, the private establishment of new plantations is continuing despite the fact that governments are scaling back incentive programs.

Another source of concern has been the profitability of private investment in these industries. In 2000, a PricewaterhouseCoopers study found that the 50 largest global forestry companies earned, on average, a paltry 4.1 percent return to investors. Over-capacity in the industry and vast potential supplies of wood from poorly regulated forests have undercut prices and hurt the performance of even the best-run firms. A history of poor returns makes it hard for the forest industry to raise still more money to continue the shift to high-yield wood production. The current consolidation of the timber industry, however, will help surviving firms win new investors. Government efforts to improvement management and restrict cutting of natural forests will also favor modern industry, which has a smaller footprint. While many questions remain, the industry is at the point where the fundamental economics favor this shift to high yield production. Fast forests are not like radios or telephones—this new technology is not so dominating in performance that it will rapidly become ubiquitous.

Whether fast forests are sustainable will depend on three other issues: 1) the goals that animate our efforts to protect forests and the “story” about the role of plantation forestry, 2) the ways that land use ownership and regulation (and other related

policies, such as taxes) affect the incentive to manage some lands intensively while setting others aside, and 3) the outcome of the debate over certification.

The goals that are adopted and the “story” that emerges about the role of plantations will be vitally important. In terms of setting goals and drawing attention to forests, it would seem that much useful activity is already under way. Environmental NGOs around the globe have organized behind forest protection. All major forestry firms now participate in various activities to lessen the environmental harms of forestry. Multilateral development funders such as the World Bank have added the protection of forests and their role in alleviating human poverty to their agendas. The United Nations engages forestry issues through the FAO and the ongoing effort to implement commitments made at the 1992 Earth Summit in Rio de Janeiro (at which forestry policies were hotly contested). Since Rio, an alphabet soup of panels, forums, and task forces on forests have filled U.N. meeting rooms. This year, the U.N. launched an annual Forum on Forests to provide an outlet for the many clamoring voices. Forests do not suffer from a lack of attention in international politics.

The problem is the absence of a clear and widely shared goal to guide policy. Because the U.N. framework includes all nations, forest agendas are confused and exceedingly complex, and progress is measured by the placement of commas and clauses. Worse, since Rio, the central debate has been whether and how to negotiate a legally binding forest treaty. Experience in managing other international environmental problems shows that binding treaties work best when they include detailed commitments with which governments can comply. A binding instrument is ill suited to forests, however, because governments -- and the people they represent -- do not yet share a vision for how to protect the world's woodlands. Moreover, detailed actions would necessarily vary by country and be extremely difficult to codify into a single international law. Key elements of a sensible coherent vision -- such as lifting grain and forest yields -- are impossible to plan top-down by regulatory treaty.

A better approach would begin by adopting a nonbinding but clear, quantitative, measurable goal: namely, a forest estate expanded by 200 million hectares in 2050 and in which a smart, sustainable forestry industry concentrates on little more than 10 percent of the forested area. This "90-10" vision would serve to anchor and focus a bottom-up process through which governments and stakeholders -- individually and collectively -- would explore the actions they must take to achieve their goal by 2050. Responses could then vary as necessary. Some countries, such as Brazil and Indonesia, could conclude that the best way they can contribute trees to the world balance sheet is by improving the regulation of their public lands. Others, such as Chile and New Zealand, could do their part by striving to become industrial wood baskets. Still others, such as Russia, could focus on improving forest institutions. Sten Nilsson of the International Institute for Applied Systems Analysis has shown that Russia has great potential to spare trees by exposing the forest sector to modern market discipline and regulation.

Measuring progress will require a better system for tracking and assessment. Data on forest cover already abound, but reliability varies by country, as do definitions of terms as fundamental as "forest." Information on key elements, such as changes in crop and timber yields and production areas, is fitfully reported in many places. All but a few countries lack data and analysis of milling efficiency. Private groups,

especially commercial firms, could fill the gaps. But so far they have had little incentive to do so because no guiding forest vision has informed and focused the policy debate.

In other examples of international environmental cooperation -- such as cleaning up the North Sea or combating acid rain in Europe -- clear, ambitious, and achievable visions backed by data systems have proven to be key to success. In those cases, as in forestry today, governments were at first uncertain what they could achieve but were keen to make an effort. Nonbinding legal frameworks, along with periodic performance reviews, facilitated action and learning. Only when governments had come to understand what commitments they could realistically implement did they establish binding treaties to lock in progress.

A bottom-up process is needed because no single set of policy instruments is appropriate to all settings. For example, factors such as land ownership vary widely. In the United States and most of western Europe, for example, forests are held mainly in private hands. Moreover, the real story about the potential for plantations will emerge from real practice. While yields and profits make plantations attractive to investors, environmentalists nevertheless worry that industrial plantations will deplete nutrients and water in the soil and produce a vulnerable monoculture of trees where a rich diversity of species should prevail. Meanwhile, advocates for indigenous peoples, who have witnessed the harm caused by crude industrial logging of natural forests, warn that plantations will dislocate forest dwellers and upset local economies. Pressure from these groups helps explain why the best practices in plantation forestry now stress the protection of environmental quality and human rights -- and why large firms, with the most exposure to pressure, are generally the most scrupulous. In Sweden, for example, large industrial forest owners aim to follow strict codes of conduct that respect the traditional practices of indigenous peoples, whereas smaller landowners still tend to fence the reindeer-herding Saami people out of their traditional grazing grounds. As with most innovations, achieving the promise of high-yield forestry will require feedback from a watchful public. Public scrutiny will help industry to make the new technologies socially acceptable.

The “story” that will become associated with plantation forestry still lies in the balance, and constructing the “right” story will be difficult because the main environmental benefit will not reside within the planted woods, however. It will lie elsewhere: in the trees spared by more efficient forestry. An industry that draws from planted forests rather than cutting from the wild will disturb only one-fifth or less of the area for the same volume of wood. Instead of logging half the world's forests, humanity can leave almost 90 percent of them minimally disturbed. And nearly all new tree plantations are established on abandoned croplands, which are already abundant and accessible.

But nobody lives in the global average—we live, rather, in specific locations and thus attention to the story about plantations will require attention to local benefits and costs—not their global average. In the U.S. this dispute is playing out in the Southeast, the wood basket, where some people near plantations have cried foul. The data suggest that even in the U.S. south that high yield forestry is a boon, but so far that story has not been well articulated. Objectively, the greatest threat to forests in the southeastern United States is urban sprawl, but the image manufactured by

opponents of high yield forests is that plantations bear the guilt for falling trees. The industry as well as those who are mindful of the potential for a visionary “Great Restoration” must do better in explaining the real story and connecting that story to responsible, attractive futures.

The experience here in New Zealand could be the most important in setting a proper story for forest plantations. An explicit policy, based on extensive dialogue with the key stakeholders, has encouraged the shift from extensive to intensive harvest. At the same time, the land liberated from timbering has been set aside—a visible quid pro quo. Brazil would benefit from a similar exercise that couples the decline in Amazon felling with the rise of Brazil’s planted forest industry. But the experiences of Brazil, New Zealand and the United States reveal the difficulties: the effects on land use are distributed and not everyone is happy with this shift.

Third, as the stakeholders debate the vision of a Great Restoration, they will clarify the needed complementary policies and programs. One such requirement is better strategies for dealing with the vast areas that lie "in the middle" -- lands that are not under intensive cultivation or wood production but are also not formal, strictly protected nature areas. To date, much of the debate over protecting forests and wilderness has focused on formally demarcated and legally protected areas. Such protection rightly safeguards Earth's greatest forest treasures, but formal protection holds little promise for most of the world's woodlands. Today, only about eight percent of world's forests are formally protected in parks, and countries have adopted widely varying strategies for protecting lands—some have imposed strict rules on large areas of forest while others have made greater use of protection schemes that involve multiple uses (see Figure 6). Now, having already protected special lands, many governments hesitate to expand formal protection, for fear of locking away land that might serve other purposes. In many settings, forest dwellers also resist "protecting" their forests because well-meaning but ham-fisted governments have tried to secure forests in their natural state by banning long-standing local practices such as hunting and small-scale forestry. New systems of land protection may be needed—systems that look beyond strict protection of lands (e.g., national parks) and toward multiple use classifications and perhaps even positive use zoning, where specific (small) areas are designated for high yield forest production.

In a world governed by markets, part of the answer to the quandary over formally protecting lands lies in finding new systems for protecting lands while not foreclosing ways to assign economic value to standing forests (other than as cut timber). Most of the world's untouched frontier forest is still protected by economic factors -- remote locations and unfavorable terrain keep farmers and lumberjacks at a distance. But threats multiply where roads and rails penetrate, bringing saws to trees and timber to markets. Revenue from ecotourism may help preserve forests, as might schemes to value forests' contribution to the ecosystem (such as their climate-cooling sequestration of carbon).

COMMON CAUSE

For the great restoration to succeed, farmers, foresters, and environmentalists must recognize their common interest in high-yield production. Those concerned with forests have traditionally viewed farmers as part of the problem. But by lifting yields, farmers can be part of the solution. Meanwhile, foresters are wary of environmentalists who, they fear, seek to make forestry unprofitable and to fence off every parcel of land that can be freed from production. Environmentalists, in turn, accuse foresters of destroying diversity, polluting the land, and displacing local people. But Big Timber and Big Green can and must learn to meet each other's core concerns.

The conflict between these groups is especially evident in the effort launched by the environmental community -- and by some forest-products companies, mainly in Sweden, that already meet extremely tight environmental standards -- to certify wood that is produced "sustainably." Certification is the fourth and final challenge—the topic that has occupied the most intense debate between the industry and its critics today although, I think, it is really only one dimension of the political process that will determine the future of plantation forestry.

So far, only a tiny fraction of production forests have been so certified, and most consumers have refused to pay extra for "green" wood. But certification is gathering force; standards established over the next few years may lock in forest practices for decades. These standards should be set with the path to long-term restoration in mind. In principle, the leading certification system -- the Forest Stewardship Council -- is compatible with such a goal, but efforts are needed to demonstrate that economically feasible certification can favor high-yield growth. Certification that favors low-yield strategies may produce a happy tree but lead to a small forest.

I don’t know where the certification system will settle, and as certification takes hold there will be looming conflicts between some certification proposals and the rules embodied in the WTO. The disputes between the U.S. and the E.U. over genetically modified crops, and earlier disputes over hormones, give a taste of the types of conflicts that can arise on wood certification. What is clear, however, is that certification could as much a powerful tool for the forest planters who want a larger market share as it is for the environmental community that wants to halt the sale of “unsustainable” wood. If the certification debate, in particular within the FSC, moves toward setting standards that discourage high yield production then this latent coalition of Big Green and Big Timber will split apart. That would be bad news for the Great Restoration.

The certification debate underscores the fact that no single approach is enough for achieving the Restoration by 2050. Policy must exert leverage in all areas: adopting new technologies and practices to improve forestry and agriculture, building a better information system, and launching a bottom-up process for translating the grand vision of the Great Restoration into detailed strategies. Realistically, one cannot expect all nations to come on board at once. But surely the leading forest planting nations—a group that includes industrialized and developing nations alike—can take the process seriously. At the same time, the leading firms that would benefit from

preserving the option of high yield forestry must work harder to set goals and complementary stories about the role of plantation forests.

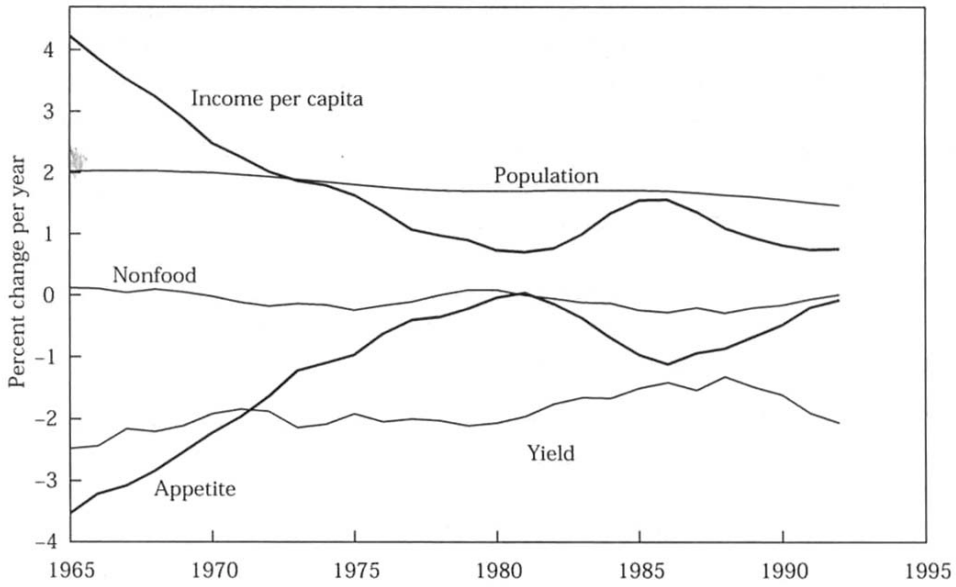
Although 2050 remains distant, most elements of the plan need to be put in place in half that time -- by 2025. Trees are slow growers, and so the saplings that will deliver nearly all the 2 billion cubic meters of wood needed in 2050 must start growing 20-25 years earlier. 2025 is not so far away in a capital-intensive business.

Neither feeding the world population nor supplying timber and pulp requires the world forest estate to shrink, as it has ever since ancient civilizations felled their forests to smelt, build, heat, and cook. Rather, while profitably meeting growing demand for wood products, humanity can vastly increase the area of forests and simultaneously reduce the amount of those forests that is disturbed. Such a Great Restoration is truly a worthy goal for the landscape of the new millennium.

Error! Unknown switch argument.

Figure 1: *Two possible paths for the world's forests.* In the "Skinhead Earth" scenario (top right), global agriculture and forestry industries continue at their current inefficient pace, by 2050 reducing the world's forests (industrial and non-industrial) by 200 million hectares. However, relatively small increases in crop and timber yields over the next 50 years could in fact lead to a "Great Restoration" (bottom right), growing the world's forests by 200 million hectares by 2050. Sources (rounded estimates): 6000 B.C., World Conservation Monitoring Centre, World Resources Institute, and World Commission on Forests and Sustainable Developments; 1990's, U.N. Food and Agriculture Organization Global Fibre Supply Model data; 2050, author's projections. Reproduced from: Victor, David G. and Jesse H. Ausubel. *Foreign Affairs* 79(6): 127-144).

FIGURE 1 Five forces driving cropland change



NOTE: The plotted figures are ten-year moving averages of annual percentage changes calculated from the values centered on the year shown. Ten-year moving averages lessen the effect of short-term fluctuations, such as oil price shocks.
SOURCES: FAO (2000), World Bank (2000).

Figure 2: ***The Power of Productivity.*** Chart shows the percentage change each year in five forces that drive the area of cropland: Population, Income ($/person), Appetite, Nonfood and Yield (hectares of cropland per quantity of crop). The net effect of these five forces on the total area of cropland is the sum of these five forces; during the quarter century shown here, total cropland area has expanded only 10%, or about 0.4% per year. Two of the lines on this figure require some explanation. Appetite, or "diet," is the food consumed per unit of income—a force that, on average, offsets the effects of rising income. Wealthier people eat more, only to a point, and they also tend to eat more inefficiently (calories as meat rather than as primary foods); but these effects diminish and thus the ratio of primary calories consumed to income declines. "Nonfood" is the ratio of agricultural cropland to food crops and reflects shifts in the balance between food crops and nonfood crops such as tobacco and coffee—shown here for completeness although, in practice, shifts between food and nonfood crops are not big players in the world trends for total cropland—the nonfood line wavers around zero for the whole period. For more detail on the units and trends see:

Waggoner, Paul E. and Jesse H. Ausubel. 2000. "How Much Will Feeding More and Wealthier People Encroach on Forests?" *Population and Development Review* Available at http://greatrestoration.rockefeller.edu.

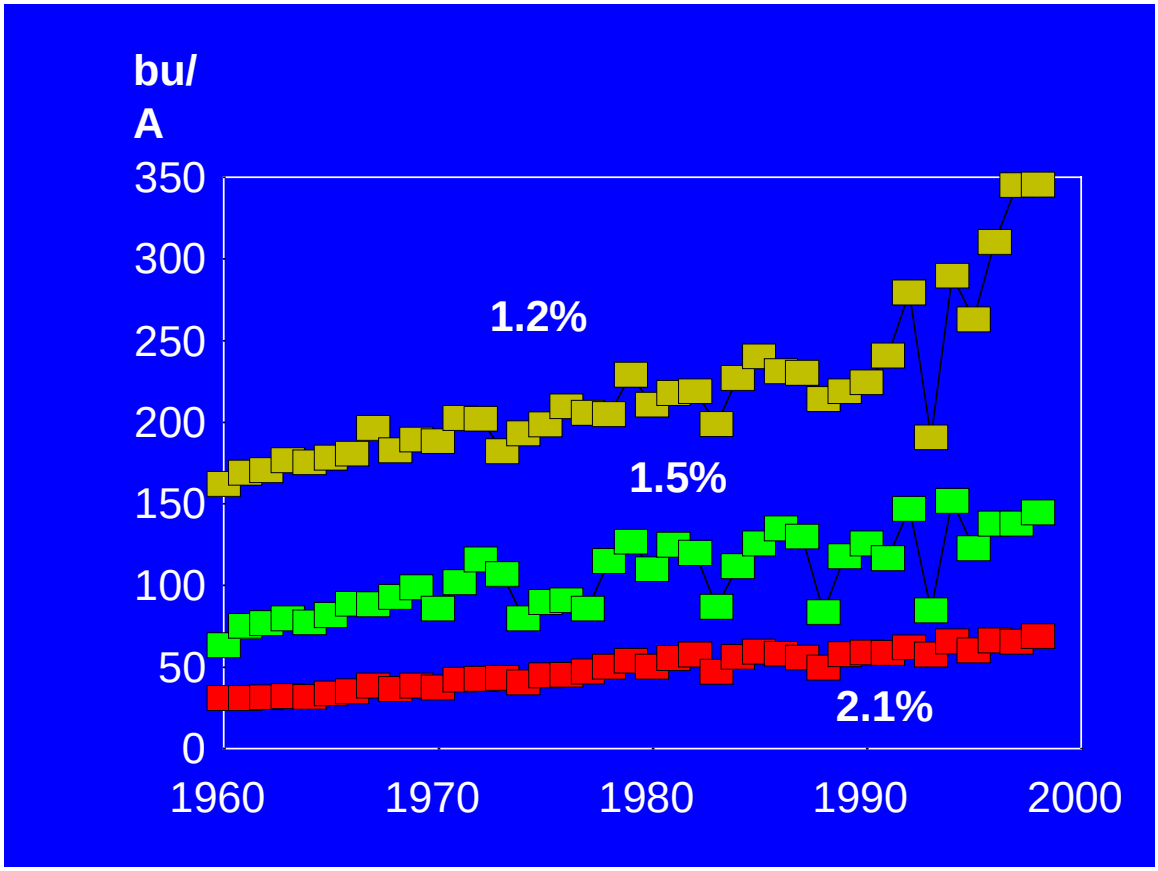


Figure 3: *Maize yields for the "Iowa Master" (top line), average for all of Iowa (middle line) and world average (bottom line).* Iowa Master is the top corn grower each year and one measure of best practice. The gap between the Master and the Iowa average, and between the Iowa average and the world remains large – indicating the potential for much improvement of the averages. Units are bussels/acre. (Convert from bushels/acre to tonnes/hectare with multiplication by about 0.06.) Figure supplied by Jesse H. Ausubel. See also Jesse H. Ausubel, 2002, "Maglevs and the Vision of St. Hubert" in W. Steffen, J. Jaeger and D. Carson, eds., *Challenges of a Changing Earth* (Springer, Heidelberg); and, Jesse H. Ausubel, 2002, "On Sparing Farmland and Spreading Forest," in: Clark, T. and R. Staebler, eds., *Forestry and the Great Divide: Proceedings of the Society of American Foresters 2001 Convention*, Society of American Foresters, Bethesda, MD 127-138.

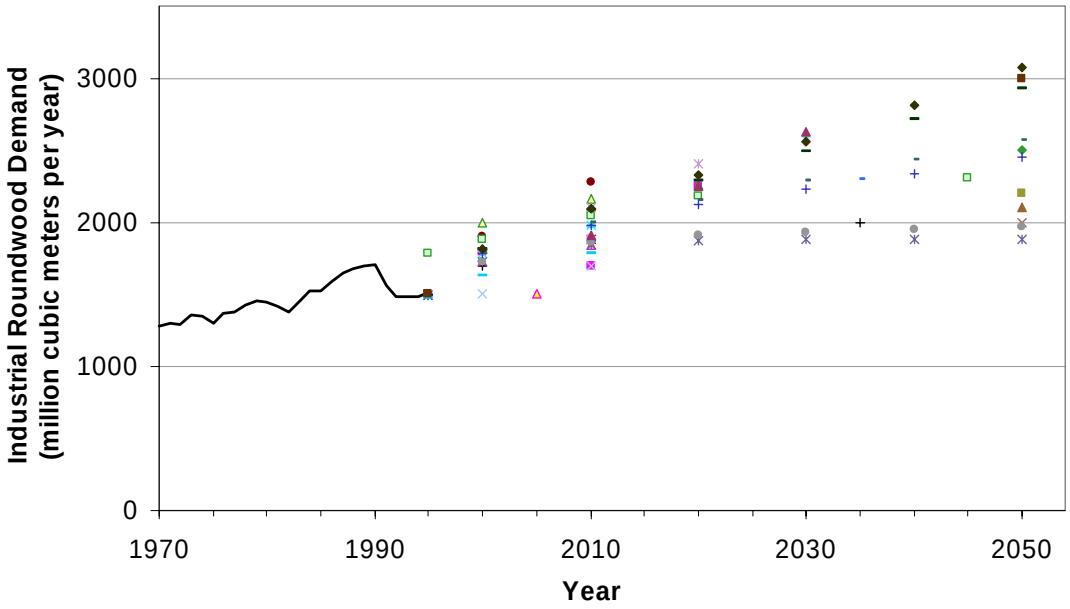


Figure 4: *Historical and projected demand for wood*. Historical data are derived from FAO; projections include all major projections published by the late 1990s. For a key to particular projections and analysis see Weiner, Rebecca U. and David G. Victor. 2000. "Industrial Roundwood Demand Projections to 2050: A Brief Review of the Literature." Paper presented at The Great Restoration: The Potentials for Forest Protection to 2050, meeting convened by the Council on Foreign Relations and the World Bank/World Wildlife Fund Alliance, 20-21 January, Washington, DC. Available at: http://greatrestoration.rockefeller.edu/21Jan2000/WeinerVictor.htm.

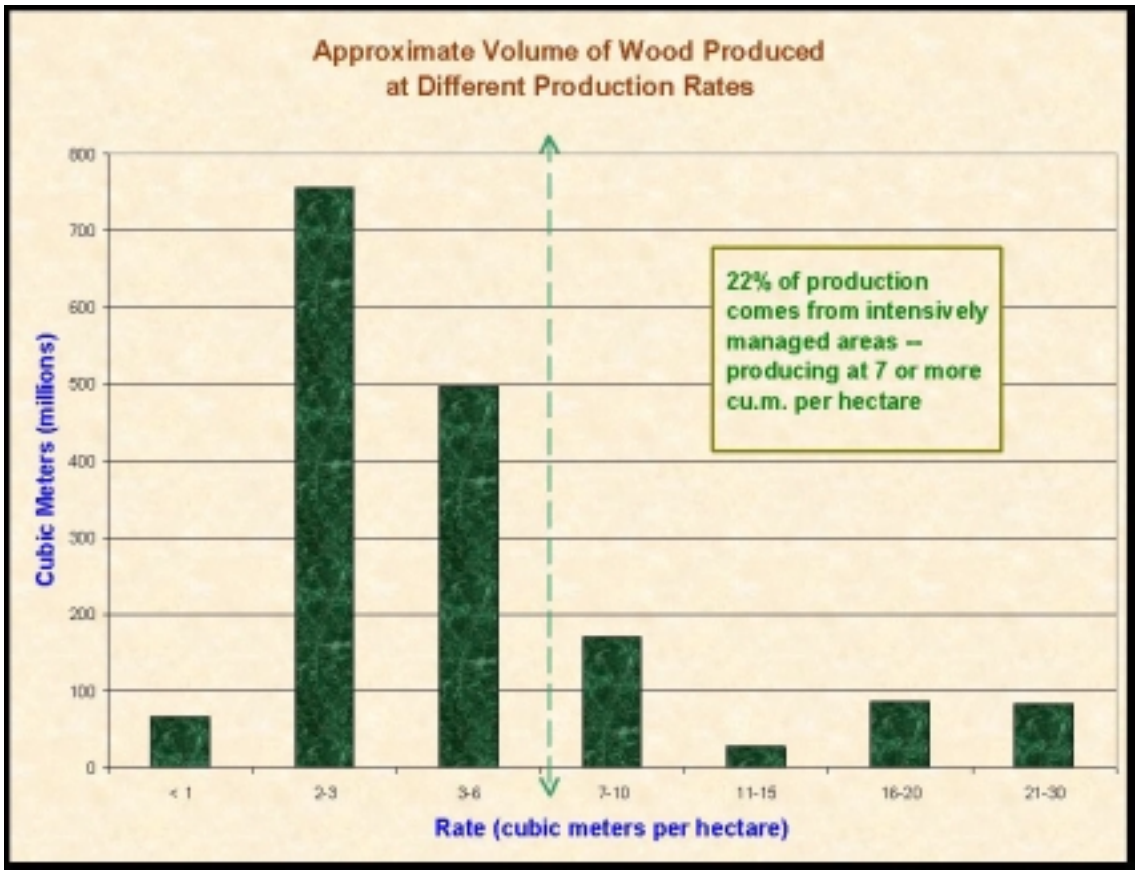


Figure 5: *Approximate Volume of Wood Produced at Different Production Rates.* Data derived from a study by Hagler for WWF and suggest that about 1/5 of the world's wood production already comes from forests with yields of 7 cubic meters/hectare or higher. While most wood is produced in forests with yields of only 3 m^3/ha—the large overhang of high latitude forests such as in Canada and Russia—the vision for a "Great Restoration" calls for continued economic pressures and protective legislation could push the world's foresters to produce at average yields of 5 m^3/ha by 2050.

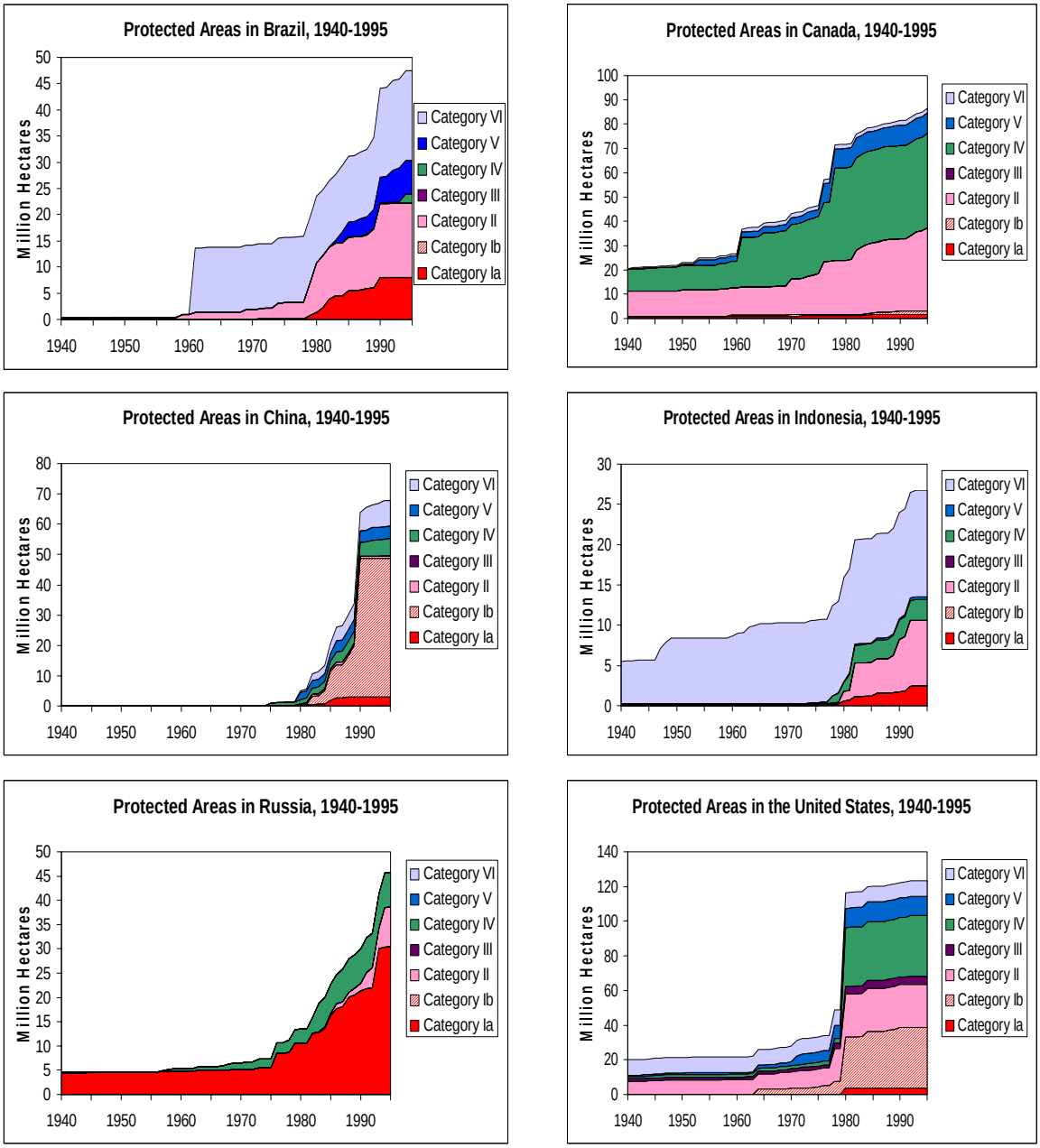


Figure 6: *Protected Area Designations, 6 Countries.* Classification is the IUCN system where level I is the most strict. Source: Victor, David G. 2000. "What Roles Can International Law and Institutions Play in Restoring World Forests?" Paper presented at The Great Restoration: The Potentials for Forest Protection to 2050, meeting convened by the Council on Foreign Relations and the World Bank/World Wildlife Fund Alliance, 20-21 January, Washington, DC.
Available at: http://greatrestoration.rockefeller.edu/21Jan2000/Victor.htm.