Forestry in the Next Millennium: Challenges and Opportunities for the USDA Forest Service

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Discussion Paper 99-15

January 1999

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Abstract

Throughout the globe, forestry faces predictable trends associated with the transition from reliance on natural forests to ones created through human stewardship. Laid over the ordinary economics of this transition are increases in the values of the environmental services that forests provide. The three general approaches to forest management--natural forest management, plantation forest management, and preserve management--are evaluated in this economic context. The USDA Forest Service has interesting opportunities to apply each approach, but doing so will require profound organizational changes.

Key Words: forestry, Forest Service, economics, environment, timber, forest plantations

JEL Classification Numbers: H41, H42, Q23, Q28

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Clark S. Binkley*

As the end of the century draws close, it has become fashionable to speak solemnly about the "next Millennium" with the implicit connotation of timeless truths lurking just beyond the shadows. But, as you read this, remember that the next millennium is less than 1000 days away! It is, perhaps, hard to get too lost in so short a time.

The following remarks *do* carry a pretence of truths lasting more than 1000 days. Indeed, the kind of changes outlined will play out over the next several decades. In particular, continued increases in the value of the environmental services that forests provide will pose great difficulties for modes of timber production involving natural forest management, and, ironically, for the preservation of environmental values on those lands dedicated primarily to that purpose.

Forestry is an ancient profession with long traditions in Asian as well as European cultures. To look to the future it is useful to begin with the past and the first written English definition of forests. Johnson's dictionary, published in 1701, defined a 'forest' as:

> A certain territory of woody ground and fruitful pastures, privileged for wild beasts and fowl of forests, chase and warren to rest and abide in, in the safe protection of the King for his pleasure.

By implication this also defined forestry. The forester's sworn duty was to protect the "vert and venison" (i.e. the wildlife habitat and the wildlife itself). Failure to do so was punishable by flogging or death.

Two points relevant to our circumstances today flow from this definition. First, forests, taken in their totality, must accommodate a wide variety of users. Forests where human interference is absent (or nearly so) provide important spiritual, economic ecological and cultural values. Forests help regulate key global biogeochemical cycles. Forests are the inspiration to poets and artists. For billions of us they form the backdrop to everyday life. Wood is one of the world's most important and most ubiquitous sources of energy and industrial raw materials. And, literally millions of aboriginal people call forests "home".

Second, the word "forest" is not so much a scientific term as a social construction, dependent on contemporary norms and values. That we chuckle at the archaic language and meanings of three centuries ago simply confirms this point.

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To think about the management of forests in the future, it is useful to begin by considering how we got where we are today. The first section of this paper tells the story of the depletion of old-growth timber and the transition of the forest sector to reliance on forests created by human stewardship. This transition has several decades to run, so understanding it provides a helpful context for evaluating the near-term performance of alternative forest management approaches. The second section discusses three alternatives--natural forest management, plantation forestry and the management of parks and preserves--that respond more or less well to the underlying economic and social trends. Conclusions reflect on the enduring responsibilities of foresters and the special problems faced by the USDA Forest Service.

1. FORESTRY IN THE LONG SWEEP OF HISTORY

As a result of the long production cycle for forests and the large standing inventory of trees relative to annual usage, the forest sector possesses a degree of temporal momentum that is present in few other aspects of human endeavor. This momentum permits us to foresee the outline of developments over the next several decades, even if the details are unclear and uncertain. To describe the dynamics of forest sector development, consider forests at the global scale in the long sweep of history. To do so, I take the economist's perspective of holding everything else constant recognizing that the real world harbors a much richer fabric of complications.

The underlying story is the transition from a "hunter-gatherer" phase of forestry to a "husbandry-stewardship" phase. For agriculture this transition began 10,000 years ago when our ancestors discovered einkorn wheat growing wild in the Fertile Crescent (Diamond, 1997; Huen et al., 1997). Prior to that discovery, subsistence required humans to glean sustenance from numerous wild organisms. Now we get virtually all of our food from about ten domesticated plants and five domesticated animals. In developed countries, a few of us still scavenge from the wild Earth, but only for sport, hobby or other atavistic reasons. The wild landscape is the source for only a tiny fraction of our food, and, for agriculture, the transition is now complete. Since the production cycle for trees is comparatively long and the inventory of standing timber is large relative to annual consumption, the transition in our use of forests will take far longer than it did for agriculture. This transition explains much of our circumstance today.

Timber depletion drives the dynamics of the transition. Early on, timber prices are low and forest land is more valuable for other uses, especially the production of food, so the trees are removed and not replaced. In an old-growth forest, net accumulation of merchantable timber is low or negative (especially on the economic margin), so any harvest at all causes the standing inventory to decline.

As the timber inventory declines, timber becomes increasingly scarce. Timber prices rise for two reasons. First, as logging moves into more distant and more difficult terrain (the outward shift of the extensive margin) increased costs push prices up. Second, as a result of the connection between the markets for timber and the markets for other capital assets, timber rents increase (Lyon, 1981).

Three factors limit the increase in timber prices. First, as prices in one region increase, it becomes economic to operate in other regions that harbor primary forests. For example, the relatively high timber prices in the US in the late 1960s and early 1970s opened the door for expanded production in the BC Interior. And, similarly, higher prices in BC have opened the door for the Russian Far East to expand production into Asian markets.

Such inter-regional shifts in the extensive margin obviously comprise only a finite response to timber scarcity. As prices rise for timber from natural forests, purposeful husbandry of planted forests becomes economic. Examples abound around the world, including virtually all the currently managed forests in Europe, and some of the land in the US South and West, in Australia, and in Brazil, and much of the forest in New Zealand and Chile. A recent comprehensive and definitive study found the median cost of timber production (including land rental, silvicultural costs and interest) to be $US7/m^3 for teak, $8/m^3 for eucalyptus and $20/m^3 for southern pines (Neilson, 1997). These costs are far below current stumpage prices for natural forests in much of the world.

Finally, increases in timber prices drive numerous changes in how we use wood. On the supply side, higher timber costs lead to conservation in its use in manufacturing. For example, over the last decade the lumber recovery factor (the amount of lumber produced per unit of log input) has increased 1.4%/yr., despite deterioration in log quality (Binkley, 1993). On the demand side, engineered wood products that use wood more efficiently (OSB, MDF, wooden I-beams, Parallam® etc.) have become more prominent. For example, wooden I-beams now command 25-30% of the North American floor joist market, displacing wide dimension (2x10 and 2x12) sawn lumber. More generally, each 1% increase in lumber price leads to a 0.3% increase in the consumption of steel, a 0.15% increase in the consumption of cement, and an 0.65% increase in the consumption of bricks (Binkley, 1993). Increase in the use of these alternate materials occurs *despite* their higher environmental cost.

The second key element of the story of forest sector development relates to the increase in demand for the environmental services of forests. The demand for most environmental services is highly correlated with personal income. The evidence for this connection between income and demand for environmental services is well documented for some aspects of the environment (clean air, clean water, outdoor recreation) and the positive relationship between income and environmental values is probably more generally true as well.

That humans value the aesthetic aspects of the natural world more once their material needs have been satisfied is not surprising. In his excellent review of human relations with forests in the antiquity, Perlin (1991) comments

> Seneca articulated the romantic view of forests shared by many of the leisure class of his time: 'If you ever have come upon a grove that is full of ancient trees which have grown to unusual height, shutting out the view of the sky by a veil of pleated and intertwining branches, then the loftiness of the forest, the seclusion of the spot and the thick, unbroken shade on the midst of open space will prove to you the presence of God.' (Perlin, 1991, p. 120)

One cannot help but note the similarity of this comment, made nearly two millennia ago, with contemporary descriptions of old-growth forests.

But, most environmental services operate outside of formal markets either because they are true public goods (i.e. goods where the consumption by one person does not diminish that available for others--aesthetically pleasing landscapes are a good example) or because society has chosen not to allocate them via markets (e.g. domestic water supply, outdoor recreation). It is a simple truism that such goods are systematically over consumed and under produced. Market-based patterns of use do not and cannot reflect the societal values of these inputs and outputs. Forest sector development may decrease the supply of these environmental services. Increased income (ironically, created in part by exploitation of forests) will increase the demand for them. Prices are not available to signal relative scarcity and to induce the socially appropriate changes in production and consumption. Once the mismatch between the supply and demand for the environmental services from natural forests grows large enough, governments will intervene through forest practice regulations and land set-asides. Both kinds of intervention will push the costs of timber production still higher.

These predictable trends have three important implications for forestry in the next millennium:

(i) price increases for timber are limited by the availability of plantation technologies to grow industrial roundwood and by our capacity to substitute wood-saving technologies and other materials for traditional wood products.

(ii) the implicit "price" of environmental goods and service provided by the forest is not bounded--there are no limits on increased income, and there are few, if any, technical substitutes for these environmental services.

(iii) forest land has become scarce, that is, there are many competing demands for forest land. It is therefore logical to substitute other factors of production--especially capital and technology--for land, particularly for industrial timber production.

The challenge for the profession of forestry is to craft forest management approaches that respond to these overarching economic imperatives. Three general approaches appear to be available--natural forest management, plantation-based technologies and nature preserves. The remainder of this paper discusses each of these.

2. NATURAL FOREST MANAGEMENT

The key challenge in natural forest management is to produce industrial timber at an acceptable cost while protecting critical environmental values on precisely the same areas used for timber production. This objective is generally accomplished through management by

a public "integrated resource management" agency operating under some kind of forest practice code, perhaps with forest certification added on. This forest management technology faces great difficulties and I am skeptical about its success, for five reasons.

First, mixing market and non-market "products" creates incompatible objectives for a public agency. The costs of each product cannot be unambiguously measured, either in theory or in practice. For example, the timber inventory comprises both the "factory" for producing timber and wildlife habitat and the vegetation needed for watershed protection. There is no unambiguous way to ascribe the cost of creating and maintaining the timber inventory separably to each output. Furthermore, it is difficult to measure ecological outcomes of alternative management regimes, especially for an increasingly skeptical public. Commenting on ecosystem management, the forest ecologist Alverson and his colleagues noted:

> These approaches imply that we know, or will know in the near future, how to actively manipulate forest stands for timber production while sustaining all valid aspects of biodiversity on the same acreage. Because [such] claims...have been shown to be invalid or overly optimistic once they were seriously evaluated scientifically, we urge readers to carefully evaluate similar claims made in this present context. (Alverson et al., 1994, p. 159).

Remember Gordon Baskerville's famous forest management dictum: "If you can't measure it, you can't manage it." In the absence of good measures of input costs and product outcomes, it is unlikely that public agency managers can appropriately balance--at the same time and place--all possible outputs of a forest.

Secondly, forest practice codes are costly with no guarantee of positive ecological outcomes. For example, the recently enacted BC Forest Practice Code reduces the size of cutblocks and imposes minimum green-up ages before adjacent cut blocks may be harvested. These prescriptions sound positive, or at least harmless, or so it would seem. But detailed simulations of the long-term consequences of these simple rules depict high degrees of forest fragmentation, reduced forest-interior habitat and increased forest-edge habitat, and a great increase in the length of the active road system. All of these effects produce negative environmental consequences.

Whatever the ecological effects, these changes in forest management greatly increase the cost of industrial timber extraction. In 1992 the Coast-wide logging costs equaled $\$57/m^3$. By 1996 (once the forest practice code was fully implemented) the costs had risen to $\$88/m^3$, an increase of over 50%. Largely as a consequence of these increased costs, the return on capital employed in the BC forest industry is now $700 million/yr. less than its cost of capital. The capital stock is not being renewed, and the industry will become increasingly non-competitive and unsustainable.

Third, forest certification--perhaps the end-point of forest practice regulation--does not appear to be the answer. Aside from process issues related to the Forest Stewardship Council criteria (the criteria are largely arbitrary, and the development process excludes key

stakeholders), widespread adoption would appear to severely curtail the use of wood--one of the world's only renewable sources of industrial raw materials and energy. In a recent definitive census of all forest certified at the time (comprising about 0.1% of the world's forests), Ghazali and Simula (1996) found that the average output of industrial roundwood on certified forests was $0.7m^3$/ha/yr. This implies that the world would require about 4.7 billion ha of forest to produce today's level of wood consumption, and an increasingly larger area each year as demand for wood expands with increased population and wealth. Unfortunately, the world's forests now only comprise 3.6 billion ha! Hence, managing all forests to the low level implied by the current Forest Stewardship Council standards would condemn all wild forests to industrial exploitation by humans.

Finally, at the same time that forest management costs increase, public revenues will fall. Recall that the value of non-market environmental goods and services are increasing relative to timber values. It is therefore logical to shift the production mix away from timber towards these non-marketed goods and service. But the budget for public forest management agencies is generally proportional to their cash income, either implicitly through the political budget process or explicitly if some agency revenues are held internally. This implies that the resources available for forest stewardship will decline just at the time that the forest management problems become more complex. The USDA Forest Service has eliminated literally thousands of jobs as the timber program has declined. Those interested in the non-timber aspects of forests typically do not lobby for increased budgets for the integrated resource management agencies. As a consequence, it is fair to conclude that the natural forest management paradigm is not sustainable because it does not (and probably cannot) provide the resources necessary for responsible forest stewardship.

In short, the natural forest management paradigm that has dominated the practice of forestry since its inception faces daunting challenges. The information base required to retain public confidence has exploded just at the time that forestry management and research budgets are declining. The regulatory structures that are imposed to deal with the increasingly valuable environmental outputs of our forests have unknown and possibly negative environmental consequences. But they do have high costs. The costs are registered in a declining forest products industry as well as a decline in the use of one of the world's most environmentally friendly materials and sources of energy. And the politics of public forest management agencies generally mean that their budgets will decline as they responsibly and appropriately shift the output mix away from their traditional emphasis on timber production. As a result of these difficulties, I predict a continued struggle and early demise of natural forest management.

If not natural forest management, where are we going to get our wood?

3. PLANTATION MANAGEMENT

Plantations permit foresters to substitute capital and technology for land. This is an extraordinarily powerful tool.

Studies initiated by John Gordon in the early 1970's examined the maximum theoretical timber yields based on the biochemical efficiency of trees in turning sunlight, water and carbon dioxide into economically usable plant parts. The Weyerhaeuser Company applied these models to study sites in the US South and Pacific Northwest where they practice most intensive timber culture. Yet on these sites, best management practices achieved only 40-50% of the modeled maximum yields, and natural stands on the sites produced 10-25% (Farnum et al., 1983). When examined across the globe, two to five fold increases in specific timber yields appear to be generally technically feasible and economically attractive.

Plantations are appealing due to this large capacity to free natural forests from intensive exploitation for industrial purposes (see Sedjo and Botkin, 1997). Within a region, every hectare of plantation forest can free up to five hectares of natural forest from industrial timber production. The substitution is far greater between regions, with one hectare in Brazil substituting for perhaps 20 hectares of land in Siberia.

Combined with sophisticated wood products technology, plantation-grown wood can substitute for most--if not all--of the products obtained from natural forests. Indeed, the uniform (and possibly designed) fiber characteristics of plantation-grown wood makes it more desirable for many products. The use of sophisticated engineering concepts and small amounts of non-wood materials in such products as laminated veneer lumber or oriented strand lumber will obviate the need for traditional sawlogs.

4. PARKS AND PROTECTED AREAS

If future timber production is focused on plantations, how and where will we provide for the key non-timber values of forests? Parks and protected areas will become an increasingly important answer to this question. But however challenging the situation is for natural forest management, the circumstances are far more difficult for protected areas. Establishing parks and protected areas creates at least three kinds of problems--philosophic, managerial and technologic.

The philosophic problems arise directly from our name for these lands--"protected areas." Protected from what? Presumably the answer is "protected from human interference." Hence we define "nature" tautologically as "forests in the absence of humans." This tautology, as Cronon (1996, p. 81) notes is extremely problematic ". . . if nature dies because we enter it, then the only way to save nature is to kill ourselves. The absurdity of this proposition flows from the underlying dualism it expresses. . . . It is not a proposition that seems likely to produce very positive or practical results."

One popular standard of Nature, so defined, is those conditions existing prior to European contact. Such a definition is deeply troubling. In the first place, it is a profoundly racist form of neo-colonialism. If Nature is defined as the forest without humans, then one implication is, of course, that indigenous people are not human. This is nothing less than another form of *terra nullius* that has been the basis for European subjugation of native people throughout North America.

In the second place, this definition ignores the profound impact that indigenous people have had on forests. While the literature is now growing on this point, with excellent examples from Europe, Asia, South America and Oceania, let me quote just one example from North America. Pyne(1997) notes

> In 1878 John Wesley Powell published a map of Utah for his *Report on the Lands of the Arid Region of the United States*, long celebrated as a seminal document in the history of conservation. His crews had classified land by four categories--desert, irrigable, forest and burned. The burned lands proved the largest in area, rising from the grasses that fringed the desert to the rims of the high plateaus. The primary source of fire was the local Indian tribes, burning for their traditional reasons. Given time (and not too much of it) the burned area would overwhelm the forest, and with its watershed ruined, the irrigable would regress into desert. The future of the Rocky Mountains, Powell lectured, depended on the stability of their forested watersheds, and the future of those forests depended on fire protection.

Instructively, the title of this chapter is "The Great Barbecue."

The Wisconsin glaciation apparently forced native Americans southward. As the ice sheet retreated, people migrated north, living in the productive successional forests at the edges of the glaciers. As a consequence, people occupied parts of North America before trees did. In these areas it is literally precise to say we have no knowledge of ecosystems in the absence of humans.

This philosophic problem implies the management problem. If we (justifiably) reject pre-European settlement conditions as the ruling definition of Nature, then we must purposefully choose the specific ecosystem conditions we want to sustain. Reflecting on the what he calls the "contested moral terrain of ancient forests" in Oregon and Washington, Proctor(1966; 295) puts the question in its post-modernist form: ". . . whose nature should we save?" He answers, "There is no one nature to save in the Pacific Northwest since nature is always in part a social construction." Management of parks and preserves requires thoughtfully disentangling our social constructions of nature to separate those elements that arise from values from those that arise from objective features of the landscape (Binkley, 1998).

An example from British Columbia will illustrate the point. The 45,000 ha Khutzymateen, a spectacular drainage on the North Coast adjacent to Southeast Alaska, was declared as a grizzly bear reserve in 1994. Grizzlies are abundant in the valley, largely, I am told, because of the beneficial mix of early and late successional habitat in close proximity with one another (and because the valley is inaccessible to public roads so hunting pressure--legal or illegal--is nil.) The early successional habitat is the result of logging, and--in the absence of further disturbance--will disappear over time. Our current construction of the term "park" precludes precisely the activities needed to create this kind of habitat. The population of bears is likely to decline as a result, and we can anticipate the unhappy situation of grizzly bear reserve with a small and declining population of its namesake species.

The biotechnology of conservation is poorly understood. In the Khutzymateen example, how can we maintain high-quality bear habitat in the absence of logging? And how can we do so at an acceptable cost? Such questions demand a substantial, focused research program, and foresters are well-qualified to lead it.

5. CONCLUSIONS

In the next millennium, the role of foresters will remain much the same it was when Johnson penned the definition quoted at the beginning of this paper: stewardship and husbandry of forest lands for the wide range of values they provide. What has changed is the economic context, our knowledge of the underlying production technologies, and our social constructions of just what comprises a "forest."

It is logical and appropriate that the forestry profession responds and adapts to these new circumstances. Natural forest management is contentious, and will decline in importance as a source of industrial timber supply. As a result of the large standing inventory of timber and the significant amount of installed industrial capacity reliant on this management approach, the end game will take quite a long time. As timber production declines in importance as part of this paradigm, the resources available for forest stewardship will decline and management standards will deteriorate. Might it be wise public policy to accelerate the demise of this outdated, unsustainable management approach?

For industrial timber production, intensively managed plantations are increasing in importance. This is especially true on lands currently classified as non-forest--marginal agricultural lands, pasture lands and grasslands. With all the political attention directed to the declining years of natural forest management, are we adequately investing in education, research and technology related to plantation management? From my recent experience as the Dean of the Faculty of Forestry at the University of British Columbia, I know that in Canada we are not.

Finally, parks and preserves represent a major opportunity for contemporary forestry, and opportunity to re-embrace the "vert and venison," concern for which founded the profession in the first place.

A major impediment to effective public forest management is understanding public desires for alternative approaches. Through literally thousands of interviews, the social psychologist Stephen Kellert has identified a typology of nine different attitudes, or "constructions" of Nature (Kellert, 1993). While the structure of the typology appears to be robust to cultural differences, the frequency distribution of individuals among the various categories differs dramatically among countries. For example, Kellert (1995;110) finds ". . . a Japanese public far more inclined than the American to emphasize control over nature." The North American concept of wilderness is wholly absent in Germany where humans play a leading role in the landscape. Some would have us chose one construction of Nature over all others, but enforcing such a choice is inconsistent with the liberal notions underlying western democracies.

The key to successful pluralistic forest management, then, is to develop management technologies that correspond to the various social constructions. While these are well developed for utilitarian and dominionistic constructions of Nature (to use Kellert's typology), they are comparatively poorly understood for naturalistic or ecologistic constructions.

The USDA Forest Service would logically respond to this diversity of constructions of nature not by choosing one approach, but rather by crafting a mix of these approaches to apply to different lands under their management. Each has its own relevance to the peculiar institutional and ecological characteristics of the national forests.

Some of the national forest lands are suitable for intensive timber management. The fraction is probably small and is mostly located in the US South and Pacific Northwest. Despite the innate suitability of these lands for plantation management, the USDA Forest Service has no particular comparative advantage in applying this management regime, for two reasons. In the first place, plantation forestry is among the most capital intensive activities known. Public agencies do not reward profitable deployment of capital so it is unlikely that the public sector can be as effective as the private sector in plantation management. In the second place, virtually all of the benefits of plantations forest flow through the market, so the public sector has no particular reason to engage in this form of forest management. It would therefore be logical for the Forest Service to spin-off to the private sector, through trades or outright sales, its lands that are particularly suitable for intensive management. Any funds raised in this manner could be redeployed either in a trust funds to support non-timber aspects of existing forests, or to purchase private lands (or land-use rights) that provide substantial public values.

Since the Forest Service already looks after extensive areas of land--the national wilderness system--for non-industrial purposes, managing forest lands as nature preserves is clearly consistent with the its remit. No doubt the area in preserves within the national forests will increase over time. However, as I argued above, this form of management still requires one to articulate the ecosystem conditions that are to be sustained. As Kimmins (1994) has pointed out, the currently popular notion of "ecologically sound" management, by itself, excludes very little until some particular ecosystem state is declared preferable to other possible ones. To develop and sustain a leadership position in the management of preserves will require the USDA Forest Service (i) to develop effective means of discerning socially preferable ecosystem conditions in the face of chaotic, pluralistic interactions among stakeholders, each holding particular--and possibly mutually exclusive--social constructions of nature, and (ii) to create and apply new technologies for sustaining the chosen conditions. As the proportion of national forest land in preserve management increases, the need for public subsidy of the Forest Service will also increase. If the needed resources are not forthcoming, stewardship standards much inevitably fall.

Finally, the national forests may have a unique opportunity to craft a sustainable version of the natural forest management paradigm, but major organizational and institutional changes would be required. Of specific concern is the need to maintain adequate resources for excellent stewardship in the absence of a large timber program. One approach would be to

corporatize the national forests along the lines of the New Zealand Ministry of Forests (prior to privatization) or the US Postal Service. Governed by an elected Board of Directors, the "US National Forests Corporation" would be empowered to sell *all* the products of the forest, from water to wood with a mandate to maximize the asset value of the land base under the constraint of annual, public stewardship audits. Such an organization would pose no great difficulty for products currently traded in markets (e.g. timber) or for products that could readily be marketed (e.g. recreation or water). For true public goods (aesthetically pleasing landscapes, carbon fixation), the Corporation would contract with Congress or others to provide the needed services. The public interested in increased provision of such goods would logically lobby Congress to increase the contract rates. The Corporation might securitize certain income streams in order to raise needed capital. Only through such an organizational mechanism might adequate funds be available for forest stewardship.

Such a change would also imply changes in the USDA Forest Service research activities. The research program logically falls into two categories. One responds to the public-good aspects of forest sector R&D related to the forest industry. Because it is difficult for any one firm to fully appropriate all the benefits of new innovations, individual firms will systematically underinvest in R&D. Along with the nation's universities, the US Forest Service's research program is one means to respond to this situation. The returns to forest sector R&D have been high (Hyde et al., 1992) and are apt to remain so as long as the US is a net importer of wood (Binkley, 1997). The public interest in forest sector R&D could be met in several alternative ways, including direct public subsidy as is now the case, or via an R&D tax levied on the consumption of forest products.

The second part of the research activity responds directly to the R&D needed to support the management of the national forests. There is no reason to suspect that the optimal research program for this purpose would bear any relationship whatsoever to the one needed to respond to the public good aspects of forest-sector R&D mentioned above. The Corporation might contract with a national forestry research body, or might contract with universities, or might have its own in-house research facility. Confusing these two general purposes of national forest research serves neither well.

Foresters often lament the long time periods involved in forest management. Ironically, it is precisely this characteristic of the sector that permits us to predict with some certainty the major underlying trends that characterize forestry in our era--the transition, for industrial purposes, between reliance on old-growth forests provided wholly by nature and second-growth forests created through human stewardship. Organizations well adapted for the early phases of the transition must change and adapt if they are to be effective in the later stages. The USDA Forest Service--one of the world's pre-eminent land management organizations--just now has precisely that opportunity.

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