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RESEARCH NOTE 2003-1

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(Clark S. Binkley - 2 February 2003)

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Conservation of the world's forests is a most important and pressing contemporary problem. Of particular concern are those distant, remote forests where the direct effects of industrialized human activities are, at the moment, still small. This paper discusses one approach to conserving these relatively pristine forests—developing rapidly a large and productive are of forest plantations. The argument draws from and summarizes a much larger body of work, complete with references to classical philosophers, ancient definitions of forestry and *bon mots* from the great Gifford Pinchot himself (Binkley, 1997a,b; 1998; 1999; 2002). This paper takes a different tack and distills the essence of the argument into as clear and concentrated substance as possible.

The argument is organized in four sections below.

The first provides societal context and objectives. The second lists the key assumptions that underlie the argument and the problem more generally. The third explains why plantation forests offer significant environmental benefits. The final section concludes with some questions that remain to be addressed.

I. Context and Objectives

Argument about forest plantations requires a holistic perspective of the forestry problem. Just what does 'holistic' mean in this context?

First, one must consider the full range of environmental values and resource services that are o btained from forested landscapes. No sentient person now doubts the importance of forests in supporting human welfare, providing

- low-embodied-energy building products;
- positive control over the hydrologic cycles that nourish us and the crops that feed us;
- the aesthetic backdrop for our lives and recreations;
- numerous important and interesting plants and animals that sustain and amuse us in ways too numerous to catalog;
- a store of spiritual values.

And, literally millions of humans call forests 'home.'

To support and sustain society's interest in forests requires reliably producing over the very long run this full range of products. Some will find dissonance in this economist's way of characterizing the problem; economic words jar ecological and environmental sensibilities. The problem can be restated in a different (but identical) way that may be more sonorous: our objective is to create a set of forest conditions that sustain human welfare, not just for this generation but for all generations. Reverting to economist-speak, the former statement of the problem is just the dual of the latter, so it makes no difference if we speak of forest outputs or forest conditions as one may always be mapped back into the other.

Second, 'holism' implies a global perspective. The forested regions of the globe are inexorably linked. A common atmosphere nurtures them (and is nurtured by them). Economic forces mediate world trade in forest products and consumption patterns. The rapid flow of information, technology and ideas affects our use and social constructions of forests. Sensible thinking about forestry keeps in mind the possibility that intervention in one place or in one sphere of the problem can result in distant but unanticipated changes elsewhere. Of particular importance is to ensure that actions taken in the name of the environmental improvement in one place do not simply shift environmental damage to others.

Third, the increase or decrease in products produced by forests must be considered in the context of their potential substitutes, and the economic and environmental effects of changes in the rates of consumption of these substitutes. Reducing wood use, for example, may mean increases in the consumption of steel, concrete or plastics. Life-cycle analysis tools (for example, Forintek Canada's ATHENA® model) now permit us to evaluate those tradeoffs, and these tools should be employed in forest policy discussions. Such an approach would emphasize the need for increasing the efficiency of wood use via

- recycling and re-use,
- improvements in wood products and processing technologies, and
- better wood building design and construction.

In the present context, the need is to explicitly connect these technologies to plantation-grown timber.

A critical objective of any sustainable enterprise is to reduce the amount of 'nature'—energy, resources, and land—used per unit of economic activity. This has been called the de-materialization of the economy, or, perhaps more descriptively 'eco-efficiency' (Schnidheiny, 1998). In the late 1990s, Elizabeth May, head of the Sierra Club of Canada, commented that her organization's objective was to reduce the energy and resource use per unit of Canadian GDP. Forest plantations can and must support this objective.

Logging old-growth forests comprises an important special case of this general problem. The forest sector would desirably move as rapidly as possible away from reliance of timber logged from old-growth forests, whether boreal, temperate or tropical. Perhaps logging in these forests can be sustainable, perhaps not. But, why risk unproven management strategies that purport to sustain environmental values while logging old growth? Why not embark on a policy of sustaining our material needs with minimal reliance on the forests of the world that have not yet succumbed to human exploitation? Forest plantations offer this possibility.

II. Assumptions

Several assumptions underlie the argument

a. As a result of increased population and wealth, demand is increasing across the full range of products of the forest—not for each and every product but for both material and non-material 'products' of the forest.

b. The rate of increase in the demand for roundwood is slowing (in terms of consumption per capita or consumption per unit of GDP) as a result of technological innovation. The rate of increase in the demand for many environmental services of forests (measured in similar terms) is increasing as a result of increased wealth, changing sensibilities and, perhaps, reduced supply.

c. The price of timber is capped by the availability of substitute products and production technologies; the "price" (i.e. society's marginal willingness to pay) for many of the environmental services from forests is not capped—there are no good substitutes for the environmental services of forests, especially for what we call "wilderness".

d. The inputs needed to produce any forest outputs—especially land and capital—are limited and in scarce supply. It is therefore desirable to economize on their use and to deploy them so that they generate the greatest possible impact on producing the products we want from forests.
e. The 'excess demand' for many environmental goods and services from forests arises partly, but not wholly, because consumers face a zero price for their consumption.
f. It is far more difficult to substitute capital/technology for land in the production of most environmental goods and services of the forest than it is to do so for timber.
g. It is socially desirable to internalize the negative and positive environmental externalities faced by 'economic agents' (e.g. forest landowners) either by completing markets or by efficient regulation.

Some of these assumptions are necessary to sustain the argument, some are sufficient, and others are merely consistent with it. But, they all bear attention.

III. The Case for Forest Plantations

The challenge for contemporary timber production is to craft management approaches that respond affirmatively to these overarching economic imperatives. Broadly speaking, there are two sources of timber supply—natural forests and plantations.

Natural forest management technologies face daunting challenges—they are too costly, they cannot reliably produce positive environmental outcomes, they are not economically sustainable—to name just a few of the problems (Binkley, 1997a, 1999). Analysis of a recent version of the natural forest management paradigm—Willer and Hall's (2001) so-called "Long Rotation Forestry"—provides some insight into the problems. The Willer/Hall analysis compares the economics of short, "industrial" rotations and longer rotations they feel will help to restore coastal ecosystems in the Pacific Northwest. They specifically examine the yields and timber supply from a 45-year rotation and a 140-year rotation on high-site Douglas-fir lands. Based on natural-stand yield tables, they note that the average sustainable yield—timber supply—from the longer rotation is greater than that from the shorter one. They conclude that the longer rotation forest actually conserves land since the average supply is higher.

This argument is flawed in three important respects. First, it does not account for the vastly increased—an inefficient—use of capital in the long rotation forest. This is an important omission because forestry is one of the most capital-intensive enterprises known to humans (Binkley, 1994).

Table 1 below shows the analysis. The top half of the table—yield inventory, price and cost assumptions—are taken directly from their analysis. As can be seen, they conclude that both regimes are profitable, but the 140-year rotation is far more so. The bottom half of the table computes the annual cost of carrying the growing stock inventory at two discount rates, 4% and 8% (This analysis uses a linearization of the technique described in Binkley (1994). Recently market transactions in this region suggest that these estimates are a bit too low, but they suffice for the purposes of this argument). Once capital costs are included in the analysis, the 45-year rotation is far more economic. The 140-year rotation loses a great deal of money—this can hardly be called sustainable! Those managing forests must scrupulously conserve on the use of costly capital inputs. Intensively managed, short-rotation plantations are one means for doing so.

Table 1. Performance of 45 and 140yr Rotations in Oregon Coast Range

	45-yr Rotation	140-yr Rotation
Timber Supply (mmbf)	90.6	125.1
Inventory (mmbf)	1019.7	5284.5
Revenue ($mm)	57.182	104.171
Expenses($mm)	21.155	25.538
Annual Earnings (w/o capital costs)	36.028	78.633
Capital Costs($mm)		
4% Interest Rate	16.219	132.869
8% Interest Rate	32.439	265.738
Annual Earnings (w/ capital costs)		
4% Interest Rate	19.808	-54.236
8% Interest Rate	3.588	-187.105

Source: Willer and Hall (2001); capital costs added by the author. Data refer to a hypothetical 88,000 acre high-site coastal Douglas-fir forest

The second difficulty with the Willer/Hall prescription comes in cost of moving to their recommended solution. Assuming that long-rotation forestry were desirable, their analysis is far too sanguine about the transition costs. They comment "…making the transition to long rotations may involve some short-term reductions in logging…" (p. 14). In their case, the 'short-term' spans nearly a century. The only way to lengthen a rotation is to wait. Assuming that the entire industrial forest estate in the PNW is now fully regulated at a 45-year rotation, the Willer/Hall prescription implies absolutely no timber supply (except for thinnings) from private forests for 95 years! Because of the meager public timber supply now available in the region, such a prescription has obvious, negative implications for sustainability of economic activities related to timber production in the region. It also has negative and not-so-obvious implications for timber production and materials use elsewhere.

Third, Willer and Hall ignore the capacity of timber plantations to substitute capital and technology for land. This is an extraordinarily powerful tool that is, by definition, not available to natural forest management regimes. And, the substitution of capital-intensive technologies for land is exactly what economic forces are telling us to do.

Studies initiated by John Gordon in the early 1970s examined maximum theoretical timber yields based on the biochemical efficiency of trees in turning sunlight and water into economically usable plant parts. The Weyerhaeuser Company applied these models to two sites where—at the time—they managed lands about as intensively as they are managed anywhere in the world. One site was in the Pacific Northwest and one was in the U.S. South. Yet on these sites, best management practices achieved only 40 to 50 percent of the modeled maximum yields. And on those same sites, natural stands produced only 10 to 25 percent of the maximum yields. When examined across the globe, two- to five-fold increases in specific timber yields appear to be technically feasible and economically attractive (Farnum, Timmis, and Kulp, 1983).

In the case of the Pacific Northwest, John McMahon noted nearly a decade ago that on a good site (SI=32m) the simple acts of site preparation, rudimentary genetic improvement, thinning and fertilization increased yields by a factor of 3.7 on a 50-year rotation. These practices also moved the point of maximum average yield from 100+ years to perhaps 40 years.

Plantations for timber production are appealing due to this large capacity to free natural forests from intensive exploitation for industrial purposes. Within a region every hectare of plantation forest can free up to five hectares of natural forest from industrial use. The substitution is far greater across regions, with for example, one hectare of timber production on plantations in Brazil substituting for perhaps 20 hectares of land in Siberia or the Canadian Interior. Combined with sophisticated wood-products technology, the plantation-grown wood can substitute for most if not all of the products obtained from the natural forest. Indeed the uniform and possibly designed fiber characteristics of plantation-grown wood make 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 the thing we now call a sawlog. We see evidence of this already: in recent years small second-growth sawlogs in the PNW have commanded a premium over larger ones; pulpmills in the northeastern US are closing while their associated paper machines are switching to eucalypt pulp furnish imported from Brazil.

At Hancock Timber we recently did some simulations of aggregate global timber supply and demand in order to understand the role of planted forests in the future balance. The simulation assumptions were simple—extend current rates of plantation establishment and productivity. The only innovation was to permit the plantations to become more productive over time—anecdotal evidence from Westvaco suggests that technical progress in growing trees is about 3%/yr (this is consistent with experience in agriculture). The simulations imagined that annual demand would first be met by the sustainable annual harvests from plantations, and by natural forests only after that source of supply was exhausted. With these assumptions, by 2025 logging on natural forests would fall by more than half—from about 1.3 billion cum today to about 600 million cum then. As a point of reference, this later quantity of wood could be supplied by taking half the current harvest of natural forests in the eastern US, and half the current harvest from natural forests in Europe (Binkley, 2000)

Under this scenario, about 100 million hectares of degraded pasture and other agricultural lands would be planted for timber plantations. About two thirds of this area would be used for timber supply, and the remainder would be devoted to restoring and protecting riparian areas, and creating landscape-scale biodiversity.

Under this scenario, the forest industry would have a stable, uniform and perhaps less controversial source of fibre. Timber-dependent communities would have a bright and sustainable future. Financial investors in forestry would have a reliable source of returns—biological growth and technical innovation.

Under this scenario, there would be no need to log the old-growth forests of Canada, Russia or the tropics. The over 3 billion hectares of closed forests in the world could be released from intense pressure for industrial exploitation. From an environmental perspective, this appears to be a most attractive proposition.

IV. What is needed to achieve this vision?

Achieving this vision would be facilitated by a global agreement among conservation organizations, government and industry on the pivotal role of intensively managed plantation forests in achieving an economically, ecologically and socially sustainable forest sector. The problem has two parts. The first is the role of plantations in the larger forested landscape. The second is how plantations themselves are to be managed.

A key issue is to see plantations in the context of an overall landscape design that includes plantations, natural and quasi-natural forests managed for a variety of outputs, and parks and conservation reserves. In such countries as Canada where the government controls virtually the forested land, this kind of landscape design can readily occur through public processes and tenure reform.

In the United States, the allocation among purposes has largely been made (although is constantly evolving at landuse margins). The US has public land devoted primarily to public values, and private land devoted primarily to private values. Logic suggests approaches matched to our extant ownership patterns. The management of public lands should intensively focus on providing key environmental and ecological values before turning to regulatory regimes focused on private lands. There has been a massive failure to do so in the United States, and, with the precipitous decline in the budgets for state and federal land management agencies, the problem appears to be getting worse. Coupled with the fact that, if a small area of plantations provides the vast majority of industrial timber supply, the problem of managing lands for other purposes will become even more pressing.

Private owners readily respond to signals from the market place. This being the case, it makes a great deal of sense to use markets to internalize the positive and negative environmental externalities associated with forests. Emerging markets for carbon credits offer some hope here, and the broader market-based agenda of such organizations as Forest Trends and the Pacific Forest Trust merit attention and support.

Finally, it is clear that market-based initiatives are unlikely to solve all the problems of public values arising from private lands. If needed, regulatory regimes applied to private lands should reflect the primary social benefits of private land, and should be as stable as changing societal conditions and scientific knowledge permit.

How should plantations themselves be managed to achieve the full landscape-scale environmental benefits described in this paper? The ‘social compact’ on plantations should include such factors as the critical need for plantation projects to maintain and enhance landscape-scale biodiversity with perhaps 20% to 30% of the landbase of plantation projects devoted to the ecological services of forests (e.g. riparian zones). Fine examples of such practice include the Klabin and Aracruz operations in Brazil, and Westvaco’s forests on the South Carolina Coast. This agreement should include the careful and close control of the offsite impacts of plantation-based timber production—especially the movement of silt, fertilizer or herbicides into waterways or groundwater. A corollary is an acceptable regime for using yield-enhancing chemicals such as fertilizers and herbicides focused on minimizing use and maximizing impact. This agreement should support the use of genetically-modified organisms in circumstances where it can be clearly demonstrated that gene flow out of the plantation is not possible (for example, in asexual trees).

Intensively managed forests promise substantial conservation benefits. These conservation benefits arise at the global scale, as plantations on degraded agricultural land offset demand on remote primary forests. These conservation benefits arise at the regional scale as the incremental timber supply from plantations helps to ‘pay for’ reductions in supply associated with creation of protected areas or changes in management of natural forests to accommodate greater sensitivity to environmental values. And, these conservation benefits may arise at the local level as conservation management is incorporated into the more environmentally sensitive areas of plantation projects. Those interested in the environmental benefits of forests should therefore find positive ways to encourage forest plantations.

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