FIXING FAILED FORESTS

Tom Bender

"Continuation of the recent trend toward very short rotations can only mean sharply reduced productivity relative to potential, restriction of future management options, reduction in non-timber benefits, and exacerbation of anti-forestry attitudes among the general public."[1]

"The most recent phase of forest management in the Pacific Northwest – dominated by large clearcuts and short rotations – has been a political and social disaster."[2]

Robert O. Curtis, USFS Forestry Sciences Laboratory

A recent opportunity to revisit some of the forestry economics issues first explored in my 1994 *Improving The Economic Value Of Coastal Public Forest Lands*, has brought together considerable new information supporting the greater resource productivity of long rotation forestry, as well as insights into the economic issues connected with it. The benefits of extended timber harvest rotations is now being explored within the forestry community itself, bringing greater clarity to issues of timber yield, thinning, and importance of non-timber products and benefits.

My '94 paper focused on coastal Oregon public forests, one of the most highly productive forestry regions, as does much of this discussion. Growth in less productive regions is slower, and appropriate rotation lengths even longer. Because of variation in site potential, management practices, and thinning regimes, care should be taken in extrapolating directly to other situations.

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I. DECEPTIVE AND DEFECTIVE DATA

There is growing consensus that longer rotations than currently practiced on private (and often public) timber lands result in substantially greater benefits:

* more timber volume produced per year
* higher quality and higher value timber
* reduced operating costs
* increased annual revenues on a long-term basis
* increased value for recreation
* more profitable secondary forest products
* increased salmon and fisheries productivity (which can surpass timber in terms of value)
* reduced need for herbicides and slash burning
* improved variability of age distributions and ecological diversity
* greater carbon sequestering
* improved habitat for fish and wildlife
* freeing people, and funds to pay them, for more meaningful work for society
* avoiding damage to soil fungal mats that harms forest productivity.
* hydrological and long-term site productivity benefits
* there- to five-fold reduction in yearly clearcut acreages
* Reduction in regulation when practices align with ecological and social benefit

How far rotations can beneficially be extended is still uncertain, because of non-existence of data on long rotations beyond 120-140 years, and variations of initial stocking and thinning. Concerted focus on those areas of research is needed.

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Past use and presentation of forestry data has skewed discussion, resulting in acrimonious differences between various forest interests:

* Forest economists used to show generic growth curves such as Fig. 1 to the public, saying they need to cut trees at the point where growth tapers off in order to maximize yield.

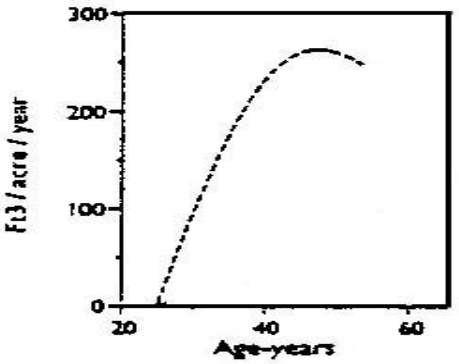


Fig. 1: Generic forestry growth curve.

Such curves are deceptive. They have been used to infer that growth drops drastically after maximum points, when in reality it often extends for decades at or within a few percentage points of maximum. (See Fig. 2) They ignore that substantially higher management costs and lower product quality occur with short rotations, which strongly affect the net value of different practices. And the most commonly used curves (McArdle, 1961) have been shown to be inaccurate – growth actually peaks much later in real life, under virtually all conditions.

* "MAI" curves (mean annual increment) plot average cumulative growth from time of planting. These curves also have been used, cut off at the CMAI point, to say harvest must occur then, or before then at the point of maximum PNV (present net value). In reality (Fig 2), most MAI curves continue to show fairly *constant growth* at or near peak productivity *beyond all data available*. And what is produced is higher quality lumber at lower operating cost than in earlier years.

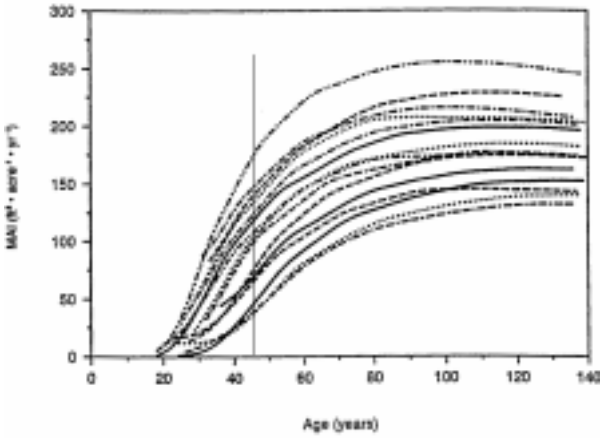


Fig. 2: Similarity of growth curves for different site indexes and stocking, showing their virtually level slope over long periods nearr CMAI. Vertical line shows current commercial rotation lengths. (after Curtis, 1994)

* Most simulation curves, even when shown past the CMAI point, end at 120 to 140 years. The reason is not that growth drops off dramatically (indeed, Fig. 2 shows that on many sites the CMAI point isn't even reached by that age). The primary reason is that we have no older "managed" forests . . . there is no data. And where data manipulators have no data, they will not tread. The secondary reason concerns future discounting which has wrongly dominated conventional economic analysis (see below and Bender (2002).

* It *is* possible to extrapolate growth curves beyond the end of available data. (Fig 3) There is no reason to expect radical change in growth patterns, or anything other than a gradual change in MAI slope as a stand ages. Certainty is less the farther you project, of course. But in practice, each additional decade of experience at or near the end of data extends the data, allowing evolution and refinement to occur as depth of experience increases. Lack of data *today* is no excuse not to consider rotations

beyond the "end of data" point as *a goal* in the absence of serious stand damage. Core sampling of individual older trees in selected conditions can give approximate projections. Longer rotations have individual and small group tree mortality, but much of that mortality can be salvaged, and replanted with expectation of merchantable growth before final harvest.

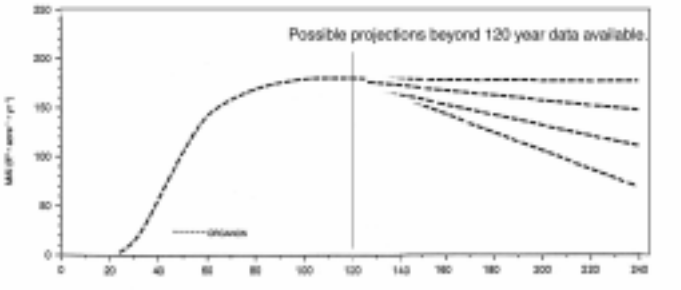


Fig. 3: Projection of MAI growth curve beyond existing data is unlikely to deviate radically from trends at end of the data set for substantial periods.

* Even ignoring their limited depth of age data, existing simulation models used to determine rotation lengths are fairly inaccurate in reflecting actual conditions, and exhibit greater variation between them than the growth curves themselves show over multiple decades (Fig. 4). There is a strong tendency to believe whatever curve a computer generates, and to accept numerical results at face value, when

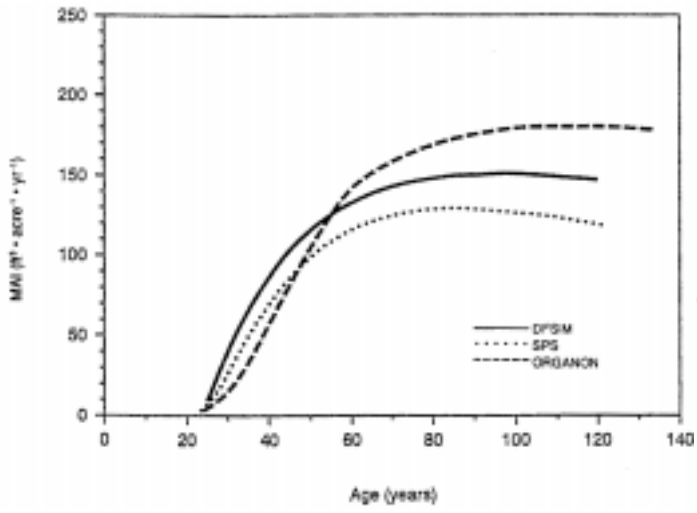


Fig. 4: Variation among various computer models for similar stand conditions. After Curtis (1994)

the number of significant digits and confidence of the data is often far less than shown.

* Most rotation length analyses fail to even show, to say nothing about considering, growth data *even reaching* the CMAI point. They assume that PNV financial considerations should be the basis of decisions. Most PNV discount rates cause premature harvests from a timber productivity standpoint, from total financial return standpoint, and also from a cost of operations standpoint. PNV is unsupportable from an overall economics standpoint as well as from the greater economic productivity available from management approaches, such as long forestry rotations, which use alternative analytical approaches.[3]

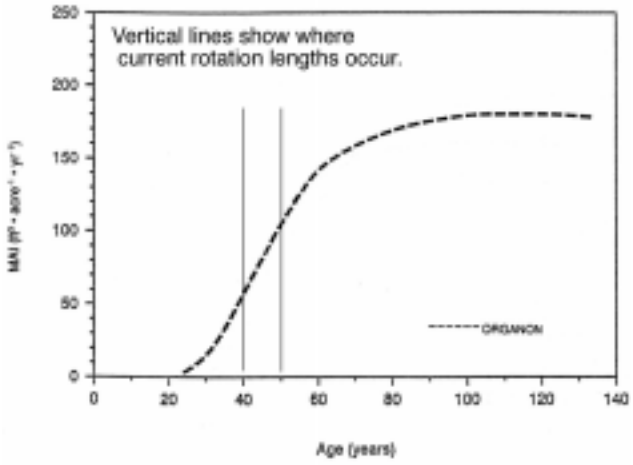
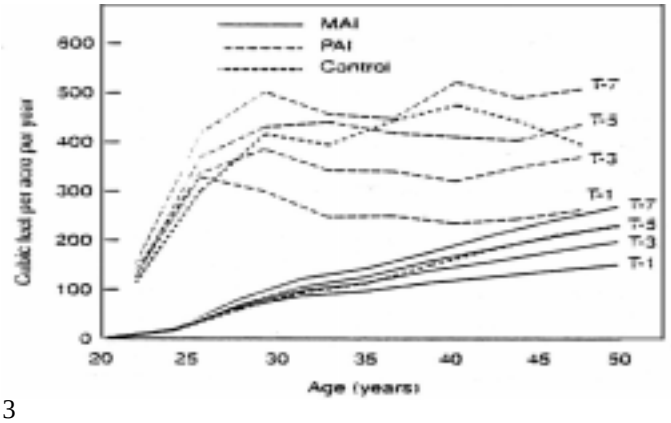


Fig. 5: Current commercial forestry rotation lengths relative to biological biomass growth curves.

* Different management practices – particularly thinning regimes – can extend the CMAI point far beyond where we have any data. (Fig 6, Curtis, 1994)



Robert O. Curtis, research forester at the USFS Forestry Sciences Laboratory in Olympia WA, in a very useful study of extended rotations as a possible way to minimize conflicts between timber production and other land uses[4], summarizes his findings:

** Harvest ages of 40 to 50 years common today in commercial forests cause substantial to large reduction in volume production (from 20 to 50 percent or more).*

** Culmination of growth is relatively late, the curve is relatively flat in the vicinity of culmination, and within unknown upper limits, moderate extension of rotations would not materially reduce long-term volume production and might increase value production. MAI curves are relatively flat for a considerable span of years beyond the maximum.*

** Databases for existing simulations are limited, outdated, and their data do not extend to the very long rotations now being discussed for some National Forest lands.*

** Principal gains from commercial thinning are not in cubic volume production, but in piece size and quality, enhanced stand health and structure that may enhance wildlife and amenity values.*

* * *

II. WHAT WE NEED TO KNOW

* Mark Wigg pioneered recent study of long rotations in 1989[5]. He compared a shift from 60 to 180-year rotations, and found a doubling of timber productivity in bd.ft., 25% increase in cubic feet production. This improved timber yield, combined with elimination of repeated replanting costs, produced a ninefold improvement in net financial productivity.

* In 1994, I combined Mark's data with available information on other forest value impacted by timber management practices.[6] While I raised the question of even longer rotations up to 240-250 years, I used Mark's 180 year rotation data, and a "zero" dollar figure for the "zero-data" secondary forest products. I made the assumption that we had no data whether possible increase in rotation length from 180 to 240 years might increase or decrease timber production or net financial value, so I assumed that a possible reduction in timber might be balanced by cost savings and ecological benefits of eliminating one more cycle of cut and replanting every 240 years. With Oregon coastal forests and rivers being largely undammed and non-urbanized, it appeared that forestry, hatcheries, and ocean conditions and harvest were the only significant items affecting salmon depletion, and that figures from the studies cited were the most appropriate available. Similarly, recreation use and secondary forestry products are as developed in these locations as anywhere, and more so than less accessible places. Combined, the value benefits suggested were on the order of 20 to 30 times the revenues from short-rotation, timber-only thinking.

* Robert Curtis' 1994 study[7] started with commercial rotations of 40-50 years, as opposed to Wigg's 60 years – a shift that had occurred in only 5 years. With the inadequacy he found in the data simulations, he did not project a precise increase in rotations, but found that "there is a considerable range of harvest ages that will produce about the same long-term annual volume production. The upper limits of this range are not known." and that "substantial lengthening of rotations . . . could mean a long-term increase in timber volume production and probably would increase value production." He compared only cubic foot volume production,

as industry practices with more total tree utilization had become more prevalent. [Though this does not negate the added value increment in "board foot" usages.] He showed increases in MAI ranging from 47% at 95 years to 285% at 128 years, compared to MAI at a 45 year harvest. His examination of a variety of thinning options and site standards concludes that "the principal gains from commercial thinning are not in cubic volume production but rather . . . piece size and quality, stand health, enhanced wildlife and amenity values. He did not appear to have examined financial benefits of lower-entry practices, or externalized benefits for other forest value.

* Carey, Lippke, and Session's 1999 biodiversity study[8] focussed on comparing unmanaged forests, ones managed to maximize timber PNV, and ones managed for conservation of biodiversity, all over a 300 year span. Their biodiversity option used alternate harvests at 70 and 130 years, with commercial thinning at 30, 50, and 70 years, plus several other constraints on production. They concluded that all common models, including their own, underestimate the time to actual CMAI. On a 300 year basis, their biodiversity option, compared to a PNV short-rotation with little riparian and no mass-wasting protection, produced only 7.5% less wood, while actually producing decadal revenues 54 to 68% higher than short rotations. Clearcut area/year was reduced 72%. While focus on the study was on ecological values, no financial analysis was included of other than timber values.

* The "Forests That Work" study done in 1999 by Chuck Willer of the Coast Range Association and Daniel Hall of the Forest Biodiversity Program of American Lands,[9] examined moving from present 45 year rotations to 140 year rotations, using ORGANON data. They found an average of 38% increase in volume of wood produced per year, and increase in annual profit of 118% even based on 1999's temporary dip in prices for large logs. While they mention other benefits from long rotations, they do not include them in their numbers. Their 140 yr rotation was apparently chosen because of the data limits of ORGANON. They indicate that after their study they were told that the productivity they used for the comparative 45 yr rotation was too generous. Correction would give even more striking contrast.

Interestingly, none of these more recent studies acknowledged Wigg's original study, challenged or corrected his figures, or attempted to include valuation of non-timber benefits of long rotations. Differences in benefits shown in the various studies appear to be changes in regeneration levels and costs, market prices, etc. The last two studies confusingly present profit increases, indicating, for example, " . . . increase profits by 218%", when actually profits *increased* 118% *to a level* of 218% of short rotations.

I think from these studies we can conclude that:

* though their detailed financial benefits have not been adequately studied, long rotations of three or more times current practices can be more favorable from both a timber yield and financial basis.

* secondary forest values other than timber may well be substantially in excess of timber values, are severely affected by forestry practices, and need to be included in any evaluation.

* major study is needed on the magnitude and nature of those benefits – and should take priority over continued studies of timber costs.

* though further study is urgently needed, none has come to light to contradict the sources cited in my '94 study.

* the total long-rotation timber plus non-timber benefits appear to be far greater than those of short rotations.

* * *

III. FREQUENTLY ASKED QUESTIONS

Our choice and use of economic terms is often primarily as persuasive tools, unsupported by underlying ecological or financial actuality. Here are some frequently made assertions and questions concerning forestry economics that need revisiting:

** Forestry is a highly capital-intensive industry. We can't wait 250 years to get a return on our investment.*

You're right. Anyone who put a lot of money into bare timberland and had to wait 250 years to harvest would be in a heap of trouble. But commercial timberland does not operate on the "single plot" basis. It operates on a firm basis. Every firm owns lots of plots – some bare, some ready to harvest, some in between. Nobody is investing money in regeneration and waiting 250 years. Most costs are handled through current cash flow. Revenues from the plots cut one year pay for other plots being replanted that year, roads being built that year for next year's cuts, etc.

Forestry needs to be looked at as a long-term on-going operation, which it is. That is where maximum timber value, fisheries value, secondary forest products value, recreation value all occur – *every year*. Long rotations mean cutting a smaller percent of land area each year. But that smaller area has more timber volume on it, and sale value, than on the larger yearly cuts with short rotations.

What *are* the capital costs of forestry? Primary are land purchase, regeneration (site prep, planting, competitive release (weeding), and animal protection), overhead (fire protection, road maintenance, staff, property tax, and equipment), thinning, cut preparation, logging (felling, bucking, yarding and loading) and haul costs. Of these, cut prep, logging, haul costs, regeneration, and competitive release are all harvest expenses, and paid for from gross sales revenues at or near the time of sale, so are not really capital "investments". (Federal tax law requires that regeneration costs be capitalized and written off over time, even though required by state laws as part of permit to harvest. This obviously needs to be changed.) Other current costs (everything other than land purchase) are covered through current revenues.

It is interesting to note that, in addition to significant increases in timber production and quality, a shift from 45- to 180-year rotations (for example) eliminates or avoids three out of every four cycles of cutting/planting, reducing related costs by 75%. Cut prep, bucking, yarding, site prep, planting, competitive release, and animal protection costs only happen once, and are reduced 75%. Felling, loading, and hauling costs are reduced to a lesser degree. Thinning tree densities to prevent suppression-related mortality similarly need only occur once, rather than four times. Overhead may be reduced somewhat.

Land purchase costs are a special category. One person told me it would be hard to argue that forestry is not capital intensive to a stockholder of Willamette Industries, who had just sunk $1 billion in land purchase. A purchase of timber land has several dimensions – land to grow trees on; existing trees on the land that are producing wood; existing trees on the land that represent marketable timber, either now or in the future. Much of timber land prices represent product inventory on the stump.

Land cost itself reflects only one thing – expected net profitability of its use. Higher profitability comes from one of two things – higher productivity and lower operating costs, which long rotations represent, or liquidation of timber value through short rotations. The later is only a short-term, inflationary effect. The true value of $1 billion of land in short rotation would be *greater* if put into long rotation.

Neither existing "long" rotations, nor extended rotations to 200 years adversely affect

"capital costs" of forestry on a firm level. Yearly cuts and consequent revenues are on-going. No firm sits and waits either 50 or 200 years before obtaining revenues from thins or cuts to cover debt service. If yearly cuts and revenues don't cover land purchase and operating costs, land values adjust to accommodate.

** What about corporate raiders taking over a company because of its timber inventory assets?*

What many forestry people really mean when they talk of "capital intensive" forestry is that huge amounts of product value are sitting on the hillsides year after year, and they'd love to liquidate that value. It's not the *cost* of the trees, it's the *value* of the trees that is the capital in question. They haven't paid anything for it. It just sits there in the sun, growing more 2x4s year after year – for free. But they'd love to get their hands on the money from selling it. The confusion is that trees are *both* productive capital *and* product – they produce wood, and *are* wood. We've seen, though, that the unnecessary work and financial costs of repeated short cycling, and the potential growth *lost* through every cut cycle make massive inroads in both the timber productivity and the financial benefits of harvesting it. Leaving trees on the stump longer in reality costs nothing, and provides immense long-term, ongoing benefits.

The one real risk involved is the lure of the "equity value" of timber on the stump for corporate raiders, who hope to overbid the value of the company and pay off the debts through rapid liquidation of the timber. Any sane society would have regulations to prevent that. Specific to forestry, federal and state forest practice regulations, responding to extremely abusive "cut-and-run" forestry practices in the early 1900's, half-way protect tree "assets" through rotation length requirements, which can and should be extended to reflect the social and economic value of long rotation forestry and to require harvest practices that achieve those potentials. At the same time, such regulations would prevent forest "liquidation" and the threat of hostile corporate takeovers based on it.

** Don't timber company managers operate under the constraint of fiscal responsibility to company shareholders, and thus cannot lengthen rotations?*

We've shown that long rotations provide higher on-going economic and financial productivity – other than temporary short-run "liquidation" practices which should be prohibited. As noted above, forest practices regulations can be changed to require long (and more productive) rotations, freeing company managers of that decision.

There are also as many stockholders interested in higher long-term return on their investments as those interested in short-term gain. Stockholders can potentially also take legal action to force management to adopt practices that are in the long-term more profitable. I would not be surprised to see legal action by stockholders to force management to achieve the higher returns available from long rotations. There's no requirement that "highest return" must mean *short-term* returns. The "responsibility to shareholders to maximize profits" is smoke, intended to force adoption of PNV principles.

** If forestry doesn't meet R.O.I. (return on investment, or equivalent of discounting future) of the market, won't prudent investors pull their money out and put it in alternative investments?*

Perhaps. A lot of that talk is pure bluff, trying (often successfully) to scare people into agreeing to unreasonably favorable conditions for the investor. But we've shown that long rotations provide immense savings in operating costs while dramatically increasing timber productivity. Mill operations and transport are largely separate from timber operations, and not directly dependent on a single operation.

The only part of timber investment ROI tied to rotation length is land costs. If an investor wishes to sell and invest more profitably elsewhere, that is their prerogative. One of three things happens: 1) they sell to someone who is happier with the investment and continues; 2) they sell to someone who can't make it under new conditions, and sells out for less; 3) they sell out for less, acknowledge they paid too much for the land, take a loss and move on. Worst case is they can't find a buyer, default to the government for taxes, and the timberland joins other public timberland. In any case, replanting is a condition of harvest, the hills continue to be covered with trees sitting in the sun growing more 2x4s. All other operating costs are tied to harvest, and long rotations make them more profitable. Forestry is not run by capital investment. It is run by the sun.

* *But don't we want our forests to be profitable?*

Yes . . . and no. We want them to be productive ecologically and efficient economically in terms of creating useful product. We want them to minimize negative costs externalized onto fisheries, climate change, recreation, secondary forest products, etc. But we have to remember that from a classical economics viewpoint on a societal level, *profit is something to be minimized!* In a mature economy, profit from new discoveries is acceptable, but true competition is supposed to reduce normal "operational" profit to zero – to the level of providing fair wages and return on investment. Much of the big-$ activity in forestry, as in other industry, has less to do with efficient operation than with trying to achieve controlling market share, siphoning money off for foreign investment, or short-term stockholder profits to justify high CEO bonuses.

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IV. TRANSITIONAL STRATEGIES

Many silviculturists express concern about the effects of increasingly short rotations on public and private lands, and the difficulty of returning to long rotations once caught in short rotations that eliminate more mature tree stands. The simple analogy is how do you get out of debt once you're in it? Concern is expressed about reduced timber harvests, income, and wood products availability during a period of reduced harvests needed to return to longer rotations.

My personal feeling is that the concern is excessive. Part of the concern comes from people who do not want to change practices that impact immediate profits. Like getting out of debt, however, it needs to be done, and the long-term benefits are substantial. It is highly unlikely that the entire web of corporate forest owners, small timberholders, state and federal agencies, – plus timberland owners worldwide – will suddenly act in unison to change practices.

There are other products that can be substituted for many wood product uses. Recycling and efficiency improvements are possible. Exports can be reduced without hurting domestic consumption. Building fewer second homes and oversized mansions would cause little impact on our true well-being. Higher prices would reflect in part the reality of a past and presently subsidized market by overharvesting the resources of future generations.

Restriction on harvest of federal lands in recent years due to endangered species issues has acted inadvertently to give a respite to those lands and to initiate a period of regrowth. Federal forests have already begun the process of transition, and the feared effects of those restrictions have turned out to be far less than imagined. Some increase in harvest of federal lands to a 2% POI (percent of inventory) may be possible, and might mitigate reduced harvests elsewhere. Improvement in the complex and contradictory web of regulatory and administrative requirements can certainly provide significant improvement in both timber and financial productivity which can mediate impacts of transition to longer rotations.

There are also many areas, such as Oregon's Tillamook Burn and the East Cascades ponderosa/juniper issue areas, where inadequate management practices and seed and species selection has resulted in severe forest health issues, such as Swiss needle cast, which are reducing timber productivity. Early harvest and replanting of such areas in lieu of older and healthier areas may be a helpful strategy.

Some recently developed management strategies for biodiversity call for alternate medium and long rotations to develop more varied forest structure. At the same time, concern for wind, fire, and insect damage in older stands calls for salvage harvests of infected areas in conflict with overlying rotation requirements. By focusing more on long rather than medium rotation lengths, with the knowledge that salvage harvests will inevitably occur, long rotation benefits can possibly be achieved more simply.

The simplest base strategy for transition that I am aware of remains that developed in the early '90s by Hans Burkhardt (1994) using "percent of inventory" as method of determining yearly allowable cuts.[10] Depending on the ultimate rotation length sought, a certain "percent of timber inventory" is allowed to be cut each year, less than the yearly growth. As the growth beyond that amount adds to inventory, the allowable cut increases, until inventory reaches the target amount and the % of inventory results in maintenance of that inventory associated with the desired rotation. It is the simplest, least expensive, easiest to implement and most effective means to restore depleted forests to full productive capacity.

A 2% per year harvest (based on frequent rather than single-aged cuts) appears to correspond very closely to the percent of maximum stand productivity regardless of species, growing site or silvicultural method used. Obviously the inventory is far greater on the long rotations, so yearly harvest actually increases.

The second primary element of minimal impact transition back to long rotations involves very specific use of thinning strategies - both early in a rotation and in the extended periods. This allows salvage of shading mortality, early establishment of preferable tree spacing, and on-going maximization of volumetric growth rates, while allowing an amount of harvest through the process. As thinning harvests are more expensive than clearcuts, a balance between cost and amount of timber harvested needs to be sought.[11]

The development of transitional strategies are obviously site-specific, institution-specific, and political. They need to take account local needs, alternatives available, and what tradeoffs the communities involved wish to make. Restocking our forests and returning to longer rotations, in excess of 150 years in most cases, is essential and profitable to our society on a multitude of levels, and is vital to ending the acrimony around harmful forestry practices that has continued for over a hundred years.

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[1] Curtis, Robert O., "Timber Supply in the Pacific Northwest," JOURNAL OF FORESTRY, Sept. '96.

[2] Ibid.

[3] Bender, Tom, LEARNING TO COUNT WHAT REALLY COUNTS: The Economics of Wholeness, 2002; and Bender, Tom, "Foreclosing Our Future: Truth and Consequences in Economics," April, 2002. See also Richard B. Norgaard and Richard B. Howarth, "Sustainability and Discounting the Future," in ECOLOGICAL ECONOMICS, 1991; Colin Price, TIME DISCOUNTING AND THE FUTURE, 1993.

[4] Curtis, Robert O., "Some Simulation Estimates of Mean Annual Increment of Douglas-Fir" USFS Research Paper PNW-RP-471, 1994.

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[7] Curtis, Robert O., "Some Simulation Estimates of Mean Annual Increment of Douglas-Fir" USFS Research Paper PNW-RP-471, 1994. See also, Curtis, Robert O., "Extended Rotations and Culmination Age of Coast Douglas-fir: Old Studies Speak to Current Issues," USFS Research Paper PNW-RP-485, Nov, 1995.

[8] Carey, Andrew; Lippke, Bruce; and Sessions, John, "Intentional Systems Management: Managing Forests for Biodiversity," JOURNAL OF SUSTAINABLE FORESTRY, Vol. 9(3/4), 1999; Hall, 1999

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[11] See Curtis, Robert O., "Extended Rotations" USFS PNW-RP-485, 1995; and Curtis and Carey, Andrew B., "Timber Supply in the Pacific Northwest," JOURNAL OF FORESTRY, Sept. 1996.