Forestry in the 21st Century: Dealing with the Consequences of Success

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THE UNIVERSITY OF MONTANA SCHOOL OF FORESTRY
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The Plum Creek Lectures
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Nick Baker and Jennifer O’Loughlin, Editors

School of Forestry
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The Lectures

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Effects of Habitat Fragmentation on Resident and Colonizing Small Mammals

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Introduction

Habitat loss is one of the primary threats to maintaining biological diversity (Harris 1984, Wilcox & Murphy 1985). Declines in species richness or populations are primarily attributed to habitat loss, but habitat fragmentation, which subdivides populations, is also an important factor (Wilcove et al. 1986, Goodman 1987, Noss & Cooperrider 1994). Habitat fragmentation seriously threatens the stability and persistence of wild populations because the size and isolation of remaining habitats increases the probability of extinction through demographic, environmental, or genetic stochasticity (Wiens 1976, Harris 1984, Soul 1986, Gilpin & Hanski 1991, Andren 1994). Studies of patch size usually address population-level questions such as minimum viable population size and extinction rates (Boecklen 1986, Fahrig & Paloeimo 1988, Gilpin & Hanski 1991, LaPolla & Barrett 1993), edge effects (Stamps et al. 1987, Temple & Cary 1988, Harper et al. 1993), or gene flow between patches (Lande & Barrowclough 1987, Mills & Smouse 1994). Little is known about the fate of animals in a continuous habitat before and after habitat loss and fragmentation.

The short-term effects of reduction in habitat can be separation of families and breeding demes and an influx of surviving animals into remaining habitat fragments (Bierregaard et al. 1992, Lms et al. 1993). The impact of this influx of animals into established resident populations is unknown, but increasing density and intrusion of unrelated, unfamiliar individuals into established family units purportedly can reduce juvenile recruitment and survival (Charnov & Finerty 1980, Lambin & Krebs 1991, Lambin 1994, Wolff & Schaub er 1996), probably through
infanticide (Brooks 1984, Wolff & Cicirello 1991) or competition for food resources that take away the benefits of kin groups (Lambin 1994, Wolff 1995). Thus, the short-term effects of immigration of strangers, isolation, and emigration on fitness of residents in subdivided habitats are not known, but may be negative.

The science of biodiversity conservation has emphasized strategies for retaining species in native habitats (Noss & Cooperrider 1994, Scott & Csuti 1997), yet in many areas habitat loss and fragmentation have already resulted in the local loss of some species (Reaka Kudla et al. 1997). Interest in restoration ecology is increasing (Jordan 1997), and reintroduction of organisms into habitats or areas where they are locally extinct is becoming commonplace (e.g., the gray wolf [Canis lupus] and black-footed ferret [Mustela nigripes] in Montana). Although the wildlife literature has many examples of successful introductions or reintroductions, empirical data on the colonizing phase of population growth is generally lacking. Most studies of animal movements in fragmented habitats examine movement among patches of already established populations (e.g. Forman & Godron 1986, Robinson et al. 1992, Bowers & Dooley 1993) or along corridors (Bjornstad & Hansen 1993, LaPolla & Barrett 1993, Johannesen & Ims 1996). The movement of individuals and growth of recolonizing populations is poorly understood.

My colleague, Jerry Wolff, and I have used gray-tailed voles (Microtus canicaudus) to examine short-term effects of individual-scale habitat fragmentation (Wiens et al. 1993, Andren 1994) on small mammals for two field seasons. Gray-tailed voles are a common small mammal species found in grasslands in the Willamette Valley, Oregon. Their mating system is polygynous or promiscuous, females are territorial, males have large home ranges that overlap those of several females, and juvenile dispersal is male-biased (Wolff et al. 1994).

My objectives were two-fold. First, I tested whether animals perished or moved into remaining habitat after 70% of their habitat was removed. Andren (1994) proposed that the random sample hypothesis (Conner & McCoy 1979) was a good predictor of the effects of habitat fragmentation in landscapes with 30% of suitable habitat remaining. In these landscapes, habitat fragmentation is primarily a function of habitat loss; whereas with more than 70% habitat reduction, patch size and isolation complement each other, compounding the effects of habitat fragmentation. Second, I sought to determine if there is a fundamental difference in movements and demographic parameters between vole populations already existing in fragmented habitats versus populations colonizing patchy habitats.

I tested the null hypothesis that movements and demography would not differ between two manipulated habitats of comparable area: one single patch of habitat (referred to as a large fragment) and a mosaic of 25 small fragments separated by 4 m of nonhabitat. Each small fragment was smaller than the home range of one animal. I hypothesized that a 70% reduction in habitat would result in an immediate loss of animals from the cleared area. I also hypothesized that abundance would not differ between the two manipulated treatments, but would be lower on those treatments than on controls.

I predicted surviving animals from the cleared areas would move into the remaining habitat, temporarily increasing densities and disrupting reproduction. I
predicted that by the end of the summer, colonizing populations would not differ from resident populations with respect to abundance, but that colonizing voles would move more readily among habitat patches.

Study Area and Methods

The study was conducted at the Hyslop Agronomy Farm of Oregon State University, approximately 10 km north of Corvallis, Oregon. The experimental units consisted of 12, 0.2-ha (45 x 45 m) enclosures planted with alfalfa (Wolff et al. 1994, Edge et al. 1996). Each enclosure was constructed of galvanized sheet metal approximately 90 cm high and buried 90 cm deep to prevent escape of, or entry by, burrowing animals. A 1-m-wide strip along the inside of the fence within each enclosure was kept bare to minimize use by small mammals. Each enclosure initially contained 1,850 m (43 x 43 m) of alfalfa habitat. Twelve outbred voles (6 males and 6 females) were introduced into each of the 12 vacant enclosures in early April 1994 and again in 1995. In 1994, we manipulated alfalfa in eight of the enclosures in two arrangements (Figure 1). We reduced the alfalfa habitat within four of the enclosures to one centrally located 25- x 25-m (625 m²) fragment (large fragment).

We reduced the alfalfa habitat in four other enclosures to 25 small fragments, each 5 x 5 m (25 m²). Each small fragment was separated from adjacent fragments by a barren strip of nonhabitat (matrix). Each fragment was approximately one-half the size of an average home range for a female (= 56 m²) and one quarter the size for that of a male (= 94 m²) (Wolff et al. 1994). The total area of suitable habitat in the small fragment enclosures was 625 m², the same as in the large fragment enclosures. We kept the matrix between the small fragments and around the large fragments bare by mowing and removal of debris.

In 1994, we manipulated the habitat in the treatment enclosures in two steps. On 30 June we sprayed the alfalfa to be removed with the herbicide glyphosate (this herbicide is nontoxic to small mammals). The alfalfa turned brown and died within one week after the herbicide was applied. From 22 to 27 July, we mowed the dead alfalfa and removed the residue, leaving a matrix of bare ground. We maintained four unmanipulated enclosures as controls. In 1995, we continued to maintain the matrix area between patches as bare ground, but otherwise did not further manipulate the enclosures. Thus, in 1994, habitats with resident vole populations were fragmented; in 1995, voles were introduced into already fragmented habitats.

Four traps were placed in each small fragment 1 m in from the edge with 3 m between traps. Trap spacing in the large fragments and control habitat was 4.3 m. Before habitat removal and fragmentation, we placed one 8- x 9- x 23-cm Sherman live trap at each station for a total of 100 traps per enclosure. After habitat removal and fragmentation, we placed two traps per station in the large fragments and 20 traps in mowed areas along the enclosure fences, 10 m from the fragment. This trap arrangement allowed for 100 traps in each of the control and small fragment enclosures and 92 traps in the large fragment enclosures (Figure 1). Recapture probabilities were always >80% and did not differ based on number of traps.
Trapping Procedures

We trapped for four consecutive nights (i.e., 1 trap period) at two-week intervals from May through early September 1994. Traps were baited with oats and sunflower seeds, set in the evening, and checked once a day at sunrise. Traps were propped open and pre-baited during nontrapping weeks. We ear-tagged all captured animals for permanent identification and recorded body mass, sex, reproductive condition, and trap location for each capture. We considered females to be in reproductive condition if they were lactating, pregnant, or had widely parted pubic symphyses. Males were considered adult and reproductive when they reached a body mass of 30 g. Testes are relatively small in gray-tailed voles, and their size cannot be estimated externally (Wolff et al. 1994).
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Data Analysis

We estimated population size for each enclosure and trap period using the program CAPTURE (model M, Jackknife estimator; Rexstad & Burnham 1992), which gives the best estimates for our system (Manning et al. 1995). Population density was calculated by dividing estimated population size by the area of unmowed alfalfa habitat. We measured sex-specific effects of habitat loss and fragmentation treatments on movements of voles by the proportion of voles captured in more than one 25 m² area within a time interval. We used Statistical Analysis System (SAS Version 6.05; SAS Institute, Inc. 1990) to conduct all data analyses. We had only four replicates for our treatments and had considerable variation among replicates, so we set alpha at 0.1 to increase statistical power to detect biologically meaningful results (Schauber & Edge, unpublished observation). We used multivariate repeated measures analysis of variance (MANOVA) to test for differences among trap periods, differences among treatments, and interactive effects of trap period and treatment on density and movements. We also used this suite of statistical procedures to test for effects of time, treatment and gender on the proportion of voles moving among fragments in three time periods: before herbicide application (7-28 Jun 1994 and 6-27 Jun 1995), between herbicide application and habitat removal (6-26 Jul 1994 and 5-21 Jul 1995), and after habitat removal (2 Aug-5 Sep 1994 and 1 Aug-1 Sep 1995).

Results

Demography

We caught a total of 1,521 animals 4,634 times in the 12 enclosures from April to early September 1994. In 1995, we caught 635 voles 5,008 times between 6 June and 21 September. In 1994, peak density estimates based on the amount of habitat in each enclosure (control and pretreatment habitats were 0.185 ha and treatment habitats were 0.0625 ha after habitat removal) were 545 animals/ha in control, 1,056/ha in large fragment, and 2,880/ha in small fragment enclosures (Figure 2). Densities did not differ among treatments and controls prior to habitat removal (< 2.41; > 0.145), but differed among treatments and controls during all trap periods after habitat removal (F > 5.6; < 0.0273). After habitat removal, densities in small fragment enclosures were greater than in controls (Tukey’s Range Test, < 0.05) and greater than in large fragment enclosures (Tukey’s Range Test, < 0.10).

At the highest densities, an average of 9 voles occupied each 25 m² fragment in three of the four small fragment enclosures. The colonizing populations in 1995 reached much lower maximum densities than did the resident populations in 1994 (Figures 2 and 3). Peak densities in 1995 were 105 animals/ha in controls, 315/ha in large fragment, and 405/ha in the small fragment populations (Figure 2). Densities did not differ among treatments in 1995 (F = 2.9; = 0.12).

Movements

Movements of voles among patches varied among treatments and between sexes and were also different each year. In 1994, prior to herbicide application, 60% to 75% of male voles moved between areas that would become fragments within a
trap period with no differences among treatments and controls ($F = 0.01; = 0.987; \text{Figure 3}$). However, movements of voles differed among treatments and controls between the time of herbicide application and habitat removal ($7.5; = 0.004$) and after habitat removal ($F = 54.7; < 0.001$), with movement in small fragments less than in large fragments and controls (Tukey’s Range Tests, $< 0.05$).

In 1995, movements of colonizing male voles differed among treatments ($F = 5.2; = 0.03$; Figure 3). Movements in small fragments were less than in large fragments and controls during all three time periods (Tukey’s Range Tests, $< 0.05$). However, about 50% of colonizing male voles moved among small fragments in 1995 (Figure 3) compared to less than 20% in 1994 (Figure 2). Overall, male voles were more likely to change patches during a trap period than were females in both 1994 ($F = 9.0; = 0.008$) and 1995 ($F = 6.0; = 0.012$). In 1994, before herbicide application, 50% to 60% of female voles moved among areas that would become fragments and movements were similar among treatments; but following herbicide application, movements of voles differed among treatments and controls between the time of herbicide application and habitat removal ($F = 9.5; = 0.002$) and after habitat removal ($F = 38.2; < 0.001$); movement in small fragments was less than in large fragments and controls (Tukey’s Range Tests, $< 0.05$; Figure 4). In 1995, colonizing female voles in the small fragment enclosures consistently moved among fragments less often than females in large fragment and control enclosures for all three time periods (Tukey’s Range Tests, $< 0.05$; Figure 4). However, colonizing female voles were almost three times as likely to change fragments after habitat removal as were resident females.

## Discussion

The short-term effects of habitat fragmentation seem to be fundamentally different in existing versus colonizing populations. Vole densities were much greater, and movements of both males and females were substantially reduced in existing populations after fragmentation (1994) compared to colonizing populations (1995). Reproductive activity and survival were similar for both the existing (Wolff et al. 1997) and colonizing (Nelson 1996, Davis-Born 1997) populations in each of the three treatments. Although movements of colonizing voles were reduced in small fragment enclosures relative to control and large fragment...
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enclousres, voles of both sexes colonizing patchy environments moved more readily among fragments than did voles from existing populations after habitat fragmentation.

These greater movements of voles in our colonizing populations are probably related to relatively low densities and the absence of conspecifics in adjacent fragments. Habitat saturation of territorial females and aggressive adult males can create a social fence and deter immigration in high density populations (Hestbeck 1982, Wolff 1993); the voles in our colonizing populations would have been less subject to these pressures than the voles in existing populations. Population densities in the treated habitats reached much higher densities than the controls for both existing (1994) and colonizing (1995) populations.

The behavioral mechanisms that permit such high densities in small habitat fragments are unknown, but may be associated with degree of relatedness or familiarity of neighbors (Charnov & Finerty 1980, Lambin & Krebs 1991, Lambin 1994, Wolff 1995). Related or familiar individuals may behave amicably and nepotistically toward one another, increasing survival and recruitment (Ylonen et al. 1990, Lambin & Krebs 1993, Mappes et al. 1995), purportedly through reduction in infanticide (Wolff 1995). Neighbors in large or continuous populations are more apt to consist of “strangers” than “friends,” which may negatively affect juvenile recruitment and survival (Boonstra & Hogg 1988, Lambin & Krebs 1993, Mappes et al. 1995). Wolff and Schauber (1996) reported that juvenile recruitment was lower in fragments that contained unrelated females than in fragments containing related females, suggesting that relatedness or familiarity affected recruitment on a small scale. The overall population-level effect would be higher densities in a series of small habitat fragments than would occur in one continuous fragment of comparable area. Wolff et al. (1997) reported the unexpected result that removal of 70% of the habitat, leaving one large fragment or 25 small fragments, did not affect population size, reproductive rates, juvenile recruitment, or juvenile emigration in our short-term experiment.

Voles in the cleared areas did not perish, but were able to establish home ranges in the remaining habitat. All populations continued to increase after habitat removal and fragmentation, suggesting that populations were below carrying
capacity at the time of habitat removal. Thus, the data did not support the hypothesis that habitat loss and fragmentation would have negative demographic impacts on populations of gray-tailed voles, but did support the hypotheses that fragmentation would reduce movements and thus alter social structure. The fact that animals from cleared habitat were able to move into and become established in the remaining habitat suggests a social system flexible enough to accommodate this influx of animals. The major effect of fragmenting a large habitat into several small fragments was to reduce movements and movement distances, increase survival of adult males, and reduce rates of juvenile sexual maturation. These data do not support the random sample hypothesis (at least on a short-term basis), proposed by Andren (1994), that the effects of habitat removal would be directly comparable to habitat loss and would not be affected by fragmentation per se. These results suggest that, at least in the short term, voles adapt to loss of habitat.

Higher densities of small mammals in remnant habitats have also been recorded for whitefooted mice (Peromyscus leucopus) red-backed voles (Clethrionomys gapperi) (Yahner 1992, Nupps & Swihart 1996), and root voles (Microtus oeconomus) (R. Ims, personal communication) and may be characteristic of small mammals in general. Differences between existing and colonizing populations may have been caused by annual variation, which I was unable to remove from these post-hoc analyses.

Populations in all enclosures, including the controls, were substantially lower in the colonizing populations than in the exiting populations. However, the differences among control enclosures during the two years were within the normal range of variation we have observed in more than 30 control populations in previous experiments (Edge and Wolff, unpublished data), whereas differences among treatments during the two years were greater than expected. The main effect of habitat loss and fragmentation was confining animal movements. Home-range sizes of voles in control enclosures average 56 m² for females and 94 m² for males (Wolff et al. 1994, whereas after fragmentation voles were often confined to one 25² fragment. In the small fragment enclosures, as many as 3-4 breeding adult females, 4 adult males, and 5-7 juveniles shared a 25² fragment (see also Wolff & Schauber 1996). Because female voles typically occupy exclusive space with respect to unrelated females, and males have large overlapping home ranges (Wolff et al. 1994), habitat fragmentation drastically altered the social structure by confining both sexes to small areas and "forcing" shared use of space. The immigration of presumed "strangers" had no measurable effect at the population level; however, juvenile recruitment was lower in fragments containing unrelated females than in fragments containing related females (Wolff & Schauber 1996).

These results suggest that at the individual level, juvenile recruitment may have been lowered by an influx of strangers, but this difference was not manifested at the population level. Habitat fragmentation also reduced home range sizes and movements of root voles in an experimental enclosed system (Ims et al. 1993), and this was more pronounced for females than for males (Andreassen et al. 1996). Diffendorfer et al. (1995) similarly reported that cotton rats (Sigmodon hispidus) deer mice (P. maniculatus) and prairie voles (ochrogaster) moved less often but greater distances as fragmentation increased.
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In the short term, gray-tailed voles responded to individual scale fragmentation and a 70% reduction in habitat area with a slight negative effect on juvenile recruitment, which may have been associated with an influx of strange females, but no population-level response (Wolff et al. 1997). Habitat loss and fragmentation did not cause immediate mortality of animals in destroyed habitat, but immigration into remaining habitat may have slightly decreased the fitness of resident females (Wolff et al. 1997). In the short term, habitat loss and fragmentation will result in an increase in population density in remaining habitat because of immigration from altered areas. A 4-m barrier inhibited but did not prevent dispersal, especially in colonizing populations, a result similar to that found by Andreassen et al. (1996) for root voles. Wolff et al. (1997) predicted that isolation would increase reproductive success and juvenile recruitment and survival in the short term, but long-term effects of inbreeding and reproductive suppression would lower population viability. Further studies on the effects of habitat fragmentation should be conducted long-term or during harsh (e.g., winter) conditions to determine how subdivided populations respond to annual population bottlenecks (Brunkal and Edge, unpublished ms.).

These results are similar to those of other experimental studies of voles in fragmented habitats (e.g., Ims et al. 1993, Bowers 1994, Barrett et al. 1995, Johannesen & Ims 1996) and confirm that vole species may be good ecological model systems. Spatially, these experiments, like those of many others using small mammal models (e.g., Harper et al. 1993, Ims et al. 1993, LaPolla & Barrett 1993, Diffendorfer et al. 1995), were conducted at the individual scale of fragmentation (Haila1990, Andren 1994). This spatial scale of fragmentation is probably most representative of animals living in patchy environments or medium-to-large animals living in highly fragmented landscapes (e.g., urban areas, agricultural areas, woodlots or prairie potholes) that possess similar behavioral traits.

Acknowledgments: This analysis relied on data collected by several colleagues and students including R. Davis, N. Nelson, E. Schauber, and J. Wolff. I borrowed text liberally from an earlier manuscript (Wolff et al. 1997). I am grateful to student assistants who helped with enclosure maintenance, data collection and arduous habitat manipulations. Personnel from the Hyslop Agronomy Laboratory assisted with alfalfa culture.
Questions from the audience

I have a question about scale that relates to the classical studies on the impacts of fencing on demographic machinery. Your study population is entirely within fenced enclosures. Do you think you might have observed different patterns if the voles could have dispersed beyond the enclosures?

Excellent question. The question relates to classical research design—the enclosure-type studies—and the premise that you invariably get a “fence effect” where the population within an enclosure will get much higher than it would in the open.

The first three years of our study (prior to 1994) we simultaneously ran enclosed and non-enclosed grids. We found that although the enclosure population densities were substantially higher, the demographics were essentially the same. Both populations had a high point in late July or early August and then start to decline. The behavior is the same, but the population in the enclosures is quite a bit higher.

In the period when the animals were out of danger and more or less forced to go into pastures did you notice any increase in injuries from aggression or stress?

A: No, but its difficult to consistently identify or track that. You have several hundred animals to process, and our presence and the enclosures certainly make them cranky. We do see wounds – the males especially tend to get wounds on their faces and flanks – but we haven’t noted whether enclosures affect the frequency of those injuries.

Has predation been considered as a factor in population decline in your enclosures?

Absolutely. Predation certainly is a plausible hypothesis for looking at these population declines and it certainly is occurring in our enclosures. We believe that during the winter study period, horned owls were significant predators in our enclosures. We found we could do a marked recapture study from the skulls versus the ear tags that you get in the pellets—and you get a significant portion of ear tags in those pellets. We get coyotes that get over enclosures, the foxes jump in, we get weasels that get over the enclosures, and so we get a million predators, we have kestrels, we have redtail hawks, and we have carries that work these enclosures. And we try to quantify the raptor stuff and it really doesn’t pan out very good. What you did was watch swoops or attacks or attempted prey captures, and there did not appear to be any difference in sample sizing the population.

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Sustainable Forestry:
Will Science or Religion Prevail?

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Neil is a leading authority on forest policy and factors influencing change in natural resource policy and management. He has served as chair of the external review panel for the American Forest and Paper Association's Sustainable Forestry Initiative.

Foresters and other professional natural resource managers develop theories and proposals for land management based on science. Scientific origins, they feel, make those proposals superior to those of people without similar technical training. It becomes hard for them to understand why their authority in these matters should come under such harsh criticism – and at times, outright rejection – from people whose lives and interests are affected by land management proposals or decisions.

It becomes even more frustrating for land managers as they gain access to scientific concepts and tools that are significantly more sophisticated, accurate, and useful than ever before. Convinced that they are better able to understand the complexities of natural systems and adapt management responses to a constantly changing natural world, (and the equally fluid social dynamic within which we all operate), professional managers seem to find themselves facing increased, rather than diminished opposition to their work. "Why is that?" they wonder.

This could be a most useful line of inquiry, particularly for young people preparing to enter the professional ranks. From youth's perspective, it is easy to dismiss the work of one's professional elders, believing that they didn't understand, had the wrong cultural approach, were too inflexible, or lacked the scientific and technical tools we have today "We will," the new practitioners vow, "do it much better than they did." It is easy to forget that today's mid-career and senior managers were yesterday's students, convinced that their insights were far superior to those of their elders. And it is they who, today, generate such intense public
opposition and rejection. Something kept things from going as planned, it seems, and if we don’t try to understand that something, it may continue to place obstacles in the path of resource managers for the foreseeable future.

One way to begin thinking about the situation may be to frame it in the terms of a debate as old as civilization: science versus religion. These two ways of thinking about truth have never co-existed easily, and the differences between them may be relevant to our question. For this discussion, we will define science as a way of seeking truth through structured experimentation and testing of questions and hypotheses – searching for relationships that can be demonstrated consistently enough to support the contention that they are representations of fact. We will define religion as a means of expressing faith, and faith as a belief in things that we have not seen.

Neither approach is inherently right for all questions. Each may be superior for certain types of questions, and both are the source of strongly held opinions and attitudes. Every person I know uses both approaches in developing and explaining the things they hold to be most true and important, and that is as much the case in regard to natural resource issues as it is to questions of mathematics or philosophy. What may be useful, then, is to recognize that these two approaches are different, and that acknowledging their differences can minimize conflict. Such an approach may help to untangle the threads of an argument and accommodate the legitimate differences in how people arrive at their opinions about these matters. To do that, however, we need to recognize that scientific and religious conflicts have usually been settled (where they have been settled!) in different ways. In science, it is normally time and overwhelming evidence that eventually resolve a dispute. That isn’t always true. I would hope that everyone in this audience has, more than once, faced results that rejected a previous hypothesis and, as a result, arrived at a fundamentally different version of the truth. That is the nature of science, and being open to new or surprising results is part of scientific training.

Religious beliefs are less likely to be altered by facts or new discoveries. Many religious disputes have grown stronger over the ages. Those that have faded from view have, it appears, been defused primarily by mutual tolerance: It is OK for you to believe your way if you’ll permit me to believe my way. Many of our inter-denominational battles have faded when this approach was used. The participants searched for areas of agreement, worked cooperatively in those areas, and agreed to recognize and avoid disputed topics.

If this is an accurate portrayal of the differences inherent in these approaches, then it seems logical that:

Where differences of opinion are based primarily on different views of scientific interpretation or facts, it will be useful to employ additional data, experimentation or the outcomes of actual events to help narrow those differences.

Where differences of opinion are based primarily on faith-based beliefs, it may be most useful to employ understanding and tolerance to narrow them and find areas of agreement as a means of making things less contentious.

Where we confuse the two – that is, where we extend tolerance to ideas that have been demonstrated to be just plain wrong, or offer fact-based rebuttals for
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ideas held as a matter of faith – the result is not likely to narrow differences and may, in fact, exacerbate them.

The trick, it seems, is to identify where science ends and religion begins – and vice-versa – so that we can communicate our differences more effectively and, perhaps, resolve some of them a bit easier. That is harder than it sounds because much of what each of us personally thinks to be fact is really faith. We may not remember why we hold a given idea so strongly, but if someone tries to disprove it, we’ll turn off our ears and ignore them. Furthermore, when someone or something challenges an idea that is a cornerstone of our belief system, supporting many of the positions we take, we’ll cling to it even more fiercely, knowing that if it is lost, much of the structure built upon it will crumble as well. Today’s focus for natural resource management is sustainability – the use of natural systems in ways that provide for the needs of the present without compromising the ability of future generations to meet their own needs. This definition, taken originally from the Brundtland Commission, is the guiding principle of sustainable forestry as contained in the American Forest & Paper Association’s Sustainable Forestry Initiative (SFI). It is further refined in the SFI to mean practicing forestry with a land stewardship ethic that integrates the reforestation, managing, growing, nurturing and harvesting of trees for useful products with the conservation of soil, air and water quality, wildlife and fish habitat, and aesthetics.

This is an articulate expression of what forest management should do and one that has been accepted in a similar form by our federal government and many foreign governments as well. It sounds both scientifically and ethically sound, and achieving it can certainly bring many benefits. But, in terms of our discussion about communications, we probably should deal with the concept of sustainability as a matter of faith, not science. Many thoughtful and expert people think we can manage forests sustainably, applying the best practices we know today and improving them as we learn more.

But is that a demonstrated fact, or is it a belief? Obviously, it is a belief. We can’t set up replicated experiments to prove it. We can’t point to a forest that has been managed in a certain way for a long time and say, See, there’s a sustainable forest.

Sustainability deals with the future, not the past, and we have no guarantee that the future will be a repeat of the past. A management scheme that worked well for the past several decades may be totally overwhelmed by unmanageable change if the future were to be significantly different in terms of climate, the impact of people, introduced pests and diseases, and so on. Our best management response today may need to change as we see the forest change in the future. Bringing the best management to bear on our forests today is like putting the most skilled pilot in command while white-water rafting an uncharted river. It is no guarantee; but it is the best strategy available.

So what can we say about sustainable forestry? First, many knowledgeable people sincerely believe it can be done. Many of our leading forest managers, on the basis of what is happening today in their forests, believe they are already achieving it. But there are others who are deeply cynical about the possibilities.
They point to past forest management schemes that were enthusiastically pro-
moted, but which turned out to have unforeseen problems. You experts were
wrong before, maybe you’re wrong again, they say. That’s a hard argument to
refute, especially when you are looking for facts or hard evidence to prove your
point.

Maybe this is the kind of a religious argument where we need to build under-
standing and tolerance rather than try to argue facts. Let us practice the best
forestry we know how to do. Work with us to improve our practices where we can.
Watch our results, and see if they meet your expectations. Those are pleas for
tolerance. And they are the messages being sent from the Sustainable Forestry
Initiative. The forest products industry has learned, often from harsh experience,
that you can’t build a factual case for what is essentially an issue of trust and
belief.

To back up this search for public understanding, the SFI contains some fairly
specific guidelines about such things as the proper rate of reforestation, limiting
the visual impact of clearcuts, and investing in wildlife habitat and other research.
These are, in turn, backed by a set of performance measures that each company
collects data upon, and reports upon, each year. That data is summarized and
published for public review. But how much of this approach is based on scientific
data or proof? Although its proponents would argue that all modern forest manage-
ment is science-based, and that is certainly true, it is also true that many of its
elements and goals elude scientific testing. For example, it is almost certainly
impossible to prove that any of today’s systems are sustainable. You simply
cannot provide an experiment that can provide proof of what will happen in the
future. You can build a model, based on the best relationships you have developed
through science, but it still rests on the assumption that the future will be a
reasonable repeat of the past.

It is feasible (if one has the courage to do it) to demonstrate that some ap-
proaches are unsustainable. If we define a sustainable system as one that retains
its complexity, including structures and processes, then it becomes possible to
demonstrate that some systems have deteriorated. But interpreting the meaning of
that loss can be a difficult challenge at times. We can, for example, show where a
species was lost to extinction. That is certain evidence of a system decline. But
how will the system reflect that loss? If there are other available species that can
fill in the ecological niches and provide structures and functions similar to before,
the impact on the system may be totally invisible. We are faced with the fact that
eastern hardwood forests lost a major species (chestnut) in a very short time. In
addition to being a major structural component of the forest, it was a nut-producer
that was a basic food source for many species. But other species took its place,
and there is little evidence that the present forest is unsustainable due to the
chestnut’s loss. Pollen studies indicate that eastern hemlock dropped out of the
eastern forest for 500 years or so, then re-appeared. As far as I know, nobody has a
solid idea what that meant to the dynamics of the system while it was taking place.

A study can be designed so that one or more of the treatments will drive a
forest into decline. That may be, in fact, the only way to really demonstrate the
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difference between a sustainable and an unsustainable practice. But such experiments are only possible on very small scales and short time frames that may not accurately indicate the true effect. Attempting to do large-scale, long-term experiments in which some of the area is destroyed will probably attract more public opposition than most scientists want to tolerate. The bottom line may be that judging which forestry practices and systems are likely to be sustainable requires a complex mixture of facts and beliefs. Most of the facts will be documented or observed results about failures of the past. Most of the beliefs will be based on what current theory and approaches offer, in terms of avoiding those failures in the future. If the proponents of a system are challenged to prove that their option is truly sustainable, that can be a pretty uneven debate, particularly if they try to conduct the argument on the basis of scientific evidence. The case may best be presented as one of continued, and cautious, experimentation, adaptive management approaches coupled with sensitive monitoring and feedback mechanisms that can quickly tell what seems to be working and what is not.

In searching for specific ways to measure progress within the SFI, its designers were often hard-pressed to identify meaningful performance measures. Look at the reforestation requirement, which is actually one of the easier measures to define. In order to comply with the SFI, companies are required to reforest by tree planting or seeding within two years after a final harvest, and within five years in a planned natural regeneration.

Obviously, reforestation is one of the key criteria for sustainable forestry. We still have memories of the bad old days when forestry was a cut and run operation that left smoking badlands behind. That legacy spurred national commitments to tree nursery and planting programs in both the public and private sectors, and made reforestation one of the key determinants of sustainable forestry.

Is there any scientific significance in the two- and five-year time requirements of the SFI? No, probably not. But they are technically feasible and economically sensible, and they foster the spirit of regaining forest cover as rapidly as possible after harvest. By measuring their success at reforestation, SFI participants give the public an assurance that when they cut trees, they replace them quickly. That fulfills a need to respond to public opinion, which consistently demonstrates in surveys that the public feels tree planting after harvest to be one of the most important aspects of responsible forestry. The annual SFI progress reports show that today’s companies easily meet this demand because it is common practice. What this indicates is that a practice modern foresters take for granted as part of normal operations is hugely important with the public, because many people believe that a timber harvest destroys the forest.

I might add, parenthetically, for millions of people in America today, that is a fact. They live in suburban areas like I do, and every timber harvest they see (and thousands of people drive by them) is a clearcut leading to a crop of condominiums. In that situation, cutting down trees means the end of another patch of forest. Public opinion surveys regularly reflect the view that America’s forest resource is being destroyed, when the data illustrate that it is holding its own or growing slightly, and is significantly larger than at the beginning of this century.
There was a lot of debate around the clearcut size requirements in the development of the SFI guidelines. Here is an issue where science and religion have really clashed over the past decades. For many years, foresters tried to convince people that clearcuts were a good thing, an effective means of harvesting and reforesting certain species. But no matter how much scientific data was arrayed to support the practice, public opposition was intense and undiminished.

So the designers of the SFI decided that the issue was not silviculture; it was aesthetics. The only way people would tolerate clearcutting as a forest management tool was if the visual impact could be reduced. The result was an SFI guideline establishing a goal of 120 acres as the average-sized clearcut for industry. What is the scientific basis for a 120-acre average? Well, as far as I know, there is none. That size was chosen because it was agreed to be a reasonable target that would cause companies to think more specifically about the visual impacts of their harvest practices, and set them on a course of reducing those impacts.

It is instructive to remember that, at the time the 120-acre size was selected, there were no data on past clearcut sizes to provide a guide. Only after the 120-acre size was established, and the annual SFI progress reporting had begun, was there any real information on clearcut size. It turned out, when the data were taken, average clearcut size for the industry in 1995 was 66 acres. In 1996 it was 61 acres; in 1997, 58 acres.

It is interesting to note that, even though the original target was too large to create downward pressure on clearcut sizes, there seems to be a downward trend under way. That may be a temporary thing. We don’t know. But clearcuts on industrial forests are averaging around 60 acres in size across the nation, and that size is declining slightly at the moment. Does this mean industrial foresters are becoming more alert to the visual impacts of forest harvests, and thinking about how to factor those concerns into their planning? That appears to be true.

The other aspect of clearcutting under SFI is the so-called green-up requirement. Under SFI guidelines, a harvested area must have trees at least three years old or five feet high at the desired level of stocking before adjacent areas can be clearcut. This is having another interesting effect. As company foresters design clearcuts to remain within the size limits, and also to limit visual impacts where possible, they are forced to design the uncut areas in many instances. By leaving an area uncut, but recognizing that it will probably be cut in the future under the same minimum standards, the forester needs to leave an uncut area that is large enough, and properly shaped, to be an appropriate future harvest site.

Remember, these are on company lands, most of which are dedicated to commercial timber production, so future harvests are assured. In some regions, these are lands that were clearcut 20 to 40 years ago, and are now ready for a second or third harvest. In some cases, there are huge areas of even-aged plantings, because that was what was done at that time. Now, the clearcut layouts, coupled with the protection of streamside management zones, are creating a new landscape, with a noticeable change in the diversity and shape of forest structural patterns.
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Two results seem likely. First, a diversity of wildlife habitats, in contiguous and fair-sized pieces, is being created. Second, single-structure conditions, susceptible to single-event disturbances, are being replaced.

Incidentally, clearcuts were used on about 40% of the land that industry harvested in 1997, a percentage that has remained fairly constant for three years. Thinning and salvage harvests made up 42%, and shelterwood and other forms of selective harvest made up the rest. Clearcutting may be the most visible form of timber harvest, but it is not the most extensive, at least not on SFI lands at this time.

This provides us with some interesting observations about the imposition of arbitrary – one might say political – performance guidelines within the SFI. Even though there is little or no scientific basis for the established numerical limits, they are having an effect on the way industrial forestry is being conducted. And, because they are easily measurable, they are establishing a data set from which future observers will be able to tell how these management actions affect the sustainability of the forest. In other words, because of these criteria and their measurements, we will be better able in the future to build scientific arguments for these practices and their application or adjustment.

Let’s turn now to some of the other aspects of sustainable forestry, as defined in the SFI definition. If you take a public poll about the things people prize most about forests, the chances are that clean water, clean air and wildlife habitat will come out near the top in every instance. Clearly, if it were to meet public expectations for good forestry, the SFI must focus attention on these issues.

Objective 3 says that SFI members will meet or exceed all established Best Management Practices approved by EPA, all applicable state water quality laws and regulations, and the requirements of the Clean Water Act for forest land. Here again, the SFI requirement is a political one: Meet or exceed all legal requirements.

In practice on the land, however, that becomes quite specific. Different states have different BMPs and legal requirements, and each company needs to meet those in the diversity of environmental conditions they encounter. A great deal of progress is being made in designing streamside management zones and other riparian protection measures, as well as installing BMPs in other situations. Several companies we have visited have a comprehensive internal auditing system in place to assure full compliance with water quality laws.

Again, a new and significant data set is being developed regarding industrial forestry and its relationship to water resources. Little of this data has been previously available. The result, many SFI foresters hope, will be state and federal regulations that can be more flexible, more easily adapted to the soils, slopes and waters on each site, and based on better data about water quality effects than have been previously available.

What about wildlife habitat and biodiversity? What is the SFI trying to do to assure that they are considered in today’s industrial forest management? Actually, there are two implementation guidelines within the SFI that bear directly on these issues. One says that sustainable forest management must enhance the quality of wildlife habitat by developing and implementing measures that promote habitat
diversity and the conservation of plant and animal populations found in forest communities. The other says that foresters will contribute to biodiversity by enhancing landscape diversity and providing an array of habitats.

The $64 question, of course, is how to achieve these goals in actual land management situations. When does a proposed management action enhance habitat diversity and when does it diminish it? These are questions that require one to think about the actual site, and its landscape context.

Because this is so complex, the SFI has spawned a huge amount of biological research into forest wildlife situations, launched studies as to what kinds of wildlife and biodiversity conditions can actually be measured on the land, and set out to better define what sustainable forestry must seek to achieve if it is to meet these objectives. Some of the results seem likely to contradict some of our long-held beliefs about forest wildlife, while some of the new measures are likely to have a significant impact on the entire practice of forestry.

First: the research. From a wildlife habitat viewpoint, small clearcuts are not necessarily better than large ones, and a landscape with no clearcuts may be inferior in terms of habitat diversity. Different suites of species use different forest structural conditions, and having a diverse set of conditions seems the best strategy to conserve biological diversity.

Studies in intensively managed forests, such as the pine plantations of the South, find a wide diversity of species, and many keystone species like black bears and bobcats use them intensively. Studies of reptile and amphibian populations are underway. I've visited several SFI forests in the South, where studies are finding a rich array of diverse herpetological fauna. What is happening, of course, is that these plantations are increasingly diverse, primarily because of the attention to water quality protection. When you manage the stream- and lake sides to protect water quality, you create a more diverse pattern of habitats and protect the biologically rich riparian zones.

Nesting bird populations in the East are under intense study, due to the decline of many species, but so far intensive forestry doesn't seem to be much of a factor. In urbanized, fragmented areas, nesting success seems significantly lower due to increased predation and competition from species like cats, dogs, raccoons and cowbirds. In the larger forested landscapes that are unmanaged, the need appears to be for more open nesting habitat, not more interior habitat.

Nesting success in intensively managed forest areas seems to be fairly good, largely because these areas are usually isolated from the human-associated species that prey on nesting birds. One conclusion from all this research seems likely: Intensive forest management is not inconsistent with high wildlife habitat values, including the conservation of many species of concern, where the needs of these species are factored into land management decisions.

In studying how to measure the impact of forest management on wildlife, the conclusion being reached in the SFI appears to be that the best approach is to work with habitat diversity and patterns. It is simply not feasible to count critters, nor is the presence or absence of a particular species on the day of a survey necessarily significant.
A more practical approach appears to be a careful mapping of vegetation type and structure, with special attention given to riparian areas. Management that enhances a balance of habitat types (the best balance is seldom known, but research is under way) and patterns seems to be the most promising. In this approach, one considers the size and arrangement of forest patches, the connectivity between them for travel routes, and their relationship to the surrounding landscape. Obviously, this takes a fairly sophisticated land classification system that may be too difficult for many small land managers to handle. Work is under way to develop models and patterns that can be adapted to various sizes of ownerships and situations.

One unsolved issue is how one might think in landscape terms when data is only available on a single, relatively small property. That may eventually be addressed by regional habitat assessments made by public agencies from remote sensing information, but those products are not yet available.

Let's cycle back to our original question, which is: How much of what people are doing today in sustainable forestry is based on science, and how much is based on belief? We can now ask a second question: What are sustainable forestry efforts, like the SFI, doing to help build our science base so that we separate unsupported beliefs from those that are reinforced by scientific findings?

The answer to our first question, it seems to me, is that a significant amount of our work in sustainable forestry is based on beliefs, not scientific proof. We think a certain management scheme will be sustainable into the foreseeable future. That's excellent, and far better than being convinced that it will not survive. But the truth is, we don't know for certain. We can't conclusively identify a sustainable condition; only unsustainable ones. And we can't argue conclusively that the absence of unsustainable indicators means that the system is sustainable. We are, in effect, doing the best that we know how, given current understanding and tools. Where the public has no trust in that ability and refuses to let managers practice their craft, we may never know whether they would have succeeded or failed.

What we will learn, if we persevere in preventing managers from managing as we now do on much of the public lands, is where the winds of unmanaged change blow these systems. Whether that will teach us anything valuable or not is debatable. The fact that last week's winds of change blew a system in one direction has little bearing on the effect of next week's winds, which may be significantly different. Or on other systems, at other stages of development. If, in the end, what you learn is that chaotic systems do chaotic things, I guess that's a lesson. Whether it is a lesson that helps us solve the problem of living on this planet without diminishing or destroying the lands on which we depend, is dubious in my view.

While the goal of sustainable forestry may be more a matter of belief than proven fact, the pieces that go into it are increasingly a matter of measured impact. The SFI is gathering, for the first time on such a large scale and diverse landscape, actual data and trends on forest management practices and their effects. For industry lands, the SFI is providing measures of forest harvest methods, of the amount of stream corridors being managed for wildlife habitat and water quality, of the rates of reforestation. It is sponsoring and applying research.
about forest soils and their change, about the effect of forest practices on wildlife species such as reptiles, amphibians, and songbirds that have seldom had much study in the past, and about new ways to monitor forest change.

The results of these studies are going to become increasingly important in replacing bad information with measured and verified information. As time passes, and the new facts become embedded in the belief systems of a new generation of scientists, managers and the public, that research will have an effect. Remember, however, it would be unlikely that it will have immediate effect. Scientists win arguments by outliving their opponents, not by overpowering them.

I may have failed to answer the question I posed in the title, “Will science or religion prevail in our discussions of sustainable forestry?” In the short term, widely held beliefs about forests and forest management – even those that are inconsistent with what forest ecologists think they know about forests and their functions—are winning many of the large confrontations over forest policy. Changing or reinforcing those widely held beliefs is a function of both scientific inquiry and time.

Forest scientists and managers must seek understanding and tolerance, rather than scientific proof, as a means of gaining the social permission to practice their craft. They must not pretend to know for certain those things about which they are still learning. They must not pretend that measuring what happened last year in Nature’s chaotic environment is an absolute indicator of what will happen next year. They must admit that the art and science of land use management is essentially a practice carried out in the same sense as medicine, music or law. The best practitioners are constantly learning, and improving, and using the best that others have learned. Today’s practice is better than yesterday’s practice and short of tomorrow’s. If, in the practice, good scientific testing can demonstrate solid facts or relationships, those should be as widely shared as possible, even if (one might say, particularly if) they fly in the face of widely held belief.

But we must also face the reality that each of us has a belief system based on a set of truths, half-truths and myths that we can seldom identify, let alone trace to their source. Those belief systems change over time, sometimes on the basis of science, sometimes on the basis of the rise of a very persuasive, possibly false, prophet.

While most of us harbor the belief that false theories about the environment will eventually be proven false by events, we must face the fact that forests are complex, slowly-changing, enormous systems, and it may take decades or centuries to demonstrate some facets of their true nature. In the interim, the best strategy is to encourage scientific progress wherever possible, while recognizing the fact that science does not rule the hearts of humans, religion does. Science holds many useful answers; but faith drives most political solutions, because it is the true believers on each side who join the fight over forest policy. We must, somehow, begin to recognize and learn to bridge the communications gaps that divide these believers if we are to have a forest management system that fits the complex challenges presented by our attempts to bring sustainable management to America’s forests.
Sustainable Management of Forests: Some Comparisons between Central Europe and the United States

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Abstract

Following the introduction of planned forestry and the regular high forest system more than 250 years ago, forests in Central Europe became increasingly shaped by plantation silviculture. Many natural woodlands were replaced by planted forests, and forest plantations are still being established through afforestation of extensive land areas. Nowadays, forests are managed for many different purposes, including wood production, recreation, ecological, cultural and amenity values, biodiversity, soil and groundwater protection. This brings new challenges to forest management and silviculture. To reach a sustainable forestry, in the sense of Brundtland, we are now reshaping European forestry towards a more nature-oriented silviculture. Maybe forestry in the United States can benefit from the mistakes we made during the last two centuries and take a shortcut toward sustainable forestry.

Introduction

Some 250 years ago, heavy exploitation of Central European forest resources led to the genesis of planned and well-regulated forestry. In Denmark, for example, the unregulated exploitation was carried very far before efficient central control reversed the development (Figure 1). Similar trends may be found in many differ-
ent countries; only the time and area scales differ. In the United States, the time curve moves in accordance with the colonization and industrialization of the West.

In this paper we highlight some key issues that we believe are common to the development of forestry and forestry paradigms in industrialized countries – the temporal path from exploitation of natural forests through regulation-oriented forest management over an ecologically based paradigm to so-called integrated multiple-use forestry. During this development, natural forests are often replaced by planted stands and past deforestations are compensated for through afforestations. Consequently, forest management becomes characterized by plantation-like approaches. The traditional regulation-oriented approach may succeed in sustaining some forest values, especially wood production, but leaves many others degraded. As a consequence, a site specific and ecologically based forest management evolves. This, however, may not satisfy society's requirements for sustainability, regarding issues such as biodiversity, aesthetics, and cultural and spiritual values.

Nowadays, the majority of the adult population in industrialized countries, born and raised in cities, is employed in the service and information sectors and has different value concepts and relationships with nature than did their ancestors. Unlike their agrarian ancestors, very few are directly utilizing nature for a livelihood. Instead, urbanites enjoy the luxury of focusing on romantic, idealistic and symbolic forest values. This has lead to major changes in forest policy in several countries (Koch and Kennedy 1991), and we believe that it will lead to more changes in the future. Based on current social and silvicultural challenges in Europe, we suggest possible shortcuts toward a sustainable management of planted forests that may also apply to the United States.

**Planned Forestry in Central Europe**

The industrial revolution of the nineteenth century lead most European countries to focus on wood production on a sustained-yield basis to fulfill the increasing and changing demands for wood products. A highly regulated plantation forestry soon proved to be an efficient means of achieving and securing this narrowly focused single-use objective. Agrarian forest grazing practices were forbidden, remaining forest areas were preserved and intensively managed, forest
lakes and bogs were drained and afforested, and afforestations took place. Often exotic tree species or provenances were used.

The aim was to increase wood production and change assortment compositions to favor the industrial use of wood. Often this was achieved by turning the forests into easily manageable, highly productive, pure and even-aged stands. In many cases biological diversity and multiple-use forest values were reduced in the chase for wood production efficiency.

Plantation forestry is very functionalistic and has been compared to the functionalism in architecture illustrated by the architect Les Corbusiers’s plan for a part of Paris (Figure 2). An approach of this kind, irrespective of its merits, implies uniformity and concomitant drawbacks such as the risk of ecological instability. In response, an ecologically based paradigm, notably for silviculture, has evolved during the twentieth century. According to this paradigm, forest management should be more site-specific, and stand treatments should be based on a close correspondence with natural forest ecosystems. However, being largely focused on wood production, this initial nature-oriented approach has not kept pace with changing societal value concepts.

Integrated, Sustainable, Multiple-use Forestry

To adapt to changing social values of forests, Central European forestry now aims for a so-called integrated, sustainable, multiple-use forest management concept. This concept implies an integration of forest functions such as wood production, biodiversity, recreation, amenity values, groundwater protection, and carbon fixation.

Figure 2
primary (or dominant) use is necessary (e.g., Daniels 1987). The concept implies, however, that the decision maker, aiming at the long-term optimal combination for society, at each decision takes into account all the present and future goods and services which forest land could provide (Figure 3).

This may lead to an economic loss to the private forest owner because many non-timber values could not be sold. However, the losses are seldom large and often compensated for by the government, or looked upon as an investment made by the private forest owner to avoid further restrictions in timber production.

A good Danish example of integrated multiple-use forestry is the very intensively managed national forest Jægersborg Dyrehave, approximately 15 km north of Copenhagen. This forest is about 1,200 ha large, has 3 million recreational visits / year, a population of 2,000 fallow deer and red deer, and an annual timber harvest of 8,500 m³.

Outputs per unit area in national forests are much larger in Denmark than in the United States, and so are the corresponding inputs in labor and capital. However, Denmark is only producing one-fourth of its own wood consumption, and Central Europe two-thirds of its total consumption. So Denmark and Central Europe as a whole export some of their forestry-related environmental problems, and draw heavily on the forest resources of other countries and regions. Thus, nationally or regionally, sustainable forestry may result in adverse effects on sustainability in other parts of the world. This is one of the reasons for the intensive forest management in Europe and for the plans to convert more agricultural land to forest.
Segregation or Integration?

It seems to us, as foreigners, that most large conflicts over forest land in the United States have been handled by "slicing up the pie into pieces" (e.g., national parks, wilderness areas, wild and scenic rivers, spotted owl habitat conservation areas, and tree farms). This is probably a logical reaction in a large country with an abundance of natural resources and land areas. The size of the pie, however, is not infinite. Surprisingly the United States, in spite of the country's vast forest resources, for several years has only produced about 85 percent of its own wood consumption (U.S.D.A. Forest Service 1989). The United States is, like Central Europe, to a large extent relying on the forest resources of other parts of the world. These two regions are so wealthy that they may import wood, and thereby export some of their environmental problems relating to forestry. In doing so, are we truly following the motto of the Brundtland Report (WCED 1987): "Think globally, act locally?"

As a consequence of the "Slicing up the pie into pieces" policy, multiple-use forestry in the United States often is realized by segregation rather than integration of forest functions (Figure 4A and 4B). In Europe, we have approached similar forest-interest conflicts from the opposite side – not from an abundance of forest resources, but on the contrary, from a lack of forest resources (Figure 1). This has taught Europeans the hard way to use forest resources in an integrated manner for multiple purposes (illustrated in Figure 4C).
The Silvicultural Challenge in Europe

The current silvicultural challenge in Europe is to create and maintain forest types that favor both production of wood and the non-wood benefits of the forests. This challenge is by no means new, but for two centuries the main thrust in Central European forest management has favored a silviculture for pure, even-aged stands.

Now it is realized that a nature-oriented silviculture may provide a viable basis for an integrated and sustainable forest management. With afforestation, an expeditious and well-targeted effort toward integration is particularly important to minimize uniformity of plantations and related drawbacks, as well as potentially negative environmental effects. In terms of silvicultural systems, the introduction of a nature-oriented approach may be illustrated as in Figure 5. In the temperate broadleaved zone, silviculture should move away from the clearcutting system toward a single tree selection system. In this process, the size of regeneration units decreases, the shelter effect increases, and regeneration becomes diffuse in space and time.

Care is required, however, not to regard the single tree selection system as the standard or the goal for a nature-oriented silviculture. Depending on site and other circumstances, other silvicultural systems, and even those at the other extreme of the scale, may provide for a close-to-nature management. This holds, for example, in regions where forest ecosystems are regenerated by "nature" through burning. Likewise, the time scale needed to alter silvicultural practices will depend on site conditions and should be considered carefully. Irrespective of the local target level for a nature-oriented silviculture, forest management will be less simple and a more intensive administration will be required than in the situation where timber is the main issue.

**Figure 5**
The Gradient of Silvicultural Systems, Illustrated by Two Main Characteristics: The Degree of Shelter and the Size of Regeneration Units. (Source: Skovsgaard 1995)

**SHELTER EFFECT**

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**SIZE OF REGENERATION UNIT**
The Past Negative European Influence

The single-use forestry paradigm was brought to North America, Australia, New Zealand, Japan and India by European (mostly German) foresters (Behan 1975). Because of the wood scarcity experienced in many European countries in the eighteenth and nineteenth centuries, sustained flows of wood products were the primary social-value contribution of past times’ “modern” forestry. The professional value system that developed included a belief that the answers to forest management questions, since they were seen as biological and engineering issues, were to be found by foresters in the forest itself. It also included a tendency to disregard people and their “eccentric” forest values, such as beauty and quiet (Duerr 1979).

Bernhard Fernow, a German-born and -educated pioneer of American forestry, wrote in 1902 (Fernow 1902): “The first and foremost purpose of a forest growth is to supply us with wood material; it is the substance of the trees itself, not their fruit, their beauty, their shade, their shelter, that constitutes the primary object...”

In the United States, however, there was early concern with multiple-use social values, and a recognition that conflicting interests over forest management could arise. As dean of America’s first forestry school (Cornell University, 1897-1903), Fernow learned this in 1903 when his Forestry Department was denied funding and terminated by the New York legislature as a result of clearcutting on its school experimental forest (Rodgers 1968).

The Current Positive (?) European Influence

In forestry, positive influence often originates from negative experience. If there is a lesson to be learned from the European history of plantation or plantation-like forestry, it might be summarized as follows:

1. Preserve natural forests.
2. Do not convert semi-natural forests to even-aged, pure stands, but try to move directly to a more holistic nature-oriented silviculture.
3. Create and maintain a forest plantation that develops into a “real” forest as fast as possible. This is the most important issue relating to a “successful” afforestation (successful in terms of sustainability, sensu Brundtland). The basic idea behind this is that you should not only grow and manage trees, but also manage the whole forest. This is different from the “pure” plantation philosophy with its uniformity. The challenge is to manage for the single tree and the whole forest ecosystem at the same time, i.e., “To Follow and Support Nature in Its Effects” as stated by the Danish forester D.N. von Warnstedt in 1781.
4. Carefully consider how the new plantation is adjusted to the ecology of the whole landscape when planning an afforestation. Inside the plantation, the design at forest level as well as at stand level should from the start mimic and accommodate for what is considered to be the “final” outcome.
5. Prefer local tree species and local provenances that already have proven their ecological stability.
6. Be patient. It will take several decades to create a forest ecosystem from a plantation.
For more detailed suggestions we recommend *Creating New Native Woodlands* by Rodwell and Patterson (1994) and *The Design of Forest Landscapes* by Lucas (1991).

**Closing Comments**

Based on more than 200 years of experience with planned and well-regulated forestry, it is evident that developing more holistic approaches in silvicultural practices and in forest management is the biggest current challenge for forest science as well as for practice. This will most certainly have an important bearing on future research activities, and requires enhanced cooperation across scientific disciplines, across professions and across countries. Changes in silvicultural practices already influence research needs and will require additional funding that may not be proportionate to changes in economics, whether they be considered negative, as on the corporate level, or possibly positive, as on the socioeconomic level.

Politicians, policy makers, forest managers and forest scientists all have to acknowledge that these challenges may be as far-reaching as those of our predecessors at the introduction of planned forestry in the mid-1700s.

*Parts of this paper are based on Koch (1991) and Skougaard (1995), and an enlarged version is submitted to the international journal New Forests (1998)*

**Questions from the audience**

You closed by suggesting that there are things that perhaps we should not do here. Among them was introducing species that are not native. What about the question of genetic engineering of tree species, where researchers do not introduce a separate species, but experiment with the genetic code? Is that a problem in Europe? Or do you see that as a problem in the United States?

I don’t know about the situation in the United States but I know we have lots of discussion about it in Europe, and I myself have been very reluctant to start research on it. Just the day before I left, I had a discussion with a colleague on that question and I think it is very, very difficult to find out what is right in forestry about it. But it is going on in Europe. A lot of the big timber firms invest heavily in research in genetic engineering – really heavily – and they have found some amazing resources in Sweden and Norway. So in Norway, it is forbidden to use in practice, and I also want to forbid research into it.

At my research institute we are now going to start slowly. We are going to use genetic engineering in Christmas trees because one-third to half the income for private forestry in Denmark comes from Christmas trees; and since we use true introduced species for Christmas trees, we think that the risk is not that big. We are going to make genetic engineering in insect prevention, and we think we can do that and not spread through the ecosystem. In other situations you run the risk that it could spread through the ecosystem.
Values, Beliefs, and Management of Forests... at the Close of the 20th Century

I believe that you are far ahead of us in using genetic engineering in the United States, but I ask myself, have you had the discussion with the public about it? We haven't had that in Europe.

One year ago, I personally was completely reluctant to say this is something we should do because we are close to nature and so on. Now that I have studied it more, especially some of the things they are doing in Sweden, I think that this could be some kind of clean technology. If we use it right, we could get rid of herbicides and pesticides, but we have to be aware of the risks. For the last 40 years we have been using pesticides without considering the risks.

I think that the risk control that we have in the European Union, where every plant is very closely studied before it is allowed to be introduced, is a good way. I don't think we should do biological engineering to make plants more resistant to, for example, Round Up. I think that is the wrong way. We should take a broader approach that considers resistance to insects and parasites. Difficult questions.

You have talked about social values a number of times in your talk. How did your research organization consider social values, and how will the forester, like the forester you showed us, make use of that knowledge about social value?

The broad definition of social values you probably know better than I. Social value, to me, is all of the different non-monetary values to society. We have done most research into forest recreation, and we have been mapping all the forests in Denmark and how intensively they are used for recreation. So we know where to distribute recreation resources, we know where we should put recreation higher up in the multiple use priorities compared to timber production and so on.

We have also measured the time distribution of recreation use, and we found in Denmark, where the shops have restricted business hours, that Danish families shop on Saturday morning, so there are very few people in the forests Saturdays from 8 a.m. to 1 p.m. Because we know when people are not likely to be in the forest, we can allow organizations to teach orienteering, hunting or other organized activities during the low-use times on weekends.

We have also made preference studies of scenic values and so on. Do people prefer snacks out in the forest? They don't. They prefer not to have litter in the forest. They don't know about biodiversity. Danes want to have garden-like forests.

So we have to educate people. We have a big education program for school children that we call forestry schools. Local forest rangers takes city school children out in the woods four or five times a year to learn about the forest. Was that the sort of thing you were looking for?

One of the shifts that's been occurring here has been a move away from stand-level management, toward broader-scale ecosystem approaches. You seem to be saying that we need to do both.

Yes.
What are some practical ways you have found to blend those directly together?

No doubt you are far ahead of us in working at the landscape level and thinking in terms of ecosystems. One reason for that is that the average forest in Europe is private property and very small—about one hectare (two acres). So to look upon the landscape level you must look upon a lot of different forest owners' properties. That makes it very complicated for us.

We could learn something about landscape level management from you. You could probably learn something about single tree selection from European foresters. We try to aim for what we call a good diameter cutting for a specific site—the size we will let them grow before harvest, the size that has the optimum value for the wood industry. We try to aim for the single tree in the ecosystem aspect: If we cut this tree, which is the right size, it will provide space and light for a new tree to grow. So your equipment and everything is developed using forest engineering skills to cut this tree that is in exactly the right place and is exactly the right size for making nice furniture. You get high top value for it, and you open up the light, so you have an effective nutrient cycle, you have new forest coming in, and you don't have nutrients leaching into the water.

Is there an effort to establish a percentage of land area in nature preserves?

We have protected reserves. Four percent of Denmark is nature protected. When we protect nature we don't do it as restrictively as you do. Of course we have national parks some places in Europe, but every spot has been intensively used by human beings for thousands of years.

So our nature reserves allow grazing, traditional farming and traditional forestry. Or we make nature reserves where we say, here we want to do forestry as it was done 200 years ago, to have this kind of forestry where there is a specific flora and fauna. In Europe, nature reserves don't mean hands off. Often it means some kind of even intensive use, managing a forest for a specific ecosystem.

What do Danish people do when they want a wilderness experience?

(Laughs.) Visit the United States.

That is something that you really have. We go to United States or we go to northern Sweden or Finland, and that is probably the new development you are going to see in Europe. We are becoming more like the United States in that people are traveling more. To have a beach and sunshine you go to Florida or California. We go to Spain or Greece. If we want a wilderness experience, we come to the United States, Finland, or Sweden. The Finish and Swedish forestry societies are afraid that this may turn Finland and Sweden into a big national park. So on the European level, we have the same debate, but not so strong, of course. Since we speak nine different languages, it is difficult to have strong conflicts.
What species do you favor for timber production in Denmark?

In Denmark, Norway, Sweden, and most of Scandinavia, Norway spruce (*Picea Abies*) has been our favorite tree species. We have problems with that, though, because it doesn’t like mild winters much, and we have had some mild winters. Now we are shifting to oak and beech. We get very high prices for oak and beech, and we make it into Scandinavian furniture which we sell to the United States.

I was interested to notice that on the coast of Norway they are planting a lot of Sitka spruce and their seed source is British Columbia. Does Denmark cultivate Sitka spruce?

Yes, I think about 10% of our forest is Sitka spruce (*Picea sitchensis*). Of course, our seed sources are a little further south than Norway’s. Sitka spruce does well along our coastline because it is more hardy against salt. Dr. Sareflew would like to grow more, but we would like to mix it with broadleaf species.

So we have a lot of introduced species. We have had good value from, as I mentioned, fir from the Pacific Northwest – we use that for cuttings. Denmark is exporting Christmas trees and decoration greenery all over Europe. So we have introduced a lot of species, and have been very happy with them. They have worked very well. *Thuja plicata* has also been working well. But we are now shifting slowly back again to more oak and beech. They are more biologically stable and give a more original ecosystem.

Do you do much with hardwoods, like beech and oak?

Beech and oak especially, but maple too; and they bring us very high prices.

What is the pragmatic aspect of single tree selection on steep slopes, where bringing trees in can cause considerable damage to the residual standing trees, especially with very long trees that need to be skidded out. How do you do that in single tree selection?

I am from a country where the highest mountain, which we call the Mountain of the Sky, is 500 feet tall. The same goes for most of central Europe: We don’t have your mountain system, so I would not be the right one to answer that. That is why I stress that I don’t know your silviculture system, I don’t know which silviculture solution would be correct for you, and I don’t know the technical aspects of how you do it.

If you have a problem like that to solve, go to the forest engineers. They can solve it. It shouldn’t be the forest engineers who dictate to us, it should be the other way around. We, as natural resource managers, should ask the forest engineers, “How can you do it?” They can find out if cable yarding, or helicopter logging, or whatever is the solution. It’s their job, to solve the technical problems.

What impact does your more natural silviculture system and focus on single-tree selection have on your number of seedling plantations?

I can’t give you figures on that, but the nurseries – most of which are private – have had a bad time, and some have gone bankrupt. We try to have national control on the seed, so our seed is collected by the government. Then the state forest service sells the seed to private nurseries and the one or two big nurseries that the states forests services own.
Can you talk about the role of forest product certification in the European market?

Forest certification has been discussed a lot, and I think it is a difficult discussion. Right now, in Poland all the state-owned forest land is certified, and the Swedish industrial-owned forest land is about 60% certified. The forestry society in Europe has tried to stick together, but we haven’t succeeded because we are also in competition with one another.

The Finnish foresters are very angry with the Swedish. In Finland you have a lot of small farm forestry. I think the average farm forest in Finland is about five hectares—while in Sweden there is a lot of industrial forestry—like your Plum Creek here—and it is much easier for a company to get one certification for their three million hectares than it is for the hundreds of small landowners to get their small farm forests certified.

So Sweden, no doubt, has an advantage in competition because they have certification. The major countries demanding certification on lumber that they buy are Germany, Great Britain and the Netherlands.

What we are afraid of in Europe is that suddenly one of the big furniture chains like Ikea—you know about Ikea—would only buy certified lumber with an FSC (Forest Stewardship Council) stamp. That is why some countries have been moving pretty fast to certification. Denmark has not been moving fast, and Sweden has taken the lead, which might encourage more countries to certify.

Keep in mind, too, that there are several different certification systems. In Europe, the Forest Stewardship Council’s certification scheme is the most popular.

In Denmark our forest law is very, very strict. Even private forests are controlled. If you want to do some cutting, you have to get permission. We have very strict public control of private forests. Because we have such strict regulations, Denmark has asked that all our forests be covered by one certification. That has not been approved by the FSC. They want additional controls that are more restrictive than our forest law, and that creates a situation which is, in fact, not democratic. You have one entity who could always turn the button a little, and if you accept this kind of certification level, well next year it should be this, next year it should be that, and you don’t have a democratic process, as you do when you have legislation. So personally, I think it would be nice if this could be discussed at the international level so we could clearly define sustainable forestry. The whole FSC came up because we saw a lot of non-sustainable forest in the tropics, and that makes sense, because the consumer wants to have control by not buying teak from non-sustainable forestry.

Personally, I don’t really like the way that you can always turn the button without having any democratic control over it.
References
The Seventh American Forest Congress:
Can Democracy and Resources Co-exist?

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Devolution, local interests, democratic processes: These are all words in political vogue, used to describe events around the world. They are often linked to what some see as the emergence of a global, market-driven economy, brought on by information technology, falling barriers to trade (in capital and labor as well as goods) and democratization. The link between democracy and market capitalism is much debated. If there is a link, it is probably, in part, because in democratic societies a much broader array of individuals has access to the means of economic and social advancement.

A traditional means of economic advancement in many societies has been access to the forest. Its contents have always, in every place, been translatable into value—if you can get your hands on them. Not least for this reason, the history of forest administration and management has been a top-down history. Forests were simply too valuable to be made widely accessible. Protecting the king’s game, the royal navy’s masts and ships’ timbers, and the government’s range from the unwashed gave rise to the jobs of game-keeping and forestry. The protection and husbanding of forests were mostly (entirely in Western civilization, until recently) in the province of governments and the nobility. It was what we would now call a public-sector function. Most of our current views and laws about forests are still strongly flavored by this history.

Much of the rhetoric and political action about forests in this country can be
The Seventh American Forest Congress: Can Democracy/Resources Co-exist?

seen as an intellectual field of fire to hold forests harmless from the baneful influences of democracy and market capitalism. Examples abound; Hardin’s myth of the “tragedy of the commons,” Leopold’s view that trees and rocks should enjoy the same ethical consideration as humans, the earlier deification of “Nature” by transcendentalists such as Thoreau: all carry the message, implicit or explicit, “hands off” or at least “ask us first” if you are a commoner or a capitalist with designs on the forest. This view may have achieved its purest form in legislation introduced into, but not passed by, Congress in the 1940s. Favored and lobbied for by Gifford Pinchot, it would have required every tree cut for sale in the United States to be marked at breast height and on the stump by a U.S. Forest Service forester (Anthony Smith, personal communication).

So we have an interesting time. Democracy, particularly of the local variety, is promoted; large government projects are in disfavor. Market capitalism is on the rise, with potentially profound effects on forests. A friend in the United Nations told me last year that donor agency investment in forests in developing countries is now equal only to the growth in private foreign investment in the same countries’ forests. But our rhetoric, and most of our laws about forests, are predicated on public-sector, top-down control by a remote political and intellectual elite. Something has to give. It is my purpose here to examine what seems to me to be the beginning of the resultant major change in how we regard and manage forests. I will use as a vehicle a major ingredient of that change: the Seventh American Forest Congress (SAFC) and its genesis and aftermath.

The Rise of Ecosystem Management

The earliest glimpse of SAFC came in a conversation criticizing the “one size fits all” mentality that the conversants both thought they saw in the forest debates of the time (the early 1990s). The essence of ecosystem management (EM), a forestry response to the rise of democracy and market capitalism, is that one size doesn’t fit all. Rather, the management of a forest is conditioned by the objectives, people and ecology specific to a real place. It is necessary here to briefly trace the rise of the EM concept and its current state, particularly since those who stand to benefit the most from it—the proponents of local democracy and market capitalism—have been among its major public detractors.

North American land use history set the stage for the emergence of EM late in this century (Gordon 1993). Native Americans vigorously managed parts of the continent, but usually in a subsistence, rather than an accumulation, mode (Cronon 1983). Early traders extracted fish, fur, wood and minerals, but did little that could be described as management. As European settlement progressed, land became a commodity and an avenue to economic improvement. As land was surveyed and sold, careful recognition of its productive capacity was coupled with the aggressive notion that this capacity could be improved through management. As knowledge and technical capability increased, the manipulation of productive capacity through drainage, fertilization, and improved varieties of plants and animals shaped management methods. Until this century, the clearing of forests for agriculture was a major way to add value to the land commodity. But as the
frontier “closed” in the late 19th century, concerns about water, “timber famine” and the loss of “nature” began to change the way we thought about land. We were in transition from being an empty country to being a full one. The growing recognition that society depended on a limited landscape for its sustenance called forth the concepts of conservation, sustainability and, eventually, a general approach to these now called ecosystem management. Scarcity, rather than abundance, had become the intellectual driver in the space of a few decades.

On this century-long intellectual journey, we experimented on a grand scale. We protected enormous tracts of forest from settlement and development. We tried to water the arid West, with Phoenix and Los Angeles, among other things, as outcomes. New England and Puerto Rico were deforested and reforested. Most of the vast bottomland forests and tall grass prairies of the Midwest were converted permanently to annual crop land, often with elaborate drainage schemes. Much of the South was converted from trees to cotton and back to trees. We now face the task of interpreting and managing the mosaic we have created in ways that satisfy society’s rapidly increasing appetites and concepts of the “good life.” Forests have played an important role in the entire drama, from their removal to add value to land, through their conversion to products and other forms of capital, to their perceived role as important life support systems. Now, with the development of adaptive ecosystem management underway (Gunderson and Hollings 1996), they may play a leading role as we learn collectively to manage scarcity.

In its simplest form, adaptive ecosystem management has five basic tenets, all admirably suited to the rise of local democracy and market capitalism:

- Manage where you are
- Manage with people in mind
- Manage based on specific local knowledge
- Manage across boundaries
- Manage with learning and improved decision-making as explicit goals

These seem simple, but they are difficult in practice, particularly since they must all be done all of the time for the management approach to be successful. For example “manage where you are” seems at first glance to be gratuitously simplistic. However, our worst blunders in forestry have likely resulted from transferring management practices and objectives of one location to another without sufficient adaptation. But the one that has proven most elusive for natural resource managers is the second, “manage with people (constantly) in mind.” Our long-standing, regal point-of-view (and our social proclivity for being alone or surrounded by others like ourselves) has conditioned us to deal with “publics” at arms length and through excessively formal bureaucratic mechanisms. Worse, it has conditioned us to believe we know what other people think and want without asking them.

The Seventh American Forest Congress was an attempt to support the development of ecosystem management by documenting what many people thought forests ought to be and do, and by creating a mechanism to involve a much broader group of people in forest policy and management now and in the future.
The Seventh American Forest Congress

A number of people, including John Gray and Perry Hagenstein, had been urging a Forest Congress since the mid-1980s. The previous (sixth) congress was held in 1975 (and times had clearly changed since then); but there was no action to convene a congress until a series of events beginning in 1993 (Bentley and Langbein 1996) were motivated by conversations following the Pacific Northwest Forest Conference. During and immediately after the conference, many friends in the forest products industry perceived me as hostile to their interests, while I believed they were unrealistic about the direction in which society was pushing all of us in the forestry community. They saw me as a troublemaker, and I saw them as fighting a losing, rear-guard action.

In hindsight, I think we were both right. But the conversations revealed something else, "...the need for a special Presidential summit reflected the shortcomings of how public forest policy was formed and ultimately implemented. The most progressive research findings and management ideas were integrated poorly into forest policy decisions.... Even though policy decisions formed in legislatures, the courts and public agencies often appeared to conflict [or be counterproductive], no plan – or even as dialogue – existed to examine the problems and reconcile the conflicts. From these initial conversations, an idea emerged to create a dialogue on forest policy that would capture the best knowledge and focus on points of agreement" (Bentley and Langbein 1996).

A group calling themselves the Yale Forest Forum discussed these ideas at length and then planned a "leadership meeting" that brought together a diverse group at the Lied Center of the Arbor Day Foundation, in Nebraska City. The key organizational decisions that created the Seventh Congress were made at the Nebraska Roundtable, and the general format of the local and national roundtables that constituted the Seventh Congress was created there. From June 1995 through February 1996, 51 local roundtables and 43 collaborative meetings were held; in February 1996, the national roundtable, involving more than 1,500 participants, was held in Washington, DC.

The focus of all these activities was to find areas of broad agreement among purposefully diverse audiences, and to craft a vision and set of principles for the future of America's forests. Only one speech was given on the main floor of the Congress, by Jaime Pinkham, then Chairman of the Intertribal Timber Council [Pinkham was a 1996 Plum Creek Lecturer. (Ed.)]. Collectively, these were in many ways remarkable and productive events. Levels of agreement on vision elements were high. Following are those that received 75% or more agreement at the national roundtable. I believe they form a strong basis for action, which I subsequently will describe.
Vision Elements with Approval Level

In the future our forests will be:

- Held in a variety of public, private, tribal, land grant and trust ownerships: 90%. Meaning: we don’t have a big category-of-ownership problem.
- Enhanced by policies that encourage both public and private investment: 89%. Meaning: forest investment is encouraged by most across sectors.
- Be able to sustainably provide a range of goods, services, experiences and values: 88%. Meaning: we like multiple use if we can figure out how to do it.
- Maintained or enhanced across the landscape: 85%. Meaning: keep the forests we have and restore those that are degraded.
- Shaped by natural forces and human actions that reflect the wisdom and values of an informed and engaged public: 84%. Meaning: much broader public understanding and involvement is needed.
- Managed...[to] foster forest integrity and maintain a broad range of....benefits: 79%. Meaning: one size indeed doesn’t fit all.
- Sustainable; support biological diversity; maintain ecological and evolutionary processes; and be highly productive: 75%. We must have our cake and eat it, too.

I believe that the vision and the process of the Seventh Congress are legacies that give us a clear – though difficult – path to a bright forest future. This will involve recognition of several important boundary conditions and the establishment of partnerships to test management approaches, perhaps in a “model forest.” We are on the cusp of a new way of doing our forest business as a direct result of the forces of our time: democracy and markets. What should we pay attention to?

The New Forest Paradigm: Diversity

We are in a new era of the human relationship to forests, which reflects the increase in human population and its resulting political and technological effects, a better scientific understanding of forests, fear of absolute loss of animal and plant populations, and the rise of democracy. An increasing numbers of intellectuals believe “nature” has ended, and that humans actively or passively manage the entire biosphere (Jantzen 1998). According to this view (which I think is essentially correct), there are no “managed” or “unmanaged” forests, but rather a broader array of forests managed in a variety of ways. An increasing array of benefits from forests is recognized; an ever-broader array of alarming consequences of forest loss is projected. The greater range of benefits, coupled with growing scientific knowledge, demands a broader array of forest management skills and has fostered new applied forest technologies. Interestingly, all this intensified forest management has occurred with an increase, rather than a reduction, in the most economically significant use of forests by people: wood products production.

In the United States, wood is still (by weight) the dominant industrial raw material. Since 1940, the U.S. population has doubled, and we have tripled our per capita use of paper, so our increase in paper consumption is enormous. Finally, we have recognized that people living in and around forests are extremely important in forest management, and we have begun involving them in management decision-making. In one word, the new management paradigm is diversity: of purpose, kind
of forest, management skills and options, forest components and benefits and, most of all, diversity of those involved directly or indirectly in management decisions. Stakeholders exist.

**Faster Action Based on New Policies**

Paradoxically (because things traditionally happen slowly in forests) the new paradigm calls for more rapid development and implementation of strategies. If we are to learn from our actions in model forests “in time,” we must accelerate the rate at which new approaches are tried. This, in turn, will require broad-based understanding and trust among stakeholders. The only effective way to achieve this trust is through long-term broad involvement techniques, like those used by the Seventh American Forest Congress. One major failing of “public involvement” under the old paradigm is that it was sought in response to specific issues and planning initiatives. Thus, the fabric of group interaction had to be continually recreated, often with groups without previous participation experience. Cumulative understanding and trust were neither created nor reinforced; rather, interest groups learned ever-better ways to “win” rather than developing a broad understanding of forest processes and possibilities.

Another way to speed things up will be through the use of adaptive ecosystem management, made possible, in part, by the broad and continuing understanding and trust developed in processes such as those previously mentioned. The old paradigm called for us to learn, then do. Because forests and scientists are what they are, the learning phase tended to be long; but this was thought to be necessary, since we didn’t want to make “mistakes.” Research was done to produce a given level of certainty, then management actions could proceed. Two things were wrong with this. First, an agreed-upon level of certainty was rarely reached or stated by scientists; and, second, management usually got tired of waiting and went ahead anyway. Tying management action to the time scale and culture of science was a grand experiment, but it has failed utterly. We need to replace it with learning-by-doing on a management scale, using model forests as demonstration areas. With many things tried, on many forests, for many reasons, learning will accelerate rapidly—if we actually begin to do things.

Science-based assessments, where pertinent questions about the management of a specific area are raised, agreed upon and answered with the best of current knowledge will precede management experiments, which will be designed to try more than one approach at a time in a comparative format. Then, as results from the management experiments begin to come in, more focused research can be used to answer detailed questions arising from the management experiments that are specific to the area and objectives.

Making this work, both in the sense of maintaining stakeholder trust and in the sense of maintaining quality-of-work standards, will require some form of “triangulation – certification by third parties of the efficacy of forest management over large areas and long times. This activity will probably be, like all the other components of the new paradigm, diverse – particularly in different cultures. In the U.S., its application in New England will likely be quite different than in the Pacific.
Northwest. But it will probably have some similarities wherever it is applied, including credibility, and an area (rather than ownership) focus. Forest management certification, and consequent labeling of forest products will help us learn how to do this, but I don’t think we fully know how yet. A major role for model forests can be to test different ways of approaching triangulation. For example, how to determine whether management approaches in large areas successfully achieve diverse goals. Current certification efforts have been characterized, with some accuracy, as “boutique solutions for Macy’s sized problems.”

All these elements – continuing stakeholder involvement, adaptive management, and effective triangulation – can and must be pioneered on model forests beginning now. Model forests will be both public and private forests, often in partnership, where stakeholders have agreed to try new things and approaches. If model forests are not created, it is hard to see how we will ever get past the local gridlock that often blocks forest management planning.

The Next Generation Of Environmental Regulation

Partnerships and incentives for positive goals appear to be going beyond top-down national and international regulation in many areas of environmental regulation (Chertow and Esty 1997). This is perhaps particularly true of forests in the United States in all their biological and ownership diversity. Existing environmental laws and agencies regulating forests (e.g., EPA, ESA, state forest practices regulations) have provided experience and perhaps a basis for enforceable expectation. Expanding their scope and function may not be productive, particularly if the same goals can met with cooperative participants rather than rigid, “one-size-fits-all” bureaucratic rule-making. It is increasingly clear that the major threat to forest conservation is forest conversion to other uses. If regulation makes conservation more expensive or legally risky than development or agriculture, for example, it will be counterproductive. If the social and political trends toward devolution, democracy and partnerships persist, incentive-based compliance may emerge as the political, as well as the technical, future of regulation.

It may be that all model forests should encompass a diversity of ownerships in societies where such diversity is significant, so that these notions can be tested as rapidly as possible.

Good Technology Simplifies Life

We often view technology as gadgets, and certainly we have many new gadgets that can help us to better manage forests. GPS/GIS systems allow mapping and analysis that were not even imagined a few years ago. Helicopter and skyline logging, low-ground-pressure vehicles, improved road building methods, better field measurements derived from ecosystem ecology and other basic sciences, and better ways of conducting stakeholder meetings derived from the social sciences and using computers and telecommunications equipment are all examples of gadget-based technological progress applicable to forests. But the ultimate technology is still human thought. We need an all-encompassing theory that defines how we should think about forests and all their diversity.
Somewhat unexpectedly, science is helping with this. Forests are now clearly seen as more than collections of populations of organisms (Gordon et al. 1993). We recognize the myriad ways in which their components are connected. Now we need to think not only about the internal connectedness within the forest, but the external connections among all forests, all ecosystems, and to include humans as part of those ecosystems. In spite of assertions to the contrary, we know it is possible to learn about human values and how they affect forests. Where we have looked, we have found that political values and systems have profound physical and biological effects on forests (Nelson 1998, dos Santos 1996).

Perhaps the greatest potential harvest from model forests will not be wood products, but knowledge of how diverse cultures and political systems shape forests. There are many theories about this, but little measurement and comparative data.

An International Framework

The central conundrum of the model forest movement is diversity. But since this is also the summary of the new forest management paradigm, it should be possible to make this into a virtue. I am sure that we can develop a better framework based, in part, on these elements:

**Communication structures:** Certainly the communication revolution has given us possibilities here, but much remains to be done. Model forests should communicate among the forest stakeholders and with each other in real time. This will require a common language, or facile translation, and a common medium. The communication should be forest-to-forest and not routed through a centrum, although a central coordinating body is inevitable and probably necessary. The most common medium will probably be the Internet but this will take a lot of work.

**Acceptance of diversity:** Diversity of people, goals, and local and country strategies will be a great strength of the great model forests experiment, and must not be compromised.

**Information synthesis and dissemination:** The overall goal is to learn; this is where a centrum will come into its own, not to command, but to keep, synthesize and disseminate the rapid increase in knowledge that will follow implementation. Every day should produce lessons learned. All involved should hear about them rapidly, so that the amount of thought applied per hectare can increase rapidly throughout the network.

**Focus on keeping forests as forests:** It is more important to maintain the forests we have, and to improve them in locally important ways, than it is to impose some overarching standard of management. Indeed, we can't predict the future, and what seems clever today may not tomorrow. So the lack of a single set of principles rigidly enforced is probably a virtue as we prepare for an uncertain future, in so far as it allows us to try lots of approaches.
Questions from the audience

Yesterday I was listening to the radio and I heard about the huge fires in third-world countries. I had the impression that the United Nations is observing the fires, but not taking action. What should they be doing?

I'm not sure which fires you were hearing about, but the fires in Asia and Indonesia have mostly been the result of converting forest to agricultural land. In this scenario you get a one-time benefit by cutting and selling off the timber. The remaining vegetation and slash are burned to prepare the land for marketable crops, which provides a longer-term benefit from the resulting agricultural land.

That is an example, in my view, of the market working in a status-based system. Landowners are allowed to benefit from these practices, and the negative impacts are considered what economists call externalities: The people who breathe the smoke and suffer the health consequences, for example, are not asked whether they would like that to happen. So those fires are a good example of how we have treated resource problems. We wait until they happen, and then we worry about them. Usually they play themselves out in some way that is not part of anybody's design.

My hope would be that through broader understanding and techniques developed in model forests we will, in the future, avoid situations like that. There are many other important aspects, too. Rural poverty is affected by forest management, and, in some cases, the value inherent in forests can reduce poverty at a local level. But what I know for sure—I think—is that waiting until crises occur leaves us very little latitude. In the United States our approach to the controversy over old growth in the Pacific Northwest has been mostly to fiddle while Rome burns, and a lot of it has been destroyed while we were having fun arguing. I think there are no quick fixes for things like that. The only real remedies are long term approaches.

Are landowners and governments learning from these mistakes?

They should be, and it's our job as resource managers to see to it that they do.

The idea of model forests sounds great, but, as you know, the devil is in the details. How will the network of model forests be established?

I think—I don't know for sure—that Canada did it through a competitive process in which the opportunity to develop the model forests was auctioned off. I think that approach has a lot of merit because the proposals had to have certain qualifications—diversity was one—and I think we could do the same thing.

I don't want to insult the people who work their shirts off, but I think the models that work best are the ones that spontaneously arise, without official status or blessing, in response to conditions. I hope that Congress will encourage people to be creative, and encourage the involvement of a much broader range of people. Again, I will emphasize that the people in the cities are the ones we have to reach.
You have mentioned democracy and capitalism a number of times this evening. Who gets to play? How do you create a level playing field? And who decides who can be on the playing field?

The end point, at-the-limit answer is everybody. We are not there yet by a long shot, so governments will still be responsible for providing and defining the level playing field. That is the role of both national and local policy. We are seeing movement. Just as in the United Kingdom, Wales and Scotland are suddenly independent, here we find states are increasingly taking back power from the federal level. But federal policy will still be necessary to level the field.

The practical problem that I see is that federal policy is often too specific, and I don’t think you can be specific unless you have a specific place in mind—and yet we legislate virtually linear programs to make decisions for places about which the legislators know nothing.

As the dean of the School of Forestry at Yale, what are some of the things you are doing in your school to foster this type of understanding? What are you doing to help your students become able future decision-makers?

We are trying lots of things, though I won’t say that any of them work perfectly.

In the past 20 years we have greatly increased the amount of social science in the forestry curriculum to foster an understanding of people and social issues. Another approach has been to eliminate departmental boundaries in the school and to encourage — against the academic tide — interdisciplinary projects and cooperation. I think we are having some success with that. We are not fortunate enough to have the kind of extension connections that you do in rural states, but we do outreach programs that involve us with the outside world.

We are now using forums to reach out to private forest owners so we can hear what they have to say. We host forums on current issues, like the Maine clear cut moratorium referendum. That is what we are doing. Is it effective? We will know when we see how our graduates do.

You suggested that we move faster in coming to management decisions. Is that the result of reason or desperation?

I may have given the wrong impression. My concern is that we try new forest policy ideas rather than talking about them for 15 years— but I don’t mean shoot from the hip. There must be controls, and we will need watchers watching the watchers until we are more perfected as a species.

So, consider things, do a structure assessment — but then move ahead and don’t be afraid to try some different things, some new things, on a scale that’s large enough to tell you something, but small enough so you don’t precipitate disaster across an entire continent. That is what I mean by trying things faster. That is the importance of the model forests: They are places where you can try things at an appropriate scale.
Do you think there is a similarity between the Model Forest concept and the US Forest Service's "Forest Plan" program of a few years ago, where each National Forest produced thousands and thousands of documents and letters, and organized community meetings to gauge public opinion and evaluate social issues?

The information that was gathered in that program was—and continues to be—extremely valuable. In retrospect, I think it turned out to be far more valuable than we had expected.

If we did it again, we would encourage more flexibility and more adaptive behavior among the Forests, and let each Forest interpret the rules in light of their local or regional situation. We have learned that public involvement as a response to something doesn’t work nearly as well as public involvement in the planning or goal setting stages. People want to be in at the beginning, and not merely brought in to respond to a predetermined set of alternatives. Now what we have to do is apply what we learned.

You often say "we." In the larger political picture, who is “we?”

Good question. To me “we” is everybody who isn’t in Congress. That is not a joke. I am serious about that.

There are all kinds of new alternative channels for democracy to happen that have evolved because the existing channels were too narrow and restrictive. It is like the broadening of the electronic spectrum for communications. I don’t think Congress is bad—it is necessary and fine, but there are other channels.

In terms of faster action, how accommodating is the current political structure?

My view is: not very.

We have the adaptive management areas under the President’s plan in the Pacific Northwest (I mention that because I know something about it) and in five years something has actually happened on only two or three of the 12 defined areas.

Part of the problem is that the program is governed by a rigid set of rules that nobody fully understands rather than by a flexible group of sensible people. This leads to stasis. I would like to see us relax the rules and transfer the initiative to groups of people who have a stake in the outcome.

Thank you for listening.
Certification of Forest Practices
Robert Seymour
Curtis Hutchins Professor of Forest Resources,
University of Maine

Robert has developed a leading program of quantitative silviculture and applications of forest stand dynamics to forest management. He is a Pew Scholar and is working on several projects related to management of forests to maintain diversity and other values in the northeastern United States. He has served on forestry certification panels in the Northeast.

Introduction

I want to acknowledge and thank the Plum Creek Lecture Committee for inviting me to speak on forest practice certification—a topic that deeply interests me. The issue of certification is new in the western United States and fairly new to forestry worldwide. My own first published paper appeared in the Journal of Forestry just three years ago.

In my presentation today I will
- Relate my experiences in developing certification procedures
- Talk a little bit about the certification evaluation process
- Discuss certification criteria and on-site procedures
- Describe what I see when I do these evaluations
- Give my opinions on the weaknesses and strengths of our landowner clients.

I will conclude by describing some of the issues and concerns surrounding forest practice certification.

Kevin O'Hara says I am so enthusiastic about certification that I sound like a salesman. I do not think I am overly enthusiastic. My role—and I find it most exciting—is to develop the standards and the evaluation process, and then actually do the evaluations. This involvement gets me out into the field and really improves my teaching and research. Kevin has called me an overeducated forester. I guess it is my way of vicariously managing land.
About Scientific Certification Systems

Scientific Certification Systems (SCS) is a private company that made its mark certifying organic foods and performing life cycle analyses. They developed their forest certification program in the early 1990s and are accredited by the Forest Stewardship Council — the international body organized in 1994 to accredit certifiers. SCS is one of three accredited certifiers currently operating in North America. The eastern United States forest types that SCS has evaluated, and with which I am most experienced, are the spruce-fir type — common in Maine — and the black cherry forests of Pennsylvania.

The concept of certification is one of the things that makes forestry exciting for me right now, because it is new stuff. I have served on five evaluation teams as a consultant for SCS, evaluating a total of four million acres for these clients:

- Seven Island Land Company (1993) — a million-acre family ownership managed by a group of foresters in the eastern United States
- Kane Hardwood division of Collins Pine (1994) — famous as the first United States landowner to receive certification, operating mainly in the Sierra-Nevada Mountains in California
- Menomonee Tribal Enterprises (1996) — Native American tribal lands in northern Wisconsin
- Pennsylvania Bureau of Forestry (1997-98) — a prototype effort to certify public lands
- J.D. Irving Company (1996-ongoing) — a U.S./Canadian operation on nearly five million acres and the first industrial firm to go through the certification process

Other forest certification systems

There are other certification or auditing programs, which I’ll just mention here. You may have heard about the AF&PA Sustainable Forestry Initiative — a voluntary effort undertaken by many forest industry companies — and the Canadian Standards Association. CSA differs from the FSC in being more process-oriented, while FSC certifications lean toward a performance orientation.

SCS’s Forest Stewardship Council-accredited forest evaluation process

Whether it is in individual landowners interest to subject themselves to this process, and whether they could pass, are two different stories. Today I’ll talk about the process and some upcoming issues.

Three evaluation program elements

SCS’s FSC-accredited system has three program elements:

- Sustainable timber management
- Ecosystem maintenance (the ecological aspects)
- Socioeconomic issues (the human and economic issues)
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Each of these elements has major criteria, and each criterion has specific performance stands. For landowners to become certified — which gives them certain marketing advantages — they need to score 80 (on a scale of 100) or above in each of the three program areas. They can’t do well in two and blow off the other one.

**Evaluation criteria**

Here are the evaluation criteria for each program element:

**Ecosystem maintenance:**
- Forest community structure and composition
- Long-term ecological productivity, nutrient cycling, site productivity
- Wildlife management practices
- Watercourse management practices
- Pesticide use
- Ecosystem reserves (i.e., land that is not under any form of extraction)

**Socioeconomic**
- Financial stability of the enterprise (this is of critical importance, because a company likely to fail or change hands cannot provide long-term stewardship)
- Community and public involvement
- Public use management (e.g., recreation)
- Investment of capital and personnel in good forestry
- Business practices (how the company treats employees and contractors)

**Sustainable forest management:**
- Harvest regulation (allowable cut)
- Stocking and growth
- Pest and pathogen management strategies
- Forest access
- Harvest efficiency and product utilization
- The management plan and the inventory information

**Some specific performance standards**

I could teach a whole course on this, but today I’ll give a few examples of specific performance standards. Each of the 17 criteria I’ve mentioned above have — not quantitatively, but in words — what we could consider ideal performance and what we see as the marginal threshold (i.e., an 80). I began developing these standards of SCS in an intensive two-day session preparing for the Seven Islands evaluation. Once the criteria were established, we could go out, look at landowners and their sites, and attach numerical scores to what we saw.

A typical SCS evaluation team includes a timber specialist (that’s usually me), an ecologist or wildlife biologist (who focuses on the ecological stuff), and an economist/policy type who does the socioeconomics. The team has experience...
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and training and has often worked in the field as a team. The socioeconomic evaluation might require stakeholder interviews and other non-field work, but otherwise we are in the field taking notes. Optimum 100-point performance in the silviculture arena would include:

- Stand treatments designed and carried out to fully meet future yield targets (volumes and products)
- High-quality, vigorous trees and stands favored for retention
- High-risk, low-vigor and poor-quality trees and stands routinely given highest harvest priority
- Young age and/or small diameter classes of preferred species adequately present over the entire ownership and developing as planned
- Timber production silvicultural systems that strive to maintain the original diversity of species and structure of endemic natural forests
- No excessive and unnatural uniformity of composition and structure
- Planted stands employing native (or closely related non-native) tree species, established and tended to conserve natural structural features of the original forest (i.e., large cavity trees, rare species, snags, coarse woody debris, undisturbed islands)
- Silviculture not narrowly focused on high timber yields
- Fully and currently knowledgeable foresters to prescribe silvicultural treatments based on scientific silvicultural practices
- Prescriptions tailored to individual stand conditions and markets

Here are some examples of what we see in the field:

- An improvement cutting in Pennsylvania harvested some lower-value red maple and left healthy black cherry. That's the kind of positive thing we look for.
- In another area is a big veneer red oak on the right and other trees left that are not high quality. We occasionally saw this not so good situation.

Obviously we cannot see everything in one stop. We make lots of stops and take many samples.

We look at the interface of timber production silviculture with ecological aspects and biodiversity: Are you using silvicultural systems, not just for production, but also to maintain some of the region's native species, and to avoid extensive, unnatural uniformity and composition structure? The issue of plantations and planting is very controversial (I will give an example from Irving Company in a bit). Using native species or closely related non-invasive exotics scores higher than other approaches. Retention of natural structural elements, cavity trees, coarse woody debris and so forth are very positive features. Recently we decided that it is not only the practices but, more important, the quality of the foresters and managers. Are they fully knowledgeable and up-to-date on silvicultural information?

This brings up the whole point of trust. A reality of this business is that if landowners succeed in becoming certified, they are certified for five years. We may
spend only one or two days with individual foresters and may not even meet many of the foresters who work for the company. We have two days to judge whether we can trust these people to manage the land well for five years with only annual audits.

So we look for certain things. Are they knowledgeable? Do they have continuing education credits and other ongoing training? Do they have advanced degrees or good experience? These are all pluses.

Here are some examples of non-certifiable (less than 80 points) silviculture performance:

- Managed stand conditions consistently fail to support yield targets and will result in significant future shortfalls in volume or value
- Harvest practices driven by short-term product values or mill demands that fail to appropriately discriminate among categories of growing stock within and among stands
- Regeneration cuttings, thinning operations and young stand management consistently create significantly understocked conditions, with little prospect for good stand development
- Managed stand conditions are not meeting the yield targets that underlie the allowable cut analysis
- Regeneration cuttings result in understocked stands

In Pennsylvania you see nice stands of black cherry that are worth a lot of money — $3,000 or $4,000 per 1,000 bf stumpage for cherry veneer — so you get $10,000/acre timber sales. But many of the young stands in northern Pennsylvania are what they call orchard stands: a 25-year-old stand — if you want to call mostly red maple and beech, with virtually no cherry, a stand — with a lot of ferns and herbaceous vegetation. This is, of course, a minor negative if a backlog of this stuff was created before they began to improve their practices, but it is a huge negative if they continue to create these stands.

If your silviculture is designed to simplify stand structure for administrative expediency, so you can get by with fewer foresters at the ecological cost of diversity: this is a negative. If you have foresters who haven’t been near a classroom in 15 to 20 years, who use outdated science, don’t read the literature, use broad-brush treatments instead of a stand-specific, targeted approach, these are all obvious negatives. There is nothing new about any of this. It is just good timber management.

The evaluation process

The process begins with a preliminary evaluation for anyone who wants, or is considering, certification. One or two team members go out in the field to look for the big issues that might prevent certification, evaluate the things the landowners think they are doing well, and check for things they haven’t considered. This preliminary evaluation reveals potential certification problems before a more costly full evaluation. It is a quick and dirty overview, looking for the obvious.

On the basis of the preliminary evaluation, the landowner decides whether to
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proceed with the certification process. If so, the team convenes to refine criteria, evaluates the site, scores the site on the basis of the criteria, and writes its report. The client reviews the report for technical accuracy and, of course, to debate some of the conclusions. Then it goes out for peer review, like a manuscript submitted to a journal. The reviewers are not necessarily picked by the client, so they have a degree of autonomy.

Everything up to this point, except for an executive summary, is confidential. If the client doesn't pass, or if the report contains confidential economic data, that information is not revealed. The executive summary contains all the findings and a public summary of the forest management plan.

If the landowner passes all three areas with scores of 80 or more, annual audits monitor behavior and performance according to the established criteria. In Pennsylvania, not all criteria are weighted equally. Elements like harvest regulation (i.e., allowable cut) and financial stability are typically weighted as 30% to 40% of the entire score within their respective areas. Forest access (i.e., road system) may be only 5%. We review documents and management plans on-site.

In field evaluations, we choose where we go. What I have found works well is that on the first day we are on the district, we let the foresters take us wherever they want, so they can show off their best work. After that, we go back and look at various things in more detail, so we choose at least half the stops. We interact heavily with the professional staff, but we also interview stakeholders in the region to see if the landowners are good corporate citizens. We do a lot of just standing around in the woods, talking with foresters, and asking questions like, "Why is this oak tree marked? It looks like a nice tree to me," to get a sense of the whole silviculture approach.

When we see things in the field that seem problematical, we confront the people immediately. For example, we might say, "I see something here I am a little nervous about. Is this true, or am I just looking at this wrong? Help me understand." That gives them the opportunity to go to another stop where things are clarified. We don't want to write it down in the field and later render a negative judgment in the report if this is not typical. It is very hard to get a feel for this interactive part of the process without engaging in it, but it is a very important part. It builds credibility into the final report and helps ensure that our perceptions are accurate. When the client reviews the report, there are no surprises.

For a private landowner, we release only the top three scores. In the first stage of the Bureau of Forestry evaluation in Pennsylvania (about 1.2 million acres), the scores were 84 in timber, 82 in ecosystem maintenance and 91 in socioeconomic. It passed most of the individual criteria but got scores below 80 in forest community structure and ecosystem reserves (both in the ecosystem maintenance category), management plan, investment, capital and personnel. When we multiplied the raw scores by the weighting factors, they passed the major elements so were certifiable. But when landowners have raw scores below 80, there are mandatory conditions they must meet for up to five years to raise the low scores to passing.

Peer review is usually a desk audit, but in the Irving case, there were ongoing ecological issues, so we brought in Gordon Baskerville, Hamish Kimmins and some
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others. They spent two days on-site at Irving's expense, went out on the land with Irving, critiqued the work we evaluators had done, and then wrote peer review reports based on eye-witness accounts. This is how we build rigor and scientific credibility into the process.

Anyone familiar with Pennsylvania knows that the most sensitive forest management issue is deer. Not only are deer an ecological and timber issue, but also a political issue. Deer populations are so high — and managed to be high for hunting — that it is very difficult to achieve acceptable hardwood regeneration. To get regeneration, standard practice is to fence with seven strands of solar-powered electrified wire or woven wire.

You can deal with some aspects of the deer problem with fencing, but there are many biodiversity issues to be resolved before the forests of Pennsylvania become sustainable. It is not just tree species that are threatened by overbrowsing, but a lot of herbaceous species as well. Sustainability requires that deer populations go down. No one disagrees with this, except possibly hunters. Biologists and foresters are unanimous about the need to reduce deer populations. For that reason we gave the state forest of Pennsylvania a non-passing score for forest community structure.

They had a hard time with this, and things became uncomfortable due to the politics involved. I was somewhat sympathetic because in Pennsylvania, foresters have no real control over game populations. We gave them credit for their proactive approach to dealing with this; but the fact is that the game commission in Pennsylvania is an autonomous group, run by the hunting/sportsmen/tourist lobby to keep deer populations high. The result, in many cases, is 60 to 80 deer per square mile. Fencing isn't enough.

We recognized that in Pennsylvania's state forests, the deer problem is not presently under foresters’ control, but changing state policy could solve it. We reasoned that consumers buying certified Pennsylvania red oak flooring expect the lands to be managed sustainably by the Commonwealth of Pennsylvania. Consumers don't know or care whether it is the game commission, the governor or the Bureau of Forestry doing the managing. The state must now move from managing for nutritional carrying capacity to managing for biodiversity. We need to be patient about this, but we will monitor their progress.

Certification weaknesses

Let's talk a little about some weaknesses in certification programs. What are the minuses for landowners who subject themselves to the process? In the private sector, well-meaning but overworked and under-funded foresters end up doing things like diameter-limit cutting, letting contractors control prescriptions and things of that sort, when some more sophisticated, exemplary silviculture is appropriate. My wife is a former industrial forester, and she was really proud of her ability to manage crises. I said, "If you guys invested a month or six months into planning, you wouldn't have most of these crises." My attitude is, if you are always reacting to crises, I won't have a lot of confidence in your strategic approach to managing timberlands.
There is a tendency for foresters newly out in the real world, fresh out of school and without experience, to think they are doing excellent work, when, in fact, it is mediocre compared to what could and should be. We get comments like, “We don’t need to mark these stands. The contractor will do a better job.” My response is, “Are your foresters that bad? Why have foresters, if the contractors can do it?” This isn’t necessarily the foresters’ fault. Management may not be willing to hire enough foresters to do the job.

We also hear, “I laid out this road and it’s the only place I could put the road and we got some siltation in the streambed, but that’s the only thing we could do” — as though the stream created the problem. The point is: We cannot and do not accept or reward poor management.

When land managers haven’t been in the classroom for a long time and haven’t kept up with state-of-the-art management via continuing education or the current literature, we get some really outdated forest science. When I am told, “We don’t believe in stocking guides or density management diagrams; we know better, we have an intuitive feel,” I think, “You may have a better approach, but maybe you are just out there with a paint gun.”

Pennsylvania has what they call the wild areas, which are not total ecological reserves or wilderness. They can cut in them under certain circumstances, but they are supposed to be left alone for backcountry recreation and to allow natural processes to work. But what we found when we went out there is that foresters like to put up timber sales in the designated wild areas because — and someone actually said this — “If we don’t do that, the locals will get the idea we can’t cut in there.” One even said that the reason they like to cut in these areas is to “create early successional habitat, because the only early successional habitat they had in there came from fire.” Well, of course. That’s the natural process at work and doing just fine. The whole idea of using natural disturbance regimes as models, especially in natural areas, is foreign to them.

One forester said, “Well, we just changed. We used to manage for wildlife, now we manage for biodiversity.” I work with Mac Hunter, who wrote the famous book about this, and this is just an extension. Wildlife species are part of biodiversity. It never occurred to me that there would be an either/or situation; but this was a case where they had cavity trees with birds nesting in them marked to harvest. They had reserved other trees to get a sort of a uniform tree species distribution, but those were actually all good-growing stock trees. Their explanation was, “Now that we are on this new biodiversity paradigm, we don’t have to worry about all those traditional wildlife things anymore.”

So we do evaluations for these landowners, and they have cut all the wildlife trees or snags down. They tell us, “That doesn’t matter because we have plenty of these ‘on the landscape.’” This is the “we gave at the office” attitude to managing for biodiversity. In my situation as an evaluator, I don’t really know if they have done that or not, so it is logical to ask, “If every time you cut through a stand, all the snags are down and there is no woody debris left, how can you assure me there is plenty on the landscape?” They may have some inventory data, or they may not have any data at all. There is a tendency now to deal with everything “at
the landscape level” because that is a popular term. There is a tendency now to ignore traditional stand level stuff, which is also very important.

Sometimes we get into debates about the performance standards themselves, usually with people in the field whose company managers did not tell them the sort of standards that we use. We find something that is a flagrant violation, and they say, “What’s the problem?” We have to draw a very clear line here. We are evaluating. We are not managing the land. It is the land manager’s role to establish management practices. It is our role to evaluate the results. That distinction must be made very clear.

Here is what I think is the most important thing of all in building a strong operation. It is what I call “skilled balancing of competing values.” Our evaluations, if you haven’t realized it by now, are not strictly ecologically driven “green” certifications. We are looking for the best balance of timber, ecosystem and socioeconomic issues. As I said earlier, there are plenty of very economically driven forest industries that probably do good socioeconomics and certainly do good timber management. But, in doing that, they are really pushing ecological issues, so they get a very low score in the ecosystem area. That is a typical pattern. For those land managers, the ability to back off, to treat the ecosystem issues with more sensitivity, but without sacrificing timber yields too much, is a very difficult thing — and when we see it, we reward it.

There is a lot of debate over whether or not timber sales should be marked. It is not necessary that every timber sale, every harvest, be marked. There are prescriptions that are very uniform, like commercial thinnings, that you can probably trust skilled logging contractors to implement with some guidance, but that’s certainly not everything. When foresters actually go out and mark all the sales, they’re not just ensuring better performance on the silvicultural prescription; it also means that professionally trained individuals have walked that whole harvest block. If it’s done in the right of time of year, it benefits not only the silviculturally important diversity, but also the vernal pools and the special areas that you wouldn’t necessarily see if you depended on the contractor’s judgment. That is not to say that contractors cannot do these things well or that there should not be a real partnership between managers and contractors. But when I see responsibility completely turned over to the contractor, I get very nervous.

One unfortunately rare sign of real strength in both industrial and non-industrial forests is a chief forester, or district silviculturist, who spends time in the field mentoring young foresters, making sure that silvicultural prescriptions have consistency over the district, and strategically applying the company’s approach (rather than apologizing for bad management, or sitting around the office, where operations people call the shots).

Let’s talk some about the issues. One issue is that companies have suddenly got religion. They may have had a bad historical record — a real black eye in the public sector — but they recognize that there is good PR here, and they are trying very hard to change. They have now received the timber, socioeconomic and ecological messages. The Forest Stewardship Council was officially formed in 1994, and stuff that happened before is grandfathered.
But we don’t want to certify somebody based just on a great plan or a great intention. We have to see evidence of ability to carry out the plan in the forest. We have to see real change on the ground. I want to see at least a year or two of that; but that is admittedly a very short-term thing. This is a new issue, people may well be trying hard, and we don’t want to discourage them. We might say, “All right, we sort of trust you, but let’s have some conditions. We are going to audit you every year to make sure you continue to progress.” With Seven Islands, one of our issues was that they didn’t mark enough sales. They probably marked 20% of their cuts. Now, a few years later, they are willingly marking 80% of their cuts.

One very positive thing in Pennsylvania is that they go out of their way to reserve small clumps of hemlock, because, of course, the deer make that species particularly difficult to regenerate. These old, relic hemlocks are extremely valuable, and the state has a blanket policy of reserving them wherever they find them. That is a very progressive step. In what is now a hardwood forest, they have gone back in with enrichment plantings of white pine— which is certainly hard to justify economically. It is a very progressive ecological step. If you can get people doing that, it about the best you can expect, and would weigh positively both in the silvicultural and ecosystem maintenance areas.

Let’s talk about the plantations-to-natural forests conversion business. It is a big issue back East (and probably in other areas too). And it is a killer that could come up anywhere you have industrial forestry and reliance on planting. In the Southeast (and many other places), there is virtually no native forest left. It is fairly agricultural. Even in Maine, a lot of stands have always been forested, but they have been partially harvested maybe five or six times, so you don’t have a good benchmark on what the native forest was. So you get into how much of an ecological restoration you should expect, versus just maintenance.

Here is the primary principle that the FSC adopted: The virgin forest or well-developed secondary forests in these sites should be conserved and not replaced by tree plantation. You read that and say, “Well, most planting in silviculture is not enrichment planting or fill planting. It is just planting.”

But now you read the criteria 9.1 under the Natural Forest Principle (again, you can read it for yourself), and you find that planting is not a problem at all if you are using it as fill planting, especially if you are using native species or planting to conserve local genotypes. As long as you are not significantly altering the ecosystem, there is not a problem with the act of planting trees. I certainly wouldn’t be a part of this if there was general prohibition on planting per se.

And then 9.2 says that planting (I hate the term replanting) to regenerate stands is appropriate— even where you have complete regeneration failure and on very dry sites— if you are planting with local seed sources and native species. So if you read the general principle, you say, “Looking at the natural forests we’re looking at, planting is certainly possible.”
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To help you understand this, I'll add the definitions:

- "Well-developed secondary forests" are second-growth forest that originated after the original logging disturbances.

- "Plantations" are forest areas lacking most of the principal characteristics and key elements of native ecosystems as defined by regional standards.

So really, this just begs off. Does it apply to every time you plant trees in a monoculture, or when you mix species or fill-plant a plantation? I don't think so. They are saying that this issue of conversion must be taken up regionally.

There are several regional working groups in North America and around the world trying to flesh these things out. We had to deal with this in the Irving case, because they had done some planting. Irving manages land in northern New Brunswick, where the native forest is white spruce, balsam fir and some northern hardwood stands.

Irving started planting more aggressively in the late 1950s, and they used to cut what they called cereal-box clear cuts that ignored any landscape ecosystem boundaries. As we say in the certification business, this is Irving B.C. — Before Certification. This would never be certifiable, and they wouldn't pretend it was; but this is the way they used to manage. In the past, they might plant white and black spruce, with hardwood islands without landscape connectivity. They would build straight roads — native hardwood species on one side, an excellent plantation on the other — but not a community composition that would be growing typically in this part of the landscape.

Now Irving, in response to principle 9 and the issue of trying to make plantation forestry more ecologically benign, is routinely practicing what you would call aggregated retention: islands and so forth, and even individual-tree retention on harvested blocks that will be planted. They are also leaving nice uncut riparian zones and large uncut reserves and unique sites; as they thin these plantations, they leave aspens because they are excellent cavity trees, being a short-lived species.

This represents a change for Irving. In the old way of thinking, it is not as silviculturally effective. They have lengthened rotations and changed a lot of their plantation forestry so that 30-year-old black spruce plantations look very similar to 70-year-old natural black spruce stands. We cannot make superficial judgments about this, but it is certainly not some sort of ecological horror being perpetrated on the landscape when they try to do this sensitively.

Functionally, it is a different story. It is hard to do any functional stuff when you are out in the field. The bottom-line issue is: Are the planted stands actually "plantations" in the FSC sense? (I've stopped calling them "plantations" because it has a pejorative connotation.) Are they serving ecosystem function as well as a natural black spruce forest would? That is not clear. As evaluators and scientists, we couldn't decide that they were not certifiable on ecological grounds, but neither could Irving prove that they were certifiable.

Here is a real dilemma, because regional standards don't exist and probably would not deal with this in any case. They will allow some planting under some
undefined circumstances. The only resolution we could see was a scientific adaptive management approach. Irving will continue to plant, but will implement a monitoring program with real-time feedback. If the planting is creating ecological problems that can’t be remedied by changing the silviculture, they will either stop planting or forgo certification.

The other key issue is how the matrix as a whole is being managed. Right now, Irving has about a third of the landscape in plantations of various vintages, and they plan to have about half the landscape in planted stands when they are in a steady-state situation. We can’t prove that ecological problems exist, and Irving can’t prove that they don’t. If the matrix is well managed, our hypothesis is that Irving is going to succeed. They have passed the initial tests and have very sensitive management of the matrix in the natural stands and riparian zones. Their progress deserves at least interim certification, subject to a number of conditions.

There are certainly critics who don’t feel there should be any planting and converting in these native forests. But in the same area, right across the border from New Brunswick, is Maine. There, half the landscape has been converted to potato farms. So I wondered, if the landscape that is forested were well managed under all these natural criteria, would the landowners be certified? Of course they would. Then, if you take those potato fields, replace them with plantations of native species, in an ecologically progressive way, it’s hard to argue that that doesn’t at least deserve a chance at certification. We can’t say that it is ecologically sustainable, but it is a real-world, decent, working hypothesis.

People say evaluation takes a lot of education, a lot of experience. You can’t do this right out of school. If certification really takes off, how are we going to train evaluators? Ideally we need people with a good scientific background, which means a really rigorous undergraduate degree, preferably at least a master’s degree, some advanced academic work, and then a lot of real-world experience. Such people are not that common, and they tend to command high salaries and good jobs.

The other issue is dealing with areas where small owners dominate the landscape. It is not economically feasible to bring in a team of three PhDs to look at a 100-acre woodlot. This may be an appropriate role for non-profit state agencies, to bring some level of certification rigor to small ownerships. We already have things like the National Tree Farm System, and the Sustainable Forestry Initiative is doing outreach through their logging contractors, so there is potential for dealing with this issue.

I have been engaged in many challenging initiatives, including serving on a governor’s council of sustainable forestry and conducting an active silviculture research program. But certification is by far the hardest thing I am involved with. It is mentally challenging, and it is physically demanding, because you spend long days in the field, trying to do four things at once: 1) trying to think about what you just saw at the last stop, 2) trying to engage your host, 3) trying to figure out what is going on in this spot, and then 4) trying to think about what to do next, based on what you see here. You are trying to capture all of this, writing it all down so you can remember it. At Seven Islands, for example, we went through a million acres in
two weeks, visited more than 100 sites, and spent a lot of time walking around those sites. We would jump out of a vehicle and walk half a chain, sometimes 10 chains into the woods, up the creek, look at the riparian zone, whatever the issue was. It is very challenging.

FSC certification is a balanced approach with very high standards. It is not for everybody. It is no accident that a lot of the landowners who have been certified are typically old family ownerships, where there is long-term continuity of stewardship. They are not publicly traded corporations; you can’t buy stock in them. Irving — owned by the Irving family — is an industrial example of that. They are somewhat immune to short-term, bottom-line pressures. I think this is an important observation.

That is not to say that that couldn’t change if certification really takes off. Obviously this is a market-driven approach, but right now I would say there is a reason why not everybody is leaping on the bandwagon. However — and this is where I really get enthusiastic — I have been on panels looking at regulatory approaches, and I think that rigorous certification — if it is really rigorous, balanced and scientifically credible — has much more potential to foster excellent forestry. To demonstrate this, I use a metaphor from education. If you have kids in school, or if you are a student, ask yourself if you would rather get a C- in a really hard course, or would you prefer to get an A in some Mickey Mouse course? I know what my sons would say, and what I would say if I were a student. The answer is obvious, if you really want to learn and improve. Looking back at my own educational career, some of the hardest courses were the ones in which I learned the most. I may not have gotten a C-, but I probably didn’t get an A either. If I needed to get a good grade in a course so that I could go to graduate school or law school or whatever, it might be a different story.

To me, forestry and enlightened forest management are better served by rigorous approaches. I am not saying that SFI and some of the other self-auditing programs won’t do some good, because they are affecting huge acreages. Their standards are not the most rigorous, but we are talking about 50 million acres, all of which will get better because of SFI. I think both approaches can go forward in harmony. But FSC certification is performance-oriented and rigorous; the standards are not just politically correct, but scientifically based. I hope that they encourage people to strive for certification. The process will lead them to much better forestry, even if they don’t necessarily pass everything.

I guess that if I were in the industry, I would not necessarily be the first to jump forward to be certified. But I sure wouldn’t want to be last, because I think consumers will increasingly demand these products. I may not be the best person to talk about the market for certified products — I am a silviculturist, not an economist — but there is much more motivation for this than the market.
Robert Seymour

Nobody is in this for the marketing right now. They are in it for the credibility. Industrial forestry suffers from a lack of credibility, particularly in the United States. It is hard to gain credibility with a Sustainable Forestry Initiative-type of self-auditing program. It may be well meaning, but as long as it is self-auditing with no third-party, impartial, scientifically accredited review, it is not going to work. The FSC-certified SCS, Smart Woods and the other certified organizations do provide that needed credibility.

Questions from the audience

Have you determined the cost-per acre of certification?

There is strong economy of scale in the certification process. I would estimate that the on-the-ground analysis costs for certifying a million acres would be about eight cents per acre.

To get a good perspective on the certification process and costs, I suggest that a panel of landowners who have experienced the process present their viewpoints on costs and benefits. Landowners we have worked with say the on-the-ground evaluation is actually the least of the costs. Irving, for example, says that the biggest costs in their case are in redoing their management plans, monitoring and, in some cases, the reduction of their allowable cut for ecological reserves on their own lands. All of that costs. It is not free.

If I understand you correctly, you certify landowners, rather than the land itself. Is that correct?

Technically, FSC certification is attached to the land, but we do this through the landowners.

So you are actually evaluating a very small portion of the land you are certifying.

I guess that’s true, but most certification is of large private properties. The Pennsylvania State Forest was the only exception. For small private property we need some sort of lower cost approach. There are two examples that I think are promising. We have two consulting firms in Maine and one in New Hampshire — two that have been accredited by Smart Wood, one by SCS — that have clients, in a client pool, about 5,000 to 20,000 acres of clients. These are firms of two or three consultants, small operations, which have less than $200,000 of business a year. They may have 50 to 100 clients.

They submit their client list to be evaluated. (I actually haven’t done these small ones, but I can talk about them.) We pick some representative stands to examine, just as we do when we evaluate large landowners. We don’t look at every stand. We pick at random to create what we think is an objective sample. We do the same thing with small woodlots. We don’t visit every landowner, but we do visit enough of them to establish that there is consistency in the foresters’ approaches to those pieces of land.

In my mind, the most promising way of certifying these small woodlots is through certifying consulting foresters, who can then manage these lands to certified standards. The landowners who own the woodlots would then be able to
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take advantage of any market benefits. There are a lot of issues to deal with in the approach, but I think it is worth pursuing.

How do you deal with the disparity that allows a large landowner to evaluate five percent of their land and receive certification, while small landowners must evaluate (and bear the cost of evaluating) a much larger proportion of their properties?

That’s another nasty one. I was part of a consulting team that did a preliminary evaluation for a large consulting firm on about 30,000 private acres, representing about five percent of the landowner’s forest property. I thought to myself, if we pass this five percent, the CEO, manager or president will have to decide whether it is better to ignore the idea of certification, or to say that five percent of his operations are certified. I think I know the answer to that. So they were just testing the water in that case.

The preliminary process in that case was confidential and never made public. The company learned what they needed to do to bring the management on the rest of their acreage up to certified standards. I don’t think they ruled it out, but they didn’t decide to leap forward either.

In the eastern United States, it is an axiom that most consultants earn 80% of their money on 10% of the timber sales, the big jobs, like a liquidation cut where the owner is converting the land to another use. What does that say about the forester? I think that certainly is an issue that deserves more attention.

There are landowners who just aren’t interested in sustainable management, and it’s hard to not manage those lands, as part of your consulting business. I can see a standard where at least 50% (or some percentage) of your business or the land you manage might have to be certifiable.

The photograph of the Maine potato fields fascinated me, because there seems to be a separation between the land that is forested and the land that is in the industrial agriculture production model. In other words, there are different standards there. Has there been any attempt to integrate a more sustainable agricultural principle that would work to prevent soil erosion, a return to native agricultural species and things like that, and even go a step further, even to suburban and urban development, so it’s not segmenting and fragmenting habitats and ecosystems?

That slide is actually from New Brunswick, Canada – not Maine – but you could find that in Maine.

I am not aware of any coordinated approach to include agriculture and development into the certification process. In Maine, agriculture is in serious decline. The potato farmers have to compete against Western farmland watered by federal irrigation projects.

Frankly, Maine is a lousy place to grow crops because it is cold, but there are a lot of dairy farms. We have sustainable agriculture programs, but they have not looked at integrated woodlot management. There are big dairy and agricultural co-ops, and farmers own a lot of woodland. I think there is potential to organize these people, but right now it is an untapped area. If it is going to happen, it will come through the agricultural co-ops.
Are criteria different for different landowners?

Yes. The work we did in Pennsylvania shows why that is necessary. We expect more from public land managers than we do from private and industrial landowners, especially on questions of public involvement and ecological reserves. We weighted these sorts of issues more highly in Pennsylvania and reduced our emphasis on the traditional stuff.

In practice, the standards don’t vary that much. We compare all possible pairings of issues, and an algorithm cranks out a relative weight or importance. The team sits down at the beginning of the process, gets familiar with the issues and discusses, for example, whether forest access is more important than harvest regulation. Is it way more important, way less important, about the same? — those kinds of questions and rankings. So to the extent that there is a need to tinker with standards to recognize ownership and other differences, that can be done. But differences would be slight.

Wouldn’t these variable standards compromise the consumers’ interests they are intended to protect?

Well, the standards don’t change — just how the scores are weighted. In my view, changing the standards could compromise certification, but we are talking about how the standards are weighted statistically — how you weight silviculture versus other standards, for example. I would be interested in discussing this further, because I do see your point.

You mentioned the costs of the certification process. What return could a landowner expect on “green” lumber compared to non-certified timber?

It is hard to say. People tell me that ‘green’ lumber does not command a premium. There may be exceptions in the case of small manufactured products, but generally what certification buys is access to markets — that is, you can always sell your product, especially during down cycles, because while consumers may not pay more for them, they prefer certified materials if they are available.

Marketing plays a large role in this. That’s good, but the products that emphasize certification and ‘greenness’ are things you can see: finished flooring, paneling, doors, mill work — the things that go into a home that is a million-dollar monument to your ego, where you have your buddies over drinking cocktails, and you can say, “I paid six dollars a board foot for that floor instead of three, because it is certified green.” Two-by-fours, sheet rock and commodities are a harder sell, because you can’t brag about those spruce two-by-fours in that wall.

But while bragging rights play a big part in this, architects are beginning to specify the certified materials, so it is starting to catch on. I think it will gradually work its way into the system; and while consumers may not pay more for it, it will squeeze out other non-green stock. In Great Britain, certification is now required on certain materials; in this country, I know Home Depot has announced that their purchasing policy would give preference to certified products. But that is an unrealistic policy if certified materials are not available. Still, it is a big plus for certified wood products producers to know their products have an edge in bad markets.