

Biodiversity, Beauty and the "Beast": Are beautiful forests sustainable, are sustainable forests beautiful, and is "small" always ecologically desirable?¹

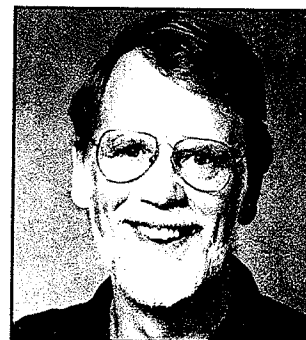
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Biological diversity is our planet's inheritance from millions of years of evolution. It is nature's "insurance policy" against change, and a rich legacy which will help future generations of humans adjust to change. We squander this inheritance at our own risk, and to the detriment of future generations. Humans have been reducing the earth's biological inheritance for thousands of years, but we now have the knowledge, and hopefully the intelligence, to arrest this historical pattern. The idea has developed in western society that if something looks "nice," it must always be ecologically superior and better for biodiversity than something that is visually undesirable. There is also the idea, which appeals equally to our sensibilities, that there is a "balance of nature," that nature seeks and needs an equilibrium condition, and that change in this condition is bad. Ecosystem disturbance and change are seen as threats to both the survival of nature and to biodiversity. There is no evidence that such generalities are true, and lots of evidence that they are not. Beauty is in the eye of the beholder. What may be judged to be "beautiful," sustainable and good stewardship by an ecologist or biodiversity expert may be ugly, at least for a period of time, to the average citizen. What may be beautiful to a person in the street may not be sustainable of the very ecological and social values that they desire for their children's children. On the other hand, there are many examples in which visual images do provide an accurate assessment of ecological condition and sustainability. The challenge is to identify when our "gut reaction" to visual images provides a reliable basis for making changes in our relationship to resources and the environment, and when it does not. The key message is that we should let knowledge of the ecological and biological diversity of forests, and the associated values we wish to sustain, play a major role in deciding how the many different kinds of forests in the world should be managed. We must not permit dogma, mythology and untested or disproven ideas to prevent us from attaining our biodiversity and sustainability goals. We must not apply any one single forestry policy or management method everywhere, and we must balance the important aesthetic considerations with the ecology of the values we wish to sustain.

Key words: sustainability, biodiversity, ethics, aesthetics, ecological rotations, respect for nature

La diversité biologique est un héritage de notre planète qui découle de millions d'années d'évolution. C'est la « police d'assurances » de la nature contre le changement, et un legs de grande valeur qui aidera les générations futures d'humains à s'ajuster aux changements. Nous dilapidons cet héritage à nos propres risques, et au détriment des générations futures. Les humains ont réduit l'héritage biologique de la Terre depuis des milliers d'années, mais nous avons maintenant la connaissance, et heureusement l'intelligence d'arrêter ce modèle historique. Une conception s'est développée dans la société occidentale que si quelque chose paraissait « bien », cela devait dans tous les cas être écologiquement supérieur et meilleur pour la biodiversité que quelque chose qui était visuellement indésirable. Il existe aussi un concept, qui fait appel également à notre sensibilité, d'« équilibre de la nature », que la nature est à la recherche et a besoin d'un état en équilibre, et qu'un changement dans cet état est une mauvaise chose. La perturbation d'un écosystème et le changement sont perçus comme des menaces pour la survie de la nature et la biodiversité. Il n'existe aucune preuve que de telles généralités soient véridiques, et beaucoup de preuves qu'elles ne le sont pas. La beauté est dans l'œil du spectateur. Ce qui peut être estimé comme étant « beau », durable et d'une saine gestion par un écologiste ou un expert en biodiversité, peut être laid, au moins pour une période de temps, pour le citoyen moyen. Ce qui peut être beau pour une personne de la rue peut ne pas être durable au niveau des valeurs proprement écologiques et sociales qu'elle désire pour les enfants de ses enfants. D'un autre côté, il existe plusieurs exemples pour lesquels les images visuelles constituent effectivement une évaluation précise des conditions écologiques et de la durabilité. Le défi réside dans l'identification du moment où nos « réactions viscérales » à des images visuelles représente une base fiable pour entreprendre des changements au niveau de nos relations avec les ressources et l'environnement, et quand ce n'est pas le cas. Le message fondamental est que nous devrions laisser la connaissance de la diversité écologique et biologique des forêts, ainsi que les valeurs qui y sont associées que nous voulons maintenir, jouer un rôle important pour décider comment les différents types de forêts mondiales devraient être aménagés. Nous ne devons pas permettre aux dogmes, à la mythologie, et aux idées non éprouvées ou réfutées de nous empêcher d'atteindre nos objectifs de biodiversité et de durabilité. Nous ne devons pas appliquer n'importe quelle politique forestière ou mode d'aménagement où que ce soit, et nous devons atteindre un équilibre entre les principales considérations esthétiques et l'écologie des valeurs que nous voulons maintenir.

Mots-clés: durabilité, biodiversité, éthique, esthétique, révolution écologique, respect de la nature



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... A thing is right when it tends to preserve the integrity, stability, and beauty of the biotic community. It is wrong when it tends otherwise.

... Conservation is paved with good intentions which prove to be futile, or even dangerous, because they are devoid of critical understanding either of the land, or of economic land use.

Aldo Leopold (1953)

Introduction

In common with many other animals, humans are a highly visual species. While we lack the acuity of many species of bird, we depend less on our senses of hearing and smell and more on our sight as compared with many other mammals. This above-average visual sense may reflect our evolution from tree-dwelling primates, but whatever the explanation, it results in a vitally important role of visual information in our lives. Our initial stages of mate, car and house selection, and much of our material purchasing activities (e.g., clothes, art, appliances) are based largely on visual stimuli. We also make profound judgements about the condition and desirability of our environment on the basis of visual impressions.

Humans are an emotional species. We seem to make many of the important decisions in life based on our heart rather than our head. The judgement and choices we make are largely the combined result of the sensory information we receive and our emotional responses to this information. One emotion that appears to be common to many people is a general dislike of change in our environment. We become emotionally attached to the environment we grow up with, and regret the loss of the familiar when change occurs.

As a species that is highly visual and dislikes change, many people judge visible environmental change as undesirable and even bad. If the change also looks bad, we tend to judge it even more negatively. The larger, the more dramatic, and the less aesthetic the change in the environment, the more people tend to assume that the environment has been damaged. Change over small spatial scales which produce modest alternations to the aesthetics are widely assumed to be more "environmentally-friendly" (i.e., good) than spatially and aesthetically larger changes.

Forest environments are always changing under the influence of local ecosystem and landscape processes. Change is initiated by human or non-human-induced disturbance – the former is assumed by many to be bad, while the latter may be considered good or bad. Change continues post-disturbance as a result of ecological processes that act to return the ecosystem to its pre-disturbance condition, or to some final "stable" condition that is then perpetuated (or so the theory goes) until it is again disturbed. This condition is referred to as the ecosystem "climax" condition, and in some types of forest may represent the culmination of ecosystem development.

Perhaps because the ecosystem seems to "want" to return to its climax condition (ecological processes often lead the ecosystem towards it), disturbance that interrupts this development is widely viewed as "bad." This philosophy holds that the "best," the "highest," and the "ethically correct" condition for a forest ecosystem is the mature or climax condition; that young, "juvenile" or immature ecosystems are somehow less desirable and merely an unwelcome stage that has to be passed through as quickly as possible on the way back to the "correct" ecosystem condition: "old growth" or climax.

Another belief system about forests is that "ecosystem integrity," "ecosystem health" and "biodiversity" reach their zenith in very old forests, and that this advanced ecosystem stage is, therefore, biologically richer, more robust and more resilient than younger stages.

The sum of these notions leads to three key ideas: that 1) disturbance in forest ecosystems, especially human-caused disturbance, is bad; 2) biodiversity is greatest in the least disturbed forests, and 3) we can judge the "goodness" or "badness" of ecosystem conditions based solely on visual information. None of these ideas is supported as generalizations by our current scientific knowledge of how forest ecosystems function. Their implementation as the foundation for policy and practice in forestry in ecologically diverse landscapes would be as unsuccessful in achieving conservation, sustainability and biodiversity goals as the application of any other single management paradigm or philosophy in such variable environments.

In this paper I will examine the question "Are sustainable forest landscapes always beautiful? Are beautiful forest landscapes always sustainable? Can we evaluate biodiversity and sustainability issues based on visual information alone?" I will start with a brief review of "biodiversity" and "sustainability." I will not attempt to define "beauty" as this is a highly individual, value-based judgement.

Biodiversity

Possibly the single most emotive and influential term in the current debate over forest management, "biodiversity" is also one of the most complex and poorly defined. Biodiversity, the diversity of all aspects of life and biological communities, can be measured many different ways:

1. Genetic: the diversity of genotypes within a species in the area of interest.
2. Species: the number of species in the area of interest (species richness), and the relative abundance (e.g., common, average, or rare) of the different species in the area (species evenness).
3. Taxonomic: the number of genera, families and higher taxa.
4. Structural: the diversity in the vertical structure (e.g., the number of different canopy layers (trees of different heights) and understory layers (e.g., shrubs, herbs, mosses)) of the plant community, and the horizontal diversity (the spatial patchiness) in structure. The diversity of plants and animals of different life forms (e.g., trees, shrubs, herbs, mosses, evergreen deciduous plants; herbivores, carnivores and detritivore animals).
5. Functional: the diversity of different functional groups (ecological guilds) in the area (e.g., shade-tolerant or shade-intolerant plants; fast growing and slow growing plants; plants that are nutrient-demanding or tolerant of low nutrient availability; seed feeding or leaf feeding herbivores; fungal feeding or bacterial feeding soil animals.)

6. Temporal: the degree of change over time in all the other measures.

These measures can be assessed over small areas (stands: 1–100 ha) – alpha diversity; local landscapes (100–10 000 ha) – beta diversity; and regional landscapes (perhaps >10 000 ha depending on the area concerned) – gamma diversity. Alpha diversity is the variation in measures 1 to 5 in local stands. Beta diversity is the variation in these measures between local stands that vary in soil characteristics and disturbance history; it usually refers to diversity within a single climatic area. Gamma diversity is the variation in both alpha and beta diversity measures 1 to 5 over areas large enough to include more than one climatic area and, consequently, more than one ecological zone.

Temporal diversity tends to be high at the alpha spatial scale (because of disturbance and successional recovery), moderate to high at the beta scale (again, because of disturbance and recovery, but it may also be a fairly constant shifting mosaic of ecosystem conditions), and moderate to insignificant at the gamma scale (generally a shifting mosaic of rather constant overall character). The actual level of temporal diversity will depend on the severity, frequency and spatial extent and pattern of disturbance (“natural” or human-caused, both of which should be considered as natural). Temporal diversity at the beta scale is greatest when there is the widest range of age classes of stands in the forest.

Considering the diversity of measures of biodiversity, and the almost ubiquitous occurrence of ecosystem disturbance and the associated temporal diversity, admonitions to “protect biodiversity” and “conserve biodiversity” are, at best, ambiguous, and at worst, unattainable. Maintaining any one of the alpha measures 1 to 5 without change may prevent natural temporal diversity. But, in many forest ecosystems, maintenance of ecosystem function and species diversity requires the temporal diversity that results from disturbance and the processes of ecosystem development. For example, in many Canadian forests, deciduous hardwood tree species, which are so important for the long term maintenance of soil fertility, site productivity, wildlife habitat and various measures of alpha diversity, require periodic ecosystem disturbance because they are disturbance-dependent, early seral, shade-intolerant plants. Variation over time in most alpha and many beta measures of biological diversity are necessary for the long term maintenance of these and other diversity measures. However, maintaining temporal diversity will result in changes in measures 1 to 5. Policies designed to “conserve” biodiversity must, therefore, be based on explicit and specific goals with respect to the various measures of diversity at the three spatial scales, and must sustain historical patterns of temporal diversity if historical ranges in other biodiversity measures are to be sustained at any of these spatial scales.

Sustainability

If we were to accept that in the absence of human activity forest ecosystems are stable, equilibrium systems, the definition of sustainability would be easy. It would be the absence of significant change. Sustainable forest management would involve only those activities that result in minimum ecosystem disturbance and change, and which maintain the ecosystem in a climax or old growth-like condition. Most measures of biodiversity would remain relatively constant, and temporal diversity

would be minimized. However, that is not the natural ecological character of most forests, and this invalidates the idea of constancy as the basis for the definition of sustainability.

Given the well-documented role of periodic disturbance in sustaining ecosystem function and diversity, sustainability must be defined as a *non-declining pattern of change*. Such a pattern, and thus sustainability, cannot be described or defined in terms of any one of: 1) the degree and spatial scale of disturbance (e.g., pictures of recently clearcut areas); 2) the frequency of disturbance (e.g., the rotation length or frequency of harvest in even-age forest management, the frequency of partial harvesting in uneven age forest, or the frequency of fire, insect epidemics or landslides); or 3) the resilience of the ecosystem (the rate of the ecological processes that return the ecosystem towards its pre-disturbance condition). It is the combination of these three variables that defines non-declining patterns of change. This combination is captured in the concept of “ecological rotations” – *the time taken for an ecosystem of a particular resilience to recover from a particular disturbance back to pre-disturbance condition, or to some desired new condition*.

Ecological rotations in a particular ecosystem can range from short in the case of partial timber harvests or low intensity “natural” disturbance, to medium or long in the case of clearcutting, landslides, or stand replacing fire, insect, wind or disease events. The specific combination of disturbance severity and disturbance frequency chosen to produce an ecological rotation in forest management will depend upon the degree of ecosystem disturbance required to achieve specific biodiversity, ecosystem structure and ecosystem function goals. Where these goals require less disturbance, the frequency can be higher (shorter rotations) and vice versa. Where management objectives call for frequent entry partial harvesting, disturbance at each harvest entry must be limited, but this may not provide the level of disturbance required by the ecology of certain desired species. The disturbance required to sustain these species may require infrequent harvest entries.

The desired frequency of timber harvests is generally influenced by economic, social and other non-ecological/environmental consideration. However, if the forester wishes to define frequency of disturbance in this way, his/her choice of severity and scale of disturbance must be constrained to that defined by the ecological rotation, if sustainability is a goal. Similarly, if foresters wish to apply a particular severity and scale of disturbance for silvicultural, wildlife habitat or other reasons, then their choice of frequency of disturbance will be constrained.

Recent applications of the concept of ecological rotations can be seen in the concept of “variable retention logging” (VRL). In this system, the degree of ecosystem change caused by timber harvesting is moderated by the retention of patches of snags, younger trees and/or mature trees within a cut block. This is done to sustain mature forest structural attributes in a stand that is being logged at a frequency that is too short for these structural features to be renewed by processes occurring within the rotation period. VRL allows for the maintenance of ecological features of both younger and older ecosystem stages within a single stand, and a balance of economic and environmental objectives on the same area. It is a way of achieving an ecological rotation in a reduced period of time, but care must be taken, by the use of ecosystem management simula-

tion models, that other aspects of sustainability are addressed in a system that is focused on stand structural attributes.

Beauty and the Beast

Ecosystem disturbance is both natural and, in many forests, necessary to sustain historical ranges of ecosystem productivity and biological diversity. Depending on the aesthetic preferences of the observer, the immediate results are not always beautiful. Wildfire, landslides, insects, diseases, wind and logging can all diminish the aesthetic values of a stand or a landscape for periods varying from years to many decades. However, unless the disturbance frequency is substantially shorter than the ecological rotation, aesthetic qualities are restored as the forest regrows and the ecosystem returns towards pre-disturbance conditions. Like the "ugly duckling," or the allegorical story of "Beauty and the Beast," initial ugliness may hide, or give way to, beauty. Conversely, beauty may be "skin deep"; superficial "beauty" may hide, or give way to, something less desirable.

Many types of forest harvesting diminish the aesthetic quality of a stand or a landscape for a while, only to give way in time to a visually attractive younger forest or a new and different landscape mosaic. Accompanying the aesthetic changes will be changes in various measures of biological diversity and ecosystem productivity. In some cases, these measures will be increased by disturbance even though the aesthetic quality has declined. In other cases, declines in aesthetic values will be accompanied by declines in certain functional and diversity values. As the aesthetic quality recovers, there will be changes in functional and diversity characteristics, but there will not be any simple, predictable relationships between the visual recovery and the changes in these characteristics.

Perhaps the classic case of the aesthetic "beast" turning into beauty is clearcutting. Arguably the most aesthetically displeasing and most publicly disliked of the silvicultural systems, clearcutting can, and frequently does, result in beautiful second growth forests. This is especially true if natural regeneration, topographic diversity, longer rotations, variable retention logging and stand management activities combine to promote in the younger stands the visually pleasing structures and species diversity normally associated with older stands. In contrast, partial harvesting without adequate disturbance can, in some forest types, promote a forest that is maladapted to the climate, has a high incidence of parasites and diseases, and has reduced levels of some measures of biodiversity. Immediately following harvest the aesthetics of a particular partial harvesting area may be far preferable to that of clearcutting, but after several or many decades the aesthetic status of the two types of logging can reverse.

Aesthetics, Sustainability and Biodiversity

There is little doubt that in the case of the most extreme ecosystem disturbance (e.g., landslides that remove the soil mantle and leave only hard, unweathered rock or compacted subsoil), visual evaluations provide a reliable basis for predicting impacts on ecosystem productivity and measures of biodiversity. Similarly, very extensive and severe wildfires, or very large clearcuts that are subsequently burned but not planted, will recover very slowly because of slow natural processes of regeneration. Again, the visual information can provide an acceptably reliable evaluation. In less extreme cases, useful relation-

ships between visual information and ecosystem sustainability are generally not available. Without understanding ecosystem resilience (which cannot be easily judged by the visual clues available to the average person) and the anticipated frequency of future disturbance, simple post-disturbance visual observations provide no basis for sustainability evaluation.

The visual quality of a forest is an important value for most people. Consequently, foresters should not ignore aesthetics simply because it is not well correlated to ecosystem "health," "integrity," "sustainability," or to measures of biodiversity. Managing a forest to provide recreation and spiritual values and to maintain the visual quality of the environment for people is one of the responsibilities of a forester. However, one must ask, "should foresters threaten the future sustainability and biodiversity of a forest in order to satisfy the aesthetic preferences of the present generation?" Would this be aesthetic self-indulgence on our part? Or should we balance our visual preferences against our "intergenerational equity" obligations to pass on to future generations the biological diversity and ecosystem functions we think they will want?

There is no simple answer to this question; it will vary in different countries and societies that have different aesthetic preferences, in different types of ecosystem, and between different geographical locations for any particular type of ecosystem within a particular country. However, in seeking an ethical answer to this question, we must respect nature for what it is, and not what we might wish it to be. We must respect the role of both disturbance and ecosystem processes in defining the ecological characteristics of forests, which in turn determine sustainability, biodiversity and ecosystem "beauty."

The "Beast" in Forestry

The "Beast" in forestry is not reliably related to aesthetic preferences of people. While "ugliness" in ecosystems is sometimes usefully related to ecosystem characteristics, in most cases it is not. This is because "beauty" and "ugliness" are not absolute values; they depend on the preferences of individual observers. It is also because there are few reliable relationships between aesthetic values and measures of environmental condition and function. The "Beast" in the past has between unregulated exploitation or "administrative forestry" where this has ignored ecological diversity and impaired ecosystem function. It has failed to respect "nature." This "Beast" is steadily being tamed, although it still raises its "ugly" head in some parts of the world. However, there is a new "Beast" to be dealt with. It travels under the guise of "beauty." It is forestry that is designed to satisfy our visual preferences but which ignores the ecology of sustainability and diversity – forestry that denies the ecological role of frequencies, severities and scales of disturbance that are in balance with ecosystem resiliences and are necessary if we are to be successful in passing on desired forest values to future generations.

I am not referring here to intensively managed, even-aged, monoculture plantations managed on short rotations. These wood fibre production systems are a vital part of human activity supplying both desirable and necessary wood products and certain non-wood forest products, values and services to society. Such plantations, when managed sustainably, help take the pressure off unmanaged native forests and are a vital component of any conservation strategy. However, they often lack the aesthetic qualities of a more "natural" forest, although in some

cases (e.g., fire-origin boreal pine forests), such plantations closely approximate "natural" stands, and, therefore, do have "natural" aesthetic qualities. My comments refer more to the management of native forests, especially those that are being put under management for the first time.

The emerging "Beast" in forestry is thus the mirror image of the earlier "Beast" which ignored ecological diversity and ecosystem function, and frequently applied excessive combinations of disturbance severity, scale, and frequency that were inconsistent with the maintenance of desired values. The new "Beast" is making exactly the same mistake, but at the other extreme of the disturbance spectrum: too little disturbance rather than too much, which was often the problem in the past. Both "Beasts" must be tamed and replaced by a respect for ecological diversity and the variable role of disturbance in different forest ecosystems. Variable retention logging to represent a spectrum of severities of disturbance (which approximates the application of the full range of silvicultural systems, modified to sustain a wider range of values than was the case in the past), variable rotation lengths, and variation in the size of disturbance patches are necessary to ensure that forests are managed under ecological rotations to maintain non-declining patterns of change in stand conditions, and a non-declining shifting mosaic of disturbance patches of different sizes and ecological conditions across the landscape.

Developing a Land Ethic: Respect for Nature

With the world population reaching six billion in the summer of 1999 (a six-times increase since 1800, and a doubling since 1960), with a possible future population growth to somewhere between nine billion and 15 billion over the next century or two, and with about 40% of the world's forest cover having been reported as lost, there is a critical need to develop a more sustainable relationship between humans and the other species with which we share the planet.

In developing this theme in his essay **The Land Ethic**, Aldo Leopold stressed the importance of sustaining the "integrity" and "stability" of the biotic community. His writing, including **The Sand County Almanac**, has provided the philosophical foundation for much of the modern conservation and environmental movements. Leopold's concerns, including the often-quoted phrase "the first rule of intelligent tinkering is to keep all the parts," clearly refers to the landscape rather than the stand level. After all, nature is continually replacing many of the parts at the stand level (alpha temporal diversity). Implicitly, his reference to the biotic community was intended to embrace the concept of ecosystem, in which change is part of integrity and stability. Unfortunately, in the first quotation from **The Land Ethic** at the start of this paper, he links the "beauty of the biotic community" to the "integrity and stability" of that community. This has been misinterpreted by many to imply that change and "ugliness" in the biotic community are inconsistent with "integrity and stability." This does not appear to be what Leopold intended, and the second quotation from **The Land Ethic** clearly shows his concern that the common misunderstanding of these issues can render well-intentioned conservation efforts ineffective or even counter-productive. While the first of these quotations appears commonly in the conservation and environmental debate, the second rarely does. This has contributed to the misunderstanding of the relationship between visual and aesthetic evaluations of ecosys-

tems and their ecological condition. It has contributed to the aesthetic evaluation of the environment rather than an analytical, ecological analysis.

The foundation for a land ethic must be respect for nature. There are two broad meanings of the term respect:

- to esteem, revere, honour, to treat with deference;
- to notice with attention, to take due account of.

The first of these sets of meanings implies a qualitative, spiritual and value-based approach to the object of respect. It is closely linked to the ideas of equilibrium, and lack of disturbance and change. It is often associated with aesthetics and visual evaluation. This aspect of respect plays an important role in establishing the values and ecosystem condition and services we want sustained in our forests. It relates to the setting of land use policy and objectives of management, in which aesthetic values play an important role.

The second set of meanings implies a quantitative, analytical and scientific approach to respect. It is linked to careful observations of ecological and biological diversity, of ecosystem structures and processes and of the role of disturbance and ecosystem recovery as "natural" processes involved in, and necessary for, sustaining a variety of desired forest values and conditions. This interpretation of respect is the necessary foundation for the design of forest management strategies and practices that will ensure that we respect nature in the sense of the first definition.

Respect for nature defined in this way is clearly consistent with Leopold's writing. His ideas do not, as is sometimes inferred, relate only to the first definition of respect; they apply to both.

Conclusions

We owe it to our great grandchildren to pass to them a world in better condition than was inherited by our generation. At the same time we have to satisfy the needs and, where possible, the desires of the present generation. As a society we must learn to act more ethically: to do the right thing.

Unfortunately ethical behaviour in forestry cannot simply be defined in terms of present conditions. "Doing the right thing" involves a consideration of short, medium and long term consequences of our actions. This means that both the short-term aesthetic qualities and the long-term ecological consequences of management decisions should be considered. Because of the lack of consistent relationships between visual qualities and the ecology of forest stands and landscapes, short-term visual characteristics cannot be the basis for forecasting the medium and long-term consequences, despite their importance as a short-term forest value. "Beautiful" stands and landscapes are not necessarily sustainable. Sustainable stands and landscapes are not always "beautiful" all the time. Small-scale disturbance is not always what is needed to maintain desired levels of biodiversity and future ecosystem productivity.

Sustainable forest management must be founded on a respect for nature as it is, not as we might want it to be. Respect for nature requires a clear separation between "beauty" and the sustainability of the diversity of values we wish to leave as a legacy for the future.

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