Close-to-nature silviculture: is this concept compatible with species diversity?

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Summary

The concept of close to nature silviculture is an old one. It was developed by K. Gayer at the end of the last century, and has been applied for more than a hundred years, for example in Switzerland and Slovenia, mostly with success.

There are different ways to characterize such silviculture, depending on the relative emphasis which is given to 'culture' and 'nature'. In the past there have been different interpretations. Leibundgut adopts a liberal interpretation, which he relates to primeval forests, whereby he accepts the use of all forms of regeneration, including regeneration on large areas. On the other hand, Möller gives a more strict interpretation based on successional processes.

Nowadays the concept needs to be extended to include the importance of favouring diversity of forest biotopes and the potential for using natural processes for economic reasons. It is necessary to utilize a great diversity of silvicultural techniques, following Leibundgut's principle of 'free choice of fellings' (Leibundgut, 1949).

The importance of new demands on silviculture

Since the Rio Earth Summit in 1992, many basic concerns have been changing our approach towards nature. In order to understand this profound change in our perception of environmental problems, a new paradigm is being gradually developed. Forests represent a major component of the earth's range of ecosystems, and, at least in functional terms, retain the characteristics of such systems. The pressure on forestry to counteract the destruction of nature is therefore very high. We become more and more aware of the fact that nature can not be exploited beyond a certain limit. Furthermore, these problems have to be considered on a large scale, going beyond state boundaries.

This is not a new problem. The limits of development have been postulated since the sixties. I would like to recall the commitment of the Club of Rome to drawing attention to environmental issues in the well-known book by Meadows *et al.* (1972) *The Limits to Growth*.

The same applies to the concept of close-to-nature silviculture. This concept was developed at the end of the last century, at a time when new paradigms were emerging, under the influence of the Physiocrats and their motto 'Return to nature'. The concept of close-to-nature silviculture was first formulated by Karl Gayer, professor of silviculture at the forestry faculty of Munich in 1880, and especially in 1886 through his seminal book *The Mixed Forest*.

Experience from more than a century of close-to-nature silviculture in Switzerland

We have been applying Gayer's silvicultural philosophy in Switzerland continuously for more than a century. In applying this philosophy, improvements have been made at a practical level. Much knowledge is derived from practical experience. Some ideas have been proved to be right. Others were wrong or have at least been more difficult to realize.

It is important that silviculturists, in their enthusiasm for the concept of naturalness do not simply emphasize success, but also look critically at the more difficult points, because much can be learned from previous mistakes. Failures which have been almost forgotten can thereby be avoided in future. It is, therefore, necessary to be adequately critical and to dig out failures from previous experience. This is not very easy, as the brain tends to dismiss failures and to retain only success. Also, in silviculture, due to the slow development of forests, failures tend to disappear from our memories, as well as from written sources.

If we look closely at the experiences drawn from the past century of application, we realize that insufficient progress has been made towards the following original goals:

1 establishment of mixed stands,
2 promotion of stand irregularity.

The tendency of natural succession to result in single-species stands

Where the first of the above points is concerned, Burschel (1987) has made a critical appraisal of failures over the last century in Bavaria, where Gayer worked and disseminated his ideas. The main reason for this is that mixtures of tree species complicate stand evolution, and mixed stands need more silvicultural interventions to ensure the survival of less competitive tree species. If these interventions are not undertaken, nature develops towards domination by only a very few competitive species, and forms relatively unmixed forests. The study of natural European forests shows that a very small number of tree species dominate, and results in the creation of mainly uniform stand structures.

These two characteristics, of simplification of structure and species composition, occur more under good site conditions that under harsh ones. This fact becomes evident if we observe natural forests. In fact, European virgin forests are mostly monospecific, being dominated by single species such as beech or oak. Associated species are generally suppressed because of their lack of competitiveness. (It is noteworthy that this model works for European conditions, but not for the conditions of North America.) Only where site and climatic conditions deteriorate do we find naturally mixed forests. With decreasing precipitation, for instance, oak successively replaces beech. Beech–fir–spruce mixed forests appear with decreasing temperature, i.e. in the montane elevation belt.

The tendency of natural succession to result in structural regularity

The same principle can be observed with regard to stand irregularity. Virgin forests generally show regular structures, at least during an essential part of their development. From the phase of 'aggradation' to the end of the 'optimal' phase, homogenization (i.e. creation of regular stands) can be observed as a dominating principle. Only in the 'regenerative' phase, when stands become disrupted in senescence, can a tendency towards mixtures be found.

In this case also, evolution of the stand depends on site and growth conditions. One of the best examples of the dependence of stand structure on site conditions is the difference of structure of natural spruce forests at various elevations (Korpel, 1982, 1995). This forest formation occurs naturally in the Alps at montane and subalpine elevations, i.e. at an elevation of 1100 m above sea level, in moderately continental climatic conditions. Natural spruce forests in the Alps are generally very dense, fully closed, and regular in structure during an important part of their development cycle. The reason for this lies

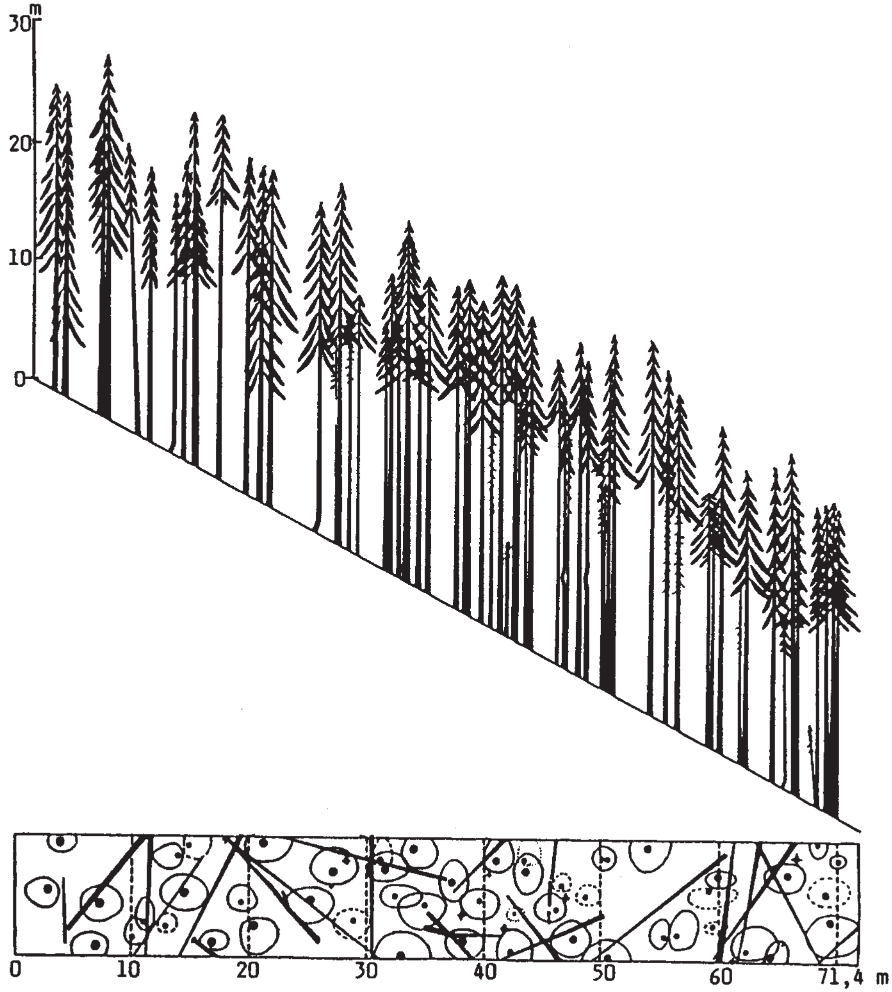

Figure 1. Example of regularity of stand structure of natural spruce forests in European high mountainous conditions at montane level (after Korpel, 1995). Forest of Kotlov žab; western Tatras, Slovakia; elevation: montane.

in the extraordinary adaptivity of this species with regard to light conditions (tolerating both full light as well as shade) and its very good utilization of space (see Figure 1). This tendency to create regular closed structures is true only below certain elevational limits.

At subalpine elevations, i.e. above 1400–1500 m elevation, spruce forests show irregular structures. The reason for this lies in the frequency of snow damage and consequent interruption of stand closure on a small scale (see Figure 2).

The difficulties of creating long-term irregularity in forests

The second goal which has not been reached in Switzerland, in spite of a strong desire to do so and the efforts of foresters for more than half a century, was to create irregular stands everywhere. This is true as a general rule, and especially for medium-elevation forests on natural beech sites.

This assertion may come as a surprise because

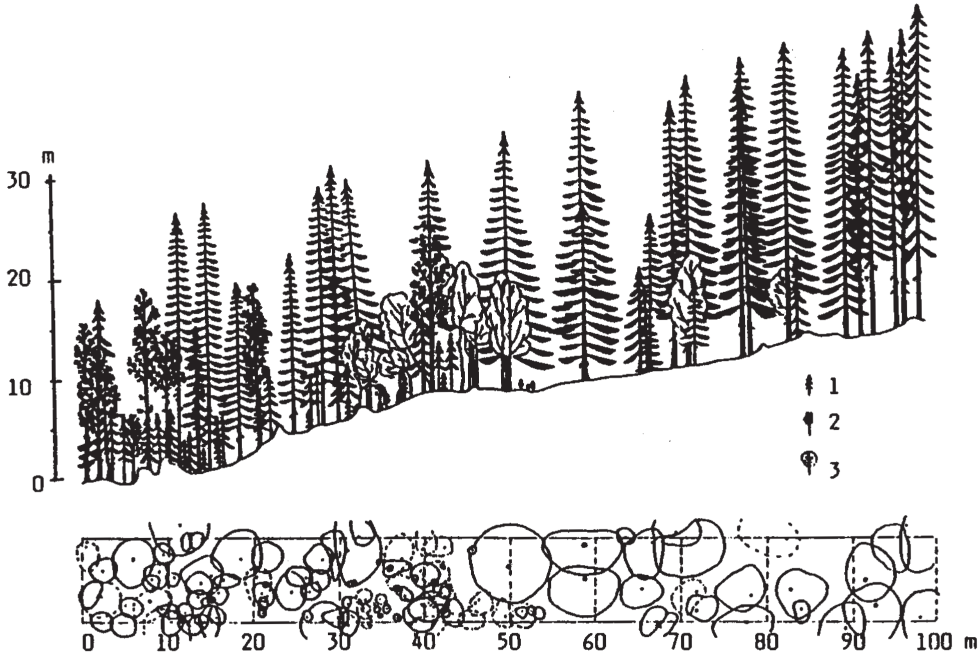

Figure 2. Example of irregularity of structure of subalpine spruce forests (after Korpel, 1995).Virgin forest area Nefcerka, Slovakia, elevation 1500–1550 m; subalpine belt.

Switzerland is a country which is well known for its use of an uneven-aged forest system, the so-called selection system or plentering. This silvicultural concept was formalized as a full and very original silvicultural system by the Swiss forester Henry Biolley, a contemporary of Gayer at the end of the nineteenth century. Biolley's main publication on the selection system dates back to 1901. The system has been applied firmly and consistently ever since, in regions with a tradition of this special type of forest tending; very successfully, for instance, in the Canton of Neuchâtel and in the valley of Emmental (Canton of Bern).

As a matter of fact, the selection system could turn out to be one of the best tending systems for the future, with regard to the complexity of objectives and the economic difficulties of harvesting timber. This system gives a well-balanced result, based on biological rationalization or 'natural automation'.

To be realistic, it has to be said that according to the national inventory only 8 per cent of our forests are functionally irregular (i.e. with an irregular structure which remains constant in the long term). This fact has to be analysed with critical objectivity, although it must be agreed that the result of the survey is disappointing, considering the fact that Swiss foresters have tried to apply the selection system in a significant proportion of our forests, far exceeding the 8 per cent which has been achieved. In fact, for almost 50 years before World War II, Swiss foresters had tried to operate the selection system almost everywhere; even in forests of broadleaved trees and of light-demanding species. For the last two forest types, attempts to obtain permanent irregularity completely failed. The reason for this is that in sites where single-tree selection and natural regeneration are difficult and where natural stand evolution tends toward regularity, it is necessary to engage in very intensive and often repetitive silvicultural interventions to achieve these goals.

One of the consequences of the application of single-tree selection on a large scale over many decades in Switzerland was a lack of regeneration of some species, with only shade-demanding tree species being favoured; especially silver fir (*Abies* *alba* Mill.), which only conforms to site conditions in a few areas. This undue promotion of silver fir, together with the shade-tolerant beech, had very negative consequences, as silver fir has a predisposition to die-back after a succession of dry years. It is important to remember that the problem of forest decline began, in the fifties, with the decline of silver fir.

A second observation which we made in Switzerland in the fifties was the lack of young stands and of recruitment of pole-sized trees. These observations led Swiss foresters, and above all those responsible for silvicultural education, to appreciate that within a general concept which claims to be naturally-oriented, a system is needed which leaves space for single-tree regeneration, as well as for extensive regeneration according to the particular characteristics of the different tree species. We are not speaking of a return to the clear-cut philosophy, but of a system which includes extensive regeneration in extended gaps, to ensure the growth of light-demanding species and thus promote optimal mixtures.

This was the reason why Schädelin (1928) and after him Leibundgut (1946) included both the selection system and the irregular shelterwood (femel) system within the compass of close-to-nature silviculture. The main characteristic of such silviculture is to use all the modes of regeneration to be found in natural forests, depending on the type of shading given by the older trees, to ensure natural renewal. This definition of the term 'nature' in the close-to-nature concept is based on the fact that in natural forests we generally find all modes of regeneration. However it is necessary to emphasize the fact that the normal renewal pattern in virgin forests is predominantly based on regeneration under shelter, in long-lasting and overlapping periods between mother and sister generations (Korpel, 1995). Individual or single-tree regeneration in the manner of the selection system is very unusual, or almost non-existent, in for instance natural beech forests (Reh, 1993).

The selection system is, therefore, a typical man-made system, which can only function as long as periodic interventions correct the tendency towards stand closure. However, it has a high degree of self-regulation and self-regeneration once it has been established. The great difficulty lies in creating the starting prerequisite: sufficient irregularity. As a natural quasi self-functioning system, the selection system is one of the best systems for close-to-nature silviculture, but it is not very easy to achieve in practice.

Characteristics and merits of the liberal definition of Swiss to close-to-nature silviculture

Swiss forestry has developed a relatively liberal and pragmatic way of considering naturalness in silviculture, with the emphasis on 'culture' rather than 'nature'. It is based on a combined use of different silvicultural techniques. It is not a rigid silvicultural system, but rather a collection of objectives to be reached; in terms of tree-species composition, stand structures, and fulfilment of different objectives. The different forms of felling and regeneration are included in the palette of relevant silvicultural methods. To characterize such a polyvalent view of silviculture, Leibundgut developed the principle of 'free choice of felling'. This principle appears to be remarkably modern, considering the new issues of biodiversity and aesthetics in forestry.

The concept of close-to-nature silviculture is open to a variety of interpretations, which mainly depend on the emphasis given to the terms 'culture' and 'nature' and the values which we associate with these.

Depending on one's background and interests, there are today tendencies towards very different interpretations of the concept of what may justifiably be termed 'close-to-nature'. In addition to the liberal interpretation developed in Switzerland, there are other very strict ones, some of which emphasize only limited forest development processes.

Organizations involved in nature conservation tend to support a view which is based more on the term 'nature' than 'culture'. From their point of view, such a policy seems logical, in defending this area of interest. Positions of such extremity cannot be accepted, as they ignore the interests and needs of others. They tend to believe that only untouched nature and only protected forests meet the needs of species conservation and are, therefore, necessary for the maintenance of biodiversity. Such an argument is only valid if we compare extreme systems, for instance artificial forestry with virgin forest. Numerous scientific results show that multiple-use forestry is not incompatible with nature conservation together with a high level of timber revenue, provided that certain rules of management are respected. On the contrary, some specialists predict that forests managed in a modern way, with emphasis on multifunctionality and the promotion of diversity (e.g. more dead timber) can have a more positive effect on biodiversity than leaving the forest untouched (Ammer *et al*., 1995).

The new European forestry: considering all objectives in combination

The need to promote biodiversity must now be incorporated into our silvicultural concepts. Forests include some of the best-developed structures in nature, and therefore characterize and encompass important habitats for fauna and flora. Our contribution to biodiversity lies mainly in producing an important diversity of biotopes, by creating different structures and using different forms of regeneration. Biodiversity in the forest requires monospecific biotopes as well as mixed forests; single-tree and extensive regeneration; dark forests as well as light ones. The principle of such silviculture can be called 'the principle of diversity by diversification' (Schütz, 1997).

The challenge for forestry and silviculture today lies in the fact that their objectives have changed considerably, and still continue to change radically. The reason for this is that not only do new areas of need emerge, but also new interest groups. General requirements for social amenities or objectives are becoming more important than particular interests. Tomorrow there may be global concerns for the preservation of life conditions on the planet. This phenomenon leads to conflicts of interests. In this sense, we fully agree with Ciancio and Nocentini (1995) that silviculture increasingly has to manage a complexity of issues and, as this complexity is made by mankind, close-to-nature systems have to incorporate the most disruptive participant: mankind. It seems evident that, in order to attain the goals of nature conservation, it is firstly necessary to convince mankind of the need to conform to the requirements of nature. The main problem of close-to-nature silviculture is a question of harmonious coexistence rather than the segregation of functions of putting nature in a glass case.

In the first instance, these conflicts of interests can lead to confrontation and even to polarization and controversy. Conflicts cannot be solved by ignoring the different interests in question or by entering into an ideological fight. This only leads to unproductive philosophical dispute. We need an ideologically free way of finding solutions by bringing together the different points of view and looking for appropriate joint solutions (Scherzinger, 1996). Therefore, it is necessary to emphasize good solutions rather than fighting against poor ones. A close-to-nature concept which is only derived from a rejection of clear-cutting is not a good one.

To foresters practising single-tree selection based on the conviction that this is the only correct system, our advice, based on experience in Switzerland, is: beware of the risks of forgetting the need for recruitment and sustainable regeneration. It is good to fight against an excess of clear-cutting. However, it is important to develop methods for controlling the sustainability of stands, by controlling the requirements of recruitment. For light-demanding species, single-tree selection does not seem to be the appropriate way to ensure regeneration of appropriate species.

The challenge of silvicultural practice: reconciling economy and ecology

The challenge of today is to reconcile traditional objectives (for instance timber production) with new ones such as social requirements and the newly emerging obligation to ensure maintenance of forests as part of our heritage.

Where nature is concerned, it is necessary to achieve coexistence between naturalness on the one hand and the artificiality of today's world on the other. Our artificial way of living creates new needs and requires more of nature as compensation. It is also necessary to take into account the different conflicts in order to define the best way to resolve these. As needs are changing continuously, the principle of adaptation (i.e. to consider the possible changes of the forest's original functions and to ensure adaptability of forests which we establish) has to be given a high priority (Schütz, 1997).

One of the biggest barriers to finding a solution today is the increasing discrepancy between economic and ecological interests. We are confronted with both an economic crisis in timber production and the ecological crisis. It is necessary to reconcile these two poles and to find silvicultural systems which respect not only naturalness but also costs and productivity, because it is on the economic issues that the chances of success really depend. For this reason, we have to promote systems based on biological rationalization in preference to those based on mechanical criteria. In this context we mean 'selfing' systems; for instance, in forestry, using self-regulation and self-regeneration, which today is called 'natural automation'. This way of reconciling economy and ecology can be called the 'nature opportunistic' way in silviculture (Schütz, 1997). It is conceived not only as a matter of economic efficiency but also has ecological significance. Only more or less self-functioning systems have a chance of thriving in the long term.

Figure 3 illustrates the parameters which need to be considered in seeking new systems. All three dimensions need to be considered simultaneously, as the three dimensions are not necessarily convergent. Absolute naturalness is neither convergent with structure nor with the axis which is concerned with the necessity and costs of controlling development by silvicultural interventions. A realistic and opportunistic polyvalent silviculture will seek optimal ways for realizing the best combination on these three axes.

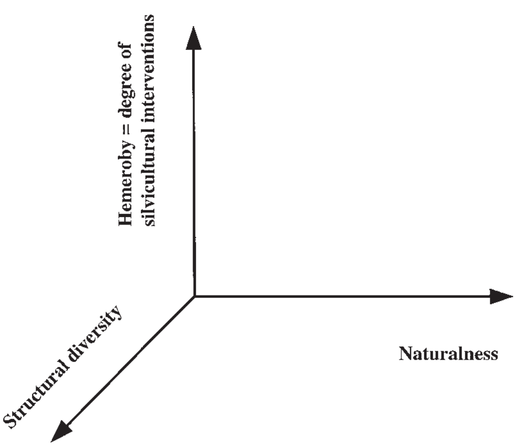

Figure 3. The three dimensions defining a real multifunctional (polyvalent) silviculture.

Conclusions

However, solutions do exist! The silvicultural concepts which we have been developing until now have been oriented towards the optimization of only one need; which is, usually, timber production. In the future, we will have to rethink our concepts and include genuine multifunctionality in the management of the different functions, not only on a large scale but also on the level of forest stands. This is valid for tending operations (i.e. thinning systems) as well as for regeneration systems. As far as tending operations are concerned, we have to discriminate between different elements within the stand. In one and the same stand, different trees can fulfil different objectives and thus be treated in different ways.

This is an important challenge which should encourage silviculturalists to go forward in a constructive and positive way.

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