EMERGENCE OF A BIODIVERSITY CONCEPT IN SWEDISH FOREST POLICY

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Abstract. Sweden's forest policy was fundamentally changed in 1993. Timber production and maintenance of biodiversity then became objectives of equal dignity. In the past, timber production had been the single primary aim of Swedish forest policy. The strategy established for maintaining biodiversity is based on a system of forest reserves and management of the matrix that mimics natural processes and builds in natural structures at the stand and, when applicable, the landscape level. One reason for not basing the strategy on reserves only is that almost all Swedish forests have been intensively managed and, as a consequence, there is a shortage of areas suitable for reserves. The new forest policy presupposes a consensus in the forestry sector of the importance of maintaining biodiversity. Training and information are as important as legislation. Maintenance of biodiversity is not an operative goal. This makes it difficult to predict the outcome of the policy and, consequently, there is a need for monitoring routines to enable changes to policy implementation. Such routines have yet to be developed.

Keywords. BIODIVERSITY, TIMBER PRODUCTION, FOREST HISTORY, FOREST POLICY, SWEDEN.

1. Introduction

Swedish forestry has been governed by production-oriented forest policies since the beginning of this century. Almost all forest land has, as a consequence, been used for production of saw-timber and pulp wood and the proportion of natural forests is only a few percentage points. This forest management has changed structures and functions in the forest ecosystems which has negatively affected a large number of organisms (Ahlén and Tjernberg, 1992; Ehnström et al., 1993). Exclusive of sub-alpine forests, about 0.5% of the productive (site productivity $\geq 1 \text{ m}^3 \text{ ha}^{-1} \text{ yr}^{-1}$) Swedish forest land is protected (Statistics Sweden, 1994).

These circumstances, increasing ecological awareness, popular environmental concern, pressure from non-governmental organisations, as well as the fact that Sweden has committed itself to maintaining biodiversity, have brought about a new Swedish forest policy, aiming at more than just timber production. The policy may be illustrated by the first paragraph of the recently adopted Forestry Act which states that 'The forest is a National resource. It shall be managed in such a way as to provide a sustainable yield and at the same time maintain biodiversity. In forest management other public interests should also be considered' (Swedish Forestry Act, 1993).

To fulfil the commitment to maintain biodiversity it is necessary to modify forest management (Liljelund et al., 1992). In this sense, it should be noted that the Swedish situation differs from that in other regions in the boreal biome. In Canada and Russia, there are vast forests in which natural processes operate unaffected by humans. In these countries, the natural forests play a key role in preserving biological diversity. In Sweden, on the other hand, a forest policy aiming at maintaining biodiversity must focus on the managed forests. Plant and animal diversity will be enhanced if the
frequency of natural structures and processes is increased in these forests (Franklin, 1992; Liljelund et al., 1992; Attiwill, 1994; Haila, 1994). However, the present array of species in Swedish forests cannot be maintained only by means of modified stand management. There are species that depend on processes and structures that cannot be preserved with the kind of disturbances that come with forestry for timber production (Ohlson, 1990; Esseen et al., 1992). For those species, reserves are probably the only alternative.

In this paper we describe the emergence of a new Swedish forest policy, focusing on the developments of the last year and the means by which the goals should be attained. To facilitate understanding of the motives for the Swedish line of action, we briefly relate parts of the Swedish forest history and what large scale landscape changes forestry has caused.

2. Swedish Forest History

Human impact on Swedish forests has differed between regions. The country may be divided into three regions each with its unique forest history (Figure 1). In the most densely populated southern fifth of the country, Götaland, a large proportion of the forests has been converted to arable land. By the middle of the 19th century the forested area was probably at its lowest level (National Atlas of Sweden, 1990). Because of intense grazing and neglect of regeneration after cutting, forests were fairly open. About one hundred years ago, reforestation, mainly by planting of Norway spruce (Picea abies (L.) Karst.) and Scots pine (Pinus sylvestris L.), successively increased the forested area (Juhlin Dannfelt, 1959). Absence of grazing by domestic animals combined with systematic silviculture has, over the years, created dense forests. The major part of Götaland is hemiboreal (Ahti et al., 1968) but the boreal and the temperate vegetation zones are also represented in the region. In Svealand, the region located north of Götaland and of about equal size, the iron industry required large quantities of wood and charcoal until the beginning of the present century (National Atlas of Sweden, 1990). Plots where charcoal was produced were evenly spread out in the forests and cutting for charcoal was, during some centuries, done in a purely exploitative manner. Cutting of timber for sawing as well as grazing contributed to keeping the standing volumes in the forests at relatively low levels (Nordquist, 1959). To ensure the supply of charcoal and other essential wood products, forest management based on the clear-felling system was introduced in the middle of the 19th century. Because of this forest history, most sites carry their second or even third rotation. Svealand is a transition region, including both the hemiboreal and the boreal vegetation zones. As in the rest of boreal Sweden, Norway spruce and Scots pine are the dominant tree species in this region comprising about 85% of the standing volume (SUAS, 1993).

The northern two-thirds of Sweden, called Norrland, has always been sparsely populated. Most people live along the coast and in the large river valleys. In this region, partial cutting to a diameter limit was introduced at the beginning of the 19th century (Östlund, 1993). Developing industrialism in Europe needed large quantities of timber and a logging frontier moved northwards during that period (Bunte et al., 1982).
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The forests were exploited for large diameter Scots pine timber which was abundant all over northern Sweden. Towards the end of the last century, Norway spruce and smaller trees also became valuable because of the developing pulp and paper industry. Until the 1940s, however, management was mainly carried out by means of selective cutting and the desired regeneration generally did not occur. The north Swedish forests therefore successively became more open and more spruce-dominated. For these supposedly well growing, but in reality low-producing forests, the expression 'green lies' was coined. During this exploitational period, standing volume in the five northernmost provinces of Sweden, which together make up Norrland, decreased by around 30-40% (Linder and Östlund, 1992).

In order to increase the future cutting level in Norrland, the state forestry launched a restoration program in which substantial resources were put into regenerating low-stocked sites (Höjer, 1954). Large clear-fellings that were thoroughly cleaned manually, mechanically, or by means of herbicides, were planted, sown or naturally regenerated. Also company and non-industrial private forestry abandoned selective cutting in favour of clear-felling. Since the clear-felling system was successively introduced on a broader scale in Norrland in the 1940s, around 40% of the productive forest land has been clear-felled and regenerated, primarily with Scots pine, with the aim of achieving pure even-aged stands. In about 1970, lodgepole pine (Pinus contorta Dougl. ex Loudon) was introduced on a large scale to Sweden from western Canada. In spring 1992, it was growing on around 540 000 ha predominantly in Norrland where the species covers 4% of the forest land (von Segebaden, 1992).

For Sweden as a whole, large scale impacts on the forests can be illustrated by different means. Consistent chronosequences of regeneration measures, growing stock, etc. are easily obtained from the Swedish Statistical Yearbook of Forestry which has been published since 1951 (NBF, 1951-1994). Soil scarification or prescribed burning

Fig. 1. Three major regions of Sweden with significantly different forest histories.
for forest regeneration was carried out on 4.8 Mha of the 23.6 Mha of productive forest land between 1951 and 1992. During the same period, 6.1 Mha have been artificially regenerated by planting or seeding and 10.6 Mha have been pre-commercially thinned. (When evaluating these data, it should be kept in mind that the Swedish rotation period is typically one hundred years, and that some areas are pre-commercially thinned two times or more.) Also, forest drainage has influenced Swedish forests. Of today's productive wetland forests, one fifth (i.e. 1.0 Mha) have been drained (Hånell, 1990). This type of ditching has consequently influenced 4% of the total Swedish productive forest land.

This somewhat simplified and very brief Swedish forest history illustrates the fact that nearly all forest land has been managed in one way or another for at least a century. Natural or semi-natural forests comprise small islands in a matrix of managed forests (Angelstam, 1992). Today, around 3.5% of the forested area is protected—mainly subalpine forests in the north-west. In 16 out of 18 provinces in the southern third of Sweden, the protected forest area is less than 1% (Kardell and Ekstrand, 1990).

3. Ownership, Forest Inventories, and Red Lists

Some 50% percent of productive Swedish forest land is non-industrial and privately owned. The proportion is higher in the south and decreases towards the north. Approximately 42% of the forest land is owned by companies, of which about one-half belongs to a joint stock company, with the state as the largest shareholder. The remaining 8% is under other public ownership categories. The mean area of non-industrial private wood lots is about 50 ha and a minority of the forest owners depend on the forests for their living. On a national level, however, the Swedish forest industry is of great economic importance generating the largest net export value. As in Finland and Norway, the Rights of Common Access allow people to freely enter any forest land for the purpose of enjoying natural amenities, without permission from the owner of the forest (Paulsson, 1978). It is possible to hike, make a fire, pick berries and mushrooms etc., as long as the forest owner is not caused any economic damage or other significant inconveniences.

The National Forest Inventory (NFI) has been carried out since 1923 to obtain comprehensive data on Swedish forests in order to monitor and forecast the forest resources at regional or national levels. Thus, it is an important component in establishing Swedish forest policy. By means of sample plots arranged in square clusters, the whole country is now covered every year. As forestry historically has emphasised timber production, the NFI has focused on data describing volume and yield of stem wood, soil conditions, ground vegetation and forest health (Ranneby et al., 1987; Söderberg, 1993). Since the first NFI, the estimated standing volume in Sweden has increased continuously from $1.8 \times 10^9$ m$^3$ in the 1920s to $2.8 \times 10^9$ m$^3$ in 1990. The estimated annual increment during 1988-1992 was about $1.0 \times 10^4$ m$^3$. This by far exceeds the estimated annual harvest of $0.64 \times 10^4$ m$^3$ during the same period (SUAS, 1993). Forecasts for long-term timber yield in the 1980s showed that it was possible to increase harvesting on a sustained yield basis, although a broader spectrum of forest products and functions were promoted (Bengtsson et al., 1989).
As a tool for the implementation of the forest policy of the time, the Swedish parliament decided in 1979 that the Forest Administration (the National Board of Forestry [NBF] and 24 County Forestry Boards) should carry out an inventory on all private, non-industrial forest land, the so called General Forest Inventory (GFI). It was supposed that efficiency of forest production would increase, with a general increase in forestry activities, if detailed knowledge was available on the condition of the non-industrial privately owned forests, and on the silvicultural measures needed to keep up the production in those forests (NBF, 1981). The inventory was done by aerial photograph interpretation complemented by field surveys. Areas with conservation values were noted, although not systematically (Eckerberg, 1990). The GFI included forest condition and suggested stand treatments. They were presented on forest maps and data bases describing compartments. Costs for the GFI increased however, and it was considered that the preparation of management plans resulting from the GFI would be the forest owners’ responsibility. In 1993, the parliament decided to stop the GFI. About 1.2 Mha (10%) of the non-industrial private land was therefore not covered (NBF, 1994).

For the forest ecosystem, as well as for other ecosystems occurring in Sweden, lists of threatened and care-demanding species are kept in a data base at the Swedish University of Agricultural Sciences (e.g., Ehnström et al., 1993). The lists follow the IUCN categories and are established as Red Lists by the National Environmental Protection Board. A recent analysis reveals that very old, dying and dead trees, features that are changed or lacking in Swedish forests (Esseen et al., 1992; Lämås and Fries, 1995), seem to be critical substrates for a large proportion of the forest species included in the Red Lists (Berg et al., 1994). Most of the Red Listed forest plants are cryptogams, while insects make up the majority of animals.

Nationwide inventories of forests with high nature conservation values and of wetland forests are now underway. The inventories were started in 1991 and 1992, respectively, and will be finished in 1997 (see below).

4. A New Swedish Forest Policy

Forestry legislation has several hundred years of tradition in Sweden. The first Forestry Act (FA) was passed in 1903 and was primarily a reforestation law. Environmental considerations were included in 1975. The FA adopted in 1979 explicitly stated certain measures to be taken when clear-felling in order to meet conservation and other public interests. The primary goal of forestry was, however, still to utilise the forest’s timber production capability to achieve a high and valuable yield in a sustainable manner (Swedish Forestry Act, 1979). For the first time the state-owned forests were also governed by the FA which until then had only concerned other public forests and private forests.

In 1990 the government started work on a new Swedish forest policy. A parliamentary committee was to evaluate the current forest policy and propose changes based on that evaluation and on forecasts within a broad field. In addition, the committee was instructed to include responsible stewardship in the new forest policy that would maintain biodiversity (SOU 1992:76, 1992).
An expert group analyzed different ways of maintaining biodiversity in Swedish forests. They estimated that the reserved proportion of 0.4% of the productive forest land, which are exclusively reserves in sub-alpine forests (Kardell and Ekstrand, 1990), needed to be increased to 15% if biodiversity was to be maintained (SOU 1992:76, 1992, and literature cited therein). However, because of previous management, there is a shortage of natural forests suitable for reserves, and the reserves would in any case, be isolated so that dispersal possibilities for organisms through "a hostile matrix" would be uncertain. The line of action suggested by the group, and which was accepted in 1993, was instead to reduce the proposed reserved proportion 'by more than half' and to modify management of the remaining forest land. Modifications should aim at mimicking natural processes and build in natural structures into the production forest, e.g., self-thinning, tree species mixture, and dead trees. The combination of reserves and modified forest management was, except for biological and ecological reasons, considered the most efficient solution. For example, state-owned forests that could be relatively easily reserved are mainly situated in northern Sweden. In addition, unreserved state-owned forests are managed mainly for timber production and are not suitable as reserves. Another alternative is a combination of reserves, intensively managed forests close to industries and a low intensity timber management matrix. As all forest land is accessible to people on the basis of the Rights of Common Access, intensively managed forests close to industries and, therefore also close to densely populated areas, were not found to be an appropriate alternative. Furthermore, timber production and nature conservation are not always mutually exclusive which means that from an economic viewpoint it would not be optimal to separate the two kinds of land use.

In 1993, the parliament adopted the new forest policy based on the proposal of the committee (1992/93:JoU15, 1993). Timber production and maintenance of biodiversity are now the main objectives with equal importance. As a part of the forest policy the FA was revised (Swedish Forestry Act, 1993). In the revised FA, silviculture is less regulated than in the former FA partly because of a general trend in Sweden towards less regulation and partly because fewer regulations are believed to cause more variation in the forests which in turn is believed to enhance biodiversity. Forestry is also governed by legislation other than the FA, e.g., by the Nature Conservancy Act (NCA) (NCA, 1964). This controls ditching and since January 1994 it has been possible to protect a defined set of biotopes (≤ 5 ha) of high conservation value, e.g., forests along gullies, post-fire successional forests, and natural and semi-natural old-growth forests of specific qualities, by means of the NCA (NCP, 1994).

Apart from different kinds of reserves and protected biotopes ≤ 5 ha, a complementary voluntary system was launched in January 1994, which gives the forest owner economic compensation for restrictions put on his rights to cut on sites with conservation value. Restrictions are agreed upon between the forest owner and the Forest Administration. In every case the aim of the agreement is that conservation values should be preserved, while economic sacrifice by the forest owner should be minimised. Although only tested on a small scale (about 60 cases in the whole country between January and December 1994) (G. Nordanstig, Swedish National Board of Forestry, pers. comm.), this kind of "nature conservation agreement" (Carlsson, 1994) seems to be promising from both a nature conservation and an economic point of view. A new system of subsidies to encourage the use of silvicultural treatments that enhance
biodiversity is also under development. If a forest owner uses prescribed burning to regenerate a site, he may be partly compensated for extra expenses in relation to costs of the normally used mechanical soil preparation. These subsidies have replaced earlier timber production oriented subsidies.

The inventories launched in 1991 of wetland forests (Rudqvist, 1991) and in 1992 of forests with high conservation values (Nitare and Norén, 1992) are important components in the new forest policy. The latter biotopes may be called "woodland key habitats", areas with features making them possible to host Red Listed species. To some extent, the woodland key habitats, and probably also some wetland forests, will receive protection. The wetland forest inventory is done by the Forestry Administration and covers all forest land, while woodland key habitats are inventoried only on non-industrial privately owned land. On land owned by forest companies and on public land, woodland key habitats will be inventoried by the owner, at the owner's expense. As of June 1994, 7500 woodland key habitats have been mapped on 2.2 Mha out of 11.5 Mha of non-industrial privately owned forest land. It should be noted, however, that these habitats may differ in size from a fraction of a hectare to several hectares (M. Norén, Swedish National Board of Forestry, pers. comm.).

Courses and information programmes directed towards forest owners, employees in forestry, and contractors, have over a long period of time been a part of the implementation of forest policy in Sweden. From 1989 to 1993, most contractors, almost all forest workers and about one quarter of forest owners, participated in short courses ("A Richer Forest") initiated by the NBF, and focused on forest ecology, nature conservation, and silviculture (G. Nordanstig, Swedish National Board of Forestry, pers. comm.). During the last few years, many employees of forest companies and the NBF have spent 10–20 weeks at university level courses concerning these new aspects of forest management.

The Forestry Administration has since the end of the 1980s undertaken a program to assess environmental considerations after final felling. Examples of considerations are to what extent single trees, groups of trees, border zones towards streams and other open areas are left uncut (NBF, 1991; Sandström, 1991). In a comparison between one follow-up in 1989/90 and one in 1992, the proportion of acceptable clear-cuts had increased from 66% to 88% (Sandström, 1994).

5. Concluding Remarks

Timber production has affected almost all Swedish forests. Accordingly, there is very little natural forest except in the sub-alpine area. In comparison with conditions prevailing before humans affected the forests on a large scale, processes and structures on different spatial levels have been heavily altered.

In the pre-industrial era, Swedish forests had multiple-use functions. In the industrial era, on the other hand, timber production has been the dominant use of the forests. This has been encouraged by a forest policy which until the end of the 1980s had been successful; in the sense that at present there is a potential for increased cuttings and the fears of timber scarcity once prevalent in parts of Sweden have been avoided (SOU 1978:6, 1978; SOU 1992:76, 1992). The estimated future non-declining
timber yield, however, depends on no severe restrictions being put on timber production or production not being affected by environmental degradation.

Increased knowledge of forest ecology, increased demand for environmentally friendly products, increased public environmental awareness, etc., has stimulated a search for strategies to maintain biodiversity. At the beginning of the 1990s the Swedish government started work on a new forest policy. The strategy that was established for maintaining biodiversity in Sweden is based on a system of forest reserves and a management of the matrix that mimics natural processes and builds in natural structures at the stand level, and, when applicable, at the landscape level. The strategy is determined by, among other things, the fact that almost all forests have been intensively managed, hence there is a shortage of natural forests suitable for reserves (Harris, 1984; Wilcove, 1989).

There are some reasons why all forests, and not only the state forests, should be subjected to modified management. Firstly, the state forests are mainly located in the northern interior parts of the country. If forestry was modified only on public land, the maintenance of biodiversity in the south and along the east coast would rely very much on reserves, of which there are very few in these parts of the country. Secondly, the state forests are to a large extent in fact privately owned in the form of a joint stock company. As the general public and institutions own as much as 49% of the shares, it could be argued that the state forest and private forests, in this meaning, should be treated similarly. Finally, the diversity among forest owners and the few restrictions on timber production practices, lead to diversity in goals of forestry and varying intensity in timber production among forest owners. Some people assume that this also promotes biodiversity. This, however, has not been established.

The new Swedish forest policy presupposes a consensus in the forestry sector of the importance of maintaining biodiversity. This is expressed in the way the policy is implemented, e.g., by courses for forest owners and forest workers instead of strict regulations. Concerning actual stand management, there are no environmental considerations explicitly stated in the FA regarding pre-commercial and commercial thinning operations. If, in the future, natural structures are to be achieved in old stands, tending of young and middle-aged stands must be done in a way that makes it possible for these structures to develop. According to today's legislation, necessary modification of the traditional management, during this phase, will be based on the land-owner's own initiative.

It has been recognised that planning at a landscape level is valuable in forest management where preservation of biodiversity is given priority (Hansson and Angelstam, 1991; Franklin, 1992; Oliver, 1992). This was acknowledged in the preparatory work for the forest policy, but not stated in written legislation. However, forest companies are now beginning to implement landscape plans on their holdings (e.g., Stora Skog, 1993). In regions with predominantly privately owned lands, it is assumed that co-ordinated achievements to preserve e.g., woodland key habitats extending across estate borders, should be done on a voluntary basis with guidance from the County Forestry Board (SUO 1992:76, 1992). So far, these kinds of agreements have not influenced nature conservation to any larger extent.

The goal to maintain biodiversity as stated in the Swedish forest policy is not operative meaning that it cannot be expressed in terms of, e.g., size of populations or areas of specific habitats. This makes it difficult to predict the outcome of the policy
and, consequently, there is a need for monitoring routines to enable changes to policy implementation. Such routines have yet to be developed.

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