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AN ECOSYSTEM APPROACH TO THE MANAGEMENT OF NORTHERN CONIFEROUS FORESTS

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Note by the Secretariat

INTRODUCTION

The present note is one of several background documents forming the basis for a broader review of the linkages between forests and biological diversity. At its second Conference of the Parties, the Convention on Biological Diversity decided to make a special contribution to the Intergovernmental Panel on Forests, (Decision II/9). In this statement the importance of biological diversity within forest ecosystems was stressed. Furthermore, the need for the development and implementation of sustainable forest management methods was considered to be one of the main priorities (paragraph 12). The decision also stated that ``sustainable forest management should take an ecosystem approach and aim at securing forest quality as related to the CBD, comprising such elements as forest composition, natural regeneration, patterns of ecosystem variation, ecosystem functions and ecosystem processes over time".

This contribution presents a general review and discussion of the current ideas regarding ecosystem forest management for the conservation of biodiversity, it also contains a brief overview of related political and market driven processes. It focuses on the need to develop biodiversity indicators and discusses the problem on how to decide a national strategy balancing the two concepts of in-situ conservation and multiple use forest management. This note draws upon the experience attained by management practices in northern coniferous forests.

Additionally, a list of practical experiences (case studies) and scientific findings is also provided. These examples cover areas with different degrees of forest degradation due to land use history and different patterns of land tenure.

The Convention on Biological Diversity provides the following definitions:

Biodiversity: is `` *...the variability among living organisms from all sources including, inter alia, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes the diversity within species, between species and of ecosystems* " .

Biological Resources are defined as "... *genetic resources, organisms, or parts thereof, populations, or any other biotic component of ecosystems with actual or potential use or value for humanity*",. and

An **ecosystem** is "*a dynamic complex of plant, animal and micro-organism communities and their non-living environment interacting as a functional unit*" (art. 2).

We observe that the operational goals which are applicable to forests and forestry in the CBD text are rather general in character. In fact, CBD requests Parties to "*promote the protection of ecosystems, natural habitats and the maintenance of viable populations in natural surroundings*" (art 8: In-situ conservation) and to "*adopt measures relating to the use of biological resources to avoid or minimize adverse impacts on biological diversity*" (art 10: Sustainable Use of the components of biological diversity). This is certainly a very important framework, but we can envision a clear need to move towards a more concrete and focused approach regarding forests and biodiversity.

ECOSYSTEM APPROACH:

An ecosystem approach to forest management means: to consider a large number of values, to emphasize a number of scientific disciplines, to incorporate local and traditional experiences and to be constantly aware of the consequences of our practices within forest ecosystems.

Defining biodiversity goals for forests and their sustainable use, forces us to move from the general goals of "*preservation of natural conditions and processes*" towards more concrete and specific goals related to biological resources . Since northern coniferous forests are highly dynamic systems, focusing on the species and gene levels will give us a better approximation and levels of detailed information than targeting habitat and ecosystem levels, which at any point in time, are more unstable and difficult to define.

1. ECOSYSTEM MANAGEMENT AND BIODIVERSITY GOALS

A biodiversity goal in connection with sustainable forest use should be formulated so as to preserve the present species populations at a viable level or stage, within a specific

geographic range, be it national, regional or landscape level. Such goal is easily understood and used by practitioners. Hence, we are urged to develop operational goals and use methods such as habitat conservation, employ "natural" disturbance factors and others in order to keep population sizes at the levels required to maintain and preserve an adequate genetic variation of the gene pool.

Under the CBD the sustainable use of biodiversity means "*the use of components of biological diversity in a way and at a rate that does not lead to the long-term decline of biological diversity, thereby maintaining its potential to meet the needs and aspirations of present and future generations*".

In 1993, Franklin suggested that sustainability means the "maintenance of the ***potential*** for our terrestrial and aquatic ecosystems to produce the same quantity and quality of goods and services in perpetuity". This concept is ruled by two guiding principles which cover both the physical and the biological aspects of productivity, and they are useful in the development of forestry activities based on ecosystem management approaches. These guiding principles are:

A. NO NET LOSS OF PRODUCTIVITY: or preventing the degradation of the productive capacity of our lands and waters.

B. NO ACCELERATED LOSS OF GENETIC POTENTIAL: preventing the accelerated loss of genetic and species diversity.

A long term potential of forest ecosystems to sustain productivity is uncertain in a biodiversity degraded state. For instance, frequent forest fires in northern Europe have definitely changed local productivity and significantly affected the build up of nutrient rich humus layers of great importance for efficient re-growth.

It is also worth recalling two issues in relationship to sustainable forest management. Firstly, we face a lack of *detailed* information which is needed to reach the proposed biodiversity goals and secondly, we may potentially face conflicts amongst the different components of sustainable forest management.

2. MANAGEMENT APPROACHES

Many scientific disciplines have contributed to the development of new forestry methods and approaches. Areas like population genetics, ecology, conservation biology, landscape ecology, disturbance ecology and forest history -among others- have provided useful, thought-provoking ideas and have created opportunities to develop new hypothesis for an ecosystem management of forests. The lack of a complete, thorough or detailed information should not discourage pro-active strategies and precautionary approaches in the decision making process.

Prevention of allelopathic effects on pine	Prescribed burning

In different countries, the main methods for the application, planning and management guidelines may have different legal status. Planning procedures may be legally forced upon forestry and management guidelines could be incorporated in a national forestry act. Today, many forestry companies, forest owner's associations, individual land owners and even wood purchasing organizations have their own guidelines and planning procedures to meet most or some of the eleven guideline types mentioned above.

3. CURRENT STATUS AND TRENDS

3.1. POLITICAL PROCESSES AFTER RIO

Many of the political processes following the Rio Conference have dealt with sustainable forestry at the criteria, principle and indicators level. A good overview has recently been presented as a Secretary General's report of the ongoing work of the Intergovernmental Panel on Forests (IPF) in its document E/CN.17/IPF/1996.

For temperate and boreal regions, most political action has been taken in connection with both the Helsinki and the Montreal processes. Within these fora, biodiversity is seen as one of several criteria for sustainable forestry, and they aim at the maintenance of biological diversity in forest ecosystems.

At the national agencies level and within the scientific community, biodiversity indicators have been and are a topic of great concern. Some illustrative examples can be found in Mc Kenney et al. 1994, Swedish Environmental Protection Agency, 1995 and the National Board of Forestry (Sweden), 1995.

Several other criteria, such as, forest resources, productive and protective functions, etc, also have relevance to the conservation and enhancement of biological diversity, and should be considered.

In general, the Helsinki and Montreal processes identify the need to find measurable indicators for the evaluation -at the national level-, of the progress achieved in the implementation of their sustainable forest management agreements.

In the above mentioned IPF report. the Helsinki and Montreal processes consider indicators at the ecosystem, species and genetic levels. Table 4 presents a summary of those criteria.

Studies of natural forest ecosystems and their dynamics are perhaps the most important contributions to our present understanding of forest ecosystems. Most definitions of biodiversity indicators, as well as practical guidelines for a sustainable forest management take natural forest ecosystems as a reference where we can search for guidance. In the northern coniferous forest region, where historically there is a rather late human influence, this perspective seems appropriate. In other temperate forest ecosystems, e.g. nemoral deciduous forests, with a long history of land use such as cattle grazing or hay moving, the focus must be much more on traditional agricultural methods and other human activities as a reference.

The significant amount of new information gathered in the last four decades has demonstrated that ecosystems in general and forests in particular are extremely complex systems with intricate webs of interactions. Numerous studies have also shown high levels of biological diversity, and their tight linkages to forest ecosystems. Our current efforts to find new forest management techniques are at best our first working hypotheses. These hypotheses now need to be tested.

2.1 ADAPTIVE MANAGEMENT APPROACH

Studies of natural forest ecosystems and their dynamics are perhaps the most important contributions to our present understanding of forest ecosystems. . Most of the new insights have been collected in different types of ecosystems where forests, both tropical and temperate have made significant contributions.

The Adaptive Managment approach (Walters and Holling 1991), proposes the implementation of guidelines which should be accompanied by the development of a monitoring system where certain biological indicators are assessed over long periods of time.

Figure 1, describes the creation and flow of information needed to develop sustainable management practices based on the adaptive management approach. The ecological generalizations of importance are put into several different groups. This figure is the summary of scientific information to formulate a working hypothesis 1, which implemented will create a new forest landscape, which in turn will have to be compared with natural forest ecosystems. This approach should also incorporate the needs and expectations of local people and future generations. The comparisons obtained, together with new and additional information, will then form the basis for working hypothesis 2 ... n.

A-knowledge:	Descriptions of natural forest ecosystems including e.g. structures, processes, dynamics, complexity, species composition and interactions.
B-knowledge:	Description of lack of components in managed forests in relation to biodiversity and the properties above.
C-knowledge:	Generalisations from theories, modelling and testing of processes emerging from fragmentation and dilution of properties at different levels.
D-knowledge:	Local experiences of responses of the ecosystem due to traditional or modern management.
E-knowledge:	The unknown future breakthroughs.

In table 1, a number of general and relevant scientific deductions and theories are presented in an A-C manner. The D level is most often only applicable at the local level and thus is not suitable for general review.

Table. 1 Some relevant examples of scientific generalisations for the development of sustainable forest management methods regarding biodiversity. The references are collected mainly from northern coniferous forest examples.

"A-C Knowledge"	Examples of references.
A1. Habitat duration time is linked to life-history traits e.g. dispersal ability of its organisms.	Hansson, 1992, Denslow, 1980.
A2. Species often need combinations of different habitats.	Pellmyr, 1984, Gutowski, 1990.
A3. Habitat quality is important.	Esseen et al., 1992,.
A4. Keystone species exist and their loss may cause ripple effects.	Hairstone et al., 1960, Angelstam, 1992.
A5. Species show significant adaptations to natural disturbance regimes.	Ingelög et al., 1987, Heliövaara and Väisänen, 1984.
A6. Different forest ecosystems can be characterised by specific disturbance regimes and successional patterns.	Esseen et al, 1992.
A7. Certain structures e.g. logs may serve an important role as biological legacies during disturbance phases.	Franklin, 1990.
A8. Forest continuity at different levels have importance for species survival and possibilities for colonisation.	Peterken and Game, 1984, Topham, 1987, Rose, 1996.
B1. Populations are today often unnaturally fragmented and forced into a metapopulation structure due to habitat loss.	
B2, C9. Size and shape of forest blocks influence species composition.	Forman and Godron, 1986.
B3, C10. Edge effects influence predation, competition and local climate.	Forman and Godron, 1986
B4, C11. Landscape structural grain size is important.	Van Horne, 1983.
B5. Forest fire, amount of big trees and dead wood are important characters known to have declined in number or frequency.	Zackrisson, 1977, Esseen et.al 1992, Linder and Östlund, .
B6. Natural disturbance regimes differ considerably from disturbance by forestry operations.	Schimmel, 1993, Johnson, 1992.
C1. Small populations cause genetic depletion	Soulé 1985, 1987.

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C2. Inbreeding is most plausible in a fragmentation situation	Lovejoy, 1977.
C3. Species have specific area requirements in habitats that often are patchily distributed.	
C4. Fragmentation and isolation of habitats leads to increased risk for extinction, Threshold values exist.	Harris, 1984, Andrén 1994.
C5. Different population sizes are related to different survival possibilities. Threshold values exist.	Shaffer, 1981, Lande, 1987.
C6. Survival probability might be possible to calculate for different populations.	Gilpin and Soulé, 1986.
C7. Within a metapopulation, occupancy of a certain habitat island is a balance between immigration and extinction. By chance, a number of suitable habitat patches are always empty.	Andrewartha and Birch, 1984.
C8. Potential distances moved during dispersal are extremely important for the persistence of subpopulations	Hansson et al., 1992.
C12. Dispersal corridors may be crucial for species survival	Saunders and Hobbs, 1991.
C 13. Habitat specialist species are more susceptible to fragmentation than generalists	
C14. Larger habitat fragments are needed in order to preserve species richness when the habitat has become rare in a landscape.	Svensson, manuscript.

The working hypothesis - Guidelines for sustainable forest management

In different parts of the boreal region scientists, as well as agencies and foresters, have begun to convert ecological knowledge and local experience into either specific management guidelines or working hypotheses. The level of application in the field differs between countries and regions, but generally speaking, we are facing a huge field experiment or test of the different guidelines that have been adopted. It is very important to stress the recognised need for local adaptations of the general knowledge presented.

In table 2 a number of guideline types are presented with comments regarding examples of scientific support (see table 1) and practical applications.

Guideline type	Examples of scientific support	Practical applications	Method
1) Create a system of protected areas.	A3, B6, C4 etc.	Covers all in situ conservation (protected areas) in scales from national parks and reserves, downwards to critical habitats and smaller woodlots.	Planning
2) Establish buffer zones or special restoration zones adjacent to protected areas	B3, C10 etc.	Buffer zones are either totally protected or are subject to special management considerations.	Planning
3) Protect or restore networks of protected forest corridors.	A6, C12 etc.	Networks and corridors are used to connect protected areas or to increase the amount of certain riparian or moist habitats.	Planning
4) Protect riparian systems.	B3, C10, C12 etc.	Buffer zones alongside streams and lakes are prescribed, with different widths or adaptation to site qualities along the watercourses.	Management guidelines and planning
5) Consider natural spatial patterns at the landscape level.	A6, B1, B2, C9 etc.	Includes the adaptation of forest block sizes, qualities and distributions to natural conditions.	Planning
6) Mimic natural disturbance regimes	A5, A6, A8, B5 etc.	Normally includes the choice of specific management methods such as: prescribed burning, natural regeneration, selective cutting, selection of tree species etc.	Management guidelines

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7) Increase the structural diversity of stands.	A6, B5 etc.	Normally, there are prescriptions for tree retention or restoration of dead trees and logs, as well as the desired composition of tree species.	Management guidelines
8) Consider natural temporal patterns.	A6, B6 etc.	Usually involves increased rotation periods for certain forest types.	Planning
9) Minimise erosion and damage to adjacent ecosystems.	B6 etc.	Includes avoidance of certain site soil qualities, protection of buffer zones and prescriptions for road nets and harvesting models.	Planning and management guidelines
10) Balance the use of more intensive production methods.	B6, B3, C10 etc.	Use of e.g. exotic tree species or fertilizers are restricted to appropriate scales and levels.	Planning and management guidelines
11) Avoid disturbing activities close to the breeding sites of sensitive species		Special cutting restriction zones close to e.g. nests or lekking grounds during the sensitive season.	Planning and management guidelines
12) Balance biotic processes affecting biodiversity		Reduction of high levels of browsing game spp.	Planning and management guidelines
13) Take action against anthropogenic pollution affecting biodiversity		Liming, fertilisation	Planning and management guidelines

These 13 guideline types cover most of the different approaches which so far have been seen in practical forestry. The relevance of each guideline type differs between the different ecosystems and their historical forest background. In one way, guideline type number 6: Mimic natural disturbance regimes, if broadly adopted, could solve most problems. In table. 3 an example is presented on how natural disturbance patterns might be transferred into practical management guidelines for a Northern European forest site (from Fries et al. manuscript).

Table 3. Natural processes, structures and features typical of a Scots pine forest on dry or mesic sites in Swedish boreal forests, and the silvicultural measures which would preserve or promote these (after Fries at al. manuscript).

Natural process, structure and feature	*Silvicultural measures*
Fire with mean return interval of around 50 years	Prescribed burning
Natural regeneration	Use of natural regeneration (e.g. by means of seed trees or shelterwood) or seeding
Uneven-aged stand structure	Leave out, vary or modify the traditional low thinning (and accept self-thinning) Leave trees or groups of trees at final felling
All-sized structure	Leave out, vary or modify the traditional low thinning (and accept self-thinning) Leave trees or groups of trees at final felling
A fraction of broad-leaved trees, primarily white birch	Favour other species than pine, in the first place broad-leaved trees
Several centuries old pines	Leave pines or groups of pines at final felling
Standing and fallen dead trees, also large ones	Leave trees as relicts Leave out, vary or modify the traditional low thinning Girdling, pushing over or felling selected trees
Fire scarred living and dead trees	Prescribed burning
Burned ground	Prescribed burning
Warmed up ground	Removal of trees or (better) prescribed burning
Exposed mineral soil (at severe fire)	Prescribed burning, or (better) slight or moderate mechanical disturbance of ground vegetation e.g. by scarification
Nutrient release	Removal of trees Prescribed burning Mechanical disturbance of ground vegetation e.g. by (slight or moderate) scarification

Table. 4 Indicators for biodiversity criteria in Helsinki- and Montreal-documents.

Indicators	Helsinki-process	Montreal-process
Ecosystem level		
Distribution of forest ecosystems	+	+
Extent of protected areas	+	+
Fragmentation		+
Species level		
Number of forest dependent species	+	+
Number of forest dependent species at risk	+	+
Extent of mixed stands	+	
Reliance on natural regeneration	+	
Genetic level		
Number of forest dependent species with reduced range		+
Population levels of key species across their range		+
Management of genetic resources	+	

2. FOREST TRADE AND CERTIFICATION SCHEMES

Beside the political processes mentioned, certification systems which are market driven processes are being discussed and developed at this time. Thus far, no system has reached a level where more accurate indicators are suggested. In some countries (e.g. Sweden and Canada) the development of *forestry standards* as a basis for forest certification are being developed. These standards will probably be a mixture of indicators and direct operational management guidelines. Additionally, the Forest Stewardship Council (FSC) is developing independent certification schemes and ISO (International Standards Organization) is considering the certification issue.

FORESTRY GUIDELINES VS INDICATORS

Forestry guidelines are often detailed and locally adapted to site qualities and ecosystem types.

Regarding indicators, there is always a risk that general indicators for large regions will wrongly reflect the status of progress at the local level. Very few of the suggested indicators cover the implementation of an ecosystem approach in forest management. The extent of protected areas (if smaller areas within managed landscapes are included), mixed stands and a reliance on natural regeneration are examples of attempts to incorporate such management indicators. However, these are also typical examples of general indicators which have poor local application. If an indicator system is to work as a basis for adaptive management, or is to actually improve the implementation of sustainable forest management practices which enhance biodiversity, then more scientific work is needed in order to find suitable and appropriate indicators.

STRATEGIC CHOICES: PROTECTED AREAS, ECOSYSTEM MANAGEMENT OR PLANTATIONS

National governments who may wish to consider a forestry strategy based on an ecosystem approach face a suite of decisions. One of the most basic decisions to be made, concerns the need of a balance between in-situ conservation, ecosystem forest management and intensive forest management including plantations.

The preliminary selection of international indicators, e.g. the amount or extent of protected areas, suggests that certain strategies are considered superior by definition. However, a number of factors must influence each national strategy. The simple question to be answered before any decision is taken is: Which strategy will best improve long-term conservation and the use of biodiversity based upon the present situation? The

question may seem trivial, but experiences and the development of indicators show that it needs to be addressed.

The choice of the appropriate strategy is, of course, dependent on how the biodiversity goal is defined. Two mayor values of biodiversity have been identified: (a) the goal concerns biodiversity per se regardless of its role for ecosystem functions and (b) biodiversity as of primary importance for ecosystem functions (productivity). In the second case, a balance between in-situ conservation and ecosystem management is needed for long term sustainability, while more intensive forestry methods have no place. In the first case, even forest plantations and intensive forest management solely for wood production may, at least in theory, be a component in a forest landscape or in a national perspective. Historically, cases of long-term, high intensity land use in northern Europe, have shown that wood production may even increase, in spite of an ecosystem degradation of both biodiversity and natural processes.

If goal two is considered relevant to a specific ecosystem type, then the range of choices for a national strategy is narrow compared to a goal 1 situation. In order to attain a good balance among the appropriate management regimes, the present biodiversity situation must be considered especially where it has been created by forestry/land use history. In figure 2 the timber frontier through northern Europe is approximately reconstructed (Angelstam 1996). It shows that large portions of Scandinavia and Finland were converted from natural forests into managed forests or agricultural lands 100-200 years ago and in some regions much earlier by wood cutting for mining operations or by agricultural development. Today, the frontier has reached the most inaccessible parts of north-western Europe and Russia, leaving only minor remote areas or areas of low productivity as natural forests. For instance, in large parts of Finland and Sweden, a complete protection of the remnants of natural forests will simply not be enough to reach a specific biodiversity goal, even at the national level. The importance of an ecosystem approach where forestry is used to restore qualities and still utilize the raw materials from the forest is, in this situation, a proper strategy when combined with traditional in-situ conservation. Close to the timber frontier the importance of protecting areas tends to increase. Here it is still possible to reach a national biodiversity goal by setting aside large parks or reserves where certain uses are restricted or prohibited.

In figure 3 different situations and their relation to the need for ecosystem management are shown schematically. The ecosystem approach is the best to use as a main restoration tool in areas with a low natural forest cover and a high degree of forest degradation. On

the other hand, many areas with natural forests are still under threat. In the perspective of a human population explosion, the pressure on these areas will certainly be a better alternative than exploitation and degrading by cutting. In a landscape matrix with a mixture of managed and natural forests, new forestry management methods may serve as a possible buffer against large scale losses of biodiversity due to fragmentation and other processes.

In summary, the balance between the protection of forests and the adoption of ecosystem-based forestry methods must be decided for each individual situation. In almost all cases, in-situ conservation is desirable and needed because we will never be able to mimic a natural ecosystem completely with forest management and use. For certain species with large area requirements demand that large areas of wilderness be set aside. The role for ecosystem management approaches are important, especially in regions with high proportions of degraded areas as in Northern Europe. Depending on the functionality of biodiversity for the long-term productivity of forest soils, some proportion of intensive plantation forestry probably will always be acceptable from a biodiversity point of view. This will especially occur where plantations are a component in largely deforested areas or as a minor component in other matrices. This type of forestry, with its capacity to produce large amounts of wood per hectare, may have the consequence of lowering the pressure on remaining natural forests.

CASE STUDIES ON FOREST POLICY AND MANAGEMENT PRACTICES:

The rapid development of new forestry ideas during the last two decades has primarily taken place within a number of sites and countries which include coniferous forests. This is mainly because of the severe conflicts in these countries between traditional clear-cutting forestry and the changed values which have developed in these highly urbanized nations. In this note, three specific cases are presented to document the implementation of the ecosystem management approach. The cases selected are 1) Pacific Northwest (PNW) of USA, 2) Canada and 3) Sweden. Rather than covering all aspects of each case, the intention of this note is to point out some of the fundamental differences, important to understand how the implementation of processes may take place.

1) New Forestry in North-West USA

Status and Development

As a result of changed values in society and the emerging conflicts during the 1960's regarding clearcutting in general, a number of new federal laws were implemented. The development of ecology and its influence on both the perception of different values and the direct effect on silviculture also played a part. Without doubt, the two laws having the most important historical influence on the change in forestry practices are: 1) the National Forest Management Act (NFMA) and 2) the Endangered Species Act. The NFMA was primarily set to handle the clearcutting conflict and included elements on how to meet biodiversity requirements. The concept of minimum viable populations (MVP) was created for vertebrate species, where much of the initial attention was focused. The NFMA only concerns federal lands. Thus the U.S. Forest Service had to start up interdisciplinary planning procedures, which involved various public interests.

In the late 70's, environmentalists started to realise the inherent power in the present legislation. Much of the development and the driving force for the great changes that have occurred since then is connected to the "Northern Spotted Owl" and its listing as an endangered species in 1990. Some of the major events in this conflict, which changed the whole regional sector of forestry operations, may be summarised as follows:

1990 The forest service plans for owl conservation are for the first time considered "not adequate".

1990 The first conservation strategy for the Northern Spotted Owl, known as "the Thomas Report", is developed. Strong demands for large reserves are put forward but not adopted by Forest Service in the region.

1991 The court closes down all timber sales from the PNW region due to a lack of proper management plans. The conflict escalates.

The Congress creates a "Scientific Panel on Later Successional Forest Ecosystems", free from agency influence, which presents a number of alternative scenarios for spotted owl survival, consequences for other species, economical impacts and employment. All old-growth forests are mapped. A timber sales reduction from 5 billion boardfeet/yr to 1,6 billion and the loss of 60 000 jobs in the region are suggested.

1992 The courts still do not allow cuttings due to lack of adequate plans.

1993 The President calls for a conference to remove the gridlock for action. A science panel gets the mission to develop alternative solutions.

1995 The President brings the question back to local negotiations in order to find the best solutions available. No general openings for timber sales from federal lands in Pacific NW, but a congressional decision, approved by the President, approves harvesting in order to protect damaged forest stands. This decision has caused new waves of protests from NGO's.

In several of the suggested action plans, a dominant feature is the set aside of large forested areas as nature reserves. As a parallel development, the concept of "New forestry" /...

appeared in the late 80's. In several of the spotted owl action plans, reserves are combined with new forest management ideas in order to minimise the negative impact of cutting and production areas in the landscape matrix. All new scientific knowledge arising from PNW old-growth research also creates a greater understanding and appreciation of the broad concept of biodiversity. Special attention is taken to riparian forests because of highly valuable and sensitive fish stocks and stream ecosystems. Legislation at the state level has been developed, especially regarding stream side considerations.

Special features

In comparison with. northern European conditions for example, a larger proportion of the forest lands in the PNW are federal or state owned (ca 50 %). Private and industrial forests have to a lesser, but increasing degree, been influenced by the changes in the 80's and 90's. However, initiatives like "Timber-Fish and Wildlife Agreement" and the "Sustainable Forestry Initiative" have certainly caused changes to occur even on industrial and private forest lands. Several forest companies today have ambitious programs for more sustainable forest management methods.

Major events causing change

Typical for the Pacific Northwest process is the major role of legislation, the Court system and the media. The public interests expressed through these systems have a very strong position. The Spotted Owl conflict has, without doubt, focused on the special values of old-growth forests. The focus has also been directed at the concept of biodiversity and, in general, a broader ecosystem approach by forestry. The public involvement in landscape planning procedures has also created a new way of thinking by both foresters and environmentalists, strengthening the basis and "permission" for further testing and development of sustainable management methods. The forest industry is, however, urging once again to be given access to the federal lands and has at present won a limited victory by being allowed to carry out the salvage logging of damaged forest stands.

Present driving forces

At present the battles in the courts are continuing. The cuttings allowed in damaged old-growth forests, for protection reasons, is taking place without traditional planning procedures on federal lands. This is causing inoptimal solutions in relation to future conservation and timber harvesting strategies.

The driving forces are still at the highest political level within the US. Market driven processes for the change of forest management, as in Europe, have still not appeared to any important extent.

2) Development of sustainable forest management in Canada

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Status and development

The history of forestry in Canada can be categorized into four principal stages: exploitation forestry administrative forestry, ecological forestry and social forestry (Kimmins 1995).

The initial "exploitation phase" began with the colonization of the North American continent and ended at the turn of this century in 1909 with the first national forest congress. With this congress began the "administrative forestry" phase. The congress was initiated in order to address public concern regarding perceived forest depletion. The outcome was periodic national reviews which assessed the state of Canada's forests.

It was not until the last quarter of this century that ecological forestry in Canada began to gain momentum. This stage of forestry is characterized by single-species management approaches implemented at the local level, and general site-based forestry and wildlife guidelines. During this period the publication of the World Conservation Strategy by IUCN influenced Canada's provincial and territorial governments who, in co-operation with non-governmental organizations and the private sector, began the development of their own forestry, fish and wildlife conservation strategies. Shortly thereafter, the Canadian Council of Forest Ministers (CCFM) presented results of the National Forest Congress held in 1986, termed *A National Forest Sector Strategy* (1987).

Early in the 1990's the ecological stage was replaced by the "social" stage of forestry. Society now demanded greater input into natural resource management issues, including forest management. Public demands included preservation of natural forest habitat, identification and conservation of endangered species, and above all, the sustainable development of forestry. One government policy to address these concerns of the public was the *Wildlife Policy for Canada* (1990), which called upon all Canadian jurisdictions to provide for biodiversity, sustainable renewable resource policies and programs, and multi-sectorial planning. To keep pace with changing public attitudes, the CCFM together with other stake-holders initiated a public participation procedure to achieve consensus on broad new directions for forest management. This new strategy, *Sustainable Forestry - A Canadian Commitment* (1992), outlined some 90 action items and defines sustainability as the ability to maintain and enhance the long-term health of forest ecosystems, for the benefit of all living things both nationally and globally, while providing environmental, economic, social and cultural opportunities for the benefit of present and future generations. The Canadian Sustainable Forestry Strategy will be evaluated and modified in 1997 to reflect current knowledge.

Special features

Canada's forests are predominantly (i.e. 94 %) publicly owned, while only 6 % are privately owned. A regional look at the pattern of land ownership gives insight into the status of "natural forest" and "unallocated forest" in Canada. The majority of forest land in Nova Scotia and Prince Edward Island are privately owned. Forests in these regions contain very few natural forest areas, whereas regions to the North and further West have much larger proportions of natural forests.

Major events causing change

The major events causing change include: the spotted owl/old growth controversy; increased information and reporting services(i.e. mass media). Highly active Canadian and international pressure groups, agitation by native people's groups and conflicts with European consumers have added further arguments for change.

Present driving forces

The dominant role that the export of forest products play in Canada's balance of trade have prompted Canada to take a lead role in developing international agreements on forests. The first example being Canada's participation in UNCED'92, where Canada, together with many other countries, was signatory to four documents that directly relate to forest practices. These were: *Framework Convention on Climate Change, Convention on Biological Diversity, Agenda 21, and Guiding Principles on Forests.* Second, is Canada's present involvement in the provision and implementation of region-specific scientifically based standards (ISO 14000, FSC) of sustainable management for all forests. The *Forest Practices Code* of British Columbia (legislated 1994) and The *Commission on Resources and the Environment* (for B.C.) are new examples of present driving forces dealing with forest regions having high proportions of public ownership. Regions with very little public forest land ownership such as the Maritime provinces (Nova Scotia, Prince Edward Island, New Brunswick), presently lack clear direction.

3) Policy, guidelines and implementation in Swedish forestry

Status and development

Environmental considerations within Swedish forestry, aiming at conservation of biodiversity and other non-commercial products, started to appear in connection with the development of the National Forestry Act of 1979. The first major step to suggest biodiversity guidelines for forestry operations was included in a general book on endangered species and biodiversity conservation (Ahlén 1977).
During the 1980's, a debate loaded with conflicts between NGO's and forestry emerged. Much of the debate focused on the need for preservation of the last remnants of virgin coniferous forests in the subalpine region, a problem that still has not reached a final solution. During the 80's, a general awareness of the problems related to forestry increased within forestry sector itself. A shift to a more general use of modified methods connected with final felling started to show up, although the speed of change was initially slow.

In the beginning of the 90's a new national forest policy and legislation was worked out and adopted. In this national forest policy the production goal and the environmental goal were considered equally important. Biodiversity conservation was raised as the most important environmental goal to reach and was formulated so as to preserve all natural species in viable populations. Together with these political decisions, it was also decided that the main responsibility for actions which would meet the political demands was with /...
the forestry sector itself.

Swedish forestry legislation is, by tradition, valid for both state- and private forests. The latter covers 88 % (50% private owners and 38% companies) of the productive forest lands. Changes in other laws also influenced forestry during the 80´s and 90´s. Most important and worth mentioning, are a number of additions to the Nature Conservation Act including the prohibition of draining forest wetlands plus the protection of certain critical habitats for animal and plant life. During the 1990´s the implementation of new forestry guidelines has accelerated in the direction of an ecosystem approach.

Special features

Special for the Swedish and, to a certain extent, Nordic (Sweden, Finland, Norway), conditions is the position along the timber frontier gradient where most of the forests (90-95%) have been degraded from a biodiversity point of view. At the same time, the forests are well-managed and highly productive regarding wood. Parts of southern Sweden were not only degraded, but also deforested during the mid 1800´s, due to expansive agriculture or logging for use in mining. To a large extent these forests have recovered during this century. From a biodiversity point of view, more sensitive and specialised species have had their ranges restricted considerably. This is due to both the fragmentation of natural forests and the dilution of important structures and natural processes.

Major events causing change

In the Swedish process NGO's and scientists have played an important role in influencing both politicians and foresters. The massive building up of basic knowledge among foresters and forest owners, for example due to information and education campaigns such as "A richer forest", has certainly been highly valuable in changing attitudes and a preparing for the adoption of new guidelines.

Present driving forces

The fulfilment of the demands in the new forestry legislation driven primarily by the sector authority (National Board of Forestry) and under supervision of the Environmental Protection Agency, is of course important. Both agencies have prepared specific action plans (1995) for biodiversity conservation within their respective sectors, as a part of the national CBD process. However, most of the pressure which is causing acceleration of the implementation of new guidelines, is to be found in the increasing environmental interest by the consumer market for forest products. NGO s, customers for forest products and consumers have collaborated in different ways, thereby creating a growing market pressure for an ecosystem approach in forest management operations. The market, in this perspective, should be considered as primarily western Europe. This new situation has lead not only to a change in forest practices, but also to a big need for communicating these changes to the market. The concept of forest certification has emerged, but still has not yet been put into reality. In Sweden a special Forest Stewardship Council (FSC) working group, with representatives from forest industry, forest owners, NGO's, trade unions, indigenous native people's organisation and other economical interests, is presently trying to reach a consensus about the standards for well-managed forests in Sweden. At the same time, a Nordic certification project is running in order to find ways to integrate a certification system involving Sweden, Finland and Norway.

Conclusions

The review of current knowledge and applications of an ecosystems approach to forest management needs to be summarized into some general deductions. Some conclusions are worth mentioning regarding both the scientific basis for change and the directions of change:

- In order to develop a sustainable use of northern coniferous forests, an ecosystems approach, based on natural forest dynamics and disturbance regimes, appears to be the best alternative. Comparisons between traditionally managed forests and natural forests have given us knowledge about a number of structures and processes of importance for the conservation and restoration of forest qualities

- More research is needed in order to identify thresholds for the required quantities of relevant components for biodiversity.

- Most available knowledge is too general and is in need of local adaptation if correct applications are to be made successfully.

- Proposed guidelines from different regions must be considered as working hypotheses in /... need of testing, for example through adaptive management approaches. For this reason,

specific biodiversity goals related to scale in combination with a well-developed monitoring system are necessary components.

- There is still a need for the development of relevant indicators in order to enable monitoring and adaptive management strategies.. These indicators need to be adapted to local conditions.

- In-situ conservation (protection of forests), at different levels, is normally a necessary part of ecosystem management for any forest area. Therefore strategies and planning for both protection and management of forests need to be integrated.

-The balance between the use of in-situ conservation (protection of forests) and ecosystem management is influenced by the land use history in each region. In areas with a high proportion of natural forests, forest protection plays a more important role than in areas with a high level of degraded forests.

Regarding different implementation methods used, these conclusions appear to be the most important:

-It must be stressed that there is a need to consider national cultures, traditions and patterns of ownership before selecting the appropriate tools for implementation of new forest policies and ideas.

- In many cases, legislation has played, at least initially, an important role as a means of introducing public interests into forestry.

- Education and information are inevitable, necessary measures that must be taken if a successful and long-term change of behaviour is to take place.

- In some regions where primarily the market influences forestry, forest certification and eco-labelling of forest products play an important role in the present development of new forestry standards and methods.

- Ecosystem management requires inventories, planning, locally adapted guidelines, field controls and monitoring as efficient means of action.

- Different NGO's have in all cases, played an important role in influencing politicians, consumers and the market.

A review of criteria and indicators developed in the political arena in order to measure national progress resulted in the following conclusions:

- Very few indicators have relevance for the measurement of the implementation of a broad ecosystem approach in forestry. Indicators need to be developed.

- Indicators for regions or even nations must be very general and open to local adaptations and solutions. More specific indicators must be developed in connection with local adaptive management applications.

General Conclusions

Since both a proper selection of parameters and of instruments are highly dependent on national conditions, the type of approaches already made in CBD are relevant to promote the development of national strategies which incorporate all useful instruments. These types of biodiversity commitments should also be included in the work of other ongoing and future fora.

A general reflection is that only a combination of additional scientific work, ongoing extension service, education and information as well as the development of systems of protected areas, makes it possible to reach the biodiversity goals. Depending on the previous land use history, the relative value of these components will vary. If good information is promoted both within the forestry sector and the public in general, the need will emerge for inventories, planning, certification, eco-labelling and even legislation. Detailed management guidelines developed in legislation or body of regulations could run the risk of being viewed out in the field as inadequate short lived ideas. A general broad support is a strong and necessary instrument to get nations to develop programs for adaptive management in combination with education and other biodiversity-related activities.

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