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MULTIPLE-USE FORESTRY IN THE SCANDINAVIAN COUNTRIES

O. SAASTAMOINEN, S-G. HULTMAN,
N. ELERS KOCH & L. MATTSSON (EDS.)

SELOSTE

METSIEN MONINAISKÄYTTÖ
POHJOISMAISSA

HELSINKI 1984

COMMUNICATIONES INSTITUTI FORESTALIS FENNIAE

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Cover (front & back): Scots pine (*Pinus sylvestris* L.) is the most important tree species in Finland. Pine dominated forest covers about 60 per cent of forest land and its total volume is nearly 700 mil. cu.m. The front cover shows a young Scots pine and the back cover a 30-metre-high, 140-year-old tree.

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O. SAASTAMOINEN, S-G. HULTMAN,
N. ELERS KOCH & L. MATTSSON (EDS.)

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Proceedings of the Scandinavian symposium held in Rovaniemi and Saariselkä, Finland, September 13—17, 1982

Approved on 2. 12. 1983

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The proceedings of the first Scandinavian symposium on multiple-use forestry (held in Rovaniemi and Saariselkä, Finland, September 13.—17., 1982) include 22 papers and introductory notes of the editors.

The topics of the papers are the following: contents and concepts of multiple-use forestry (six papers), forest recreation and amenity values (six papers), forest berries (one paper), forests for grazing and game (five papers) and planning for multiple-use forestry (four papers).

Ensimmäisen yhteispohjoismaisen metsien moninaiskäyttöä käsittelevän symposiumin (joka pidettiin Rovaniemellä ja Saariselällä 13.—17. 9. 1982) kokoomajulkaisu sisältää 22 symposiumissa pidettyä esitelmää ja toimittajien laatiman johdantoluvun.

Esitelmien aihepiirit ovat metsien moninaiskäytön sisältö ja käsitteet (kuusi esitelmää), metsien virkistyskäyttö ja maisema-arvot (kuusi esitelmää), metsämarjat (yksi esitelmä), metsien käyttö laiduntamiseen ja riistan elinympäristönä (viisi esitelmää) sekä metsien moninaiskäytön suunnittelu (neljä esitelmää).

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To Professor Lauri Heikinheimo
on his retirement June 1, 1984

FOREWORD

This publication documents the first Scandinavian symposium focused on multiple-use forestry. It was held at Rovaniemi and Saariselkä, Finland, September 13—17, 1982. The participants of the symposium were researchers and professionals from Denmark, Finland, Norway and Sweden.

The symposium was organized by the Multiple Use Working Group of the Scandinavian Society of Forest Economics. However, the idea for a Scandinavian symposium originated from an informal group of forest recreation researchers headed by Professor Lars Kardell. The symposium was planned by Dr. Olli Saastamoinen and Dr. Leif Mattsson of the Multiple Use Working Group, and Dr. Sven-G. Hultman, representing the Forest Recreation Group. In addition, Professor Einar Stridsberg participated in the initial stage. Dr. Saastamoinen was in charge of local arrangements and also chaired the symposium.

The practical arrangements and this publication were made possible by assistance in the form of money and personnel from the Finnish Forest Research Institute. A grant from "Nordiska forskarkurser" helped greatly in the realization of the symposium. During the symposium and field trips, hospitality and professional assistance were offered by the Ministry of Agriculture and Forestry, the City of Rovaniemi, the National Board of Forestry, the District Forest Board of Lapland and many others.

Professors Lauri Heikinheimo and Eero Paavilainen read the manuscript of the proceedings. The English language was checked by Pat Marino-Hultman, Richard Foley, Ashley Selby, Peter D. Coley and Malene Djursaa.

We express our gratitude for all the help and support received for the arrangements and documentation of the symposium.

It is our hope that the proceedings will encourage further research in the field of multiple-use forestry in all Scandinavian countries. We hope also that the beneficial collaboration between the researchers of participating countries as well as between them and representatives of forest organizations and authorities — expressed in the resolution of the symposium — will continue in the future.

Rovaniemi, Uppsala, Klampenborg and Umeå, September 1983

Olli Saastamoinen, Sven-G. Hultman,
Niels Elers Koch & Leif Mattsson

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MULTIPLE USE OF FORESTS IN THE SCANDINAVIAN COUNTRIES: AN INTRODUCTION

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The purpose of this introduction is to provide a framework for the papers presented in the first Scandinavian symposium on multiple-use forestry. First certain specific circumstances and features concerning the multiple use of forests in the Scandinavian countries are outlined. Each paper is then summarized and commented. Finally, some consideration is given to issues not covered by the symposium.

Key words: Multiple use, Scandinavian forestry

Introduction

These proceedings include papers from Finland, Sweden, Denmark and Norway on varying topics within the main theme of multiple-use forestry. There are papers on concepts, theory and practice as well as papers dealing with more specific problems in the relationship between forest uses. There are also papers describing the extent of singular forest uses, the production of different forest values and the inventories of such values. All these descriptions are focused on other uses and values than wood production.

This means that wood production, the most important use of the forests as seen from a traditional point of view in all four countries, is only brought up in relation to the other uses and values. This is, of course, due to the fact that there is already a large body of knowledge on wood production. Knowledge about other values and about relations between different forest uses is, on the other hand, relatively poor. At the same time, the relative importance of some of the other values and uses has increased in recent years.

The papers are arranged by subthemes. Below we present a framework for every subtheme. Each paper is summarized and some comments are offered. These are partly based on discussions held during the symposium. However, it should be made clear, that the comments represent the editors' interpretations and values. They do not attempt to voice the general opinion of the symposium participants.

Finally, we mention some of the many uses, functions and issues which were not covered sufficiently in the proceedings, and consider briefly the future of multiple-use forestry.

Multiple-use forestry: contents and concepts

The four Scandinavian countries have much in common as to geography and history. They possess also a common demographical factor: all are small countries by population — from 4 to 8 million inhabitants. Sweden, Norway and Finland are sparsely populated (13—18 inhabitants per

sq. km) but Denmark has a much denser population (119 inhabitants per sq. km).

Also from a forest resource point of view Denmark is different. Its forest land per capita is only 0.1 ha, while Norway has 2.2 ha, Sweden 2.8 ha and Finland 4.1 ha. The economic importance of forests varies accordingly from country to country.

An institutional fact of great importance for multiple-use of forests is the common right of access to all forest land, regardless of ownership. This historical tradition allows free access and overnight camping even on private forest land as well as, for example, picking of berries and mushrooms. Again, Denmark is an exception. There, the public is allowed to enter private forests (> 5 ha) only in the daytime and on foot.

The common right of access is a legal tradition but it is not necessarily a part of written legislation. Of course, the state of multiple use principle as an administrative and operational rule is the stronger the better it is formulated in the forest laws. In this sense there are some differences among the four countries. Norway, and to some extent also Sweden, have recently improved their forest legislation from this point of view.

The forest legislation in Denmark and Finland as yet does not directly recognize the principle of multiple use forestry. In Denmark these aspects are to some extent regulated by the Nature Conservation Act. In Finland only the paragraphs concerning state forests give a weak obligation to take the public interest into consideration. A committee report on forestry from 1981 suggested some improvements in the Finnish forest legislation from the multiple use point of view, especially for state forests, but these suggestions are still under discussion.

Although legislation concerning the principle of multiple use of forests is a recent development, the practice of utilizing the forests in multiple ways has a long history. This is well described in the first paper of the proceedings by Einar Stridsberg. He presents the multitude of forest use in the early Swedish agrarian society and makes it clear that conflicts between forest uses are not a new phenomenon. According to the author, a transition from the agrarian multiple use forestry to single use forestry (i.e. timber harvesting for forest industry) started already in the 19th century. At present there is again a tendency towards multiple use forestry but with quite different problems from those of former days.

From this historical background it seems appropriate to bring up a basic question: What do we mean exactly by the concept of "multiple-use forestry"? It can be answered in at least two ways; by describing how the concept is practised, or by discussing theoretical definitions. Thus, Börje Falk and Allan Mörtnäs examine how various uses besides wood production are taken into account in the Swedish forest policy. Elis Hedén then presents a picture of how the concept is understood and applied in the Swedish state forests. The paper by Sven-G Hultman adopts a more philosophical and critical view. He first describes how the concept has evolved and is practiced in the United States Forest Service. By comparison, he voices the opinion that in Sweden the concept has not been precisely defined. On the basis of a tentative definition he concludes that multiple-use forestry does not even exist in Sweden.

Other views of how the idea of multiple-use forestry can be understood and applied are offered by Niels Elers Koch and Torstein Opheim. Koch gives a rough picture of the extent of various forest functions in Denmark at the national level. He presents statistical data on forest areas with each function classified according to its importance. The paper by Opheim describes Oslomarka, the large and famous Norwegian forest area surrounding the city of Oslo. The area is important for outdoor recreation and other non timber uses. But at the same time it has national significance from the point of view of timber production. The case of Oslomarka, which is owned mainly by private forest holders, represents a common problem: how to handle multiple-use forestry in private forests.

Forest recreation and amenity values

Scandinavians often engage in outdoor recreation, and forests are the traditional environment for many activities.

This is well documented in Denmark, due to a large Danish research project summarized



Figure 1. Picking forest berries is an important part of the common right of access to forest. (Photo: Domänverket)

here by Niels Elers Koch. The project started in 1975. It aims at producing a better basis for decisions in the field of forest recreation. In Koch's paper some results — mostly those on forest recreational use — are reviewed and compared to similar results from other Scandinavian investigations. They show, among other things, a very wide variation in recreational use among forest areas.

In the following paper Jens Bjerregaard Christensen describes how he has used some of the data from the above mentioned project in an economic evaluation of forest recreation. Christensen's paper is the only example in the symposium proceedings of an attempt to evaluate one of the "other" functions of the forests economically, so that the function can be compared, for example, with the economic value of wood production. Although many studies in this field have been made in other countries, few exist from Scandinavia.

In two papers, Tuija Sievänen presents studies concerning the recreational use of forests near two towns in Finland. In the first paper she demonstrates the high interest in outdoor recreation among the population of a small northern town, and the important role of forests as a recreational environment, especially in winter. Her next paper deals with methodological issues. Three methods for the inventory of urban forest recreation are compared: field observation, field interview and mail questionnaire.

Besides the important questions about the extent of forest recreation and how to measure and evaluate it, one can ask why people use forests for their recreational activities and what factors, except distance from one's residence, make some forests preferable to others.

This question is no doubt connected with the aesthetic quality of forests. The paper by Risto Savolainen and Seppo Kellomäki presents methods and results of a Finnish study focused on assessing the scenic value of forest landscape, i.e. what type of forest do people prefer.

In a paper within the subtheme "Forests for grazing and game" it is concluded that

animals can habituate to disturbances from human activities to a certain extent. The same is probably also valid for human experience of the forest. A forest activity which in its innovation phase may be considered as negative by some interest groups could, after some time, be seen as indifferent.

However, this still leaves difficult questions. Are there limits to what the general public can get accustomed to? Furthermore, what is it expedient to habituate to when the relationship between people and forest is considered in a long-term perspective?

These are, as we regard it, questions which require also untraditional approaches such as the one in the paper by Aarne Reunala. When he deals with the question of how people experience the forest, he operates with psychological concepts, describes three levels of forest symbolism and discusses the relevance of symbolism in the controversies between recreation and timber production.

Forest berries

One of the important physical resources of the Nordic forests are the berries. In Finland, Sweden and Norway they make up a considerable part of the recreational value of the forest. But in many areas, picking of wild berries also contributes substantially to the standard of living. In Denmark, being the most fertile farm country of the four, the production of forest berries does not have the same importance.

Unfortunately, there is only one paper in the proceedings on berry production. Jouko Kortesharju presents data on cloudberry crops in Finland and discusses, among other things, the effects of forest drainage on the crops.

Although other studies about forest berries and mushrooms are not covered in the proceedings it should be mentioned that much research has been devoted in recent

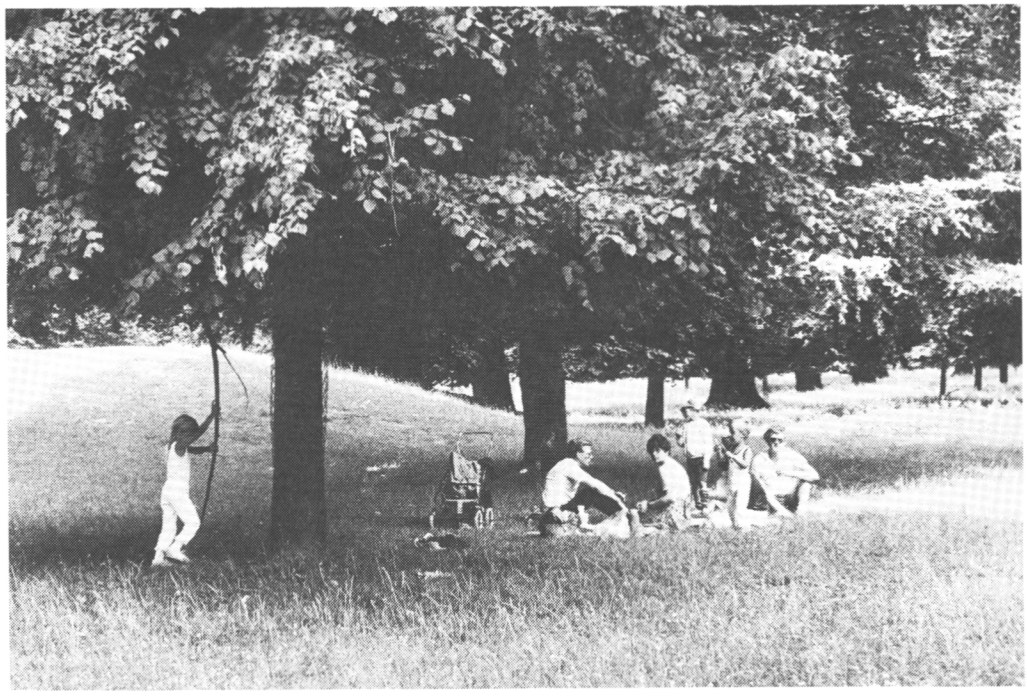

Figure 2. About 90 % of the adult Danish population visit the forest at least once a year. (Photo: Søren Fodgaard)

years to these questions. Especially in Sweden, nationwide inventories of forest berries and mushrooms have already been completed, and in Finland a large research project has started. Norwegian studies have mainly dealt with cloudberry cultivation.

Forests for grazing and game

Hunting is one of the oldest forest related activities. Forest grazing is another traditional forest use which, however, has disappeared in many areas due to the intensification in agriculture and in forestry. But especially one form of grazing, reindeer husbandry, is a vital industry in the northern parts of Norway, Sweden and Finland.

Leif Mattsson describes how the relationship between wood producing forestry and reindeer husbandry has developed in Sweden. In general, reindeer keepers much more than forestry representatives claim that the relationship involves problems, which have also increased during recent decades. Therefore an attempt to look at the forestry development from the reindeer keepers' point of view is made in this paper.

The paper by Timo Helle and Jouni Aspi focuses on a specific problem in the relationship between forestry and reindeer husbandry: the impact of prescribed burning on reindeer pasture. The preliminary results suggest that prescribed burning would be a less harmful method for site preparation than ploughing.

In the third paper on reindeer issues, Eero Mattila describes a system for inventory of reindeer winter ranges in Finland, based on the National Forest Inventory. It is a good example of the usefulness of integrated forest inventories.

Relatively much research has been done on the pasture production of reindeer grazing land. Some research has focused on changes in this production due to the impact of forestry activities. But many questions are not yet answered. However, there is even a greater lack of knowledge about the impact of forestry on the possibilities for reindeer husbandry to make rational use of the grazing land. Also, with the opposite impact, that of reindeer husbandry on wood production conditions, many questions remain to be studied.

The paper by Tord Johansson, based on studies in Sweden, about sheep-grazing on reforestation areas, is interesting mainly for two reasons. It describes a relationship which seems to involve mostly positive reciprocal impacts. Most importantly, sheep grazing eliminates the need for a very controversial forestry activity: herbicide spraying to control unwanted broadleaved vegetation. Although of very limited extent today, this double land use could be an advantageous combination for the future, at least in forests near population centers and in agricultural areas. Similar results have been obtained in Denmark both in research and in practice.

The paper by Johnny Lund Jeppesen deals with a special multiple use problem in the most intensely used forests in Scandinavia. It describes the disturbing impacts on the game (roe deer and red deer) by various recreation activities in Danish forests. One conclusion in Jeppesen's paper is that the animals can get used to these activities to a certain extent.

One may add that the question is not only how much human disturbance the game or other animals can take. The opposite question is often as valid. At least in Sweden and Finland the population of moose, the most important game species, has increased to the extent that forestry people are more than anxious about the damage to pine seedling stands.

Planning for multiple-use forestry

It is generally agreed that forests have many values and can produce many different kinds of goods and services. The final question still remains: in what way should we plan the forestry so as to achieve some kind of optimum combination of potential uses? The last four papers in the proceedings approach this question from very different viewpoints.

In the first paper Olli Saastamoinen takes a theoretical approach when he describes the concept of product transformation telling concisely the interchangeability between forest uses. The study of product transformation gives basic knowledge on the technical alternatives of product mixes. To complete the economic analysis in a traditional way, some procedure for pricing the



Figure 3. Reindeer are managed in forest and fell areas in the northern parts of Finland, Norway and Sweden. (Photo: Olli Saastamoinen)

unpriced products of forests is needed, as demonstrated in J. Bjerregaard Christensen's paper mentioned earlier.

The paper by Erik Skärbäck describes the tools available in Sweden to the urban planner to facilitate multiple-use of forest land near residential areas. His concrete example relates to outdoor recreation. Anja Finne and Pekka Ovaskainen, on their part, describe the planning procedures and problems of the Urho Kekkonen National Park, which is the newest flagship in the Finnish system of nature conservation areas.

The approach in the last paper is that of a traditional forestry planner. Pertti Veijola presents a simple model from Finland for multiple-use planning, which helps to give the other uses equal weight with logging and silviculture in short-term plans.

The development of multiple-use forestry is closely related to progress in the planning procedures. At present it may not be unfair to say that the forest management plans in commercial forests are often not much more than timber management plans. They only seldom take care of other forest values systematically, even if in this respect great differences may prevail in different countries and forest ownership categories. It seems clear that in the future more emphasis must be laid on the development of operable planning systems and procedures for multiple-use forestry. Also the involvement of various interest groups and the public to the forest planning must be considered.

Functions and issues not covered by the symposium

Although the ambition of the symposium was to cover the main aspects of multiple-use forestry in Scandinavia, many uses, functions and issues were, of course, not touched upon or were treated insufficiently. A few examples are:

- hunting
- production of mushrooms
- production of Christmas trees, as well as decoration greenery and lichens
- protective functions of forests: water regulation, climate influence, erosion control etc.
- forests for pollution (including noise) abatement
- the forest as a cultural resource and heritage
- future potential for human use: genetic conservation
- strict preservation problems and their ecological and ethical basis

The omission or insufficient treatment of these aspects in the proceedings does not mean that they are considered unimportant

— only that the symposium had certain limitations.

In some cases the omissions were due to the fact that people engaged in these problems could not take part in the symposium. In other cases they reflect the situation that there are many problems to which little research has been devoted.

The first scientific studies on multiple-use forestry appeared in the sixties, but the major part of multiple-use research in the Scandinavian countries has been published during last ten years. If this growth in the scientific interest is any evidence, we have experienced a turning point and entered a time where non-timber uses will receive increasing concern. The timber will, however, still remain a major forest product when seen from a national perspective. What is evident and significant is that the overall importance of forests will be growing.

Even if the research on multiple-use forestry has increased, the scientific community in this field is still small in relation to the great number of complicated research problems.

This serves as a reminder of the great work that lies ahead — if we want to make multiple-use forestry a vital and applicable concept. It is a great challenge, but could be a rewarding one.

But to succeed, it is not enough merely to encourage research. Also good collaboration between the practical organizations and the scientific community is of vital importance, as stated in the resolution of the symposium.

MULTIPLE-USE FORESTRY IN FORMER DAYS

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ODC 902+913+907+908+(485)

The purpose of this paper is to give a long-time historical perspective on the multiple-use forestry problems that have developed during the last decades. From a very simplified land-use model of the agrarian society a more accurate analysis is made of the multiple forest functions of that society. The next part describes how the economic, technical and social upheavals of the industrial revolution caused a transition to "single-use forestry". The trends are followed up to the 1950's.

Key-words: forest history, agrarian land use, multiple use

Introduction

The presentation is based on the forest-historical research I have done with Leif Mattsson and published in two larger works (Mattsson & Stridsberg 1981, Stridsberg & Mattsson 1980).

In man's use of the forest, great disparities will be found between different epochs and different societies. This paper describes the development from the forest uses in the agrarian society — where the multiple forest functions belonged to the "secondary outfield activities" (cf. below) — to the forestry of the industrial society with its economic, technical and social upheavals. Despite many clashes between industrial forest exploiters, official silviculturists and agrarian forest owners it is evident how the new forces shaped a trend towards "single-use forestry". These tendencies are followed up to the 1950's when forestry, according to a broad opinion, had solved its major problems and seemed to pass into a prosperous and harmonious era.

The sweeping changes which have occured during the last three decades must be so well known to the participants of the symposium that a description is unnecessary. The questions to put forward instead seem to be: "What are the reasons behind the changes? Why did the situation become another than the proposed?" By placing the symposium discussions of today's problems in a wider historical perspective, I hope that they will be useful and fruitful also in shaping the forestry of tomorrow.

Characteristics of multiple-use forestry in different epochs

Nature as a recreation resource, as a free benefit available to all, has become a more and more important and expanding theme in the industrial society. In a society, where the urban population amounts to more than 90 %, the need is very great for outdoor recreation and contact with nature.

The turn to this new form of living has been very rapid. About 100 years ago, 3/4 of the people in Sweden lived in the countryside, and the contact with nature was much more great and direct. However, it was not forestry but agriculture which formed the base for living. As in our days, the forest was the outfield ground. It was located

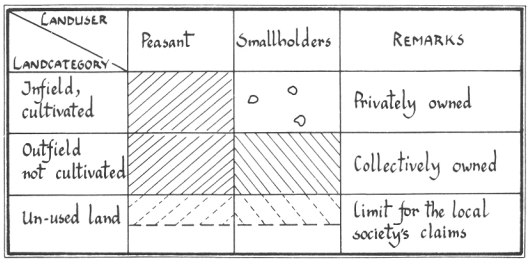

Figure 1. A model of land-use in the agrarian society.

around the infield ground, which formed the primary living conditions for the peasantry.[1])

The origin of this form of society, when mankind learned to herd animals and to cultivate the soil, is hidden far back in prehistoric times. From hunting, fishing and searching over wide areas for what nature could give, the peasant took the production of the ground in his own hands. And with this soil cultivation the proper living area was reduced. Outside the fences that sheltered and limited the cultivated land, begun the outfield ground which for the nordic countries had a vast area but a sparse population and a secondary interest.

With a growing population the growing need for further production was first satisfied through further cultivation of the infield ground and from expanding this over the areas close to the fences. Only on the third hand were more distant areas taken into account, partly through cultivation of fertile places and partly through a renewed and intensified exploitation of what nature provided directly.

Regarding the last land use it was probably used mainly by landholders with crofts too small to survive on through agriculture alone. For them, forest products of many different kinds became very important. But also for cattle raising an expansion of the infield ground meant a growing demand on the outfield use. A larger meadow area meant that more cattle stock could be held through the winter which, in turn, required greater areas for forest grazing in the summer. Moreover, the best forest grazing grounds, were often the first to be cultivated. This further increased the size of the areas needed for forest grazing.

The above presentation can be illustrated in a 4-field figure. Land users are divided into "peasants" and "smallholders" and land categories into "infield" and "outfield". With the exception of small crofts, the infield ground is held by the peasants and is privately owned. In contrast, the outfield ground is collectively owned (Fig. 1).

The figure also suggests a third ground category: un-used land without interest for the local society. However, the figure indicates that the owning claims of the local society go further than the production-minded reasons which have ruled the model. These claims result from a territory-thinking, aimed at getting land-reserves for own future use and to prevent other local societies from encroaching.

The forest functions in the agrarian society

The outfield forest in the agrarian society thus played a secondary, but by no means negligible role. Especially for cattle-raising in the forest regions is it true that the meadow area played a keyrole. However, the harvest from this was only enough to allow the animals to survive the winter. The proper animal production occured during summer and on the outfield grazing. Also for crop-raising, a shifting cultivation through burning of forest land played a supplementary role to soil cultivation on arable land.

Forest use in this agrarian society was more "ground-minded" than nowadays. The collecting of berries, mushrooms, moss and lichen concerned other plants than trees and the collecting of roots, bark, resin, leaves and fruits other parts of the tree than the stemwood. The sparse tree-vegetation caused by forest grazing, and the broad-leaved deciduous forests with fruit-bearing trees and a rich yield of leaves for fodder was to

[1]) The terms "infield" and "outfield" are taken from the swedish Glossary of Forestry (Skogsordlista 1978). Cultivation of the soil is the criteria which separates infield from outfield. In "A Glossary of Geographical Terms" (Stamp 1966), "infield" is characterized by intense and continous cultivation while "outfield" is periodically cultivated land. In this paper, "outfield" consists both of periodically cultivated land and of un-cultivated land used for grazing and other purposes.

a modern mind a very specific forest. However, this was true also for the agrarian society itself. The park-meadow belonged not to the outfield but to the infield ground.

The importance of hunting obviously decreased with development of the agrarian cultivation. In later medieval times it had become a pleasure-occupation for king and noble. With the exception of the northern part of Sweden, where hunting still played a role for subsistence, a law was made in the 17th century forbidding hunting of royal game animals "lest the peasantry by such hunting should neglect the care of their farms".

Hunting of game birds was not forbidden, though, and hunting of predatory animals was a duty. Hunting or not hunting was not so much a question of who was the owner of the hunting-ground as of the form of hunting.

Although wood-harvesting was not as dominating in the older agrarian society as it is today, it was still of great importance. The primary need was for fire wood and timber for household use such as house-building, fencing, making hay-racks etc. For almost every kind of implement, wood was the dominating part. In the plains, where the population was dense and the distance long between settlements and wood resources, this could be a problem. After some presages already in the 17th century the wailing over wood-shortage and forest devastation in the 18th century often took very extreme forms. Also for outfield-use, wood played an important role for heating, for erecting sheds and huts and for building bridges and planks. But here it always, for the common people, had the character of a free benefit.

Concerning timber for sale the oak and some other broad-leaved deciduous trees played a role already in medieval times. With the royal game animals in mind, the crown asserted that such "bearing trees" belonged to it even if they grew on peasant land. As time went on it was, however, not the fruits but the timber for shipbuilding that made the oak so attractive to the state. Yet, coniferous saw-timber had a much larger part of the wooden goods market and played a considerable role for export.

However, the most important forest product on the export-sector was the charcoal through its importance for the mining industry. Also tar had a higher export-value than wooden goods in the 17th century. As for tar-burning, this was made solely from pine and mostly of roots, but by barking the standing trees it was possible for the peasantry to also make the stem rich in pitch. By burning of broad-leaved trees — in south Sweden mostly beech, in northern Sweden birch — potash was derived. In other regions, rich in firewood, these trees were the basis for firewood-demanding enterprises such as salpetre-boiling, brick-burning and making of potato brandy. Birch bark also gave an opportunity for the poor but handy man to gain extra earnings. In the forest region of south Sweden, tree products formed the base for the development of a handicraft which later went on in the direction of textile-goods and furniture making.

Forest use in the agrarian age was really a very multiple use. In most cases it claimed a heavy labour input with a very modest output. Its most important social significance was that it provided employment for the smallholders and the disinherited peasantry without enough arable land. "The forest as the coat of the poor man" (skogen som fattig mans tröja) seems to be a nordic phrase with a deep meaning.

The transition to single-use forestry

Starting in the mid 19th century a very obvious transition has occured from this very multiple forest use to timber-harvesting for a forest industry. Yet one can find signs of such tendencies to single-use forestry already earlier. In the research project "The individual, society and the evolution of the rural landscape" at the University of Stockholm this theme is elucidated through a micro-study of the hamlet of Barknåre in northern Uppland. My part in this research is to analyze the influence of the development on this small and local agrarian society by the rising of Lövsta bruk.

This ironwork was founded by the crown in the 1570's. After being bought by the great industry-magnate Louis de Geer in 1643 it grew very rapidly into the biggest ironwork in Sweden. Its demand on charcoal had far-reaching consequences also on the agrarian land about 20 kilometres around the industry



Figure 2. This 170 year old stand represents a very rare kind of forest environment in Sweden. (Photo: S-G Hultman)

site. For the hamlet region of Barknåre it meant a great expansion in economic and social life.

From 1650 to 1740 the number of farms more than doubled and charcoal-burning in the outfield forest grew to be of the same importance as the earlier predominating agrarian occupations. However, the welfare and the gains of this development to the greatest part was reaped by the ironwork. The peasantry, who formerly had been free taxpayers, largely became tenants.

One of the main features of the explosive growth during "the industrial revolution" was the greatly improved communications network. This is especially true of the timber-exploiting in northern Sweden which depended entirely on the river-driving. Because of a rapid agrarian colonisation in the north during the 19th century, the labour-mobilisation was no great problem for the growing sawmills. There, this labour was needed only in the winter when agriculture was resting. Through the sawmill industry's "investing in accessibility" the sawlog consumption had increased by eighteen times from 1850 to 1900 simultaneously with a decrease for many of the older forest products. For tar, salpetre and potash the industrial development itself meant a decreasing demand on the older production forms.

The end of shifting cultivation, including burning — preached without success for centuries by the authorities — suddenly became a reality when the sawmill company offered the crofter better wages for his labour and the farmer better prices for his timber. It is really most astonishing that such forms of the older agrarian forestry as forest grazing could continue long into the 20th century despite the strong changes that characterized the agrarian production.

For the forest authorities, who preached rationing of the forest and investments in silviculture, the new "opportunistic industry" seemed to be a forest exploitation. A forest

committee of 1868 judged that such an exploitation would transform the northern forest regions of Sweden to "an utter wilderness, devoid of civilization for all time". When the principle of sustained yield later, around the turn of the century, was acknowledged by the forest industry the clashes with the silviculturists ceased. Instead, a conflict developed with the representatives of agriculture. The now "sustain-yield-minded" forest industry was not as before content with far reaching cutting-rights but bought whole farms with infield ground as well as the outfield forest. This problem was solved by the land acquisition act of 1906 which forbid companies to acquire land.

Despite these hard and deepgoing economic, social and land use conflicts and a hot debate between state, industry and farm forestry as to which one carried on the "best" forestry, it became more and more evident during the 20th century that these differences in opinion more concerned the means than the goals. Also, there was now full agreement, that forestry must be based on silvicultural activities: timber harvesting must be followed by regeneration measures. Concerning the direction of the wood production the opinion seemed to be unanimous. The forest industry's demand for a sustained yield of wood corresponded largely with the forest owners' claims for a satisfactory outcome from silvicultural investments, the forest workers' claim for a satisfactory earning and the wish of the authorities for a prosperous commercial and industrial life.

When the Minister of Agriculture proposed the silvicultural law of 1948 it was very evident how the above mentioned tendencies and principles had come into the fore, and pressed the older forest agrarian forms back. Forest grazing had ceased to be of any importance and the firewood consumption, which had peaked at the end of the World War, decreased in the next decade to negligible amounts. Forestry had become a single-use activity with the aim to produce raw material for the forest industry. And after a long and hectic period of conflicts, forestry now seemed to pass into a prosperous and harmonious era.

The problems of today

When we now — three decades later — look at the situation, it is, however, quite different. "Multiple-use" has anew become a mighty slogan. But unlike the approach of the agrarian society, present-day multiple use mostly concerns environmental protection aspects and recreation. To elucidate these very important, but also difficult problems, is one of the ambitions of this symposium. But it cannot be the task of this paper. Its aim has been limited to providing a deeper dimension by way of a long-time historical perspective.

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MULTIPLE USE IN SWEDISH FOREST POLICY

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The purpose of this paper is to clarify the concepts and background ideas of the multiple use forest policy in Sweden. After a short review of the various uses of forest land in the past, it is described how the multiple use idea has been introduced into the forestry legislation of today. The work of applying rules in practical forestry is exemplified. Finally, some aspects of the future development of multiple use forest policy are discussed.

Key words: forest policy, government policy, Forestry Board, multiple use

Historical background

The forest is a living ecosystem which we use in many ways. For a long time it was used for hunting and food gathering. Later the forest was grazed by cattle and cultivated. Man is without doubt part of this ecosystem and has achieved the power to influence and change it in a way that only natural catastrophes could before. Most of the productive forest land has been affected by some form of forestry work.

The rural population in Southern Sweden considered the forest mainly as pastureland up to the 20th century. Large areas, today afforested, were then heavily used for grazing and thinly covered by bushes and a few trees. Mining consumed much timber in Bergslagen. Slowly the sawmill industry grew along the coast of Norrland causing heavy plunder of the forest in this area. Some silvicultural measures were already carried out in the Middle Ages on Crown land for use of timber for the navy. Also the forests belonging to the castles and manors were managed especially for hunting purposes. The feared shortage of timber for mining caused the start of silvicultural measures for timber production in Bergslagen.

There have been directions regulating forest use for a long time. The oldest legislation affected, for example, the right to shift and cultivate forest land, grazing, hunting, the right to fruit-bearing trees and large trees for masts and ships. The act of 1734 introduced more general conservation rules. From 1903 to 1975 forest legislation contained mostly rules aiming at an even satisfactory timber yield with one important exception: the rules for forests which are difficult to regenerate and for forests with a protective function.

Nature conservation is introduced into the Forestry Act

In the 1960s people's interest in what was happening to nature increased. The methods used in forestry were eagerly discussed and criticized. Official investigations were started and from 1962 to 1978 at least six government reports dealt with the matter of "nature consideration"* in forestry. In 1975, as a result, an additional paragraph was introduced into § 1 of the Forestry Act: "Consideration should be shown for the interests of nature conservation". The National Board of Forestry was commissioned after discussions with the National Environment Protection Board to issue directions and cooperate in executing the measures.

* "Nature consideration": to take nature conservation into consideration.

In the directions to § 1 of the Forestry Act, regulations were introduced on considerations to be shown in various working operations such as final fellings, establishment of stands, stand treatment, logging, transport and chemical use. Consideration should be shown close to paths and roads, on waste land and small special terrain parts, near mating areas important to birdlife, for rare plants and close to tourist roads. These regulations distinguished between consideration to be shown on all forest land and forest land where special consideration should be shown to recreational interests and to the comfort of persons living near-by.

The Forestry Commission of 1973 presented a report in 1978, Forest for the Future (SOU 1978: 6—7). After having circulated the report for comments, the Government presented a bill: Guidelines for Forest Policy etc. (Regeringens prop. 1978/79: 110), in which the consideration of nature conservation and outdoor recreation was emphasized considerably more than before. In this bill the Minister of Agriculture made some statements of importance for our subject (pp. 52—53):

"As I have said before forest management must take into consideration the fact that the forests are environment for flora and fauna, that they influence water-balance, local climate and the possibilities to use forest land for outdoor recreation. Furthermore, the interest in preserving certain elements of the cultural landscape must be considered. Forestry must be practised so that the conditions for multiple use of our forests are not disturbed.

According to my opinion, these interests could in many cases be fulfilled within the frames of rational forestry. As to the demands for the outdoor recreation environment, it is in the vicinity of urban areas and in some other areas of special significance for outdoor recreation that complications may arise in setting aside satisfactory recreation areas without hampering forestry too much. In other areas, demands for a good outdoor recreation environment can be satisfied within the frames of "Common Right of Access" without hampering forestry. To satisfy outdoor recreation and other interests, adjustment and consideration are needed concerning various measures taken in forestry. As before, restrictions which could be included in a rationally practised forestry should be regulated by consideration rules in the forestry legislation. The rules should apply primarily to such measures as cutting, stand treatment and establishment of stands, —.

The regulations I have mentioned could also be used to satisfy some of the interests of cultural monument preservation. I want to pay attention to the fact that stationary ancient monuments are protected specially by the Act on Ancient Monuments (1942: 350). When working out the regulations discussions ought to be held with the authorities involved."

The Government bill led to a new Forestry Act (SFS 1979: 429). The first article runs as follows:

"By means of proper utilization of their wood-producing capacity, forest land and forests growing on them should be managed in such a way as to provide a permanently high and valuable timber yield. This management should pay heed to nature conservation and other public interests."

This is almost the same wording as the first article had since 1975 but with the addition of "other public interests" which also includes reindeer husbandry. "Nature consideration" also got a special article, § 21, in which there are general recommendations and detailed regulations. In the decrees to the Act (Skogsstyrelsen 1979) a new instrument for practical work with "nature consideration" aspects was established which means that special forest management plans (NISP) can be set up for the most sensitive areas. These plans are free of charge to the forest owners. The "nature considerations" to be taken should be pointed out in detail in these plans.

Discussions on the multiple use concept in the Swedish forest policy

The environmental movements have claimed that the Swedish forest policy concerning nature conservation is narrow-minded and that it hardly satisfies the idea of multiple use. The nature conservation aspects and the use of the forests for recreation are, according to the critics, almost only dealt with as restrictions on the production of industrial wood.

In the official report Forest for the Future (SOU 1978:6) there are some very important principal statements which have to be regarded before a judgement like that above can be made:

— "The Common Right of Access" allows most kinds of recreational activities on all forest land
— Many other articles than § 21 satisfy the nature conservation interest by requiring silvicultural measures to achieve a sustained yield of timber. Short-range exploitation is not allowed.
— The demand for a high industrial wood production must be adapted to other claims for forest land. The restrictions on wood production should not be more than what is unavoidable to fulfill other demands.

To compare with the multiple use concept in the USA is not relevant because of its being sectorized. In the USA, it has a very qualified shape in the state forest while there are many restrictions on outdoor recreation in the private and company forests.

In Sweden, multiple use is as a matter of fact an obvious condition and a starting point for practising forestry on all forest land. The Forestry Act is considered to be an act of conservation intending to preserve and also improve the natural resources of the forests for the future. This statement is expressed in the County Forestry Boards' comments on the National Physical Planning.

Multiple use in the Forestry Administration work

The main principle when choosing between many interests is mostly to consider recreation and nature conservation aspects in such ways that losses of industrial wood production are limited. The Forestry Administration (the National Board of Forestry and the 24 County Forestry Boards) is working with these guidelines to promote forest work and at the same time show adequate consideration to nature conservation. The most important instrument for this is the Forestry Act, article 21, which gives detailed recommendations both to the forest owner and to the forest authorities. These recommendations have been worked out in consultation with the National Environment Protection Board and are well established within forestry. The aspiration is that the forest owners follow these recommendations quite naturally without any prodding from the authorities. If it is needed the County Forestry Boards can give the forest owners so called "hints and directions" on what to do and if this does not help the County Forestry Boards can prescribe what to do.

The rules and recommendations in article 21 are arranged in two parts. One is applied to all forest land. For forests close to urban areas and on land sensitive from a nature conservation point of view more far-reaching considerations are to be taken. This can illustrate the ambition and the possibilities for forest production also in very intensive multiple use areas close to urban areas.

The instrument most used to influence the forest owner is, however, information and advisory work. The many books and pamphlets used in these activities illustrate how the content of the recommendations has developed and become more complete. In 1975, we started with education and teaching aids which to a great extent deal with consideration to the landscape and to people's well-being.

In the Forestry Act (SFS 1979: 429) flora and fauna have a more prominent position. The qualifications of our forestry staff improved on these subjects as a result of extensive personnel training. Two books have been published, one on fauna preservation in forestry and the other on flora preservation in forestry. In a few years we will publish a book on preservation of ancient culture in forestry and thereafter a book on outdoor recreation and forestry.

A rather new task for the County Forestry Boards in Northern Sweden is to support consultations between the representatives of the reindeer owners and the forest owners. These two industries use the same land and represent in this way multiple use on large areas. A pamphlet containing hints and recommendations concerning forestry and the reindeer breeding illustrates how we work to eliminate unnecessary antagonism between the two industries. Most of the content in the recommendations has been produced by a consultation group in which both parties and the authorities are represented. The illustrations in the pamphlet (cf. Fig. 1) are made by a Laplander which shows that team work is necessary. In a few years there will be a special education program on reindeer husbandry for our staff and also a book written mainly by Laplanders.



Figure 1. Tree lichens are an important forage for the reindeer which should be considered in the forestry planning. (Drawing: Lars Anders Utsi)

An alternative multiple use forest policy?

We have tried to show how multiple use is an obvious prerequisite for Swedish forestry and for our work in the Forest Administration. However, the main point in this forest policy is to improve the industrial wood production with as little damage or disturbance as possible on other productions or functions of the forests. Of course, this could be considerd as a passive role against the other interests. Our organization could perhaps have been given the task to help and develop other forest productions. From research by Lars Kardell and others we know, for example, that a very small amount of the production of berries and mushrooms is used. Our inventory work will in 15 years cover all private forest land in Sweden. We could easily cover the data on the production of berries as well as the wood production. It also would be possible to inform the public where to find the berries. To do this we need public resources, i.e. tax revenue. Today it is not likely that our organization would receive more resources and therefore, we should be forced to reduce our ambitions to improve wood production. A development of the forest policy in these directions is most unlikely today when demand to care for wood production is increasing.

The Swedish forest policy concerning multiple use is certainly the only realistic one. Forestry does not include other forest products but should be carried out with a high degree of respect to them. This is very clearly expressed in the Government bill (Regeringens prop. 1978/79: 110, p. 52):

"Forestry must pe practised in such a way that the conditions for multiple use of our forests are not disturbed."

The same statement is found in the foreword to decrees concerning the Forestry Act (Skogsstyrelsen 1979):

"The use of the forest and forest land is of great importance not only to forestry. The forest is the habitat of flora and fauna which cannot tolerate drastic changes in their environment. It influences determining environmental factors such as water-balance and local climate. The forest is also an indispensable asset for outdoor recreation including such activities as hunting, berry and mushroom picking etc. It is in some cases an important element in the cultural landscape."

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MULTIPLE-USE FORESTRY PRACTISED BY THE SWEDISH FOREST SERVICE

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The Swedish Forest Service claims that an extensive outdoor recreation may quite well be combined with economic forestry. In intensively utilized recreation areas close to big cities, a more far-reaching adaption of forestry is sometimes necessary. The needs of scientific nature conservation can often not be met, unless a Nature Reserve is established and no economic forestry is practised.

The Swedish Forest Service has all domains classified in land-use classes, in which other interests than timber production have a varying weight.

The right of common access to land ("Everyman's Right") is an important element in multiple use of forest land in Sweden.

Key words: forest policy, national forests, multiple use

Introduction

The Swedish Forest Service (SFS) is responsible for administration and care of state-owned forests and farm land in Sweden. The possessions are concentrated in the north of the country, but there are Crown forests all over Sweden. The state owns about 20 % of the productive forest land in Sweden.

SFS has a long tradition not only in forestry but also in nature conservation and outdoor recreation. Before the National Environment Protection Board was established in 1968, SFS served many of the purposes, which the nature conservancy authorities now have taken over and greatly developed in many ways. Erik Höjer, former Director General of SFS, started to talk about multiple use forestry as one of the first in Sweden after a visit to USA in 1960.

In the last few years SFS has developed into a business enterprise and to a great degree left its role as an authority. On the forestry side the National Board of Forestry now serves these purposes on the basis of the Forestry Act. SFS has recently been ranged under The Forestry Act and under the supervision of the National Board of Forestry.

Environmental management programme

How then, does multiple-use forestry function in SFS? How much space may other interests be given in a state forestry that is very similar to private forest companies and has to compete with them on the same conditions?

The Government ordinance concerning SFS from 1975 states: "SFS practises forestry, handling of wood and other connected enterprises . . . The activities of SFS shall aim at obtaining the highest possible long-term financial result in co-operation with the State-owned Forest Industries (ASSI). Simultaneously SFS shall achieve an acceptable annual result in view of business economics."

The ordinances do not mention multiple use; they are concerned with the economic

results of forestry. However, the Nature Conservancy Act and the Forestry Act both cover other interests in the forest land. SFS itself interprets the ordinances in the way that activities should be carried out in accordance with commercial principles, but with substantial room for environmental consideration, for instance. This is expressed in the Environmental Management Programme for SFS from 1973. The programme was developed from the ideas of Erik Höjer, and is still valid.

Forestry, as practised in Sweden, implies that wood production capability is maintained or better still improved in the future. Fundamentally, the demand for good planning of the natural resources coincides with the economic and sustained yield forestry interests. SFS wants to preserve the environment and practise economic forestry in such a way that the vital power of the forests in the long-term is maintained or improved.

It follows, that forestry must not be detrimental to soil and water from an environmental point of view. As far as possible the beauty of the landscape shall be preserved for the future, and visitors shall have access to the forests for recreational purposes. This implies that a general and extensive recreational use of all Crown forests should be promoted, and that the more intensive recreational activities should be concentrated in selected Crown forests and other specially reserved areas. Wildlife should also be preserved and, when possible, improved.

There is no reason to conceal that timber production comes first in the use of forest land. And why should it not in such a vastly forested country with so few inhabitants and where wood and forest industry for hundreds of years have had a decisive importance for national economy and employment?

All forest land is important for forestry even though the production capability varies, as do the costs of taking out the wood. To nature conservation and outdoor recreation the value of the forest land varies depending on biological conditions of plant and animal life and of the location and suitability for outdoor recreation.

Starting from this point of view all the domains of SFS are classified in land-use classes. For the different classes detailed land use plans in the form of working plans, disposal and management plans, and extraction plans are then made.

The land-use classes are:

I Forest land with timber production as the main use. This class constitutes the main part of the forest land area.
II Forest land where special consideration is to be given to nature conservation and recreational activities.
III Land reserved for non-forest products.
IV Agricultural land.
V Specially reserved areas. Included here are Nature Reserves, Crown Reserves and Forest above the reforestation limit.

The domains are to be reclassified continuously as the conditions change.

Even if timber production is the main use within *Land-use class I,* nature conservation, wildlife management and outdoor recreation should always be considered when planning and carrying through measures. Close to houses, roads, lakes and streams special attention is required. Single trees, groves and bushes should be left. In areas highly frequented by the public, it may be advisable to choose regeneration by means of seed trees, even though planting may be preferable from an economic point of view.

Deep cultivation ploughing of clearfelled areas should be restricted to areas where other methods of scarification are unsatisfactory from a biological point of view. The use of pesticides should also be restricted. In connection with forest fertilization a strip 50 metres wide should be left alongside lakes, major watercourses, private lots and areas which supply fresh water.

Land-use class II includes:

— areas visited frequently for outdoor recreation purposes
— recreation areas providing special facilities for recreational activities
— landscape preservation areas in which the scenic beauty or nature conservation is of special value.

Accordingly, class II includes different types of special land-use beside economic forestry. Silvicultural activities should be adapted to the use of each particular area. Economic sacrifices are accepted; they should, however, always be kept in reasonable relation to the aim of the area.

Each area should have a specially adapted management. Examples of divergencies from the normal silviculture program are:



Figure 1. Moose *(Alces alces)* is the most important game species — but also a problem for forestry. (Photo: Börje Mineur)

— A prolonged rotation period can be accepted.
— The clear cut areas shall be planned in such a way that the scenic beauty is disturbed as little as possible.
— When cutting is performed with subsequent planting, a number of big, beautiful trees should be left standing.
— Variation in tree species is recommended and a greater proportion of hardwood can be accepted.
— Deep cultivation ploughing is not accepted.

Some words may be mentioned about *Land-use class V*. The ownership of all National Parks and most of the state-owned Nature Reserves is exercised by the National Environment Protection Board. There are however Nature Reserves also in Crown forests. Furthermore, SFS has established about 750 Crown Reserves with a total area of about 45 000 hectares. These are as a rule exempted from normal forestry. For each one there is a management plan adapted to the object of the reserve.

In the areas closest to the mountains in the north of Sweden, SFS has exempted more than 500 000 hectares from normal forestry, due to biological motives. The uncertainty of regeneration is so great, owing to the climate, that clear cuttings are not performed. Adjustments of this reforestation limit are made when a more reliable basis for forming a judgement is available. Reindeer husbandry and nature conservation will, however, also in the future have access to large areas where no intensive forestry is carried on.

In this way other interests than timber production have always a place in the management plans of SFS. It ranges from general consideration of nature conservation and outdoor recreation on common forest land in accordance with guidelines in the Forestry Act, to reserves where economic forestry is not practised at all.

SFS manages 3.75 million hectares of

forest land below the reforestation limit. Of this 55 000 hectares (1.5 %) are reserves. An equal amount of land, 56 000 hectares (1.5 %) are classified in an intermediate group. In these areas, other interests are considered more than on common forest land but without reaching the status of a reserve.

Education and practice

Planning for multiple use of forest land is not worth much if it is not carried into effect by the people who do the job. As an essential part of achieving this SFS has given all forest workers and foremen a training course, "Miljövård i skogsjobbet" ("Environmental care in the forest job").

Furthermore the County Forestry Boards have recently provided education in both fauna and flora preservation in forestry. SFS has utilized the possibility to send foresters and foremen to these courses.

Hunting and fishing are highly appreciated leisure time occupations on the domains of SFS. Both hunting and fishing licenses are sold at current market prices, but the ambition is to provide as many opportunities for hunting and fishing as possible. We estimate the number of hunting and fishing days on the domains of SFS to 3—400 000 each. Hunters and anglers are often looked down upon by "true" nature lovers. The fact is, however, that they are great in numbers. They are often very well informed naturelovers and they make considerable voluntary contributions for preservation of game and fish.

When comparing multiple use of forest land in, for instance, the USA and Sweden it is important to remember what the right of common access ("Everyman's Right") means in Sweden. Much of what in the USA is regarded as a result of planned multiple use in certain areas is included as a natural part of the right of common access to all forest land in Sweden. Take for instance the right to move about freely in fields and woods, to camp for one night without the landowner's permission, to swim and boat in lakes, to go ashore, to pick mushrooms and berries and to make a camp-fire provided there is no danger of causing a forest fire.

To facilitate all this utilization of the domains, SFS generally keeps the forest roads open to the public. This is true also for other landowners, unless there are special reasons for closing a road.

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MULTIPLE-USE FORESTRY IN SWEDEN: UNDEFINED — AND NON-EXISTENT?

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The Multiple Use concept is reviewed as it applies to the USA and to Swedish forestry. It is concluded that Multiple Use is well established in theory and in practice in the USA. In Sweden, however, it has not even been defined, much less applied. This conclusion is based on a tentative definition offered by the author. Finally, it is hypothesized that Multiple Use in Swedish forestry is a long time off — but that it will come because of a mounting pressure from interests other than the traditional, wood producing ones.

Key words: forest policy, multiple use, concept

Introduction

The Swedish *forests* have many functions and can provide for many uses (Andersson & Hultman 1980). This fact is no proof, though, that our *forestry* is a multiple-use forestry.

There is a difference between forests and forestry. Forests are the objects of forestry. Forestry should, as most foresters would agree, be a rational practice. Management should be guided by policy and supported by sound and careful planning.

If, in this policy, it is acknowledged that forests have many functions — would it not seem logical that the planning and practice of forestry should be set up to handle these values in a methodical manner?

In the Swedish forest policy, however, wood production is clearly stated as the main objective. Still, forestry representatives often claim that we have a multiple-use forestry.

How is this possible? Could it be, that the concept "Multiple Use" has never really been defined? Is there, as indicated above, a confusion between "forests" and "forestry"?

Just what do different groups mean by using the phrase "multiple-use forestry"? Is it more than a cover-all (cover-up?) term? In what way, if any, does multiple-use forestry differ from forestry in general?

All of these questions, and many more, must be answered if Multiple Use in the forest sector is to have any real meaning and practical significance. In this paper, I indicate, what to my mind, should go into a definition of multiple-use forestry. Based on that definition, I discuss whether Swedish forestry is, in practice, applying the multiple use concept or not.

The concept historically reviewed

This review is based on a selection of literature which describes the present situation and the evolution of the concept in the USA. I have also searched for Swedish literature where the concept is discussed as it applies to Swedish conditions.

Multiple Use in the USA

The concept, no doubt, emanates from the USA. The main reason for this is, in my

opinion, that the "common right of access to land" does not exist in USA. After World War II, the rapid increase in outdoor recreation put a heavy pressure on the *federal* lands. Recreational use of the national forests tripled between 1948 and 1960 (McArdle 1962, p. 144).

Added to this, is the specific American attitude that these lands — as opposed to the private ones — should be managed so as to serve the many needs of the people *directly.* On private property, whether industrial or small private, the owner should be free to manage his land according to his intentions. This is, incidentally, also said to be "good for the nation", but in a different way.

A political basis for the Multiple Use ideas had been laid much earlier. The Forest Administration Act of 1897 specified that the so-called Forest Reserves — the origin of today's National Forests — were established in order to "improve and protect" the forests "or for the purpose of securing favorable conditions of water flows, and to furnish a continuous supply of timber for the use and necessities of citizens of the United States" (quoted from Cliff 1962, p. 175). In a letter from the Secretary of Agriculture written in 1905, the guiding philosophy for the management of the national forests is stated: "Where conflicting interests must be reconciled the question will always be decided from the standpoint of the greatest good of the greatest number in the long run" (p. 175).

Another focal point in forest Multiple Use history is the Fifth World Forestry Congress. It was held in Seattle, Washington in 1960 and had as its theme "Multiple Use of Forest Land". Only two months earlier, a new Forest Law with the very name "Multiple Use-Sustained Yield Act" had been passed in the USA!

What, then, is meant by Multiple Use of forests in the United States? First it should be made clear that the description below relates to the federally owned forests. Later, I will comment on the way the concept is defined and applied on private forest land.

The US Forest Service perception of the concept can be illustrated by quoting Edward P Cliff, Assistant Chief of the Forest Service:

> "In order to make multiple use work it is necessary to have *well-defined management objectives,* and plans which are carefully *coordinated* with resource potential and demands . . .
>
> You will observe, too, that the management *decisions are based on all the relative values* of the various resources and *not necessarily on the economic factors alone.* In planning and setting priorities, the intangible values which are difficult or impossible to express in monetary terms are given *equal consideration* with those that produce financial returns" (Cliff 1962, my italics).

Another aspect, which to my mind is a *sine qua non,* concerns the role of *planning* in multiple-use forestry:

> "Multiple use is *not a passive* practice. On the contrary, it is the *deliberate and carefully planned integration of various uses* so as to interfere with each other as little as possible and to supplement each other as much as possible. Multiple use is *by no means an assemblage of single uses.* It *requires conscious, coordinated management* of the various renewable resources, each with the other, without impairment of the productivity of the land" (Mc Ardle 1962, p. 145).

Multiple Use in Swedish forestry

In the search for early references to Multiple Use in Swedish forestry one can start from a standard work published by the Forest Service: "Sweden's forests during 100 years" (Arpi 1951). Nowhere is the concept mentioned and only a small percent of its several hundred pages deal with anything but wood production. Forest production and forest management are seen as identical with the production of wood.

Another example of the lack of definitions can be found in a speech by the former Chief of the National Board of Forestry, Ebeling (1974). The title was: "How should forest land be used in an optimal way for multiple purposes?" In spite of this, Ebeling makes no attempt to define just what he means by Multiple Use.

The first person to use the phrase more frequently seems to have been Erik Höjer, former Chief of the Swedish Forest Service. On returning from the 1960 World Forestry Congress he wrote occasionally about the concept. His personal involvement in this issue did not, however, seem to influence the con-



Figure 1. A type of forest environment which is much preferred for outdoor recreation by the Swedish population. (Photo: S-G. Hultman)

crete planning and management of the state forests. Instead, the Forest Service increasingly became an institution with the same dominant goal as the private forest companies: to produce profit. This goal was eventually clearly stated in the royal directives of 1968.

An official report (SOU 1978: 6—7), on which the present Forest Law is based, does not mention Multiple Use. This is all the more surprising since the instructions for the committee clearly stated that: "The starting point should be that forest land shall be used in the best interest of the society" (p. 24).

Quite similar is the way the committee treated nature conservation and outdoor reacreation. Again, although the committee was clearly instructed to "closer examine the consequences for the environment of the present and future cutting policy" the report only contains a few, general phrases on the issue. Other forest values are treated under the heading: "Factors which hamper the forest production".

To return quickly to the American scene, it is interesting to note that the official Swedish forestry attitudes can be well illustrated by quoting a frank statement made by the vice president of the Weyerhaeuser Company, one of the biggest private forest industries in the USA (Orell 1962, pp. 182—183):

> "Properly managed, as are most of the industrial forests, these lands also automatically provide beneficial multiple uses.
>
> — — — —
>
> The timber industry believes that multiple use . . . is simply the accomodation of a maximum of other compatible uses with the highest single use of the land. The highest primary use of private commercial forest land is the growing of trees for successive timber harvest. Multiple use — the maximum utility of every acre of forest land — has long been the objective of every forester . . .
>
> — — — —
>
> Multiple use, then emphasizes the priority of the highest major use."

Considering the national forest policy, it is quite logical that planning within the Swedish

forest sector does not include other uses than wood production. Because of this, the National Physical Planning which started in the late 1960's found it necessary to deal with these problems. It is not surprising that the suggested regulations from the Physical Planning have been heavily criticized by traditional forestry interests (cf. Lindevall 1981 and a reply by Hultman 1981b).

During a conference, Mårten Bendz, then Dean of the College of Forestry, explicitly discussed the concept of multiple-use forestry (Bendz 1976). Forests, he said, can be managed for many purposes and according to different strategies. He mentions single use, dominant use, and multiple use. However, he did not carry the discussion further since he found it only of theoretical interest. In practice, he said, foresters have always had some kind of Multiple Use in mind. — In my opinion, this kind of *laissez-faire* approach to forest management cannot be said to constitute multiple-use forestry.

One of the few recent discussions of the Multiple Use concept in the Swedish setting was made by Rydbo and Hofsten (1979, p. 182 f), both top executives in the Swedish Forest Service. Their conclusions are: we have nothing to learn from the US Forest Service ideas; Multiple Use has been practiced for a long time in Sweden; we already have an extensive network of laws which takes care of all the important conflicts that could possibly arise between use of the forests for wood production and other uses.

The premise for their discussion is, of course, the official forest policy where wood production is the central aim. Consequently, conflicts (if they exist, which the authors by and large deny) should be solved not in the forest planning, but on a different level and by allocation of land to different purposes.

This review of the scant Swedish writing on multiple-use forestry should, hopefully, be proof enough of the proposition in the title of my paper that the concept has never been defined in Sweden.

Defining multiple-use forestry

In my opinion, the best statement of the Multiple Use concept has been offered by King (1980, p. 4); an application of that of Gregory (1955):

> "Multiple use ... (is) ... the conscious and deliberate use of the land for the concurrent production of more than one good or service ..."

The central words in this definition are *conscious* and *deliberate.* This implies many of the same key factors which were mentioned earlier, and constitute the basic criteria for multiple-use forestry:

- a clear statement of objectives for each use
- equal consideration of all uses (whether they can be measured in economic terms or not)
- careful coordination of uses
- explicit descriptions of conflicts
- a planning procedure, which is logical, rational and open to inspection.

A difficulty in King's definition lies in the word "concurrent". A forestry, which on a *national* level might quite correctly be called "Multiple Use", could on a *local* level very well be seen as "single use". An additional criterion on multiple-use forestry, then, is that the planning must be done on several levels, including a local. Roland Gustavsson (1979, p. 3) recognized this very clearly:

> "What most people mean by the concept is, however, not primarily the use of the same land for several purposes but rather a small-scale zoning of the landscape, where a certain use dominates ... in one area whereas a very different use can dominate in a quite adjacent area. — A key concept is *"scale":* not to let any demand be exclusive (quite dominating) in large areas (regions, parts of communities) but rather see to it that also in smaller areas several uses can exist and that the dominant use can change".

Does multiple-use forestry exist in Sweden?

If the above criteria are accepted it follows logically that multiple-use forestry does *not* exist in Sweden. Neither the forest organizations nor the official state forest policy, recognize other uses than wood production as having the same "basic right" to exist on forest land. Hence, objectives are not stated for these uses, they are not coordinated, conflicts are not described (they do not exist!) — and planning is almost non-existent.

A further indication of the lack of Multiple Use is the fact that forest organizations have few, if any, specialists to plan for and manage outdoor recreation, nature con-

servation, interpretation etc. All functions are to be handled by The Omnipotent Forester (Behan 1966).*

It is also likely, that multiple-use forestry in Sweden (as defined by me) is not about to arrive in the near future. This is due to at least two important factors. First, the official state policy — and the professional foresters' attitude must change. (These two are much closer connected than is generally admitted, or realized — see Hultman 1981a.) But attitudes, national policies and laws change very slowly.

Secondly, much research must be carried out to develop sound planning methods, especially on how to integrate intangible values. This work has hardly even begun in Sweden!

Concluding remarks

My personal opinion of the benefits from a Multiple Use planning of the Swedish forests was well phrased by Cliff (1962, p. 180):

"... the US Forest Service firmly believes that multiple use management will yield the greatest total benefits to the public from the use of all the resources. The rewards to society and the satisfaction to the forester who practices it can be great."

Today, 20 years after Cliff's statement, the concept is practiced on all Forest Service land. But many problems remain and much development work still needs to be done. This is witnessed by the following quote from Rexford Ressler, vice president of the American Forestry Association:

"... I suspect that in the future ... we'll see a renewed interest in a sophisticated system for allocating land for mixed uses and for a given period of time. So I think the multiple-use concept is in its infancy; I don't think it's passe" (Journal of Forestry 1979).

*) Personally, I do not believe the introduction of specialist *knowledge* is, in itself, a guarantee for a higher degree of Multiple Use. What might make a difference, though, is the fact that different specialists have different attitudes, basic norms, biases, and occupational deformation (Hultman 1981a).

As for the situation in Sweden, I agree with the County Forest Chief C-O Bosson (1973, p. 50):

"We really need to see to it that the concept of "Multiple Use" becomes more common in practice."

However, I believe a change is bound to come eventually. Pressure from the "other interests" is growing, which was well illustrated in many comments to the mentioned committee report on a new forest policy.

Finally, I would like to recall the Recommendations of the Fifth World Forestry Congress:

"*The congress calls* on all governments to study, develop, and encourage sound concepts of multiple-use management as a means of providing optimum satisfaction of human needs from forest and related lands; *and urges* the various Nations of the World to accelerate the exchange of information on their experiences and conclusions in the development of their multiple-use programs" (Fifth World Forestry Congress 1962, p. 1).

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MULTIPLE-USE FORESTRY: DANISH STATISTICS

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This paper is an extended version of the Danish reply to the FAO/ECE Forest Resource Enquiry for 1981, part III. The following functions of the Danish forests are identified: wood production, recreation, hunting, protection, nature conservation, grazing, production of Christmas trees and decoration greenery, water supply and employment-work. For each function the forest area is classified into classes of importance based on the available information. This is done for all forest land in Denmark and for three subcategories of forest.

Key words: Multiple use, forest statistics and resources, indirect significance of forests.

Introduction

FAO/ECE have in their latest Forest Resource Enquiry for 1981 included a part III concerned with the role of forests in supplying environmental and other non-wood goods and services (FAO/ECE 1981). This paper is an elaborated and illustrated version of the Danish reply to the enquiry. The reply has been circulated to other subject matter experts in Denmark, and the author acknowledges their comments.

Forestry produces many goods and services. For most of them, however, we cannot express their value in monetary terms or in any other uniform unit. Nevertheless, those who are responsible for land use policies have to make decisions. I believe, therefore, that it is important to try to identify and indicate the importance of the other functions of forests in addition to wood production. Otherwise, these functions could be forgotten in the forest policy making.

The purposes of the FAO/ECE special enquiry are as follows. For each country to:

1. Identify and indicate the importance of the different functions of forests (the following two sections of this paper).
2. Estimate the impact of the other functions on wood production, and to identify the major problems and issues of conflict in multiple-use forestry (the last two sections of this paper).

The purpose of this paper is to show that in Denmark it is to a great extent possible, to make the above-mentioned quantifications and descriptions. The value of such information increases when comparisons can be made between different countries. But comparisons between different categories of forests within one country could also be of interest as illustrated in the following sections.

The functions of forests in Denmark

In Figure 1 the information on the functions of the Danish forests and their importance is summarized. Details of the basis for and the definitions used are given in the following section. It should be noted that:

1. A part of the information is based on "educated guesswork" as described in the following section.
2. Different functions can all have high importance in the same area (e.g. wood production, hunting

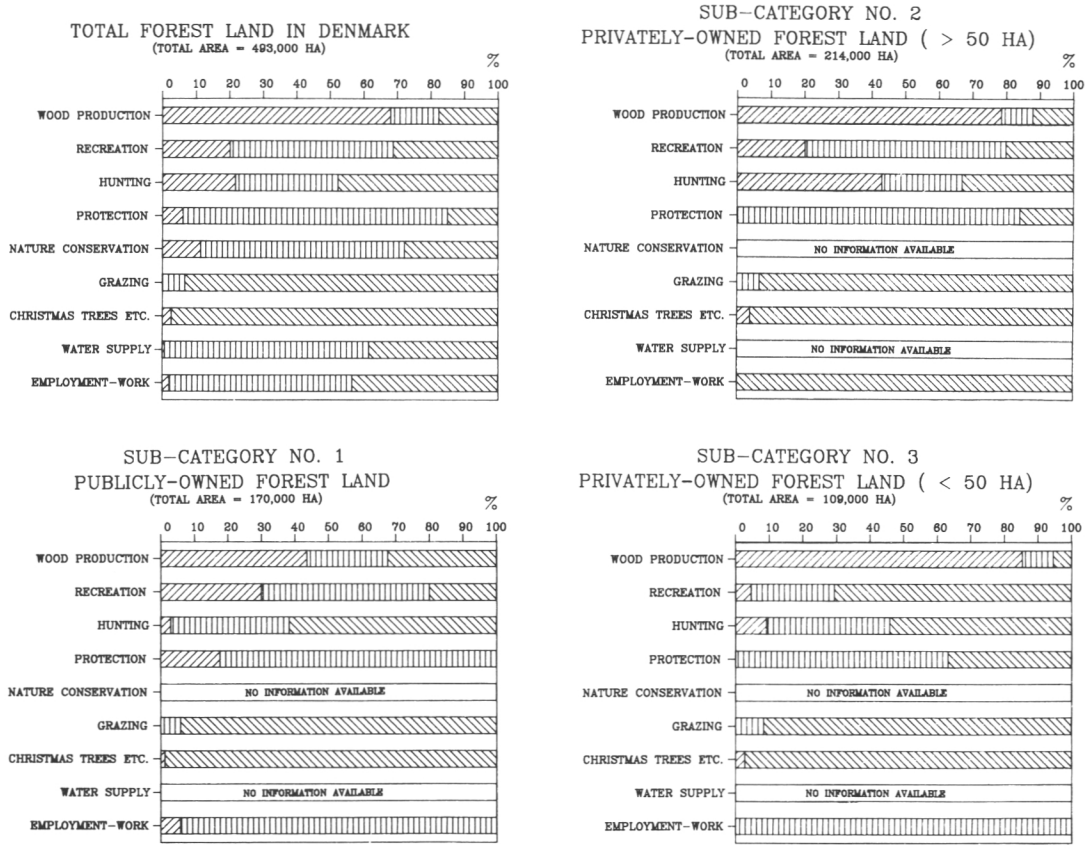

Figure 1. The percentage distribution of the forest area according to classes of importance for different functions of the forests and different categories of forest land.

and recreation) even in cases where the goods or services in question are produced at very little cost and with nc restrictions on other types of production.

For some functions the classification according to importance differs markedly between the different categories of forests:

— Areas with high importance for protection and employment-work are all publicly-owned.
— The forest itself is protected for all publicly-owned forest (medium importance on the protection function). This is not the case for all privately-owned forest.
— The amount of employment-work on the bigger private forests is close to nil.
— The production of Christmas trees and the hunting function are predominant on privately-owned forest land.

For other functions the differences between the categories of forests are smaller:

— The percentage share of forest land with medium or high importance on the recreation function is nearly the same for publicly-owned forests and the bigger private forests, but much less for the smaller private forests.
— The wood production function does not show such great differences between the categories of forests compared to the differences in the other functions.
— Grazing has only medium importance on a smaller amount of land. It takes place on both publicly-owned and privately-owned forest land although the main purpose normally differs: landscape maintenance on publicly-owned land and food production on privately-owned land.

The basis and the definitions used

In the following the basis for and the definitions used in Figure 1 are presented.

Classifying the total forest and other wooded land into sub-categories of land

The 3 sub-categories in Figure 1 are the most important classes from a forest policy point of view, and at the same time traditional classes in the Danish Forest Statistics (Danmarks Statistik 1979). ("Publicly-owned" in Denmark means owned by the state, regional governments, municipalities, and the church).

Reference: Danmarks Statistik 1979 (including not overgrown forest area).

Wood production

Low importance:
— Cuttings $<$ 1 m³/ha/year on average over a long period (50—100 years).
— Consists mainly of *open woodland* and not overgrown forest area.

Medium importance:
— Cuttings from 1—3 m³/ha/year on average over a long period (50—100 years).
— Consists of forest areas with poor site quality and "protection-forest" (protection against sand drift: 30 000 ha publicly-owned forest areas).
— Estimates for sub-category nos. 2 and 3.

High importance:
— Cuttings $>$ 3 m³/ha/year on average over a long period (50—100 years).

References: Danmarks Statistik 1979, Skovstyrelsen 1981, and Dansk Skovforening 1981.

Recreation

In the Nature Conservation Act it is stated that the public is allowed to enter private forest ($>$ 5 ha) on foot only, and only in the daytime.

The recreational use of the Danish forest has been inventoried for nearly 3/4 of the area of forest properties of 50 ha or more (Koch 1980). It is therefore possible to make the following classification-criterias which in a simple way for each forest combine proximity to population centres and special qualities/attractions.

High importance:
$RVH \geqq 120 - 0.5 \cdot MTD.$

Medium importance:
$12 - 0.1 \cdot MTD \leqq RVH < 120 - 0.5 \cdot MTD.$

Low importance:
$RVH < 12 - 0.1 \cdot MTD.$

Where:
RVH = Total number of *R*ecreational *V*isitor *H*ours per year per hectare *for each forest.*
MTD = *M*ean *T*ravelling *D*istance in kilometres to the forest (one way) *for each forest.*

For forest properties of less than 50 ha there exists no inventory for *each* forest. A general survey shows, however, that the level of recreational use on the average is much lower in these forests (Koch 1978, p. 430). It is *estimated* that many small forests are used sparsely and that few are used moderately to heavily.

References: Koch 1978, and Koch 1980.

Hunting

The number of hunters is about 180 000 ($\sim$ 3.6 % of the population). The Danish hunting statistics show the bag record for each of the 14 counties Denmark is divided into (Strandgaard & Asferg 1980). It is based upon questionnaires to the hunters and the rate of return is high (96 % in 1976/77).

The following composition shows the norms which have been used:

Species	Annual bag per 100 ha		
	LOW	MEDIUM	HIGH
Roe Deer *(Capreolus capreolus)*	$<$ 0.7	0.7— 1.19	$\geqq$ 1.2
Pheasant *(Phasianus colchicus)*	$<$ 6.0	6.0—19.9	$\geqq$ 20.0
Wood Pigeon *(Columba palumbus)*	$<$ 5.0	5.0—9.9	$\geqq$ 10.0

Which gives the following distribution of counties:

Low importance: Nordjylland, Viborg, Ringkøbing, Ribe and Sønderjylland.
Medium importance: Århus, Vejle, Frederiksborg, København and Bornholm.
High importance: Fyn, Vestsjælland, Roskilde and Storstrøm.

For the 3 forest land sub-categories the area in each county is known (Danmarks Statistik 1979), and Figure 1 is filled-in without taking into

account that the hunting probably is less intensive on the publicly-owned forest land.

Note: The statistics are in this way based upon county records, not records for each forest.

Nearly all forest areas in Denmark can be rented out as hunting areas for US $ 20 per ha per year or more. On that basis it can be seen that hunting has a high economic importance on all forest land.

References: Strandgaard & Asferg 1980, Danmarks Statistik 1979.

Protection

High importance:
— Protection against sand drift: 30 000 ha state-owned forest areas — "the dune plantations" in the western part of Denmark.

Medium importance:
— Protection of the forest itself.
— The Forestry Act of 1935 prescribes that:
  1) all land, which in 1805 was covered with proper forest,
  2) all publicly-owned forest, and
  3) all land afforested with public support
  should be kept as forest reserve.
— It is estimated that at least 80 % of the Danish forest area is forest reserve.

Low importance:
— All other forests. Estimates for sub-category nos. 2 and 3.

All forest areas in Denmark have a general protection function as wind shelters.

Reference: Skovstyrelsen 1981.

Nature Conservation

About 180 000 persons are members of the Danish Nature Conservation Association (~ 3.6 % of the population).

In every region (county), the regional nature conservation authorities have classified the land according to nature conservational importance. No statistics are, however, available on the distribution of forest land according to conservation classes. The information in Figure 1 is based purely on guesswork.

Reference: Part I of the FAO/ECE enquiry, table 3.

Range (grazing)

According to the Forestry Act of 1935 no grazing is allowed in forest reserves, which make up at least 80 % of the Danish forest area. Due to the closed forests the graze production is also rather low.

The amount of forest land with medium importance for grazing is estimated.

Christmas trees and decoration greenery

In spite of the small land area that this function demands (2 % of the forest area), it accounts for nearly 20 % of the money income to the forestry sector. On average the figure is about 30 % in the privately-owned forests, and even on larger forest properties the production can account for more than 50 % of the money income.

Main tree species: *Abies nordmanniana* and *Abies procera.*

Reference: Christensen 1979.

Water supply

No classification has yet been made. It is, however, believed that this function will be of major importance in the year 2 000.

The information in Figure 1 is based purely on guesswork.

Employment-work

The number of unemployed in Denmark is about 255 000 persons (~ 9.7 % of the labour force). Nearly 1 000 persons have been extraordinarily employed in the publicly-owned forests and some in the smaller private forests.

For some forests owned by municipalities the function may have a high importance. The amount of area with high importance for sub-category no. 1 is estimated.

The present impact of the other functions on wood production

Recreation and Nature Conservation

a) It is estimated that there is a loss in wood production in the publicly-owned forests cor-



Figure 2. The area of beech forests in Denmark has decreased due to economical reasons. (Photo: N. Elers Koch)

responding to about US $ 4 million per year (~ 0.1 million m³ per year).

The losses are due to:
— planting and keeping broadleaved forest instead of spruce forest
— keeping open areas in the forest
— rotation periods beyond optimal
— not harvesting old trees.

b) Forest fires due to the forest visitors occur rather rarely. Estimated loss in wood production is about US $ 25 000 per year.
c) Increased costs due to specially adapted silvicultural and harvesting methods hardly occur, since Danish forestry is using small-scale methods.
d) Prospects for the year 2 000: Losses will increase.

Hunting

The most significant impact on wood production in certain areas is caused by the red deer and the sika deer. A more general impact is caused by the roe deer.

The annual loss is probably less than US $ 5 million per year, but no investigations have been made for the whole country.

Protection

The 30 000 ha of high protective importance are on poor sites, so the function does not lower the wood production.

Grazing

No important impact on the wood production (cf. sub-section "Range").

Christmas trees and decoration greenery

Losses in the volume of wood produced:
13 000 ha from 9 m³/ha to 3 — 1 m³/ha on the average ~ *80 000 — 100 000 m³/year.*

Prospect for the year 2 000: the production will move from forest land to agricultural land, so the loss in wood production will decrease.

A subject matter expert *(Paul Christensen,* Danish Institute of Forest Technology) has given the following elaboration/correction: It is a part of the production of Christmas trees which will move to agricultural land. At the same time it is

expected that more forest stands will be used for production of decoration greenery. Therefore it is not believed that the loss in wood production caused by this function will decrease.

Water supply

Till now: no major impact on wood production. Prospects for the year 2 000: smaller restrictions on wood production due to this function.

Employment-work

Increased costs for wood production due to less trained workers.

Increased volume of wood produced due to more intensive management.

Problems and issues of conflict in multiple-use forestry in Denmark

The tax system and the larger private forest estates

The tax burden on the larger private forest estates has increased dramatically in recent years. The effect is that less money will be invested in the forest and the volume and quality of the wood produced will decrease.

The agricultural crisis

On the poorer sites farming without irrigation cannot pay off. Some of these areas will probably be afforested. The increase in the forest area is estimated to 0.3 % per year. (Skovstyrelsen 1977).

The decrease in the area of the beech forest

The area of the beech forest has decreased. Regulations can be expected.

The use of insecticides and herbicides

This has till now caused no major conflicts in the field, but has been the topic for discussions of principles.

The forest sector has been granted an exemption to use DDT against *Hylobius abietis*. If this does not continue major costs must be expected unless a substitute is found.

Conflicts between different types of forest visitors

These exist between orienteers and hunters, hunters and ornithologists, horse-riders and many other forest visitors, and between moped riders and nearly all other forest visitors. These conflicts have no direct impact on wood production. The benefits from the recreation function are lowered, however, unless the conflicting groups of forest visitors are separated.

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NOTES ON THE OSLOMARKA

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ODC 916+(481)+903+913+907.2

The paper gives a brief outline of some land use problems and management questions connected with the forest area in Oslo and surrounding municipalities. The views presented should be looked upon as a case study of the approach to a rather complicated multiple use problem, and the outcome illustrates the practical solution.

Key words: Multiple use, forest policy, recreation

Some statistical data

The area which in everyday language often is named as the "Oslomarka" or "Marka" is an area of nearly 1700 km^2 situated in Oslo and surrounding municipalities. The Oslomarka includes areas in 18 municipalities in the counties: Oslo, Akershus, Buskerud, and Oppland.

The commercial forest area is estimated at 1360 km^2. On the average the productivity of the forest is significantly higher than in the larger coniferous forests elsewhere in the country. The National Forest Survey has estimated that the annual productivity of the Oslomarka is 4.4 m^3/ha, while the productivity elsewhere is 3.8 m^3/ha. To illustrate this in another way: The annual quantity cut in the Oslomarka is about 3—4 % of the cutting-quantity of Norway while the commercial forest area amounts to only 2 per cent of the total commercial forest area of the country.

The dominant tree species of the Oslomarka are Norway spruce and Scots pine. In some areas we find mixed forests but in larger parts Norway spruce is the climax tree alone. In only minor parts Scots pine has the single role as the climax tree. Figure 1 gives some snapshots from the Oslomarka.

In a number of the rural districts surrounding Oslomarka timber production is important for the economic activity. Sawmills and other timber-based factories are naturally connected with the forest activity. The products have a short way to Norway's largest market for wood products.

A large number of the lakes in the Oslomarka serve as the main source of fresh water for Oslo and surrounding municipalities.

The Oslomarka is centrally located to the most urbanized and most densely populated region of the country. Considered as a land use problem the area is under high pressure from people who want land for a variety of irreversible objectives. As a case study it should be noted that the Oslomarka has been the scene of the most intensive forest land use conflicts in Norway in recent decades.

From a recreational point of view investigations have shown that during a year about 600 000 people are using the area for various purposes, such as hiking, skiing, orienteering, jogging, bicycling, canoeing, berry picking, and mushroom picking. On a nice winter Sunday it is estimated that about 100 000 skiers are using the Oslomarka. Accordingly, the impact of the area as a source of recreation for 15 per cent of Norway's population should be observed. In addition many places are of value for scientific and teaching purposes, and for general preservation purposes. Altogether 33 areas are under special observation for such objectives.

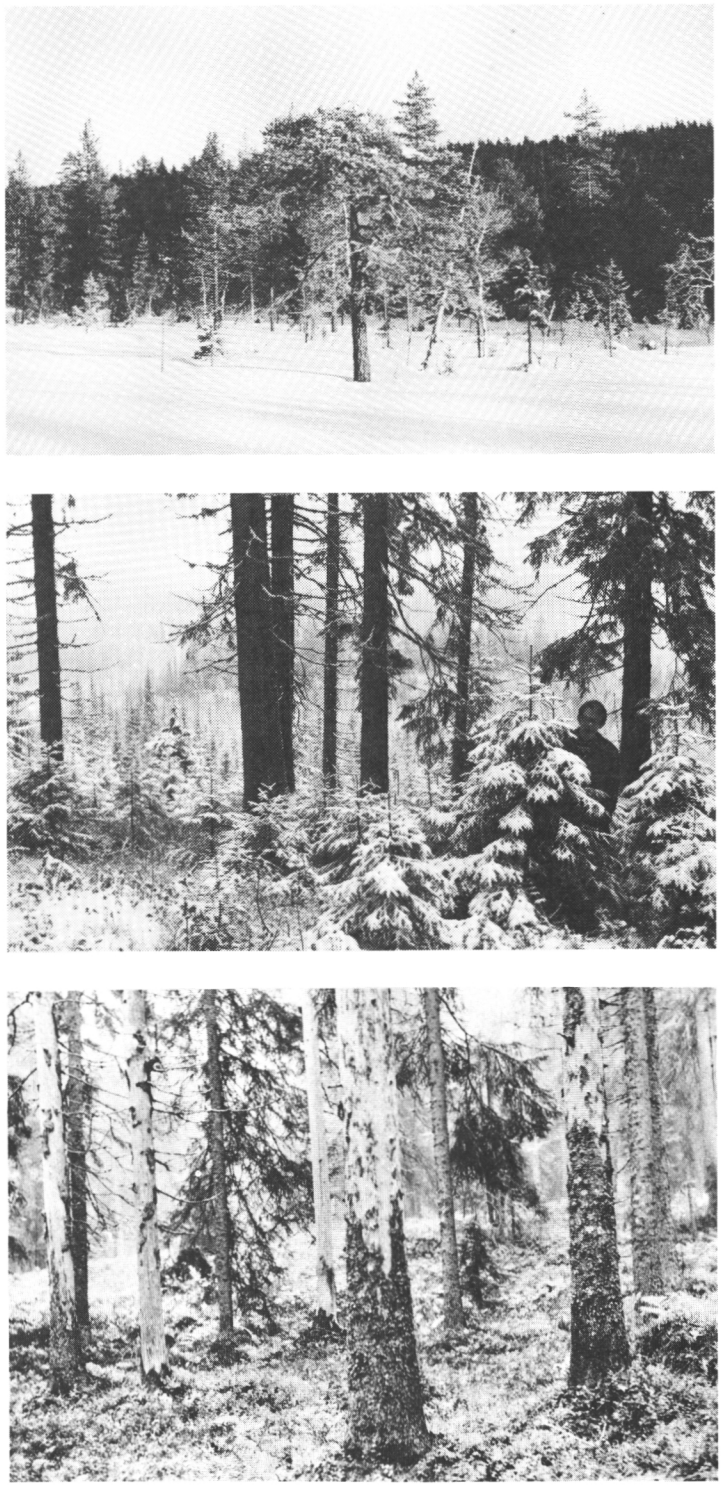

Figure 1. Photographic impressions: scenery (above), new and old forest (midst), a result of the bark beetle (below).
(Photos: Liv Rigmor Sølland)

Of these areas 14 are landscape preserves, 15 nature reserves, and 4 geological (and other) monuments. The total area amounts to 160 km^2.

The Oslomarka is divided into nearly 2 000 forest ownerships. Of the area 70 per cent is privately owned, 16 per cent is owned by municipalities, 13 per cent is commonly owned by farmers (almenninger), and only 1 per cent belongs to the state.

The author is indebted to Ivar Ekanger, Asbjørn Svendsrud, and Liv Rigmor Sølland for valuable comments.

The Oslomarka-discussion

The discussion related to the Oslomarka extends over many years. The participants covered the whole range of viewpoints: individuals, organizations, and public agencies. An impressive amount of information was made available through the discussion and through some comprehensive research projects at the Agricultural University of Norway. Just recently Hansen (1982) has reviewed the literature. In his study he has made an interesting comparison between the situation of the Oslomarka and that of the Boundary Waters Canoe Area in Minnesota. Hansen emphasizes that the conflict problem occured when increasing recreational use, particularly by skiers and hikers, created demands on the area that were in conflict with timber operations. These users wanted greater protection of scenic values, reduction of logging and road building, preservation of wilderness tracts, and a return to more traditional management practices.

The discussion on forest management, silvicultural practices, road building and land use in general has revealed rather fundamental problems of integrating forest production with recreational and environmental concerns. Construction of roads has turned out to be the most controversial issue. The contemporary logging methods and techniques have been highly criticized. The forest owners and managers have been under considerable pressure to practice "people forestry" instead of "timber forestry".

With the majority of the area in private ownership it is natural that the discussion has included the concept of having ownership of a forest property. In forest areas everybody has free access to the land for various recreational and outdoor activities. Oslomarka is one of the forest areas in Norway where this very old right has been executed most intensively. This situation has developed through tradition, and practical solutions have been found. In this context it is interesting to note the statement made by Hansen (1982): "Lands in private ownership in the United States are not subject to the degree of regulatory control possible in Norway".

The administrative outcome

The Oslomarka controversy caused debates in the Parliament and led to more restrictive legislation. In 1976 the Act on Forestry Protection was given some important amendments. The purpose was to state the multiple use concept more explicitly in the law.

The Forestry Act still has as its objective to increase the productivity of forest land and to promote afforestation and forest protection. But the objects clause also states that "stress shall be laid on the importance of the forest as a source of recreation for the population, as an integral part of the scenery, as an essential environment for plants and animals, and as an area in which such sports as hunting and fishing can be undertaken". Furthermore, The Forestry Act was given a new section, 17 b. According to this section the King is given authority to lay down further provisions in forest areas of particular value to recreational interests and nature conservation. This section formed the base for the temporary regulations — or provisions — of forest management and road construction which were introduced in 1977. These regulations are still in use.

The regulations contain stipulations about forest road construction, terrain transport, regeneration cutting, clearing and readjustments of trails and tracks in connection with logging operations. The regulations are administered by the Ministry of Agriculture in consultation with the Ministry of Environment.

Gradually outdoor recreation committees and organizations have been given an official right to give their opinion before a decision is made by the Ministry. They are also en-

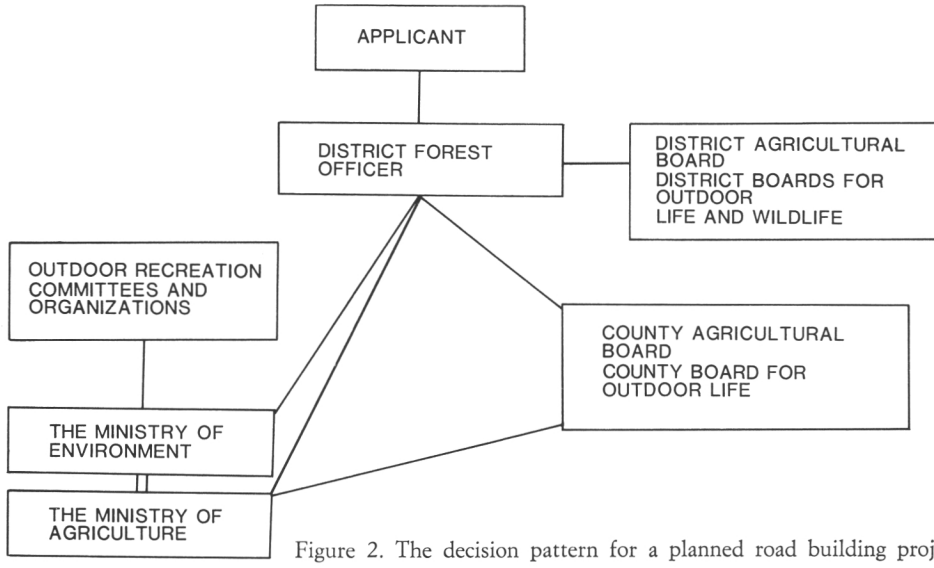

Figure 2. The decision pattern for a planned road building project.

titled to appeal a decision. With regard to planned road building projects hearings are held, and the Ministry of Agriculture invites the organizations to joint inspections. This procedure, especially the inspections, are of course, a time consuming process. However, the experiences show that it has turned out to become a positive approach to solve complicated problems.

Figure 2 shows the decision pattern for a planned road building project. The final decision is made by the Ministry of Agriculture in consultation with the Ministry of Environment. This demonstrates the highly centralized character of the procedure.

In the present management of the Oslomarka, the administration is divided between the Ministry of Agriculture and the Ministry of Environment on a functional rather than a spatial basis. According to administrative theory this is regarded as a complicated decision scheme. In his study Hansen (1982) "predicts continued controversy particularly over relatively minor matters of rather local concern with a division of authority".

Clearly, the problem should be focused on. For the people in charge of administration the problem has to be taken as a challenge to avoid such conflicts that are connected with the administrative pattern rather than to the substance of the actual case.

Some economic considerations

As we have seen it in the Oslomarka, urbanized forestry has impacts on the economy of the timber production. Professional judgement is no longer accepted as adequate. Multiple use management requires more administrative work, and the time horizon for the planning of timber operations has to be extended. The "best alternative" for the timber operation may not be accepted because of — for instance — the concomitant requirements of technical facilities.

This implies a forest activity at a higher cost level than normally expected. However, the problem should not be exaggerated. Traditional forestry has to consider a variety of aspects also. Accordingly, the problem should not be regarded as a new one as such, but it has to be more explicitly defined today than earlier.

If the objective of the analysis is clearly defined, as the maximum — or the optimum solution, a criterion function might be constructed and economic impacts derived. But if the objective is not so clearly stated it becomes difficult to construct a reasonable criterion function. Simon (1957) has stressed this problem. According to him the decision maker seeks a "satisficing" behaviour rather than a maximizing one. There exists a clear distinction between the two attitudes: Models of "satisficing" behaviour are richer than

models of maximizing behaviour because they not only treat a certain point but the method and path of reaching it as well.

This description may characterize multiple use management in general and the management of the Oslomarka in particular. On the one hand the foresters have to live with conflicts that must be taken as challenges. On the other hand it is urgent that they find economic solutions where it is necessary to employ alternative thinking related to a "satisficing" rather than a maximizing procedure.

Svendsrud (1977) has examined the multiple use management of the Oslomarka from an economic point of view. He demonstrates that various management alternatives may differ greatly economically. However, the differences shown in such model studies may be somewhat deflated in practical life, but the model studies are important to simulate experiences. Svendsrud stresses the need for overall planning as an appropriate means of finding economically feasible adjustments. This procedure may lighten the conflicts and perhaps eliminate some of them.

As shown by Svendsrud (1977) it is possible to employ models that theoretically describe the economic meaning of multiple use management. The problem is to develop relevant quantitative methods.

For the Oslomarka situation this is still an unsolved question. However, through long use and tradition it has become widely accepted among the whole population that the area has important social and cultural functions.

Although these functions may not be quantifiable it is fairly easy to simulate the reaction from the people if the area should deteriorate. These reactions might be taken as the shadow prices of the social and cultural services of the Oslomarka.

Concluding remarks

In the late fall of 1982 the Norwegian Government decided not to introduce a special law concerning the management of the Oslomarka. The government assumed that the present regulations satisfactorily encompassed the different activities of the area. However, a Marka Council of 9 members was established. Formally, this took place in February 1983. The council has representatives from municipalities, counties, and the important user interests in the area. The main duty of the council is to give advice to the Ministry of Environment, the Ministry of Agriculture, and other ministries. The council should give its opinion on actual cases and projects presented by the ministries.

Furthermore, the intention is to decentralize the decision pattern with regard to the forestry regulations. The ministries will then be playing their ordinary supreme role also in the cases regarding the Oslomarka.

Accordingly, the Oslomarka retains its multiple use status with forest production continuing to play a major role, but within a set of regulations relative to various management operations.

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PROJECT "FOREST AND FOLK": A SUMMARY*)

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The *Project "Forest and Folk"* undertaken by *The Danish Forest Experiment Station* is described. This research project is aimed at producing a better basis for decisions in the field of forest recreation and is the first comprehensive research project of its kind in Denmark. The project has in the period 1975—1980 been financed by the *Danish Agricultural and Veterinary Research Council.*

The working tasks of the project are: (1) to measure the recreational use of the forests; (2) to measure the preferences/perceptions of the population and the forest visitors; (3) to set up models for the use and preferences; and (4) to make economic analyses of forestry recreation. References to the most important Nordic literature in those four working areas are given.

The various investigations made by the project are briefly described, some results are presented and compared with similar results from other Nordic investigations.

Key words: Forest recreation, recreational use estimates, international comparisons.

Project "Forest and Folk"

The research project *"Forest and Folk"* was started in 1975 at *The Danish Forest Experiment Station.* The aim of the project is to work out a better basis for political and administrative decisions in the field of forest recreation in Denmark. The project was initiated and financed during the period 1975—80 by the *Danish Agricultural and Veterinary Research Council.*

The following *working tasks* for the project have been determined:

1. To describe the use of the forests for recreation on the national, regional and local levels. ("Use estimation").
2. To describe the forest preferences/perceptions of the population and the forest visitors on the national, regional and local levels. ("Preference estimation").
3. To set up models and prognoses for the use and preferences. ("Recreation modelling").
4. To make economic analyses of forestry recreation in relation to the other functions of the forests. ("Recreation economics").

Table 1 gives references to the most important Nordic literature in these four working areas. The table is hardly complete.

In the following sections the investigations carried out are briefly described with the main emphasis on the investigations of the recreational use of the forests.

*) This paper is a translated and slightly changed version of a paper given by the author on the plenary session of the XV. Nordic Forest Congress, Copenhagen, June 11, 1982.

Table 1. List of the most important Nordic literature in the four working areas of Project "Forest and Folk".

SWEDEN	NORWAY	FINLAND	DENMARK
	1. Use estimation		
Statens Offentliga Utredningar 1964	Langlien 1969	Saastamoinen 1972	Bondo-Andersen 1973
Barklund 1971	Statistisk Sentralbyrå 1971	Jaatinen 1973	Helles & Thormann 1974
Kardell 1972	NIBR 1972	Saastamoinen 1979	Koch 1974
Statens Naturvårdsverk 1974	Haakenstad 1975	Saastamoinen & Sievänen 1981	Koch 1976a
Heglebäck 1978	Statistisk Sentralbyrå 1975		Koch 1976b
Kardell & Pehrson 1978	Kjøde et al. 1979		Koch 1978
			Friluftsrådet 1979—82
			Koch 1980
	2. Preference estimation		
Kardell 1972	Haakenstad 1972	Lovén 1973	Degener 1963
Brinkman 1974	Haakenstad 1975	Kellomäki 1975	Bondo-Andersen 1973
Kardell 1976	Sorte 1975	Jaatinen 1976	Helles 1973
Kardell & Pehrson 1978	Kjøde et al. 1979	Eskelinen 1979	Koch 1974
Hultman (in press)		Savolainen & Kellomäki 1981	Helles 1975
			Koch 1977a
			Koch 1977b
			Friluftsrådet 1979—82
	3. Recreation modelling		
			Christensen 1981
	4. Recreation economics		
Håkansson & Hägglund 1969	Strand 1967	Mikola 1973	Helles 1977
Höjer 1971	Johannesen 1970	Vesikallio 1974	Christensen 1981
Kardell 1973	Jørgensen 1974	Heikinheimo et al. 1977	
Kardell & Ericson 1975	Norges Landbruks-høgskole 1974	Saastamoinen 1977	
Lönnstedt 1975	Qvigstad 1974		
Lindgren 1976	Hofstad 1976		

Note: The references are given in the literature studies (IUFRO 1981), (Koch 1975), (Koch 1976), (Koch 1977a), (Koch 1978), and (Koch 1980) and for the most recently published in the list of references of this paper.

The recreational use of the forests

Forest recreational use can be measured in various units: number of visitors, number of visits or number of visitor hours (cf. Koch 1978, p. 296 and p. 353).

It is important, however, to keep in mind that the observable use of the forests for recreation is a result of peoples' choice between i.a. the known and available opportunities for forestry recreation. In this way the forestry sector itself influences the amount of forestry recreation.

The *potential demand* for forestry recreation has not been investigated in the project; only the result of peoples' recreation-choice, as it can be observed in the field, has been described.

The investigations of the forest recreational use have been divided into a national survey (part I), regional investigations (part II) and local investigations (part III). A schematic outline of the different data collections, and how they have been integrated, is given in Figure 1.

The national survey of the use of the forests

Some results from this investigation, which has been published (Koch 1978), will be reported with a certain emphasis on comparisons with other similar Nordic investigations. Of course, such comparisons can only be made with reservations as discussed in detail in part I (Koch 1978).

About 90 % of the adult Danish population visit the forest at least once every year. This is a rather high percentage compared to other recreation activities, cf. Figure 2.

In Norway it has been found that between 92 % and 96 % of the adult population in

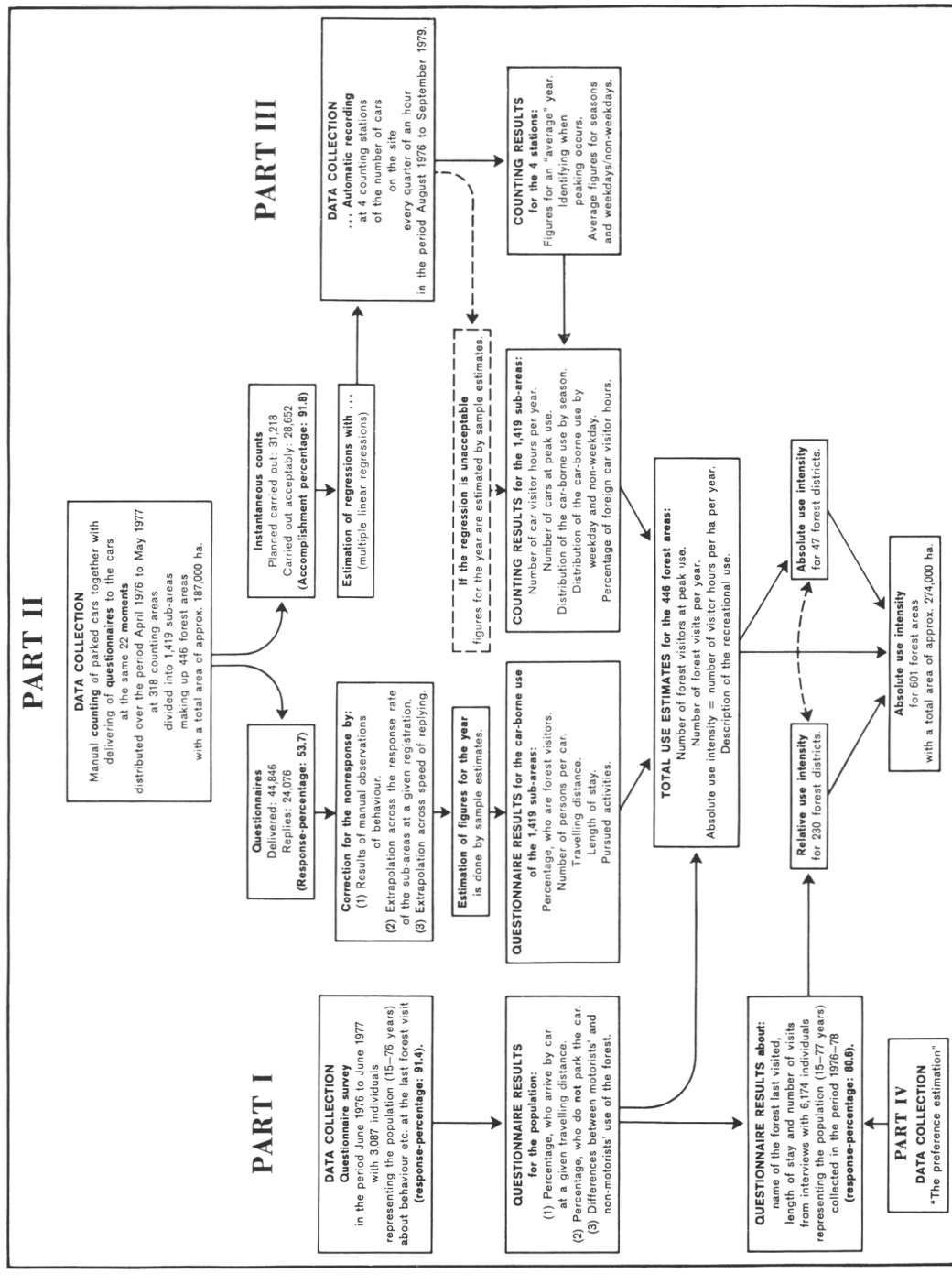

Figure 1. Schematic outline of the data collections used in describing the recreational use of the Danish forests. The main emphasis in the figure is on how the data collections have been integrated in the regional investigations — part II (Koch 1980).

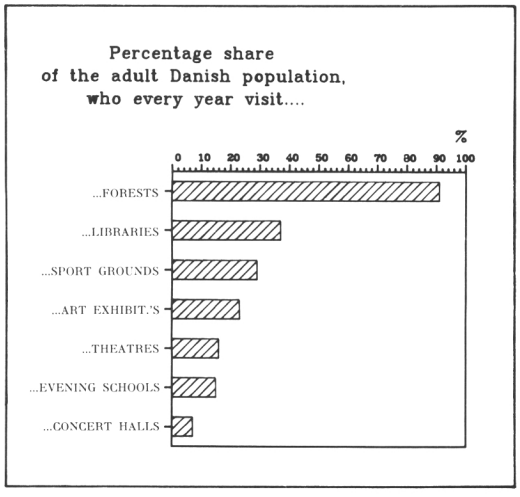

Figure 2. Participation rates for different recreation activities in Denmark (Koch 1978, p. 314).

five different residential areas visit the forest at least once every year (Norsk Institutt for By- og Regionforskning 1972). While the same participation rate for forest recreation in Sweden has been estimated at 79 % (Statens Naturvårdsverk 1974) and 85 % (Statens Offentliga Utredningar 1964).

The "normal" Dane (the median in the distribution) spends about 30 hours in the forest per year, distributed over 11 forest visits. The more prosperous social groups visit the forest more frequently, on average, and that is also the case for people living close to a forest. Generally speaking the longer the travelling distance people have to the forest, the more seldom are their visit in the forest, and the longer the time they spend on each visit. The survey shows that a little more than 2/3 of the visitors' last forest visit took place less than 10 km from their residence, and nearly 1/3 less than 2 km from their residence.

Figure 3 shows comparisons of some results from the Danish survey and a similar survey from Sweden. Based on this it may be concluded that the Swedes compared to the Danes visit the forest less frequently, spend more time on each visit, and generally use less time travelling to the forest.

From Table 2 it can be seen that the Danes walk alone in the forest less frequently than the Swedes and the Norwegians. Perhaps the

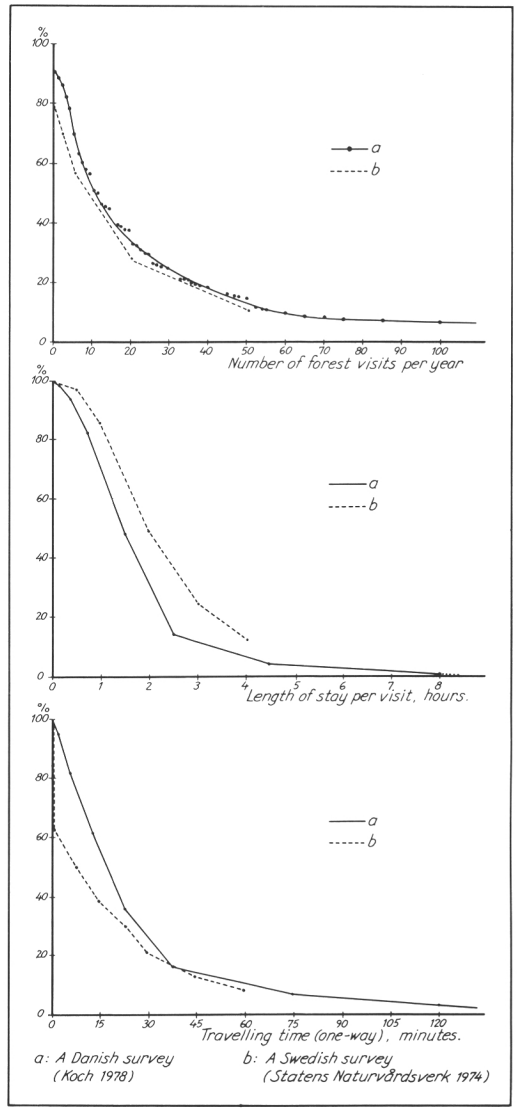

Figure 3. Comparisons of the cumulative distributions of two Nordic surveys according to number of forest visits, length of stay, and travelling time (Koch 1978).

fear of the forest is greater in Denmark, a densely populated farming country, than in the other Nordic countries?

The figures in Table 3 also reflect a cultural difference in recreational behavior in the Nordic countries. Here in connection with the choice of means of the transportation to the forest.

Table 2. Percentage share of the forest visits with a group size of one person. Results from three Nordic surveys.

Sweden: (Statens Naturvårdsverk 1974)	16 %
Norway: (Statistisk Sentralbyrå 1975)	18 %
Denmark: (Koch 1978)	13 %

Note: See also (Koch 1978, p. 324 f).

Table 3. Distribution according to the means of transportation used to the forest. Results from three Nordic surveys.

Means of transportation	*Norway* (Statistisk Sentralbyrå 1975) %	*Sweden* (Statens Naturvårds-verk 1974) %	*Denmark* (Koch 1978) %
On foot/ski	59	43[a)]	27
Horse	—	—	1
Bike	2	4	7
Moped, motorbike, scooter	1	0	2
Car	33	47	55
Bus, train	3	4	6
Others	2	0	0
Total	100	100	100
Number of respondents	≤ 251	973	2629

Note: a): Inclusive of 25 % with the reply: no transportation.

The regional investigations of the use of the forests

The purpose of the regional investigations (part II) has been to estimate and describe the recreational use of the individual forest and the variation in the use between forests in each region of Denmark. As opposed to this the purpose of part I was to give a summary of the recreational use of the country's forests by the Danish population and to gather some information used in part II (cf. the schematic outline in Fig. 1). Therefore the methods of data collection are totally different in the two investigations: Part I is based on a questionnaire survey, while part II is mainly based on manual countings in each individual forest carried out with the help of about 1000 foresters.

Part II was published in 1980 (Koch 1980), and a schematic outline of the method

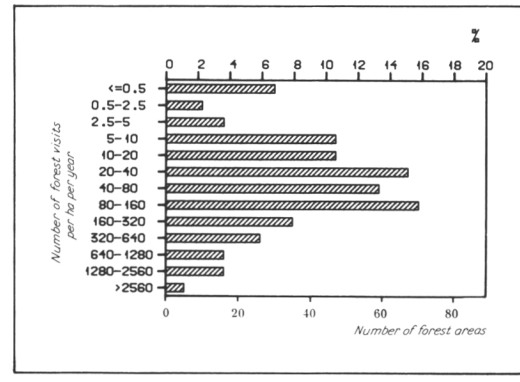

Figure 4. Classification of the forest areas investigated according to the yearly number of forest visits per ha (Koch 1980).

of investigation is given in Figure 1. In this connection it must be noted that with this newly-developed and tested method of investigation it is possible to get an estimate of the recreational use of an area, for the cost of driving through the area about 20 times, each time in less than one hour.

The main result of the investigations is a classification of altogether 601 forests, covering nearly 3/4 of the area of Danish forest properties of 50 ha or more, according to their intensity of recreational use. Based on questionnaires a description is also given on *how* the different forests are used for recreation.

Figure 4 illustrates one of the more important results of the investigations. It appears that there is a very large variation between the different forest areas in the yearly number of forest visits per ha. In each of the 14 regions (counties) that Denmark is divided into, it can be found that some forests are used up to about one thousand times more intensively than others. The most intensively used forest in the investigation is used about twenty thousand times more than the least intensively used forests.

In the author's opinion this must be taken into account in the formulation of a Danish forestry and recreation policy.

In contrast to the other Nordic countries, Denmark may be characterized by having a rather uniform geographical distribution of a relatively small forest area per inhabitant.

Table 4. Some measured use figures in selected investigations from Sweden, Norway and Finland.

Country	Reference	Forest area	Number of visits per ha per year
Sweden	(Kardell 1972)	Bogesundslandet	34
	(Heglebäck 1978)	Nackareservatet	1500
		Järvafältet	300
		Lovön	100
Norway	(Haakenstad 1975)	Frognerseter-/ Sognsvannsområdet	223
		Ringkollenområdet	23
Finland	(Jaatinen 1973)	Keskuspuisto	2200
		Luukkaa	315

It must therefore be expected that an even greater variation between forests in the intensity of forest recreational use could be found in the other Nordic countries. However, the investigations carried out in the other Nordic countries have only dealt with rather few and relatively intensively used forests (Table 4). The most important reason for this is probably, that until now it has been rather difficult and costly to measure the amount of recreational use for a given forest.

The local investigations of the use of the forests

These investigations (part III) have several purposes:

To function as a data basis for the regression estimates made in the regional investigation (cf. Fig. 1). To give an exact description of the time variation in the amount of forest recreational use, and, given that, to give some knowledge of the trend in forest recreation in relation to e.g. the price of petrol.

The investigations have not been published yet, but they consist mainly of permanent automatic recordings of the number of cars present on 4 forest sites for every quarter of an hour since 1976/77 ("the net counting procedure"). Figures 5 and 6 give an impression of the character of the results.

In the Nordic countries a similar Finnish investigation has recently been published by Saastamoinen & Sievänen (1981).

The forest preferences

Project "Forest and Folk" has carried out various relatively comprehensive investigations with the purpose of getting a better knowledge of the forest preferences/perceptions of the population and the forest visitors.

None of these investigations have been published yet. Only the preceding literature studies and descriptions of the methods of investigation used by the project have been printed (Koch 1977a and Koch 1977b).

Recreation modelling and economics

These two fields of study have not yet been investigated intensively by the research project "Forest and Folk".

However, they have been the main theme of a Ph.D.-study at the University College of North Wales, financed by the Danish government, and using i.a. data from part II of project "Forest and Folk" (cf. Christensen 1981). In this symposium proceedings Jens Bjerregaard Christensen, himself, has presented some of the results of his studies.

It is the author's hope that this collaboration will continue.

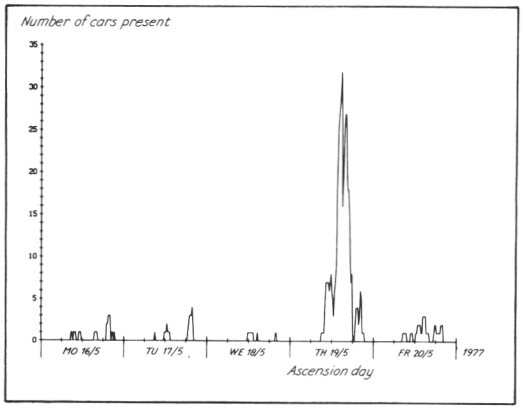

Figure 5. The fluctuations in the number of cars present on five days at one of the counting stations.

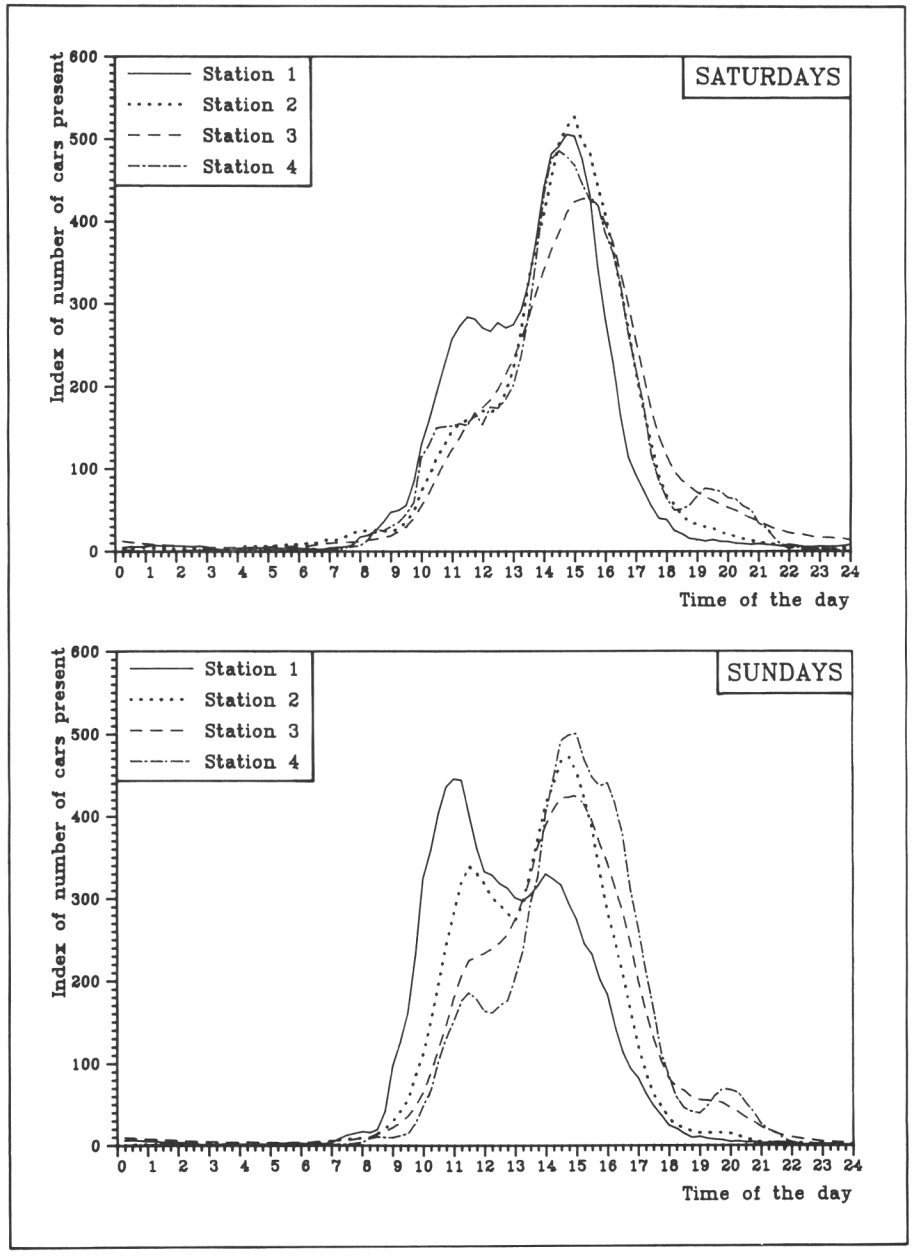

Figure 6. The average fluctuations in the number of cars present at the four counting stations on Saturdays and Sundays.

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Note: See also Table 1.

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RECREATION ECONOMICS: SOME RESULTS FROM A DANISH STUDY

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This study attempts to establish a value for forest recreation by applying modified Clawson analyses to data collected from forest visitors in North Zealand, Denmark, during 1976—1977. The procedures used in applying these analyses are described in detail. While establishing the consumer's surplus for each of the forest areas, it became clear that forests may be divided into 3 types: those of local, regional, and national importance. Results from a forest of national interest ("Jægersborg Dyrehave og Hegn") and from one of regional interest ("Hareskovene og Jonstrup Vang") are presented.

Key words: Recreation economics, forest recreation

Introduction

Forest areas have always produced a variety of products useful to man. These include timber, fuelwood, forage, game, grazing area, etc. although the importance of each of these products has changed over time. Now, there is a growing demand for the "production" of additional goods, especially forestry recreation. This good is not priced in the normal market system and hence, no commercial value has been placed upon it. With the steady increase in leisure time, income and, thereby, mobility of individuals, this has become a problem, for it is only possible to estimate the level of "supply" which should be aimed for when we know the shape of the demand curve.

In Denmark, the annual number of forest visits has been estimated at 100—150 mill. (Koch 1978) which "indicates that the recreational value of woods in Denmark is far above the value as a production factor of trees" (Groes 1979).

This emphasizes the importance of finding methods which can be used in planning processes designed to optimize the mixture of outputs from forest areas in such a way as to maximise social welfare; thereby, hopefully, minimising conflicts between different interest groups.

Several methods have been developed for this purpose and a brief introduction to the theoretical bases for evaluating recreation forestry can be found in Christensen (1982). In Scandinavia, the number of works attempting to evaluate recreation forestry have been very few and a summary can be found in Christensen (1981). (A major work by Strand (1981) has later been published).

The aim of this paper is to present some of the problems and results from a Danish study (Christensen 1984) in which a Clawson method has been applied to data provided by "Project Forest and Folk (PFAF)" (Koch 1978, 1980) in order to yield ideas as how a better basis for economic decisions concerning forestry recreation can be achieved.

Methodology

Aims of the study

The aim of the study was to look at all forests in a region of Denmark and carry out Clawson analyses (Clawson 1959, Clawson & Knetsch 1966), i.e. relate visit rates to travel costs in the following manners:

1) A Clawson analysis for a particular forest based on the actual observed number of visitors.
2) A Clawson analysis for a particular forest when alternative areas have been taken into consideration.
3) A Clawson analysis for a particular forest based on the visitors for whom that is the nearest forest.
4) A Clawson analysis for "all forests as one", i.e. aggregating all forests observations as if they were all from the same forest.

The data from PFAF

The data made available from PFAF included, for each forest investigated, a frequency distribution of the yearly number of carborne visitor groups distributed to postal codes for the year April 1976 to April 1977. The data are derived from PFAF part II (Koch 1980) by combining results from manual counting of parked cars on 20 different occasions between 1st April 1976 and 1st April 1977 and responses to hand distributed questionnaires on the same 20 occasions.

The region investigated

The area chosen for the study is North Zealand including the peninsula Hornsherred and the island Amager. It is a well defined area surrounded by water except for the south western borderline. The area is approx. 1966 km^2 with a population of approx. 1.54 mill. In the area, the forests are the primary outdoor recreation facilities (except seashore recreation) and the total area of the directly investigated forests is approx. 22 700 hectares, which is 80 % of the total forest area in North Zealand. The area consists of 2 counties, Frederiksborg and Copenhagen. The area is shown in Figure 1a.

Unit of visitation

The unit of visitation is visitor groups per household and not, as is usually used, visits per capita. This is done for the following reasons:

1) One carborne visitor group is likely to be one household coming to the forest.
2) The decision to come to the forest is probably made on the assumption that it costs the household (family) x amount to drive to the forest and not that it costs x' amount per member of the visitor group.
3) It gives less variability in the travel costs because it is now the cost per car which is the travel cost although it is a fact that some cars bring five people, while others bring one person to the forest.
4) The number of households in the area is accessible.

Zoning unit

As the questionnaires had information on the postal codes of people's startpoint, it was decided to use postal codes to group people into population zones. The number of households in each postal area is available. In Figure 1b is shown the area with the population zones and the number of households per km^2.

Unit of travel costs

The primary unit of the calculations is kilometres. This is done in order not to introduce another source of inaccuracy. It was felt that it was easier to calculate all consumer's surpluses in the unit of kilometres and then, finally, to imply what a given kilometre price would mean to the surplus. Inaccuracy occurs for two main reasons: 1) the means of transport differ, and 2) the perception of costs differs. This last point is especially difficult to handle. However, as it is the visitors' willingness to pay that we want to measure, it is considered that the perceived costs should be used. But are perceived costs the marginal costs or the average costs? It is assumed here that most visitors, when deciding to make a trip, consider their marginal costs or variable cost.

The variable costs for driving a car during the period 1976—1977 can be taken to vary



Figure 1. Map of the studied area with a) the investigated forest areas marked and b) the population zones shown.

from approx. 44 øre to 76 øre per kilometre (approx. US $ 0,05—0,09 per kilometre) depending on the size of the car (Truelsen 1977). A good average is 60 øre per kilometre (approx. US $ 0,07 per kilometre). The price if fixed costs and depreciation are included could vary from approx. 78 øre to 372 øre per kilometre (approx. US $ 0,09—0,43 per kilometre) all depending upon the make of the car and the yearly use (Truelsen 1977). The Directorate of Traffic gives a price per kilometre of 52,1 øre (approx. US $ 0,06 per kilometre) for the marginal costs (Vejdirektoratet 1977).

Distances

A. *Travel distances.*
The forests and the postal areas were identified on maps in the scale of 1 : 50 000. A gravity point for each forest and postal area was determined. The distances were measured along the most obvious road choice from each forest to each postal area from which visitor groups were observed. Then the maximum distance for each forest to a postal area with number of visitor groups > 0 was found. Distances were then measured to postal zones from which no visitor groups were observed if the postal zone lay within a circle where r = the maximum distance as defined above.

B. *Logical distances.*
When measuring the distances above it became clear that the forests could be divided into three groups as follows:

1. Forests of national interest
2. Forests of regional interest
3. Forests of local interest

In order to distinguish these forest types, it was decided to identify an approximate distance to the nearest forest(s) from each postal area and a distance from postal areas within which people would find a reasonable variety of forests including at least one of type 2. In this manner, it is possible to select observations and we can, for example, do an analysis for a particular forest based only on the visitor groups for whom that is the nearest forest (the Clawson analysis type 3 above; see Christensen 1984).

Weighting

It was assumed that the number of visitor groups n_i from a given zone of origin observed within a given forest was Poisson distributed with parameter λ_i. Then the variance of the visit rate (V_i) will be (for a more detailed investigation see Christensen and Price 1982):

$$\text{Var}\ (V_i) = \lambda_i / N_i^2$$

where: V_i = estimated visit rate from zone i
N_i = zone population in zone i.

In order to balance the variance when estimating the trip demand curve, each observation should be weighted by:

$$N_i^2/\lambda_i = N_i/E(V_i)$$

As some of the observations are zero, we could not approximate the above weighting with N_i/V_i and, instead, a two stage model was applied, first a curve was fitted to unweighted observations and then the predicted values from this were used as weighting in the second stage.

Selecting a model for the trip demand curve

A negative exponential model of the form:

$$V_i = a \cdot e^{bx_i} + e_i$$

was considered to be more appropriate than a linear regression or a 2nd degree polynomial.

This was judged on the following observations:

1) At no price is a negative visit rate predicted and nor, therefore is a "negative consumer's surplus". This is considered to be a very important feature. Other works (Bowes and Loomis 1980) have used linear regressions and have had to ignore negative visit rates. Alternatively, they have used negative visit rates when calculating total number of predicted visitors for zero additional entrance fee, but ignored the "negative consumer's surplus".

2) It had the smallest SS-residual of the models tested.

3) The consumer's surplus becomes a finite integral. For zone i with travel cost c_i the consumer's surplus becomes:

$$CS_i = N_i \cdot \int_{c_i}^{\infty} a \cdot e^{bx}\,dx = N_i \cdot a/b \left[e^{bx}\right]_{c_i}^{\infty} \Rightarrow$$

$$CS_i = -N_i \cdot a/b \cdot e^{bc_i}$$

The number of predicted visitor groups (pvg) from zone i:

$$pvg_i = N_i \cdot a \cdot e^{bc_i}$$

and hence consumer's surplus per predicted number of visitor groups (CS_i/pvg) is:

$$CS_i/pvg_i = -1/b$$

This means that a good approximation of the CS for an area is:

$$CS = -n_i/b$$

where: n_i = number of observed visitor groups.

Database

All the information discussed in the previous sections was combined into a working file as shown in Figure 2. This working file was used as a database for the computer programmes in carrying out the Clawson analyses described earlier.

Results

Two forest areas

In the study the consumer's surplus was calculated for 25 forests in the area. However, here we look only at the results from two forest areas: "Hareskovene og Jonstrup

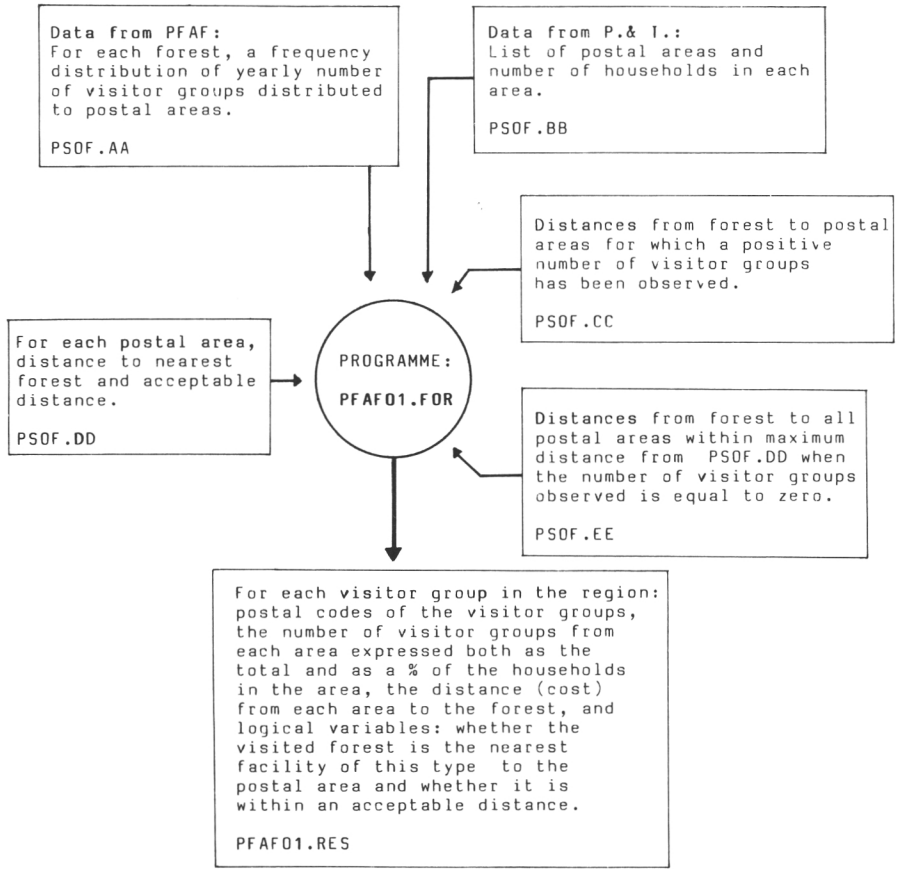

Figure 2. The creation of the database.

Table 1. Consumer's surplus for "Hareskovene og Jonstrup Vang".

Model	No. of zones	No. of visitor groups predicted	No. of visitor groups observed	Consumer's surplus	CS/pvg
1	70	56 160	59 104	452 535	8,06
2	43	56 214	58 960	457 952	8,15
3	22	52 193	52 229	345 294	6,62
4 B	7	53 679	59 104	511 564	9,53
4 C	7	46 847	59 104	498 879	10,64
4 D	7	45 154	59 104	484 601	10,67
4 D'	7	49 669	59 104	234 427	4,72
5	10	58 262	59 104	434 991	7,47

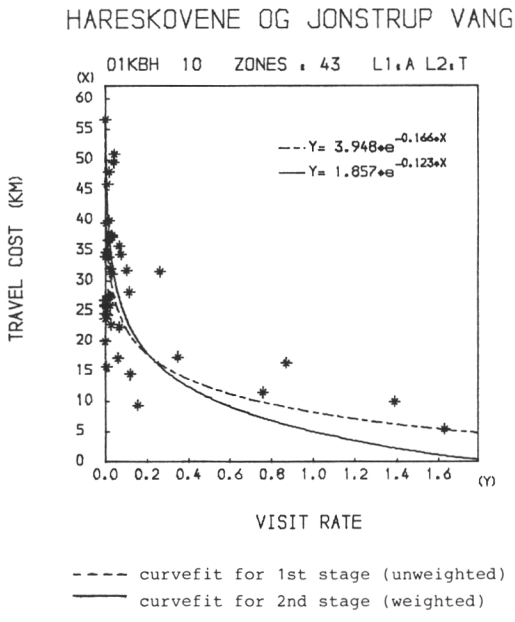

Figure 3. Trip demand curve for "Hareskovene og Jonstrup Vang" for model no. 2.

Vang" and "Jægersborg Dyrehave og Hegn". This is done in order to clarify and explain some of the differences between the variations of the applied method.

"Hareskovene og Jonstrup Vang"

All the results from this forest (forest no. 10 in KBH in Fig. 1a) are summarized in Table 1 and in Figure 3 is shown an example of the trip demand curve, model no. 2 below.

Basic models

1) When all the zones are used (in total 70), the consumer's surplus is calculated to 452 535 units for a predicted number of visitor groups of 56 160. The actual number of visitor groups (i.e. the sample estimate from PFAF) was 59 104. The consumer's surplus per predicted visitor group is 8,06 units.
2) When only the postal zones for which the forest was within an acceptable range were considered (see "Logical distances"), 27 zones were excluded thus leaving 43 observations upon which the demand curve was estimated. The consumer's surplus was calculated to be 457 952 units or 8,15 units/pvg for the 56 214 visitor groups predicted. The difference between model 1 and model 2 is not very big. The trip demand curve for this model is shown in Figure 3.
3) When only those postal areas for which the forest is within the distance to the nearest forest are selected, we are left with 22 zones. In this case the consumer's surplus is 345 294 units or 6,61 units/pvg, which is approximately 28 % less than the results derived above.
It should be noted how well the predicted number of visitor groups in the three models matches the actual number of visitor groups. This is even true for the individual zones.

Rezoned models

In order to test the sensitivity of the zoning system and the cost function, an option was built into the programmes which allowed the rezoning of the models.

In the three zoned models, the postal areas are rezoned according to a chosen zone width in more or less concentric zones. In this way, the method becomes very similar to the traditional Clawson analysis. The option works in the following way: The maximum distance ($maxD_i$) is found (see "Travel distances").

For "Hareskoven og Jonstrup Vang" this is equal to 34,8 km. The width of the zone interval is chosen and the number of zones is calculated as:

$$\text{Number of zones} = \text{ROUND}\ (maxD_i/x_i + 0{,}5)$$

where

ROUND = a function which rounds the argument to the nearest integer.

x_i = width of the zone interval.

If the width of the zone interval is chosen to be 5,0 km, the above equation gives the number of zones to be 7 which means that all postal areas up to a distance of 35,0 km are used in the analysis. For each of the 7 new zones, the cumulated number of visitor groups and zone population will be calculated and from those figures, the visit rate can be found.

The travel costs can be calculated using one of the following three models:

B) "Normal costs" which is the distance to the middle of the zone.
C) "Uniform costs" which is the distance calculated with the assumption that the population is uniformly distributed over the zone.
D) "Weighted costs" which is the average distance to the postal areas within the zone weighted according to the number of households (zone population) in each postal area.

For model 4 B, a consumer's surplus of 511 564 units is calculated for 53 679 visitor groups which is equal to 9,53 units/pvg. Models C and D give similar results. C gives 498 879 units for 46 847 visitor groups or 10,64 units/pvg and D gives 484 601 units for 45 154 visitor groups or 10,67 units/pvg. Models C and D are, for the total consumer's surplus, quite similar to models 1 and 2. However, as the predicted numbers of visitor groups are smaller for C and D, it makes the consumer's surplus/pvg slightly bigger.

It should be noted that these models are still weighted similarly to the individual models by zone population/visit rate. If we did not weight, the consumer's surplus would decrease as shown in model 4 D' which consists of the same data as 4 D but where no weighting has been applied. This results in a consumer's surplus of 234 427 units for 49 669 visitor groups or 4,72 units/pvg.

If, instead of using a zone width of 5,0 km, we used 3,5 km, thereby establishing 10 zones, we will get the results shown in model 5. This gives a total consumer's surplus of 434 991 units for 58 262 visitor groups or 7,47 units/pvg.

Which model is, then, the "right" one? This forest can be taken as an example of a type 2 forest, i.e. a forest of regional interest. Therefore, model 2 ought to be the most representative although, in this case, the difference between models 2 and 3 is small and the number of visitor groups declines by only approximately 6 000 when only the postal areas nearest the forest are used.

"Jægersborg Dyrehave og Hegn"

This forest (forest no. 3 in KBH in Fig. 1a), on the outskirts of Copenhagen, is by far the most important recreational area in North Zealand and is the most frequently visited with an estimated annual number of visitor groups of 381 685. This is a forest of national importance. All of the results for this forest are summarized in Table 2.

Basic models

1. When all of the 87 zones were included the consumer's surplus was 12 573 819 units for 375 798 groups predicted or 33,46 units/pvg.
2. When all the zones for which the forest was within an acceptable range were selected, a consumer's surplus of 15 299 526 units was found for a predicted number of visitor groups of 56,52 units/pvg.
3. When only the zones for which the forest is the nearest are considered, we are left with 19 zones. This gives us a result of 2 385 562 units for 262 320 visitor groups or a CS/pvg equal to 9,09 units.

Table 2. Consumer's surplus for "Jægersborg Dyrehave og Hegn"

Model	No. of zones	No. of visitor groups predicted	No. of visitor groups observed	Consumer's surplus	CS/pvg
1	87	375 789	381 685	12 573 819	33,46*
2	42	270 696	357 775	15 299 526	56,52
3	19	262 320	262 530	2 385 562	9,09
4 B	12	341 685	381 685	11 822 601	34,60
4 C	12	318 629	381 685	12 896 367	40,47
4 D	12	245 748	381 685	15 381 372	62,59
4 E	4	262 302	262 530	2 363 033	9,01
4 F	8	310 330	357 775	11 128 336	35,86

* Due to the inelasticity of the function used, no useful fit was obtained until the data were separated into two groups (see Christensen 1984).

Rezoned models

The different methods of calculating the costs are discussed above ("Hareskovene og Jonstrup Vang").

When we use the same zones as in model 1 but rezone in 5 km intervals, we get 12 zones and the consumer's surplus is 11 822 601 units for 341 685 visitor groups or 34,60 unit/pvg. This was with the "normal costs" (4 B) but if we weight the costs according to zone population (4 D), the consumer's surplus increases to 15 381 372 units and the number of predicted visitor groups decreases to 245 748 leading to a consumer's surplus/pvg of 62,59 units. If we rezone model 3 with 10 km intervals and use "weighted costs" (4 E), we get a CS/pvg of 9,01 units which is very similar to what was found using model 3.

If we rezone model 2 with a zone interval of 7,5 km (4 F) and again use "weighted costs", we get a consumer's surplus of 11 128 336 units for 310 330 predicted visitor groups or a CS/pvg of 35,86 units.

Discussion

The results shown above indicate that the forest area "Jægersborg Dyrehave og Hegn" is more important than "Hareskovene og Jonstrup Vang". Furthermore, for "Jægersborg Dyrehave og Hegn" it is interesting to note that the value of the area is higher when it is considered at a national level. The rezoned models give results similar to models 1, 2 and 3 and they are, in fact, quite similar as the points are still weighted according to the procedure explained earlier. As discussed above, the unit of calculations was kilometre. If we want to estimate an actual monetary value of the consumer's surplus for "Jægersborg Dyrehave og Hegn" which has a consumer's surplus (CS/pvg.) in the range of 30—60 units (which is equal to approx. 18—36 Dkr. or US $ 2,07—4,14 per visitor group) we obtain a value of around 10 mill. Dkr. (approx. US $ 1 150 000) for the total number of yearly carborne visitor groups (based on 1977 level and price). These values do not include time costs and it should be emphasized that only carborne visitor groups have been considered. In addition, no expenditures for maintaining such a high visitor level are deducted. Forests important at a regional level have values of around 10 units for CS/pvg and local forests less than that.

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RECREATIONAL USE OF URBAN FORESTS IN ROVANIEMI

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The study concerns the recreational use of urban forests. The objects have been both the forest areas and the population of the town of Rovaniemi in Lapland. The main results concern the quantitative factors of urban forest recreation.

The study presents the participation rate in outdoor recreation among the population of Rovaniemi, the number of visits in urban forests and of some outdoor activities among outdoor recreationalists.

The location of the residences of visitors using different recreational forests are of some interest. The time patterns of outdoor recreational activities in urban forests was one subject of investigation.

Key words: forest recreation, urban forestry, participation rate, number and frequency of visits

Introduction

Rovaniemi is located in Finnish Lapland and it is the administrative, commercial and cultural centre of the country's most northerly region. The climate is hard. The snow stays from November to April in normal winters. Summer is short and cool, in July the mean temperature is 15,3 °C. Forests surround Rovaniemi. Typically there are plenty of hills with poorly forested tops, and peatlands in the valleys. The location of the city at the junction of two rivers, Ounasjoki and Kemijoki, limits the access to all forest areas. For these reasons outdoor recreations is concentrated into a few areas, in spite of the surrounding forest areas.

The town has a population of about 29 000. Seventy two percent of the townspeople earn their living from trade, transport and the service professions. Industry accounts for 25 % and forestry and agriculture 3 %. Tourism is an important industry. The age structure is quite normal for a Finnish middle-size town: 25 % children (0—14) (21 % in the country), 18 % young (15—24) (16 %), 31 % younger middle-age (25—44) (32 %), 20 % older middle-age (45—64) (20 %) and old (65—) (11 %). The sex-ratio is 52:48 in favour of the female. The social structure is typical for a town which is based on administrative and trade affairs and educational institutes. The majority of inhabitants are white collar workers.

The aim of the study

The aim of the study has been to investigate the recreational use of urban forests. The object of the observations has been both the urban forest areas and the town population's outdoor recreation. This paper concentrates on the population. In this investigation outdoor recreation includes walks for pleasure and all kinds of outdoor activities directed towards natural areas. All activities concerning journies to work, school, shopping, gardening, etc. were omitted from the concept. Outdoor activities are for example jogging, hiking-walking, skiing, swimming, hunting, nature observing.

The method used to collect the study material was the mailed questionnaire. Field interview and field observations were also used for the assessment of outdoor recreational activities in two forest areas, Korkalovaara and Ounasvaara.

Forest recreation in Rovaniemi

The most important indicator of the quantity of outdoor recreation is the participation rate. Among the population of Rovaniemi town the participation rate was high (88 per cent). Outdoor recreation seems to be the most popular leisure activity (e.g. Kämäräinen 1967). In a study concerning outdoor recreation in Finland the participation rate of "walking for pleasure" (the most usual form of outdoor recreation) was 87,1 per cent of the total population in Finland in 1978 (Ulkoilututkimus 1980). In our study we compared outdoor recreational conditions in Rovaniemi and Kerava, which is located in southern Finland. The participation rate of Kerava was 80 per cent.

The Rovaniemi inhabitants took part in recreational activities inside the town area or very close to it about 1,2 milj. times in 1978. Of those visits about 0,6 milj. were directed to Ounasvaara and Korkalovaara recreational areas. The other half of the outdoor recreation was directed mostly to the build-up areas of the town. There were about 0,2 milj. visits in the regional outdoor recreational areas. Outdoor recreation activities such as visits to summer-cottage, picking berries and mushrooms, hunting, fishing outside the town make up a large part of the outdoor recreation among the Rovaniemi population. The recreationalists took part in these activities about 0,6 milj. times. Of all outdoor recreational visits about 60 % were directed to areas located within the town limits or very close to it, and 40 % outside the town.

Ounasvaara is the most popular area in Rovaniemi. The area is about 7 km^2. The highest point, Isorakka, is 210 meters above sea level (Kemijoki is 74 m above s.l.). In the area there is a skiing center with skilifts and skijumps, a sports institute, hotel, camping site, ski cabin and many roads and trails for walking and hiking, as well as ski routes (with lighting in winter). It is a well equipped recreation area both for Rovaniemi residents and tourists. Almost 15 000 citizens (56 per cent of population) use Ounasvaara for outdoor recreation.

The second most popular is Korkalovaara with 9 000 visitors (34 per cent of population). The forest area of Korkalovaara is a typical recreational forest area in the surrounding suburbs. The residental areas have about 3 km of common boundaries with the forest area. Inside the area of easy accessibility there are about 10 000 inhabitants. The area contains one lighted trail about 4 km long and a small path for jogging.

The average Rovaniemi dweller took some form of outdoor recreation activity about 91 times per year. The outdoor recreational visits were distributed so that 29 of the visits (32 %) occurred in winter (from January to April), 39 (42 %) in summer (from May to August) and 23 (26 %) in the autumn (from September to December). The main part of the visits to the urban forests occured in winter (48 %).

When considering the distribution of Rovaniemi dwellers into activity groups it appears that over half of the recreationalists (55 per cent) participated in some kind of outdoor recreation activity more than once a week. The largest group, 25 per cent of all outdoor recreationists, participated in some outdoor recreation twice a week. Some 3 % took daily outdoor recreation. The outdoor recreationalists in Rovaniemi did some relaxing outdoors 1,8 times per week on average (Fig. 1).

In addition to the visits to urban forests, the Rovaniemi inhabitants take part in many special outdoor activities which often take place outside the town area. Of these out-

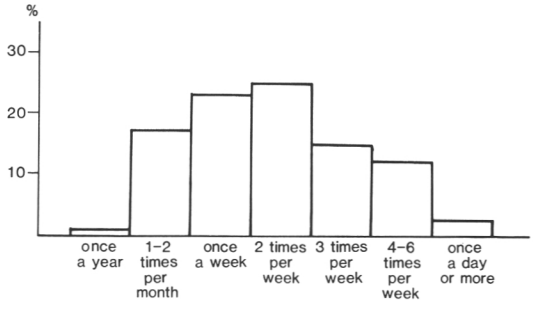

Figure 1. The distribution of outdoor recreational visitors on the basis of frequency of outdoor recreational visits per week.

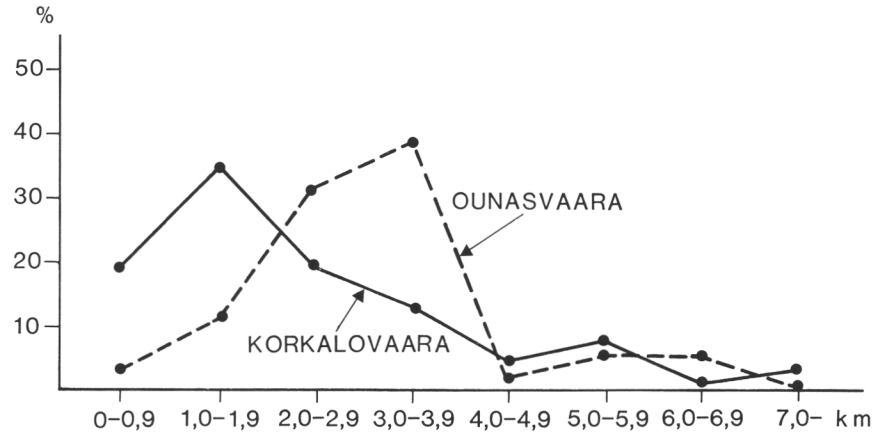

Figure 2. The distribution of outdoor recreational visitors on the basis of the distance between visitor's residence and forest.

door activities berry- and mushroom picking was the most popular activity (about 55 % of the outdoor recreational population) in 1978. Among the total population of Finland the comparative participation rate of berry- and mushroom picking was 72 % in 1978 (Ulkoilututkimus 1980). The outdoor recreationalist of Rovaniemi made on average 8 visits to the forest for picking berries and mushroom during summer and autum of 1978. The average number of visits to summer cottage was 26 (41 %). Hunting is a speciality in Rovaniemi. As much as 16 % of the outdoor recreational population hunted for sport. If only males over 15 years are taken into account, 40 per cent of men took part in hunting. The participation rate of hunting in Kerava, southern Finland, was only 5 %. Cycling and fishing concerned about 30 % of outdoor recreationalists.

The location of the residences of visitors using recreational forests are of some interest. The mean distance between visitor's residence and the forests (in the point of interview) was, for Ounasvaara 2,7 km and for Korkalovaara 1,8 km. For Korkalovaara, more than a half of the visitors lived one kilometer or less from the forest. For Ounasvaara, most of visitors (over 80 %) had distances of 2 km or more to the forest (Fig. 2).

Figure 3 describes contacts between town dwellers in different areas and the outdoor recreational areas. Here it is easy to see how Korkalovaara is the area for one suburb while Ounasvaara receives visitors from all parts of the town.

The time patterns of outdoor recreational activities in urban forests was one subject of our investigation. The time patterns are divided into three categories: seasonal, weekly and daily patterns. The time patterns throughout the day were studied separately on Sundays and workdays in summer and winter. The peak hours of day seem to have a certain pattern: on Sundays around midday, and on workdays in the early evening. (Saastamoinen & Sievänen 1981).

The time patterns throughout the week reflects the distribution of work and leisure time on different day of a week. It's quite natural that the weekend is the most important period for outdoor recreation. Though, the recreational activity is surprisingly high on workdays. In Rovaniemi the visit numbers of workdays were about 50—70 per cent of the Sunday level (Saastamoinen & Sievänen 1981).

The seasonal variation of outdoor recreation in urban forests is effected by the weather, but also by the distribution of holidays. In urban forests, the winter, spring and autumn are the periods of lively outdoor recreation, while at mid-summer there is little activity. The peak period for the recreational activities in urban forests is during the period February to March — it is the main skiing season in Finland.

In the summer months, the outdoor recreation of the population is more diverse than in the other periods of the year. In the summer many people spend their leisure time at summer cottages, holiday resorts, on beaches and water areas (Saastamoinen & Sievänen 1981).

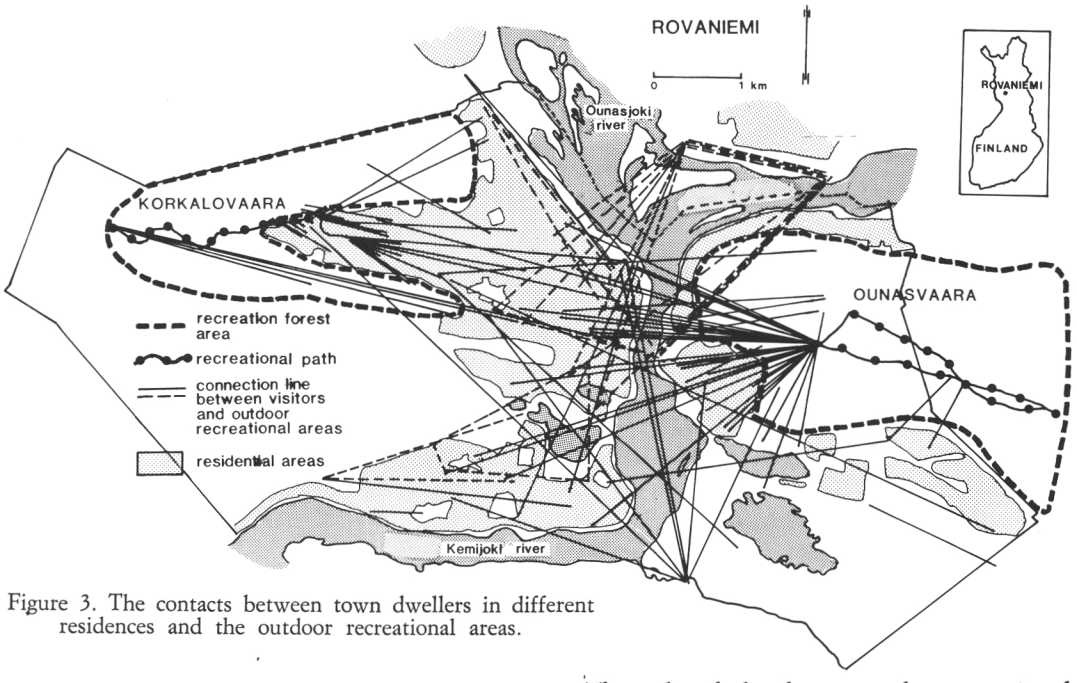

Figure 3. The contacts between town dwellers in different residences and the outdoor recreational areas.

Discussion

We can say that outdoor recreation belongs to the everyday pattern of living. The factor effecting participation rates are, in the first place, the socio-economical and age structure of the population (the demand factors) and in the second place the possibilities offered for outdoor recreation in the neighbourhood of one's home area (the factors of supply). The main part of those inhabitants in Rovaniemi not participating in outdoor recreation are mainly persons who are invalids or who are too old. The same thing is apparent in Kerava, which has been the town selected for comparison.

Though the age structure of the population in Rovaniemi is somewhat older than in Kerava, the participation rate is higher in Rovaniemi. The difference of the participation rates between Rovaniemi and Kerava can be explained on the basis of the factors of supply of the recreational environment. It is obvious that good outdoor recreation facilities make people active in outdoor recreation. In Rovaniemi, the forest areas are better equipped for outdoor recreation compared with Kerava. For example during the season of darkness (September — February) the lighting of skiing routes seem to be necessary for the effective use.

The role of the forest as the recreational environment is difficult to discriminate from other elements of the landscape. If we anyway want to adjust the role of the forest as an recreational environment on the basis of visits to different kinds of areas, we must consider all those visits which consider the forest as a main environmental element. From all recreational visits we must deduct those visits which are clearly direct to the build-up areas of towns (streets, sports fields, parks, etc.), water- and beach-areas or agriculturel areas (fields, gardens). In Rovaniemi, it is not easy to find areas in which the forest does not play significant role. But if we consider purely forest areas, and the activities for which a forest is needed, we can say that 70 % of all recreational visits are related to the forest environment.

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COMPARISON OF DIFFERENT METHODS IN THE INVENTORY OF URBAN FOREST RECREATION

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The aim of the study has been to compare different methods in the inventory of urban forest recreation, especially the number of visits in four recreational forest areas and the frequency of visits among visitors. The methods were: field observation, field interview and mailed questionnaire.

The paper presents some notes concerning the difficulties that occur in such inventories when forest areas are open for public use. The suitability of the methods, and their reliability, is discussed.

Key words: forest recreation, outdoor recreation, urban forest, inventory method

Introduction

Measuring the quantity of the recreational use of forests is a basic problem in the field of recreation research. Quantity indicators are needed for the evaluation of the importance of social and personal recreation and their status compared with other ways of using nature, and especially forest resources. Quantity indicators are therefore a matter of necessity.

As a subject for research forest recreation is complicated. Forms of recreation differ from each other because of the area, time, information, interest, attractiveness and facilities for access and accommodation. People have different requirements and different use intensities with respect to forest recreation. In Scandinavian countries there exists a common right of access to forest areas for recreation regardless of the ownership of the land. Because of this right, visitors to the forest are allowed to walk without restriction and occasionally stay and overnight in the forest. This makes it difficulty to measure the quantity of forest recreation.

In this paper forest recreation means the recreational use of urban forests. Outdoor recreation is a wider concept and include walks for pleasure and all kinds of outdoor activities directed towards natural areas. Activities concerning journey to work, school, shopping, as well as such activities as gardering etc. are left outside the discussion.

Outdoor recreation can be considered: a) from the standpoint of the outdoor recreational area, and b) from the standpoint of the outdoor recreationalist. The most important factors concerning the recreational use of a forest area, according to Koch (1976, p. 7—8) are: the number of visits, the number of visitors and the length of stay per visit and per visitor. The central factors concerning the recreationalist are: the number of visits, the variation of visits in time, the frequency of visits per unit period and the number and quality of the areas used for outdoor recreation. The recreational behaviour of a population can be studied on the same basis.

The purpose of this paper is to consider different methods of measuring the patterns of recreational behaviour of a population and the use of some urban forest areas in Kerava, a small industrial town (population 20 000) in Southern Finland. Three different inventory methods are presented and their suitability for studying urban forest recreation are evaluated.

	VARIABLES	QUESTIONNAIRE	INTERVIEW	OBSERVATION	NUMBER OF METHODS FOR COMPARISON
1	THE NUMBER OF VISITS IN A CERTAIN RECREATIONAL AREA				3
2	THE NUMBER OF VISITS TO ALL RECREATIONAL AREAS IN THE TOWN				-
3	TOTAL NUMBER OF VISITS OF THE RECREATIONALISTS				-
4	THE NUMBER OF VISITS OF THE TOWN POPULATION				-
5	THE PARTICIPATION RATE IN OUTDOOR RECREATION				-
6	THE NUMBER OF THE RECREATIONALISTS (THE VISITORS) TO A CERTAIN AREA				-
7	THE ACTIVENESS OF THE RECREATIONALIST				2
8	THE NUMBER OF THE RECREATIONAL AREAS				3
9	THE DISTANCE BETWEEN THE RECREATIONALIST'S HOME AND THE FOREST				2
10	THE DURATION OF STAY				2
11	THE LENGTH OF WALK				2
12	THE RECREATIONAL ACTIVITIES				3
13	THE PARTY OR COMPANY WITH THE RECREATIONALIST				3
14	AGE AND SEX				3
15	OCCUPATION, STATUS AND EDUCATION LEVEL OF THE RECREATIONALIST				2
16	CIVIC AND NUMBER OF CHILDREN OF THE RECREATIONALIST				-
17	WORKING CONDITIONS OF THE RECREATIONALIST				2
18	JOURNEY TO WORK DESCRIPTION OF THE RECREATIONALIST				-
19	THE STANDARD OF LIVING OF THE RECREATIONALIST				-
20	THE RECREATIONALIST'S OPINIONS OF RECREATIONAL AREAS				-
21	THE TEMPORAL VARIATION OF RECREATIONAL USE OF AN AREA	TEMPORAL VARIATION BETWEEN WEEKDAYS AND SEASONS	TEMPORAL VARIATION BETWEEN WEEKDAYS AND SEASONS	TEMPORAL VARIATION BETWEEN TIME OF DAY, WEEKDAYS AND SEASONS	3
	THE NUMBER OF VARIABLES	21	12	6	

Figure 1. The methods and variables used in the study.

The methods compared

The aims of the methods

Burton and Noad (1968, p. 5—34) and Burton (1972, p. 33—62) have classified the suitable methods for recreational studies into six classes:

1) physical evidence in the environment
2) mechanical and electronic devices
3) documents
4) observation
5) self-administered surveys
6) interview surveys

In studies of forest recreation, and outdoor recreation in general, all these above mentioned methods have been used. In many studies two or more different methods have been used side by side either with the same aim, or supporting each other. (Jaatinen 1973, Kardell 1972, Haakenstad 1975).

Because this study was directed at both the recreational use of forest areas and to the town population, the chosen methods were 1) field observation, and 2) interview in the forest areas, and 3) a mailed questionnaire to a sample of the population.

The object of the field observation in the forest was the quantity of outdoor recreation. The measurement unit was the number of visits per unit of time. The counting of visits was based on the observation of visitors during a chosen time period.

Visitors to the forest areas was the subject of the field interview. The aim of the interview was to collect information concerning the recreational use of the forest area in which the observation was carried out. The whole population of Kerava were the subject of the mailed questionnaire. The methods chosen, and the factors measured with each method are shown in Figure 1.

Data collection

Four forest areas from all forest areas of the town were subjectively chosen for field observation (Fig. 2). From each forest area one central observation point was chosen for observation. In each area the representativeness of the observation point was studied separately.

The observation time was chosen as follows. The observation period was one year (1. 5. 1978—30. 4. 1979). During the year there were systematic observations twice a week, on Sundays 11—12 a.m. and on Wednesdays 18—19 p.m., one hour at a time. The relationship of the chosen observation hour with the whole day was checked by observations for whole days (from 6 a.m. to 8 or 10 p.m.). This happened 10 times on Sundays, of which 7 were in summer and 3 in winter, as well as 7 times on Wednesdays, of which 5 times were in summer and 2 times in winter. The days for the total observations were chosen randomly.

The observation gave the number of visits and the seasonal and daily patterns of recreation in some urban forest areas (Saastamoinen & Sievänen 1981). In the present paper only the first point is under consideration.

The interviews were made mainly during the period of July — November. At the same time, the total daily observations were carried out. The interview-sites were the observation points mentioned above.

The sample of visitors was arranged so that the first visitor passing the observation point was interviewed and thereafter every fifth visitor. Only persons over 15 years were interviewed.

The data collected was based on 106 interviews. The results considered in this paper are the number of visits made by visitors to the observed forest during the whole year and their seasonal distribution, and the number of visits during the previous week.

The mailed questionnaire was directed to a sample taken from the whole population of Kerava. It was taken from the taxation register by random-start systematic sampling. The population consisted of all residents over 15 years. The sample size was 724, and the response rate was 63 %. There were thus 416 observations of residents' participating in some outdoor recreation. The data collected by the questionnaire concidered in this paper were: the number of recreational visits to the urban forests in 1978 and their seasonal and regional distribution; the number of recreational visits made by respondents during the week prior to answering the questionnaire and the total number of recreational visits in 1978 made by the respondent.

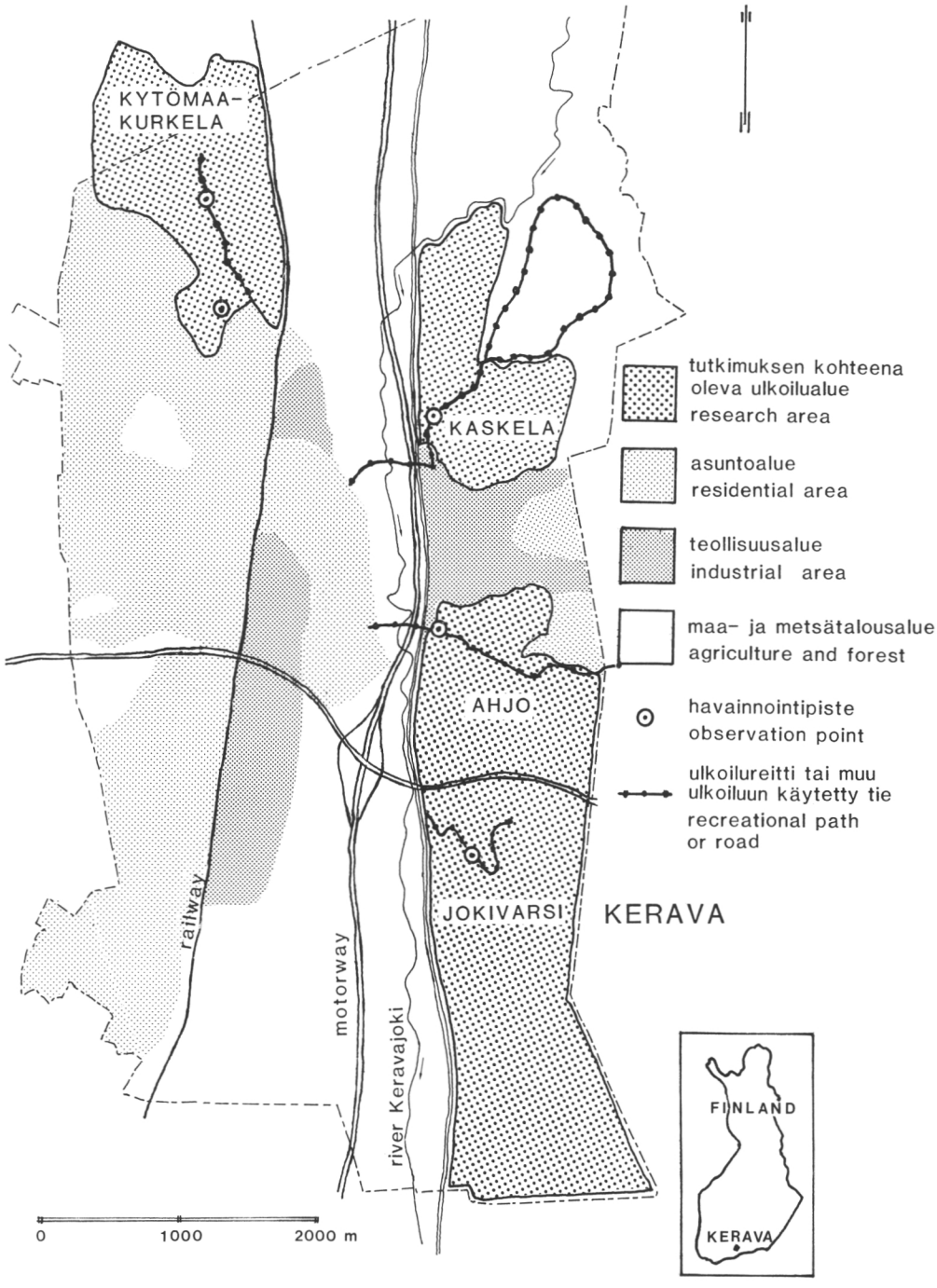

Figure 2. The locations of the investigated forest areas in Kerava.

measurement				*result*
the hourly frequency (fixed time) separately in sunny and rainy days	→	1	→	the monthly mean of visit frequency of one hour in an observation point separately in sunny and rainy days
		↓		
the relation between one hour and a whole day	→	2	→	the monthly means of visit frequencies of sunny and rainy days in an observation point
		↓		
the number of sunny and rainy days	→	3	→	the number of visits during a month in an observation point
		↓		
the length of observation time	→	4	→	the number of visits during the whole observation time
		↓		
the correlation between the number of visits in the observation point and in in the whole forest area	→	5	→	the number of visits in the whole forest area during the observation time

Figure 3. The counting of the total number of visits obtained by field observation.

Some remarks on the analysis

The use of field observations to estimate outdoor recreational visits was based on the a priori knowledge that some regularity in the temporal behaviour of outdoor recreation is to be found. If the proportional number of visits in a certain hour of the day is maintained, even if the number of visits per whole day may vary, it is possible to count the number of visits per a day at the basis of the regression between a particular hour of the day and the whole day. For this purpose, observations of the same hour of the day, and of the whole day were needed. Figure 3 shows the process of counting the total number of visits.

Because the sample of visitors in the field interview were selected for interview from visitors passing the observation point, the probability to be selected is greater if the recreationalist visits the area often than less often (Haakenstad 1975 p. 11). For this reason there is overrepresentation of the very active. This source of error was reducted by applying a coefficient which takes into account the difference of visit activity in the sample visitor group and in the total visitors group.

The total number of visits (V) in the forest area under study during a certain time period can be obtained as follows:

$$V = \sum_{i=1}^{n} k_i \, u_i \quad \text{where}$$

$$k_i = P_i \cdot K \text{ and } P_i = \frac{v_j}{a_i}$$

- V = total number of visits in forest area
- k_i = the number of visitors belonging to the activity group i of the whole visitor group K
- u_i = the mean number of visits in the activity group i during a certain time period
- K = the whole visitor group of forest area
- P_i = the probability of a visitor in an activity group i to become selected
- a_i = number of interviewed visitors in activity group i
- v_j = number of visits of an interviewed visitor j
- i = activity groups 1, 2, 3, 4, 5, 6, 7 (1 = once a month, 2 = 2—3 times per month, 3 = once a week, 4 = 2 times per week, 5 = 3 times per week, 6 = 4—6 times per week and 7 = once a day or more)
- j = visitor

The total number of visits to a given outdoor recreation area during a certain time period was estimated on the basis of the visit frequency of respondents to the mailed questionnaire. The relationship of the sample population taking outdoor recreation and the whole population was computed and this relationship was used as a transformation coefficient to obtain the total number of visits.

The town population was divided into two groups: those participating in outdoor recreation and those not. This was possible with the help of a short follow-up questionnaire to non-respondents. The proportion of population participating in outdoor recreation was 80 %.

The transformation coefficient is the correlation between the respondents of the questionnaire and the population taking outdoor recreation.

transformation coefficient

$$T = \frac{V}{v}$$

V = number of population taking outdoor recreation
v = number of respondents taking outdoor recreation

Comparison of results obtained by different methods

The number of visits in four forest areas

The number of visits were measured independently by two methods, the field observation and the mailed questionnaire. The third method was the field interview supplemented by a mailed questionnaire. Table 1 shows the visit numbers from four recreational forest areas estimated by three methods.

A comparison of methods based on these figures gives only indirect information concerning the suitability of the methods for inventories of outdoor recreation. One reason for this is that it is very difficult to determine any limits of confidence for the variables obtained. Conclusion drawn under these limitations and with the obvious weakness of comparison, must be considered tentative. All three methods gave visit numbers in approximately same size-class in two forest areas. The other two had quite large differences in visit numbers, but they did vary in the same direction.

It would seem that each of the methods under discussion are to some degree suitable for this kind of inventory task, but some restrictions must be taken into consideration. They are probably the main sources of error in this study.

Table 1. The number of visits to four recreational forest areas in Kerava during the period 1. 5. to 30. 8. 1978 based on three different methods.

Forest area	The number of visits according to		
	field observation	field interview	mailed questionnaire
Kurkela-Kytömaa	26 000	30 000	28 000
Kaskela	22 000	19 000	17 000
Ahjo	28 000	69 000	54 000
Jokivarsi	8 000	—*)	18 000

*) the number of obtained interviews was only 7

The biggest differences between methods appear in the Ahjo area (Fig. 1 and Table 1). This study only included urban forest areas which were not espicially designated for outdoor recreation. They are normal forest open for public use. The boundaries of the observed areas were therefore not well defined. The area may vary with different methods, and that might be one explanation for the differences observed by the three methods for the same area.

In three cases the mailed questionnaire and the field interview do not give very much different results. The field interview, however, gave in all cases greater estimates than the mailed questionnaire and the differences are all in the same direction. In two cases the field observation gave quite similar values with the mailed questionnaire, but the differences go in opposite directions as well as of the field interview (see Kurkela-Kytömaa and Kaskela in Table 1). The main reason for the inconsistensy of the field observation is probably the small number of measurements. They are troublesome and require many workhours and a large workforce. In spite of the considerable work done in this investigation, the number of observations seem to be unsatisfactory. In general, the character of the field observation leads to the assumption that its results are underestimates rather than over-estimates.

The reliability of the results of the mailed questionnaire depend on the representativeness of the sample. Secondly, only right questions give successful answers. The respondents were asked their visit frequency in different outdoor recreational areas. This estimate can be affected by a slip of memory. "It is a very common feature in interview and questionnaire surveys that indicators of quantity have quite low reliability" (Julkunen 1970, p. 80). Another source of error is the above mentioned difficulty to give exact boundaries to the forest areas under study.

The field interviews had their own difficulties, mainly concerning problems of the best indicator for visit activity. The frequency of visits per unit of time and per visitor was estimated in different ways. This problem is

considered in the next section. The experiences of this study do not provide possibilities for making any definite conclusion concerning the suitability hierarchy.

The labour inputs for data collection by the three different methods were as follows:

	labour input manhours
Field observation:	
field work before observation	55
preparing the form	35
observating: weekly	120
a whole day (12 times)	165
controling observations	75
Together	450
Field interview:	
planning the interview areas	15
preparning the form	25
interviews	160
Together	200
Mailed questionnaire:	
planning the form	50
picking sample	30
mailing	110
handling replies and follow up letters	40
Together	230

The field observation method was about twice as labours as the two others.

Field observations and mailed questionnaires are methods that can both be improved for the measurement of outdoor recreation quantity. The field interview has problems because of its restricted application to an unknown proportion of the total number of users. The field observation principle gives possibilities for the most reliable study, but the laborious and costly arrangements may create difficulties.

The frequency of visits of outdoor recreationalist

The frequency of visits per unit of time made by one outdoor recreationalist was measured in several ways. The basic measurement was the mean number of visits during one week by visitor to the forest area, or by the population taking outdoor recreation. Table 2 presents all these different variants of the variable computed from the data of surveys made in Kerava.

The concept of outdoor recreation visits is of course important and effects the numbers. In this study, the concept quite largely determines, and perhaps exaggerates, the scale of visits for the purpose of outdoor recreation.

Table 2. The average frequency of visits by an outdoor recreationalist in Kerava computed by two methods using seven different indicators.

The measurement means	The number of visits during a week Mean		N	Mode
I The number of visits during a whole year questionnaire	2.3		408	
II The number of visits during the week prior answering				
a) questionnaire in autumn	3.6	±0.3**	403	3
b) field interview in summer	4.4	±0.5**	106	3
c) field interview in winter	3.5 (3.0)*	±0.2**	618	2
III The number of visits on the basis of date of the previous visits prior answering				
a) questionnaire in autumn	2.7		403	
b) field interview in summer	2.4		106	
c) field interview in winter	2.3		618	

* the mean number of visits during 7 day prior to the interview (does not include the visits concluding to interview)
** the significance level of 5 %

To examine this problem some comparable measurements of the recreational use of both urban forest areas and the outdoor recreational behaviour of urban population were required. When choosing the field observation method the number of visits was the only unit relatively easy to count. Because the pattern of the recreational use of urban forests is assumed to vary little only, the number of visits was accepted as the unit of measurement. It was also thought to be a useful indicator of the outdoor recreation activity among the population.

However, the means obtained by the different methods vary quite a lot. It seems that every method used here have their own problems.

The frequency of visits varies from 2,3 to 4,4 visits per week. The lowest figure is obtained on the basis of the yearly frequencies among Kerava residents. The hihghest is of the visitors to outdoor recreational areas in summer. The indicators based on the previous outdoor recreational visit gave means of 2,3, 2,4 and 2,7.

There is a common apprehension that questionnaire and interview surveys have an ability to exaggarate quantitative indicators

of behavioural frequencies (Kardell & Pehrson 1978, p. 90). It would seem that "the number of visits during the week prior to the interview" must include exaggeration, but one factor effecting the mean may be the point of time of collecting the data. All the field interviews were collected during the peak periods of the recreational use of forests. So was the mailed questionnaire posted in the autumn, when weather conditions were still quite favourable for outdoor recreation. This may be one reason for the exaggeration compared with the mean for the whole year. Further, the respondents of field interview are very likely the more active "outdoor types" than the population in general. The lower means among the questionnaire respondents show that the measurement of these variables for the whole population are necessary and the interviews made on the outdoor recreational area tend to give higher figures.

Discussion

The inventory of outdoor recreational use of forest is a research topic that requires much development in Finland. The field observation is a reliable method if the resources are sufficient. Usually there is lack of resources, time, workforce and funds, to realize all required observations. That is why the field observation methods are difficult to implement intensively enough (Haakenstad 1975, p. 25). The unreliability factors occured from the coverage of the observations regionally and in time and the observation errors of observers.

The use of field observation has a regional character. Furthermore, long time series of measurements are needed to diminish the effect of random factors like weather. The use of mechanical and electronic devices to support the human observation must be considered (e.g. James & Schreuder 1972, Kardell 1972, Swarre 1975, Koch 1976, Colling & Grayson 1975). A lot observations of the outdoor recreational use in the observed areas are required for the successful organization of systematic observations over long time periods. They must be made throughout the whole year, in all weather conditions and if possible at many observation points in the observed forest. The coverage of the observation point have to be checked several times.

The arrangement of our field observation is supplemented by the experiments of Heglebäck (1978). He tested three different field observation methods: counting at the entering sites, counting at a station, and mobile counting. The counting at the entering sites gave the best result. Kardell (1972) has demonstrated the serviceability of many field observation methods. He has found that counting parked cars in a central entering site was the best method when most of the visitors come to the area by car. This method was applied also by Koch (1980).

The object of field interviews are the people who use the interview area for recreation. The limitations of the interviewed groups is both an advantage and a disadvantage. It is advantageous that the outdoor recreational behaviour and opinions of one area and one group of outdoor recreationalists can be identified (Kardell 1972, Jaatinen 1973, Haakenstad 1975). The interview method demands the use of sample methods. The visitors to an outdoor recreational area can be defined accurately, but their total number is unknown. Because of this, the choice of the sampling method and the size of sample are difficult to plan.

Further difficulties are the strict limits concerning the character, length, and intimacy of questions and of the interview. There must not be too many demands on memory. The interview must concern outdoor recreation at the time of the interview or at a time close to it.

The suitability of field interviews for the measurement of outdoor recreation activities in Kerava must be considered from the standpoint of the study as a whole. In the present study its purpose was to complete a field observation, and obtain some facts concerning the characteristics of visitors, the frequency of their visits, the length of their stay in the study areas, the area used for recreation and the size of the population using the area as well as where the visitors come from. The field interview alone is not particulary suitable as a method for assessment of the quantity of outdoor recreational use in an area.

The field interview is useful for supporting field observations to collect data concerning qualitative factors of forest recreation. The data must be collected during all seasons, all

weekdays and whole days so that the moment of interview does not create a special pattern of outdoor recreational behaviour (Jaatinen 1973, Haakenstad 1975, p. 11).

The mailed questionnaire has one considerable advantage. It is relatively easy, at moderate cost, to reach a large number of people. In this study it would not have been possible to use any other method to investigate the total recreational use of the forest areas, or the outdoor recreational behaviour of the population, in Kerava. For estimates of the total recreational use of forests among a population, the mailed questionnaire seems to be the only suitable method.

The difficulties that arise when using questionnaires are many; e.g. how should questions be presented so that they are understood as intended? (Haakenstad 1975, p. 12). Ambiguous information is useless. The measurement problem demands the use of concepts like "outdoor recreation area" and "outdoor acitivity". The explanation of those concepts are difficult and in practice one can never be sure if they have been fully understood.

The concept of outdoor recreation can, in fact, be understood in many differents ways. Different people have different ideas as to what can be called outdoor recreation. This is because of the complexity of the substance of the activity. For example, in this study all trips and activities concerning school and shopping, etc. were considered to be outside of the concept outdoor recreation. However, a person who walks to work to get fresh air and some recreation at the same time may regard himself to be participating in outdoor recreation.

An important standpoint concerning the succesful application of the mailed questionnaire is timing. A solution is to divide the sample into groups to which to questionnaires are mailed in different seasons (Koch 1978, p. 299). The sample must then be relatively large.

The general conclusion made on the basis of this study is simple: each method used had its own advantages and disadvantages. For the inventory of total forest recreation, no single method is enough. The use of different methods simultaneously seems to be the best solution. However, each of them seems to need still development.

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SCENIC VALUE OF THE FOREST LANDSCAPE AS ASSESSED IN THE FIELD AND THE LABORATORY

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The scenic value of selected forest stands was studied with the help of questionnaire addressed in the field to actual stands and in the laboratory to photographs of the same stands. The field and laboratory measurements yielded similar results, suggesting that black-and-white photographs may represent a reliable tool for estimating the scenic value of forest landscape. The results showed that mature stands of moderate density had the greatest scenic value. This was especially true of coniferous stands with intermixed birches.

Key words: Forest landscape, scenic values

Introduction

In boreal and temperature zones trees and forests play an important role in landscapes. The scenic value of forests is related to several structural characteristics of forests and tree stands. Tree species composition and the age structure of forests seem to be among the most important (e.g. Haakenstad 1972). The factors affecting the scenic value of forests landscapes are, however, seldom treated in detail in the literature (e.g. Hultman 1976).

One of the most important obstacles due to this deficiency seems to be the difficulty of developing methods of measuring the scenic value of trees and tree stands. Consequently, no simple and reliable methods for quantitative assessment of scenic value are available (Hultman 1976).

In the following we present a method of integrating photographs and questionnaires in assessing the scenic value of forest landscape. The measuring principles may also be applicable in practice to landscape architecture and landscape management. Some empirical results of the structural characteristics affecting the scenic value of forests stands are presented and discussed.

Methods and material

Method of assessing the scenic value

The scenic value of selected tree stands was assessed in the field through a questionnaire and in the laboratory through photographs of the same tree stands. In both phases the scenic value was measured with the help of adjectives with which the persons participating in the study expressed their scenic preference as regards the real tree stand or the photograph of the same stand. The measuring procedure in the field was similar to that by Kellomäki (1975).

Five groups of persons participated in the study. First, two groups of first-year students studying forestry at the University of Hesinki assessed the scenic value of the selected tree stands both in the field and in the laboratory. Later, these two groups are together called the Basic Group. Second, an additional group of forestry students, later called Comparison Group, made the assessment only in

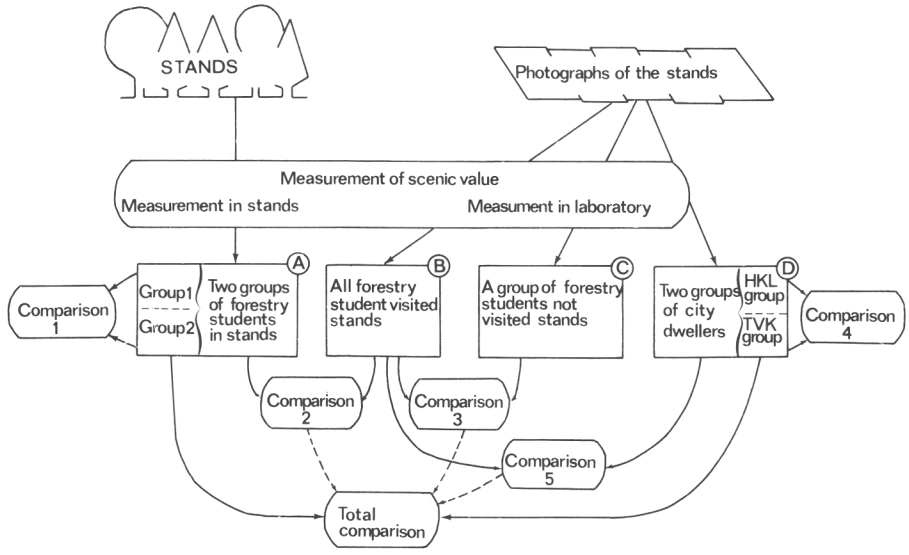

Figure 1. Schematic presentation of the phases of the study.

the laboratory. All the groups of the students were randomly selected from volunteers. Third, two randomly selected groups of ordinary city dwellers gave their assessment in the laboratory as did the third group of forestry students. These groups are called Recreational Group One and Recreational Group Two. The phases of the measurements are presented in detail in Figure 1.

During the measurements in the field and laboratory, the group members were asked to express their scenic preference within the range of the adjectives: inspiring, pleasant, ugly, original, repulsive, soothing, attractive, monotonous, delicate, varying, depressing, unpleasant, beautiful, revealing, interesting, startling and expressive.

The adjectives formed the basic items of the scenic index which was compiled as a sum of seperate items. Each item was given a numerical value ranging 4—7 or 4—1 depending on the direction of the attitude. Since four items expressed negative attitude and eight positive attitude, the value of the scenic index range was 37—72. The procedure is, in principle, the same as that used for measuring the meaning of words with the help of semantic differentiation as presented by Osgood et al. (1957). The principles for selecting the adjectives and compiling the scenic index used in this study are given in detail by Kellomäki (1975).

Study areas

The field measurements were carried out around the Forestry Field Station, University of Helsinki, in Central Finland (61° 24' N, 24° 15' E.), in summer 1978. Altogether, 34 separate tree stands were assessed. The study areas formed a successional series of the development of a tree stand representing a varying tree species composition and age distribution. In addition, the tree stands are typical of commercial forestry, including varying density and the amount of harvesting residues and undergrowth.

Consistency between field measurements and laboratory measurements

Measurements by forestry students

The consistency between both assessments is close as is indicated by the high value of the correlation coefficient between the field and laboratory assessments of the Basic Group (Fig. 2). The same is also obvious from the following parameters of the assessments (Table 1).

Table 1. Comparison between field and laboratory assessments made by basic group.

Assessment of the Basic Group	Mean value	Mean deviation	Range of variation
Field	56.9	6.8	44—63
Laboratory	56.1	7.8	42—65

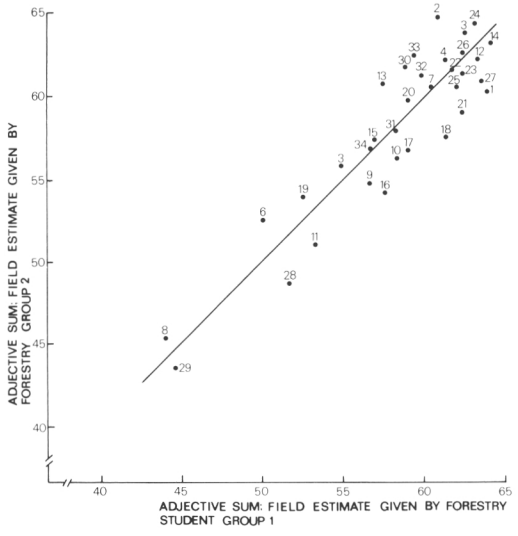

Figure 2. Correlation between the adjective sums given by both forestry student groups on the basis of the field visit and the photographs ($r = 0.943$).

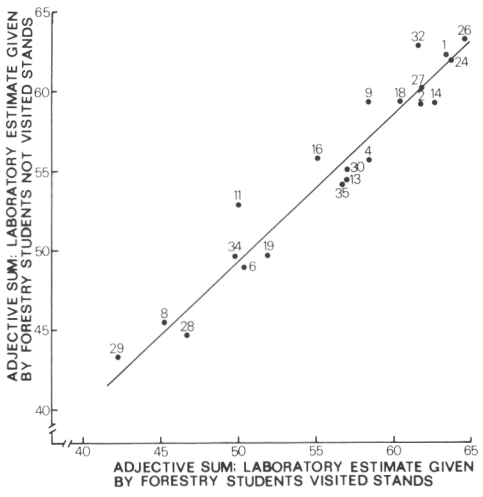

Figure 3. Correlation between the laboratory assessment of forestry students who visited the field and those who did not visit the field ($r = 0.957$).

The mean value for the field and laboratory assessments are nearly the same. This is true also for the variation due to the participants. The range of variation was, however, somewhat wider in the laboratory than in the field measurements. In other words, the same persons had clearer preferences in the laboratory than in the field.

The consistency between the laboratory assessment of the Basic Group (forestry students who visited the field) and the Comparison Group (forestry students who did not visit the field) is also close, as appears from Figure 3. In other words, persons with the same educational background had very similar preferences without the field experience to those of their colleagues with field experience. The same is also evident from the following parameters of the laboratory assessments of both Groups (Table 2).

The consistency between the assessments of the Two Groups was so close that even the most and least preferred stands were the same in both assessments. In other words, it seems to be possible to accord scenic rank to tree stands in the same way on the basis of photographs and field stands.

Measurements by city dwellers

Both Groups of city dwellers gave similar assessments in the laboratory (Fig. 4). This is also apparent from the following parameters of the measurements calculated for both Groups given in Table 3.

The consistency between the assessments of the two Groups was so great that again the most and the least preferred tree stands were the same in both assessments. In other

Table 2. Comparison between laboratory assessments by forestry students with and without field experience.

Study group	Mean value	Mean deviation	Range of variation
Basic Group	56.1	7.8	42—65
Comparison Group	55.1	8.2	43—63

Table 3. Comparison between laboratory assessment by two separate groups of city dwellers.

Group of city dwellers	Mean value	Mean deviation	Range of variation
Group One	55.9	10.2	40—66
Group Two	54.0	9.4	40—65

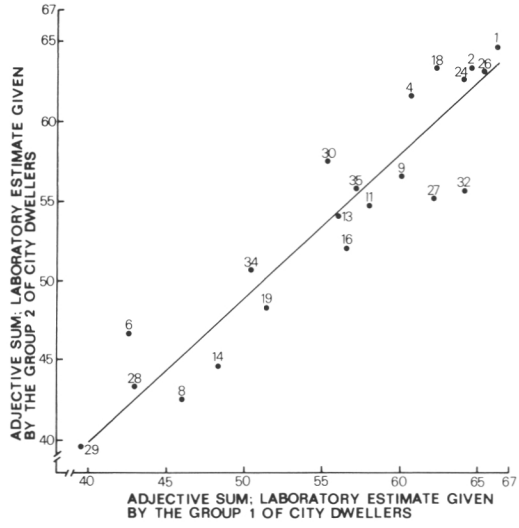

Figure 4. Correlation between the laboratory assessment of the two groups of city dwellers ($r = 0.928$).

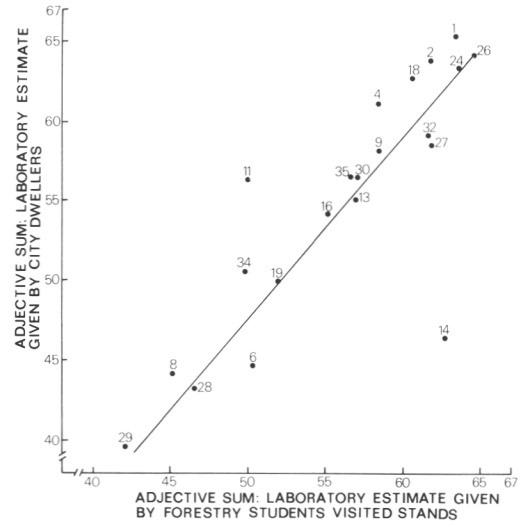

Figure 5. Correlation between the laboratory assessment of the city dwellers and the forestry students who visited the field ($r = 0.830$).

words, there seems to be some concistency among city dwellers as regards the scenic value of tree stands.

The scenic preferences of the city dwellers were linked with field measurements through a comparison to the laboratory assessment given by the Basic Group, i.e., forestry students who visited the field. The correlation between these assessments is not as close as that within and between forestry students or city dwellers solely (Fig. 5).

However, also in this case the coefficient of correlation is as great as 0,830 even though the background of the study groups varies considerably. Thus, it seems to be apparent that tree stands could be ranked according to their scenic value on the basis of photographic assessments given any group of recreations. Further studies are, however, needed to confirm this hypothesis.

Scenic value of tree stands as related to the stand structure and other characteristics

The field and laboratory assessments were related to several characteristics of the stand structure. The tree species composition and the stand age or the stage of development appeared to be the most evident factors affecting the scenic value of the tree stand as demonstrated in Figure 6. The birch *(Betula* spp.) has considerably higher scenic value than Norway spruce *(Picea abies)* and Scots pine *(Pinus sylvestris)*. This difference is maintained thoughout the whole succession of the tree stand. It is worth noting that the scenic value of unclosed seedling stands is greater than that of closed seedling stands or a stand at pole stage. Regardless of the tree species, the scenic value of the tree stands seems to increase further when the succession of the tree stand progresses.

It was also apparent that the presence of undergrowth increased the scenic value of a stand. The increased scenic value seems to be due to evenscattered undergrowth. On the other hand, no major effect exists when the density of the undergrowth exceeds 1000—1500 stems per hectare. Especially the tall undergrowth, i.e. suppressed trees and a bush layer with a mean height greater than 1.5 m, increased the scenic value of the tree stands. This was especially true as far as the coniferous tree species were concerned.

One of the most important factors outside those associated with the tree stand was the presence of harvesting residues. A linear decrease in scenic value takes place when the coverage of harvesting residues varies 0—60 %. The greater values of the coverage of the harvesting residues result in a drastic de-

crease in the scenic value. The threshold for the accelerated decrease of the scenic value was the value of 70—80 per cent of the coverage of the harvesting residues.

Among the other important characteristics was the range of vision, i.e. the range of view. In other words, an increased depth of view was associated with an increased value of the scenic index. The scenic value culminated, however, when the visibility exceeded 40—50 m. In other words, a moderate range of vision was preferred, but only to a limited extent as indicated by the effect of a neighbouring stand in the actual perspective. The effect of the neighbouring stand was the greatest and the most positive when the view was not too limited.

Discussion and further elaboration

Selected adjectives were given to several groups of forestry students and city dwellers with which they were asked to express their scenic preference on selected tree stands in the field. The measurements were repeated in the laboratory on the basis of the photographs of the same stands. The environmental preferences have been measured similarly with adjectives by several authors (e.g. Jacob 1973, Shafer & Richards 1974, Lane et al. 1975), since Osgood et al. (1957) developed a semantic differential for measuring preferences or attitudes.

The validity of the scenic index was assessed through questioning the participants "how great is the internal scenic value of the tree stand", giving them four alternatives: very small, rather small, rather large and very large. As appears from Table 4, there is a considerable consistency between this question and the scenic index.

It is also apparent that the background of the participants has no major effect on the measurements. The preferences may, however, also include other elements, e.g. recreational, besides visual ones associated in the tree stands (cf. Combrich 1953, Hepburn 1967, Shafer & Richards 1974). The effects of these factors are not eliminated but assumed to be the same in all cases.

Table 4. Correlation coefficients between scenic index and control question "how great is the internal scenic value of the tree stand" indicating the validity of the scenic index. Assessments given by separate groups.

	Field measurements	Laboratory measurements			
	Basic Group	Basic Group	Comparison Group	City dwellers	Total
Correlation coefficient	0.785	0.815	0.789	0.789	0.791
Number of observations	646	399	399	525	1969

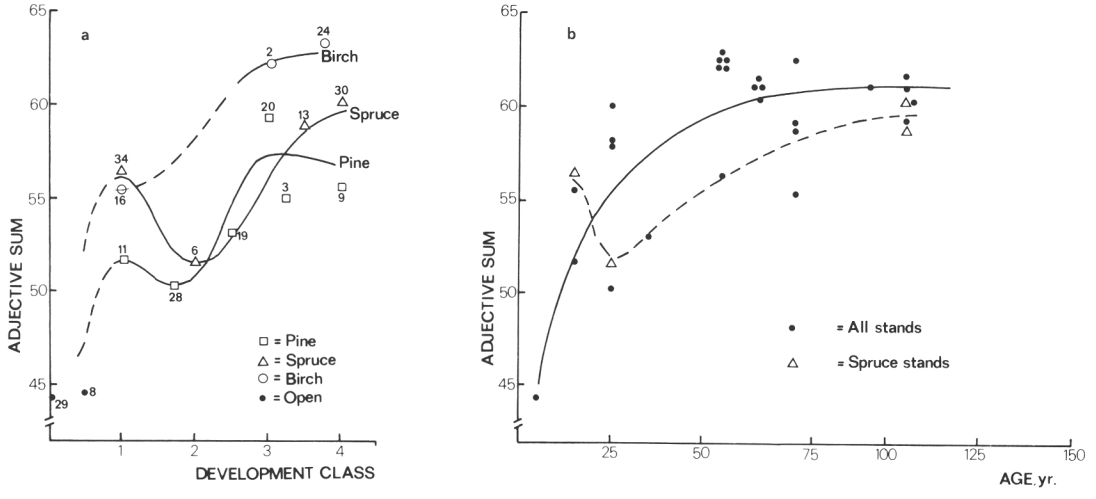

Figure 6. Dependence of the adjective sum on development class (a) and the stand age (b) in pure pine, spruce and birch stands.



Figure 7. Forest stand number 29. The value of scenic index 39.



Figure 8. Forest stand 34. The value of of scenic index 57.



Figure 9. Forest stand number 4. The value of scenic index 63.

The reliability of the scenic index was evaluated in several ways. First, a comparison of the deviation between the scenic index of Basic Group one and City dwellers shows a per-stand consistency. In other words, the assessment pattern of both groups was similar regardless of the tree stand. Second, two different photographs representing tree stands 30 and 35 gave a very similar value for the scenic index for these stands regardless of the study group (Table 5). The result accords with the findings by Nohl (1974) who demonstrated that no major increase in measuring accuracy is obtained with an excess number of photographs of the stand compared with a limited number of photographs.

Similar results are presented also by Shafer and Richards (1974) and Daniel and Boster (1976). Consequently, our results suggest that even black-and-white photographs may give a reliable tool for the evaluation of the scenic value of the forest landscape (cf. also Hultman 1976).

The range of variation of the scenic index field measurements was 56 per cent of the theoretical one. Among the most preferred stands there were mature deciduous stands and mature coniferous stands with mixed deciduous trees. Furthermore, unlimited visibility increased the given value of the scenic index to a certain degree both in field and laboratory measurements. In other words, a sparser stand with tall trees was awarded the highest value of scenic index in response to measurements. Earlier, for example, Kardell (1979) emphasised a sufficient range of vision as a basic element of preferred views (cf. also Lovén 1973).

The maturity and the tree species composition explain only partially the variation

Table 5. Mean ($\bar{x}$) and standard deviation (D) of the adjective sum for photographs 30 and 35 representing study area 30. Estimates given by the forestry student group which did not visit the site and two groups of city dwellers.

Group	Photograph	Adjective sum	
		$\bar{x}$	D
Forest students who did not visit site	30	55,00	7,17
	35	54,05	4,87
First group of city dwellers	30	55,33	7,11
	35	57,25	6,98
Second group of city dwellers	30	57,53	5,98
	35	55,85	5,48

Table 6. Correlations between the adjective sum and all the variables describing the solid pattern of the environment.

Model and its variables	Standardized regression coefficient	Explained variance decreased by %	Total correlation
Variation of view	.437	16,6	.624
Dominated trees, proportion of spruce	.329	8,5	.315
Dominant height	.713	8,1	.715
Harvesting residues, coverage	—.315	6,5	—.570
Total volume	—.401	3,0	.517

Degree of determination, 86 %

of the scenic index in Table 3, where the relative explanatory power of several factors is presented. The variation of the view as expressed by the respondents on a four-degree scale, i.e., not at all, slightly, rather and very varied. The variation of the tree stand is closely correlated with the tree species composition, especially with the share of deciduous tree species. It also appears that our results concur well with those of Kellomäki (1975), emphasising the great scenic value of non-dense, mature stands with a mixture of coniferous and decidous tree species.

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FOREST AS SYMBOLIC ENVIRONMENT

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ODC 907.2+907.6

Three levels of forest symbolism are described. Environmental symbolism means that familiar forests are valuable to us because they reflect memories of our past life experiences. Neurotic symbolism is possible because forest is an age-old symbol of mother. To mother-forest we can project feelings that we could not express to our real mother as children. Archetypal symbolism means that forest is a symbol of unconsciousness and in a forest we can experience something about the basic structure of life and ourselves. The relevance of symbolism to forestry and outdoor recreation is discussed.

Key words: intangible values, symbols, environment, neurosis, archetype

Intangible values, symbols

The relation man-forest has three dimensions:

- man has always used the material products of forests to his benefit,
- as a living being, man is dependent on ecosystems; destruction of forests would mean a threat to man himself,
- forests have always been a source of many intangible values such as beauty, peace, religious feelings, etc.

Intangible values have been mentioned in forestry literature since the beginning of scientific forestry. Beauty of forests was admired, respect of nature expressed, and even forest esthetics mentioned as a subject of forestry. However, forest esthetics never developed as a serious branch of research.

In the 1960's intangible values of forests gained a new and larger audience. Intensive forestry practices had begun to change landscapes more radically, and at the same time there was a growing number of recreationists and environmentalists to witness and to criticize those changes. Loud public controversies resulted.

Forestry and foresters were accused of destroying the beauty and other values of the nature. Foresters defended themselves by emphasizing the economic importance and also the biologially sound basis of their activities, but it did not convince the critics. Different values were in conflict, the tangible and intangible (also ecological values, but I am not concerned with them here).

A part of intangible values can be called symbolic values. Almost all our observations and experiences are impregnated by symbolism (Janov 1977, p. 308). We do not see the world as such but it represents to us also something else. For example, certain scenery may remind us of our childhood, that memory may bring back a certain feeling, and finally this feeling surging from childhood may turn the experience of the actual scenery into beatiful or ugly one. This may happen consciously or unconsciously, the result in any case being that the scenery is experienced as a symbol of something past and that this symbolism affects the observation.

There is a difference between a symbol and a sign. A sign, like a traffic sign, is a means of communication that every person understands in the same manner, whereas the perception of a symbol is deeply personal, touches the entire person and depends on his cultural and social background, his individual life experiences and actual anxieties and even his bio-physio-psychological

heritage as a human being. A symbol has the exceptional quality of synthesizing in one expression all these unconscious and conscious influences (Chevalier & Gheerbrant 1973, p. XII).

As an example of a symbol, some features of the symbolism of the tree are presented in the annex. The tree is one of the richest and most widespread symbols, so wide that the bibliography alone on tree symbolism would fill an entire book. This rich symbolism, combined with symbolism of forest, animals, other plants, trails, etc., means that experiencing a forest is an extremely varied and deep experience.

Forest as an extension of the self

The relatively new science of environmental psychology offers interesting insights that can be applied to any environments. Perhaps the most relevant idea that can be applied to forests is, that the environment is an extension of the self (Horelli 1981, p. 115). The environment where we live becomes little by little familiar to us, and all experiences become, as memories, a part of us. The longer we stay in an environment, the stronger the ties are. Closely connected to this is the phenomenon of territoriality; we change the environment to signal that it is ours. We may decorate the house, plant trees, build fences, and these changes together with memories make the environment safe and dependable to us. It can be said that we have our roots in the environment.

It is interesting to see that in recent psychological research (Rauhala 1974) the human being is defined as a threedimensional unity, not only as body and mind as always before, but also as a being in relation to his environment. We cannot live in a vacuum, and in this sense the environment is really a part of us.

All this seems directly applicable to forests. Familiar forests become parts of ourselves; they become personally valuable to us on the basis of all our past experiences.

It is easy to see that the change of familiar environment is an important thing. It is even more important who effects the change, the person himself or an outsider. All outside influence is felt as an attack and deterioration of the environment because it is no more as familiar and as "own" as before (Appleyard 1979, p. 151). Especially the home environment is rich in symbolism and therefore extremely vulnerable to all outside influences. Horelli (1981, p. 164, ref. Baron 1978) speaks about environmental stress, which she defines as a situation where the person feels that he has inadequate control over his environment.

Modern forestry changes the environment and scenery more radically than before. In addition, these changes are carried out by bigger and more centralized organisations, not by local people. The result is less control for local people, and dissatisfaction, criticism, anger and a feeling of powerlessness as has been seen during the past two decades.

The education and the traditions of foresters have made this problem even worse. Foresters have a tendency to think of forests as consisting only of trees and of forestry as production of timber (for example, Robinson 1976, p. 260). As a consequence, they have not been able to see the environmental stress caused by modern forestry.

In order to reduce this kind of environmental stress, participation of people in forest planning and forest work should be encouraged. When people participate, the environment remains familiar, even after radical changes like clear-cutting or soil preparation. In the United States a system of public involvement was created for the national forests in 1974. In all major forestry projects, the public is actively encouraged to participate and express its opinions. The results are so far mixed but more positive than negative (Hewett & Hamilton 1982).

Forest as a symbol of mother

The forest is a symbol of mother. This is clearly seen in many popular expressions like "mother forest", "in lap of forest" and "rape of forest". Numerous poets and writers in all times speak about the forest as a protecting mother. Even psychological research (Lugassy 1970) has shown that our feelings towards the forest are like a child's feelings towards its mother. To some the forest gives the feeling of protection, but to others the forest can be threatening and frightening.



Figure 1. Norway spruce — a traditional Christmas tree. (Photo: Aarne Reunala)

Also mythological research (Neumann 1974) confirms that the image of the original mother of humanity, the Great Mother, has always been presented dualistically, as one who protects but also destroys.

This kind of symbolism means two things. First, in a forest we can experience something of the origins and mythological past of humanity, a kind of archetypal experience. Secondly, a forest can be experienced symbolically in a neurotic way. To mother-forest we can project feelings that we were not able to express to our real mother as children.

It is very common that children are deprived so severely, i.e., their needs are not met, that they cannot feel or even show their real needs. The real feelings, because they are too painful, are mercifully repressed in the unconscious. This concept of repression was originally presented by Freud, but in the following I present the more recent developments of Janov (1977, 1980).

With repression the neurotic process begins. In neurosis, the role of defences is to prevent the original, painful feeling from entering into consciousness. Idiosyncratic mannerisms, speech patterns, ideas, emotional expressions and emotional outbursts are, for example, neurotic defences. As soon as we defend, we begin to live symbolically in a neurotic way. We automatically symbolize friends, lovers, employers, even chance acquaintances, into images of the people who caused us pain when we were children, then hope the outcome will change (Janov 1980, pp. 26, 33). This symbolization continues with unlimited force until the day we finally feel the original painful deprivation.

Anything can be the object of neurotic symbolization. Forest as an age-old symbol of mother, is a suitable object for symbolization. Any discussion on forests and forestry can be distorted by neurotic symbolization, without the awareness of the participants. It seems to me that something like this has happened during the past twenty years, when deep emotional conflicts have arisen between foresters and environmentalists and other critics. Especially the emotional tone of accusations and counteraccusations seems to express symbolic involvement. When discussion turns to calling names like "beard radicals", "blockheads" and "idiots", we can be sure that the feeling has a deep, personal origin. Also the religious tone of the criticism (Arnold 1974, p. 38) and the holy war-aspect of some environmental groups (Robinson 1976, p. 167) points to the same kind of symbolic background.

One reason why conflicts between foresters and their critics have been so difficult to solve, is, to my mind, the neurotic symbolization of both parties of the conflict. Of course, there are real and objective reasons for these conflicts also, simply the growing pressure towards the scarce forest resources, but my point is that these conflicts have been far too emotional to reflect only a rational problem of land-use allocation. Symbolization has obscured the real world.

I think that neurotic symbolisation can also explain a part of the feeling of well-being in outdoor recreation. It has been found that a prime motivation for recreation is escape from the stresses of home, neighborhood and job (USDA Forest Service 1981 p. 96), but I would like to add that old, painful deprivations as a child are also part of the stress, and mother forest can give good symbolic consolation in such cases.

Forest as an archetype

Archetypal level is the deepest symbolic level of forest experience. Forest as an archetype means that forest reflects symbolically the basic structure of the unconscious, the undefinable essence of life and existence (Chevalier & Gheerbrant 1973, p. XIX). The concept of archetype was developed by Jung, and, as was the case with the symbol, it cannot be fully explained (Jung 9 part I, p. 271).

There are numerous archetypal experiences, and it is of interest that forest and tree are archetypes. The tree, for example, symbolizes growth, life, unfolding of form in physical and spiritual sense, development, growth from below upwards and from above downwards, the maternal aspect (protection, shade, shelter, nourishing fruits, source of life, solidity, permanence, firm-rootedness), oldage, personality, and finally death and rebirth (Jung 13, p. 350). Thus all our experiences with forests and trees give us some kind of deep, reassuring knowledge of our basic nature.

When we say that a forest is beautiful and if the experience is mainly archetypal, it means that the forest touches us to our innermost depths, with a feeling that both we and the forest are only different parts of the same life. In contrast to environmental or neurotic symbolism, archetypal symbolism is collective. All human beings are basically the same, i.e., we have the same basic structure, which we can experience in the presence of archetypes.

It seems to me that this kind of archetypal contact is a part of all our contacts with forests and trees, and this archetypal level also explains a good part of the essence of recreation. It is simply good to be in contact with nature.

A good example of archetypal forest is found in folk fairy tales, where the hero is often lost in dense, impenetrable woods. The forest, explains Bettelheim (1978, pp. 94, 155), has since ancient times symbolized the dark, hidden, nearimpenetrable world of our unconscious. "In fairy tales, internal processes are translated to visual images. When the hero is confronted by difficult inner problems which seem to defy solution, his psychological state is not described; the fairy story shows him lost in a dense, impenetrable wood . . . As symbols of psychological happenings or problems these stories are quite true."

Discussion

Nobody knows how important the preceding symbolic values of forests finally are. I think that their importance varies from person to person, in different cultures and in different times. However, it seems that during the recent radical change of forest environments, the loss of symbolic values has been one important source of criticism against forestry. People have lost their own, familiar and safe home landscapes, and they have not liked it. Two suggestions come to mind to reduce the importance of this loss. The public should be integrated more closely into forestry by information, involvement and participation in forest work. And secondly, professional forestry education should be expanded to social and human sciences in order that foresters could learn to see not only trees but also people.

Neurotic symbolization is as common as neurosis, which, according to Janov (1980, p. IX) is the most intangible, devastating and widespread of diseases. It is just good to know, I think, that any discussion on forests and forestry can be biased by neurotic symbolization. Most often neurotic symbolization is difficult to see, sometimes there are clear signs like name-calling and emotional outbursts. However, there is not much that can be done; symbolization continues as long as the neurosis.

Forest as an archetypal symbol means simply that it is good for anybody to be in contact with nature, trees and forests. Especially old trees and old, virgin forests give strong archetypal experiences. They reflect most powerfully the unknown in ourselves, our unconscious. Therefore, this archetypal importance is one more reason to conserve some old trees and old forests within commercial forests and as separate wilderness areas.

Controversies between recreationists and forestry have led to numerous studies concerning forest stand preferences of recreationists (in Finland, for example, Saastamoinen 1982, Savolainen & Kellomäki 1981).

Preferences have been measured by visual tests, either in the forest or with the aid of photographs. I think that these tests might be useful for some purposes, but that their usefulness is more limited than generally believed. This is due to the fact that forest experience is much wider than visual and it includes, for example, the three symbolic levels described above.

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Annex

SYMBOLISM OF A TREE
(Chevalier & Gheerbrant 1973: 96—112)

Symbol of life in continuous evolution, growing up towards the sky, symbolism of verticality.

Symbol of cyclical character of cosmic evolution: death and resurrection; especially the leaves represent this.

Symbol of unity of all three levels of cosmos: underground with its roots, the surface of the earth with its stem, and the sky with its top.

It combines all elements: water in its sap, earth integrating into it by the roots, air nourishing the leaves, and fire can be made by friction.

Axis of the earth, in the center of the world, touching the earth and the sky, sun and moon in its branches.

Tree of life, its fruit and sap gives immortality; widely spread beliefs on healing power of wood and branches.

Tree-ancestor: tree as a mythical ancestor of a tribe; maybe tree is the oldest symbol of man.

Tree and gods: old gods were connected with certain trees; cults of trees; tree of cross = tree of death = tree of resurrection = tree of life.

Family tree, social tree: tree symbolizes the growth of a family, city, nation, power of a king.

Continuous evolution: tree is also considered as a symbol of the union of continuous and discontinuous, a branch is a differentiated unity and an integrated part of the entire tree.

Feminine symbol: it grows from the mother-earth, it produces fruits.

In psychoanalysis: the tree is connected with mother, primordial water, ambivalent creative and destructive power, phallus; it symbolizes vital growth, continuous and cyclical, all psychological maturation, sacrifice and death, and also rebirth and immortality.

OBSERVATIONS ON CLOUDBERRY CROPS IN FINLAND

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ODC 283.1+892.71

The study gives crop results from seven experimental plots in Central and Northern Finland. The observation period was 5—11 years on different plots. Long-term crops have been small, the yearly average varying between 2.1—10.7 kg/ha. These figures are lower than most crops from earlier short-term studies. The reasons for small crops are frost and the cloudberry beetle (*Galerucella* sp.). The results suggest that there is a need for further long-term yield studies to get exact information of the value of cloudberry crops.

Key words: *Rubus chamaemorus* L., cloudberry crops.

Introduction

The cloudberry (*Rubus chamaemorus* L.) is a subarctic and circumboreal mire plant. It is economically important in Finland, Sweden and Norway, but it is also picked in the U.S.S.R. and Canada.

The cloudberry fruit is a small orange berry which is formed of 1—35 drupelets depending on pollination. The weight of the berry varies from 0.5 to 3 grams. The fruit has a unique aromatic flavor which is highly valued. Besides aroma it also has other good properties: it is rich in ascorbic acid and keeps well.

Financially the cloudberry is the most important wild berry in Finnish Lapland. Kujala et al. (1982) give some interesting statistics on the economics of wild berries in Finland. In Lapland the greatest sum is paid in most years for cloudberries although bilberry (*Vaccinium myrtillus* L.) and cowberry (*V. vitis-idaea* L.) may yield a more abundant crop. This is due to the high price paid to cloudberry pickers (17—30 FIM/kg in 1977—1981). In the years 1977—1981, 71.9 % of cloudberries bought by companies dealing with berries came from Lapland. The annual total income of pickers is presented in Table 1. The industry using cloudberries is located mainly in South Finland. There are only a couple of freezing stores in the district of Lapland. The most important products in which cloudberries are used are liqueur, ice-cream, yoghurt, jam and confectionery products.

In South Finland the occurrence of cloudberry has clearly decreased. This is a consequence of taking mires for agricultural use or peat production. The effect of forest drainage remains an open question, although much debate has taken place. However, there are no extensive studies to support any one view. Veijalainen (1976) writes that the lowering of water level with deep ditches increases the crop at first but causes a worse crop later. Numminen (1979) says that in North Finland forest drainage does not destroy cloudberry crops but makes them smaller and more regular and increases the size of berries. In northern Norway draining and fertilization for afforestation have increased the cloudberry crop substantially (Heide & Arntzen 1974). As the effect of forest drainage is not known, the National Board of Forestry has protected several mire areas which are known to be good cloudberry bogs.

Table 1. Earnings (tax-free) of cloudberry pickers in Finland 1977—1981 (Kujala et al. 1982).

Area	Earnings, million FIM				
	1977	1978	1979	1980	1981
Lapland	5.3	4.8	11.7	6.1	6.9
Other parts of Finland	1.8	0.3	8.3	1.9	0.9

Crop figures from earlier studies

Another disputed question concerning the cloudberry is the average annual yield. There is some information on cloudberry crops in different mire types, but they are mostly based on one year observations only or they are limited to very productive areas. The highest figure is given by Mäkinen (1972) and it is 558 kg/ha in 1969 from a very productive cloudberry mire at Inari, northern Finland. Mäkinen & Oikarinen (1974) report a crop of 23.5 kg/ha from Suomussalmi, eastern Finland and 43.4 kg/ha from Utsjoki, northern Lapland. The last two figures are from a very good cloudberry year, 1972. Huttunen (1978) reports that in 1974 the yield varied between 0.9—7.1 kg/ha in his study area in northern Ostrobothnia and estimates that this is 1/4 of the normal crop. Ruuhijärvi et al. (1978) have got crops varying between 0.1—91.9 kg/ha in western Lapland in 1976, which was not a good cloudberry year in the area. Jääskeläinen (1981) gives crop information from southern Finland. In 1979 the production of natural mires varied 26.5—40.6 kg/ha and that of drained mires between 15.3—30.6 kg/ha. 1979 was a good cloudberry year also in southern Finland (see Table 1). Veijalainen (1979) has made some interesting long-term observations on cloudberry crops in forest management areas in Vilppula, Central Finland and in Rovaniemi parish, northern Finland. The best annual crops in 1972—1977 are 16—66 kg/ha in Vilppula and 14—79 kg/ha in Rovaniemi. However, no averages from certain squares are presented in his paper, but variation between years and sites is clearly demonstrated.

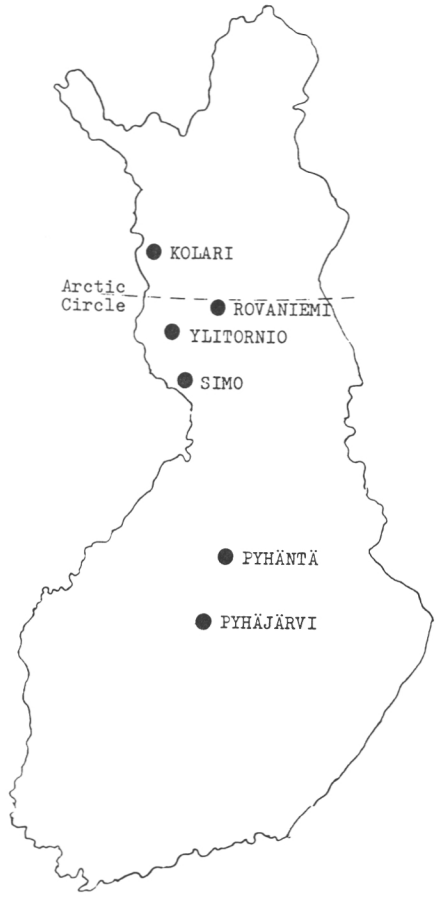

Figure 1. The location of the experimental plots.

Table 2. Average annual cloudberry crop in different study areas.

Locality and observation period	Mire type	Average crop, kg/ha/year	Area of observation field, m²
Pyhäntä 1972—1976	Sphagnum fuscum bog	6.4	2 500
Pyhäjärvi 1972—1976	Sphagnum fuscum bog	4.7	3 400
Simo 1972—1980	Sphagnum fuscum bog	2.5	2 700
Ylitornio 1972—1980	Dwarf shrub pine bog	3.8	1 800
Rovaniemi 1 1972—1982	Dwarf shrub pine bog	2.1	800
Rovaniemi 2 1973—1982	Dwarf shrub pine bog	10.7	288
Kolari 1975—1979	Sphagnum fuscum bog	2.6	288

Results and discussion

The sites (Fig. 1) and years of observations presented in this paper are in Table 2 as are also the average crops of the observation period. Some of these areas have been fertilized, mulched or drained with low ditches. These treatments have had no clear positive effects on crops, so figures can be presented here as production of natural mires. These crops tally best with the figures of Huttunen (1978) and are far behind all other yield

information presented. The reasons for poor crops are clear. In most cases night frosts destroyed the flowers and in some cases (Rovaniemi parish 1, 1973—1977) cloudberry beetles *(Galerucella* sp.) have damaged the stand so effectively that in some years it has not even been able to form flower shoots.

These observations do not give much support for conserving mires because of their value as cloudberry production areas. Heikurainen (1973) estimates that the growth of pine on drained dwarf shrub pine bog at the latitude of Rovaniemi is 1.0—1.6 m^3/ha depending on the age of trees. This may in most cases exceed the production of cloudberry although the exact sums of management costs have not been calculated. On the other hand, Saastamoinen (1979) suggests that when the profitability of forest drainage is marginal, even low net losses of cloudberry crops may make the investment for forest drainage uneconomical.

The observations of this paper as well as of all earlier studies are, however, inadequate. Only regular long-term inventories of wild berries in large areas can solve these problems. Traditionally forest inventories have dealt only with timber production, but nowadays more attention is paid to the multiple use of forests. The model for these kinds of forest inventories can be found, for instance, in Lithuania, where berries, mushrooms, medicinal herbs and recreational functions belong to the forest inventories (Misko zemiu ekonominis vertinimas 1975). A rough model for the inventory of wild berries in large areas has been developed in Sweden (Eriksson et al. 1979, Kardell & Carlsson 1982).

In Finland observations on the occurrence and fertility of wild berries were made already during the III National Forest Inventory in 1951—53 (Kujala 1964). New wild berry inventory studies were started in the Finnish Forest Research Institute in 1982 (Salo 1982). For the present only regional inventories are made, but even in this extense this research gives new knowledge of the long-term yields in Finland.

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FORESTRY AND REINDEER HUSBANDRY IN SWEDEN: SOME ASPECTS ON THE DEVELOPMENT OF A DOUBLE LAND-USE

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ODC 908.1+(485)+268.1

This paper is partly based on results from the research project "Land use — north". It deals with problems in the relationship between forestry and reindeer husbandry in Sweden. The relationship and the effects of different activities are presented in a time perspective.

In general, reindeer keepers, much more than forestry representatives, claim that the relationship involves problems. Therefore, an attempt is made to look at forestry development from the reindeer keepers' point of view. This is done as case studies of specific areas.

Key-words: forestry, reindeer husbandry, relationship

Introduction

The extent of reindeer husbandry and forestry shows a common land-use area of some 1/4 of the Swedish land area (Fig. 1). "Mountain reindeer husbandry" uses forest land the winter half of the year and "forest reindeer husbandry" uses forest land the whole year. With a proportion of 6:1 between numbers of reindeer held in "mountain" and "forest reindeer husbandry", it follows that the overlapping of time primarily concerns the winter half of the year. Grazing conditions during that time of year limit the reindeer husbandry to a rather high degree. The forestry in Norrland, especially in the inner parts, has relatively poor site conditions and forest product markets. In consequence these two forms of land-use mostly meet where they are relatively weak.

The relationship between forestry and reindeer husbandry has been the subject of an intense debate in recent years. It has also been the subject of studies within the research project "Land-use — north" (Mattsson 1981). The reciprocal influence between forestry and reindeer husbandry can be expressed in five general theses:

- it involves both negative and positive effects
- it concerns both biological production conditions and rationality in the use of natural resources
- the influence of forestry on reindeer husbandry is larger than the inverted influence
- negative effects of forestry mostly concern the winter conditions for reindeer husbandry, while positive effects mostly concern the conditions during other seasons
- because of the difference in geographical location of the summer grazing it is, however, "forest reindeer husbandry" more than "mountain reindeer husbandry" that benefits from the positive effects of forestry.

The relationship has changed quite a lot since the middle of this century. One aim of this paper is to give a very brief description of this development and its underlying factors. The development will be exemplified by looking at a specific area.

There is a rather clear opinion among both reindeer keepers and representatives of forestry, that the problems in the relationship must be solved with double land-use as a condition. This opinion has also been strongly expressed by government and planning authorities. The effects of various activities belonging to one form of land-use, must not

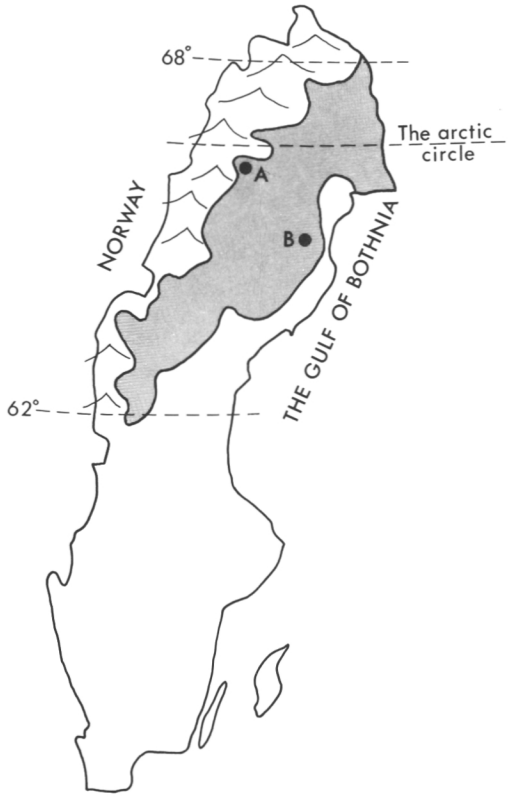

Figure 1. The common area of forestry and reindeer husbandry. (A and B indicate the location of specific areas, used by the same group of reindeer husbandry, especially studied in this paper).

make the other form of land-use impossible.

However, it is primarily the representatives of reindeer husbandry who claim that the relationship involves problems. This raises the question: What is "acceptable" concerning effects of forestry from the viewpoint of reindeer keepers? The second aim of the paper is to contribute to the answer of that question, by showing some qualities of the forestry and the state of the forest in two specific areas, one "accepted" and one not "accepted" by the reindeer keepers. The two areas embrace all stand ages and some of the forestry activities criticized by the reindeer keepers. Accordingly, we will note how different areal compositions of stand ages and forestry activities can result in different natural resource conditions for reindeer husbandry.

The dynamics of the relationship

Some characteristics of forestry development in Norrland during the past fifty years are especially significant for the development of the relationship to reindeer husbandry.

There has been a basic change in forestry method, from the dominating selection system of the 20's, 30's and part of the 40's to clear felling forestry. The transition in the 40's was much due to the demand for a long-term high production of wood for the forest industry — a demand which the old forestry method could not meet. An important ambition in the 50's was to restore the state of the forest. In large areas this restoration forestry meant clearfelling and additional regeneration measures in order to establish high productive stands as replacements for the low productive stands, which the earlier forestry had resulted in. Besides this concern for future wood resources, actual economic conditions also contributed to a trend for a "large scale forestry". From the first years of the 50's to the first years of the 70's, roundwood prices maintained about the same level. During the same time labour costs increased considerably. A mechanization of forestry became expedient to keep profitability at an acceptable level. This mechanization demanded greater size of treatment units and a larger proportion of final felling of the total felling volume.

Characteristic for reindeer husbandry during the past fifty years are, first, the quite heavy fluctuations in the reindeer population. Around 1930 the reindeer population was nearly 300 000 head. In 1940 it was down to about 160 000 while in the mid-50's it had increased to about 250 000. After a decrease to less than 200 000 during the first years of the 70's, among other things, due to bad climate conditions, there has been a considerable increase (SOU 1979:55). The number of reindeer today is nearly 300 000. Characteristic for the past fifty years is also the expanded use of technology in reindeer husbandry. Particularly in the area of transport, technical innovations have gained in importance: snow mobiles and cars as well as aircraft have become essential tools of the trade. The land-use continues in the traditional way, characterized by large areal extent and long moves of the reindeer herds. But the everyday life for reindeer keeper families has become more stationary with in-

creased possibilities to use societal services.

As a result of these developments within forestry and reindeer husbandry there has been a development of the relationship between the two land-use forms, which can be briefly described as follows.

Growth in problems in the relationship during the 50's were mostly due to the increase of final felled areas. During the following decades the annually final felled area remained about constant. But mechanized forestry caused additional problems for the reindeer husbandry because of a larger extent of the separate final felled areas and by "radical" methods within primary production, such as mechanical soil scarification, chemical regulation of tree species and fertilizing by aircraft. Furthermore, the intensity of primary production acitivities was increased during the 70's.

Fluctuations in the reindeer population imply a varying influence on the primary production of forestry and on the rationality of fellings. However, given a certain reindeer population, the influence on the latter has diminished gradually, especially in the 60's and 70's. But this change is not a result of development of reindeer husbandry, but of the more mechanized felling systems, where the presence of reindeer in felling areas cause less problems than for the old felling system with manual work and use of horse.

When the felling volume at the beginning of the 70's reached the wood increment level, this caused an alarm not only for the present relation between wood increment and roundwood consumption. Some part of the alarm was due also to the decreased future supply

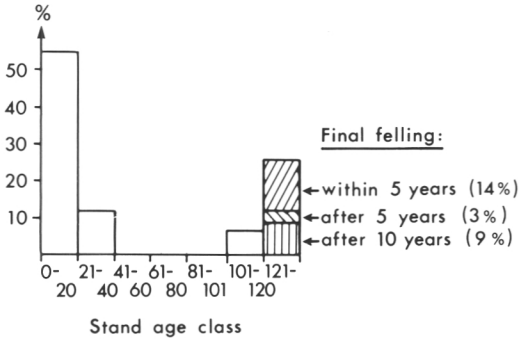

Figure 2. Age class distribution in a "conflict area" (location A, Fig. 1). Percent of productive forest land.

of old forests, which can be expected because of the unsatisfactory regeneration during the first four decades of this century. With a continued forest policy, that aims at sustained yield, this probably will result in fundamentally changed conditions in large areas for the relationship between forestry and reindeer husbandry. The final felled areas and the regeneration activities will probably not have the same extent as earlier. On the other hand, there are strong motives for forestry to increase the increment, for example by fertilizing.

A case study of the relationship

In the following, the development of the relationship will be exemplified by looking at a specific area. This area, embracing about 8 700 hectares of productive forest land, is chosen as an example mainly for two reasons:

— The forestry in the area has been sharply criticized by the reindeer keepers.
— The unsatisfactory distribution of stand ages, which is typical for the north of Sweden, is extreme in the area.

Consequently, the area cannot be seen as entirely representative for the area common to forestry and reindeer husbandry as a whole (Fig. 1). On the other hand, the past and future development of the relationship is brought out in a rather distinct way.

The area embraces a considerable part of the spring- and autumn grazing land for the pertinent group of "mountain reindeer husbandry". The location of the area is shown in Figure 1 (A). The following forest data for the area is based on the management planning of forest land.

Figure 2 shows the present distribution of stand ages in the area. For comparison, Figure 3 shows the present distribution of stand ages in all of northern Norrland.

Figure 2 indicates a noticeable extent of final fellings during recent decades. The diagram also indicates that there was no regeneration during a long period before the 40's, because of no final felling. It should be observed that such a total lack of middle age stands is not especially unusual in large forest areas in the inner parts of Norrland near the

mountains. Finally, it can be seen that the old stands will gradually be final felled within about three decades. Obviously, after that a long period will follow with no final felling.

Figure 4 indicates more precisely the development of final felling in the area since the 50's (the first final fellings in the area were made in the 40's, but these had a very limited extent). According to the reindeer keepers the area has become a "conflict area" because of an "increase" of final fellings. However, the diagram shows that the final fellings have not been more "drastic" during recent years than earlier. This divergence between the reindeer keepers' opinion and that according to the diagram, shows that reindeer keepers experience final felled areas in a special way. Since the effects of a final felling remains for many years and final fellings have been made only after the 40's, there has been an areal accumulation of effects, even if the annually felled area would be constant.

Both positive and negative effects of final felling exist in this particular area. Final fellings have caused an increase of grass production, a positive effect especially for autumn grazing. Residue from the final fellings is negative since it makes ground pasture less accessible and hinders moves of reindeer herds. In the reindeer keepers' opinion the negative effects exceed the positive one.

A simple attempt will be made to regard forestry development in the area from the reindeer keepers' point of view. The rough assumption can be made, that the negative "net balance" of effects of a final felling influences reindeer husbandry for 15 years. Considering the development of final fellings in the past (Fig. 4) and assuming also that future final fellings are carried out according to plans (Fig. 2), there is a long-term "forestry development" in the area as shown in Figure 5.

This use of forest data to explain the reindeer keepers' point of view can be criticized. The time limit of 15 years can be discussed. There are also other effects of final felling than those mentioned above. Final felling of stands with tree lichens may, for instance, entail an easily accessible pasturage during a very short time. But in the long run the final felling of such stands may entail a reduction of areas which in some years are important during early moves of reindeer herds to the mountains. Finally, it is, of course, not absolutely certain that future final fellings will be carried out according to plans. Especially in remote areas like this, economic depressions evidently may effect forestry actions.

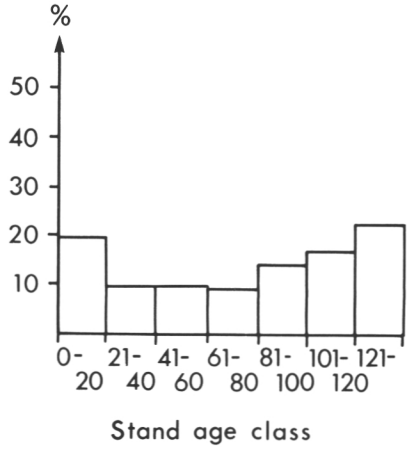

Figure 3. Age class distribution in northern Norrland. Percent of productive forest land.

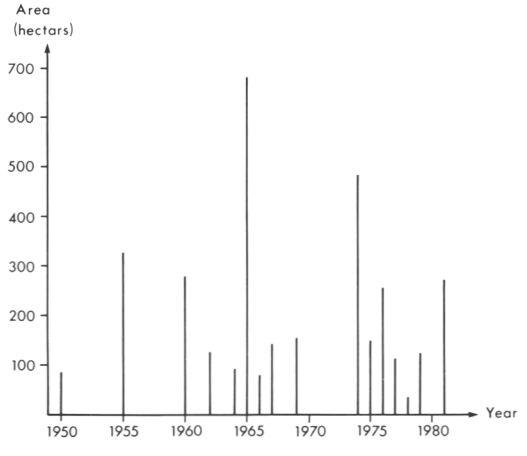

Figure 4. Final fellings in a "conflict area" (location A, Fig. 1).

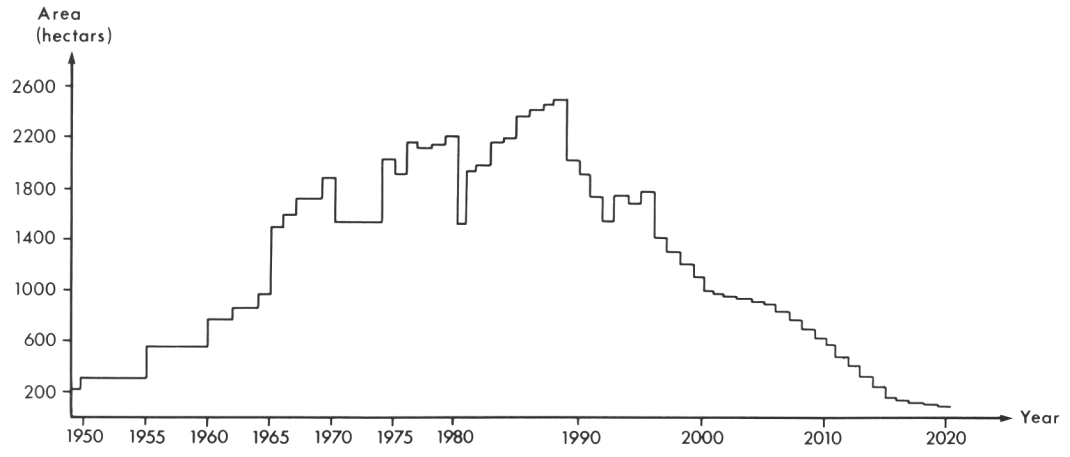

Figure 5. Long-term development of forestry seen from the reindeer keepers' point of view in a "conflict area" (location A, Fig. 1) — Areal extent of final fellings accumulated for 15 years.

Acceptable and non-acceptable forestry from the reindeer keepers' point of view

It appears that problems in the relationship between forestry and reindeer husbandry are basically due to the two confronting forms of land-use having such different principles of action. Forestry is characterized by thorough and concentrated changes of the forest ecosystem with a strict division in stands, while reindeer husbandry is characterized by slow and small changes of the forest ecosystem and with a clear need to move between alternative areas.

So for the question of what are acceptable and non-acceptable areas from the viewpoint of reindeer keepers, the structure of the forest as regards ages of the stands is of paramount significance.

A presentation will be made of two areas located next to each other and embracing about 2 500 hectars each. The areas are parts of the winter grazing land for the pertinent group of reindeer husbandry. Their location is shown in Figure 1 (B).

In 1973 the reindeer keepers appraised the overall conditions of the areas for reindeer husbandry (Statens planverk 1975). According to this, one area had good and the other area had bad conditions. The first area (the "harmony area") is described as "an area where the reindeer get on well and where they can graze without disturbance". The other area (the "conflict area") is considered as bad because of the "encroachment" from forestry. Final fellings and soil scarification are the most criticized activities.

The two areas are rather similar in all aspects except the conditions caused by forestry. This makes it possible to observe how an acceptable and non-acceptable forestry and state of the forest look to the reindeer keepers. The management planning of forest land is also the source for the presentation of these areas.

Figures 6 and 7 show the distribution of stand age classes in both areas as it was in 1973. A visual presentation is made in Figures 8 and 9.

It is obvious that the reindeer keepers do not accept an area with a large share of bare forest land and very young stands, and a small share of old stands. Seed trees do not seem to alleviate the negative effects of final felling very much. However, it is also obvious that bare forest land and very young stands can be accepted to a certain extent in a "harmony area", especially if the separate areas are not too big. The maps illustrate the common opinion among reindeer keepers that it is "the big scale" of connected final felled areas which causes considerable problems.

It should be pointed out that only a small share of the forest land in these areas has

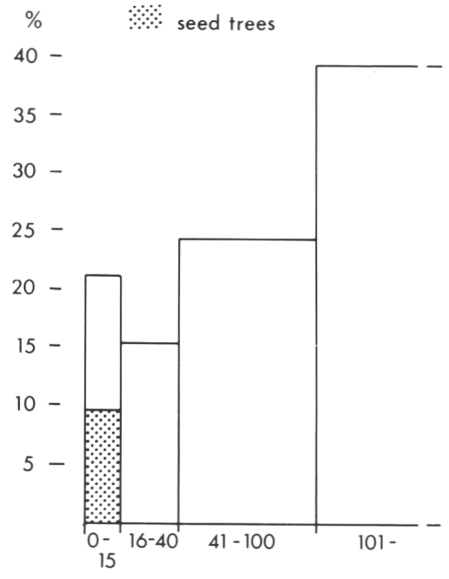

Figure 6. "Harmony area" (location B, Fig. 1) — age class distribution. Percent of productive forest land.

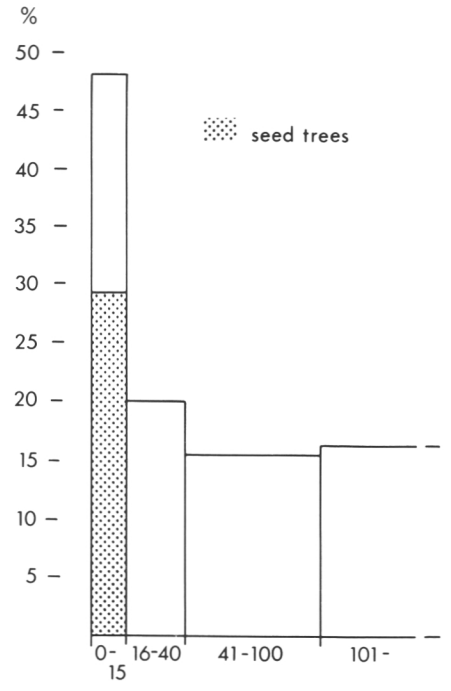

Figure 7. "Conflict area" (location B, Fig. 1) — age class distribution. Percent of productive forest land.

vegetation types where there is an increase of Deschampsia flexuosa after final felling. This is otherwise a positive effect on the pasture during early winter. In our case then, the "direct/short-term" effects of final fellings are mostly negative, especially due to deteriorated accessibility of the ground pasture.

Finally, the long-term development of age class distribution, annual final felling and soil scarification are considered (Figs 10 and 11). The development presented for 1981—2001 is according to plans and must, of course, be regarded with some reservations. However, there is no reason to believe that the future development will differ considerably from the one presented in the figures — at least if the development will be a result of the rationality of forestry only.

As mentioned above, 1973 was the year the reindeer keepers appraised the areas as a "harmony area" and a "conflict area". In the "harmony area" the age class distribution was about the same in 1959 as in 1973. The annually final felled area is relatively constant all the time up to the next century. The extent of bare forest land and very young stands (0—15 years) — the most problematic age class — is also relatively constant during the same time. The disparate changes in extent of "middle age" stands (16—100 years) and old stands (101-years) is due to different distributions of stand ages within these age classes. So, during the period 1973 to 2001 many stands will "grow out of" the class 0—15 years and "into" the class 16—100 years, but only a few stands will "grow into" the class 101- years.

In the "conflict area" the age class distribution changed very drastically between 1959 and 1973. The main reason is the very great extent of final fellings. In addition there was a relatively large extent of bare forest land and very young stands (0—15 years) already in 1959. The "problem age class" therefore amounted to about half the productive forest land in 1973. Soil scarification also had a great extent during the same 14 years. After 1973, the final felled area is at a low level, which results in a decrease of the extent of bare forest land and very young stands (0—15 years). This marked decrease is also due to the fact that many stands will "grow into" "middle age" stands (16—100 years). These will dominate the area at the beginning of the next century.

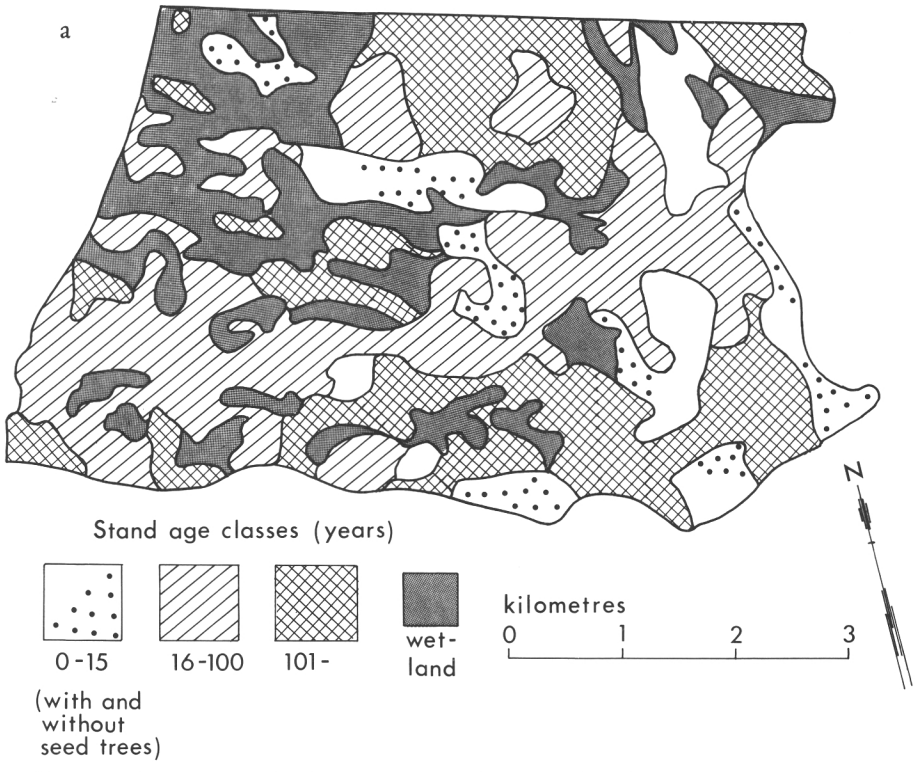

Figure 8. "Harmony area" (location B, Fig. 1) — age class distribution.

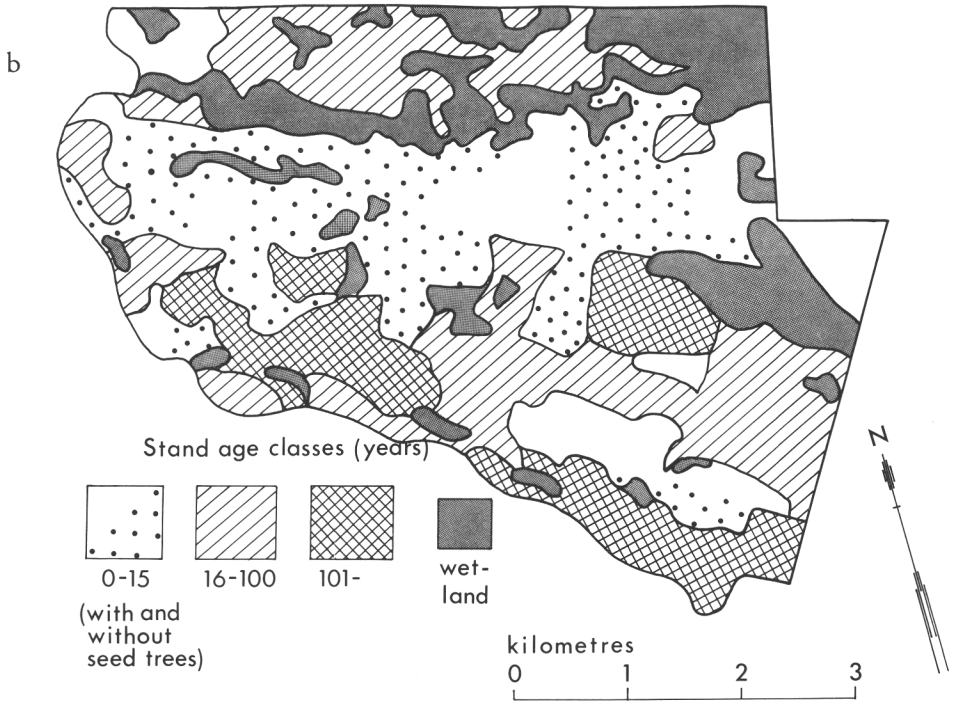

Figure 9. "Conflict area" (location B, Fig. 1) — age class distribution.

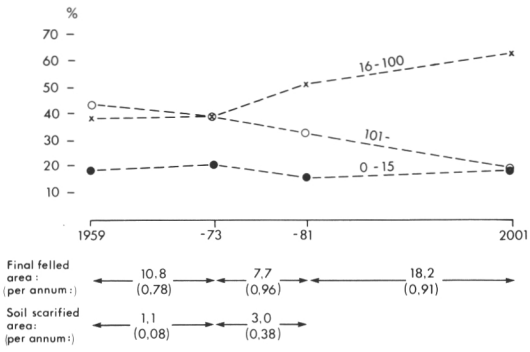

Figure 10. "Harmony area" (location B, Fig. 1) — age class distribution in 1959, 1973, 1981 and 2001, and final felled and soil scarified area during the three periods. Percent of productive forest land.

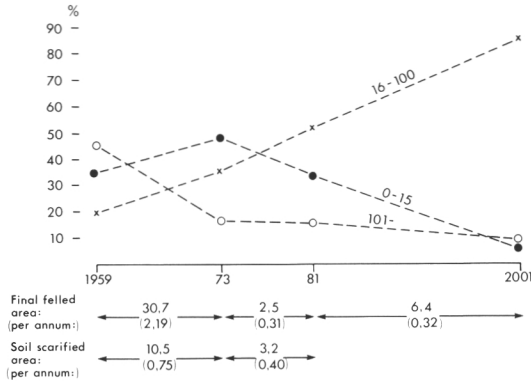

Figure 11. "Conflict area" (location B, Fig. 1) — age class distribution in 1959, 1973, 1981 and 2001, and final felled and soil scarified area during the three periods. Percent of productive forest land.

When the relationship between forestry and reindeer husbandry is seen in a long-term perspective within two specific areas like these, it appears that a "conflict phase" and a "harmony phase" are more adequate designations. Also, it appears that the occurrence of a "conflict phase" to a considerable degree depends on the fact that forestry in old times had not been able to create a proper regeneration. The situation for the age class distribution in the areas in 1959 indicates that fellings followed by a successful regeneration have been more frequent in the "harmony area" than in the "conflict area" during the first four decades of this century. The "middle age" stands (16—100 years) had an extent of nearly 40 % in the "harmony area" in 1959, while in the "conflict area" the extent of such stands was less than 20 %. So, forestry activities in the "conflict area" during the 40's, 50's and 60's were relatively much directed to a restoration of the forest by replacing too old and thin stands with new productive ones. However, this drastic change of the age class distribution in the past, causing a "conflict phase", will also in the rather near future lead to a change into much better conditions for reindeer husbandry in the area.

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PRESCRIBED BURNING FROM THE VIEWPOINT OF REINDEER HUSBANDRY

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The postfire recovery of reindeer lichens was studied in Finnish Lapland in order to ascertain the usefulness of prescribed burning from the viewpoint of reindeer husbandry. The cover percent of lichens that prevailed before the fire is reached 40 to 70 years after burning. The preliminary results suggest that prescribed burning would be a less harmful method for site preparing than ploughing in fresh and eventually even in subdry sites, since fire destroys cutting residues and deep furrows are not needed.

Key words: caribou, forest fire, lichens, reindeer

Introduction

The thick raw humus layer covering the mineral soil, especially that in fresh and subdry sites, is a major factor hindering forest renovation in northern coniferous forests. In natural conditions renovation was largely dependent on forest fire (e.g. Lakari 1920, Kujala 1926, Sarvas 1937a, Siren 1955). In the 1950's and early 1960's fire was employed in Finland in the form of prescribed burning in preparing the ground for forest renovation. From the late 1960's onwards it was replaced, however, by several kinds of mechanical methods, particularly ploughing. The positive effects of ploughing on soil characteristics and the development of seedlings and plants are well documented (e.g. Leikola 1974, Pohtila 1977, Ritari and Lähde 1978). On the other hand, ploughing is criticized continiously by the other forest users. Reindeer-owners, representing an important livelihood in Northern Finland, point out that after ploughing a given area wholly loses its importance as a winter range (e.g. Aikio, O. 1973, Aikio, P. 1977).

With the increase in ploughing costs more attention has been paid recently to the possibility of employing prescribed burning more than in the past years (Kulotustoimikunnan mietintö 1980). The present preliminary paper deals with the usefulness of prescribed burning from the viewpoint of reindeer husbandry.

Material and methods

This paper is based on two sources. First, Sarvas (1937a, b) studied forest renovation and plant succession in burned areas in Central Finnish Lapland. His material consisted, e.g., of 20 sample areas in dry and barren sites (in most cases *Calluna-Cladina* type). The cover percent of plant species was estimated from 10 (or 20) plots 2 500 cm^2 in size in each sample area. Our own material includes 19 samples gathered from sub-dry sites *(Empetrum-Myrtillus* type) in the herding association of Ivalo, situated in the commune of Inari, Northern Lapland. In addition to the method employed by Sarvas, we measured the mean height of the plants.

In this paper we will concentrate on the occurrence of reindeer lichens (subgenus *Cladina* and *Cladonia uncialis),* which are acknowledged as being essential winter food for reindeer wintering in continental taiga ranges (e.g. Andreev 1977, Helle and Saastamoinen 1979, Helle 1981).

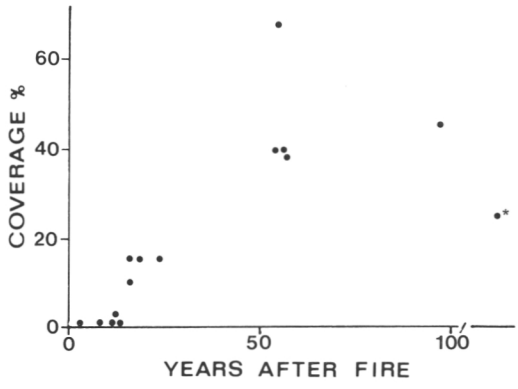

Figure 1. Relationship for mean coverage of reindeer lichens and age of burned area in dry sites in Central Lapland (calculated from Sarvas 1937b). Asterisk = unburned.

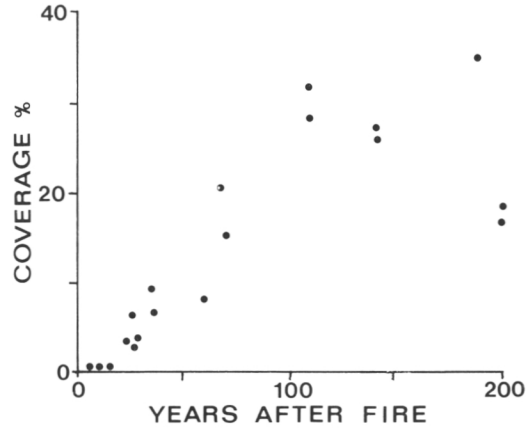

Figure 2. Relationship for mean coverage of reindeer lichens and age of burned area in sub-dry sites in Inari, Northern Lapland.

Table 1. Three characteristics species in burned dry and barren sites of different age in Central Lapland (Calculated from Sarvas 1937b).

Years after fire	Three characteristics species (%) 1	%	2	%	3	%
3	*Vaccinium vitis-idaèa*	21	*Vaccinium uliginosum*	5	*Polytrichum juniperinum*	4
8	*Calluna vulgaris*	23	*Vaccinium vitis-idaèa*	19	*Polytrichum juniperinum*	19
11	*Polytrichum juniperinum*	28	*Calluna vulgaris*	25	*Vaccinium vitis-idaèa*	9
11	*Deschampsia flexuosa*	19	*Polytrichum piliferum*	19	*Biatora uliginosa*	9
11	*Polytrichum juniperinum*	30	*Calluna vulgaris*	21	*Vaccinium myrtillus*	21
16	*Polytrichum piliferum*	46	*Calluna vulgaris*	14	*Biatora uliginosa*	14
16	*Calluna vulgaris*	40	*Polytrichum juniperinum*	24	*Polytrichum piliferum*	14
19	*Polytrichum piliferum*	43	*Vaccinium vitis-idaèa*	13	*Polytrichum juniperinum*	12
24	*Calluna vulgaris*	30	*Polytrichum piliferum*	21	*Biatora grandosa*	16
53	*Calluna vulgaris*	29	*Vaccinium vitis-idaèa*	20	*Empetrum nigrum*	13
53	*Polytrichum piliferum*	26	*Vaccinium vitis-idaèa*	20	*Cladonia silvatica*	18
53	*Cladonia silvatica*	39	*Polytrichum piliferum*	15	*Vaccinium vitis-idaèa*	14
56	*Calluna vulgaris*	23	*Vaccinium vitis-idaèa*	17	*Polytrichum piliferum*	14
97	*Vaccinium vitis-idaèa*	24	*Cladonia silvatica*	18	*Vaccinium myrtillus*	14
unburned	*Calluna vulgaris*	60	*Vaccinium vitis-idaèa*	20	*Nephroma arcticum*	17

Results

Grazing by reindeer reduces the biomass and relative abundance of reindeer lichens, but these, especially *Cladonia mitis* and *C. rangiferina,* belong to the dominant species of dry and barren sites even in areas under heavy grazing pressure (Helle and Aspi 1983). Fire, instead, wholly, destroys lichen vegetation and the succession during the following several decades after the fire is characterized in dry and barren sites by dwarf shrubs (e.g. *Calluna vulgaris* and *Vaccinium vitis-idaèa)* and mosses (e.g. *Polytrichum juniperinum* and *P. piliferum)* as shown in Table 1. The same fits, without doubt, also for sub-dry sites.

The abundance of reindeer lichens after the fire is given in Figure 1 for dry and barren and in Figure 2 for sub-dry sites. The results indicate that the cover percent which prevailed before the fire is reached 40 and 70 years after burning, respectively. Correspondingly, Figure 3 shows that in sub-dry sites the mean height of the living part of reindeer lichens reaches the "normal" level once about 70 years after the fire, thus revealing the young age and/or slow growth rate of individuals in earlier stages of succession.

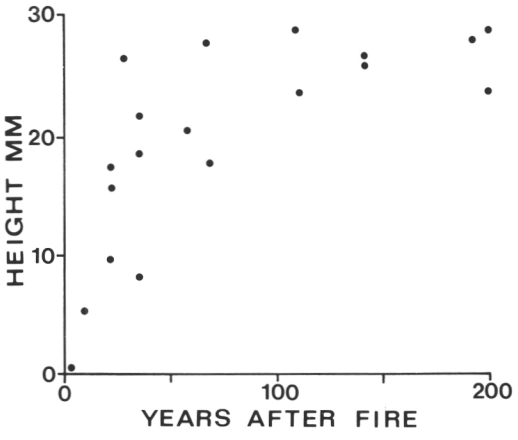

Figure 3. Relationships for mean height of reindeer lichens (living part) and age of burned area in sub-dry sites in Inari, Northern Lapland.

The maximum abundance of reindeer lichens was observable in dry and barren sites about 50 years after the fire and in sub-dry sites about 50 years later. This is obviously due, at least partially, to the fact that grazing by reindeer is concentrated in old and rather sparse forests instead of in young ones (Helle and Saastamoinen 1983). On the other hand, in terms of biomass the succession continues especially in areas under light grazing pressure, since first invaded *Cladina* species *Cladonia mitis* and *C. rangiferina* are replaced by *C. stellaris,* whose biomass is about 2 times greater in relation to percent cover (Helle and Aspi 1983).

Discussion

Most lichens invade burned area by sporedia (e.g. *C. cornuta* and *C. coccifera)* or by thallus fragments *(Cladina),* which appears to be a less effective strategy (Johnson 1981). Kershaw (1977) noted, in addition, that conditions in a burned area are unfavorable for *Cladina* because of high surface temperatures. He suggested that *Cladina* are incapable of growing before humus accumulation, as this moderates, functioning as an effective mulch, the heat flux. However, these findings can explain neither the observed difference in the rate of recovery of reindeer lichens between dry and barren and sub-dry sites nor the fact that the last *Cladina* species invading burned areas is *C. stellaris.* On the contrary, one would expect that burning of humus is less complete in sub-dry sites and that there also the accumulation of humus is faster. In addition, *C. stellaris* is commonly regarded as the most xerophilous and photophilous species among reindeer lichens (Kujala 1926, Paasio 1931, Ahti 1961, Kershaw 1971).

Helle and Aspi (1983) supposed that *C. mitis* and *C. rangiferina,* having a "loose" morphological structure, produce more thallus fragments than *C. stellaris* and for this reason they can occupy free niches (after burning or heavy grazing by reindeer) at a faster rate. However, the burned sub-dry sites studied in Ivalo were commonly surrounded by fair stands of *C. stellaris,* which adds the probability that *C. stellaris* belongs there to the first *Cladina* invaders.

The relationships between forest fire and population dynamics of reindeer and caribou have been studied especially in North America, where wide areas burned earlier yearly because of lack of effective fire control. Population shifts caused by the destruction of lichen-dominated winter ranges have been reported, but no causal relationship between population crashes and forest fires has been verified (Klein 1982 and literature cited therein).

In Northern Finland the lichen ranges are apparently more clearly the major determinant for carrying capacity (Helle and Säntti 1981). That is why the short-term influences of the fire must be taken into account when determining the usefulness of prescribed burning from the viewpoint of reindeer husbandry.

The need for site preparation before cultivation is greatest in fresh and sub-dry sites (Metsähallitus 1978, Ritari 1982). From the range data presented by Mattila (1981) (Table 2) one can calculate that about 5 percent of the total lichen biomass is growing

Table 2. Mean biomassas (dry weight kg per ha) of reindeer lichens in old forests (I) and their proportions of total lichen biomass (%) (II) in different parts of the reindeer husbandry area (calculated from Mattila 1981).

	Fresh		Sub-dry		Dry and barren	
	I	II	I	II	I	II
Northern	84	5	367	59	609	36
Central	28	5	103	63	205	32
Southern	25	6	145	67	281	27

in fresh sites and 59 to 67 percent in sub-dry sites in different parts of the reindeer management area.

Due to the scarcity of reindeer lichens, prescribed burning is without doubt suitable for fresh sites. It must be taken into account, in addition, that in fresh sites burning increases the production of green forage (e.g. Sarvas 1937b, Siren 1955), of importance for reindeer in summer (many decidious trees, herbs and forbs) and early winter *(Deschampsia flexuosa)*. As regards sub-dry sites, decision making is more difficult. Especially in Northern Lapland they represent important lichen ranges, altough the biomasses are, in general, smaller than in dry and barren sites (Table 2).

There are, however, some further points which make prescribed burning more ad-

reindeer herders (e.g. Aikio, O. 1973, Aikio, P. (1977). Ferm and Sepponen (1981) studied the succession of ploughed reforestation areas in Northern Finland. They found that the height difference between the top of the tilt and the bottom of the furrow levelled out about 20 percent in 10 years.

This process was most rapid during the first 5 years, giving an indication that the hindering effect of ploughing may last several decades. In burned areas, however, the most effective ploughing methods are not needed, with the result that such areas are easy to travel through.

The second point deals with the influence of cutting residue. According to Eriksson (1975) cutting residue covers in fresh *Vaccinium* type just after clear-cutting nearly 60 percent of the ground and 6—7 percent still 21—40 years after cutting. Cutting residue is apparently the main reason why the reindeer avoid winter-grazing in clear-cut areas (Helle and Saastamoinen 1983). When the ground is burned after final cutting there are, of course, no problems with cutting residue.

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A SYSTEM FOR INVENTORY OF REINDEER WINTER RANGES IN FINLAND

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ODC 268.1+524.6

A statistical evaluation of the reindeer winter ranges was carried out in Finland during 1976—78. The areas of the most important range strata were estimated from the distribution of the samples of the National Forest Inventory. A part of these plots constituted a subsample for the evaluation of the actual occurrence of winter forage in the range strata.

The winter ranges will be reinventoried up to 1985 in accordance with the principles above. The old subsample will be partially remeasured which makes an efficient change analysis possible. Considerable savings in expenditures are expected due to the simultaneous data gathering within the system of the National Forest Inventory.

Key words: Integrated forest inventory, reindeer range, range inventory

Introduction

General

The Finnish reindeer management area extends some 600 km in a north-south direction, its total land area being 115 000 sq.km. It consists of 56 administrative units, so-called herding co-operatives. These are combined into 14 groups of co-operatives (Fig. 1). The highest local administrative organ is the Association of Herding Co-operatives at Rovaniemi.

The average number of reindeer at least one year old in wintertime was 150 000 during 1971—1978. This corresponds to 76 ha land area or 46 ha mineral soil area per reindeer on an average. The greatest allowable numbers of reindeer in the co-operatives are regulated by the Ministry of Agriculture and Forestry.

The number of reindeer shows a tendency to increase due to the social development. At the same time, however, winter forage has decreased. This has led to conflicts between reindeer husbandry and some other forms of forest use. It has been claimed that forestry especially deteriorates ground lichen fields and destroys old forests containing arboreal lichens. The clash of interests peaked in the 1950's when the more intensive utilisation of the forests of North Finland started.

Earlier range surveys

Regulation of the number of reindeer requires information about winter ranges by co-operatives. Winter forage is the minimum factor of reindeer husbandry in Finland. For that reason inquiries concerning the actual occurrence of lichen fields have been carried out (Alaruikka 1936, Paliskuntain Yhdistys 1962).

A study of a more statistical nature was carried out in the 1960's (Helle, R. 1966). The extent of the different lichen-producing soils was estimated on the basis of the forest management maps for the state-owned forests. The actual condition of the lichen fields was not studied in the field. Helle (ibid.) evaluated the forage values of the different lichen-producing soils on the basis

of the papers published by Ahti (1959), Alaruikka (1964) and Skuncke (1958, 1959). He came to the conclusion that the grazing capacity of the Finnish reindeer management area was not fully utilized.

Kärenlampi (1973) studied the actual occurrence of lichens. It appeared that the lichen fields were worn out. The actual biomasses of lichens per unit area were far below the optimum level. This finding indicated that the grazing capacity estimate from the 1960's was too optimistic.

The basis for objective inventory

In the 1970's, it became more and more necessary to carry out an objective range inventory. In order to fulfill its purpose this must yield both area information and area-related range information. When one considers the cost-benefit aspects it is evident that a range inventory as a separate action is not very feasible.

It was considered to be a reasonable solution to gather range data in connection with forest inventories. The National Forest Inventory system (NFI) serves as the basis for this purpose because:

- NFI covers the whole reindeer management area in a relatively short time (2—4 years) every 8—10 years
- all land is inventoried independently of land-use class or ownership
- the work is objective and consistent
- the numerous classifications made in NFI make it possible to evaluate areas for a variety of purposes

Several hundred forest strata can be formed on the basis of the classifications made in the NFI field work (Kuusela 1979). Since the beginning of the 1970's some purely multiple-use aspects have also been fitted to the system (Kuusela 1977). More important than area estimation in this context, however, is evaluation of the actual condition of the ranges. Gathering additional range information provides us with compatible data for forest use planning on a sustained yield basis.

Sampling in NFI is fairly extensive owing to the great reference areas in North Finland. It is not possible to get reliable results concerning reindeer ranges by herding co-operative. In this investigation informative results can be calculated by groups of co-operatives and their combinations.

The first inventory in 1976—1978

Execution

The method of the first objective reindeer winter range inventory was as follows:

- seven range strata were defined on the basis of the site requirements of the most important winter forage plants
- the areas of the range strata were estimated from the distribution of the NFI sample plots
- the actual occurrence of lichens, hair grass and arboreal lichens in the range strata were evaluated with the aid of an additional sample measured on a part of the NFI field sample plots.

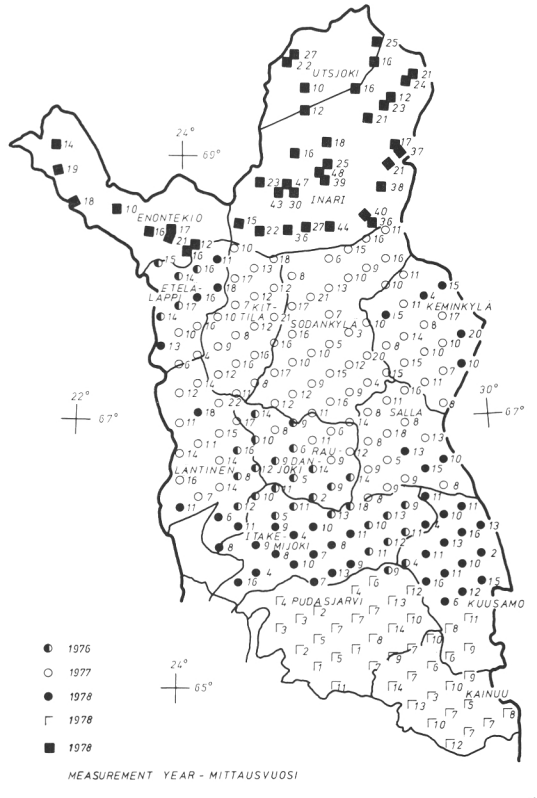

Figure 1. Number of plots in the subsample by field tracts. The study area consists of 14 sub-areas called groups of co-operatives.

Reindeer dig on mineral soils in the most critical part of wintertime, and so it was decided to exclude peatland from the study. This restriction was necessary considering also the financial aspects. The greatest part of the additional sample was measured 1—3 years after the measurement of the NFI field sample. Only in North Lapland, in an area of about three million ha, the winter ranges were evaluated simultaneously with NFI.

The National Forest Inventory in question was performed in the Finnish reindeer management area in 1974—1976 and in 1978. The methods and the results have been presented in Kuusela and Salminen (1976, 1978), Poso and Kujala (1978) and Mattila and Kujala (1980).

The additional sample consists of 3 300 plots in all. These cover the whole study area and all the seven range strata (Fig. 1). Intensity of sampling in relation to the forestry land mineral soils was fairly even over the whole reindeer management area.

Estimation of range characteristics

The winter forage plants under study are

— reindeer lichens: *Cladonia stellaris, Cl. rangiferina, Cl. mitis* and *Stereocaulon sp.*
— hair grass *(Deschampsia flexuosa)*
— arboreal lichens *(Alectoria, Bryoria* and *Usnea spp.)*

The occurrence of ground lichens and hair grass was estimated using observation squares of fixed size, number and location on every plot. In the experimental stage of the study five squares of 0,5 sq.m were used. Later, ten squares of 0,25 sq.m per plot were considered to be a more suitable solution. Estimation of coverage is easier with a smaller observation square. On the basis of the collected material it could be verified that ten is a good number statistically, too (Mattila 1981, p. 41). The distance between the squares in the sampled stand was always five meters.

The characteristics evaluated in every observation square are:

— cover density of reindeer lichens (%)
— average height class of the living part of thallus of lichens
— species composition of lichens
— cover density of hair grass
— condition of the lesser vegation
— condition of the site

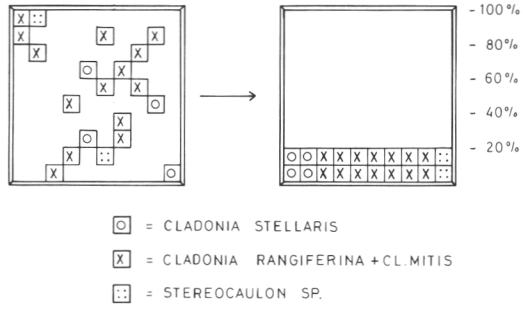

Figure 2. Estimation of the lichen coverage and species composition within each observation square, a schematic example. Total coverage is 20 % with proportions of 0.2, 0.7 and 0.1.

Height estimation of lichens was done in five-millimeter classes. Total coverage of lichens was allocated to three groups of species for biomass estimation (Fig. 2). Classifications concerning site and lesser vegetation make it possible to explain the variation in the occurrence of lichens and hair grass within stands.

Occurrence of arboreal lichens was evaluated in a circle with a radius of 20 meters in the sampled stands. In each stand a classification from nought to three was done in relation to the amount of visible arboreal lichens. The objective of this classification was to divide the quantitative range of variation into three equal parts.

Data handling and calculations

All range information was written down in numerical format on field record forms for computer handling. The files were first checked visually, completed and stored on floppy disks. Then the data was tested automatically and corrected until no errors occured (Fig. 3). In the first phase of the calculations the plot values for the different range characteristics are derived on the basis of the observation squares. A plot file is created and completed with the necessary stand characteristics taken from the NFI material.

The strata means are calculated from the values of the plots occuring in the range strata. The areas of the strata on the other hand are estimated from the distribution of the NFI samples. In the final stage of the

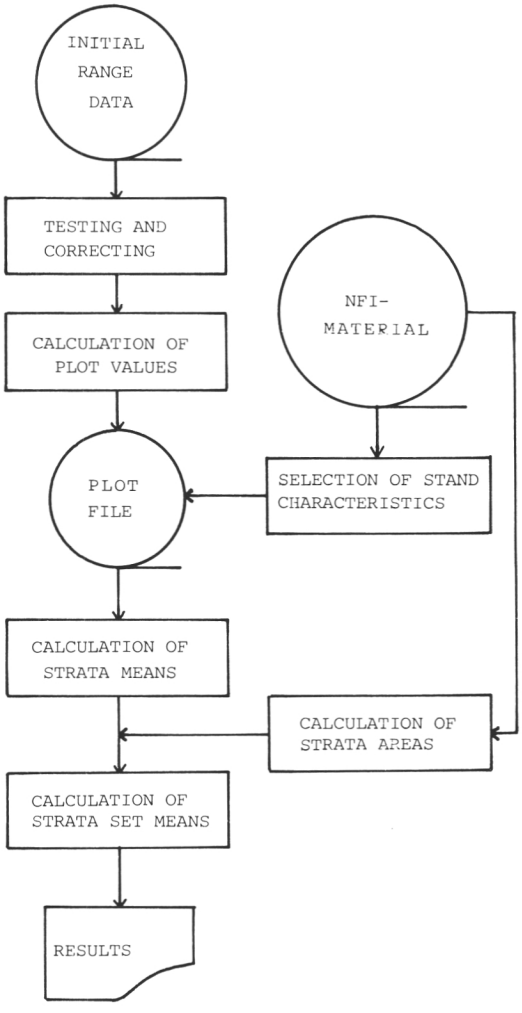

Figure 3. Data handling and calculation system.

calculations the strata means and areas are combined into strata set means and totals. The strata set means must be calculated by weighting them with the estimated strata areas. This is because the sampling intensity of the subsample is not the same in the different range strata.

The output of the calculations includes estimated means (lichens and hair grass) and proportions (forest with arboreal lichens) for eleven strata or strata sets in eighteen sub-areas. The total number of separate characteristics under estimation is 20.

Evaluation of biomasses was done using conversion functions developed by Timo Helle (Mattila 1981, p. 23). Dry matter contents (kg/ha) of lichens are derived as a function of coverage and height. Coverage is the only factor in the conversion function of hair grass.

With the aid of the estimated means or proportions and areas it is possible to calculate totals by sub-areas as for example:

— areas of lichen field and hair grass vegetation with 100 % coverage
— biomasses of lichens and hair grass
— areas of forests with different amounts of arboreal lichens

Dividing the estimated totals by the actual number of reindeer gives us information about available winter forage per reindeer by sub-area. These figures also reflect differences in the winter range situation between sub-areas to a certain degree. In the comparison, however, we must take into consideration such characteristics as number of reindeer per unit area and range strata distribution, too.

Some main results

The results of the first range inventory cannot be discussed very thoroughly in this paper. The principal publication concerning the inventory in general (Mattila 1981) was issued some time ago. The results concerning the qualitative and quantitative characteristics of the forests with arboreal lichens have been presented in a separate publication (Mattila 1979). A pilot report has also been given out (Mattila and Helle 1978).

The range inventory described here verified the results of Kärenlampi (1973) which indicated a worn-out condition of the lichen fields. According to Kärenlampi (ibid.) the highest biomass production occurs when the height of the living part of thallus is 20—30 mm. Now the estimated mean height was only 12 mm and heights over 25 mm were rare.

Another remarkable result is the fact that in the southern and central parts of the study area there are no clear differences in the occurrence of lichens in young and in old forests. Only in the northernmost areas do lichens occur more abundantly in old forests. The results cannot be explained by site distribution. This is somewhat confusing as to the presupposed harmful effects of re-

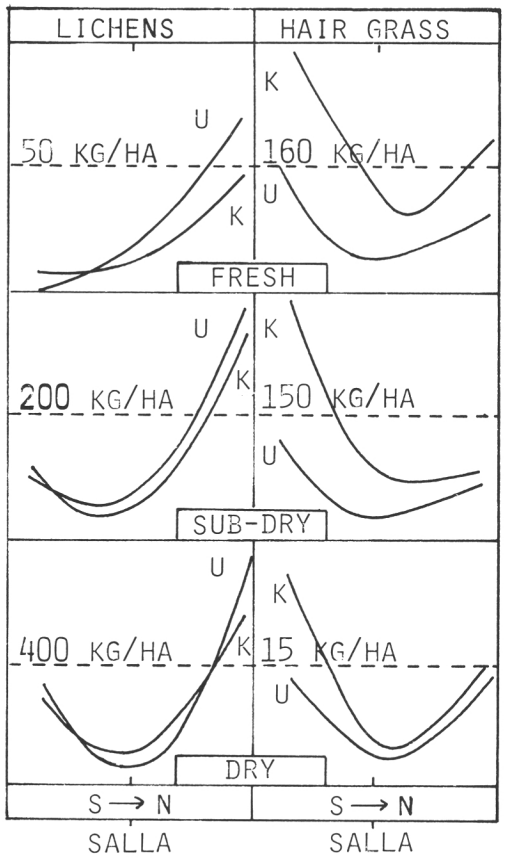

Figure 4. Occurrence of lichens and hair grass in fresh, subdry and dry sites when moving from the south to the north in the Finnish reindeer management area. U = forests to be regenerated, K = other forests.

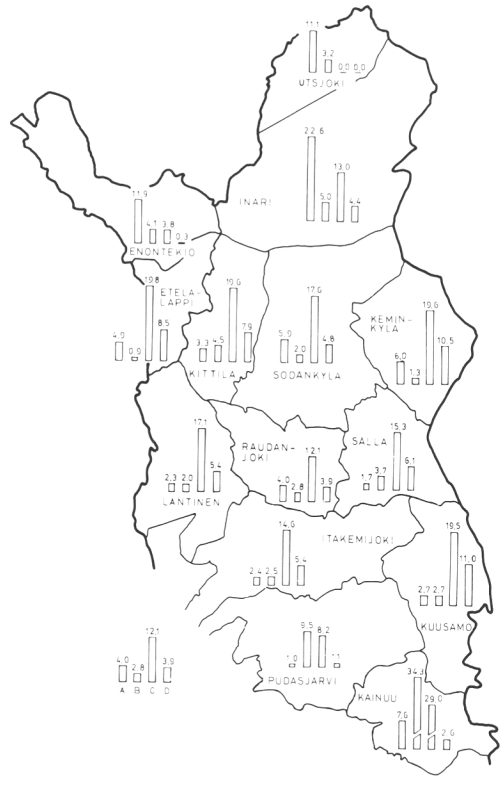

Figure 5. Available winter forage per reindeer by groups of co-operatives. A = lichens and B = hair grass (expressed as tons of dry matter), C = area of forests with arboreal lichens (ha) and D = area of forests with at least a moderate amount of arboreal lichens.

generation of forests on lichen fields. However, the situation could be different if the lichen fields were in a more natural condition.

The actual occurrence of lichens and hair grass in certain forest strata when moving from the south to the north in the reindeer management area is illustrated in Figure 4 (from: Mattila 1982). As can be seen, lichens occur only slightly more in the forests to be regenerated than in the other forests. On the other hand, regeneration of forests clearly increases hair grass. All values are decreasing to Salla and then increasing. Salla lies about in the middle of the study area. The abrupt decrease of hair grass to Salla is mainly due to plant geography, whilst the increase of lichens from Salla upward indicates a better condition of lichen fields and the less fertile sites in the north.

Available lichens per reindeer in the north is many times greater than that in the south (Fig. 5). On the other hand, the greatest biomasses of hair grass occur in the south. Forests with arboreal lichens are most abundant in the northern parts of the central reindeer management area. The importance of the forests with arboreal lichens is greatest in areas of scanty lichen fields (Helle & Saastamoinen 1979). The inventory results revealed that both ground lichens and arboreal lichens are insufficient in large areas in the central and southern parts of the Finnish reindeer management area.

Statistical aspects

The statistical precision of the main results has been derived by groups of co-operatives. The precision varies considerably depending on characteristic, strata and sub-area.

As to the proportions of mineral soil the relative standard error is 2,3 %—7,0 %. The corresponding figures concerning the areas of lichen fields and hair grass vegetation with 100 % coverage are 5,9 %—28,6 %. The total biomasses of lichens have been estimated with a relative standard error of 6,5 %—28,0 %. The last mentioned figures, however, don't include the error coming from the use of the conversion functions. On the basis of the estimated precision one can conclude that the subsample must be made more representative in the following range inventory.

Further development

A part of the field plots of NFI in North Finland have been made permanent. These plots are to be remeasured in the following inventory. This means that also range inventory will be repeated partly on the same plots. The statistical consequences of the procedure are:

- a lower number of sample plots is needed in estimation of means with predetermined precision
- the procedure is even more efficient in estimation of changes than in estimation of means
- the causes of the estimated changes in means can be explained fairly quickly because the 'history' of the remeasured plots in known.

Use of permanent plots provides us with an efficient tool for change analysis. This is very important considering the conflicts between reindeer husbandry and, for example, forestry.

All range information will be gathered simultaneously in connection with the NFI field work in the repeated range inventory. This results in considerable cost savings compared to the previous inventory. Integrated data gathering also eliminates certain inconveniences present in combining information from separate sources.

The ranges will be evaluated on a predetermined portion of the NFI field sample over the entire study area. Thus intensity of the subsample will be the same independent of the range strata. This is because intensity of the NFI samples also will be constant in areas where the NFI method is the same. In this case the strata set means are equal to the arithmetic means of plot values, which makes the calculations more simple. The estimates of the strata set means will be more precise because one source of error (areas of strata) is not included in the calculations.

An important task is to improve the biomass estimation of ground lichens and hair grass. This can be done by developing more functions and making them more precise and flexible. Arboreal lichens should also be included in the study. In the first phase, however, a representative material should be collected for that purpose.

A new round of NFI was started in the reindeer management area in 1982. Integrated evaluation of winter ranges is carried out in accordance with the principles proved in the first range inventory. The NFI field work in the study area will be finished in 1985.

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SHEEP GRAZING ON REFORESTATION AREAS

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ODC 268.1+230+907.1

Grazing has been common since man began to domesticate animals. In some places grazing has caused erosion and removal of the upper layer of the soil. The grazed reforestation area in Sweden is less than 5 000 hectares.

Sheep graze shrubs of aspen and rowan. Birch has not been satisfactory grazed and alder has not been grazed at all. Coniferous plants have not been severely damaged by sheep. Grazing by sheep is primarily an alternative to thinning by brush saw on forest areas in the neighbourhood of population centres and lakes, to create view points and to restore partly forested pastures.

Key-words: Broad-leaved trees, coniferous plants, environmental forestry, grazing, herbicides, sheep.

Introduction

Leaves are a potential source of feedstuffs for cattle. Before farming was rationalized, leaves were a part of the feed of cattle both in summer and winter (Nehring 1965, Rösiö 1918). Grazing by sheep and cattle on forest land and desert land has been common since man began to domesticate animals. The heads of cattle increased more and more when the human population rose and with it the need for milk and meat. Intensive grazing on forest land sometimes reduces shrubs and grasses very much. In some countries grazing has caused erosion and removal of the upper layer of the soil. No species of grasses or shrubs have been able to grow up again. This phenomenon is well known, for example, in some Mediterranean countries. In some cases it is possible to restore damaged lands but grazing this area must be avoided during a longer or shorter time.

Grazing on forest land in Scandinavia has been common for a long time. Trees on forest land had no economical value until 1850. Grasses and shrubs in forest land were a valuable addition during the summer because the area of the agricultural land was not large enough to feed cattle both summer and winter. Grazing was done both in the neighbourhood of the villages and on deserted places 10—30 kilometers from the villages where the cattle lived in temporary structures during the summer.

In Sweden, Norway and Finland, sheep, goats and cattle grazed on forest land until 1950, or, in some cases, till today. In Sweden a law concerning directions about reforestation was made in 1903. This law made it possible for the government to limit grazing on forest land during the period when plantations of coniferous plants were sensitive. Areas with natural regeneration were not included in this law (Brelin & Johansson 1979).

In Sweden we had an intensive debate about grazing on forest land, particularly on reforestation areas, during the period 1900—1950. Foresters generally thought that grazing on forest land seriously damaged coniferous plants (Ronge 1940, Tirén 1948). They demanded that grazing be forbidden. When the government began to give subsidies for fencing pasture on arable land the numbers of cattle on forest land decreased rapidly. Another reason for the decreasing number

of cattle on forest land was the demand for a higher yield of milk and meat which started about 1940. The cattle did not get enough food from the forest land to produce sufficiently. Grazing by sheep has been going on to a decreased extent.

State of forests in Sweden today

During the period 1923—1978 the number of broad-leaved trees on forest land in Sweden has increased sharply (Fig. 1). The increase is particularly high from 1968 to 1978 in young forests (Folkesson & Johansson 1981).

In reforestation areas there were about 7 000 broad-leaved trees per hectare during the period 1973 to 1977 (Kempe 1980). About 80 per cent of the number of broad-leaved trees on forest land in Sweden are less than 5 cm DBH (diameter at breast height) (Folkesson & Johansson 1981).

In Sweden we have an intense debate about spraying reforestation areas with herbicides. Today the law says that spraying with herbicides by aeroplane or helicopter is forbidden but there are possibilities for exemption. People are sometimes afraid of herbicides particularly in the neighbourhood of their houses and on berry-producing forest land. As mentioned before, the number of broad-leaved trees is high and about 250 000 hectares per year are in a great need of pre-commercial thinning. Because of restrictions on the use of herbicides during the 1970's and areas not being thinned, we have an accumulated need of pre-commercial thinning on about 1.3 million hectares. As a result of laws, public opinion and a direct need of pre-commercial thinning in reforestation areas and young forests particularly, we now have to use all possible methods to get rid of unwanted broad-leaved trees. Grazing by sheep is one of these methods.

Result and recommendations

During the last decade sheep grazing has been a more interesting alternative for both foresters and farmers. A lot of investigations

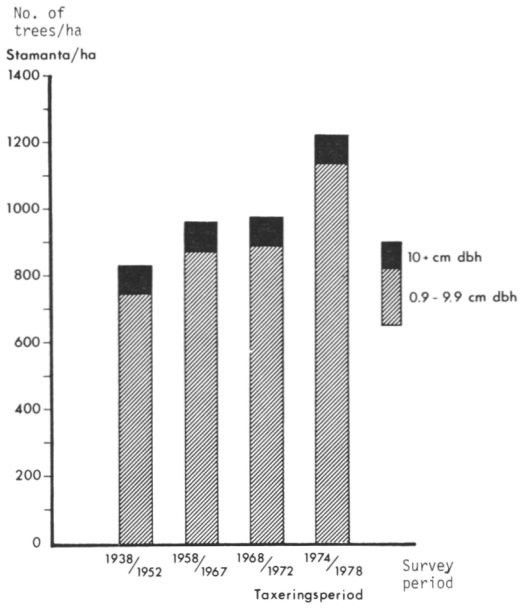

Figure 1. Number of broad-leaved trees per hectare on forest land during different survey periods. Source: Folkesson & Johansson 1981.

and trials have been started since 1970. Grazing by sheep on partly forested natural pastures has shown that sheep will not graze coniferous plants if they have access to water, salt, supplementary mineralfodder and vitamins (Steen et al. 1972, Brelin et al. 1978). Experiences of nine trials in Sweden where forest owners and sheep owners together have fenced reforestation areas and the sheep have grazed for 2—5 years, are given below (Brelin & Johansson 1979). Sheep prefer aspen *(Populus tremula)* and rowan *(Sorbus aucuparia)* to birch *(Betula pendula, Betula pubescens)* and alder *(Alnus glutinosa* and *Alnus incana)*. All leaves and fine branches of aspen and rowan in general were grazed by sheep but only a few leaves or fine branches on birch and alder were grazed. In some cases sheep will graze birch as well as aspen particularly when the suckers are less than 50 cm height. About 75 per cent of broad-leaved trees in Sweden are birch (Folkesson & Johansson 1981). Thus, it is important to know why sheep do not prefer birch. Brelin et al (1979) have shown that birch has more organic matter and lower digestibility than aspen or rowan. Another investigation of digestion of leaves by rumen microbes *in vitro* shows that *Salix* sp., birch

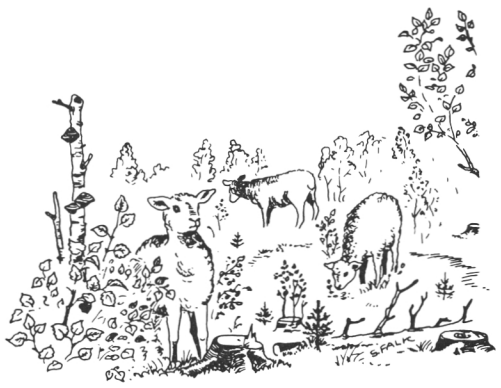

Figure 2. Sheep prefer aspen and rowan to birch and alder. (Drawing: S. Falk)

and alder have a low digestibility (Ciszuk & Murphy 1982).

As mentioned before grazing has not been accepted everywhere among foresters. The main reason is that foresters believed that grazing damaged coniferous plants. Grazing in the past was by sheep, goats, horses and cows. The main damage to coniferous plants was made by goats. Horses and cows tread the ground and damage the roots of the coniferous plants. Grazing by sheep today with supplements of water, salt, mineral-fodder and vitamins will minimize the risk of damages. A very important point is the period in the season when grazing starts and when it ends. Grazing should not start before June and should end in September or when the vegetation is grazed (Brelin & Johansson 1979). The number of sheep per hectare has to be high enough for sufficient grazing of shrubs with no damage on coniferous plants. A suitable number of ewes are 3 to 6 per hectare depending on the amount of vegetation.

As a result of grazing on forest land lambs will not have intestinal parasites when compared with lambs on fenced pasture land. The weight of lambs on forest land are then sometimes higher than of lambs on pasture land (Sjödin 1978).

Discussion

Sheep grazing in a reforestation area will reduce the number of broad-leaved trees. This method of controlling undesirable vegetation will be a supplement to conventional methods such as pre-commercial thinning with brush saw or treatment with herbicides. Forest areas with aspen and rowan which are not higher than 2.5 metres are the most suitable grazing areas. For the purpose of minimizing damage to coniferous plants there have to be salt, water, supplementary vitamins and mineral-fodder at a place where the sheep generally rest. Sheep have to be observed once a day. Bears and lynx will sometimes attack and kill sheep. The sheep might even break a leg. Sometimes there will be conflicts between farmers and hunters. The latter think that sheep graze all shrubs and grasses so that roe deer and moose will have no food (Brelin & Johansson 1979).

Instead of fencing in the sheep you might tend them. This is expensive but has the advantage that there is a person with the sheep all the time. "The shepherd" can direct the sheep to places with dense vegetation. The result after grazing with this method will sometimes be more effective for the forest owner and even for the farmer.

A comparison between pre-commercial thinning with a brush saw and grazing by sheep is shown in Figure 3. The figure shows that if the forest owner only has to pay for the material (fences) the reforestation area ought to be larger than 9 hectares for sheep grazing to be cheaper than thinning by brush saw. In case the forest owner also owns the sheep and thus has to pay both material and labour for the fence he has to fence more than 23 hectares before grazing by sheep will be cheaper than thinning by brush saw.

Sjödin (1978) gives figures from an investigation in northern Sweden where sheep grazed on reforestation areas. The 126 lambs on these 100 hectares produced 1 000 kg of lamb-meat. The value of the meat was about 15 000 Sw crs. (approx. US $ 2 000). The sheep consumed 35 tons of greenery. The cost of spraying herbicides over the field would have been 10 000—13 000 Sw crs (US $ 1 300—1 800). Bjorg & Graffer (1963) show in their investigation that 1 to 6 per cent of spruces (2/1 and 2/2) are killed by treading and few plants are damaged by browsing.

Forest areas in the neighbourhood of population centres are suitable areas where sheep grazing might be an alternative to pre-commercial thinning by brush saw. Spraying

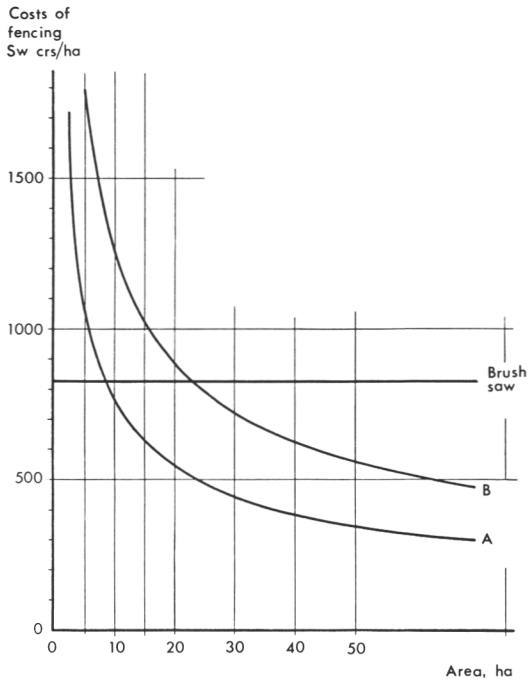

Figure 3. Cost of fencing reforestation areas as related to size of the area. A: Cost of material (fence). B: Cost of material and labour. Assumed production when clearing with brush saw: 1.5 dw/ha. (After Larsson 1982). US $ 1 = approx. 8 Sw. crs.

with herbicides is not allowed or suitable in such areas. In this case people also have a chance to study sheep in a natural way. The problem of broad-leaved trees, and a non-dramatic way to solve it, is here presented in a pleasant way. View points and parks in the population centre are other suitable areas where grazing will give good result.

In Sweden we have a lot of partly forested pastures where shrubs and trees invade. If this succession continues unhindered there will be no natural pasture land left. Grazing by sheep on these areas, where recreation or other activities take place, will restore the area. The measure will not be expensive.

Methods in forestry have been uniform during the last 20 years. In the future there is reason for a comprehensive forestry. Uniform methods will sometimes prevent development. Forest land does not only produce timber and pulp wood. But even in the main part of forest land where these products are most important, there are sometimes possibilities to use methods that both foresters and the so called public opinion may agree on. In the future, most reforestation areas will probably be treated by herbicides and particularly by brush saw or by vehicles with brushing attachment.

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HUMAN DISTURBANCE OF ROE DEER AND RED DEER: PRELIMINARY RESULTS

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ODC 156.2+907.2

A research project on the disturbing impact of human recreation activities on game in Danish forests is introduced. Three case stories describing reactions of roe deer *(Capreolus capreolus)* and red deer *(Cervus elaphus)* to orienteering events and 3 case stories of deer's reactions to battues are presented. One aim of the research is to establish at what time of the year the deer are least susceptible to disturbance. In this connection, the annual energy balance of deer is discussed.

Key words: disturbance, roe deer, red deer, orienteering, hunting, radiotelemetry.

Introduction

The second half of the 1970'ies witnessed an intense controversy between the Danish forest administration and orienteering runners, concerning the runners' access to arranging orienteering events in the Danish forests. Some roe deer *(Capreolus capreolus)* and some moose *(Alces alces)* were known to have died as a result of stress brought on by a large orienteering event in Sweden (Sennstam and Stålfelt 1976). As the pressure on the Danish forests from orienteering runners had been increasing, partly because Denmark had a world champion in orienteering in 1974, the situation gradually became critical. The forest administration wanted to protect the game, which they feared were exposed to severe strain during orienteering events, and in many cases they refused permission for such events.

Almost three quarters of Denmark is agricultural land. In contrast to the vast forest areas in the rest of Scandinavia, the Danish forests are situated as enclaves in the farmland and cover only 12 % of the total area. For a considerable part of the year, the forests — together with hedgerows and coverts — constitute the only possible cover for animals of a certain size.

As a result of this kind of countryside, combined with a much higher carrying capacity, the population density of game in Danish forests is usually much greater than the densities in the rest of Scandinavia. The population density of Danish roe deer may be as much as 10 times higher than the density of roe deer in central and southern Sweden (Cederlund et al. 1981, Strandgaard 1972). Consequently it must be assumed that the disturbing impact of human recreation activities is much greater in Denmark.

What are the costs of disturbance to animals? Disturbance may in some cases result only in some excitement in animals but may in other situations lead to panic, severe exertion and consequent damage or the death of the animal. By greatly boosting the metabolic rate, disturbance increases the animal's cost of living at the expense of its body growth, development and reproduction (Geist 1975).

The cost of excitement is highly variable,

but as a rule of thumb, chronic excitement increases the metabolic rate to some 25 % above that of maintenance. The cost can temporarily exceed twice maintenance cost (Geist 1975).

Running involves a high cost to the animal; the metabolic rate in an animal running hard may exceed the basal rate by up to 20 times (Brody 1945 — in Geist 1975), while less strenuous running still requires some eight times the basal rate (Moen 1973).

Total cost of disturbance depends, therefore, on the intensity and duration of excitement, on the distance and duration of running, and also on the decrease in food intake. Ruminants spend most of a 24-hour period engaged in some kind of food activity, as about half of the 24-hour period is spent in food-seeking (Cederlund 1981, Hjeljord 1980). As a result, deer have very limited possibilities of compensating for increased energy expenditure caused by disturbance, by increased food intake in periods of peace.

Add to this that the daily intake of energy by ruminants is very low, and it becomes clear that the cost of extra activities may very quickly put the animal into negative energy balance (Geist 1975).

The aim of the present research, of which a few preliminary results are presented here, is to elucidate the disturbing impact on the game of various human recreation activities in Danish forests, especially the impact of orienteering — but also of hunting, jogging, tourism, etc.

The research project is financed by the EEC, (Contract no.: ENV — 365 — DK(G)) and by the following Danish institutions: The Danish Forest Service, the "National Agency for the Protection of Nature, Monuments and Sites", the Ministry of Cultural Affairs, the "Council supporting and encouraging outdoor life, paying the widest possible regard to the Danish Nature", and the Game Biology Station. The project was initiated in 1980 and is planned to run for 6 years.

Study areas and methods

Two areas have been selected. First, research on red deer *(Cervus elaphus)* is being carried out in West Jutland, i.e. in most of Oksbøl State Forest District with interspersed military field practice areas (mainly open heath and grass-land). In this area of 17 000 ha, there are about 1,500 red deer in the spring. Second, research on roe deer is being carried out in part of Kalø estate in East Jutland (400 ha, of which 164 ha is forest). In this area on fertile land there is a spring population of little more than 100, of which up to 90 % are individually collar-marked. The method of catching and marking roe deer has been described in detail by Strandgaard (1972). Red deer are caught in enclosures of 30 by 30 metres with automatically closing gates, and they are anaesthetized with a dart gun.

In both research areas, 10 to 15 specimen have been radio-marked with a 150 mHz transmitter in a collar. The position of a radio-marked deer is located by triangulation, with 2 or 3 bearings per position, using a mobile receiver and a directional aerial mounted on a VW-Transporter. Automatic activity-recording of two roe deer and two red deer is undertaken round the clock in order to study daily activity patterns. (For a detailed description of the locating system and the activity-recording, see Cederlund et al. 1979). Thus home range, movements and activity-patterns of the radio-marked deer are recorded throughout the year.

Before, during and after disturbing events like orienteering and battues in the two study areas, positions of radio-collared deer are located as described above. In addition, during the event, observations are made by spotters, and by participating "disturbers" (runners, sportsmen, etc.).

In addition to research in the two study areas, observations of game have been taken in various Danish forests in connection with 20 orienteering events, involving training events from less than 50 participants to the biggest Danish event with more than 2 000 runners. Foresters and orienteerers observed game — one of each category on each observation post — and the participating runners reported their observations of game during the race. After some of the events, the orienteerers also sketched in their actual running routes.

Preliminary results

Below, some examples of the reactions of roe deer and red deer to orienteering and hunting are presented.

Orienteering

1) Pamhule Forest, 18 May 1980; 700 runners. (No radiotelemetry). 14 observation posts were placed so that the total length of the forest fringe was covered. These spotters observed 65 roe deer, of which many left the forest (Fig. 1). Within the forest, the orienteerers reported 128 observations of roe deer. Obviously some deer were observed more than once, and on this day many roe deer were forced to run long distances. Figure 2 shows that 77 % of the observations were taken during the first half of the event. This is normal, as many deer seek shelter or leave the area on the first encounter with the runners.

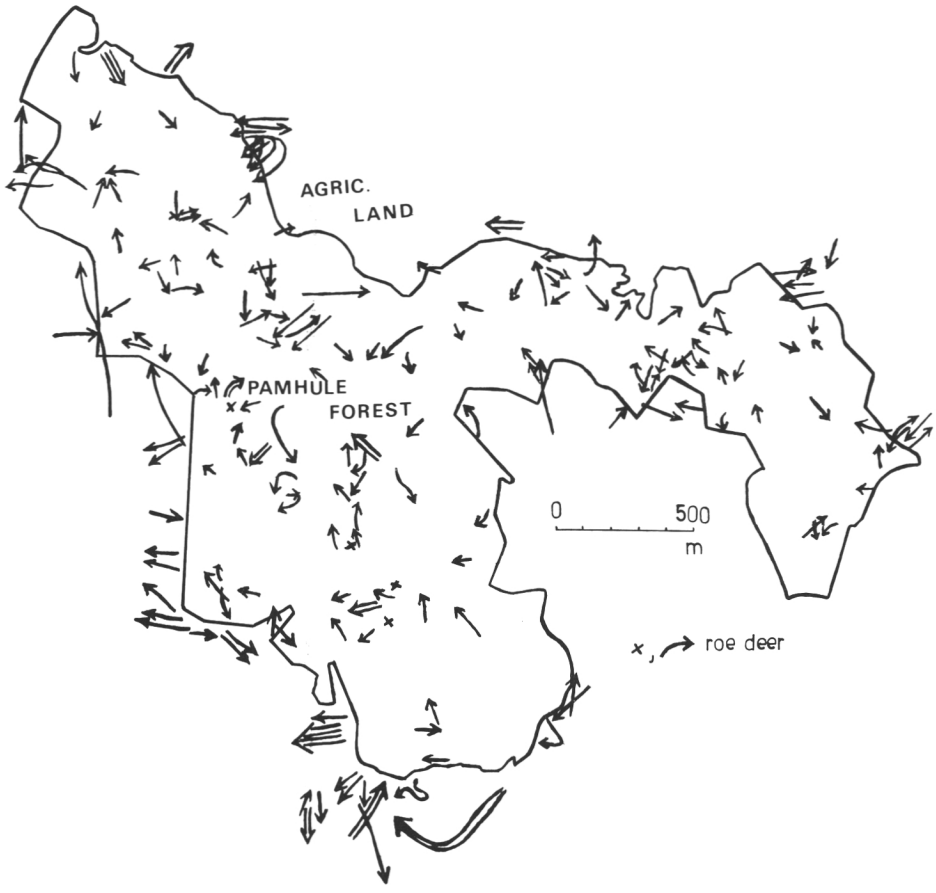

Figure 1. Observations of roe deer during an orienteering event with 700 participants in Pamhule forest, May 18, 1980. Arrows indicate directions of flight.

As no roe deer were radio-marked, nothing is known about the behaviour of the individual deer, about flight distances, or about the time of return to home range, etc.

2) Vejers Forest, 25 October 1981; 300 runners. (Part of the study area for red deer).

Five spotters observed 35 red deer, while 69 orienteerers saw 146 red deer during their running. Moreover, the movements of two radio-collared hinds were recorded (Fig. 3): Female red deer no. 2.10.B left the forest on the first encounter with runners and ran at a quick pace across the open land to a neighbouring plantation. The flight distance was 6 km. After dark the next day, the hind went homewards and walked into North Vejers in the morning, almost 48 hours after the disturbance. Hind no. 2.11.B was — before the race — in a corner of the plantation which no runners penetrated. This deer also ran to

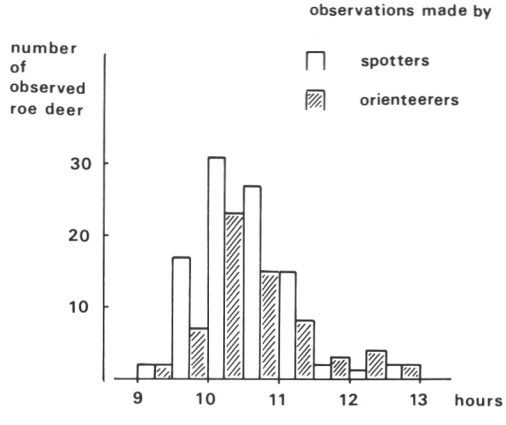

Figure 2. Frequency of observations (number of observations/ 30 minutes) of roe deer during orienteering event, May 18, 1980 in Pamhule forest.

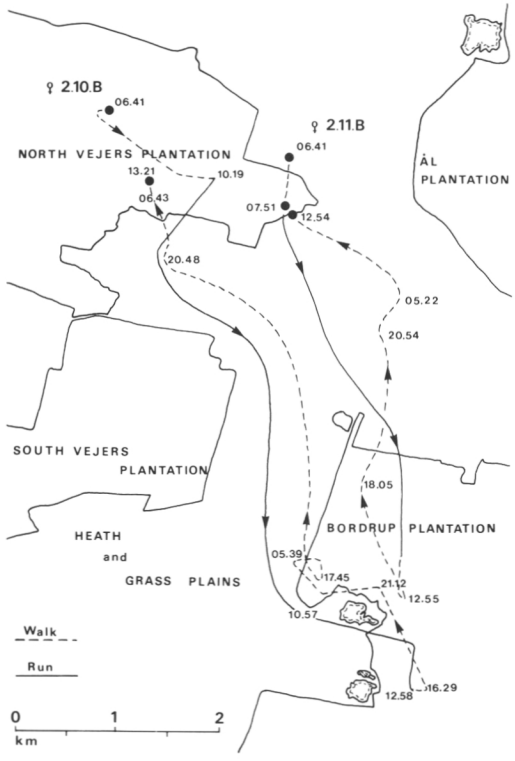

Figure 3. Movements of 2 radiomarked female red deer during and after an orienteering event in North Vejers plantation, October 25, 1981.

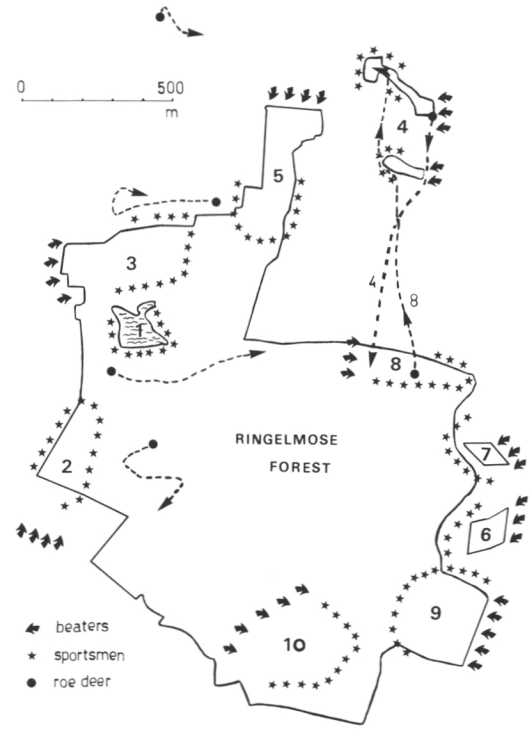

Figure 4. Movements of radiomarked roe deer during a battue with 10 beats at Kalø, November 6, 1981.

the same adjacent plantation, probably because fleeing deer from the rest of North Vejers came running through the area where it was sitting. This hind returned to North Vejers after almost 24 hours.

3) Kalø, 15 June 1982; 78 runners.
Six observers reported 26 roe deer and 45 runners reported 48. Of the runners, 56 sketched in the actual route they had followed.

All the 7 radio-marked roe deer present in the area sought cover in small dense plantings or marshes within their respective home ranges at the first contact with runners. They stayed in cover for two hours until the event was over. A few of the roe deer were only a short distance away from the passing runners. Immediately after the event, the deer left their cover and resumed normal activity within their home ranges.

Hunting

4) Kalø, 6 November 1981.
Battue with 16 sportsmen and 25 beaters. Roe deer were not shot. The battue lasted from 9 a.m. to 4 p.m. (lunch 1½ hrs.) Actual beating time: 2 hours and 27 minutes. Each of the 10 beats lasted between 9 and 26 minutes. A total of 125 game were killed, and 412 shots were fired, which makes 3.3 shots per kill.

Only one radio-collared roe deer was directly affected by the battue (Fig. 4). A doe in the fourth beat was chased out of a covert. It ran quickly one km to the forest. It stayed there until beat no. 8 started, about 3 hours later, in the area where the doe had found refuge. The deer was chased out of beat no. 8 and returned quickly to its starting point (beat no. 4). The other radio-marked roe deer were not directly in any beat at the right time, but under the influence of the activities some moved partly away from the nearest beat and partly into cover.

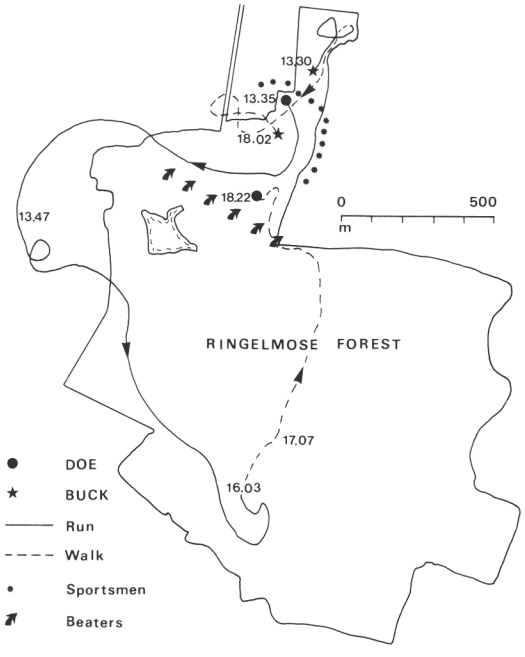

Figure 5. Movements of 2 radiomarked roe deer during and after a battue at Kalø, November 20, 1981.

5) Kalø, 20 November 1981.
Battue with about 25 participants. Figure 5 shows the escape route for radio-collared female roe deer no. 2.12.A in beat no. 7. It ran in the opposite direction of the beat, passed the beaters, ran three km, and stopped in the southern part of the forest, one km south of its home range. After dark it went north again, and 5 hours after the disturbance the doe returned to its home range.

A buck was also chased out in beat no. 7 as the sportsmen walked to their shooting posts. The buck was outside the area of the beat and ran to the north of the forest, where it stayed during the beat, which lasted 15 minutes. After 20 minutes, the buck went south through the area of the beat, and stayed in the area close by — still within its home range.

6) North Vejers, 31 October 1981.
Battue with 17 sportsmen, 5 beaters with guns and dogs. Duration of beat no. 1: 47 minutes, and no. 2: 50 minutes. Radio-collared red deer were not shot.

In the first beat (Fig. 6) hind no. 2.10.B along with its calf was chased out, passed the sportsmen and ran 1 km to the south part of the plantation. After an uneasy stay there it sought refuge in a small covert of spruce out in the open grassland. It returned to the forest after dark.

Hind no. 2.01.B was in the second beat, and it stayed there during the beat. The beaters did not catch sight of it. It left the area of the beat one hour after its termination.

Discussion

These examples of roe and red deer's reactions to disturbance during orienteering and hunting illustrate that the strategy chosen by deer is to seek cover within their home range or to leave the area until peace is restored. Repeated disturbances might force the deer to shift or to enlarge their home range, as is seen in male white-tailed deer *(Odocoileus virginianus)* in response to intensive ranching operations in the U.S.A. (Hood and Inglis 1974). Enlargement of home range implies increased roaming, and hence increased energy expenditure.

One of the goals of this research project is to determine at what time of the year the game is least susceptible to disturbance. The intake of energy by ruminants varies seasonally. Among roe deer on good forage in the summer, an intake of about twice maintenance was recorded, while in the winter the energy intake was barely above the requirements of the basal metabolism, and below maintenance (Drozdz and Osiecki 1973).

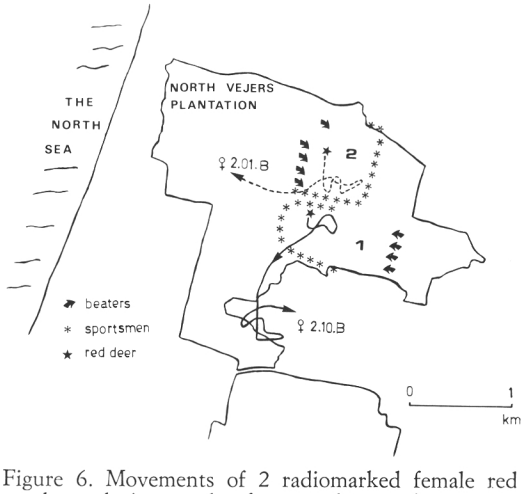

Figure 6. Movements of 2 radiomarked female red deer during and after a driven shooting in North Vejers plantation, October 31, 1981.



Figure 7. Red deer can to a certain extent habituate the human disturbances. (Photo: Søren Fodgaard)

During periods of severe winter, the deer have to draw on the fat reserves which have been accumulated during the autumn. In extremely severe winters, roe deer can survive for approximately one month, utilizing all fat reserves (Drozdz and Osiecki 1973). Deer conserve energy by restricting their movements at this time of the year (Moen 1976, Georgii and Schröder 1978, Cederlund 1981).

In November, roe deer have good fat reserves, and the winter coat is approaching prime condition. In March, the fat reserves have been depleted, the winter coat is in poor condition, and the females may be carrying two fetuses. Production of fetuses does not cost much additional energy until the last third of the gestation period, i.e. from the end of March. For white-tailed deer with one or two calves, an increase of 80 % and 130 % respectively in the metabolic rate has been calculated at the end of the gestation period and in the nursing period (Hjeljord 1980). This applies a severe strain to the female as there are only a few fat reserves left, and the deer is in the poorest condition. Food activities take up the total amount of time.

Hunting, orienteering, gathering mushrooms, tourism and other activities — all constitute elements of disturbance in the forest environment, disturbances to which the animal can adapt to a certain extent. Planning must rest on a basis of knowledge of what happens in nature, if the various recreational activities are not to jeopardize the preservation and protection of our game, which given reasonable conditions can be a source of great pleasure to all.

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PRODUCT TRANSFORMATION IN MULTIPLE-USE FORESTRY

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A key question in multiple-use forestry is the relationships between different forest uses or forest products. This question can be concisely handled with the concept of product transformation which tells the degree of inter-changeability between the relevant products. This concept is examined and the basic transformation relationships are reviewed adopting the following classification: 1. joint products in (a) fixed proportions (b) variable proportions; 2. competitive independent products with (a) constant, (b) increasing and (c) decreasing rate of transformation; 3. complementary products; 4. supplementary products; 5. antagonistic products.

Key words: Multiple use, use relationships, production theory

Introduction

One of the basic motives for multiple-use forestry generates from the high versatility of the use of forestry land. It is at least in theory possible to use any forestry land area for several different purposes such as for timber production, grazing of different domestic or semi-domestic animals, game management and hunting, wildlife, production of non-wood plants (e.g. berries, edible fungi, utility plants), watershed management, environment protection, outdoor recreation or nature conservation. Also, in practice, it is increasingly usual for many alternative uses to compete for the same piece of forest land. This situation creates a need for multiple-use management.

In such cases a key question will be the mutual relationships between the potential uses of the land area. Is it possible that each of the potential uses can utilize the area at the same time? Does some use exclude totally one or another use? Are there mutually beneficiary relationships between any pair of uses?

These problems can be concisely treated by using the concept of *product transformation*. Product transformation or, as it is also called, product substitution tells the degree of inter-changeability or trading between the uses (products) of forestry land.

In forestry timber production alone abounds with examples of product transformation possibilities (e.g. Worrell 1959, Gregory 1972, p. 259). A particular tree can be cut to yield varying proportions of sawtimber and pulpwood. A given piece of forest land may be used to produce varying species and species combinations as well as varying timber assortments (e.g. fuelwood, pulpwood, sawtimber). And as it has been widely recognized, the product transformation approach is well suited to many multiple-use problems (e.g. Gregory 1955, 1972, Lloyd 1969, Pearse 1969, Castle 1977, Zivnuska 1978, Campbell 1981, Saastamoinen 1982).

It is also useful to recognize that multiple-use problems have some similar traits with those of agriculture and therefore it is no doubt worth of studying the approaches used in agricultural production economics (e.g. Heady 1952).

The purpose of this paper is to discuss the concept of product transformation and to review systematically the basic forms of product relationships from the point of view of this concept. In addition, it is attempted to further specify some cases of product transformation in multiple-use forestry.

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Product transformation

Briefly, there are three types of production decisions (e.g. Snodgrass and Wallace 1980): (1) what products to produce; (2) how much to produce of any product and (3) how to produce them. The first type of decisions are usually referred as product-product decisions, the second as factor-product decisions and the third decisions are called to factor-factor decisions.

Product transformation concerns mainly with product-product decisions. It is an approach used to analyze the questions 'what to produce' and partially also 'how much to produce of any product'. To the latter question it is able to answer only to the extent which is possible without taking into consideration the factors. In fact, any decision concerning product quantities cannot be done without considering the factors and the total decision process in production management includes always the consideration of factors and products simultaneously. Therefore, in product transformation we are dealing only with a partial analysis of production which neglects the factor relationships, or better saying, in which it is usually assumed that resources can be held constant (a case of given level of factor use) or that they otherwise are left outside the analysis (in a case when variable factors can change). It must be pointed out that in fact only in the latter case do some product relationships manifest interest from the economic point of view.

Product transformation describe the trading possibilities between the concerned products of the forest land area in question. The degree of product transformation in a certain situation can be measured with the help of the *rate of product transformation* (RPT). It measures the number of units of product(s) which can be attained when the production of the one product is reduced by one unit. This is known as the marginal rate

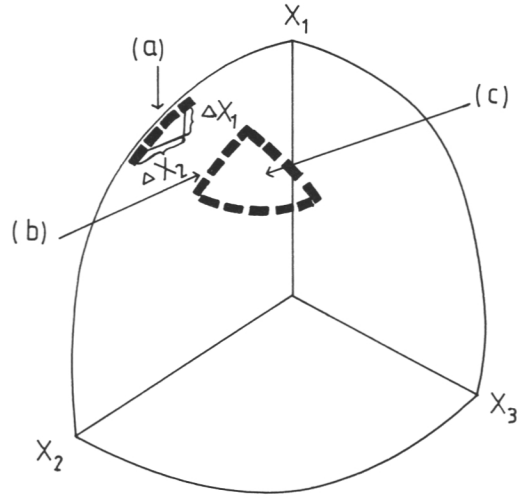

Figure 1. Rates of product transformation in the case of two products (a) and in the case of three products (b) and (c).

of product transformation. Sometimes one can also speak of average rate of product transformation.

In a case of two products (land uses) X_1 and X_2, the rate of product transformation is as follows (e.g. Naylor and Vernon 1969, p. 72):

$$X_1 = X(X_2)$$

$$RPT = \frac{\delta X_1}{\delta X_2} \qquad \text{(Fig. 1 a)}$$

If we take only one product more and have three products, X_1, X_2 and X_3, the product transformation gets more complicated. Here the analytical schema is presented for two cases.

First we can consider the rate of product transformation when the third product is assumed to have some fixed quantity X'_3.

$$\text{Then } X_1 = X(X_2, X'_3)$$

$$\text{and } \frac{\delta X_1}{\delta X_2} = \frac{\delta X_1(X_2, X'_3)}{\delta X_2} \qquad \text{(Fig. 1 b)}$$

Secondly, when both products, X_2 and X_3 are allowed to change, the rate of product transformation between X_1 and the two other products has following general form:

$$dX_1 = \frac{\delta X_1}{\delta X_2} dX_2 + \frac{\delta X_1}{\delta X_3} dX_3 \qquad \text{(Fig. 1 c)}$$

The above general cases of product transformation are illustrated in Figure 1. In fact the more common and more evident way to describe the varying cases of product transformation is to present them graphically.

There are many articles and reviews in which the main forms of product transformation curves showing different relationships between two products of forestry land are presented and analyzed (e.g. Duerr 1960, Lloyd 1969, Gregory 1972, Teeguarden 1979, Campbell 1981, Saastamoinen 1982). One of the most comprehensive contribution to product relationships, however, may be found in the field of agricultural production economics by Heady (1952), who lists the physical relationships in the following categories:

1. joint products in
   (a) fixed proportions, or
   (b) variable proportions;
2. competitive independent products with
   (a) constant, or
   (b) increasing rates of substitution;
3. complementary products;
4. supplementary products, and
5. antagonistic products.

The last category may be seen, as Heady points out, as a special form of competitive enterprises. In this case it naturally forms a third sub-class under general head of competitive independent products, namely those with decreasing rates of substitution (2(c)). In addition, antagonistic products may, with good reasons, also be seen as an extreme special case, corresponding to that of exclusive uses more familiar in multiple-use forestry.

Basic transformation relationships

There are some things which need to be considered before presenting the basic product relationships. The main point is the difference between a constant and varying resource use. Even though some product relationships may seem similar in graphical presentation in both cases, from an economic point of view they represent entirely different cases. Some attention may also be given to the fact that product transformation curves usually represent physical relationships between the products. These may sometimes differ from relationships which focus on the trade-offs between costs of production of the products. Further, the mutuality of relationships need some consideration. If some product relationship has a one-way character it may be more logical to think of it being presented in product-factor space (the other product serving as a factor) which excludes the mutuality. Finally, in the case when the purpose of the presentation is to hypothesize an empirical situation it is necessary to describe in detail the initial circumstances (for example: bare land planned to forest versus mature forest planned to clear-cut) and level of aggregation (for example: stand level, forest area level or regional level) in order to specify the position and slope of the relevant transformation curves.

In the following, the main product transformation relationships are presented once again following the above categories of Heady with some modifications. As earlier stated there are many graphical presentations of product transformation curves in two-product cases. Here it is tried further to specify some illustrations.

One of the extreme product-product situations is that of *joint products in fixed proportions* (Heady 1952, p. 203—204). They refer to commodities which, if they are to be produced at all, are forthcoming only in inflexible proportions. With given resources, there is no product transformation (Fig. 2 a). However, in the long run the fixed proportion between the products may remain constant (Fig. 2 b) or it may vary (Fig. 2 c) even if with given resources it is not possible to substitute between the products. Thus the last case is different from that what Heady (1952, p. 204, 216—217) calls joint products in variable proportions. Rather, it is another of the two cases of coupling described by Frisch (1965, p. 271).

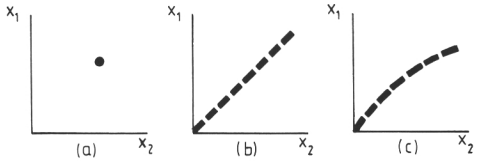

Figure 2. Joint products in fixed proportions with constant resources (a) and with varying resources with constant (b) and varying (c) fixed proportions.

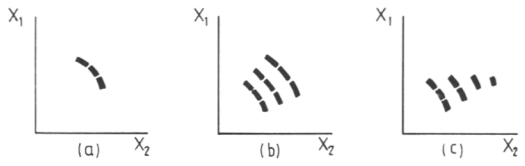

Figure 3. Joint products in variable proportions with given resources (a) and with varying resources when production level does not affect product substitution (b) and when it does affect (c).

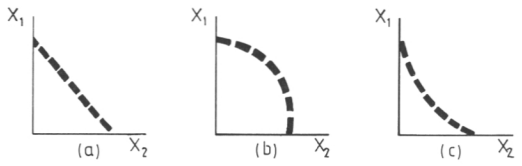

Figure 4. Competitive independent products with constant (a), increasing (b) and decreasing (c) rate of product transformation.

Heady (1952, p. 203) mentions that it is unlikely that any important products in agriculture are produced in fixed proportions. Also Gregory (1972, p. 256) states that forestry offers few examples of truly fixed proportions, although some forest areas are handled as if the proportions were unchangeable. According to him naval stores and sawtimber, or in some cases pulpwood and sawtimber, might occasionally be so considered, although in actual fact these proportions can be drastically altered. A possible example, at least in a very technical sense, is the coupling of forest landscape and forests as such: when we produce timber we at the same time also produce some kind of landscape.

The more common in forestry is the case of *joint products in variable proportions*. Frisch (1965, p. 271) calls this the case of separable products. The product transformation curve for a given level of resources indicates that there is some room for product substitution, even the products are results the same production process (Fig. 3 a). When the factor quantities are allowed to vary two alternatives occur: the change of production level does not affect the possibilities of product substitution (Fig. 3 b) or it does affect it. In the latter case, the most probable alternative is that when the production of one product is increased the possibilities for product substitution decrease (Fig. 3 c).

There are examples of separable products in forestry: timber and reindeer lichen on dry sites can be considered as such as well as timber and wildlife. Heady (1952, p. 204) states that even in agriculture joint products with latitude for substitution are a more important case.

The *competitive independent products* is the next category. The independence of products means that they can be produced separately. Products are competitive in the use of given resources if output of one can be increased only through a sacrifice in production of the other (Heady 1952, p. 204). This general case can be called assorted production (Frisch 1965, p. 10—11) or alternative processes (Dano 1966, p. 166—167).

Three subcases of competitive products are recognized on the basis of the rate of product transformation (substitution): one exhibiting *constant rate of product transformation* (Fig. 4 a), one exhibiting *increasing rate of product transformation* (Fig. 4 b) and one exhibiting *decreasing rate of product transformation* (Fig. 4 c). The cases 4 a—4 c refer to the situation where a given amount of resources is to be used. The constant rate of product transformation is due to linear production functions, where factor(s) can be used in production of either commodity (Heady 1952, p. 204). This case occurs in multiple-use forestry when, for example, a given and homogenous land area is the only factor concerned, and it is to be allocated between two uses, say recreation and timber.

An increasing rate of product transformation is no doubt the most common case met in economic literature. Increasing rates of substitution always hold true when the production function for each independent commodity is one of decreasing resource productivity (Heady 1952, p. 209). A second force which can give rise to increasing marginal rate of product substitution is non-homogeneity in quality of resources (Heady 1952, p. 215). In multiple use forestry this is very familiar situation: each site type has different qualities which usually are more suitable for some uses than for others.

The corollary of the above case, decreasing rate of product substitution, occurs when both products are produced under conditions of increasing returns. In agriculture these production situations are found especially in small farms where capital is extremely

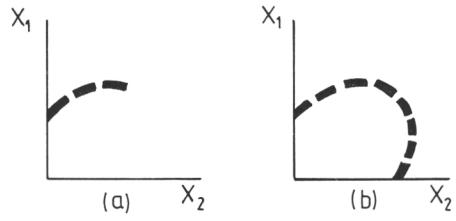

Figure 5. Complementary products with one way (a) and mutual (b) complementarity.

limited and production of any one commodity cannot be extended to a point beyond which increasing returns prevail. They also exist where production must take place on a mass-scale basis and the commodities are competitive (Heady 1952, p. 219). In multiple use forestry, cases of decreasing rate of product transformation are also met. In fact, according to Gregory (1972, p. 265) and Zivnuska (1978) they are even common. One may assume that in those land use patterns, where dominant or primary uses are prevailing, it may be due to decreasing rates of product transformation (Campbell 1981, p. 35). An example may be the relationship between wilderness oriented recreation and timber production (Saastamoinen 1982, p. 66). However, it must be pointed out that in this case the convexity of product transformation curve is more based on deductive reasoning than empirical results.

When the assumption of constant variable factors is removed, the basic forms of product transformation curves of competitive independent products are still applicable even if these cases represent quite different situations in the economical and practical sense.

Complementary products are defined in the following way (Heady 1952, p. 221): two products are technical complements when an increase in output of one, with resources held constant in amount, also results in an increase in output of the other (Fig. 5). Technical complementarity may arise because of any of the following reasons (Heady 1952, p. 222; Campbell 1981): by-product of one product is used as an input of another; one product may divert surplus resources from the second; the products may interact with each other as the proportions of non-usable joint products change with varying levels of output from a fixed technical unit. In the third case, at least, the fixity of variable factors must be relaxed.

The difference between complementary and joint products is that complementary products are produced in different processes but joint products are the result of the same process. Complementary products can be produced independently which is not possible for joint products. The difference between joint products and complementary products is seen in a form of product transformation curve. With given resources, the product transformation curve for complementary products is positively sloped (Fig. 5) but for joint products it is a point in product space (Fig. 2 a). On the other hand, the point of efficient production in the case of complementary products is the highest point of positively sloped curve. A complicating factor between complementary and joint products arises when the complementary relationship is determined by saying that an increase of one product's output also increases the other's output. This definition of product relationships is true for both complementary and joint products. However, it may be clearer to limit the use of the term "complementary relationship" to describe truly complementary products and not to use it for both cases as done by the present author (Saastamoinen 1982, p. 22—23).

For complementary products either the "one way" or the mutual nature of complementarity may have some importance. The latter case is outlined in Figure 5 b (Heady 1952, p. 222).

It is not difficult to find examples of complementary relationships in forest production. In fact, where primary forest production is concerned, many biological nutrition chains originating from forest vegetation may be said to have the characteristics of a "one way" complementary relationship: forests provide shelter and nutrition for many species of wildlife which use, for example, many by-products of tree. In addition, ground cover and brush vegetation uses those soil components and available space which are excessive for timber production. False morel *(Gyromitra esculenta)* grows best in places where there are bark residues or signs of ploughing. The shelter forest zones between agricultural lands increases agricultural production and produces more timber.

Two products are *supplementary* when, with resources constant, output of one pro-

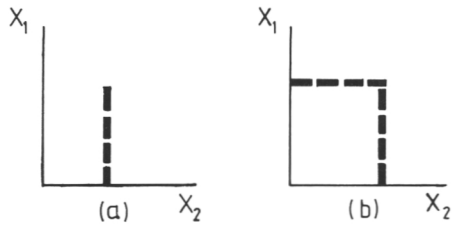

Figure 6. Supplementary products with one way (a) and mutual (b) supplementarity.

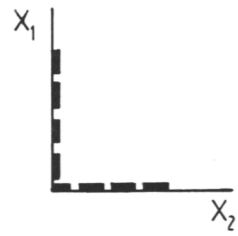

Figure 7. Antagonistic or exclusive products.

duct can be increased with neither a gain nor a sacrifice in another product. Supplementary conditions arise mainly out of time and are to be found especially where products can be produced only during a distinct and limited period of the year and the resources employed produce a flow of services over all time periods. In addition, supplementary products may be produced simultaneously whenever the flow services of resources are concerned, and one product does not completely exhaust these (Heady 1952, p. 231).

Supplementary relationships may be "one way" (Fig. 6 a) or mutual (Fig. 6 b). In the latter case the product transformation curve is in complete contrast to an exclusive relationship.

Supplementary relationships occur in multiple-use forestry when it is possible to alternate in time different uses of the same area without compromising. For example, some range areas are used by reindeer only in summer but for recreation only in winter. An example of simultaneous supplementary products may be reindeer and moose, which use the same area but utilize different species of forage.

The last category is an *exclusive* relationship between the products or forest uses. Heady (1952, p. 221) stated that while all competitive products are rivals in the use of resources, certain agricultural enterprises are antagonistic. Antagonism is expressed when the production function for two independent products changes as the two enterprises are produced in the presence of each other. Diseases may creep into turkeys when they are produced in conjunction with chickens and vice versa.

The product transformation curve for exclusive or antagonistic forest uses is an extreme case of that of competitive products with decreasing rate of product transformation (Fig. 7). In multiple-use forestry there may be only a few examples of truly antagonistic products. Near this category may be the production of decorative lichens and reindeer grazing, the former needing an area from which reindeer are excluded. In Finland the best area for producing decorative lichens is an island where reindeer cannot get to. Sometimes the character of an exclusive relationship may be due to the choice of the scope of view. A given area may be used either for timber production or as a national park but may not be divided between them because of the minimum size requirements of the latter.

Some further comments

Many authors have given due consideration to the point that product transformation curves between the two products may exhibit more than one relationships (e.g. Convery 1977, Teeguarden 1979, Campbell 1981). That is the case even when resources are held constant, for example, for complementary products, which also include a competitive range (e.g. Heady 1952, p. 224; Gregory 1972, p. 398). However, it seems that the existence of varying product relationship has its main relevance in those cases where the outputs of the products are allowed to change due to changes in the quantities of variable factors, i.e. assuming only land area as fixed. Many important problems in multiple-use forestry are concerned just the kind of situation, where in the fixed forest land area intensity of one forest use varies and where the main interest is the effect of it on other

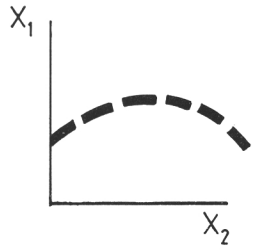

Figure 8. A product transformation curve including complementary and competitive relationships when resources are allowed to vary.

forest uses. This is, at least, a common case when the effects of the varying intensities of timber production to other uses are analyzed. What concerns the case of varying relationships, one may assume, for example, that the product transformation curve between timber (intensity of secondary production, measured e.g. by cutting removals) and forest berries (primary production, kilograms per hectare) could include both complementary and competitive relationships (Fig. 8).

Albeit it is easy to imagine and draw hypothetical product transformation curves, it is extremely difficult to construct empirical ones. The difficulties of constructing empirical product transformation curves is stressed by Campbell (1981) in his recent survey on both conceptual and empirical product transformation functions. The author's own experiences of constructing a three-product model between timber production, reindeer grazing and outdoor recreation only confirms the difficulties met in empirical research (Saastamoinen 1982). However, it also seems evident that the theoretical and conceptual framework supplied by the product transformation approach is important enough to justify and support the troublesome empirical research on production and transformation functions in the field of multiple-use forestry.

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PLANNING TOOLS FOR MULTIPLE-USE FORESTRY

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The paper presents some common planning tools which are used in Sweden to facilitate recreational land use within multiple-use forestry. The possibilities offered by the legislation on nature conservation and forestry are briefly outlined. Most of the paper describes the regular urban planning system and its usefulness in this connection. This is illustrated here by referring to the general planning process of 1980 for the Municipality of Lerum. School-classes' way of using the natural environment was investigated. The capacity for outdoor recreation in the urban fringe, as related to residential areas, was evaluated. Finally some conditions for multiple-use forestry in a specific area are discussed.

Key words: physical planning, multiple use, outdoor recreation, land use, urban planning

Introduction

Multiple-use is a concept that has been well known among foresters since the thirties. At that time the discussion of outdoor recreation and its benefits for human health became important. Outdoor recreation requires accessible land. In the USA as in most other countries outside Scandinavia private land is not accessible to the public. Publicly owned land became a necessity for outdoor recreation. The number of state parks in rural areas increased. Public ownership made it possible for the public to visit such areas. The use of land wasn't any longer just economic production but also recreation. The use of the land was multiple. Foresters managing those parks had to consider the accessibility to the forests, nature qualities and other preferences for recreation and also to make some profit of wood production.

When we discuss multiple-use in Scandinavia we have to remember the specific fact that the public may visit private forests as well as public-owned forests. That is why few forests have come into public ownership because of recreational needs. Consequently nature qualities and other non monetary values in these forest areas are dependent on private landowners and foresters.

Since landowners as well as all other enterprisers try to optimize their economy they tend to react as if recreational demands on their land is a burden. Therefore some tools are needed to facilitate recreational use of forests along with economic production.

Multiple-use means more than parallel use of land for economic production and recreation. In this article, however, I limit the discussion to these two land use interests.

Planning tools

I want to mention five different tools for this kind of multiple-use.

1. Nature reserve (§ 7 Nature Conservancy Act, NVL): an area which is protected because of its importance for knowledge about nature and the beauty of the country or because of its essential importance for outdoor recreation.
2. Nature conservation area (§ 19 NVL): an area in which special measures should be taken to protect or preserve the natural environment.

Both nature reserves and nature conservation areas are set up by the County Government Boards.

As planning-tools for multiple-use there is one important difference between these two. A nature reserve is the strongest instrument. Economic compensation for restrictions on forest production has to be paid.

A nature conservation area is the instrument to use when the interest is not strong enough for making a nature reserve. Measures to be taken for nature preservation should not cause obvious difficulties for existing land-uses. Economic compensation is not to be paid in connection with the establishment of a nature conservation area.

This last criterion is probably the reason why nature conservation areas haven't had any success as planning tools. Landowners are not positive to governmental restrictions on their land without economic compensation. Landowners are not negative to multiple-use, but prefer acting on their own as regards nature preservation.

3. The Forestry Act, especially its 21st §.

This law says that forestry should take the natural environment and outdoor recreation interests into consideration. These considerations should be decided through collaboration between the landowner and the County Forestry Board continuously during forest production. The considerations should not cause obvious difficulties for forestry. This seems to be similar to nature conservation areas. However, what makes it all easier is that the landowner and the representative from the County Forestry Board meet with boots on and decide upon measures to be taken.

For planning, this has a weak side too. The considerations refer to forestry activities only, such as limits to the size of clearcuts, regulation of transportation methods etc. It is not possible to use the Forestry Act to prescribe specific nature preservation measures. Another weakness as a planning tool is that the local physical planners who are responsible for the whole plan may have some difficulties in influencing the "boots-on-planning-process", and the considerations may not always be the most important in the local recreation planning perspective.

4. The general forest inventory (ÖSI).

Within the next fifteen years all private forest land will be inventoried. Based on that inventory, measures will be prescribed in order to increase the productivity of the forests where it is too low. Certain areas, for example forests of broadleaved trees, former meadows, and similar types of cultural landscapes will be endangered. To ensure some concerns about nature environment the inventory-staff will also be educated in nature preservation.

In this procedure local planners could influence the evaluating phase.

5. The regular urban planning system.

This is perhaps the most important tool for local planners when planning for multiple-use forestry/recreation. Indirectly, town planners decide which areas will be most frequently used for recreation and consequently in which areas multiple-use forestry will be needed.

The mainpart of outdoor recreation is located within or close to residential areas. In a master plan (Marköversikt) covering all the land of a municipality, planners can recommend that considerations should be taken to natural environment and outdoor recreation and also propose the instrument to realize the plan. It is clear, however, that a local authority doesn't control the instrument for realization, although they can influence the process.

Multiple-use in the Municipality of Lerum — an example

Background

A study has been carried out in connection with the general planning process in the municipality of Lerum, east of Gothenburg.

In this article I will refer to some parts of the study which discuss the demands on forest land from recreation interest groups, and discuss the location of areas where multiple-use forestry is needed.

The municipality consists of three small villages east of Gothenburg and some rural land, mainly forest, in between. The total need of new flats in Lerum is about 150 per year.

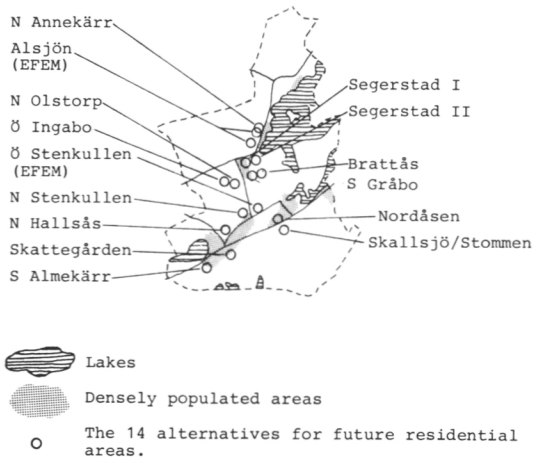


Figure 1. Lerum — an overview.

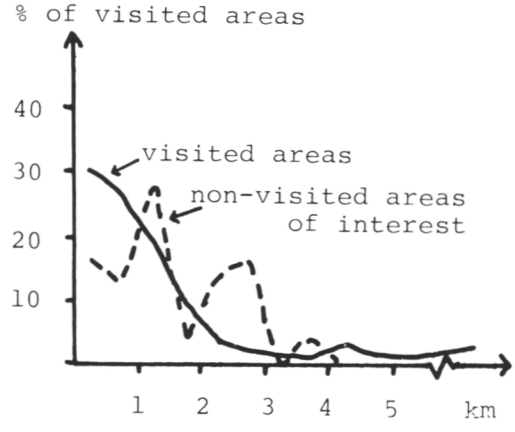


Figure 2. Visitation rate for recreation areas as a function of distance to the area.

The general planning situation was that fourteen alternative areas for residential use were given in a previous general planning phase (Fig. 1). The planning extends to 1995.

In the referred study, impact analyses were made from the perspective of agricultural interests, forestry and outdoor recreation.

Demands from schools

An important step in the study was to classify the demands of certain land-use interests. To illustrate how some demand for recreational use can be studied I will present results from a questionnaire to the school teachers. It should be noted that other recreational demands were studied too.

School teachers were asked to

1. Mark on a map which areas they visit with their school children.
2. Mark areas they would like to visit but don't.
3. Give reasons for visiting the marked areas.
4. Give reasons for not visiting areas they would like to visit.
5. Mark the location of the school.

The distance from school to the visited areas turned out to be a very important factor (Fig. 2). The average distance to the visited areas was 1.3 kilometers. The average distance to areas of interest but not visited was 2.2 kilometers.

To evaluate what qualities an area should have, one can study the reasons/motives for the visits (Table 1).

Table 1. Motives for visiting recreation areas.

Motive	per cent of answered inquiries (N = 60)
1. Physical training, for example jogging	88
2. Nature environment	75
3. Winter activities	53
4. Accessibility	50
5. Education	47
6. Water activities	30
7. Other facility establishment, outside the school-yard	25
8. Recreation (not specified)	15
9. Excursion (not speficied)	10

A more specified list is published in a report by Skärbäck (1982). The most frequently mentioned specific motives are: good accessibility of paths, orienteering, nature studies, jogging in forest and swimming.

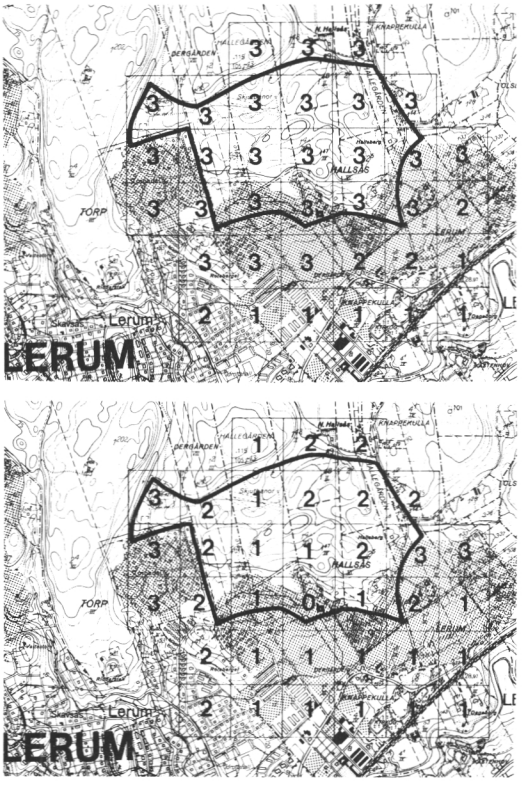
Each of the fourteen alternative areas for residential use were evaluated concerning conflicts to the mentioned land-use interests.

Impact analysis

Outdoor recreation is a complex land-use interest. It consists of different and sometimes conflicting recreational interests, as for example:

— people in existing residential areas who put demands on the land close to their homes for recreational purposes.

— people moving into new residential areas which were previously recreational land for existing inhabitants.



Capacity for outdoor recreation within a distance of 500 m from homes in each grid (250 m grid-net).

3	> 10 ha of class 3-4 highest quality
2	5-10 ha cl 3-4, or > 10 ha cl 2
1	< 5 ha cl 3-4, or < 10 ha cl 2
0	cl 2-4 are missing

Class 1 is agricultural land or other not accessible land.

Figure 3. Capacity for outdoor recreation in the urban fringe before (above) and after (below) building a new housing area. The case of N Hallsås.

The maps in Figure 3 show an example of how the accessibility to recreation areas gets worse when a new residential area (N Hallsås) is built.

Conditions of multiple-use forestry

Planning for facilitating multiple-use is significant in two phases of the planning.

The first is the choice of areas to build upon. One way to avoid conflicts is to choose areas which don't cause deterioration in the capacity for recreation of closely situated residential areas.

The second step when multiple-use can be considered is when planning a specific area. The alternative residential area (N Hallsås) in the example above can illustrate the discussion. Forests cover almost 100 % of the total area. Most of the forest is old and will be cut down rather soon. A lot of paths for jogging and hiking go through the area.

Most parts of the land are owned by the municipality. The area borders on other forests, in some of which the trees were cut down a few years ago.

Some parts of the area haven't as good conditions for forestry as others, especially bedrock areas with thin soils and some very steep slopes. It can be recommended that specific considerations will be made there based on the Forestry Act. The trees in these parts



Figure 4. Urban fringe forests are much used by youth groups. (Photo: Sven-G. Hultman)

should be cut down successively during a long time. The reason is partly to reduce the risk for erosion and partly to keep the landscape qualities acceptable for recreational purposes during the regeneration of the forests and during the process of building the first parts of the housing area.

A further aim is to make sure that recreation qualities will be maintained in the center of the area where the mentioned characteristics exist. The study referred to above, shows that capacity for outdoor recreation in the urban fringe will be reduced mostly for homes in that part of the area.

In this article I have tried to show that recreational demands on forest land can be defined in a general planning process of a municipality. The reason for doing this is to point out areas where multiple-use forestry will be needed, and further to describe which recreational needs can be satisfied in those areas, and to improve the choice of planning-tools for multiple-use forestry.

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URHO KEKKONEN NATIONAL PARK: A CASE REPORT

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ODC 907.11+627

The article gives an account of planning and practical work in Urho Kekkonen National Park North-Eastern Finland. It also gives an example of planned management policy in a large wilderness national park. Though a part of the planning and practical measures described in the article may be applied to national park work in general, the rest must be taken as an account of developing a park with strong special features.

Key words: national park, wilderness management

Introduction

Urho Kekkonen National Park was officially established in 1983. It is the 22nd national park and with its 253 000 hectares the second largest one in Finland. The park is situated in the north-eastern part of the country between Highway 4 and the Soviet border (Fig. 1). It is one of the largest remaining wilderness areas in Western Europe and has thus got a considerable conservational value.

The landscape of the park is very varied consisting of vast coniferous forests, open peatland areas, river valleys and alpine tundra. Considering the northern situation of the park its flora and fauna are comparatively rich; the park lies in the interchanging area of different vegetation and faunal zones. Park fauna includes all four big carnivores: brown bear *(Ursus arctos)*, wolf *(Canis lupus)*, wolverine *(Gulo gulo)* and occasionally lynx *(Felis lynx)*. The national park forms an important habitat conservation area for many endangered species such as peregrine falcon *(Falco peregrinus)*, golden eagle *(Aquila chrysaëtos)*, otter *(Lutra lutra)* and river pearl mussel *(Margaritana margaritifera)*.

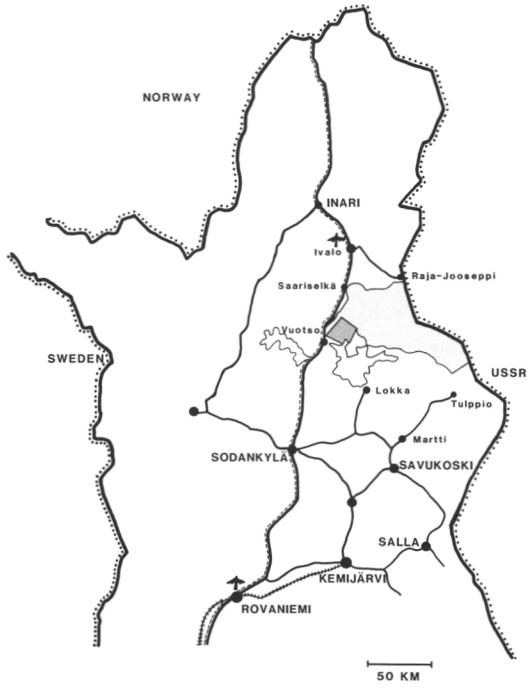

Figure 1. The location of Urho Kekkonen National Park.

The vegetation is mostly rather barren because of the poor siliceous bedrock; the more luxuriant species grow mainly along riversides.

The most important present or past uses of the park area appear to be forestry, reindeer husbandry, recreation, hunting, fishing, berry picking, mushroom collecting and gold prospecting. These different and partly conflicting uses have made the park planning a difficult and complicated task. — In the last twenty years there were several attempts to establish a national park in this region, but they all came to a dead end because of the high economical value of the area's forest resources. The establishment of the park became possible after the three local communes were promised full compensation for the losses caused by the park. Thus they are compensated for the lost employment opportunities and the amount of forest taxes they lose when forests are taken into conservational use. According to calculations the national park will cause permanently the loss of 63 forest workers' jobs. The compensation system is quite new in Finland and so far it has been realized only in this park.

Planning and administration

Following the Government decision on the 2nd of September 1980 the Ministry of Agriculture and Forestry appointed in November 1980 a planning committee to prepare propositions for the administration and financing of the park as well as for the master plan and park regulations. The committee had representatives from the Ministry of Agriculture and Forestry, The Ministry of Finances, The National Board of Forestry, the Provincial Government of Lapland, the League for the Conservation of Nature and Natural Resources, local communes and reindeer herders' cooperatives. It is not a normal procedure in Finland to have national park planning done by a committee; this time it was employed because of the importance and special features of Urho Kekkonen National Park. The committee gave its final report in April 1982 (Urho Kekkosen . . . 1982).

The park belongs to and is administrated by the National Board of Forestry. Formerly the area has belonged to three different State forest districts and partly to the Finnish Forest Research Institute. From September the 1st, 1983, the park area has been a part of the Sodankylä Forest District. As the park administration would unduly have increased the work burden of the District Forest Officer, all the duties concerning the park have been transferred to the Chief of the Lapland Forest Region, who has the Director of Urho Kekkonen National Park as his assistant in this work. Besides the Director, the park has personnel for interpretation, guarding, maintenance and administration. The personnel will be gradually increased; according to the plan the park should by 1991 give permanent employment to 25 persons; that is also a part of the compensations to the communes. The park administration will be helped in its work by an advisory committee which will have representatives from different local and administrative interest groups. The committee will give advice for the development of the park and oversee the realization of the master plan.

The master plan and the park regulations

The proposed master plan is divided into two parts. The first part is a summary of facts on which the proposals are based. It does not contain unnecessary or cumbersome details, the information falling mainly under following headings: description of the region; public uses of the park; past activities and management.

The second part is a general management plan in which the basis of the proposals is formed by a statement of the park's purpose and management objectives. It also includes: (1) resource management proposals with long term ecological management plans, land use classifications and relations to reindeer herding, fishing, hunting, collecting and fire control; (2) visitor use proposals including zonation, facilities required for accommodation, trails, interpretation etc.; (3) preliminary interpretation programme; (4) staff and labour; (5) equipment and tools. The plan is illustrated by a series of maps.

Urho Kekkonen National Park has been established for the conservation of natural

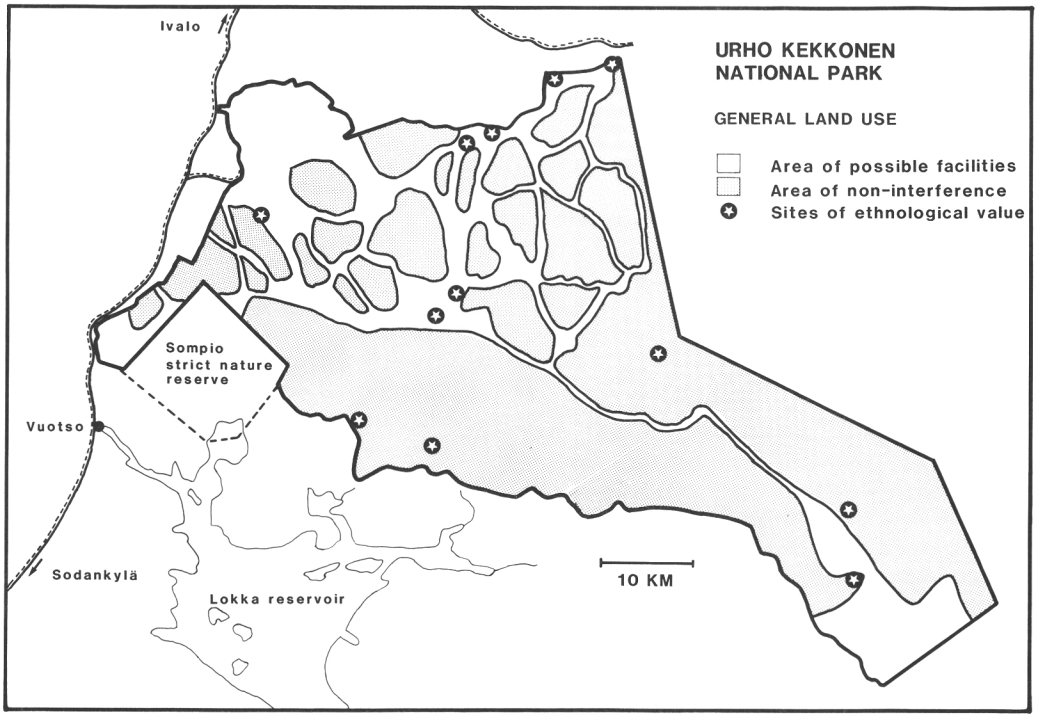

Figure 2. The general land use plan of Urho Kekkonen National Park.

environment. Its purpose is to preserve for all time wilderness, scenic beauty, native wildlife, indigenous plant life and areas of scientific importance. At the same time the park is open for the appreciation and enjoyment of above-mentioned things by the public in such ways and by such means as will leave them for future generations impaired as little as possible. Special attention is paid to preserve reindeer herding as a way of living and a source of income in the park area.

Resource management proposals in the national park include two different land use classifications. The most important one from the conservational point of view is the long term land use plan in which the park is divided into two categories (Fig. 2): areas of non-interference to be maintained in their natural state with no trails, huts or other facilities provided; areas with possible facilities for the park visitors with a minimum of disturbance of the natural environment. The second classification deals with more detailed management objectives. The broad categories of this classification are:

1. Areas in their natural state. These form the major part of the park.
2. Special management areas, where the natural state has been tampered with by people. If necessary, these may be returned into their original state.
3. Sites and areas of ethnological and historical value. These will be either preserved in their present state and use or restored.
4. Special conservation areas.
5. Facilities areas.

The facilities areas will be either outside or in the park. They may include:

— information centres (3)
— information cottages (2)
— information boards
— the park office and houses for the personnel
— nature trails
— hiking trails with campsites and fireplaces
— wilderness cabins
— ranger huts
— other structures necessary for the visitors and the park administration

The park regulations are meant to control the park users' behaviour. Beside the general behavioral rules the focal point of the

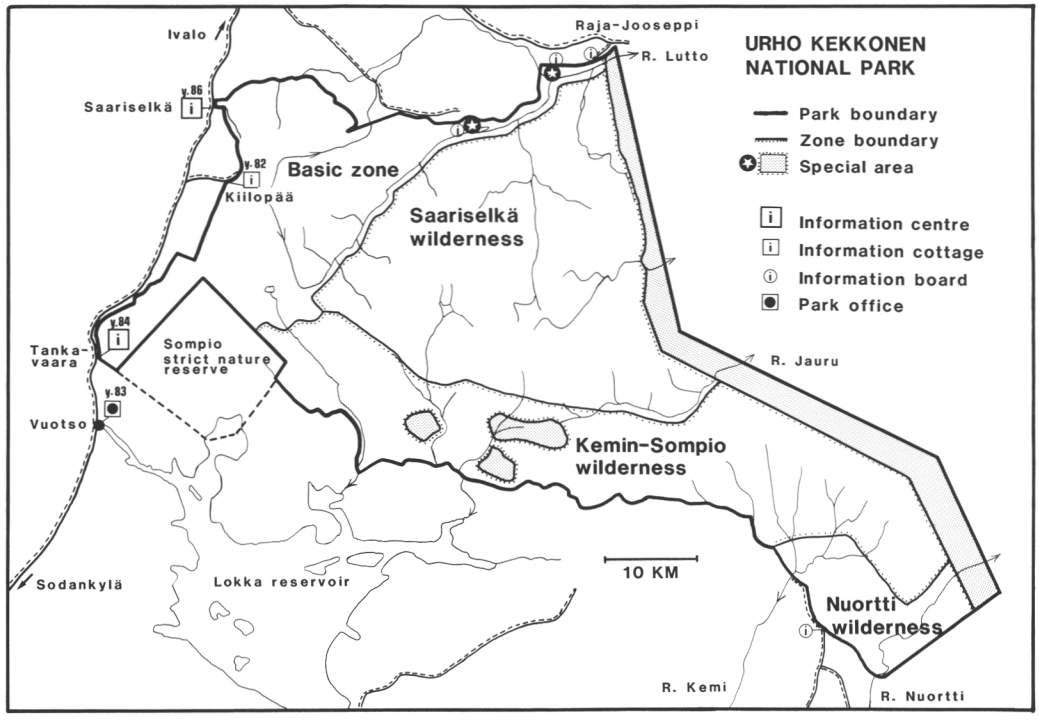

Figure 3. The visitor use plan of Urho Kekkonen National Park.

regulations is the zonation, which is intended to control the hiking, camping and firemaking in the park area (Fig. 3). The zonation is based on present use concentrations and conservational aspects. In *Basic Zone,* the area nearest Highway 4 and tourist centres and so in the most intensive use, the route selection is not restricted, but camping and firemaking are allowed only on indicated sites where fuelwood is also provided by the national park administration. In *Saariselkä and Nuortti Wilderness Areas* route selecting and camping are free, but firemaking is allowed only on indicated sites which are situated along recommended routes. In *Kemin-Sompio Wilderness Area* even the firemaking is free when the external conditions allow it (no drought, strong wind or other danger of forest fire). In addition to the major zones there are the special conservation areas where movement is forbidden either during a certain time of the year (bird sanctuaries) or outside the paths (a few ethnological sites). In the State frontier zone, movement is allowed only with special permission. The park administration can create temporary special conservation areas, if that is judged necessary.

The traditional wilderness use rights have been secured for the local inhabitants in the park. Thus they may graze their reindeer there and they have special hunting and fishing rights, too. When so occupied they can make fire and camp freely in the park area, with a few exceptions.

The planning committee suggested a visitor fee to cover at least partially the service and maintenance expenses of the park. The Act on Nature Conservation enables that an entrance fee to be collected from National Park visitors. The proposed park regulations mention such a fee stating that visits to information centres and nature trails should be free of charge, however. This step should be taken with caution, though, as at the moment all Finnish national parks have a free entrance, and a fee in this park would so be a precedent.

Present and future activities in the park management

In practice the park activities started at the beginning of 1982. In the State budget the park was granted funds for its management. At the beginning the park office was at Sodankylä Forest District Office with the District Forest Officer acting as the Park Director. In 1982 the amount of work done in the park was approximately 10 man-years. One of the main tasks was the basic inventory work. The subjects included botany, zoology, ornithology, geology, cultural history and ethnology. Most of this work was done in the areas where the first nature trails are being established. The inventories were carried on in 1983. At the moment the park personnel includes 8 permanent and 8+12 temporary employees. Some other important tasks so far have been establishing and adjusting a new unit into the State Forest system, acquiring equipment and improving the facilities. Almost all the wilderness cabins have been repaired and provided with woodsheds; the planning and building of fireplaces and campsites has been started.

When starting a new national park one of the tasks is to give the public information about the park and in some extent also to effect a gradual introduction of the new rules. This has proved to be all the more important, as most people seem to have at best vague and at worst completely erroneous ideas about national parks and their use. The most common misconception is to confuse them with strict nature reserves. Because of the limited amount of time and staff available the information has up to now been mostly directed at key groups (tourist enterprises, hiking and skiing organizations, training courses etc.) to gain a wider audience through them. The interpretation programme of the park has begun with collection of the raw material.

At the moment there are two park information cottages being prepared. The designs for the first information centre have been approved and its construction has begun. The building should be finished by the end of September 1984. The designs for the park office have also been made and the building should be ready in 1985. From September 1983 to 1985 the park has a temporary office in Vuotso.

Because of its — in Finnish conditions — rather extensive touristic use Urho Kekkonen National Park needs very careful and continuous planning and management. An acceptable compromise between the various interests might best be attained through information, interpretation and a judicious selection of recommended routes. If all the different uses coexist in the not too distant future in even comparatively good harmony the park has fulfilled its object.

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MULTIPLE-USE PLANNING IN THE FINNISH SCHOOL FORESTS

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ODC 916+627+(480)+945.3

This paper presents an example of multiple-use planning in commercial forests. The basic forestry plan in the Finnish school forests is called the multiple-use plan. In addition to the normal stand data the relative suitability for special uses must be determined for every stand. The areas with high values for many uses are defined as multiple-use areas. Special consideration is given to these areas when adjusting various uses. The procedure is divided into two phases: the location of cutting areas and the cutting planning. Thus the objectives of multiple-use forestry will be taken into consideration.

Key words: Multiple use, forest planning, school forests

Multiple-use planning in commercial forests

The principle of multiple-use has been accepted in the 1970's more clearly than before as one of the basic principles of forestry. We can find two examples of progress: first, through land-use planning great areas of commercial forest have been set aside as protected areas and second, instructions have been given to appreciate multiple-use forestry in commercial forests. The difficult problem of allocation of forest land has aroused such a lot of discussion that questions concerning multiple-use in the commercial forests have been somewhat neglected. The present instructions for state forests (National Board of Forestry 1970) and private forests (Central Forest Board 1980) are good guidelines in principle but we lack the procedure to take account of the principles of these instructions in planning practical forestry as well as in everyday decision making. How the position of multiple use will be taken into consideration still depends too much on the attitudes and knowledge of the forester, who is the decision maker. The objective must be to develop the planning system so that multiple-use has its place beside silviculture and logging regardless of the individual opinions of the planner.

The Finnish school forests

The Finnish forestry schools have had their own forests for over 100 years. The importance of school forests is great in modern forestry education. From 1973 forestry education has been administered by The National Board of Vocational Education. Since that year most forestry schools have had their own forests, about 1 000 ha each. In total there are nearly 30 000 hectares of school forests. In addition to their own forests the schools have made contracts with other forest owners, primarily The National Board of Forestry.

The main goal of school forests is to serve forestry education by providing premises for achieving educational objectives. In these forests many kinds of experimental plots for visualizing correlations in long-range forestry are organized. Forestry in school forests should give a pattern for multiple-use forestry. Therefore the basic forestry plan is not called a forest management plan, rather a multiple-use plan. There are various multiple-use plans. The multiple-use plan for the Hirvas school forest is presented in what follows.

The multiple-use plan of the Hirvas school forest

Background

The forest of four forestry schools is located 17 km south-west of Rovaniemi town. The total area is about 4 000 ha. It is a forest environment very typical for southern Lapland. The location and other circumstances make effective timber production possible. Artificial regeneration has been practised in large areas since 1906. On the other hand, many other uses are relevant in this forest: hunting, outdoor recreation, reindeer grazing and many special needs of forestry education. Thus we can think that this forest is a suitable experimental area for multiple-use forestry in commercial forests. The objective of multiple-use planning is to develop a procedure for taking the multiple-use principle into account in the decision-making of practical forestry operations.

Inventory of basic data

The forest management part of the multiple-use plan was done with the normal ADP-method of The Central Forestry Board, Tapio. In addition to the normal stand data it is possible in this method to determine the so-called possibility for special use, e.g., landscape forest, recreation forest. In addition to the Tapio method a form on every stand was filled in and the relative suitability of the stand for different uses was estimated, e.g., outdoor recreation: excellent, good, satisfactory and unsuitable. Because the inventory was made by students there were many persons involved in this work, and it was proved that data collected by this method were not entirely useful for further work. Most of the data concerning other uses were finally collected by questionnaire. Maps were given to teachers of forestry schools, members of the hunting association, a representative of the reindeer herding co-operative, and some other people living near the forest. They were asked to draw on the map the areas which have a relatively great significance for some particular use. Based on the information collected in this way and on planners' consideration, reports and maps were made of the following special use possibilities: game management, reindeer grazing, fishery, berries and mushrooms, landscape management, outdoor recreation, nature protection, education and research, gravel digging.

Adjustment of various uses

To make an adjustment of various uses possible we should know the relationships between different forest products and uses. In forestry practice we cannot make many special investigations for solving these theoretically difficult problems (e.g. Saastamoinen 1982). We must base our decisions on general results obtained through research and information collected along with normal forest inventory. The aim of the following procedure is to make the multiple-use perspectives equal with logging and silvicultural perspectives in short-term (1—5 year-) planning in forestry practice. During the last decade many organizations have developed new short-term planning models and it is thus relevant to think how multiple-use can be taken into account in these practical plans.

The adjustment of various uses is realized on two levels:

1. *Location of cutting areas* (or various silvicultural treatments)
   Level of planning: Forest areas → cutting areas. Which areas will be cut and which will be left this time?
2. *Cutting planning*
   What kinds of cuttings will be used in the stands? There are two levels here, too:
   a) One cutting area → stands
      Decision making on the stand level.
   b) Stands → details
      Instructions for details, smaller than stands.

Location of cutting areas

In location planning it will be decided how the premises of various uses can be developed in future. Location planning is done 2—4 years before felling. In every decision one must consider the impact of the decisions made before. In decision-making we have information from two sources:

a) *The objectives of logging and silviculture and order of operations*
This information is taken from the forestry management plan.
b) *The multiple-use objectives*
Information is taken from reports and maps of special uses by studying one map upon the other (Mc Harg 1970). Although there are no areas of very high value for some special use in this forest, we can see in the maps that some areas have greater relative value for a certain use than other areas. Those areas where high relative values of many uses are concentrated are called *multiple-use areas*. Some of these areas are old nearly natural forests and some are highly productive managed pine forests with some birch. When operations are planned within multiple-use areas one must consider possible consequences for special uses which have high relative values in the area. Multiple-use areas are not protected areas but they help us to make decisions with the consequences on other uses in mind (Fig. 1).

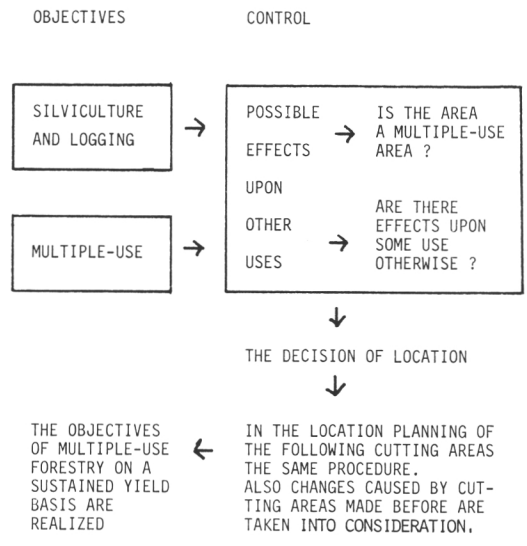

Figure 1. Location planning of cutting areas.

Cutting planning

In cutting planning, decisions on cutting method are made for every stand. When doing this work the planner must fill in a special form, which is enclosed with documents of the cutting area. This form gives more information on multiple-use for further, more detailed planning of logging operations. On the form the planner must report the following:

1. *Multiple-use areas*
   a) Are there multiple-use areas near the cutting area? Multiple-use areas are near if one can foresee some effects through cutting.
   b) Preparations for avoiding negative effects
   Here it is reported how the principle instructions for multiple-use are realized in this case.

2. *Stands which are left uncut or treated with special cutting*
   This point must be filled in whether there are multiple-use areas or not. Here instructions are given for riversides, roadsides, game management areas and other special objects.

3. *Instructions concerning details smaller than one stand*
   Instructions for logging work on how to operate with details which cannot be marked separately. Details are important for preserving the diversity of the ecosystem.
4. *The objects, which need to be put in order*
   Digging areas, wastes in forest e.g. instructions on what must be done.

Discussion

In the forestry practice in commercial forests there are possibilities for realizing multiple-use forestry without great losses in timber production or logging costs. Very often there is flexibility in cutting planning, i.e., which stands will be cut and when. We have not used the possibilities of forest management plans for multiple-use forestry fully enough. When forestry is practised on a sustained yield basis and the proportion of old or lowproduction stands in high in some forest area, it takes a very long time to regenerate all these stands. For multiple-use the result depends a lot on the order in which the stands will be regenerated and which methods will be used. In northern Finland this situation is of current interest.

For organizing forestry operations in the right way we need information on different uses. We should know which uses are possible in the area and what kind of forest is needed for various uses. Special inventories are seldom possible, but we can get useful knowledge through normal stand data knowing how different stands are suited for various uses: scenic preferences (Savolainen and Kellomäki 1981), recreation value (Saastamoinen 1982), reindeer winter ranges



Figure 2. Seed-tree method is used to regenerate pine forests on dry sites. (Photo: Olli Saastamoinen)

(Mattila 1979). The development class of a stand seems to be a useful tool in this connection. Most studies give information on stand level but in addition answers are needed to the more complex questions involving large forest areas. We should know how to operate in forestry on a sustained yield basis not only in forestry in general but also when multiple-use viewpoints are involved.

Although there are not enough results of research today in many cases we do get limited information on a certain forest area. Foresters and other people living there usually know a lot of the various uses possible in the area. Information must only be collected, systematized and combined in forestry planning. The minimum requirement is to take the information available into use. The multiple-use plans of school forests are an effort in this direction.

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RESOLUTION

The participants of the First Scandinavian Symposium on "Research on Multiple-Use Forestry" (September 13—17, 1982, Rovaniemi and Saariselkä, Finland) have discussed and found many common Scandinavian aspects of Multiple-Use Forestry, which would make further Scandinavian collaboration useful. Therefore the participants have *jointly* agreed upon the following *recommendations:*

1. Forestry and forest areas may produce many goods and services: wood, recreation, game, berries and mushrooms, nature conservation, grazing, protection, Christmas trees and decoration greenery, water supply, cultural values etc.

2. The importance of the different goods and services changes over time and from place to place.

3. However, for many of the goods and services forest areas produce we cannot, with the present state of our knowledge, express the value they have in monetary terms or in any other uniform unit. For some goods and services we have difficulties even in finding a unit of measurement.

4. This makes it difficult to decide which combination of goods and services forestry shall produce at a given place and time in order to optimize the output.

5. Therefore it is important that more work aiming at identifying and indicating the importance of the different functions of forestry be carried out.

6. Methods for product combination must be further developed and tested in the field. Decision models for choosing the "best" combination of products should be analyzed and refined.

7. To ensure both the multi-disciplinarity and the practical implementation of the work, collaboration between researchers covering the different functions of forestry, economists, planners, administrators, managers and organizations must take place.

September 16, 1982

SELOSTE

METSIEN MONINAISKÄYTTÖ POHJOISMAISSA
Rovaniemellä ja Saariselällä 13.—17. 9. 1982 pidetyn pohjoismaisen symposiumin esitelmät

Ensimmäinen yhteispohjoismainen metsien moninaiskäyttöä käsittelevä symposium pidettiin 13.—17. 9. 1982 Rovaniemellä ja Saariselällä. Kokoomajulkaisu sisältää 22 symposiumissa pidettyä esitelmää sekä toimittajien kirjoittaman johdantoluvun.

"Metsien moninaiskäyttö Pohjoismaissa: johdanto" on toimittajien (O. Saastamoinen, S-G. Hultman, N. Elers Koch ja L. Mattsson) laatima yleisesittely symposiumin aihepiiriin. Siinä tuodaan esille varsinkin ei-skandinaaviselle lukijalle tarpeellisia tietoja moninaiskäytön edellytyksistä Pohjoismaissa tähdentäen erityisesti jokamiehen oikeuksien merkitystä. Samalla valotetaan moninaiskäyttöä koskevassa lainsäädännössä olevia eroja Pohjoismaiden välillä. Pääosa johdannosta koostuu esitelmien lyhyestä esittelystä ja paikoin aihepiirien kommentoinnista yleisempää pohjoismaista taustaa vasten. Lopuksi viitataan niihin aiheisiin, jotka tulivat symposiumissa puutteellisesti esille ja pohditaan lyhyesti moninaiskäytön ja sen tutkimuksen asemaa tulevaisuudessa.

E. Stridsbergin artikkeli "Metsien moninaiskäyttö menneinä aikoina" antaa historiallista perspektiiviä moninaiskäytön nykyisille ongelmille. Artikkelissa esitellään metsien käyttömuotoja entisajan maatalousvaltaisessa Ruotsissa ja todetaan, että eri käyttömuotojen väliset ongelmat eivät olleet tuntemattomia viime vuosisadallakaan.

"Moninaiskäyttö Ruotsin metsäpolitiikassa", kirjoittajina B. Falk ja A. Mörtnäs, kertoo miten moninaiskäytön periaate on tuotu Ruotsin metsälainsäädäntöön ja millaisin toimin ja ohjein sitä ollaan soveltamassa erityisesti yksityismetsätaloudessa.

Artikkelissaan "Metsien moninaiskäyttö valtion metsätaloudessa" E. Hedén esittelee Ruotsin valtion metsien organisaation (Domänverket) toimintaa ja näkökulmia moninaiskäytön kysymyksiin. Varsin keskeisessä asemassa on metsien maankäytöllinen luokittelu, jossa muilla kuin puuntuotannon intresseillä on oma vaihteleva painonsa.

Kriittisluontoinen näkökulma metsien moninaiskäytön asemaan Ruotsissa avautuu S-G. Hultmanin artikkelissa "Moninaiskäyttömetsätalous Ruotsissa: määrittelemätön — ja onko sitä olemassa?". Kirjoittaja vertailee moninaiskäyttöä USA:ssa ja Ruotsissa ja toteaa, että Ruotsissa käsite on jäänyt määrittelemättä ja sitä on varsin puutteellisesti sovellettu käytäntöön. Kasvava paine muiden käyttömuotojen kuin puuntuotannon puolelta tullee kuitenkin ajan myötä muuttamaan tilanteen kirjoittajan mielestä.

N. Elers Kochin "Metsien moninaiskäyttö: tanskalainen tilasto" esittelee tilastoaineiston avulla Tanskan metsien tärkeimmät käyttömuodot: puuntuotannon, ulkoilukäytön, metsästyksen, suojametsät, luonnonsuojelun, laiduntamisen, joulukuusien ja koristekasvien tuottamisen, vesivarojen hoidon sekä metsien merkityksen työllisyyden ylläpitämiseen. Kunkin käyttömuodon kohdalla metsäala on jaettu kolmeen suhteellista merkitystä osoittavaan luokkaan saatavilla olevan tiedon perusteella.

T. Opheimin artikkelissa "Huomioita Oslomarkasta" kerrotaan Oslon lähellä sijaitsevan laajan Oslomarka-alueen maankäytöllisistä ongelmista, jotka Norjassa osaltaan ovat johtaneet jopa lainsäädännöllisiin uudistuksiin. Ongelmien käytännöllisessä ratkaisussa tärkeä sijansa on ollut parantaa eri käyttäjäryhmien mahdollisuuksia esittää käsityksiään aluetta koskevista suunnitelmista.

Tanskassa tehdyn koko maan kattavan metsien virkistyskäytön inventoinnin tuloksia esittelee N. Elers Kochin "Projekti 'Metsä ja ihmiset': yhteenveto". Artikkelissa verrataan myös tanskalaisia tuloksia muissa Pohjoismaissa saatuihin.

J. Bjerregaard Christensenin "Virkistyskäytön ekonomia: tuloksia tanskalaisesta tutkimuksesta" käyttää edellä mainitun tutkimuksen tietoja ulkoilumetsien taloudellisen arvon määrityksessä. Ns. kuluttajan ylijäämä lasketaan Clawsonin menetelmää soveltaen ja empiirisiä tuloksia esitellään yhdeltä kansallisen ja yhdeltä alueellisen tason metsäalueelta.

"Kaupunkimetsien ulkoilukäyttö Rovaniemellä" on T. Sieväsen artikkeli, jossa esitellään rovaniemeläisten ulkoiluaktiivisuutta, ulkoilukertojen lukumäärää eri alueilla ja ulkoiluharrastuksen ajallista vaihtelua.

Saman kirjoittajan toisessa artikkelissa "Kaupunkimetsien ulkoilukäytön inventointimenetel-

mien vertailu" tarkastellaan maastohavainnoinnin, maastohaastattelun ja postikyselyn soveltuvuutta ulkoilukäytön tutkimiseen. Johtopäätös on se, että samassa tutkimuksessa on syytä käyttää useita menetelmiä yhtäaikaa.

"Metsän maisemallinen arvo maastossa ja laboratoriossa mitattuna" on R. Savolaisen ja S. Kellomäen artikkeli, jossa empiirisen tutkimuksen perusteella todetaan valokuvien käyttömahdollisuudet maisema-arvostusten tutkimuksessa hyviksi. Koeryhminä olivat metsäylioppilaat ja ulkoilijat.

A. Reunalan artikkeli "Metsä symbolisena ympäristönä" tuo ympäristöpsykologisen näkökulman metsien käsittelyä koskevaan keskusteluun. Kirjoittaja arvioi, että metsän symbolisten arvojen tunnistaminen auttaa välttämään aineellisten ja aineettomien arvojen ristiriidan kärjistymistä metsätaloudessa.

J. Kortesharjun artikkelissa "Havaintoja hillasadoista Suomessa" esitetään ensimmäistä kertaa maassamme pitkiltä (5—11 vuoden) havaintojaksoilta hillan keskisatoja seitsemältä koealalta Keski- ja Pohjois-Suomessa. Aikaisempiin tutkimustuloksiin verrattuna havaintoalueiden pitkäaikaiset keskisadot ovat olleet varsin alhaisia. Lisätutkimusten tarve alueellisen ja suotyypittäisen kattavuuden parantamiseksi on kirjoittajan mielestä edelleen suuri.

"Metsätalous ja poronhoito Ruotsissa: aspekteja päällekkäisen maankäytön kehittymisestä" on L. Mattssonin artikkeli, jossa metsätalouden vaikutuksia porojen laitumiin tarkastellaan pitemmän ajan kehityksen valossa. Metsiköiden kehityksen dynamiikasta aiheutuu, että lähimenneisyydessä poronhoidolle ongelmia aiheuttaneet alueet tulevat vähitellen kehittymään laitumina parempaan suuntaan.

"Kulotus ja poronhoito" on aiheena T. Helteen ja J. Aspin artikkelissa. Siinä tarkastellaan kulotusta poronhoidon näkökulmasta ja arvioidaan, että se ainakin tuoreilla kasvupaikoilla on aurausta parempi menetelmä.

E. Mattilan artikkelissa "Porojen talvilaidunten inventointimenetelmä Suomessa" esitellään valtakunnan metsien inventointiin kytketyn laidunarvioinnin menetelmää ja tuloksia. Ensimmäinen objektiivinen ja systemaattinen laidunarviointi vahvisti käsityksiä jäkälikköjen kuluneisuudesta. Talvilaitumet arvioidaan toistamiseen valtakunnan metsien inventoinnin yhteydessä v. 1985 mennessä.

T. Johanssonin artikkelissa "Lampaiden laiduntaminen metsänuudistusaloilla" selostetaan Ruotsissa tehtyjä kokeita lampaiden käyttämisestä vesakoiden torjuntaan. Vaihtoehtona muille menetelmille se tullee kysymykseen ensisijaisesti taajama-alueiden läheisyydessä ja maisemanhoitoalueilla.

"Ihmisten aiheuttamat häiriöt metsäkauriille ja saksanhirvelle: ennakkotuloksia" on J. Lund Jeppesenin artikkeli, joka käsittelee suunnistuksen ja metsästyksen eläimistölle tuottamia haittoja. Kysymys on Tanskassa varsin ajankohtainen erityisesti suunnistusharrastuksen lisääntymisen myötä. Tutkimuksella yritetään mm. selvittää mihin vuodenaikaan häiriöalttius on vähäisin.

O. Saastamoisen artikkeli "Tuotetransformaatio moninaiskäyttömetsätaloudessa" käsittelee metsien eri käyttömuotojen keskinäissuhteiden jäsentelyä tuotantoteorian näkökulmasta. Esitettyä keskinäissuhteiden luokittelua havainnollistetaan graafisesti ja käytännön esimerkkien avulla.

E. Skärbäckin artikkeli "Suunnittelun keinot metsien moninaiskäytössä" erittelee Ruotsissa käytettävissä olevia mahdollisuuksia toteuttaa metsien ulkoilukäyttöä. Konkreettinen esimerkki liittyy taajaman lähellä olevan metsäalueen käytön suunnitteluun.

"Urho Kekkosen kansallispuiston suunnittelu" on A. Finnen ja P. Ovaskaisen artikkelin aihe. Kirjoittajat esittelevät Suomen nykyhetken edustavimman luonnonsuojelualueen suunnittelun vaiheita ja tavoitteita sekä suunnitteluratkaisuja.

P. Veijolan artikkelissa "Metsien moninaiskäytön suunnittelu metsäoppilaitosten metsissä" näkökulma on käytännön metsätalouden suunnittelussa. Esitetyn yksinkertaisen suunnittelumallin perusajatus on se, että moninaiskäytön näkökohtia arvioidaan kahdessa vaiheessa: hankkeiden sijoituksen suunnittelussa ja yksityiskohtaisessa hankesuunnittelussa.

Lopuksi julkaisussa esitetään symposiumin julkilausuma, jossa korostetaan erityisesti tutkimuksen ja käytännön metsätalouden yhteistyön merkitystä metsien moninaiskäytön ongelmien ratkaisemisessa.

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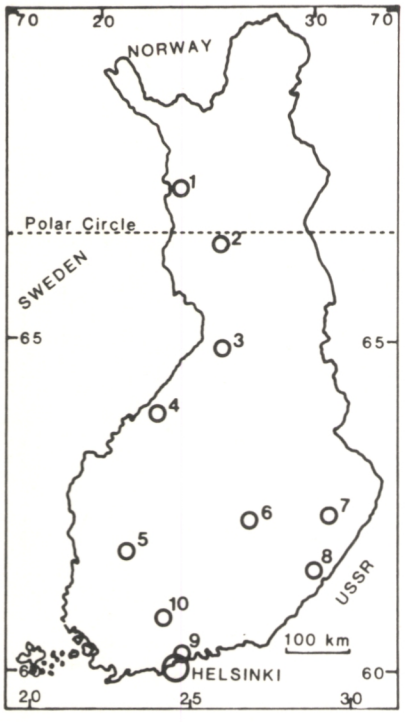

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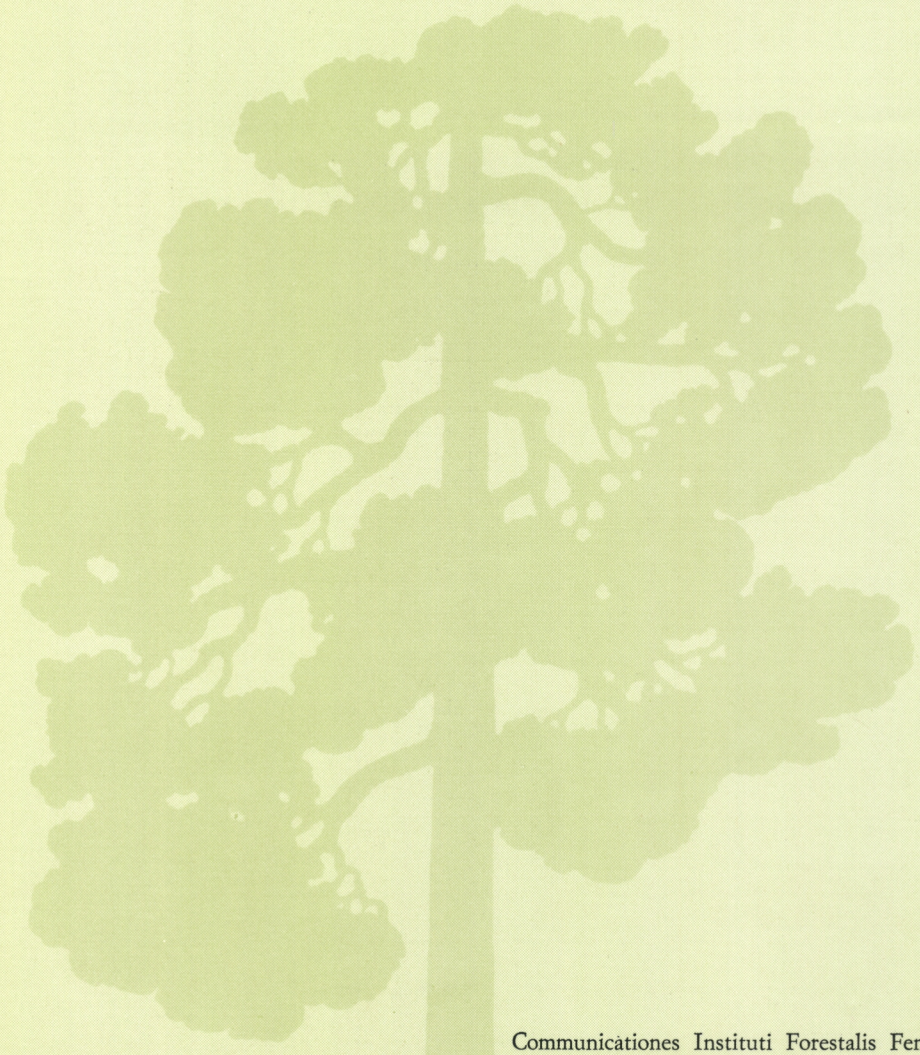
FACTS ABOUT FINLAND

Total land area: 304 642 km^2 of which 60—70 per cent is forest land.

Mean temperature, °C:	Helsinki	Joensuu	Rovaniemi
January	-6,8	-10,2	-11,0
July	17,1	17,1	15,3
annual	4,4	2,9	0,8
Thermal winter (mean temp. < 0°C):	20.11.—4.4.	5.11.—10.4.	18.10.—21.4.

Most common tree species: Pinus sylvestris, Picea abies, Betula pendula, Betula pubescens



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117 Sievänen, R. Growth model for mini-rotation plantations. Seloste: Lyhytkiertoviljelmän kasvumalli.

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119 Uotila, A. Physiological and morphological variation among Finnish *Gremmeniella abietina* isolates. Seloste: Suomalaisten Gremmeniella abietina -isolaattien fysiologisesta ja morfologisesta vaihtelusta.

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