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D 2.1.3: Definition of forest management alternatives

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Content

Abstract: Within the EFORWOOD project we research the whole forestry wood chain. The objective in workpackage 2.1 is to research the timber production and different strategies which can be used for the management of our forests. This document defines five forest management alternatives that can be arranged along a gradient of management intensity from non-intervention to intensive stand management. Beside the general approach pursued in each alternative, a corresponding set of silvicultural options is formulated as basic principles. Thus, for each alternative the typical sets of forest operation processes on a stand level can be described for the considered tree species in the Regional Cases, which are defined forests in 11 European countries. Addressing basic decisions to be met which affect tree species composition, age pattern, stand density and site conditions, these principles reflect the impact of the management alternative on forest ecosystem.

Key words: Forest management alternatives, operational processes, forest management strategy, scenario analysis, basic principles

INTRODUCTION

The selection of a forest management strategy is a crucial step in decision-making. The decision has to be made in a broad context which can only be influenced to a limited extent as some conditions such as site and terrain, forest status, current tree species composition, techniques available, economic conditions, markets or societies needs are already determined while possible operational alternatives such as planting, soil preparation or thinning can be altered. In order to develop and implement sustainable forest management strategies, it is of importance to anticipate the long term effects of alternative forest operational processes[1]. Forest management operates through various functions, often classified as planning, organizing, leading/motivating and controlling[2] at an enterprise level, whereas forest management alternatives comprise coherent sets of forest operational processes at a stand level. Thus, forest management alternatives are defined by their approach (overall concept), the general objectives and a corresponding pattern of action in forest resource management. This pattern allows for various silvicultural options in applying operational processes as well as describing the boundaries and is formulated as "basic principles".

Forest operation processes performed in forest management alternatives have an effect on the status and dynamics of processes in forest ecosystems. Since derived goods as well as services are affected; forest management alternatives have implications on all three dimensions of sustainability. One aim of our project is to simulate the effect of forest management alternatives on selected sustainability indicators by examining the value change in the indicator induced by the silvicultural treatment. Forest management alternatives might differ according to the chosen objective. Given the numerous targets that can be pursued in forest management, there are a large number of possible alternatives that could be considered in this project. Thus, for simplification, five forest management alternatives are selected that can be arranged along a gradient of management intensity. Operations can be grouped by the following (not exclusive) key parameters, i.e. species composition, management of stand density and/or pattern, age pattern/ phases of development, stand edges/ boundaries and site conditions. The amount of external energy used in operational processes might also indicate the naturalness of the management alternative.

In spite of being arranged along a gradient of intensity, the following descriptions of forest management alternatives are not totally exclusive. The descriptions rather allow for an increasing degree of freedom in possibly applied silvicultural option. Thus, the management

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[1] Forest operation processes in various stages of development are described in PD2.1.1 "Description of forest production processes"

[2] •Planning: deciding what has to happen in the future and generating plans for action.
•Organizing: making optimum use of the resources required to enable the successful carrying out of plans.
•Leading/Motivating: exhibiting skills in these areas for getting others to play an effective part in achieving plans.
•Controlling: monitoring — checking progress against plans, which may need modification based on feedback.
(source: Wikipedia (2007), http://en.wikipedia.org/wiki/Management)

objective might emphasize the economic interest possibly at the expense of an accordingly higher impact on the environmental and social dimension of sustainability. However, this is to be ascertained within the EFORWOOD project.

The following five management alternatives for the different tree species in the regional cases[3] will be described using basic principles for the four phases of development:

- Unmanaged forest nature reserve
- Close-to-nature forestry (low intervention forestry)
- Combined objective forestry
- Intensive even-aged forestry
- Wood biomass production (short rotation forestry)

The descriptions are to be read in the framework of the EFORWOOD-Project. Further, these forest management alternatives are not to be confused with "**scenarios**" as defined in the EFORWOOD-Project. An infinite number of imaginable futures might be explored for the future of the European forest sector' scenarios. However, since this is not feasible only a limited number of options for the future can be explored. This option for future development can be called a scenario and will affect the whole Forestry-wood Chain[4]. According to the assumed scenario a shift in the preference among the five forest management alternatives might be expected altering the future balance of stand management practices in a given region.

BASIC DECISIONS AND PRINCIPLES

As stated above, beside their approach and objectives, forest management alternatives are defined through a corresponding pattern of operations in forest resource management. This pattern allows for various silvicultural options in applying operational processes as well as describing the boundaries and is described as "basic principles". Thus, the basic principles have to reflect the basic decisions to be met affecting the impact of the management alternative on forest ecosystem and its derived goods and services. Table 1 summarizes 12 basic principles for defining forest management alternatives based on the application of operational processes. These basic principles partly reflect the criteria developed and discussed by WINKEL *et al* 2005[5].

Table 1: Basic decisions and principles for describing the pattern of options in applying operational processes

Basic decision / basic principle	**Operation process**	**Key parameter**	**Phase of Development concerned**
Selection of tree species (Naturalness of tree species composition) Tree species composition against the reference of potential natural vegetation Share of site-adapted tree species Share of introduced tree species	Selection of tree species	Tree species composition	"Regeneration"

[3] Selected tree species and regions are described in PD2.1.1 "Description of forest production processes"
[4] Further explanations and definitions are given in PD1.4.7 "Scenarios and external factors"
[5] WINKEL, G., SCHAICH, H., KONOLD, W., VOLZ, K.-R. (2005) Naturschutz und Forstwirtschaft: Bausteine einer Naturschutzstrategie im Wald. Naturschutz und Biologische Vielfalt (11), Bundesamt für Naturschutz, Bonn – Bad Godesberg. 398 pp.

Genetic engineering Use of genetically improved material Use of genetically modified organisms	Selection of tree genotypes	Tree genetic diversity	“Regeneration“
Type of regeneration planting / seeding, natural regeneration	Stand establishment	Tree species composition Age structure	“Regeneration“
Succession elements Tolerance of succession elements as pioneer tree species	Stand establishment Tending Thinning	Tree species composition	“Regeneration” “Young” “Medium”
Machine operation Machine movement/driving on forest soils Extent of forest opening for machine access	Thinning Final harvest	Site condition?	“Medium” “Adult”
Soil preparation Mechanical, physical and chemical site preparation Drainage	Soil preparation Drainage	Site condition	“Regeneration”
Fertilisation / Liming Fertilization to increase yield (amelioration) Compensate for nutrient extraction and reestablishment of natural bio-geochemical cycles, e.g. by liming	Fertilisation Liming	Site condition	“Regeneration” “Young” “Medium” “Adult”
Application of chemical-synthetic protective agents Extent of application of pesticides, herbicides	Pest control	Tree Species composition	“Regeneration” “Young” “Medium” “Adult”
Integration of nature protection Tolerance of biotope/habitat trees Tolerance of deadwood Biotope protection within stands	Thinning Final harvest	Density and/or pattern?	“Medium” “Adult”
Tree Removals Extent of tree components extracted in thinning or harvesting operations	Thinning Final harvest	Site condition	“Medium” “Adult”
Final harvest system Extent of area cleared by final harvest operation	Final harvest	Density pattern Age structure	“Medium” “Adult”
Maturity Felling age in relation to the potential life span of a given tree species	Final harvest	Age structure	“Medium” “Adult”

FOREST MANAGEMENT ALTERNATIVES

Unmanaged forest nature reserve

Management objective: The main objective of an unmanaged forest nature reserve is to allow natural processes and natural disturbance regimes to develop without management intervention to create natural (or authentic) ecological valuable habitats and biodiversity. They are sometimes protected by an ordinance or forest act. [6]

Basic principles: No operations are allowed in a forest reserve that might change the nature of the area (see IUFRO definition). Possible operations (with limitations) can be the building of a trail so that people can visit these places of high ecological value. Other treatments may be allowed if the naturalness of the area is at stake due to external factors such as fire. Such control measures must be very limited and the only purpose is to protect the reserve with its processes from destruction, because these habitats are often very limited in size, and therefore do not have the resilience a big area would have. A further reason for taking measures of control would be to prevent major threats for adjacent stands managed under one of the four other alternatives.

Close-to-nature forestry

Management objective: The objective of close-to-nature forestry is to manage a stand with the emulation of natural processes as a guiding principle. Economic outturn is important, but must occur within the frame of this principle. Any management intervention in the forest has to enhance or conserve the ecological functions of the forest. Timber can be harvested and extracted during these activities, but some standing and fallen dead wood has to stay in the forest, which may reduce productivity.[7]

Basic principles: Only native or site adapted tree species are chosen. The preferred method of regeneration is natural regeneration. If planting is necessary to introduce native species into a devastated forest, planting can be done, but genetic engineered planting material can not be used. Species mixtures follow the typical composition for the stand type. Site cultivation or fertilization can only be done to enhance the "naturalness" of the forest, if for example the sites have been so intensively managed in the past that these treatments are necessary to initiate any potential natural vegetation. Chemical pest control can only be applied for major events which are introduced from the surrounding stands. Small outbreaks should not be treated so that natural control processes are promoted. The rotation length is chosen to be as least as long as the ages of maximum mean annual volume increment and economic interest only play a minor role for this decision. Biological legacies and natural biotopes should be promoted inside the stands. The final harvesting system should simulate the natural disturbance mechanisms, and therefore not allow for clear-cuts (definitions may vary in different biogeographic regions) if big natural disturbances are not natural or frequent in this environment; extraction of biomass is limited to solid wood volume. Machine operations should be limited to a minimum with an emphasis on the protection of the natural structures during the activities. Vehicle movement is restricted to a strip road system (with an extensive skidding trail distance system).

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[6] IUFRO (2007), SilvaTerm data base: http://www.iufro.org/science/special/silvavoc/silvaterm/ .
IUFRO definition for forest reserve: "An area so designated and constituted under a forest act or ordinance in order to give it the desired or legal protection".

[7] FAO (2007), FAOTERM data base: http://www.fao.org/faoterm/index.asp?lang=EN
FAO definition of close to nature: "Classification of stands or forest according to how closely they resemble nature. Remark: Hemeroby classification based on impact of man, naturalness classifies the extent to which man's impact is absent or hidden"...

Combined objective forestry

Management objective: Combined objective forestry pursuits a mix of different objectives. Generally economical and ecological concerns play a major role in this strategy. It is presumed that various management objectives can be harmonized in a common approach that better satisfies diverse needs compared to zoning where individual objectives are maximised in separate areas. Additional objectives to typically timber production are water protection, mushroom production, habitat protection, avalanche prevention, game management and nature protection, fire prevention and/or recreation, and are adapted to the local situation. Due to the great variability within combined objective forestry, it is easier to define the limits of a combined objective forestry approach than the strategy itself. This allows for an optimal adaptation to the local situation[8] [9]

Basic principles: The basic principles of the close-to-nature forestry are valid for the ecological objective of the combined objective forestry. Therefore, native or introduced tree species suitable for the site are chosen on adequate sites. The preferred method of regeneration is natural regeneration but planting or seeding is acceptable to introduce native or desired species within an economic time frame. Products of tree breeding can be planted, but genetic modified planting material cannot be used. Tree species mixtures are typical for the stand type and composition. Site cultivation and/or fertilization can be done to enhance the development of the forest, provided that these treatments are necessary to initiate any potential natural vegetation. Chemical pest control can only be done for major events which are introduced from the surrounding stands. Small outbreaks should not be treated with pesticides so that natural control processes are promoted. Instead trap stems and their removal should be promoted if applicable in the situation. The rotation length is influenced by the potential natural vegetation as well as economic or other interests. The rotation length is chosen to not shorter than the ages of maximum mean annual volume increment as long as not strongly interfered by economic interest due to second harmonized management objective. Biological legacies and natural biotopes should be promoted inside the stands. The final harvesting system should enhance the chosen regeneration method. Wood harvesting is commonly limited to solid wood volume. Machine operations should emphasize the protection of the natural structures, e.g. the residual stand and soil, during the activities and vehicle movement is restricted to a strip road system (with an intensive skidding trail distance system). If the basic principles of the close-to-nature forestry interfere with the other management objectives adaptations to the management strategy can be done. This depends on the local situation. As long as the intensity of management does not increase to the level of the intensive even-aged forestry, it still can be considered as combined objective forestry.

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[8] IUFRO (2007), SilvaTerm data base: http://www.iufro.org/science/special/silvavoc/silvaterm/ .
IUFRO definition for multiple-use management: "The management of forests to satisfy a great range of (human) needs which vary from tangible raw materials to intangible benefits, without undue impairment to the land".

[9] IUFRO (2007), SilvaTerm data base: http://www.iufro.org/science/special/silvavoc/silvaterm/ .
IUFRO definition for multiple-use forestry: „ Any practice of forestry that fulfils two or more objectives of management, whether products, services or other benefits".

Intensive even-aged forestry

Management objective: The main objective of intensive even-aged forestry is to produce wood, and in respective profit. Typically intensive even-aged stands consist of monocultures (sometimes with a small percentage of admixed species) and ecological objectives are of lesser importance, depending on the impact they have on the economic return. If ecological aims can be enhanced without much loss of revenue, they are normally incorporated. National "Best Management Practices" outlining guidelines for sustainability and environmental protection limit the possible operations.[10] [11]

Basic principles: Any non-invasive tree species suitable for the site can be chosen. Planting, seeding and natural regeneration are all possible regeneration methods, economic concerns decide between the alternatives. The planting/seeding material can be genetically improved, but is not genetically modified. Typically, monocultures with small percentages of mixed-species (preferably also merchantable) are used for this strategy. Mixed-in species are only used if some parts of the stand fail, and no economic loss is associated with it. Site preparation is often used to enhance establishment success and remedial fertilization is used to increase growth rates. Chemical agents are used to a minimum necessary to treat pests and sometimes to control weed competition. The rotation length is shorter than close-to-nature forestry and multi-purpose forestry and depends mainly on the economic return. Biological legacies can be incorporated to improve the ecological values of the stand into the management, as long the economic return is not reduced substantially. Biomass extraction is commonly limited to solid wood volume but might include whole tree extraction e.g. for bio-energy. Machine operations are not limited, as long they do not harm the environment, however, vehicle movement is commonly restricted to a strip road system (with an intensive skidding trail distance system).The final harvest system is preferably clear cut or a combination of shelterwood and clear-cut if natural regeneration is preferred to reduce the investment. Any residue removal is confined to the processing of small dimension thinnings for fuel wood.

[10]IUFRO (2007), SilvaTerm data base: http://www.iufro.org/science/special/silvavoc/silvaterm/ .
IUFRO definition for even-aged stand: „ A stand or forest type, in which no or relatively small age differences exist among individual trees within it, usually less than 20% of rotation length".
[11] IUFRO (2007), SilvaTerm data base: http://www.iufro.org/science/special/silvavoc/silvaterm/ .
IUFRO definition for even-aged management: „A planned sequence of treatments designed to harvest, regenerate and maintain a forest comprising stands each of one age class".

Wood biomass production (short rotation forestry)

Management objective: The main objective of wood biomass production is to produce the highest amount of merchantable timber or wood biomass. Ecological concerns play a minor role in this strategy, as long the environment is not harmed by the plantation management.[12] [13]

Basic principles: The tree species selection depends mainly on the economic return, as long the species is not an invasive species and does not harm the forest ecosystem or the surrounding environment. The planting material, which is planted in rows, can be genetically improved and genetically modified. No natural succession of other species is possible, if it reduces the growth of the chosen tree species. The sites are cultivated with mechanical, physical and chemical site preparation and can also be drained or irrigated. Fertilization and liming are applied to the stands to enhance growth. Pests and weed competition are normally treated with chemicals. The rotation length only depends on the economic return, and no biological legacies are included. No other habitats are maintained within the stand. The intensity of machine operations is at its maximum compared to the other alternatives and is only limited by the environmental laws. The final harvesting system is a clear-cut with removal of all woody residues if there is a suitable market with an intensive skidding trail distance system.

An overview of the basic decisions and principles for describing the pattern of options in applying operational processes by the five management alternatives is given in Table 2 (APENDIX).

[12]IUFRO (2007), SilvaTerm data base: http://www.iufro.org/science/special/silvavoc/silvaterm/ .
IUFRO definition for plantation: „A forest established by planting or/and seeding in the process of afforestation or reforestation. It consists of introduced species or, in some cases, indigenous species.
One or more stands, crops or forests, resulting from artificial regeneration (and usually even-aged)".
[13] FAO (2007), FAOTERM data base: http://www.fao.org/faoterm/index.asp?lang=EN
FAO definition for plantation: „ Forest stands established by planting or/and seeding in the process of afforestation or reforestation. They are either of introduced species (all planted stands), or intensively managed stands of indigenous species, which meet all the following criteria: one or two species at plantation, even age class, regular spacing".

APENDIX: Table 2: basic decisions and principles for describing the pattern of options in applying operational processes

Basic decision / basic principle	**Unmanaged forest nature reserve**	**Close-to-nature forestry**	**Combined objective forestry**	**Intensive even-aged forestry**	**Wood biomass production**
Selection of tree species (Naturalness of tree species composition)	Only potential natural vegetation (PNV)	Native or site adapted	Tree species suitable for the site	Tree species suitable for the site	All species (not invasive)
Genetic engineering	No	Not genetically modified or breeding	Trees from breed selection but not genetically modified	Trees from breed selection but not genetically modified	Genetically modified or breeding
Type of regeneration	Natural regeneration / natural succession	Natural regeneration (planting for enrichment or change in tree species composition)	Natural regeneration, planting and seeding	Natural regeneration, planting and seeding	Plating and seeding
Succession elements	Yes	Yes	Yes/No	Yes/No	No
Soil preparation	No	No (only to introduce natural regeneration)	No (only to introduce natural regeneration)	Possible	Yes
Fertilisation / Liming	No	No (only if devastated soil)	No (only if devastated soil)	Possible	Yes
Application of chemical-synthetic protective agents	No	No	No	Possible	Possible
Integration of nature protection	High	High	High	Medium	Low
Machine operation	No	Extensive	Medium	Intensive	Most intensive
Tree removals	No	Stem (solid volume)	Stem and crown (solid volume)	Up to whole tree	Whole tree
Final harvest system	No	Mimics natural disturbances	All possible	All possible, Clear-Cut and Shelterwood cut preferably used	Clear-cut
Maturity	No intervention	Long rotation length ≥ age of max. MAI	Med. rotation length ≈ age of max. MAI	Short rotation length ≈ age of max. “€”	Shortest rot. length ≤ age of max. MAI