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Evaluation of the economic impact of Flora Fauna Habitat -management plans in forest enterprises in Germany

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Abstract

In Germany approximately 17 % of the total forest area is part of the European Natura 2000 nature conservation network and designated under the FFH-Directive or the Birds Directive. The objective is ”to maintain or restore, at favorable conservation status, natural habitats and species of wild fauna and flora of Community interest”. While FFH-areas have been designated by the Bundesländer for several years, management plans have only recently been formulated. Within the research program”FFH-Impact” [2] several FFH-management plans from different Bundesländer in Germany were analyzed with regard to the economic outcome of forest enterprises. The most relevant restrictions on forest utilization that occur are: the conservation of habitat trees, restrictions in the change of tree species and the preservation of mature stands. This paper describes an approach to appraise the financial losses of forest-land owners caused by the requirements of FFH-management plans by means of an exemplary forest enterprise and discusses the consequences with respect to financial compensations from contract based nature conservation. The economic valuation of the different FFH-measures was conducted according to the capitalized earning value concept. For this an Excel-based calculation-program was further developed. The model determines yield differentials between a reference development and the development due to the FFH-management plan for affected areas by calculation annuities based on a wide variety of natural and economic variables.

1 Introduction

The Fauna-Flora-Habitats Directive (FFH) (92/43/EEC, ”habitats directive”) as part of the European Natura 2000 nature conservation network was introduced in the EU in 1992. It aims ”to maintain or restore, at favorable conservation status, natural habitats and species of wild fauna and flora of Community interest”. To ensure the required conservation measures, EU Member States are obliged to designate Special Areas of Conservation (SAC) and Sites of Community Importance (SCI) under the FFH-Directive and Special Protection Areas (SPAs) under the Birds Directive (79/409/EEC), hereinafter collectively referred to as ”FFH-areas”, for the protection of natural habitat types and species listed in the annexes of the directive (Rosenkranz and Möhring. 2011). The FFH-directive mainly focuses on protection objectives and hardly any requirements for forest management can be drawn from it (Winkel et al. 2009). The Member States are, by

[2]”Economic analyses for implementing the FFH-directive in forests” is one of two sub-projects of the joint research project ”Impacts of nature protection requirements on forestry and the forest sector” and is carried out together with the Johann Heinrich von Thuenen Institute, Institute of Forest Based Sector Economics (OEF), Hamburg in close cooperation with bbw-consult, Freiburg and is kindly supported by the Agency for Renewable Resources (FNR) as project executing organization of the German Federal Ministry of Food, Agriculture and Consumer Protection (BMELV).

means of Art. 6 of the directive, obliged to put these conservation objectives and measures into practice by way of so-called ”management” or ”maintenance and development” plans for each of the respective FFH-areas.

In Germany approximately 17% (1.9 Mill. ha) of the total forest area is located within FFH-areas, amongst these forest habitat types there are to a large extent Beech forests which were not subject to a special protection status before (Rosenkranz and Möhring. 2011).The sustainable and multifunctional use of German forests is explicitly stated in German forest law. Forest management fulfills these statutory provisions by joining utilization, protection and recreation largely on the same ground. Therefore these forests are not only of great importance for nature protection goals but also for forest utilization and the achievement of policy aims e.g. in the fields of economics, energy policy and climate protection. While FFH-areas have been designated by the Bundesländer for several years, management plans have only recently been formulated. Thus a systematic evaluation of the impacts on forest utilization is only now possible.

Against this background, the research project ”Economic analyses for implementing the FFH-directive in forests” aims to analyze natural and economic impacts of FFH-implementation. Furthermore recommendations for the efficient implementation of the FFH-directive for forest enterprises, administration and politics shall be derived (Rosenkranz and Möhring. 2011). As 9110 woodrush beech forest (luzulo-fagetum) and 9130 woodruff beech forest (asperulo-fagetum) account for the largest shares of FFH-protected beech area (Bundesamt für Naturschutz. 2008; Forstliche Versuchs- und Forschungsanstalt Baden Württemberg. 2007) the study is focused on these two habitat types.

This paper describes how an approach by Möhring and Rüping (2007) was further developed and used to appraise the financial losses of forest-land owners caused by intensified nature conservation requirements through FFH-management plans.

2 Methodology and data

2.1 FFH-management plans in Germany

The responsibility for designating FFH-areas and implementing the FFH-management plans in Germany primarily lies with the Bundeslaender. Within the project structure legal commitment and typical conservation and development measures of FFH-management plans from all Bundeslaender (except city states) have been analyzed.

The scope of the management plans (without annex) ranges from 8-20 pages up to 200-300 pages (Rosenkranz and Möhring. 2011). The most important section of each management plan for the evaluation of the economic impact of FFH-management plans on forest enterprises is the chapter of objectives and measures: Conservation measures encompass all actions necessary to maintain or restore natural habitats and wild species at a favorable conservation status. Furthermore they can include activities to further enhance this conservation status. In the annex of management plans of some Bundeslaender measures are concretized to the level of specific forest stands (Rosenkranz and Möhring. 2011).

The most important conservation measures for Beech forest habitat types and protected animal and plant species were found to be the conservation and/or the increase of habitat trees, dead wood and old growth forest as well as the protection of habitat-specific natural species composition including the promotion (and/or the natural regeneration) of habitat-specific native

species, the conservation of rare native tree species (e.g. sorbus spec.) and the removal of non-native tree species (e.g. Douglas fir, Norway spruce) (Rosenkranz and Möhring. 2011).

These findings fit to the results of a nationwide online survey, that has been conducted during the study in order to get an overview of current expectation trends of forest owners in the FFH-implementation process (Wippel et al. 2010). About 340 mainly medium- and large-scale private and communal forest owners were asked which FFH-measures in their view would cause the biggest restrictions on forest management. The conservation of dead-wood, habitat-trees and old-growth trees (chosen by 53% of the respondents) or of areas of old-growth (chosen by 33%) as well as limitations in the choice of tree species and regeneration practices (chosen by 67%) were found to be the main measures expected to constrict forest management (Rosenkranz and Möhring. 2011).

2.2 Evaluation of FFH-measures

In order to evaluate the economic impacts of FFH-measures on forest management, ten selected private-, communal- and state-run forest enterprises in six different Bundeslaender were examined in more detail.

Reference data, i.e. objectives, management practices and key figures, without the influence of FFH were raised in each enterprise. In addition the natural impacts of FFH-measures (e.g. loss of management area by designating habitat trees) were derived from the respective management plans together with the forest managers. FFH-measures were only considered if they lead to new restrictions for the forest enterprise.

The evaluation of the different FFH-measures was conducted according to the capitalized earning value concept by calculating the yield differentials between the reference development and the development due to the FFH-management plan for the affected areas.

For these economic assessments an Excel-based calculation-model by Möhring and Rüping (2007) was further developed. The model is based on a valuation concept by Möhring and Rüping (2006). It allows the input of a wide variety of natural and economic variables and shows the results in a compressed and clearly arranged form. The basic functions of the calculation-model are described in the following:

Using yield- and assortment-models, inputs and outputs over time for both, reference data and FFH-influenced management, are estimated in physical quantities for five-year intervals until the end of rotation. These natural inputs and outputs are priced to generate cash flows for both alternatives. Therefore the model uses a stands thinning volumes and associated quadratic mean diameters (D_q) at the time of use and volume and D_q for final felling at the end of rotation. After converting standing gross volumes (over bark) into commercial volumes these quantities are valuated with net proceeds as a function of the tree species, wood quality, expense level and D_q.

Finally the model determines annuities from the cash flows by using dynamic investment calculations:

$$a = \sum_{t=0}^{n} \frac{(R_t - E_t)}{(1+i)^t} \times \frac{i \times (1+i)^n}{(1+i)^n - 1} \quad \textbf{(1)}$$

a = Annuity (equal annual payments)
t = Point in time (years since beginning of the accounting period)
n = Length of accounting period (years)
R_t = Revenues at t
E_t = Expenditure at t
i = interest rate

In doing so the net present value of the cash flow is transferred in a yearly constant amount with the annuity- or recovery-factor. The annuity corresponds with the yearly constant amount of money which can be removed from the forest enterprise as silvicultural profit contribution during a period under ”capital maintenance”. Möhring and Rüping (2007) refer to this amount as ”annual timber production value”. This term expresses that the cash flow is distributed mathematically equal over the rotation period, also it points out that the value is directly connected with the forest wood production (planting, tending and harvesting of trees). Other costs and revenues as, for example, annual fixed administration costs or income from hunting are not taken into consideration. In that sense, the ”annual timber production value” equates to a yearly contribution margin from silvicultural (biological) production including cost of capital before deducting annual fixed costs.

By applying the annuity to the entire forest rotation length (u) the formula gets following notation:

$$a_u = \left(\frac{A_u}{(1+i)^u} + \sum_{a=1}^{u} \frac{(D_a)}{(1+i)^a} - c\right) \times \frac{i \times (1+i)^u}{(1+i)^u - 1} \quad \textbf{(2)}$$

u = rotation length
A_u = Clear-cut revenue net of harvesting cost in year u
D_a = Thinning revenue net of harvesting cost in year t
c = Plantation costs

The ”annual timber production value” can also be calculated for periods shorter than an entire rotation. For a time period of n years, the annual timber production value can be determined by the following equation:

$$a_n = \left(\frac{A_{x+n}}{(1+i)^n} + \sum_{a=x}^{x+n} \frac{(D_a)}{(1+i)^{a-x}} - A_x\right) \times \frac{i \times (1+i)^n}{(1+i)^n - 1} \qquad \textbf{(3)}$$

A_x = Clear-cut revenue net of harvesting cost in year x
A_{x+n} = Clear-cut revenue net of harvesting cost in year $x+n$
D_a = Thinning revenue net of harvesting cost in year t

The difference between the annual timber production values of both alternatives is considered as monetary loss to the forest-land owner.

2.3 Data base for the valuation

The calculations were based on a data pool which reflects growing conditions in Northern Germany:
With respect to existing forest valuation directives, standard yield tables (Schober 1987) are the basis for modeling the natural production process;

Oak	Jüttner 1955 (m. Df.)
Beech	Schober 1967 (m. Df.)
Douglas fir	Bergel 1985 (st. Df.)
Spruce	Wiedemann 1936/42 (m. Df.)
Pine	Wiedemann 1943 (m. Df.)

Since todays silviculture differs from the types of thinning schemes underlying those yield tables, the average stand diameter is adjusted to the present silvicultural situations by using a Richards-Function (Wollborn and Böckmann 1998).

Timber prices are derived from the forest valuation directive of North-Rhine-Westphalia (Ministerium für Umwelt und Naturschutz, Landwirtschaft und Verbraucherschutz des Landes Nordrhein-Westfalen. 2009).

Costs for mechanized timber harvesting and skidding are taken from Arbeitsgemeinschaft forstlicher Lohnunternehmer Niedersachsen e.V. (2010).

Manual harvesting is assumed from a diameter of 45 cm upwards in softwood and 25 cm in hardwood. Cutting cost are then calculated according to the ”Erweiterter Sortentarif 2007” (Kuratorium für Waldarbeit und Forsttechnik e.V. 2012), a remuneration model for forest workers.

Planting costs were fixed at 7000 EUR/ha for Oak, 5000 EUR/ha for Beech, 2250 EUR/ha for Norway Spruce, 3300 EUR/ha for Douglas fir and 2000 EUR/ha for Pine (Niedersächsisches Ministerium für Ernährung, Landwirtschaft, Verbraucherschutz und Landesentwicklung. 2008). Silvicultural treatments are assumed at the age of 20 with costs of 250 EUR/ha in hardwood- and 500 EUR/ha in softwood-stands.

All other costs are considered as fixed costs and omitted based on the assumption that they occur independently from management regime.

Following (Möhring 2001) a real interest of 1.5 % was used for the calculations.
All these data are assumed to be constant over time.

3 Appraising the financial losses when changing the forest management regime

The following sections will show how timber production values were used to appraise the financial losses in forest enterprises in Germany through the three typical FFH-measures in woodrush Beech forests (luzulo-fagetum) and woodruff Beech forests (asperulo-fagetum).
The different measures have different effective periods, that can vary between a few years, e.g. in the case of an extension of the rotation period, and whole rotation periods, e.g. in the case of limitations in the choice of tree species. To be able to evaluate the overall effect of (medium-term) FFH-management plans on forest enterprises the economic or financial disadvantages of the different measures over periods of varying lengths are converted to an annual amount over 30 years based on financial principles [3].

Furthermore the measures affect different areas within a designated FFH-area. Financial disadvantages are calculated in relation to the measure area directly affected by a measure itself at first. In a second step the results are described and summarized in respect to the area of a habitat type.

The economic impacts of the selected typical FFH-measures shall be shown by example of a ”fictional forest enterprise”. The area of this fictional forest holding amounts to 280 ha of European Beech forest with a rotation cycle of 140 years.

3.1 Conservation of habitat trees

Mature old broadleaf trees and dead wood are of great importance for the biodiversity of flora and fauna in forest habitats. To appraise the financial loss of the conservation of habitat trees until the natural old growth and decomposition phase it is assumed, that the habitat trees to be protected are allocated in groups. Each tree has a standing area of $100\ m^2$. The groups are treated as stands that should be preserved.

In the example the FFH management plan states, that the forest enterprise has to maintain five habitat trees per hectare natural habitat type. The trees have to be older than 120 years. This results in 1400 habitat trees, which add up to an area of 14 ha (5% of the enterprises forest land). The enterprise has an reserve of old stands, so the medium age of the trees is 140 years.

Reference: Under normal conditions, the affected area of mature European Beech would be harvested an regenerated. The objective of the fictional forest owner is to convert 20% of Beech area to Douglas fir with a rotation cycle of 70 years in the future. On basis of the used models, a forest management regime with 80% European Beech from natural regeneration and 20% planted Douglas fir would achieve an annual timber production value of $139,-EUR\ ha^{-1}a^{-1}$.

[3]FFH-measures, as phrased in the FFH-management plans, are not legally binding for communal and private forestry. For these types of ownership the safeguarding of FFH-areas and measures can be achieved by market instruments such as e.g. environmental contracting. Contract durations of 30 years are common in environmental contracting in Germany.

Alternative*:* The mature European Beeches remain. The net revenue from clearcutting a Beech stand of the second yield and fifth value class in the age of 140 would be $18.720, -EUR\ ha^{-1}$. The forest enterprise loses this value which can be converted toannual amounts of $-779, -EUR\ ha^{-1}a^{-1}$ over 30 years. This "depreciation" reflects, that the loss in value does not occure immediately but over a longer period of time.

Financial loss: For the next 30 years, the financial loss is the difference between the annual timber production value of the reference and the loss of value of the abandoned trees. It totals $918, -EUR\ ha^{-1}a^{-1}$. If a total area of 14 ha is affected by this measure, the financial loss for the forest enterprise equals $12.852, -EUR\ a^{-1}$.

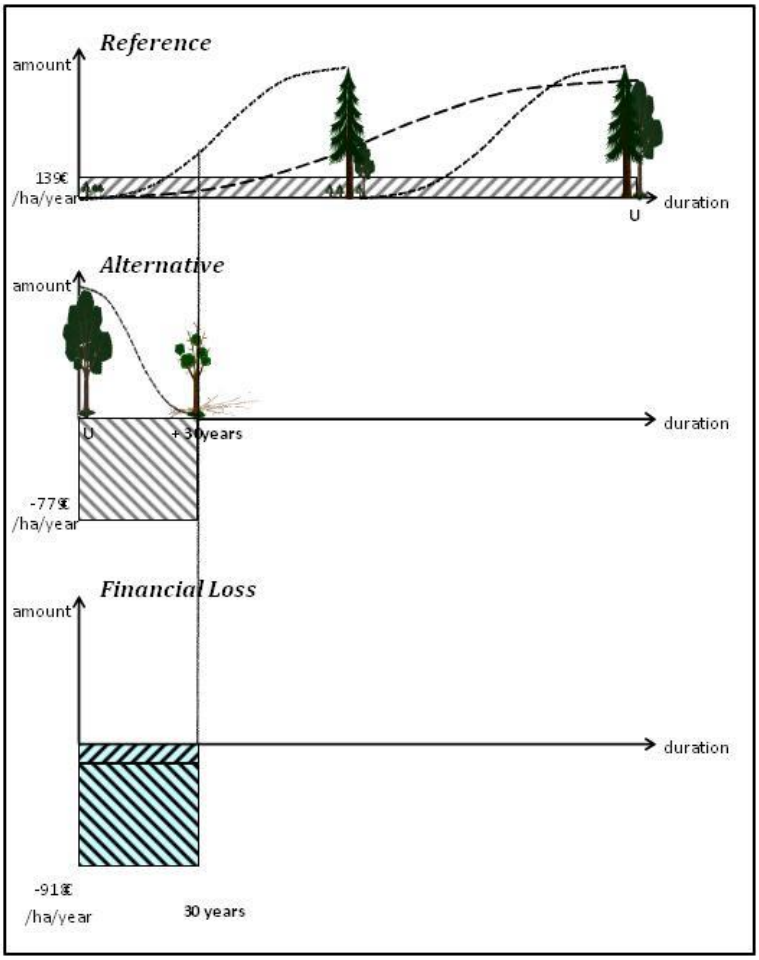

Fig.1. Conservation of habitat trees

3.2 Change of tree species

Management plans allow cultivation of non-native tree species only to a limited extent or exclude it completely. This denies forest owners the opportunity to optimize their tree species portfolio and results in losses in yield and revenue. It particularly pertains the growing, harvesting and utilization of fast growing coniferous species as, for example, Douglas fir.

The owner of the fictional forest enterprise is going to regenerate 40 ha of his forest land in the next 30 years. According to the management plan, the plantation of Douglas fir is prohibited in his forests. The resulting profit loss is calculated as follows:

Reference: A forest management regime with 80% European beech from natural regeneration and 20% planted Douglas fir would achieve an annual timber production value of $139,-EUR\ ha^{-1}a^{-1}$.

Alternative*:* Under the given conditions (with natural regeneration and no plantig costs) a forest management regime with European beech would gain an annual timber production value of $84,-0,-EUR\ ha^{-1}a^{-1}$, considering the optimal rotation length of 140 years.

Financial loss: The difference between the annual timber production value of the two species amounts to $55,-EUR\ ha^{-1}a^{-1}$ during the entire production length of European Beech.
Taking this extreme long time span into account, a different approach seems to be more suitable for practical purposes. This approach is based on the consideration that it is advantageous to continue an existing production process, despite the higher average productivity of the reference, when the existing stand has already reached a certain age. We assume that the annual timber production value of Beech is equivalent to the average annual timber production value of Douglas fir by the age of 30. Beyond this age, the Beech stand does not cause any financial disadvantage anymore, so that only the losses up to this age have to be determined. Fig. 3 illustrates this approach.

Reference: The forest management regime with 80% European Beech from natural regeneration and 20% planted Douglas fir would achieve an annual timber production value of $139,-\text{EUR ha}^{-1}\text{a}^{-1}$.

Alternative: Once a European beech stand reaches the age of 30, the average annual timber production value is $143,-\text{EUR ha}^{-1}\text{a}^{-1}$ until its optimal rotation length of 140 years. It is thereby almost equivalent to annuity of the reference. However, up to this age (the first 30 years), European Beech has a negative timber production value of $-9,-\text{EUR ha}^{-1}\text{a}^{-1}$.
Financial loss: For the first three decades, the difference of the annual timber production value between the two species amounts to 148,- $\text{EUR ha}^{-1}\text{a}^{-1}$. From 30 years of age onwards the European Beech stand is no longer disadvantageous when compared to a newly established mixed stand. In relation to the affected area of 40 ha this means a financial loss of $5560,-\text{EUR a}^{-1}$ for the forest enterprises.

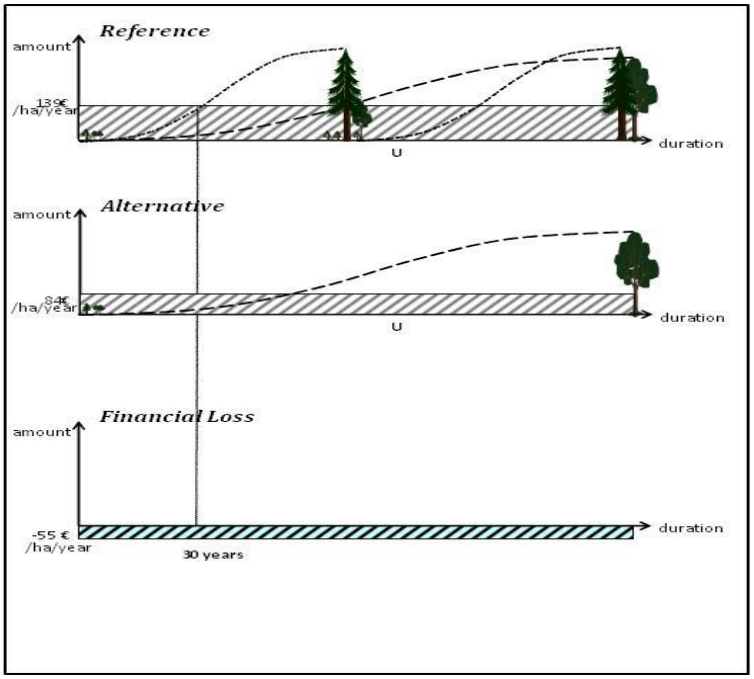

Fig. 2. Change of tree species

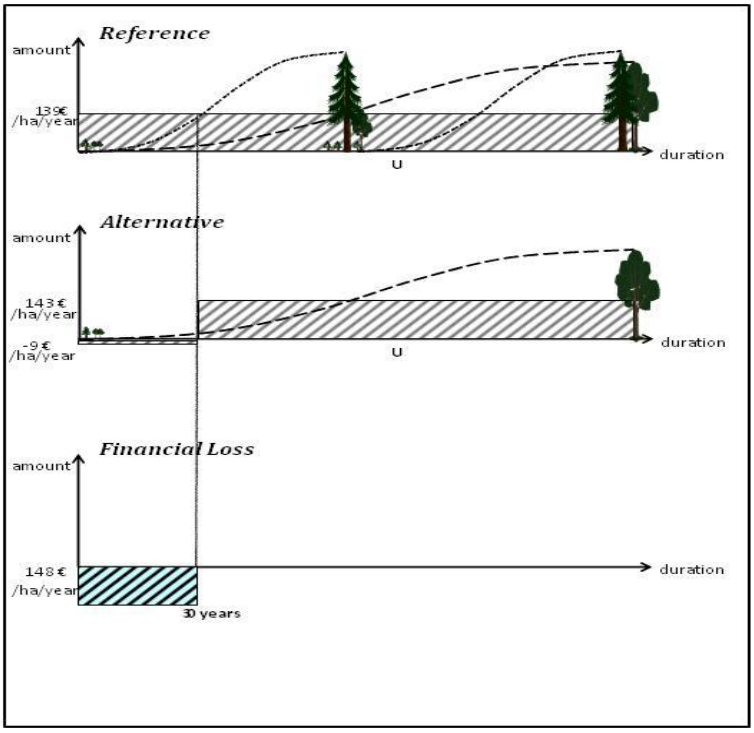

Fig. 3. Change of tree species

3.3 Preservation of a mature stand

The Fauna-Flora-Habitats Directive classifies natural habitat types in three categories depending on their conservation status. (A=Favourable condition, B=Unfavourable-inadequate, C=Unfavourable-bad). One important parameter for the classification is the proportion of old growth forests (older than 100 years) in a habitat type. To sustain this proportion, it may be necessary to maintain old growth stands beyond their scheduled rotation age. For forest enterprises with a certain forest age-class structure this can effect the potential area of final harvesting and increase the target rotation period. Financial losses can arise especially in tree species with risks of deterioration of quality in old ages as, for example, Beech due to red heart. In the fictional forest enterprise 10 ha of 140 year old mature European beech have to be maintained for three additional decades to uphold the share of old growth stands over the next 30 years. The valuation comprises two aspects:

Reference: Having harvested the mature European beech, the stands would be regenerated, 20% of Beech area would be converted to Douglas fir. The annual timber production value of such a mixed stand is $139,-\mathrm{EUR\,ha^{-1}a^{-1}}$ under the given conditions.

Alternative: The mature European Beech stands remain. The average annual timber production value of a 140 year old Beech stand for the next 30 years is $-126,-\mathrm{EUR\,ha^{-1}a^{-1}}$. This negative amount reflects the assumption of falling prices as a consequence of red heart in old growth stands.

Financial loss: For the next 30 years, the financial loss is the difference between the annual timber production values of the two land uses and totals $265,-\mathrm{EUR\,ha^{-1}a^{-1}}$. On the total area of 10 ha, this means a financial loss of $2650,-\mathrm{EUR\,a^{-1}}$ for the forest owner.

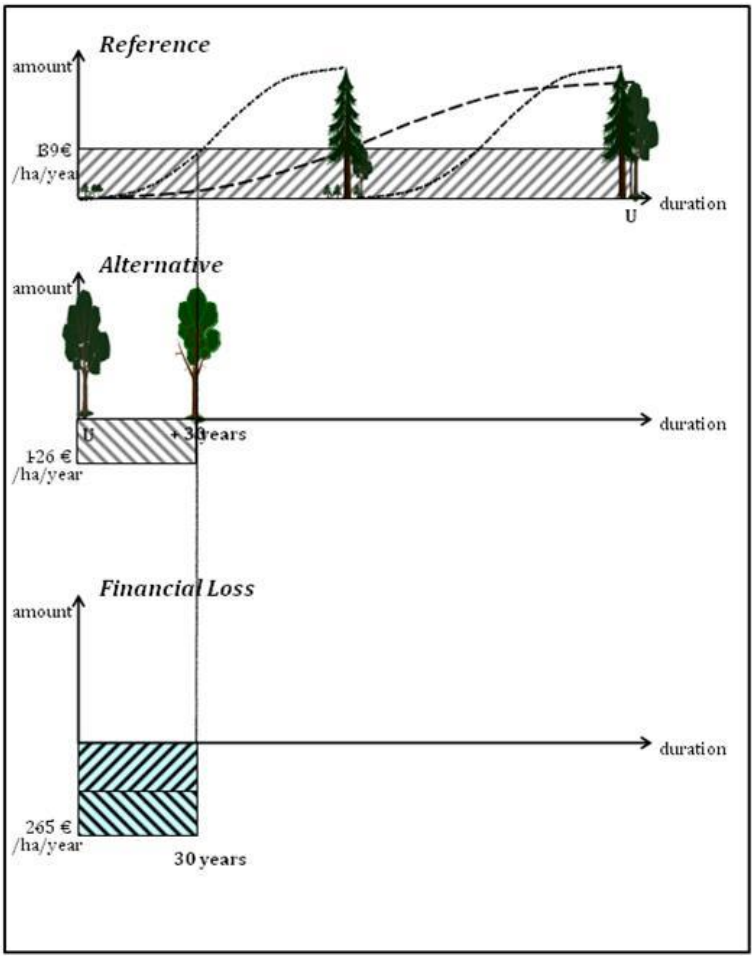

Fig. 4. Preservation of a mature stand

Table 1. Evaluation of the FFH-measures in the fictional forest enterprises

Measure	**Area [ha]**		**Financial loss [EUR/a]**		
	affected	total	per ha affected	per ha	total
Conservation of habitat trees	14		918	46	12852
Change of tree species	40		139	20	5560
Preservation of mature stands	10		269	10	2690
Total	64	280	330	76	21102

4 Evaluation of the overall effect of FFH-management plans on forest enterprises

To get an integrated view of the financial burdens a forest enterprise suffers from FFH-determined management, measure based assessments can be summed up over the total area of a habitat type.
The resulting values for the fictional forest enterprise are shown in Table 1.

The exemplary results show that FFH-management plans can have a significant impact on the financial situation of a forest enterprise. In this context, the conservation of habitat trees plays the most important role. Restrictions in the choice of tree species are particularly important, because they usually concern large areas. The financial repercussions of the preservation of mature stands are closely related to the measure area. Here they occur on a comparatively small area, so that the measure type has a lower impact in the showcase.

5 Conlusions

The concept to determine annual timber production values, developed by Möhring and Rüping (2007), is a feasible, consistent approach to provide a transparent basis for the appraisal of financial losses caused by intensified nature conservation requirements through FFH-management plans. The recent adjustments of the calculation program allow its application in a wide context.
The presented model calculations show that forest enterprises can be affected by the tightened nature conservation requirements through the NATURA 2000 network to a considerable extent. Economic effects will depend very much on the conditions of the natural environment of a forest enterprise or habitat type.
The annual timber production value can be easily interpreted as annual gross margin of the timber production (Möhring and Rüping. 2007). This offers advantages in the upcoming discussions; the annual figures can easily be supplemented by other annual expenses, for example additional administrative expenses. This is especially helpful for determine a minimum level of annual compensation payments.
However, some disadvantages remain which deserve further comment: The valuation only covers the objective of economic success as far as it results from timber production. Other objectives and non-timber outputs are not taken into account. Also risk is not included in the calculations.
The calculations presented are based on traditional yield tables for even-aged pure stands. The natural conditions of the forest enterprise should comply with these conditions. In a multi-storied, mixed permanent forest the model basis reaches its limits. The same applies to the timber assortment. Here too the grading rules should represent the actual conditions. However, traditional yield tables can be replaced by modern growth simulators that are able to depict modern management regimes (Möhring and Rüping. 2007).
Furthermore the model uses timber prices of the past three years. It can be assumed that revenues and costs change over the period under consideration. Annual payments in a specific agreement require a price escalation clause.
It should be underlined, that the financial loss calculated here conceptually represents a ”minimum price” and should not be mistaken as a ”fair price”. A fair price has to be higher than the actual financial loss to encourage a forest owner to enter into a voluntary agreement. For deviation of a fair compensation price an extra award, based on the minimum price, would be appropriate (Möhring and Rüping. 2007).

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