Zbornik gozdarstva in lesarstva 94 (2011), s. 55–66

GDK: 66+907:611:923.4:176.1 Fagus sylvatica(145)=111
Prispelo / *Received:* 13.09.2010
Sprejeto / *Accepted:* 21.04.2011

Strokovni članek
Professional report

Economic and ecologic advantages of small scale structured beech close-to-nature forest management: the case of group selection system

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Abstract

The District Forestry of the Duchy of Lauenburg (Schleswig-Holstein) changed silvicultural system in beech forests from "shelterwood with delayed clearance" to "group selection felling" due to economic, political and nature conservation reasons. The comparison of both systems showed advantages of group selection system regarding growth of valuable large diameter trees and higher overall income of about 10%, but small loss of regeneration growth and quality due to the effects of edging. The ecological values are in favour of group selection system due to similarities in forest horizontal structure with old-growth forest.

Key words: beech, shelterwood system, group selection system, forest economics, nature conservation

Ekonomske in ekološke prednosti malopovršinskega sonaravnega gospodarjenja z bukvijo: primer skupinskega prebiranja

Abstract

Gozdna uprava vojvodine Lauenburg (Schleswig-Holstein) je zaradi ekonomskih, političnih in naravovarstvenih razlogov spremenila gozdnogojitveno zvrst v bukovih gozdovih iz "zastornega gospodarjenja z odloženo pospravilno sečnjo" v zvrst "strukturiranega trajnega gozda s skupinsko prebiralno sečnjo". Primerjava obeh zvrsti je pokazala prednosti skupinskega prebiranja z vidika rasti vrednih dreves z velikih premerov in ca. 10 % višji skupni donos, a je hkrati nakazala nekoliko slabše priraščanje in kakovost mladja zaradi robnih učinkov. Ker je skupinsko prebiralna struktura gozda bliže teksturi življenjskih faz pragozda, je njena ekološka vrednost ocenjena višje.

Key words: *bukev, zastorno gospodarjenje, skupinsko prebiranje, ekonomika gozdnega obrata, ohranjanje narave*

1 Introduction

1 Uvod

The District Forestry of the Duchy of Lauenburg covers an area of managed forest of around 9,300 ha in the south-eastern part of Schleswig-Holstein, bordering on Mecklenburg-West-Pomerania (former inner-German border) to the east, Lower Saxony (R. Elbe) to the south and Hamburg to the south west. The District is official successor to the property of the former domain (Domanium) of the Dukes of Lauenburg. Besides the forest areas, there are large agricultural estates, agrarian land and many lakes that belong to it. The largest part of the Forestry District belongs to the growth zone of the East Holstein-south eastern younger glacial drift area, another part of it to the West Mecklenburg younger glacial drift area. The natural woodland community mainly consists of beech forests of various trophic levels, whereby there is a predominance of eutrophic forms rich in nutrients.

The regional climate in the south-west is Atlantic with around 740 mm / year precipitation on average over a long period of time and a mean average annual temperature of 8.4 degrees Celsius. To the north and to the east, the climate is slightly more continental. The monthly fluctuations in rainfall are relatively high, the highest precipitation being recorded in July and August, the lowest in February and March.

The geological conditions of around 60% of the area in the north of the District are the result of the bedload of the younger ice age, whereby a large percentage of very rounded end moraine deposits predominate in the North East, while in the North West more gently rolling and even flat ground moraines predominate, partly influenced by groundwater after the retreat of the ice northwards. The deposits from the older Ice Age in the rest of the southern part of the District are very deeply weathered and decalcified, the elevations have been flattened and the deep holes filled by ground flows and erosion during the

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following cold period, which make it almost impossible to identify the differences between ground and end moraines. The soil types on the younger end moraines are predominantly parabrown soils - brown soils often with easily reached free lime in the substrata. On the ground moraines, the groundwater and catchment water zones reach for the most part right into the rooting capacity areas so that here gley and pseudo-gley soil types develop.

The current distribution of tree types and species (forest management planning 2000) is shown in Figure 2.

From 1923-1926, the continuous cover forestry principle was already established in the Forestry District. The economic regulations necessary for this were suggested by Chamberlain von Kalitsch from Bärenthoren and at the same time the control method was chosen as the process

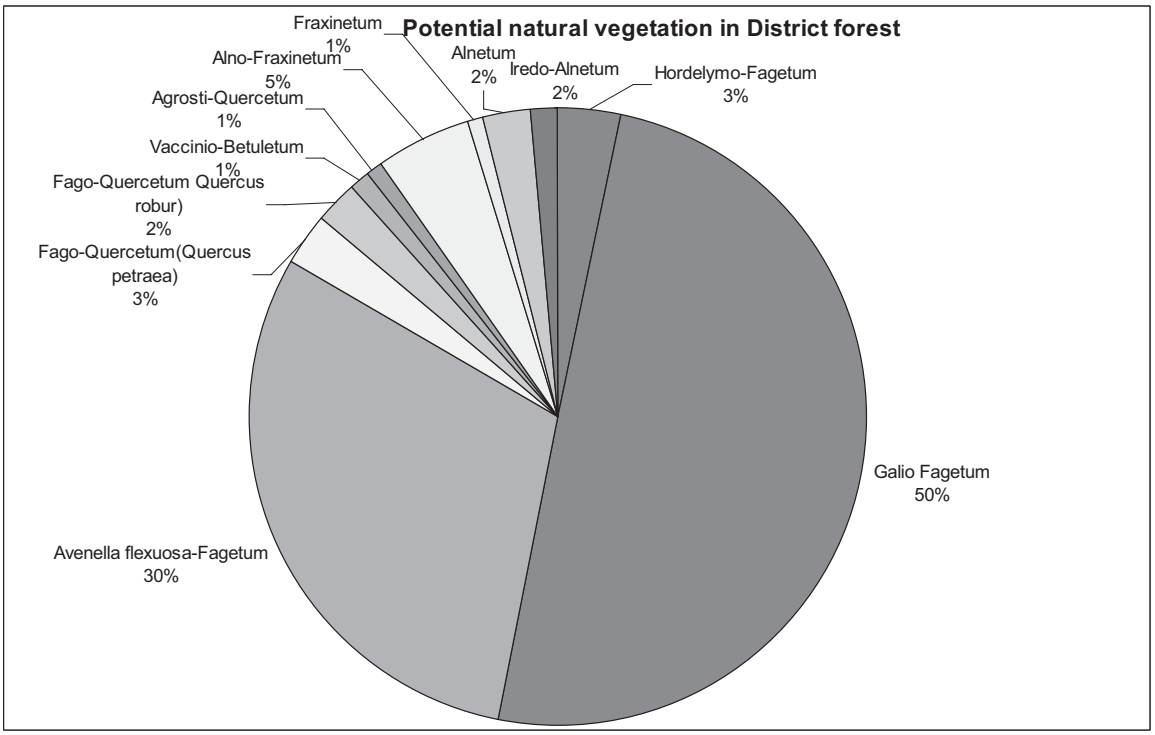

Figure 1: Percentage of the natural woodland communities in the forest areas of the District of Herzogtum Lauenburg. According to the results of the forest biotope mapping (EMMERICH, 2001).

Slika 1: Delež naravnih gozdnih skupnosti na gozdnih območjih okrožja Herzogtum Lauenburg glede na rezultate kartiranja gozdnega biotopa

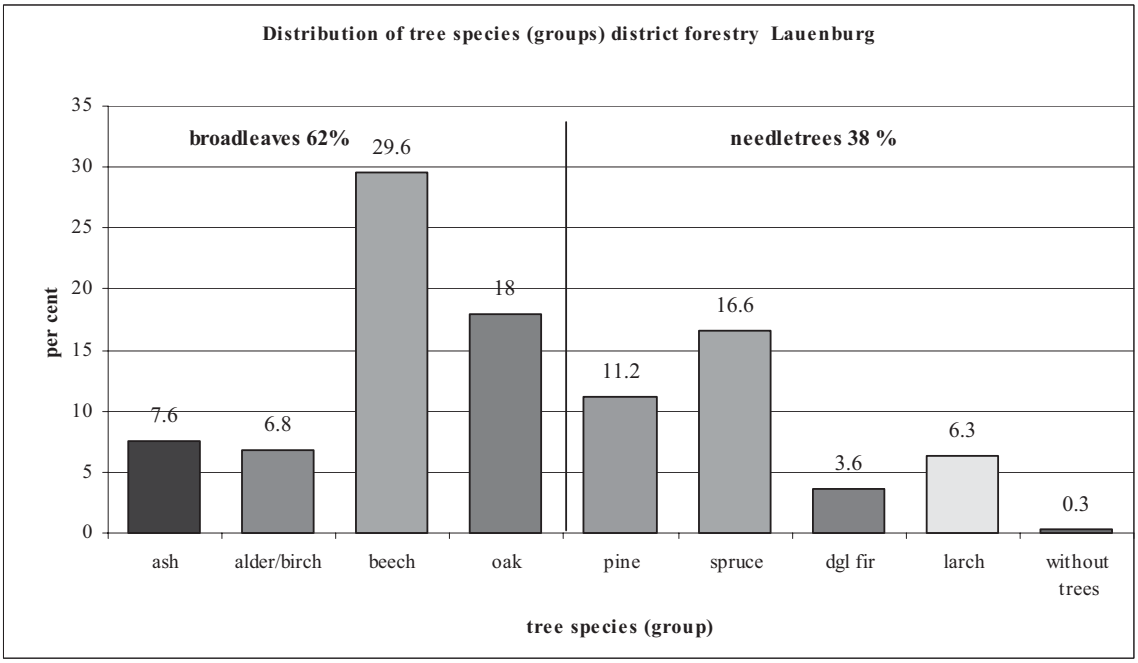

Figure 2 : Distribution of tree types and species in the District Forestry after the Forest Management Planning 2000

Slika 2: Porazdelitev drevesnih vrst in vrst v gozdni upravi po gozdnogospodarskem načrtovanju 2000

for setting it up. However, in 1935 they returned to the age class method. The ratio of deciduous to coniferous trees was 80:20 in those days. From 1945 to 1949, a considerable reduction in timber stocks had to be accepted due to firewood requirements for the cities of Hamburg and Lübeck and reparations felling. It was possible to cut a large proportion of the timber by reducing the stand density in the deciduous forests, so that only a small area was affected by clear felling. Subsequently, as a result of this kind of treatment, the forest again approached a close to nature forestry. In 1974, the first conference of the Schleswig-Holstein regional Close to Nature Forestry Association (ANW) took place. In 1998, the Federal Conference of the ANW-Germany chose the Herzogtum-Lauenburg Forests as the object of their excursion.

2 Experiences with beech forest management

2 Izkušnje gospodarjenja z bukovimi gozdovi

In the District Forestry described before, typical management system for beech forests was the so-called "differentiated age classes forest, shelterwood cut with delayed clearance" (Fig. 3).

Social and political demands for more linkage between economy and nature conservation standards in forestry and the observation of individual reference stands have stimulated empirical studies and further development of stand structure and forest management. The demands for an extensive waiver of disturbances to the ground vegetation and soil, as sometimes caused by soil preparation over large areas, must be mentioned here. Furthermore, through the effect abrupt stand clearance; the potentially promoted shade trees frequently die prematurely in great numbers during the application of "differentiated age class forest, shelterwood with delayed clearance" through the mechanical effect of wind and changing aridity on the crowns and particularly on the fine root systems. The fine root breakdown seems to allow oxygen to enter the inner core of the bole so that accelerated false heartwood is formed that is quickly joined by a fungal attack, making the trunk worthless. Nature conservationists demand greater structural diversity, especially that old trees and groups of old trees stand closer together. In doing so, managed forest would be much closer to the structurally and species rich age and decomposition phases of the (beech) primeval forests and create a greater variety of inner edge effects. According to AMMER et al. (1995), structurally diverse mixed stands represent a „quantum leap" in biodiversity as compared to single-storey pure stands. This process means that we achieve a more natural forest and a much higher

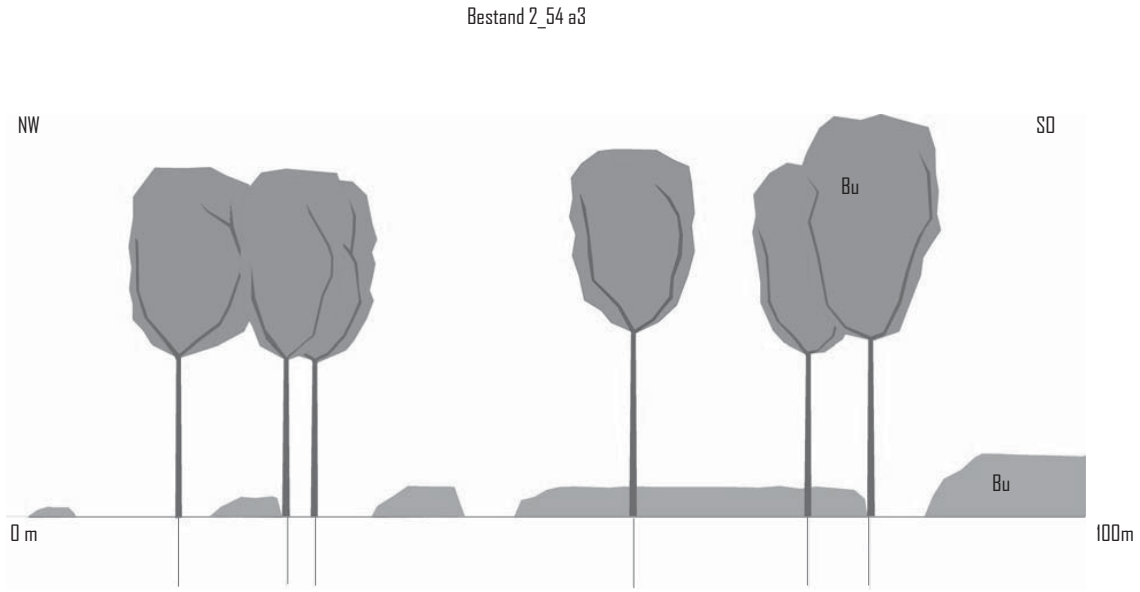

Figure 3: A model of two-layer stand of the District Forestry. Differentiated age classes forest. Shelterwood cut with delayed clearance.

Slika 3: Model dvoslojnega sestoja Gozdne uprave. Diferenciran gozd po starostnih razredih. Zastorno gospodarjenje z odloženo pospravilno sečnjo.

degree of acceptance concerning the relevant aims of nature conservation, which are of such importance especially in beech woods today. For above mentioned reasons, we have changed our beech management to: "Structured continuous forest with group-selection felling".

In contrast to the mixed coniferous forests of the Alps and the foothills of the Alps, North German lowlands comprise very few stands of field-proven continuous forests or selection forests in pure beech forests or those where beech trees predominate.

In spite of the almost systematically used shelterwood cut with delayed clearance, we could frequently find stands or parts of stands of varying size and area that either by chance or by conscious intentions come very close to the continuous forest models described in their structure and the way they grow. They were examples for us.

3 Specific features of beech continuous forests

3 Posebnosti bukovega trajnega gozda

After intense study of special literature on the subject, SCHÜTZ (1992) comes to the conclusion „that trees such as the beech with their sympodial branch system require neighbouring trees of the same height when they are young, in order to form a more or less continuous shaft

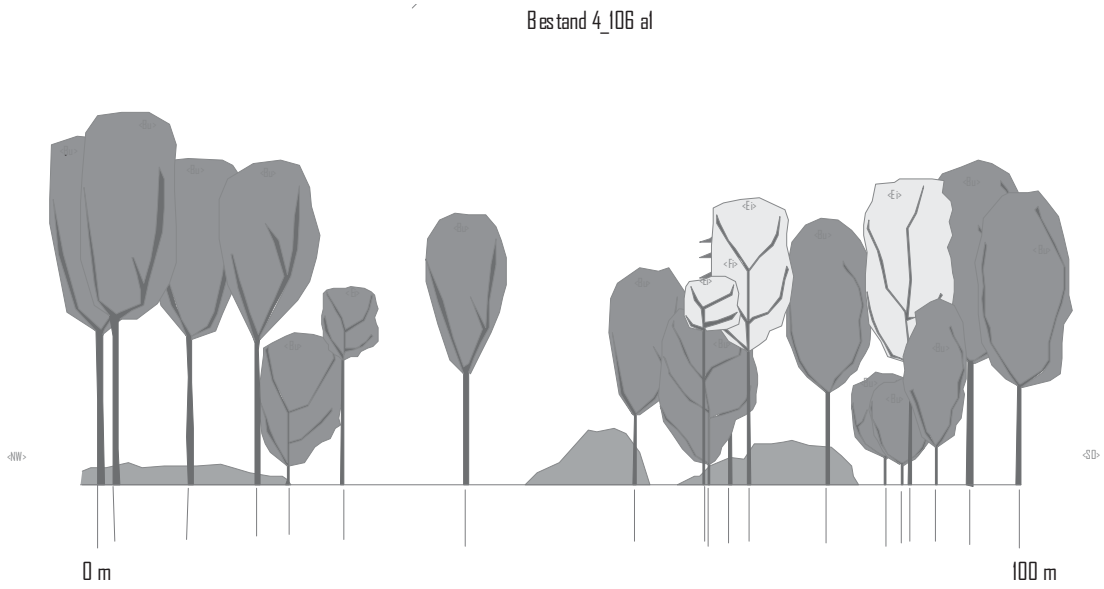

Figure 4: Profile diagram from a linear trans-section -picture (100 * 10 m) of a model beech continuous forest of the District Forestry. Structured continuous forest with group-selection felling.

*Slika 4: Profilni diagram linearnega prereza slike modela (100 * 10 m) bukovega trajnega gozda Gozdne uprave. Strukturirani trajnostni gozd s skupinsko prebiralno sečnjo.*

Besides the reasons of nature conservation, there are quite decisive economic reasons and basic demands of the close to nature forestry on the structured continuous forest with group felling. For with the planned introduction of the regeneration of the former process, besides the aforementioned negative influence on the ecosystem, a large number of good trees with a high development potential were removed from the middle layer (storey) to give light. One can speak of them as felling victims. Natural forestry, however, does not have any felling victims; rather it considers every tree to be of such value that it should be only removed in place of a better one. Thus natural forestry forbids removing a valuable tree that has not yet reached maturity for the benefit of regeneration. It was therefore both ecological and economic reasons that forced further developments, which then brought about a change.

axis capable of forming a tree top crown. In general sense, this is also valid for tree species with a similar branching morphology, such as limes, hornbeam, elms and also oaks". Furthermore SCHÜTZ (1992) quotes SCHAEFFER (1951) that the standing volume in beech selection forests, which should guarantee a sustainable regeneration and a qualitative satisfactory next-generation of trees, shouldn't exceed 200 – 250 m³/ha, and as consequence that the yield potential of the locations cannot be used completely. This is to a great extent confirmed by the observations of practising foresters in beech areas. After getting to know the so-called beech selection forests in Thuringia for the first time after the opening of the Iron Curtain (1990), where traditionally the selection of individual trees or groups of beech trees for

PALMER (2000) describes the continuous forest according to a definition of the AG Forestry Institutions of the State and the „Länder", Page 36; „.. Continuous forest is an operating mode of a managed forest, which takes out the trees individually or in small groups. The management is directed towards maintaining the forest in a permanent way.." and further on page 41: .." The selected forest is according to present-day understanding a (particularly highly developed) form of a perpetual forest and limited to forests that have a predominance of pine trees.."

felling and economic use took place over a long period of time in a certain form of ownership, the author corrected his former statements and established in the same way as those working practically on the spot, that in reality these could not be called selection forests (Plenterwald) in the sense of the classic definition, but rather stands with group structures or gap structures; in forestry language, irregular group felling forests or forests in group wise selection felling (cf. SCHÜTZ, 2001).

For REININGER (1993), however, the use of individual trees or groups of trees in beech stands is not a group felling in the sense of the well-known femel felling systems in coniferous stands frequently to be found in South Germany. There the old stock is systematically reduced through extending and bringing together the femel gaps (so-called edging), which in beech stands does not take place on account of the specific promotion of the inferior and intermediate "saplings", so that mosaic kinds of structures can develop.

In beech stands, there actually continues to be a dependency between the number, diameter and height growth of the next generation of trees and the degree of canopy closure from the older trees. A very decisive critical moment in the dynamics of beech continuous forests is the demand for a balance at the highest possible stock level, which allows the optimum yield in mass and value. The horizontal and vertical structure in beech continuous forests in group selection - as other selection forests - cannot be obtained as such without human influence. Beech stands tend towards temporary canopy closures even in primeval forests. With an increasing degree of closure basal area in breast height greater than 20 m², the value and growth performance increases. Beyond 30 m² stand basal area, no regrowable trees can be expected. By keeping the basal area artificially a little under 20 m² and thereby creating a favourable balance for the growth of new young trees, no equivalent growth as in age class forests can be achieved (cf. SCHÜTZ, 2001). For this reason, we can aim at a grouping at least in small collectives (groups) almost over certain periods of time (during selective phases) for the benefit of growth. This means to achieve a higher point of canopy closure leading to a sort of "wave movement" of the standing volume mentioned above.

In our opinion, there are three important subjects that must be researched in this context and should be examined in the District Forestry using measurement results and evaluations of the commercial operating results:

1. Are the qualitative and quantative results of this kind of management of the beech stands comparable with the traditional way or better (e.g. quality of the trees harvested, quality of the next generation of trees, optimisation of growth or rather use of the location's potential)?

2. Are the economic results and the total operating efficiency of this kind of management comparable or better than the traditional way of doing it?

3. Can the acceptance of nature conservation for the

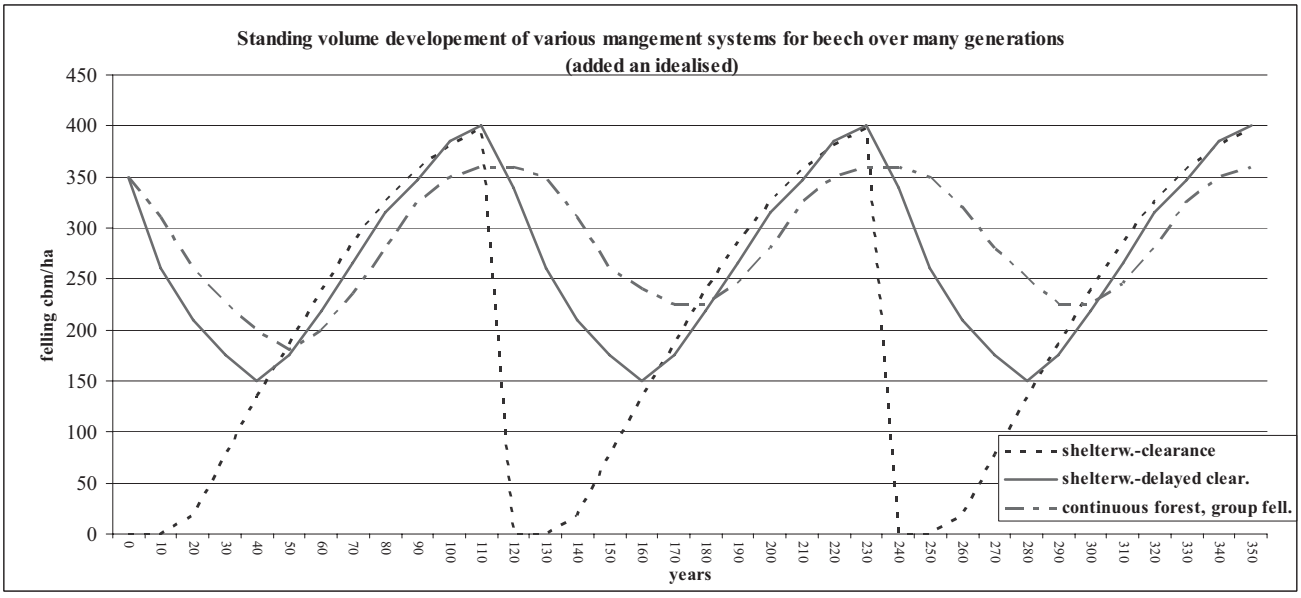

Figure 5: Standing volume development of various management systems for beech over many generations. Data for curves: shelterwood system, fast clearance from yield table MÖLLER (DK) 1933; shelterwood system, delayed clearance from BEECHSGAARD, NORD-LARSEN (2000); and structured continuous forest with group felling (FRÖHLICH, 2001).

Slika 5: Razvoj lesne zaloge različnih sistemov gospodarjenja z bukvijo skozi več generacij. Podatki za krivulje: zastorno gospodarjenje s kratko obnovitveno dobo MÖLLER (DK), 1933; zastorno gospodarjenje z dolgo obnovitveno dobo BEECHSGAARD, NORD-LARSEN (2000) in strukturirani trajni gozd s skupinsko prebiralno sečnjo (FRÖHLICH, 2001).

(further) usage of beech stands be improved in this way or even be brought into line?

4 Comparisons of systems

4 Primerjave sistemov

The question of more potentially valuable trees in the stands

Vprašanje potencialno bolj dragocenih dreves v sestojih

In the process of differentiated age classes forest, shelterwood with delayed clearance, in spite of relatively long regeneration periods of up to 50 years, particularly in the regeneration phase after the soil has been tilled and the regeneration of the whole area introduced, many inferior and intermediate trees that are weaker but have good potential are removed . This takes place in order to achieve the regeneration in the whole area with as many stems as possible and to improve height growth of the next generation of trees.

In order to examine the range of variation in the stem number in comparison to the reference stands recognised as irregular and those stands considered as two-storey stands, the data were extracted from control samples of the forest management data base 2000 considering stands over 100 years old, which are characterised as „horizontally and vertically well-structured“ and have been inventoried at least two times. The same goes for stands that are characterized as “two storeys = main storey and under storey”.

Throughout all age classes, a relatively broad variation in the diameter of the stems is recognisable in both categories. A tendency to limit this variation range with increasing age is not recognisable in the structurally irregular stands (Fig. 6) (r^2=0.02). The values of dbh vary between 30 cm and 70 cm between 100 and 150 years old. In contrast, the two-storey stands analyzed in Fig. 7 show from the beginning a more limited variation range of dbh. The mean variance of all values is around one third less than that of the collective of the structurally irregular stands and decreases considerably with increasing age.

Growth of individual (valuable) trees is high, but lower than in the two-storey stands; however over all there are more valuable trees. The annual diameter growth (average) of larger older beeches in the two-storey stands decreased from 5.8 mm at dbh 40 cm continually to a value of around 5.5 mm at dbh of 60 cm. This development is not significant considering the wide spread of the data. But this is not the aim of the representation, which is far more to prove the absolute height of growth of large free-standing trees.

The larger the tree, the less obvious is the trend of a decrease in diameter growth. Apparently the free standing allows a concentration of growth on few remaining trees that leads to a somewhat higher growth level than in the structured stands with a greater number of trees. With a wide variation and scarce correlation, their trend curve (Fig. 9) attains a lower growth level per year in comparison to the two-storey stands, from 5.4 mm per year at 40 cm dbh to 4.4 mm per year at 65 cm dbh. In spite of this relatively feeble and statistically insignificant decrease of the diameter growth, the annual volume growth of the individual tree increases from 0.069 to 0.088 volume m³

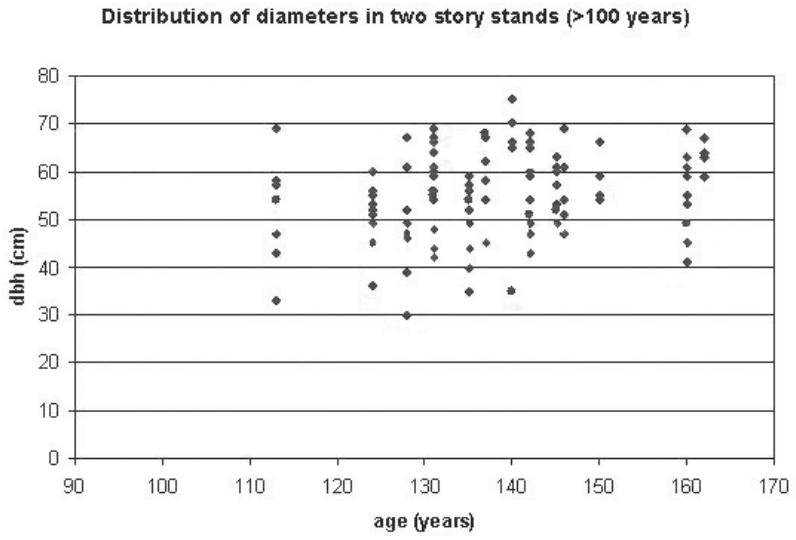

Figure 6: Diameter distribution of trees older than 100 in two-storey stands (16)

Slika 6: Porazdelitev premerov dreves starejših od 100 let v dvoslojnih sestojih

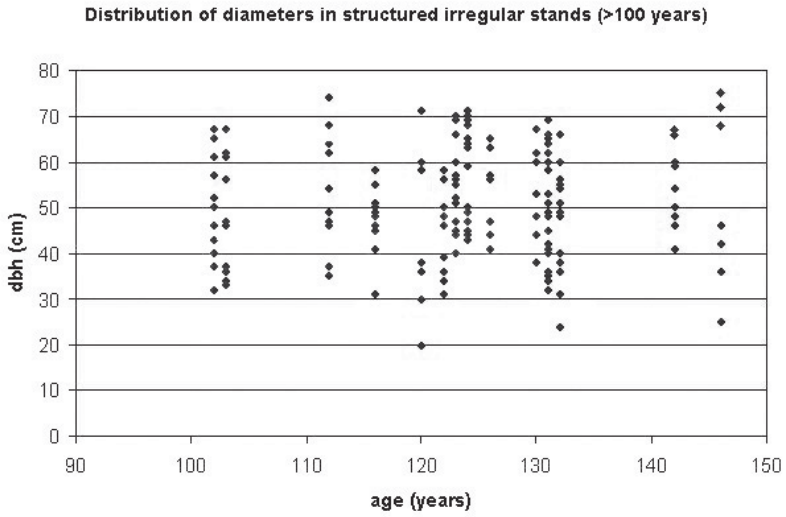

Figure 7: Diameter distribution of trees older than 100 years in structurally irregular stands (N = 15)

Slika 7: Porazdelitev premerov dreves, starejših od 100 let v strukturno neenakomernih sestojih

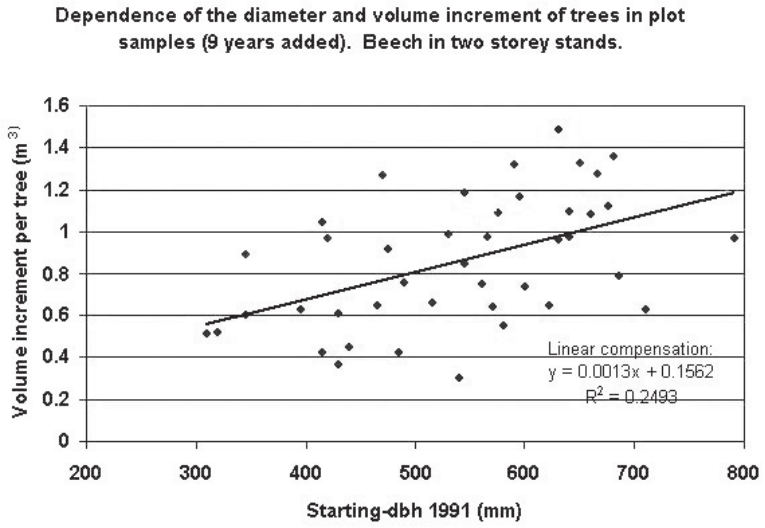

Figure 8: Dependence of the diameter increment from dbh of selected two-storey stands. Basis: Control samples plots 1991 and 2001. Figure shows all trees above 30 cm dbh.

Slika 8: Odvisnost debelinskega prirastka od prsnega premera izbranih dvoslojnih sestojev. Osnova: kontrolne vzorčne ploskve iz leta1991 in 2001. Slika prikazuje vsa drevesa nad 30 cm prsnega premera.

per tree with increasing dbh. This means that in 10 years in structurally irregular stands the trees of the main storey and the upper middle storey with more than 30 cm dbh increased on average by between 0.7 and 0.9 volume m³.

The trees of the main storey and the upper middle storey of the two storey stands, which are typical for a certain phase of the process differentiated age forest, when compared to shelterwood cut with delayed clearance, allow us to recognise a somewhat smaller decrease in the diameter growth of the larger trees. However, it must be taken into account that in the structurally irregular stands more growing trees remain over a longer period of time and therefore the lesser individual increment is easily compensated for by the larger number of trees.

The comparison of the 15 larger trees than average in irregular structured stands and the number of two-storied stands with more than a diameter of 28 cm shows quite impressively the higher number of trees in the upper middle storey of the structured stands. We can presume up to a dbh of 32 cm in the structured stands that there are trees with a serving character, filling the stand. Further we can also cautiously presume that from the dbh steps 36 cm and 40

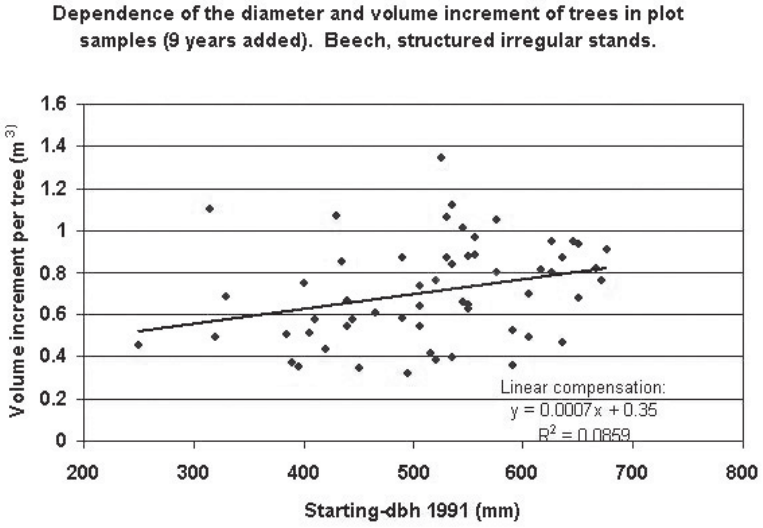

Figure 9: Dependence of the diameter increment from the dbh in the selected structurally irregular stands. Basis: Control samples plots 1991 and 2001. Figure shows all trees above 30 cm dbh.

Slika 9: Odvisnost debelinskega prirastka od prsnega premera izbranih strukturno neenakomernih sestojev. Osnova: kontrolne vzorčne ploskve iz leta1991 in 2001. Slika prikazuje vsa drevesa nad 30 cm prsnega premera.

Table 1: Direct comparison of the number of valuable trees per hectare per dbh categories. Basic data from the control samples of 15 selected structured stands and 16 two-storey stands with trees between 120 and 180 years old. Only the value of the number of stems from a BDH of 28 cm (beginning upper middle storey) is represented.

Tabela 1: Neposredna primerjava števila dragocenih dreves na hektar po kategorijah prsnih premerov. Osnovni podatki iz kontrolnih vzorcev izbranih 15 strukturiranih sestojev in 16 dvoslojnih sestojev dreves s starostjo med 120 in 180 let. Predstavljena je le vrednost števila debel prsnega premera 28 cm (začetek zgornjega srednjega sloja).

number of trees \ quality level			quality level 1		quality level 2		quality level 3		Ø quality level
two storey stands	124	100%	13	10%	82	66%	29	23%	2.12
structured irreg. Stands	205	100%	26	13%	116	57%	63	31%	2.18

cm only half the number of stems can be considered as potentially "valuable trees" and therefore as a consequence the other half must be seen as belonging to the serving group, this nevertheless results in a considerably higher number of stems of potentially valuable trees (adjusted table) in the upper middle storey of almost 40%.

From a growth point of view and as a result of the different curves in Fig. 9 and the absolute number of stems over the dbh in Table 1, we can establish that in the system of structured continuous forest with group felling there are more than 40% of the trees (around 30 per ha) of the upper middle storey, above the age of 120 years, which needs on average a 30% more time to reach maturity, i.e. to achieve a target diameter.

The question of economic results and the total operating efficiency

Vprašanje ekonomskih rezultatov in skupna učinkovitost poslovanja

Every decision to leave a product standing that could well be put on the market, such as weaker and well-formed stems of a certain size-class that are no longer absolutely necessary to protect the soil and the oncoming regeneration, represents a question of effective return at least from a financial point of view. Available capital, which after the deduction of the timber harvest costs and possibly other costs or charges is "invested" further, i.e. left in the forest and its growth and its appreciation in value must cover its costs (opportunity costs = interest). It quickly becomes clear that also the risk of a loss in value (price or cost change) or a possible total or part loss must also be included

Table 2: Model calculation of the natural and economic additional return

Tabela 2: Model izračuna naravnih in gospodarskih dodatnih donosov

Model calculation by means of example stands				
Category: shelterwood delayed clearence			**harvest cubicmeters**	**Euro**
	1	2	3	4
period	Harvest volume at beginning	Increament 10 years	Harvest cubicmeters at the end	Proceeds less harvest cost
120 – 130 years	286	63	130	5200
130 – 140 years	219	56	140	5920
140 – 150 years	135	35	100	4500
150 – 160 years	70	16	86	3655
sum			**456**	**19275**
Category: structured continuous forest			**harvest cubicmeters**	**Euro**
period	Harvest volume at beginning	Increament 10 years	Harvest cubicmeters at the end	Proceeds less harvest cost
120 – 130 years	286	63	120	4800
130 – 140 years	229	59	100	4250
140 – 150 years	188	56	95	4275
150 – 160 years	149	49	90	4275
160 – 170 years	108	35	80	3600
170 – 180 years	63	16	79	3358
sum			**564**	**24558**
difference			**108**	**5283**

in the calculation. As before, with the same consistent quality in deciduous timber, we were able to prove for our District Forestry that a continuous increase in profit is achieved with the increase in the thickness of timber.

If we introduce the values from the data in the previous chapter into the model calculations, we can estimate that with achieving the process considered so far, it would be possible to harvest 108 m³/per ha in prolonging the rotation by 20 years. The additional return (proceeds less harvest costs) produces more mass, a higher target diameter proportion and lower timber harvest costs. It thus amounts to a total of 5,283 euros per ha over the whole 60 years taken as a model.

As the time factor with 40 or rather a further 20 years is considerable, in a further graduated marginal return calculation the return of standing volume in timber at aged 120 years (11,140 Euros /ha), in both alternatives of harvesting after 40 or 60 years was calculated at around 2.4%. In a differential investment calculation based on this assumption it was possible to calculate for the process of a structured continuous forest with group felling an annual additional return of 75.88 euros/ha over 60 years, which is equivalent to an annuity of 5.74 per ha. Over a period of many years, such a forestry achieved brings an annual profit of around 50 euros per ha. Thus, assuming the choice of close to nature management system, an increase in the resulting income of around 10% can be achieved whereby certain growth loss in the regeneration through the effects of edging must be taken into consideration.

The question of nature conservation of beech stands

Vprašanje ohranjanja narave bukovih sestojev

In contrast, the ecological effects for the process of a structured continuous forest with group-selection felling is estimated to be positive in all parameters and comes relatively close to the natural forests, especially if in addition selected trees or groups of trees can remain in the stand in order to enrich it naturally and long-term with old trees and dead wood, for which this type of forest structure is predestined. Around 40% of the area of the Forestry has been designated as Flora Fauna Habitat areas or Bird Protection areas according to the EU regulations. The first evaluations of the stands and the development of endangered or rare species after 10 years show a clearly increasing tendency, which makes us happy and proud.

5 Conclusions

5 Zaključki

Forest areas close to nature (CTN) structured both horizontally and vertically with trees of different ages and a high percentage of maturing trees of high quality and size are one goal of a forestry management oriented towards ecology and economy in the natural deciduous forest areas of the North German lowlands. The growth and quality

of beech trees, but also other deciduous trees (e.g. oak, ash, sycamore, lime), are the result of optimal conditions with a temperate oceanic climate on strong locations well-supplied with water from the most recent Ice Age.

Making use of the self-regeneration and self-regulating forces stemming from the effects of light and shade reduces the operating costs and together with appropriate returns for high-value and large dimension timber leads us to expect a business advantage from this form of forest management. As such, a forest structure comes as close as possible to the phase change in primeval forests, its ecological value must also be considered much higher than forms of age classes forest or less-structured forest structure types.

So far, management forms have been developed in North German lowlands and in other deciduous forest areas in Germany that show considerable improvements in the stand structure and the maturing of individual trees of value within the forest compared to the age classes forest. Nevertheless, there are still considerable deficits with regard to the close to nature demand, and the proportion of high quality trees in the stand, that have fallen victim to felling and been taken out prematurely is considered too high.

On account of these considerations and encouraged by examples of a kind of perpetual forest structure in individual stands, the former process of "differentiated age classes forest, shelterwood cut with delayed clearance" has been further developed to the process of "a structured continuous forest with group-selection felling, also known as femel-felling".

In an operational study of natural, commercial and ecological parameters in stands managed according to the two different processes of forest structure types, it was established that the growth performance as a whole increased in this way and the quality of the amounts harvested did not pejorate. These observations were then extended to consider the use of marginal interest yield calculations, on the one hand to calculate whether it was financially profitable to leave potentially useful trees standing and also to calculate what capital yield was lost, when potential growth trees were harvested too soon (differential investment calculation).

As a result it was possible to establish from a natural point of view that on average over many years there was a clear increase in the potential use of large dimension timber. The increase in the dimensions of the larger trees however remained a little below that of the shelterwood cut stands, which in total was again compensated for by the larger number of stems. Standing volume remained clearly higher at all times and the variations remained within a range of merely 200 - 400 growing stock cubic meter per hectare. From a commercial point of view, the advantages are also perfectly obvious. The higher profits from better performance and better yields are an additional benefit to the lower costs. These are relativised by the somewhat lower quality (tendency to knots) of the logs and the inhibition of growth to be expected in the successive generations at the gap edges. The absolute cash-flows are also considerably higher than with the process "differentiated age classes forest, shelterwood cut with delayed clearance", when the large dimension timber phase is extended by around 20 years. Both processes - considered individually - already achieve a marginal return of 2.4% and more in relation to the time of the potentially possible decision to fell the trees when they are 120 years old (age classes forest), which is an opportunity-oriented way of looking at the costs. In this case, however, the process of the differentiated age classes forest, shelterwood cut with delayed clearance does slightly better, as the rapid capital turnover (<40 years) has a positive effect here. In a differential investment consideration between the two processes, an annuity of around 5.75 euros per hectare and year of further investment assessment was achieved in favour of the perpetual forest over the whole period.

In contrast, the ecological effects for the process of a structured continuous forest with group-selection felling are estimated to be positive in all parameters and come relatively close to the natural forests. This is especially the case if in addition selected trees or groups of trees can remain in the stand in order to serve as natural and long-term enrichment with old wood and dead wood as part of a perfected commercial and ecological concept, for which this type of forest structure is predestined.

These operationally established results should be verified by further scientific investigations and established on a broader more certain basis.

6 Povzetek

Gozdovi, ki so horizontalno in vertikalno sonaravno strukturirani, z drevesi različnih starosti in visokim deležem visokokakovostnih odraslih dreves velikih dimenzij, so eden izmed ciljev ekonomsko in ekološko usmerjenega gospodarjenja z gozdovi v severnonemškem nižavju. Rast in kakovost bukve ter drugih listavcev (npr. hrasta, jesena, javorja, lipe) so rezultat optimalnih rastnih razmer zmernega oceanskega podnebja in na kakovostnih rastiščih, ki so dobro oskrbljena z vodo.

Uporaba samoregenerativnih in samoregulacijskih sil, ki izhajajo iz učinkov svetlobe in sence, zmanjšuje operativne stroške gospodarjenja in skupaj s primernim donosom visoko vrednih sortimentov velikih dimenzij nakazuje, da ima tovrstno gospodarjenje z gozdovi ekonomske prednosti. Ker se takšna struktura gozda približuje izmenjavi življenjskih faz pragozda, je tudi njegovo ekološka vrednost višje ocenjena kot pri enodobnih

oziroma manj strukturiranih tipih gozdnih sestojev.

Doslej so bile v severnonemškem nižavju in drugih listnatih gozdovih Nemčije razvite metode gospodarjenja, ki kažejo precejšnje izboljšanje sestojne strukture in naraščanje vrednosti posameznih visoko vrednih dreves v primerjavi z enodobnimi gozdovi. Kljub temu pa še vedno obstajajo precejšnje pomanjkljivosti glede na zahteve sonaravnega gospodarjenja. Prav tako je delež visokokakovostnih dreves v sestoju, ki so bila predčasno odstranjena s sečnjo, prevelik.

Glede na te okoliščine in ob spodbudnih primerih strukture trajnih gozdov v posameznih sestojih so gozdnogojitveno zvrst "enodobnih gozdov z zastornim gospodarjenjem in odloženo pospravilno sečnjo" razvili v zvrst "strukturiranega trajnega gozda s skupinsko prebiralno sečnjo". Iz praktične primerjave naravnih, ekonomskih in ekoloških kriterijev v sestojih, kjer so uporabili omenjeni gozdnogojitveni zvrsti, izhaja, da se je na ta način priraščanje v celoti gledano pospešilo, pri tem pa kakovost in količina sečnje nista upadli. Ta opažanja so nato razširili z uporabo izračunov mejnega donosa, da bi ugotovili, ali se finančno splača pustiti potencialno uporabna drevesa v sestoju dlje od predvidene obhodnje, in hkrati izračunali, kolikšna je izguba kapitalskega donosa, če potencialno kakovostna drevesa v polni rasti prehitro posekamo (izračun diferencialne investicije). Z vidika rasti sestoja smo ugotovili, da se v daljšem časovnem obdobju občutno poveča potencialno izkoriščanje sortimentov velikih dimenzij. Povečanje dimenzij velikih dreves je bilo nekoliko počasnejše kot pri sestojih z zastornim gospodarjenjem, vendar je to odtehtalo večje število dreves. Lesna zaloga je bila vseskozi višja in odkloni so ostali v razponu 200-400 kubičnih metrov lesne zaloge na hektar. Tudi z ekonomskega stališča so prednosti povsem jasne. Poleg nižjih stroškov je dobiček zaradi hitrejše rasti in prirastka večji, čeprav je kakovost posekanih debel nekoliko nižja (več grčavosti) in lahko pričakujemo nekoliko slabšo kakovost in zavrto rast naslednjih generacij gozda ob robovih vrzeli. Tudi absolutni denarni tok je precej večji kot pri "enodobnih gozdovih z zastornim gospodarjenjem in odloženo pospravilno sečnjo" s podaljšano razvojno fazo dreves velikih dimenzij za okoli 20 let. Oba postopka posamično že dosegata mejni donos 2,4 odstotka in celo več glede na čas morebitne odločitve o poseku dreves, ko so stara 120 let (enodobni gozd), kar je oportuniteten način obravnavanja stroškov. A v tem primeru se "raznodobni gozd z zastornim gospodarjenjem in odloženo pospravilno sečnjo" izkaže za nekoliko uspešnejšega, saj ima hiter obrat kapitala (<40 let) pozitiven učinek. V primerjavi obeh postopkov s stališča diferencialne investicije je raznodobni gozd v celotnem obdobju prinesel 5,75 evra na hektar na leto dodatnega prihodka.

Medtem pa so bili ekološki učinki strukturiranega trajnega gozda s skupinsko prebiralno sečnjo ocenjeni kot pozitivni v vseh parametrih in se zelo približajo sonaravnim gozdovom. To še posebej velja, če lahko hkrati izbrana drevesa ali skupine dreves ostanejo v sestoju za dolgoročno obogatitev s starimi in odmrlimi drevesi kot del izpopolnjenega ekonomsko- ekološkega koncepta gospodarjenja. Te praktično ugotovljene rezultate je treba verificirati z nadaljnjimi znanstvenimi raziskavami in utemeljiti na širši in bolj zanesljivi osnovi.

7 References

7 Viri

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