

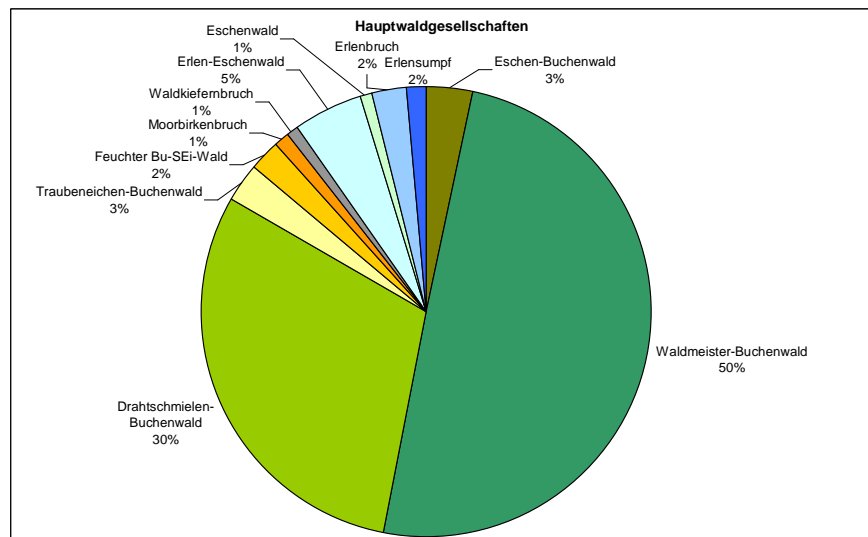
Best practices of CTN – forestry and challenges for research.

Introduction

The Forestry of the Duchy of Lauenburg District 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 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.

Fig. 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).



The regional climate in

the south-west is an oceanic climate with around 740 mm 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 a little bit 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 ground water 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 following cold period, which make it almost impossible to identify the differences between ground and end moraines.

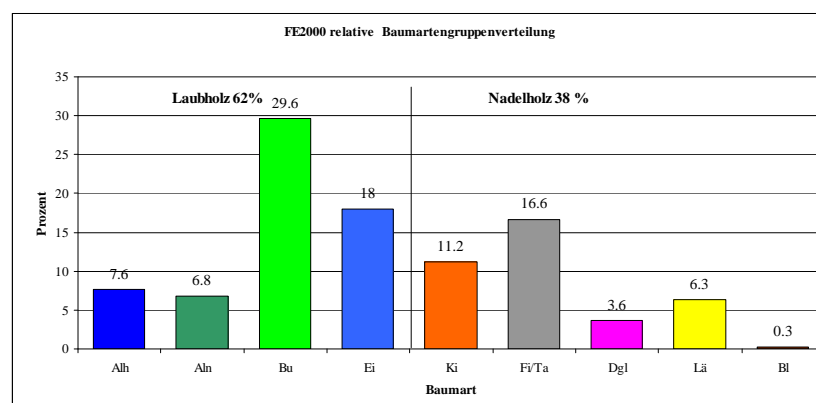
The **soil types** on the younger end moraines are predominantly parabrown soils - brown soils often with easily reached free lime in the substrata. On the ground moraines the ground water and catchment water zones reach for the most part right into the rooting capacity areas so that here gley and pseudo-gley soil types develop.

The **current distribution of tree types and species** (forest management planning 2000) is shown in the following

table:

Fig. 2:

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



From 1923-1926 the perpetual forest principle was already established in the District Forestry. The economic regulations necessary for this were suggested by Herr von Kalitsch from Bärenthoren and at the same time the **control method** was chosen as the process for setting it up. However in 1935 they returned to the age classes method. The ratio of deciduous to coniferous trees was 80:20 in those days. From 1945 to 1949 after the Second World War 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.

A. Best practices

In the District Forestry that I am in charge of, until 12 years ago- a beech management was systematically used that we have called: **Differentiated age classes forest, shelterwood cut with delayed clearance.**

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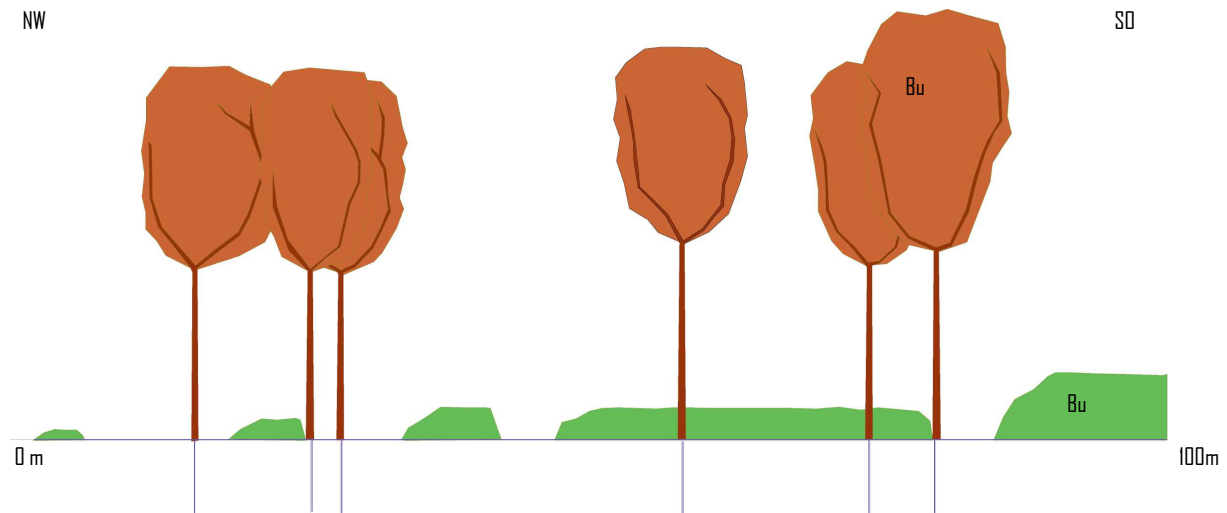


Fig. 3: Diagrammatic representation from a linear trans-section -picture (100*10m) of a model **two-layer stand** of the District Forestry. **Differentiated age classes forest. Shelterwood cut with delayed clearance**

Far-reaching ecological and nature conservation demands and observations from individual reference stands and forestry in particular have led to considerations and empirical studies on further developing the aforementioned forms of stands and usage. The demands for an extensive waiver of disturbances to the ground vegetation and soil, as caused by sometimes very deep working of the soil over large areas must be mentioned here. Furthermore through the effect of the now as before very abrupt free clearance, the potentially promoted shade trees frequently die prematurely in great numbers in the process **differentiated age classes 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 presumably allows oxygen to enter into the inner core of the trunk so that an 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 should stand closer together and in so doing come 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,

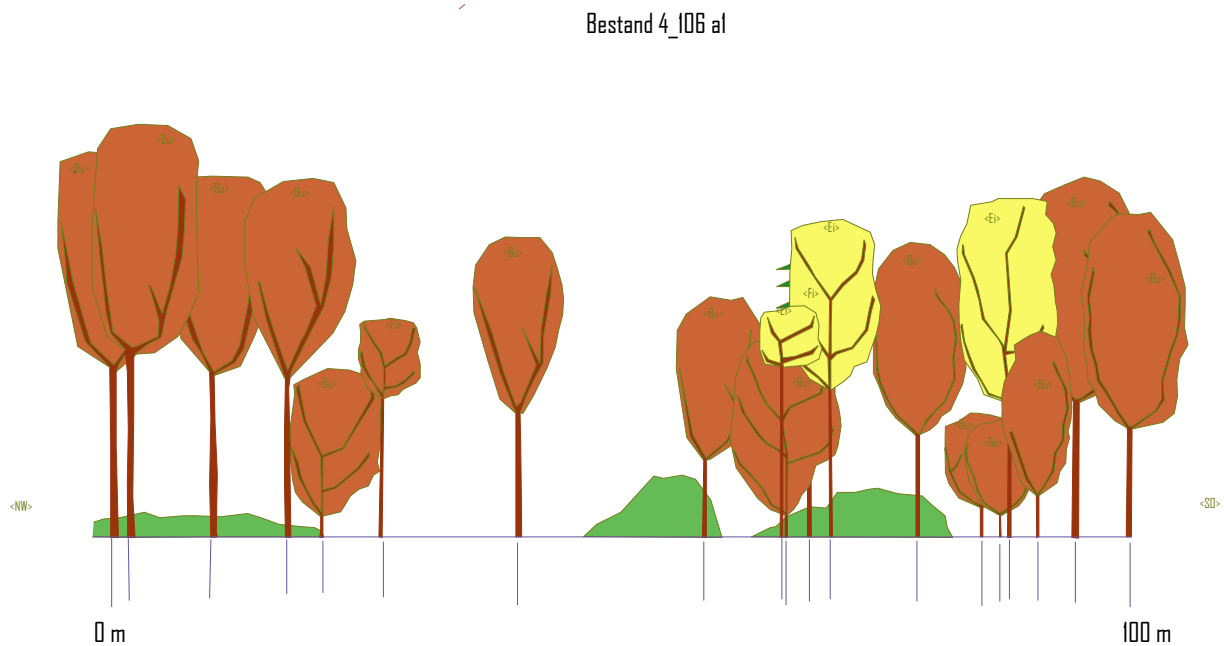
DETSCH u. SCHULZ (1995) structurally diverse mixed stands represent a „quantum leap“ in biodiversity as compared to single-storey pure stands.

This process means that we achieve a more natural forest and a much higher degree of acceptance concerning the relevant aims of nature conservation, which are of such importance especially in beech woods today.

So we have changed our beech management to a: **Structured perpetual forest¹ with group-selection felling.**

In contrast to the mixed coniferous forests of the Alps and the foothills of the Alps, in the North German lowlands there are few or no stands of field-proven perpetual forests or selection forests in beech forests or those where beech trees predominate.

Fig. 4: Diagrammatic representation from a linear trans-section -picture (100*10m) of a model **beech perpetual forest** of the District Forestry. **Structured perpetual forest with group-selection felling**



Especially in spite of the almost systematically used process, we could frequently find stands or parts of stands of varying size and area that either by chance or by conscious directive come very close to the perpetual forest models described in their structure and the way they grow. They were examples for us.

¹ PALMER (2000) describes the perpetual forest according to a definition of the AG Forestry Institutions of the State and the „Länder“, Page 36; „... Perpetual 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..“

Besides these reasons of nature conservation there are quite decisive economic reasons and basic demands of the close to nature forestry on the **structured perpetual forest with felling**. For with the planned introduction of the regeneration of the former process, besides the aforementioned negative influence on the eco system, a large number of good trees were removed from the middle layer (storey) to give light - trees with a high development potential. 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 only be taken out in place of a better one. Thus natural forestry forbids taking out 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.

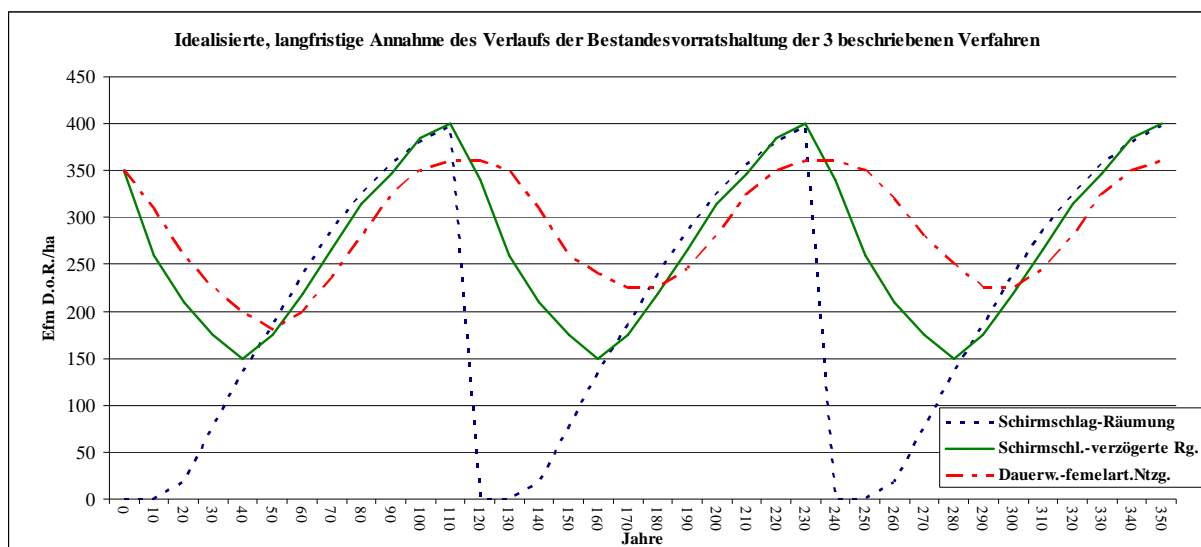
Specific features of beech perpetual forests

SCHÜTZ (1992) after intense study of special literature on the subject 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 axle capable of forming a tree top crown... . In the 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 the work of SCHAEFFER (1951) that the stock sourcing in beech selection forests, which should guarantee a sustainable regeneration and a qualitative satisfactory next-generation of trees, cannot exceed 200 – 250 stock m³/ha, and he draws the consequence from this that on account of it the yield potential of the locations cannot be used to full advantage. 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 trunks or groups of beech trees for 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 hole structures; in forestry language felling forests or forests in group wise selection felling (cf. SCHÜTZ, 2001). For REININGER (1993) however, the use of individual trees or groups of tree from beech stands is not felling in the sense of the well-known 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 felling 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 from the older trees. A very decisive critical moment in the dynamics of beech perpetual forests is the demand for a balance at the highest possible stock level, which allows the optimum performance according to mass and value. Beech perpetual forests in group selection - as other selection forests - cannot be retained as such without human influence. Beech stands - observed selectively and in phases- even in primeval forests tend towards temporary canopy closures. With an increasing degree of closure (stem base surface in breast height in excess of 20 m²) the value and growth performance increases. Beyond 30 m² stand area no new-generation trees can be expected. By keeping the base area artificially a little under 20m² and thereby creating a favourable balance for the growth of new young trees, the growth as in age classes forests cannot be achieved. (cf. SCHÜTZ, 2001). For this reason we can also demand at least in small areas (groups) or over certain periods of time (phases) the (selection) balance for the benefit of growth, which means to push it to a higher point of canopy closure leading to the “wave movement” of stock-sourcing named above.

Fig. 5: Stand stock development of various processes of beech management over many generations, added and idealised. Dates for curve **shelterwood cut, fast clearance** from yield table MÖLLER (DK)1933; for **shelterwood cut, delayed clearance** from BEECHSGAARD, NORD-LARSEN (2000); for **structured perpetual forest with femel felling** (FRÖHLICH,2001).



B. Challenges for research

In my 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 quantitative natural 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 (further) usage of beech stands be improved in this way or even be brought into line?**

With our empirical examinations we have found:

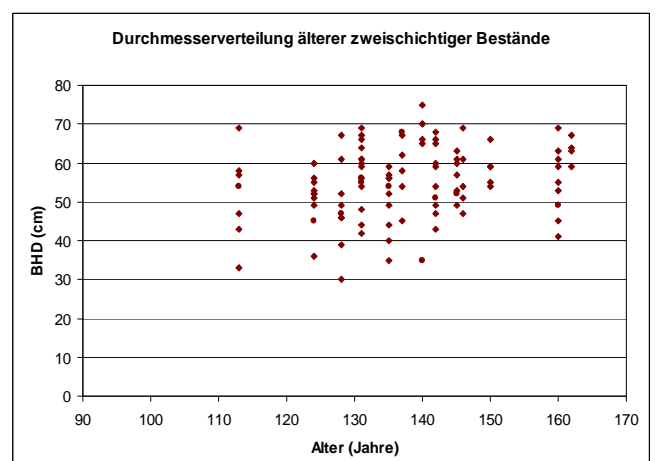
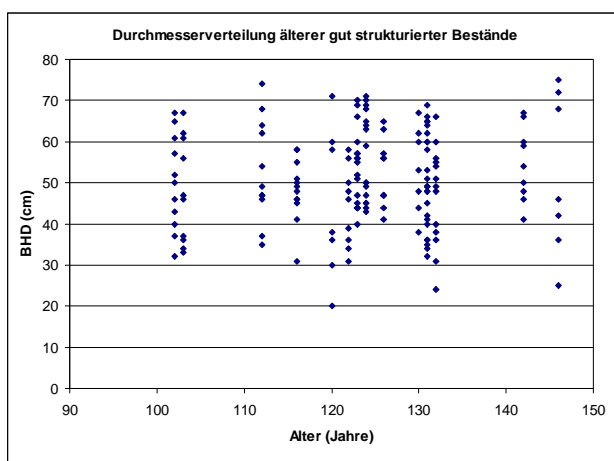
To subject 1.

More potentially valuable trees in the stands

In the process of **differentiated age classes forest, shelterwood with delayed clearance**, in spite of relatively long phases of usage of up to 50 years, particularly in the regeneration phase after the ground has been worked and the regeneration of the whole area introduced, many inferior and intermediate trees that are weaker but have good potential are taken out. This takes place in order to achieve the regeneration of the whole area with as many trunks as possible and to achieve quick growth in height of the next generation of trees.

In order to examine the range of variation widths in the number of trunks from reference stands recognised as structurally diverse and those stands recognised as two-storey stands, the data were isolated from the forest management planning 2000 and the control grab samples of all stands over 100 years old, which are marked with the characteristics „horizontally and vertically well-structured“ in the data base and have been registered at at least two systematic control grab samples. The same was the case for stands that were marked in the data base with the characteristics “two storeys = main storey and under storey” and had been registered at at least two systematic control grab samples.

Fig. 6 and 7: These show the distribution of the diameter of all trees over 100 years old in the structurally diverse stands (15) in comparison to those in the two-storey stands (16).



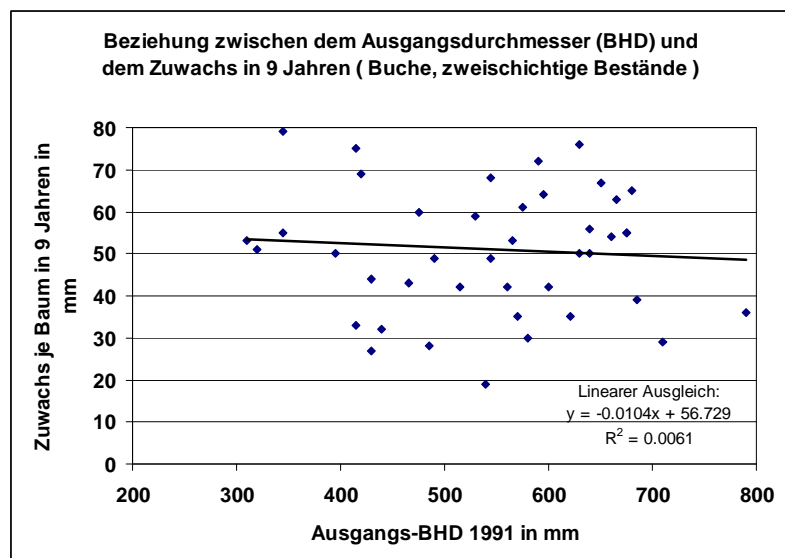
Throughout all further age classes a relatively broad variation in the diameter of the trunks was recognisable in both processes. A tendency to a limitation of this variation range with increasing age is not recognisable in the structurally diverse stands (Fig.6) ($r^2=0.02$). The established values vary between 30cm and 70 cm diameter in 1.3m height between trees of 100 to 150 years old. In contrast the two-storey stands analyzed in Fig. 7 show from the beginning a more limited variation range in the diameter of the available trunks. The middle variance of all characteristic values within this collective is around one third below that of the collective of the structurally diverse stands and decreases considerably with increasing age.

Growth of individual trees (valuable trees) is high, but lower than in the two-storey stands; however in total more valuable trees in the stands

The annual diameter growth (average) of larger older beeches in the **two-storey stands** decreases in a trend of 5.8 mm with a starting diameter of around 40 cm continually to a value of around 5.5 mm with a starting diameter of 60 cm. This development cannot however be significantly proved on account of the wide spread of the data material. 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.

Fig. 8.

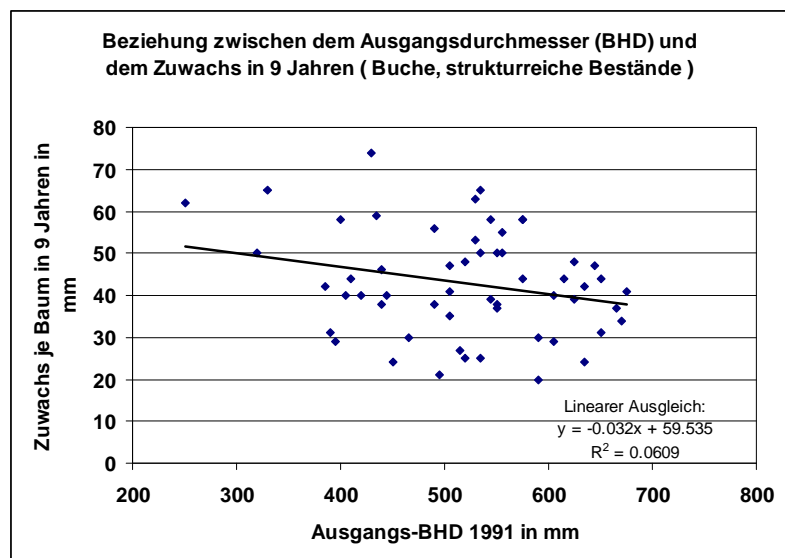
Development and dependence on the starting DBH and diameter growth of selected two-storey stands. Basis: Control grab samples 1991 and 2001. Figure shows all trees above 30 cm BDH.



The larger the trees become the less obvious is the trend to a decrease in diameter growth. Apparently standing alone and the concentration of growth on few remaining trees leads to a somewhat higher level of growth than in the structured stands with a greater number of trees. With a wide variation spread and little correlation their trend curve (Fig. 9) shows a lower growth level per year of the evaluated beeches in comparison to the two-storey stands from a

starting BDH of 400mm with approx. 5.4 mm per year and a somewhat stronger trend decrease of almost one millimetre to 4.4 mm per year from the starting BDH of 650 mm. In spite of this relatively but statistically unconfirmed decrease of the diameter growth, the annual volume growth of the individual tree increases on account of the continually higher volume of the starting body from 0.069 to 0.088 stock m³ per tree! That means in 10 years in structurally diverse stands the trees of the main storey and the upper middle story with more than 30 cm BDH increased on average between 0.7 and 0.9 stock m³ per tree depending on the individual volume at the start.

Fig. 9.: Development and dependence on the starting BDH and the diameter growth of the measured trees in the selected **structurally diverse** stands. Basis: Control grab samples 1991 and 2001. Figure shows all trees above 30 cm BDH.



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, shelterwood cut with delayed clearance** allow us to recognise a somewhat smaller decrease in the diameter growth of the larger trees. As far as the volume growth of an individual tree is concerned this superiority can be seen somewhat more clearly in the two storey stands. However it must be taken into account that in the structurally diverse stands more growing trees remain over a longer period of time and therefore what can be established as being inferior on the individual tree is easily compensated for by the larger number of trees.

The direct comparison of those trees counted in the control grab samples, those trees with more than the average diameter in 15 selected structured stands and in around the same number of two-storey 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 BDH of 32 cm in the structured stands that we are dealing with trees with a serving character, serving to fill the stand. Further we can also cautiously presume that from the following BDH steps 36cm and 40 cm only half the number of trunks can be considered as

potentially "valuable trees"² 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 trunks of potentially valuable trees (adjusted table) in the upper middle storey of almost 40%.

Table 1: Direct comparison of the number of trunks per hectare (potentially valuable trees) calculated and values calculated from the control grab samples of the BDH steps. Basic data from the control grab samples of 15 selected structured stands and 16 two-storey stands with trees between 120 and 180 years old. Represented are only the value of the number of trunks from a BDH of 28cm (beginning upper middle storey).

BHD-Stufe	28	32	36	40	44	48	52	56	60	64	68	72	Summe
N/ha (strukturiert)	2	4	7	9	13	13	12	10	9	9	9	2	99
N/ha (zweischichtig)	1	1	2	3	6	9	9	9	9	9	9	2	69

From a growth point of view and as a result of the different curves in Fig. 9 and the absolute number of trunks over the BDH in Table 1, we can establish that in the process of **structured perpetual forest with femel felling** more than 40% of the trees (around 30 per ha) of the upper middle storey, that were still there above the age of 120 years had on average a 30% longer time to reach maturity, i.e. to achieve a target diameter.

To subject 2.

Marginal return questions also not a taboo in CTN-Forestry

Every decision to leave a product standing that could well be put on the market, such as represented by weaker and well-formed trunks of a certain size-class that are no longer absolutely necessary to protect the soil and for the approaching regeneration, represents a question of **effective return** at least from a financial point of view. Available capital, which after the deduction of the wood 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 make up for 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 in the calculation. As before, with the same consistent quality in deciduous wood we were able to prove for our Forestry that a continuous increase in profit is achieved with the increase in the thickness of the wood.

² Trees are considered as „potentially valuable trees“ if they have a straight growth , a minimum of 8m without knots and a vital crown structure.

If we feed the natural values from the data in the previous chapter into the **model calculations**, we can estimate that with the further development of the process used so far it would be possible to harvest **108 cut m³/per ha** in a usage phase of the main stand extended by 20 years. The **additional return** (proceeds less harvest costs) made up of more mass, the higher target diameter proportion and lower timber harvest costs, come to a total of **5,283 euros per ha** over the whole 60 years taken as a model.

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

Modellrechnung anhand von Weiserbeständen					
Verfahren: Schirmhieb-verzögerte-Räumung				jeweils Efm D.o.R.	Euro
Spalte	1	2	3	4	
Zeitraum	Vorrat am Anfang d. Jz.	Zuwachs im Jz.	Nutzung am Ende d. Jz.	holzerntekostenfreier Erlös	
120 - 130 Jahre	286	63	130	5200	
130 - 140 Jahre	219	56	140	5920	
140 - 150 Jahre	135	35	100	4500	
150 - 160 Jahre	70	16	86	3655	
Summe			456	19275	
Verfahren: Femel-Dauerwald-strukturiert				jeweils Efm D.o.R.	Euro
Zeitraum	Vorrat am Anfang d. Jz.	Zuwachs im Jz.	Nutzung am Ende d. Jz.	holzerntekostenfreier Erlös	
120 - 130 Jahre	286	63	120	4800	
130 - 140 Jahre	229	59	100	4250	
140 - 150 Jahre	188	56	95	4275	
150 - 160 Jahre	149	49	90	4275	
160 - 170 Jahre	108	35	80	3600	
170 - 180 Jahre	63	16	79	3358	
Summe			564	24558	
Differenz			108	5283	

As the time factor with 40 or rather a further 20 years is considerable, in a further graduated marginal return calculation the return on the standing capital in timber aged 120 years (11,140 euros /ha) in both processes at the point of time of harvest of the stand or rather parts of it after 40 or 60 years was calculated at around 2.4%. In a differential investment calculation based on this it was possible to calculate for the process of a **structured perpetual forest with femel 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 the Forestry achieved an annual pure profit of around 50 euros per ha. Thus by turning to the close to nature process

an increase in the results of around 10% can be achieved whereby certain growth depressions in the regeneration through the effects of edging must be taken into consideration.

To subject 3.

In contrast the **ecological effects** for the process of **a structured perpetual 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 wood 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.

Summary

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 in the North German lowlands and in other deciduous forest areas in Germany management forms have been developed 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 perpetual 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 deteriorate. These observations were then extended to take in the use of marginal interest yield calculations, on the one hand to calculate whether it was financially profitable to leave potentially useful kinds of 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 **from a natural point of view** to establish 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 thicker trees however remained a little below that of the shelterwood cut stands, which in total was again compensated for by the larger number of tree trunks. Stock sourcing 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 perpetual 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.

Franz-Sales Froehlich, Executive Director