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Report - I

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Abstract

In this report the viability of different scoring systems for examining nature quality will be analyzed and discussed. The study compares the reliability and the differences of these distinct scoring systems' capabilities to assess forest ecosystem quality. The different scoring systems used in this report is the Untouched Natural Forest Index (UNA), subjective Group scores, and to a lesser extent the Shannon-Wiener Index. This was done through the observation and examination of three different forest areas, Ogstrup 325, Ogstrup 326 and Rankenskov. To evaluate the quality of the forest ecosystem and the effectiveness of the scoring systems, three hypotheses were proposed. (1) The UNA and Group scores change over time. (2) There is a correlation between the different scoring methods. (3) There is a general trend between the UNA and Group scores for each year. The results indicate that both UNA and Group scores can be effective methods for rating forest quality, but they can also individually highlight different parameters. Our discussion focuses on what influence forest management and differentiation in forest ecological factors have on the different scoring systems and their ratings. The limitations of the scoring systems are also discussed, and how there might be variation in their purpose of assessment.

Research Question: How viable are existing scoring systems in determining nature quality?

Introduction

In the evaluation of a given site based on almost any given criteria, indices remain one of the most common methods to assist with research, providing a well-structured framework that can be applied to a multitude of sites to assess their qualities within the same given parameters. The Untouched Natural Forest Index (referred to from this point as the UNA Index) represents one such framework, with a certain focus diverted to habitat-forming structures in a forest ecosystem that promote biodiversity.

This report aims to explore the results derived from the UNA Biodiversity Index and personalized group scores evaluating three separate sites, two located in Ogstrupskov and one in Rankenskov. Over the period of 16 years (2009-2024, Ogstrup Forest Compartment 326 and Rankenskov) and 9 years (2016-2024, Ogstrup Forest Compartment 325), several research groups (new groups each year) have gone through the same field exercise of first evaluating a site based on their own personal criteria and then through the UNA Index Questionnaire. Based on the dataset derived from these observations, this report will examine the change in scores over time, the correlation between Group Scores and UNA Index scores, and discuss the ecological differences between the sites that may explain the examined results.

The report will consist of the known historical and ecological background of the sites in question, the methodology by which the data was collected, processed and analysed, followed by the results of analysis and the discussion of key findings. The discussion also intends to touch briefly on the Shannon-Wiener biodiversity index and the difference in its approach compared to the UNA Index.

The analysis and subsequent discussion rely on the information possessed – datasets of both Group Score and UNA index scores from 2009 to 2024 and general information regarding site locations (Flora, Fauna, climate and soil conditions *expected* to be found in the geographical region and subsequently confirmed on site via field observation), as well as the historical information regarding management strategies in the area that may have affected the sites' present conditions.

We are limited in our information about the criteria of Group Scores of all three sites for our group only. With no access to the reasoning behind other group scores in the dataset, it becomes difficult to judge the dispersion of group scores in relation to the criteria under which they were made.

The limitations of the report are also present in a lack of in-depth knowledge of soil types present on the three sites, as we find one to two soil auger tests for. The size of the area is inadequate for an absolute description of the type of soil encountered.

Finally, we are not in possession of all verifiable facts regarding the sites' ecological and anthropological history and cannot say with certainty if any major events have taken place throughout the observations years, making the assessment of reasoning behind ecological conditions inherently lacking in accuracy.

Hypotheses

We proposed the following null hypotheses to be examined by the field and statistical methods for the Ogstrup 325a (2016-2024), Ogstrup 326a (2009-2024) and the Ranke (2009-2024) stands:

1. The group scores and UNA indices, both, generally remain the same for each stand over time.
2. The group scores and UNA indices, both, are generally comparable in a particular year amongst the three stands over time.
3. The group scores and UNA indices show weak to no correlation (modulus of the correlation coefficient < 0.3) with each other.

In the event of the rejection of the null hypotheses, the following alternative hypotheses were proposed for consideration for the Ogstrup 325a (2016-2024), Ogstrup 326a (2009-2024) and the Ranke (2009-2024) stands:

1. The group scores and UNA indices, both, generally vary according to a trend (increasing or decreasing depending on the results) for each stand over time.
2. The group scores and UNA indices, both, form a general trend of comparison (increasing or decreasing depending on the results) in a particular year amongst the three stands over time.
3. The group scores and UNA indices are at least moderately correlated (modulus of the correlation coefficient >= 0.3) with each other.

Materials

Ogstrup 326a, 325a and Ranke, have been observed on the 5th September 2024. Nydam was not personally observed. The consequent site descriptions are based on the delivered excursion discussions and analyses.

Ogstrup 326a:

Figure 1: Ogstrupskov 326a, 2024

Ogstrup 326a is an old beech stand from 1887 and it was the result of a natural regeneration, see figure 1. In 1993, a very hard thinning was made; a shelterwood thinning, which opened the canopy up and light could reach the ground. The intention was to force a natural regeneration (Karsten Raulund, Personal communication, 2024).

The attempt failed and the excess light on the forest floor provided good conditions for grass to thrive, which then made the beech trees stagnate in growth, making it very difficult for the beech trees to close the canopy gap.

The site also has traces of a high browsing density (Naturstyrelsen, 2.5 Natur, n.d) making it difficult for the natural regeneration to out-compete the grass. As a result, it is a very uniform stand, with a lot of large old beech trees, with only a few of them in the veteran yet decaying category while the rest are alive and well.

The understory consists mostly of small heavily browsed beeches, with only a few making it above bite height of the browsers. The forest floor mostly consists of grass. In the middle of the stand there is a large fallen oak, which has been dead for decades, and around it the new natural regeneration has been more successful.

The stand, and its surroundings seems to be a success story for regulation of hunting and logging (managed hunting) (Naturstyrelsen 1.4 Naturpleje, n.d). Except for some veteranisation in 2017-2020 the stand has been untouched since 1999 (Karsten Raulund, Personal communication, 2024).

The soil has a nutrient regime of 3-4, while the moisture regime is well drained of 4 - 5. The soil is estimated to be mull, see figure 2.

Figure 2: Ogstrupskov 325a Soil, 2024

Ogstrup 325a:

Ogstrup 325a is a middle-aged Norway Spruce stand from 1984. There is a small beech stand (325d), which we did not include in our group score and UNA score. In 2017, a very hard thinning was done to follow the forestry biodiversity plans.

The hard thinning open way to a lot of light to the forest floor. Unfortunately, there was no understory nor any deadwood from the hard thinning left this year. The thinned timber was used to finance the maintenance of the stand (Karsten Raulund, Personal communication, 2024).

Figure 3: Ogstrupskov 325a, 2024

A lot of natural regeneration was observed all over the stand, consisting of mostly Norway Spruce, but also Sitka Spruce, Oak and Birch. There are a few patches with 2-3 years old natural regeneration of Norway Spruce, and they don't seem to be affected by browsing, see photo 3. This stand is also being managed hunting and disturbance free since 2009.

The soil has a nutrient regime of 2-3, while the moisture regime varies across the stand, because of changing topography. On the tops, the moisture regime was 3-4, see figure 4. While in the depressions the moisture regime was 8-9, see figure 5. A soil sample was made both on tops and in depression. In the depression the soil was gray, indicating that no oxidation of iron was present. The low rate of decomposition of the litter and the hard soil profile differentiation in the top profiles indicates a mor soil.

Figures 4 & 5: Ogstrupskov 325a Soil, 2024

Ranke:

Ranke is a very old Beech stand from 1863, which has been managed by selective logging since 1925, and has been completely untouched since 1987 (Møller, 2017). The stand still has traces from its beech production history, hence the large old beeches, but in the last 40 or so years, windthrow has made more and more gaps in the stand.

Figure 6: Rankeskov, 2024

Figure 7: Rankeskov Soil, 2024

Natural regeneration was mostly beech as well as some elm and birch, making Ranke a much less uniform stand than 326a, see figure 6. The amount of dead wood was also higher than in stand 326a. Also, those beeches left behind from the selective logging, seems to be those of the lowest economic value, meaning they have low bole and bad shapes. There are signs of browsing, but not of the same density as in 326a. The soil has a fairly low accumulation of litter and a short organic horizon that gives way to sandy loam and quickly afterwards, large amounts of gravel and rock. While the organic layer is relatively small, the soil offers good drainage. The nutrient regime is 2-3 and the moisture regime is 4-5, and the soil is mor with beginning podzolization, see figure 7.

Nydam:

Nydam is a forest meadow in Gribskov, which was made by cutting Alnus Glutinosa down in the 16th century and then scythed 2 times a year. Several management interventions were made afterwards to increase production, for eg. like ditches. But after World War 2, scything ceased, until local enthusiasts picked it up again in the year 2000. There were floral surveys conducted in the years 1999 and 2009 (Karsten Raulund, Personal communication, 2024), (Nydamn.pdf, (n.d)).

Methods

In this section, we will present the methodological choices used in this report. The methodological approach for understanding and analyzing our methods has been a variation of statistical methods and different field methods. The first part explains the field methods used. The field methods provide observations for the interpretations, data analysis and are used to formulate hypotheses that would be addressed in our discussion. The second part will explain the statistical analysis used in our research to support our research question and whether to reject the null hypothesis or accept our alternative hypothesis.

Field methods:

The field methods used in this report are the UNA-index (untouched natural forest-index), the subjective group score, the soil boring test and the Shannon index.

The UNA-index was developed by Peter Friis Møller and GEUS (The National Geological Research for Denmark and Greenland) in 2003 (Møller, P. F. 2003). The objective of this method is to assess and evaluate the quality of an untouched forest area. The evaluation of forest quality has been conducted through various parameters, such as difference in tree species composition, topographical features, hydrological attributes and the age distribution of trees. These criteria are characteristic of an untouched Danish Forest and were established through a review of existing literature, theoretical analysis, and empirical field studies conducted within the Danish Forest ecosystem (ibid). Therefore, these parameters have been translated into a 100-questionnaire scoresheet, which contains 11 subthemes including but not limited to the above-mentioned parameters. This scoresheet was then completed for our three different chosen forest sites in Gribskov area 325 & 326, and Rankeskov. Once completed, the questionnaire and scores can be summarized to a score within 0-100, with 100 being a perfect score.

The soil boring technique was incorporated to complete the soil analysis sub-section of the sheet. This method used a soil auger, which involves collecting soil samples from different levels of soil. Various physicochemical observations were derived from this method.

The method for deciding group scores was wholly subjective but was an alternative approach to describing and obtaining field data. All the groups were instructed to make subjective observations, and therefore, evaluate the three separate sites. A score between 1-5 was then given to each site, with 5 having the best nature quality. Because it was based on subjective scores, it gave students the opportunity to express personal opinions and perceptions about the three locations. Some of the major attributes for assessment of the nature quality of the forest were its potential for regeneration, its species diversity, its forest structure, its recreational values, and its economic values amongst others. The attributes used by the other groups throughout the years are unknown, which creates another subjective aspect of this method.

Due to the lack of time, we were not able to collect the dataset for the Shannon-Wiener index ourselves. But fortunately, some secondary data was provided for the analysis.

The Shannon-Wiener index is a quantitative study to measure diversity within ecosystems. The Shannon index accounts for species richness; i.e. the amount of different species observed in the allocated area as well as the species evenness i.e. how evenly each species is distributed in the allocated area. After collecting the field data, it is possible to calculate the Shannon index with the formula $H' = -\sum(pi \times \ln(pi))$. H is the index, pi is the proportion of individuals that belong to species, and ln(pi) is the natural logarithm of pi (Barnes, B.V. et al. 1998). The value obtained using the Shannon Index accounts for both species' richness and evenness. A higher value indicates higher biodiversity.

The data from the UNA index, Group scores and Shannon index is then integrated into our statistical analysis and discussion later in the report. These indicators offered a combination of ecological evaluations and personal perspectives, which, when combined with the statistical method explained below, has enabled us to formulate discussion and conclusions regarding our hypothesis, the ecological status of the different sites, and our research question.

Statistical methods:

For the report's statistical analysis, we decided on two different methods: 1. a linear regression analysis and 2. ANOVA. For two of our hypotheses, we used linear regression to test the following: (1) The group scores and UNA indices, both, generally remain the same for each stand over time, and (2) The group scores and UNA indices show weak to no correlation (modulus of the correlation coefficient < 0.3) with each other.

For the first hypothesis, time was the independent variable while the Group scores and UNA were the dependent variable. With this, it is possible to determine if there is a significant increase over time. For the second hypothesis the UNA-index scores were the independent variable, and the group scores were the dependent variable. These results are then discussed by their p-value and R-squared value in connection with the regression slope.

For our third hypothesis, we tested if there is a difference in Group score and UNA between the areas in 2024. To test this, we decided to use an ANOVA test between the Group scores for the three observation areas and an ANOVA test for UNA-index for the three areas. To evaluate and discuss these results we will be reviewing the p-value and f-value.

It is important to understand that we choose a p-value below 0.05 to allow for the rejection of the null hypothesis and therefore accept the alternative hypothesis.

We used various field methods, including the UNA-index, Group Scores, soil boring, and the Shannon Index, to evaluate untouched forest quality and biodiversity. Our statistical analysis uses a linear regression to examine score variations and correlations. The ANOVA method is used to compare scores for both Groups and UNA among different sites in 2024. These methodologies were used for our analysis and discussion and are the prerequisite for our conclusion about the ecological quality of the observed areas.

Data Analysis & Results

The data used for the analysis spans the last 16 years (from 2009 to 2024) and consists of 548 data points which are the evaluation of three different forest stands described in detail in the Materials section of this report along with two different techniques described in Methods. There are 67 measurements of UNA index and Group Scores carried out in Ogstrup 325 as well as 103 and 104 measurements of both types in Ogstrup 326 and Ranke respectively. Each of these has been determined by a small group of students, however the overall number of evaluators is unknown. This data was analyzed to determine the existing connections between the different evaluation methods, the significance of score differences between the three different sites as well as to test how relevant a factor in forest stand evaluation is time.

Two sets of ANOVA (Analysis of Variance) were carried out which allowed to compare if there was a significant difference of evaluations by using the UNA index and group scores in the three different stands during measurements in 2024 carried out by the authors and their peers. For this analysis only 11 observations could have been used and the results are condensed in table 1. The complete results can be found in subsection "Hypothesis 2" of the Appendix First, analysis of “Group Scores” was made and resulted with relatively high (compared to critical F-value of 3,32) F-statistic value of 19,75, pointing towards a significant difference in-between variability of scores between the sites in comparison to the variability within the scores for each site. Additionally, the extremely low p-value of 3,36E-06 (in comparison to 0,05 used for the 95% confidence interval) proves that these results are statistically significant. In turn, analysis of variance showed even more statistically significant results when comparing UNA index for the three sites with an even smaller p-value of 6,63E-11 and F-statistic value of 56,55, proving that the different sites have considerably different UNA indexes which cannot be explained by chance. Even with the relatively low sample size, ANOVA was able to prove that there are significant differences in both UNA index and group scores in-between the different stands.

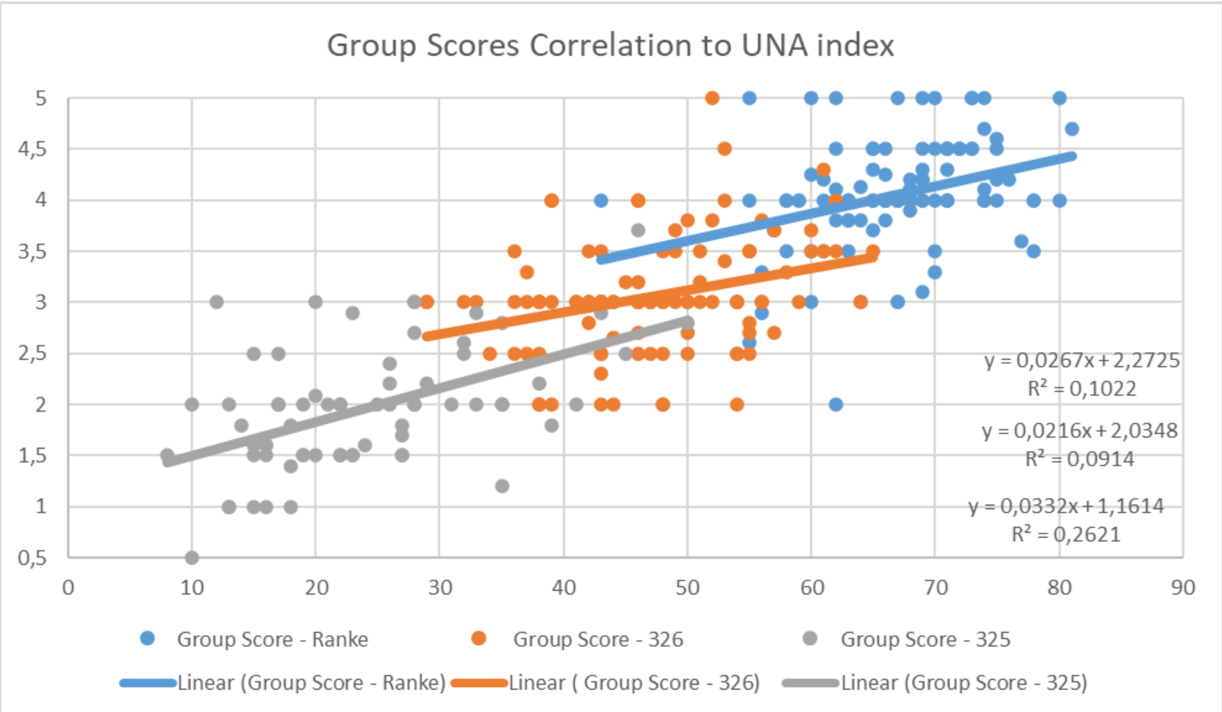
ANOVA Analysis of Variance

		Observations	Mean	F -critical	F-value	P-value
Group Scores	Ogstrup 325	11	2,5	3,32	19,75	3,36E-06
	Ogstrup 326	11	3,4			
	Ranke	11	4			
UNA index	Ogstrup 325	11	36		56,55	6,64E-11
	Ogstrup 326	11	55			
	Ranke	11	70			

Table 1. Results ANOVA for Group Scores and UNA index results. Made by authors.

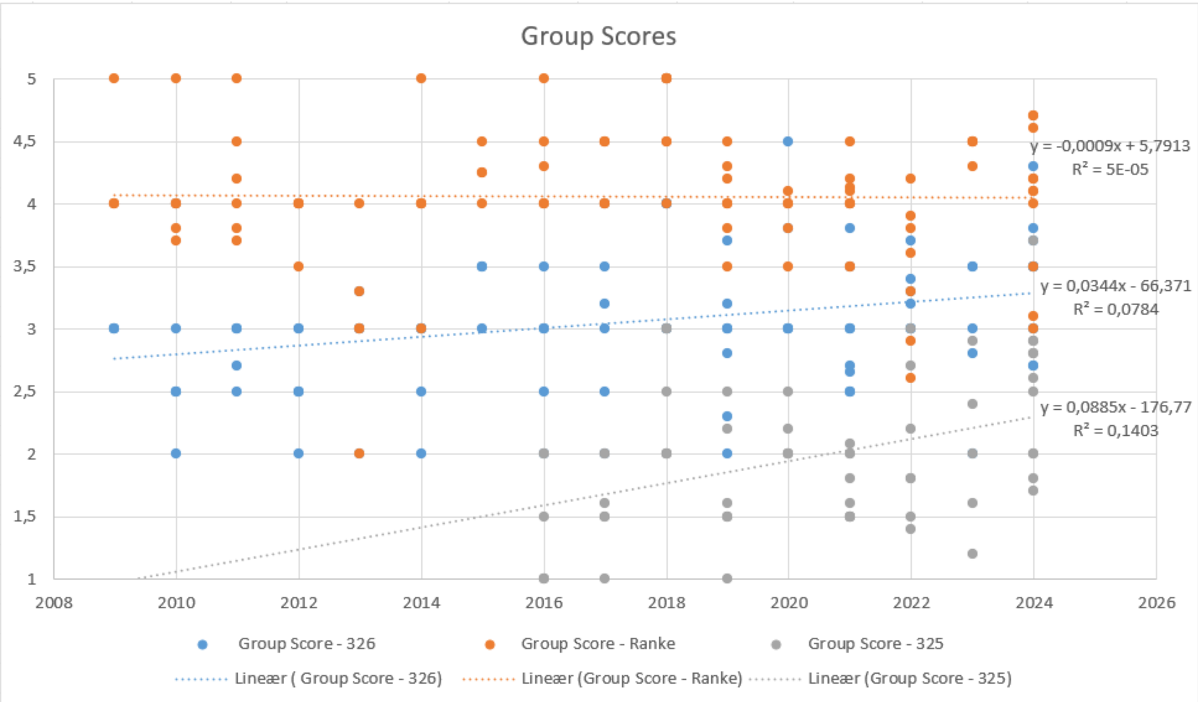
Next, nine sets of linear regressions were performed in order to measure if there has been a significant correlation between UNA index and “Group Scores” (considering “Group Scores” as the dependent variable) and how much evidence is there to say that time passage has any effect on any of the two scores. The complete regression results can be found in subsections "Hypothesis 1" and "Hypothesis 2" of the Appendix.

The first set of linear regressions consisted of a single regression for each of the three sites "Ogstrup 325"; "Ogstrup 326" and "Ranke" and resulted in quite different R-Square values of 0,26; 0,09 and 0,10, respectively meaning that 26%; 9% and 10% variability in "Group Scores" can be explained by the UNA index scores respectively in the case of each site. Furthermore, depicted in graph 1., all three regressions resulted in positive slope values, showing a positive correlation between the two evaluation methods. This positive relationship being present was backed up by the very small (much less than 0,05) p-values in each of the regressions: 9,51E-06 in the case of "Ogstrup 325"; 0,0019 in the case of "Ogstrup 326" and 0,0009 in the case of "Ranke", proving that UNA index is a statistically significant predictor of the "Group Scores".



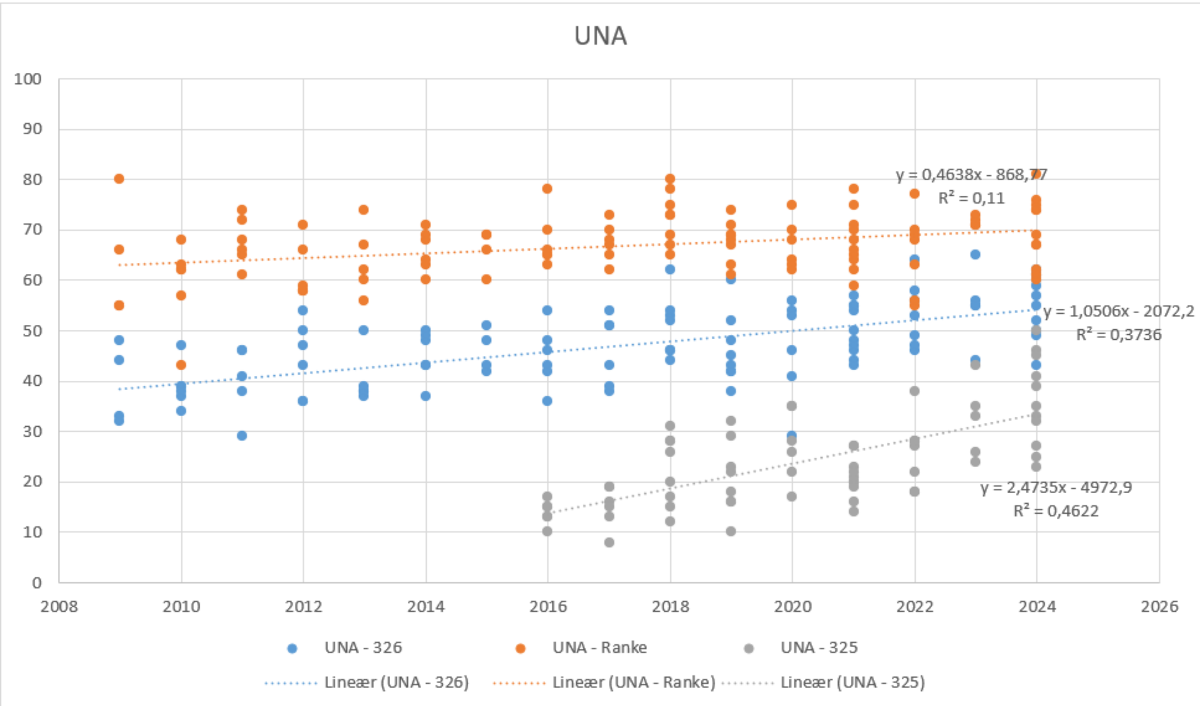
Graph 1. Correlation between Group Scores and UNA index scores. Made by authors.

The next three regressions, visualized in graph 2. allowed authors to pinpoint important statistical differences between the forest stands “Ogstrup 325”; “Ogstrup 326” and “Ranke” when it comes student groups performing subjective evaluations of the forest "quality" during the period of 15 years. Whilst “Ogstrup 325” and “Ogstrup 326" shows positive regression slope coefficients of 0,0884 and 0,0344 respectively ("Group Scores" increase on average by 0,088 and 0,034 points per annum) backed by extremely low p-values of 0,0017 and 0,0041 respectively, the regression for “Ranke” site results in a negative slope coefficient of -0,0009. However, in the latter case the P-value of 0,941 lets authors conclude that time is definitely not a significant predictor of Group Score for the specific site. Additionally, the R-square value is only 5,40E-05 showing that virtually no variability in Group Score can be explained by the time variable in "Ranke". R-square values of the first two regressions prove that approximately 14% of variability in Group Scores for “Ogstrup 325” and 8% of variability in Group Scores for “Ogstrup 326” can be explained by the model used.



Graph 2. Changes in Group Scores over time. Made by authors.

The last set of linear regressions provides factual insight into the correlation between UNA index scores and the dependent variable of time for the same three sites. In all three cases the P-value in sites “Ogstrup 325”; “Ogstrup 326” and “Ranke” was remarkably lower than the value of 0,05 used for the 95% confidence interval - 2,50E-10; 7,03E-12 and 0,0006 correspondingly. While this indicates that in all three cases time is a significant predictor of UNA index, the rates in which it correlates differ substantially and this is also visible in graph 3. For every year passing, on average, UNA index score given by students to Ogstrup 325 would increase by 2,4735 points, while it is only 1,0506 UNA index points in the case of Ogstrup 326 and 0,4638 points in the case of Ranke. In this instance the fitness of the models, as explained by the R-square values, follow the same ranking from highest to lowest. Almost half of the variance (approximately 46%) in the results for Ogstrup 325 can be explained by the independent variable of time, whilst it is around 37% for Ogstrup 326 and around 11% for Ranke.



Graph 3. Changes in UNA index scores over time. Made by authors.

The group did two calculations on the dataset given for the Shannon-wiener index, one for the data of 1999 and one for the data of 2009. The result for 1999 was 2,19, which can be considered a low result for the Shannon index for a forest. The result for 2009 was 3,74, which can be considered a very high Shannon index result. Based on these results, there was considerably higher biodiversity in Nydam in 2009 than there was in 1999. The full extent of Shannon index's calculations can be found in the subsection "Shannon index" in the Appendix 1.

Discussion

Differences between scoring for the three Sites

Based on the initial dataset and our observations in the field, we hypothesized a large variation for both Group and UNA Index scores between the three sites in 2024. The ANOVA test performed during the analysis phase has confirmed our assumptions, showing a significantly low P value for both Group and UNA index scores. It can first and foremost be inferred that the Ranke site has scored higher both on the Group Score and the UNA Index score than Ogstrup site 326, which has in turn scored higher than Ogstrup site 325.

The differences in those scores can be explained by the set of environmental conditions and management styles that affected the sites throughout their development to the present day.

Ranke represents what would be considered a typical *Fagus*-dominated stand. In the soil we find a shallow organic horizon and certain characteristic marks of podzolization in its infancy, indicating that the soil fertility in Ranke is relatively poor. The absence of vascular plant species characteristic for the area such as the Anemone further hints at poorer soil fertility than could be expected. The evenness of tree species is skewed greatly in favor of the Beech trees, that form distinct differences between individual tree ages, size and shape. An abundance of deadwood, snags and hanging trees form important habitats.

The multi-layered structure of Ranke is in our opinion the main contributor to the high Group and UNA Index scores, the reason for such structure being the management style, or rather a lack of thereof. Ranke has been left to develop undisturbed for 37 years and showcases the potential of forest ecosystems to improve in quality when left to their own devices.

Conversely, Ogstrup 326 ranks lower than Ranke despite having a larger organic horizon with more mull present in the soil profile and a larger abundance of vascular plants on the forest floor. This is, in our opinion, mainly due to high grazing pressure as evidenced by high observable damage to young regeneration and the lack of multi-layered structure of the stand. Individual tree uniformity is high, as is the discrepancy between age categories, resulting in near meadow-sized gaps in the crown that, coupled with grazing of, give way to grass and hamper regeneration even more.

Ogstrup 325 ranks lowest among the three sites. While regeneration of Spruce is abundant and richness of species is decent (owing to the presence of Birch and many vascular plant species around the artificially flooded wetland patch included in the area), soil fertility is rather poor, and due to the topography of the site the many depressions and hollows in the terrain leave the soil waterlogged (even though drainage is relatively good at the high points of the stand). Uniformity is high, and with Spruce being far more vulnerable due to recent climate changes, the risk of losing the entire crown to storm or bark beetle attack is higher. It is important to mention that our group did not include a nearby Beech stand in our observations of Ogstrup 325, which would contribute to an overall higher score

While the personal criteria from which we derived our Group Score for the three sites had a fairly large overlap with the type of focus the UNA index score provided, there were certain parameters which we assigned the sites – such as the Recreational and Economic value of the stands – that contributed to a higher group score overall. We find that these criteria hold less weight in comparison to the main contributors to the score, but they are important to include as they have had an effect, such as bringing the total Group Score up in Ogstrup 325 from 2.5 to 2.8 due to the recreational and economic value. The clear and present evidence of fungal decay in Ogstrup 326 observed by us was also a contributor to the increase in the score (with fungus playing no tangible part in the UNA scoring that limited its questionnaire to the presence of deadwood only).

Rising slopes for Group and UNA Index scores throughout the years

Despite the difference in Group and UNA Index scores, analysis shows rising slopes for all three sites. The slopes are rising significantly for all sites and methods except the group score in Ranke. This suggests that time is a contributing factor to both the UNA score and the group score, but there is also another important factor contributing, and that is management. It becomes clear when looking at the two beech stands that they are both old (+137 years old) and only 24 years apart from each other, but the structure of the stands is completely different with multiple layers, and the trees themselves are also very different. In 326a the trees are straight with medium high boles, and in Ranke they are crooked and with low boles. In 326a there is no understory or not a lot of dead wood, and in Ranke there is a thriving understory and a lot of dead wood. These differences are what makes Ranke score higher in both UNA and group score than 326a, since they are an explicit part of the UNA questions, and they contributed to the group score discussion in the field.

By looking at the management history of the area, it is becoming clear why. Ranke have been untouched since 1987, and before that it was managed by selective logging for 60 years. If the selection in selective logging were the best wood economically, then the crooked and economically bad trees are left to get all the resources to grow and fill up the canopy. In 326a the trees were tall and straight, suggesting a traditional forestry management, which stopped in 1993 were a forced regeneration was attempted and failed, leading to a big disturbance. But no dead wood was left behind and not enough time has passed since, making 326 unable to achieve the same result as in Ranke.

The slope in 325a is much steeper than in 326a and Ranke. We will say it is because the area starts by scoring very low, and right now it is picking up a lot of the "low hanging fruits" quite fast. As an example, the recent hard thinning of the area is already ticking of some boxes in the UNA questions, like the regeneration questions. Also, the closing of the ditches ticks off some questions now and will most likely lead to standing dead trees in the upcoming years. Since the management has changed recently the slope is rising quickly, and it will properly continue for the next 10 years, until it starts to slow down, because there is only so much management can do. 15 of the UNA questions are about deadwood and 11 of the questions are about large trees, which all require old age meaning time. It is possible to speed up the natural processes that contribute to a higher nature value, both in UNA and group scores, but there is still a lot of properties that require old age forests.

Correlation between UNA index and Group Scores

In essence both UNA index and Group Scores given by the students involved in the report have the common goal of evaluating nature content and the overall quality of forest structures and in this specific case the same environment has been the subject of evaluation. This is backed up by the positive correlation coefficients of high statistical significance, meaning that it could be said that with every additional point in UNA index score the Group Scores would be slightly increasing as well. At the same time, the coefficients are rather low, and the results can tell us that, in theory, even if the UNA index would be 0, Ogstrup 325, Ogstrup 326 and Ranke would still on average receive Group Scores of 1.2; 2.0 and 2.3 respectively. This can be explained by the model fitness stating that 26%; 9% and 10% of the changes in Group Scores respectively could be explained by changes in UNA index.

Taking that into account, these results spark a classic debate of correlation versus causation. It is statistically proved that the former is present, however in the scope of this report there is a lack of data and time to adequately measure the latter. From the subjective perspective of authors' experience it can be concluded that, as both evaluation methods have been used one after another in a close succession, there could be a spillover of using some UNA index measurements when defining Group Scores, for example improving the result according to the variety of dead wood being available in the specific site. This would also correspond with the fact that the site Ogstrup 326 - which was the only site that received its Group Score before any UNA index measurements were made - has the lowest R-square value of the three sites.

To sum up we can say that both methods of forest stand evaluation are correlated, however in a quite limited capacity, which points to the fact there are significant differences to the attributes prioritized in each approach. In addition, the standard error values acquired in regressions show that that Group Scores over time have a greater dispersion rate of data points then UNA index pointing towards the possibility that the rigid structure of the latter gives more consistent results, whilst Group Scores are more subjective, which corresponds with what the authors have expected.

Discussion of the methods UNA and Shannon

The calculations of the Shannon index scores uncover a distinct variation of the biodiversity between the score from 1999 and 2009. The index value for 1999 was 2.19, which can be considered tame biodiversity, while the 2009 score of 3.74 shows a high level of biodiversity. This high difference in biodiversity score from 1999 to 2009 can be traced to the distinction between richness and evenness. In 1999, there is a high richness of the species *Calamagrostis canescens* and *Phalaris arundinacea*, they make up 47% of the species cover, but this also causes low evenness. High richness but low evenness will result in. In 2009 you have both high richness and high evenness, there were 48 different species counted and not one species had a higher cover percentage than 5,36%, which makes the biodiversity high.

The methodology section outlines that the UNA index serves as a tool for evaluating and assessing the quality of forested areas. The criteria used for this assessment were derived from existing data and research pertaining to Danish Forest ecosystems. Consequently, a potential criticism of the UNA index is that it presents a rather homogeneous approach to evaluating forested regions. If it is based of Danish Forest areas it is only usable for assessing boreal and temperate broadleaf forests and should not be used to assess rainforest areas. UNA can, therefore, be geographically restricted. The scope may also be limiting or varied across different subthemes when considering scale. For example, the water level, hydrology subtheme only had 8 questions whereas the deadwood subtheme had 29 questions related to it. Hence there can be a big difference in how highly the UNA values different parts of the ecosystem. This can skew the results towards a forest ecosystem with a higher concentration of deadwood than one with high hydrological properties. But it does have the excellent quality of an easy-to-use method considering time aspects and relatively low need for expertise.

On the other hand, the Shannon-Index is a lot more time-consuming and expects a higher level of expertise than the UNA-index. This does not mean that the Shannon Index delivers better results than the UNA index. However, the Shannon-Index is not geographically restricted such as the UNA index is. Therefore, the Shannon-Index has higher versatility than the UNA index and can be used for a larger geographical variation, but this could also mean that it doesn't give especially specific results. Whereas in comparison the UNA index is more specific to a certain area and therefore might give more specific results than the Shannon index. Ultimately it could be argued that the value of a given Index is derived from the balance between its complexity and versatility, where the UNA Index aligns closer to the former and the Shannon Index – to the latter.

Conclusion

By examining the available data, we can conclude that the UNA Index is a viable method providing quick and undemanding evaluation, and it serves as an important framework within which results are generally dispersed less, as well as tightens the dispersion of subjective evaluations. It could likely be modified to broaden the scope in some areas of its study and narrow it down more in others for more accurate results, though ultimately the correlation between a subjective group score and any given index would be heavily based on the overlap between the criteria of each.

It may also be concluded that all three sites show a rise in both index and group scores over years of repeated observation, providing a measurable background we may use in argument for their improving quality from the standpoint of specified criteria.

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Appendix

Appendix 1, Shannon index

Species	1999	proportion of abundance (x/360=(pi))	ln pi	pi·ln pi
Agrostis capillaris [Almindelig hvene]		0	0	0
Allium oleraceum [Vild løg]		0	0	0
Alopecurus pratensis [Eng-rævehale]	5	0,01388889	-4,276666	-0,0594
Brachypodium sylvaticum [Skov-stilkaks]				
Calamagrostis canescens [Eng-rørhvene]	80	0,22222222	-1,504077	-0,33424
Calamagrostis epigejos [Bjerg-rørhvene]	50	0,13888889	-1,974081	-0,27418
Cardamine flexuosa [Skov-springklap]				
Carex panicea [Hirse-star]				
Carex pilulifera [Pille-star]				
Cerastium fontanum [Almindelig hønsetarm]				
Circaea lutetiana [Dunet steffensurt]				
Cirsium arvense [Ager-tidsel]	10	0,02777778	-3,583519	-0,09954
Cirsium oleraceum [Kål-tidsel]	5	0,01388889	-4,276666	-0,0594
Cirsium palustre [Kær-tidsel]	5	0,01388889	-4,276666	-0,0594
Crepis paludosa [Kær-høgeskæg]				
Dactylis glomerata [Almindelig Hundegræs]				
Dactylorhiza incarnata [Kødfarvet gøgeurt]				
Dactylorhiza majalis [Maj-gøgeurt]				
Elytrigia repens [Almindelig kvik]	10	0,02777778	-3,583519	-0,09954
Epilobium hirsutum [Lådden dueurt]	5	0,01388889	-4,276666	-0,0594
Eupatorium cannabinum [Hjortetrøst]				
Galium aparine [Burre-snerre]	5	0,01388889	-4,276666	-0,0594
Galium mollugo [Hvid snerre]	5	0,01388889	-4,276666	-0,0594
Galium odoratum [Skovmærke]				
Galium palustre [Kær-snerre]	10	0,02777778	-3,583519	-0,09954
Galium uliginosum [Sump-snerre]				
Geum rivale [Eng-nellikerod]	5	0,01388889	-4,276666	-0,0594
Glechoma hederacea [Korsknap]	15	0,04166667	-3,178054	-0,13242
Glyceria fluitans [Manna-sødgræs]				
Holcus lanatus [Fløjlsgræs]				
Juncus articulatus [Glanskapslet siv]				
Lapsana communis [Haremad]				
Lathyrus pratensis [Gul fladbælg]				
Lychnis flos-cuculi [Trævlekrone]	5	0,01388889	-4,276666	-0,0594
Mentha aquatica [Vand-mynte]				
Myosotis scorpioides [Eng-forglemmigej]				
Phalaris arundinacea [Rørgræs]	90	0,25	-1,386294	-0,34657
Poa pratensis [Eng-rapgræs]				
Poa trivialis [Almindelig rapgræs]				
Ranunculus acris [Bidende ranunkel]				
Ranunculus ficaria [Vorterod]				
Ranunculus repens [Lav ranunkel]				
Rubus idaeus [Hindbær]	5	0,01388889	-4,276666	-0,0594
Scirpus sylvaticus [Skov-kogleaks]				
Scrophularia nodosa [Knoldet brunrod]				
Scutellaria galericulata [Almindelig skjolddrager]				
Stellaria graminea [Græsbladet fladstjerne]				
Stellaria holostea [Stor fladstjerne]				
Trifolium repens [Hvid kløver]				
Urtica dioica [Stor nælde]	50	0,13888889	-1,974081	-0,27418
Valeriana dioica [Tvebo baldrian]				
Veronica chamaedrys [Tveskægget ærenpris]				
Vicia cracca [Muse-vikke]				
Viola palustris [Eng-viol]				
Viola riviniana [Krat-viol]				
TOTAL / Shannon index - Σ(pi · ln pi)	360	1	0	2,194798

Species	2009	proportion of abundance (x/560=(pi))	ln p_i	p_i . ln p_i
Agrostis capillaris [Almindelig hvene]	25	0,04464286	-3,10906	-0,1388
Allium oleraceum [Vild løg]	5	0,00892857	-4,7185	-0,04213
Alopecurus pratensis [Eng-rævehale]	25	0,04464286	-3,10906	-0,1388
Brachypodium sylvaticum [Skov-stilkaks]	20	0,03571429	-3,3322	-0,11901
Calamagrostis canescens [Eng-rørhvene]	10	0,01785714	-4,02535	-0,07188
Calamagrostis epigejos [Bjerg-rørhvene]	10	0,01785714	-4,02535	-0,07188
Cardamine flexuosa [Skov-springklap]	5	0,00892857	-4,7185	-0,04213
Carex panicea [Hirse-star]	10	0,01785714	-4,02535	-0,07188
Carex pilulifera [Pille-star]	5	0,00892857	-4,7185	-0,04213
Cerastium fontanum [Almindelig hønsetarm]	10	0,01785714	-4,02535	-0,07188
Circaea lutetiana [Dunet steffensurt]	20	0,03571429	-3,3322	-0,11901
Cirsium arvense [Ager-tidsel]	10	0,01785714	-4,02535	-0,07188
Cirsium oleraceum [Kål-tidsel]	10	0,01785714	-4,02535	-0,07188
Cirsium palustre [Kær-tidsel]	10	0,01785714	-4,02535	-0,07188
Crepis paludosa [Kær-høgeskæg]	10	0,01785714	-4,02535	-0,07188
Dactylis glomerata [Almindelig Hundegræs]	5	0,00892857	-4,7185	-0,04213
Dactylorhiza incarnata [Kødfarvet gøgeurt]	5	0,00892857	-4,7185	-0,04213
Dactylorhiza majalis [Maj-gøgeurt]	5	0,00892857	-4,7185	-0,04213
Elytrigia repens [Almindelig kvik]				0
Epilobium hirsutum [Lådden dueurt]				0
Eupatorium cannabinum [Hjortetrøst]	10	0,01785714	-4,02535	-0,07188
Galium aparine [Burre-snerre]				0
Galium mollugo [Hvid snerre]	20	0,03571429	-3,3322	-0,11901
Galium odoratum [Skovmærke]	5	0,00892857	-4,7185	-0,04213
Galium palustre [Kær-snerre]	20	0,03571429	-3,3322	-0,11901
Galium uliginosum [Sump-snerre]	5	0,00892857	-4,7185	-0,04213
Geum rivale [Eng-nellikerod]	20	0,03571429	-3,3322	-0,11901
Glechoma hederacea [Korsknap]	25	0,04464286	-3,10906	-0,1388
Glyceria fluitans [Manna-sødgræs]	5	0,00892857	-4,7185	-0,04213
Holcus lanatus [Fløjlsgræs]	10	0,01785714	-4,02535	-0,07188
Juncus articulatus [Glanskapslet siv]	10	0,01785714	-4,02535	-0,07188
Lapsana communis [Haremad]	5	0,00892857	-4,7185	-0,04213
Lathyrus pratensis [Gul fladbælg]	5	0,00892857	-4,7185	-0,04213
Lychnis flos-cuculi [Trævlekrone]	20	0,03571429	-3,3322	-0,11901
Mentha aquatica [Vand-mynte]	10	0,01785714	-4,02535	-0,07188
Myosotis scorpioides [Eng-forglemmigej]	20	0,03571429	-3,3322	-0,11901
Phalaris arundinacea [Rørgræs]	10	0,01785714	-4,02535	-0,07188
Poa pratensis [Eng-rapgræs]	20	0,03571429	-3,3322	-0,11901
Poa trivialis [Almindelig rapgræs]	30	0,05357143	-2,92674	-0,15679
Ranunculus acris [Bidende ranunkel]	10	0,01785714	-4,02535	-0,07188
Ranunculus ficaria [Vorterod]	10	0,01785714	-4,02535	-0,07188
Ranunculus repens [Lav ranunkel]	10	0,01785714	-4,02535	-0,07188
Rubus idaeus [Hindbær]				0
Scirpus sylvaticus [Skov-kogleaks]	10	0,01785714	-4,02535	-0,07188
Scrophularia nodosa [Knoldet brunrod]	5	0,00892857	-4,7185	-0,04213
Scutellaria galericulata [Almindelig skjolddrager]	5	0,00892857	-4,7185	-0,04213
Stellaria graminea [Græsbladet fladstjerne]	5	0,00892857	-4,7185	-0,04213
Stellaria holostea [Stor fladstjerne]	5	0,00892857	-4,7185	-0,04213
Trifolium repens [Hvid kløver]	15	0,02678571	-3,61989	-0,09696
Urtica dioica [Stor nælde]				0
Valeriana dioica [Tvebo baldrian]	5	0,00892857	-4,7185	-0,04213
Veronica chamaedrys [Tveskægget ærenpris]	10	0,01785714	-4,02535	-0,07188
Vicia cracca [Muse-vikke]	10	0,01785714	-4,02535	-0,07188
Viola palustris [Eng-viol]	5	0,00892857	-4,7185	-0,04213
Viola riviniana [Krat-viol]	5	0,00892857	-4,7185	-0,04213
TOTAL / Shannon index - Σ(p_i . ln p_i)	560			3,746276

Hypothesis 1

1. Regression (325 – Group Score - time)

SUMMARY OUTPUT - 325 correlation of Group Score to time								
Regression Statisti								
Multiple R	0,374622							
R Square	0,140341							
Adjusted R Square	0,127116							
Standard Error	0,572739							
Observations	67							
ANOVA								
	df	*SS*	*MS*	*F*	*Significance F*			
Regression	1	3,4809	3,480865125	10,61140984	0,001788			
Residual	65	21,322	0,32803041					
Total	66	24,803						
	Coefficien	*Standard*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95,0%*	*Upper 95,0%*
Intercept	-176,773	54,87	-3,22166744	0,001992486	-286,357	-67,1901	-286,357	-67,1901
Group Score - 325	0,088474	0,0272	3,257515901	**0,001788424**	0,034232	0,142716	0,034232	0,142716

2. Regression (325 – UNA index - time)

SUMMARY OUTPUT - 325 correlation of UNA to time								
Regression Statisti								
Multiple R	0,679869							
R Square	0,462222							
Adjusted R Square	0,453949							
Standard Error	6,978491							
Observations	67							
ANOVA								
	df	*SS*	*MS*	*F*	*Significance F*			
Regression	1	2720,7	2720,722301	55,86775008	2,50E-10			
Residual	65	3165,5	48,69933544					
Total	66	5886,2						
	Coefficien	*Standard*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95,0%*	*Upper 95,0%*
Intercept	-4972,9	668,56	-7,43821194	2,90E-10	-6308,1	-3637,69	-6308,1	-3637,69
UNA	2,473518	0,3309	7,474473231	**2,50E-10**	1,812608	3,134429	1,812608	3,134429

3. Regression (326 – Group Scores - time)

SUMMARY OUTPUT - 326 group score correlation to time								
Regression Statistic								
Multiple R	0,28004							
R Square	0,078422							
Adjusted R Square	0,069298							
Standard Error	0,546831							
Observations	103							
ANOVA								
	df	*SS*	*MS*	*F*	*Significance F*			
Regression	1	2,57	2,570023	8,5946873	0,00417			
Residual	101	30,201	0,299025					
Total	102	32,772						
	Coefficien	*Standard Erro*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95,0%*	*Upper 95,0%*
Intercept	-66,3708	23,682	-2,80262	0,0060777	-113,349	-19,3927	-113,349	-19,3927
Group Score - 326	0,034414	0,0117	2,93167	**0,0041705**	0,011128	0,057701	0,011128	0,057701

4. Regression (326 – UNA index - time)

SUMMARY OUTPUT 326 - correlation of UNA to time								
Regression Statistic								
Multiple R	0,611229							
R Square	0,373601							
Adjusted R Square	0,367399							
Standard Error	6,305587							
Observations	103							
ANOVA								
	df	*SS*	*MS*	*F*	*Significance F*			
Regression	1	2395,1	2395,128	60,238987	7,03E-12			
Residual	101	4015,8	39,76043					
Total	102	6410,9						
	Coefficien	*Standard Erro*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95,0%*	*Upper 95,0%*
Intercept	-2072,2	273,08	-7,58836	1,65E-11	-2613,91	-1530,49	-2613,91	-1530,49
UNA - 326	1,050598	0,1354	7,761378	7,03E-12	0,782075	1,31912	0,782075	1,31912

5. Regression (Ranke – Group Scores - time)

SUMMARY OUTPUT - Ranke group score correlation to time

Regressio	
Multiple R	0,007346
R Square	5,40E-05
Adjusted F	-0,00975
Standard I	0,543834
Observati	104

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regressio	1	0,0016	0,001628	0,005505	0,941001
Residual	102	30,167	0,295756		
Total	103	30,169			

	Coefficien	*Standar*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95,0%*	*Upper 95,0%*
Intercept	5,791312	23,336	0,24817	0,804502	-40,4958	52,07838	-40,4958	52,07838
Group Sco	-0,00086	0,0116	-0,07419	**0,941001**	-0,0238	0,022087	-0,0238	0,022087

6. Regression (Ranke – UNA index - time)

SUMMARY OUTPUT - Ranke correlation of UNA to time

Regressio	
Multiple R	0,331672
R Square	0,110006
Adjusted F	0,101281
Standard I	6,141328
Observati	104

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regressio	1	475,51	475,5055	12,60756	0,000583
Residual	102	3847	37,71591		
Total	103	4322,5			

	Coefficient	*Standard Erro*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95,0%*	*Upper 95,0%*
Intercept	-868,772	263,53	-3,29671	0,001347	-1391,48	-346,068	-1391,48	-346,068
UNA	0,463838	0,1306	3,550712	**0,000583**	0,204729	0,722947	0,204729	0,722947

Hypothesis 2

7. ANOVA (Group Scores – all three sites)

Anova: Single Factor (Group Scores)						
SUMMARY						
Groups	*Count*	*Sum*	*Average*	*Variance*		
GS-326	11	37,2	3,381818182	0,239636		
GS-Ranke	11	44,2	4,018181818	0,349636		
GS-325	11	27,7	2,518181818	0,357636		
ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	12,4697	2	6,234848485	19,75326	3,36E-06	3,3158295
Within Groups	9,469091	30	0,315636364			
Total	21,93879	32				

8. ANOVA (UNA index – all three sites)

Anova: Single Factor (UNA index)

SUMMARY

Groups	Count	Sum	Average	Variance
UNA-326	11	609	55,36363636	37,85455
UNA-Ranke	11	766	69,63636364	47,65455
UNA-325	11	396	36	80,8

ANOVA

Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups	6270,24	2	3135,121212	56,55351	6,64E-11	3,3158295
Within Groups	1663,09	30	55,43636364			
Total	7933,33	32				

Hypothesis 3

9. Regression (325 – Group Score – UNA index)

SUMMARY OUTPUT - 325 group score correlation to UNA

Regression Statistics	
Multiple R	0,511946
R Square	0,262088
Adjusted R Square	0,250736
Standard Error	0,530635
Observations	67

ANOVA

	df	SS	MS	F	Significance F
Regression	1	6,500538	6,500538	23,08644	9,51E-06
Residual	65	18,3023	0,281574		
Total	66	24,80284			

	Coefficien	Standard Erro	t Stat	P-value	Lower 95%	Upper 95%	Lower 95,0%	Upper 95,0%
Intercept	1,161359	0,179743	6,461229	1,54E-08	0,802388	1,52033	0,802388	1,52033
UNA	0,033232	0,006916	4,804835	**9,51E-06**	0,019419	0,047045	0,019419	0,047045

10. Regression (326 – Group Score – UNA index)

SUMMARY OUTPUT - 326 group scores correlated to UNA

Regression Statistics	
Multiple R	0,3022814
R Square	0,0913741
Adjusted R Square	0,0823778
Standard Error	0,5429753
Observations	103

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	2,994465	2,994465	10,156852	0,001914
Residual	101	29,77704	0,294822		
Total	102	32,7715			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95,0%*	*Upper 95,0%*
Intercept	2,034806	0,324808	6,264635	9,23E-09	1,390474	2,679138	1,390474	2,679138
UNA - 326	0,0216122	0,006781	3,186982	**0,0019136**	0,00816	0,035065	0,00816	0,035065

11. Regression (Ranke – Group Score – UNA index)

SUMMARY OUTPUT - Ranke group scores correlated to UNA

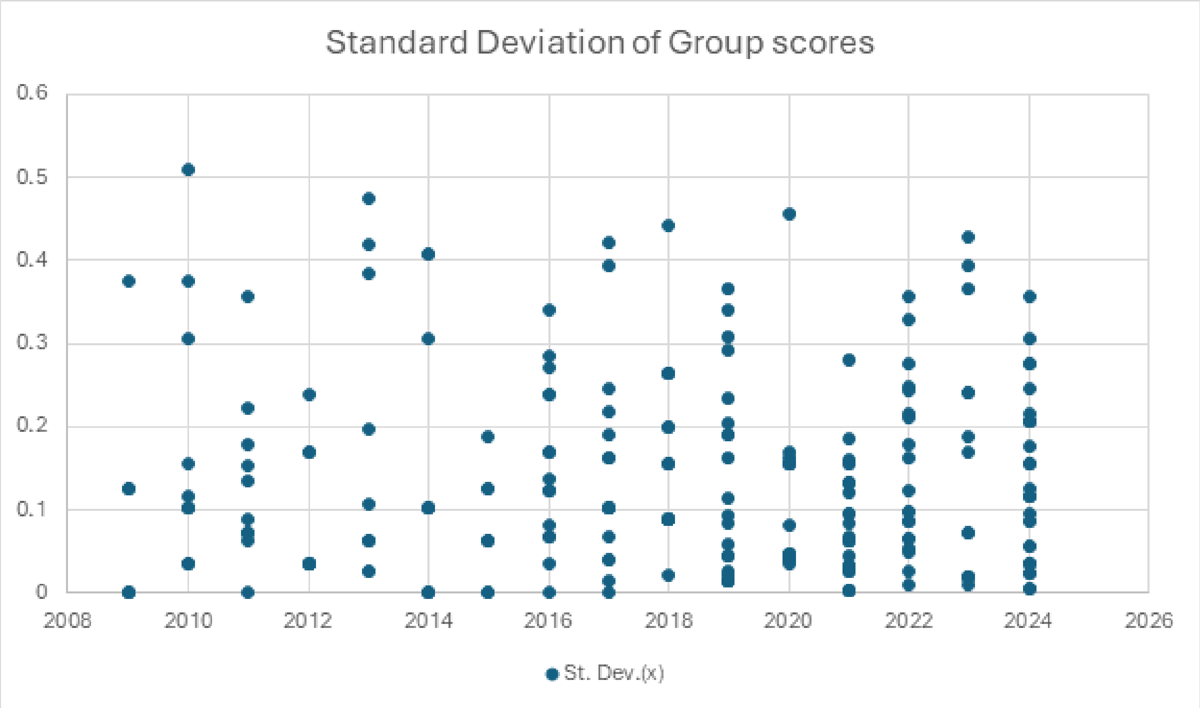
Regression Statistics	
Multiple R	0,319646
R Square	0,102173
Adjusted R	0,093371
Standard E	0,515317
Observations	104

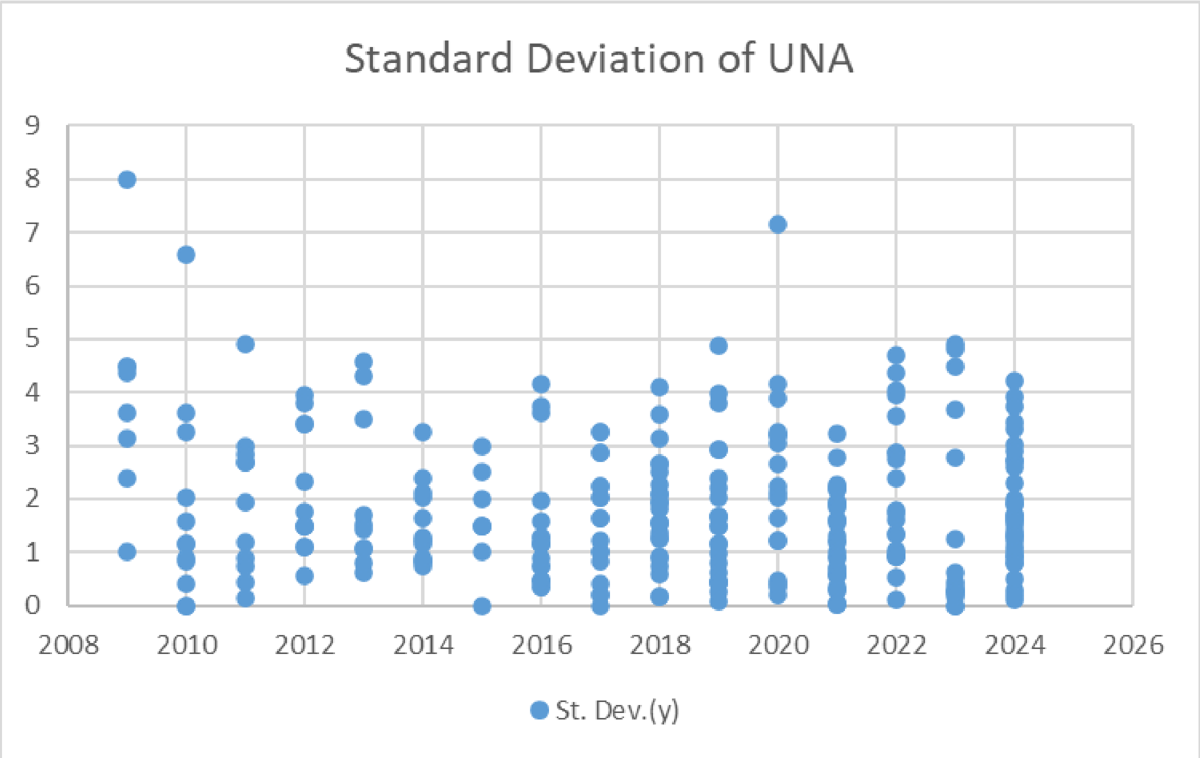
ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	3,082439	3,082439	11,60768	0,000941
Residual	102	27,08626	0,265552		
Total	103	30,1687			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95,0%*	*Upper 95,0%*
Intercept	2,272525	0,527047	4,31181	3,75E-05	1,227131	3,31792	1,227131	3,31792
UNA	0,026704	0,007838	3,407005	**0,000941**	0,011157	0,042251	0,011157	0,042251

Standard deviations of scores





UNA index results

Ogstrup 325

GEUS FOREST STRUCTURE INDEX
EVALUATION OF "STRUCTURAL DIVERSITY IN WOODLANDS" **Version 5.0 May 2005**

Site:	Number:	Fill in	FIELD NOTES (volunt.)
	Flora		
75	Forest floor vegetation of summer green vascular plants (woodland species) present at at least 10% of the area.	✓	
76	Living stems (boles) rich in bryophytes (mosses), > 25% coverage up to 3 meters.	✗	
77	Living stems (boles) rich in lichens (arbuscular or thallose), > 25% coverage up to 3 meters.	✗	
	Topography and soil		
78	Large macro topographic variation (>20 meters within 1 ha)	✗	
79	Large micro topographic variation (>1m/100m²)	✓	
80	Large mounds from storm-felled trees present	✓	
81	Large stones, rocks; min. 1 x 1 meter, natural occurrences in the surface.	✗	
82	Mull present on at least 5% of the area	✗	
83	Mor layers present on at least 5% of the area	✓	
84	Raw humus deposits (mor or peat), layers ≥ 5 cm. present on at least 5% of the area	✓	
85	Chalk visible at the surface.	✗	
86	Patches with sun exposed, naturally exposed soil surface (landslide, dune etc.) present	✗	
	Water level, hydrology		
87	Open, treeless wetlands, min 5% of area.	✓	
88	Swamp forest present (eg. Alder swamp, birch swamp forest, mixed swamp forest); min 5% of area	✗	
89	Temporary waterlogged areas (temporary lakes and ponds).	✗	
90	Humid hollows present (size min 100 m²)	✓	
91	Wells present	✗	
92	Natural, unregulated watercourses present	✗	
93	Presence of wetlands without ditches or ditches efficiently closed	✓	
94	Wet or humid soil prevailing on min. 25% of the area	✓	
	Management impacts		
95	No signs of soil cultivation	✓	
96	No ditches or ditches closed efficiently	✓	
97	No newly managed ditches (within the last 10 years)	✓	
98	No tracks from motor vehicles, driving in the stand (deep wheel tracks)	~~✗~~ ✓	
99	No signs of cutting (No stumps)	✗	
100	No younger signs of cutting (No stumps younger than 10 year)	✗	
	PART SUM 3	13	
	Part sum 1 (transfer)	7	
	Part sum 2 (transfer)	15	
TOTAL SUM (Index value)		35	

COMMENTS:

Alexander Chkareuli, Jonathan Høeg Dahl-Müller, Krisjanis Liepa, Om Vaknalli, Peter Skourup

Ogstrup 326

GEUS FOREST STRUCTURE INDEX
EVALUATION OF "STRUCTURAL DIVERSITY IN WOODLANDS"
Version 5.0 May 2005

Site:	Number:	Fill in	FIELD NOTES (volunt.)
	Flora		
75	Forest floor vegetation of summer green vascular plants (woodland species) present at at least 10% of the area.	✓	
76	Living stems (boles) rich in bryophytes (mosses), > 25% coverage up to 3 meters.	✓	
77	Living stems (boles) rich in lichens (arbuscular or thallose), > 25% coverage up to 3 meters.	✓	
	Topography and soil		
78	Large macro topographic variation (>20 meters within 1 ha)	X ✓	
79	Large micro topographic variation (>1m/100m^2)	✓	
80	Large mounds from storm-felled trees present	X	
81	Large stones, rocks; min. 1 x 1 meter, natural occurrences in the surface.	✓	
82	Mull present on at least 5% of the area	✓	
83	Mor layers present on at least 5% of the area	✓	
84	Raw humus deposits (mor or peat), layers ≥ 5 cm. present on at least 5% of the area	✓	
85	Chalk visible at the surface.	X	
86	Patches with sun exposed, naturally exposed soil surface (landslide, dune etc.) present	X	
	Water level, hydrology		
87	Open, treeless wetlands, min 5% of area.	X	
88	Swamp forest present (eg. Alder swamp, birch swamp forest, mixed swamp forest); min 5% of area	X	
89	Temporary waterlogged areas (temporary lakes and ponds).	X	
90	Humid hollows present (size min 100 m^2)	X	
91	Wells present	X	
92	Natural, unregulated watercourses present	X	
93	Presence of wetlands without ditches or ditches efficiently closed	X	
94	Wet or humid soil prevailing on min. 25% of the area	X	
	Management impacts		
95	No signs of soil cultivation	✓	
96	No ditches or ditches closed efficiently	X	
97	No newly managed ditches (within the last 10 years)	✓	
98	No tracks from motor vehicles, driving in the stand (deep wheel tracks)	X	
99	No signs of cutting (No stumps)	X	
100	No younger signs of cutting (No stumps younger than 10 year)	✓	
	PART SUM 3	11	
	Part sum 1 (transfer)	16	
	Part sum 2 (transfer)	22	
TOTAL SUM (Index value)		49	

Alexander Chkareuli, Jonathan Høeg Dahl-Müller, Krisjanis Liepa, Om Vaknalli, Peter Skourup

Ranke

GEUS FOREST STRUCTURE INDEX EVALUATION OF "STRUCTURAL DIVERSITY IN WOODLANDS"		Version 5.0 May 2005	
Site:	Number:	Fill in	FIELD NOTES (volunt.)
	Flora		
75	Forest floor vegetation of summer green vascular plants (woodland species) present at at least 10% of the area.	X	
76	Living stems (boles) rich in bryophytes (mosses), > 25% coverage up to 3 meters.	X	
77	Living stems (boles) rich in lichens (arbusçular or thallose), > 25% coverage up to 3 meters.	✓	
	Topography and soil		
78	Large macro topographic variation (>20 meters within 1 ha)	X	
79	Large micro topographic variation (>1m/100m²)	✓	
80	Large mounds from storm-felled trees present	✓	
81	Large stones, rocks; min. 1 x 1 meter, natural occurrences in the surface.	X	
82	Mull present on at least 5% of the area	X	
83	Mor layers present on at least 5% of the area	✓	
84	Raw humus deposits (mor or peat), layers ≥ 5 cm. present on at least 5% of the area	X	
85	Chalk visible at the surface.	X	
86	Patches with sun exposed, naturally exposed soil surface (landslide, dune etc.) present	X	
	Water level, hydrology		
87	Open, treeless wetlands, min 5% of area.	X	
88	Swamp forest present (eg. Alder swamp, birch swamp forest, mixed swamp forest); min 5% of area	X	
89	Temporary waterlogged areas (temporary lakes and ponds).	X	
90	Humid hollows present (size min 100 m²)	X	
91	Wells present	X	
92	Natural, unregulated watercourses present	X	
93	Presence of wetlands without ditches or ditches efficiently closed	X	
94	Wet or humid soil prevailing on min. 25% of the area	X	
	Management impacts		
95	No signs of soil cultivation	✓	
96	No ditches or ditches closed efficiently	✓	
97	No newly managed ditches (within the last 10 years)	✓	
98	No tracks from motor vehicles, driving in the stand (deep wheel tracks)	✓	
99	No signs of cutting (No stumps)	✓	
100	No younger signs of cutting (No stumps younger than 10 year)	✓	
	PART SUM 3	[illegible]	
	Part sum 1 (transfer)	22	
	Part sum 2 (transfer)	30	
TOTAL SUM (Index value)		61	