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Floodplain meadows in the National Park Donau-Auen: Vegetational developments in the last three decades

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Zusammenfassung

Naturnahes Grünland macht einen großen Teil der europäischen Kulturlandschaft und Biodiversität aus, letzteres auch auf globaler Ebene. Aufgrund seines anthropogenen Ursprungs ist es stark von der Bewirtschaftungsform abhängig. In den letzten Jahrzehnten haben solche Lebensräume jedoch massive Verluste hinsichtlich Verbreitung und Artenreichtum erlitten. In Österreich sind die Hauptgründe dafür die Intensivierung der Landwirtschaft und aufgelassene Bewirtschaftung, was zu deren Verschwinden aufgrund zu intensiver Nutzung oder Sukzession führt. Feuchte Wiesentypen wurden insbesondere oft trockengelegt und daher stark dezimiert.

Ausgehend von Originalstudien aus den 1990ern im Nationalpark Donau-Auen ist das Ziel dieser Masterarbeit, Veränderungen von Überschwemmungswiesen zu ermitteln in Hinblick auf Umweltfaktoren, Artenzusammensetzung und Biodiversitätswerten sowie die Faktoren für mögliche Veränderungen und den Einfluss der Bewirtschaftung. Wegen Klimawandel und sinkender Grundwasserpegel sollten Überschwemmungswiesen von Austrocknung betroffen sein. Konkurrenzstarke Arten könnten sich weiter ausgebreitet und Spezialisten zurückgedrängt oder verdrängt haben, daher kann eine Änderung der Pflanzengesellschaften nicht ausgeschlossen werden. Regelmäßige Bewirtschaftung kann negative Entwicklungen hintangehalten und hohe Biodiversitätswerte bewahrt haben.

75 Plots wurden im Nationalpark wiederaufgenommen. Diese waren nun entweder aufgelassen, sporadisch gemulcht, ein- oder zweischürig gemäht. Anschließend wurden in R Veränderungen von Umweltfaktoren auf Basis der ungewichteten mittleren Zeigerwerte für Licht, Temperatur, Wasser, Bodenreaktion und Stickstoff ermittelt. Die Artenzahl, der Shannon-Index sowie die Evenness wurden als Biodiversitätswerte gewählt. Pflanzengesellschaften wurden mittels einer TWINSPAN-Analyse in JUICE ermittelt. Ausgewählte Artengruppen wurden ebenso auf mögliche Veränderungen getestet.

Während es zu keiner Änderung der Temperaturwerte gekommen ist, wurde ein hochsignifikanter Rückgang der Feuchtewerte mit den stärksten Veränderungen auf regelmäßig gemähten Wiesen festgestellt. Aufgelassene Wiesen sind leicht verdunkelt und

wurden signifikant basischer. (Besonders regelmäßig) bewirtschaftete Flächen wurden signifikant stickstoffärmer. Absolut betrachtet, gingen gefährdete Rote-Liste-Arten um ein Zehntel zurück (signifikant auf aufgelassenen Plots), während Neophyten sich verdoppelt, jedoch nicht in ihrer Deckung verändert haben. Spezialisten nahmen besonders auf bewirtschafteten Flächen um ein Fünftel ab. Konkurrenzstarke Arten sind um etwa ein Fünftel gestiegen, stärker bei aufgelassener Bewirtschaftung. Gehölze haben sich zwar absolut verdoppelt, jedoch auf nicht mehr bewirtschafteten Flächen.

Vier TWINSPAN-Gruppen entlang eines Feuchtegradienten zeigen einen Rückgang von feuchten Wiesentypen seit den 1990ern, während Glatthafer-Plots mittlerweile zu zwei Dritteln vertreten sind. Darunter fallen auch alle aufgelassenen Flächen. Ebenso kam es auf diesen Plots zu einem leichten Artenanstieg, während diese auf bewirtschafteten Flächen zurückgegangen sind. Zweimähdige Plots verzeichneten den geringsten Abfall, ebenso hatten hauptsächlich sie einen Anstieg des Shannon-Index und der Evenness.

Während keine Temperaturänderungen trotz Klimawandel überraschend waren, wurde eine zunehmende Trockenheit besonders auf bewirtschafteten Flächen bestätigt. Eine Basifizierung von aufgelassenen Flächen kann ebenso ein indirekter Vertrocknungshinweis sein. Abgefallene Grund- und Mittelwasserpegel sowie die Bewirtschaftung scheinen die einflussreichsten Faktoren zu sein. Trotz Stickstoffrückgang auf bewirtschafteten Flächen konnten konkurrenzstarke Arten stärker einwandern, während besonders Spezialisten auf der Roten Liste zurückgegangen sind. Das zeigt sich auch an der Zunahme von weniger spezialisierten Glatthafer-Flächen. Dennoch scheinen zweimähdige Flächen sich bezüglich Biodiversität am geringsten verschlechtert zu haben.

Somit wurden bewirtschaftete Flächen trockener, kaum dunkler und stickstoffärmer, auch wenn zweimähdige Bewirtschaftung negative Entwicklungen zu Biodiversität am ehesten abgeschwächt hat. Rote-Liste-Arten und Spezialisten sind zugunsten konkurrenzstarker Arten zurückgegangen. Daher werden zwar Teilziele des Wiesenmanagements im Nationalpark erfüllt wie das Freihalten von Gehölzen oder der Nährstoffentzug, doch das Erreichen von Schutzzielen hinsichtlich gefährdeter Arten und Wiesentypen erscheint fraglich.

Abstract

Semi-natural grasslands comprise a huge amount of the European cultural landscape and biodiversity, the latter also on a global scale. Because of their human origin, they are largely dependent on effective management regimes. In the last decades, however, these habitats have experienced a strong decrease in size and species richness. In Austria, main factors for their strong decline are intensification of productive areas and abandonment, leading to their disappearance due to intensive management or the succession patterns. Wet grasslands in particular were often drained and therefore strongly lost in coverage.

Based on vegetational studies on floodplain meadows from the 1990s in the National Park Donau-Auen, the aim of this master thesis is to answer research questions regarding the development of the respective plots under the aspects of environmental factors, species composition and biodiversity values as well as responsible factors for the observed changes and the effect of different management regimes. Due to climate change and decreasing groundwater levels, floodplain meadows might be affected by drying out and competitive species are thought to have further emerged and pushed back or displaced specialists, leading to a change in plant communities. Regular management might have prevented negative consequences and therefore maintained high biodiversity values.

75 original plots were repeated throughout the whole National Park. Nowadays, they are either abandoned, sporadically managed and mown once or twice a year. Afterwards, changes in environmental factors were analyzed based on unweighted means of the ecological indicator values light, temperature, soil moisture, soil reaction and soil nitrogen. Statistical evidence was tested in R. Number of species, the Shannon- Index and Evenness were chosen as biodiversity values. Plant communities were depicted by a TWINSPAN-analysis in JUICE. Certain species groups were also tested for development.

Whereas no changes were detected regarding temperature, a highly significant decrease in soil moisture was generally observed with the biggest drops on regularly managed plots. Abandoned meadows slightly darkened and underwent a significant alkalinization. Regularly managed plots experienced a significant reduction in soil nitrogen. In general,

classical endangered species went down by a tenth (significantly for abandoned plots), whereas neophytes doubled in total numbers but did not change in coverage. Specialists decreased by a fifth in total, but strongly on managed plots. Competitive and common species increased by twenty per cent, to a higher extent on abandoned plots. Wooden species nearly doubled, but predominantly on meadows with no management.

Four TWINSPAN-groups were calculated, depicting a moisture gradient. In contrast to the 1990s, a crucial decrease in wet meadow groups was depicted, whereas two thirds of nowadays plots are assigned to the *Arrhenatherum*-group. All abandoned plots are appointed to this group. On plots without management, species numbers slightly increased whereas the ones on managed plots were decreased. Here, twice-mown meadows had the weakest reductions. Also, they were primarily the only group with slight rises regarding Shannon-Index and Evenness.

While no temperature changes were surprising regarding climate change, a trend in drying out of the plots could be statistically verified, at least on managed plots. Alkalinization on abandoned ones can be an indicator for the same trend. Decreasing groundwater and middle water levels as well as management regimes seem to be influencing factors. Also, nitrogen reductions on managed plots were possible despite the Donau-Auen being rich in nutrients generally. Hence, competitive and common species were enabled to further emerge, whereas specialists were pushed back, especially those from the red list which is another alarming signal. So, original plots seem to have undergone certain changes towards less specialized habitats. This is also supported by the strong rise of *Arrhenatherum*-plots since the 1990s.

In total, managed plots became dryer, hardly darker and less rich in nitrogen, even though twice-mown ones had the least negative trends in biodiversity values. Red list species and specialists went down, whereas competitive species further emerged. So, some goals of the National Park's meadow management are fulfilled (keeping clear of wooden species, reduction of nitrogen…). However, the achievement of the protective aim of endangered species and meadow habitats appears questionable.

Acknowledgements

As this master thesis is finalized and years of studying come to an end, it is my dearest wish to thank all the people without whom it would not have been possible.

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1 Introduction

1.1 Research background

Habitat degradation and fragmentation are the main drivers of biodiversity losses in terrestrial ecosystems. Under this aspect, semi-natural grasslands strongly decreased in size and species richness over the last decades in Central Europe (Hülber et al., 2017).

These grassland types account a huge amount of the European cultural landscape and have emerged since the Neolithic period a few thousand years ago due to low-intensive land utilization. Hence, semi-natural grasslands are largely dependent on effective management regimes. Otherwise, huge areas of Europe would still be forest as this is the potential natural vegetation. Despite the human origin or rather because of that, they inhabitat a high number of endemic species as specialists, which would get lost if they were abandoned, and account for comparatively high biodiversity values (Dengler et al., 2014).

Regarding the latter, such grassland types are the counterpart at a small-scale level for tropical rain forests on larger levels. So, these habitats play a crucial role in European biodiversity, also on a global scale (Wilson et al., 2012). Agri-environmental schemes (like "ÖPUL" in Austria) are an integral part in the conservation of semi-natural grasslands (Hülber et al., 2017). So called pastures are used for grazing reasons, meadows for the production of hay. Other semi-natural grassland types have developed from former agriculturally used fields. Around fifteen years ago, they accounted for a tenth of the size of the European Union or a third of the agriculturally used area (Dengler et al., 2014).

In Austria, semi-natural grassland is representative above average (Dengler et al., 2014), but 95 per cent of such grassland types are endangered (Umweltbundesamt GmbH, 2025). The main factors for their strong decline are intensification of productive areas and abandonment otherwise. In both cases the traditional semi-natural grasslands disappear, either due to the intensive management (application of fertilisers and pesticides, frequent cutting, etc.) or due to the process of succession towards shrublands or forests. Wet grasslands were often drained and therefore strongly lost in coverage (Dengler et al., 2014).

1.2 Research questions and hypotheses

During the planning process of the National Park (= NP) Donau-Auen, several vegetational studies of different biotope types were conducted in the 1990s (Schratt, 1991; Schratt-Ehrendorfer, 1993a; Schratt-Ehrendorfer, 1993b; Schratt-Ehrendorfer, 1993c; Schratt-Ehrendorfer, 1995). In times of climate change and river regulations (despite restoration efforts), floodplain meadows belong to the highly endangered grassland types. In spring, these ecosystems can turn into temporary water bodies when they are swamped due to rising groundwater levels or floodings. As these meadows are highly endangered as illustrated above, one focus of the National Park is to protect these remaining habitats (Nationalpark Donau-Auen GmbH, 2017).

By repeating the mapping of all plots on floodplain meadows in the NP around 30 years after the historic observations, the aim of this master thesis is to depict their development in terms of vegetation ecology regarding environmental factors, species composition, plant communities and responsible factors for possible changes. Also, the influence of certain management regimes is questioned.

Based on warming trends due to climate change, floodplain meadows could not have remained unaffected and therefore have been heated. They should be threatened by drying out regardless of certain management schemes. This development might have been influenced by river regulations as well which led to decreased groundwater levels and therefore drying out the respective habitats from below. Despite promising restoration efforts in the National Park in the last decades, certain changes could not have been put on hold.

Due to this assumption and agricultural changes in general, it can be postulated that competitive and common species may have further emerged and pushed back or even displaced wet specialists. An increase of neophytes can also be expected. Therefore, a change in plant communities dominated by common grass species (or ruderal species in general) cannot be ruled out either. This could have decreased the total number of species or endangered ones per plot and hence, worsened biodiversity values.

Since, however, semi-natural grassland is mainly dependent on management measurements, the effect of certain regime classes is another topic to be analyzed. Regular management could therefore have prevented negative consequences and increased the overall nature conservation value of the meadows over the last three decades. Therefore, darkening trends should have been put on hold and due to removing hay, nutrient values also might not have changed. Since the NP lies in a region with calcareous bedrock, soil reaction should have stayed the same.

On the contrary, abandonment might have failed to prohibit unfavorable changes, meaning that on such plots, darkening was promoted due to successional tendencies towards forest habitats (i.e. emergence of wooden species). Also, nutrient values should have been increased since no hay has been removed anymore. Still, soil reaction should have been unaffected due to geological conditions.

2 Methodology

2.1 Study area

The NP Donau-Auen was founded in 1996 and certified by the IUCN in 1997. It is situated between Eastern Vienna (Lobau) and Lower Austria along the Danube at a length of 36 km and ends at the Slovakian boarder with a total size of more than 9 600 ha (Nationalpark Donau-Auen GmbH, 2025b). Around three quarters of the National Park are part of the nature zone without human usage, only certain management measures are taken. Other zones are the nature zone with management measures such as mowing and the outer zone with special areas (waterways, fields…) and for reasons of tourism and administration (Nationalpark Donau-Auen GmbH, 2019).

The NP is located in the Pannonian region of Lower Austria with sunny hours and temperatures above average. During its relatively long vegetation period, rain events are relatively poor. These circumstances result in this region as being the hottest and dryest Austrian part with annual middle temperatures above 9°C and precipitation below 600 mm. Strong wind regimes can lead to desertification (Hadatsch et al., 2000).

Until the 19th century, the Danube was characterized as a dynamic river with a huge variety of main and side channels as well as old branches. Due to strong regulations, a huge amount of (mostly river-distant) channels became lost. Traverses and pathways along the riverbank further strengthened cutting of huge areas and increased sedimentation and alluviation (Reckendorfer, 2016). Since the beginning of the National Park, several restoration projects were realized as strategical goals (Nationalpark Donau-Auen GmbH, 2022).

Except for the so called “Heißländen” - dry grassland on e. g. raised gravel bodies (Nationalpark Donau-Auen GmbH, 2017) - meadows have not developed naturally in the study area. Even though they are of human origin for hunting and haying reasons (Latzin, 2006), grassland ecosystems constitute fifteen per cent of the National Park’s size (Nationalpark Donau-Auen GmbH, 2025b) and are an integral part of its total biodiversity. They are inhabited by many plant and animal species forming a variety of habitat types. Some of them are highly endangered (Sauberer & Pfundner, 2019).

2.2 Field work

A selection of 87 relevés of the historic observations was initially chosen for this study (Schratt, 1991; Schratt-Ehrendorfer, 1993a; Schratt-Ehrendorfer, 1993b; Schratt-Ehrendorfer, 1993c; Schratt-Ehrendorfer, 1995). They are corresponding to six plant communities, representing (periodically) wet conditions on meadows (Willner et al., 2022):

- *Ophioglosso-Caricetum tomentosae*
- *Agropyro-Alopecuretum pratensis*
- *Ranunculetum repentis*
- *Poa palustris-Alopecurus pratensis comm.*
- *Dactylido-Festucetum arundinaceae*
- *Ranunculus repens-Elymus repens comm.*

The *Ophioglosso-Caricetum tomentosae* is the alternative to the *Cnidio-Violetum pumilae* along the Danube, the *Agropyro-Alopecuretum pratensis* was initially detected in Austria. In contrast to the first community, the second one seems to be the corresponding equivalent on nutrient-richer sites. The *Ranunculetum repentis* rather occurs on depressed locations of temporarily flooded meadows. The *Poa palustris – Alopecurus pratensis community* shares many characteristics with the latter association but is strongly covered by *Alopecurum pratensis* (Willner et al., 2022), it could have occurred from management intensification (Zahlheimer, 1979). The *Dactylido - Festucetum arundinaceae* is a less studied association and seems to emerge in the NP due to the usage of heavier machines. The *Ranunculus repens - Elymus repens community* might be the equivalent of the *Agropyro - Alopecuretum* with a higher cover of *Elymus repens* (Willner et al., 2022).

These relevés were located in the Untere Lobau ("Uferwiesen", Viennese part of National Park), in the Lower Austrian part of the National Park in possession of the Österreichische Bundesforste and outside the National Park in possession of the town Fischamend (see Figure 1).

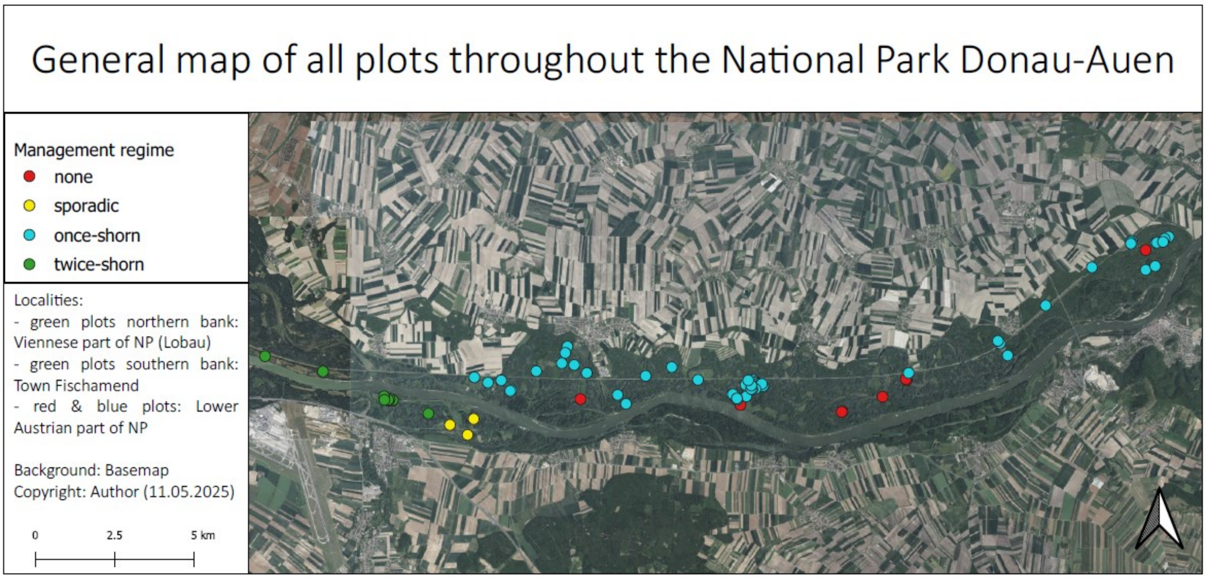

Figure 1: General map of all plots throughout the National Park Donau-Auen, symbolized according to management regime © Author

The plots were widely distributed throughout the whole National Park, primarily on the Northern bank (see Figure 1). The symbology is according to the current management regime. The relevés were classified into four groups:

1. abandoned
2. sporadically mowed (= mulching) for hunting reasons (without hay removal)
3. mowed once a year (with removal of cut vegetation, no fertilizers)
4. mowed twice a year (with removal of cut vegetation, no fertilizers)

Not managed meadows were abandoned in recent years or a long time ago. For the last two classes, no fertilizers are or were used in the near past. Certain meadows in possession of the Town Fischamend are part of the Austrian agro-environment scheme (ÖPUL; pers. comm. Josef Jäger, Franz Kovacs, Susanne Leputsch & Karoline Zsak).

In May and June 2024, field work took place. For the detailed timing of observations, the management regime of the meadows as well as the time of the historic observations were taken into account. The chosen relevés were relocated based on coordinates obtained from the original study. However, due to spatial uncertainties in the GPS measurements, plots might have been shifted by a few dm to m towards the next topographic depression for this master thesis. This was done because the original relevés of the floodplain meadows were always placed at the lowermost locations within meadows (pers. comm. Luise Schratt-Ehrendorfer).

Then, corner points of the plots were marked with metal pegs and combined by a rope. Next, relevés were mapped via a GPS app and recorded according to the modified Braun-Blanquet scale as can be seen in Table 1 (MobiWIA Kft., 2024; Westhoff & van der Maarel, 1978). The approach was to derive the ecological mapping (including header data) exactly after the methodology by Luise Schratt-Ehrendorfer to obtain statistical comparability. As literary identification keys, Fischer et al. (2008), Jäger et al. (2017) as well as Eggenberg & Möhl (2020) were used. The identification apps "Flora Incognita" (Technische Universität Ilmenau, 2024), "iNaturalist" (iNaturalist, 2024) and "Pl@ntNet" (PlantNet, 2023) supported the verifications. Additional notes regarding position and forms of the plots were taken for possible replication studies in the future. Due to already obtained management and a flooding event in June, 80 relevés were mapped in total.

Figure 2: Plot with dominating Aloperucus pratensis
© Author

Figure 3: Flooded meadow © Author

Table 1: Modified Braun-Blanquet scale: nine-step version following Westhoff & van der Maarel (1978) and converted decimal values for further analysis according to Dengler & Dembicz (2023)

Category	Maximum cover (%), abundance	*Corresponding decimal value for further analysis*
r	<< 1%, 1-3 individualds	0
+	< 1%, few individualds	0,01
1	< 5%, abundant	0,0225
2m	< 5%, very abundant	0,04
2a	5 – 12,5%	0,0875
2b	12,5 – 25%	0,1875
3	< 50%	0,375
4	< 75%	0,625
5	< 100%	0,875

2.3 Data preparation and analysis

Raw data was put into Turboveg (Hennekens & Schaminée, 2001). For further analysis, species abundance values from the modified Braun-Blanquet scale were converted to decimal numbers according to Dengler & Dembicz (2023), as can be seen in Table 1.

Since the modified Braun-Blanquet categories “1” and “2m” have the same maximum cover in field (5%) and only differ in the number of individuals, these classes were converted to the same decimal value (“0,0225” from category “1”) for testing afterwards. Changes according to environmental factors were analyzed by using ecological indicator values for light, temperature, soil moisture, soil reaction and soil nitrogen (Karrer et al., 2024). After computing the unweighted means of them for all plots and calculating the differences between the original relevés and the corresponding repeated ones in Excel, statistical analysis was done using the statistical computing environment R (R Core Team, 2022). Four forest plots and one silting plot were excluded from the analysis afterwards, resulting in 75 plots per census and 150 in total.

Ecological indicator values classify vascular plants according to directly influencing environmental factors and therefore give a sufficient hint on their habitat preferences, not their physiological ones. These numerical values are of ordinal origin and rank species on a scale, which is divided into nine sections (sometimes twelve for extreme specialists in moisture and salinity). Ecological indicator values are the results of long-term studies, and this is why they reflect rather stable ecological conditions of the investigated plots (Tremp, 2005). For this master thesis, the current Austrian list of ecological indicator values of vascular plant species was considered (Dengler et al., 2024).

The R package “Readxl“ was used for reading excel-files (Bryan et al., 2023). For data visualization, boxplots were generated to compare either the original plots with the repeated ones, various species groups or different management regimes. The latter aspect was done for a general comparison of abandoned plots against managed ones as well as to differentiate the detailed management regimes as listed before. For statistical significance of the censi comparison, pairwise T- or Wilcoxon-tests were calculated. General management classes were tested with unpaired T- or Wilcoxon-tests for two groups, detailed management classes with linear models. Ordinations (NMDS with two axes, distance measure = Bray-Curtis) were analyzed with the R packages “vegan” (Oksanen et al., 2022) and “MASS” (Venables, 2002), their statistical significance was tested with the “adonis2”-function.

The identification of plant communities was conducted for all 150 plots in JUICE by a TWINSPAN analysis (Tichý, 2002). Working groups were nominated at the fourth TWINSPAN-level. They were designated according to the plant species with the highest fidelity values for each group. Possible changes in plant communities of the 75 representative plots were analyzed in Excel.

Following species groups were further analyzed:

- Red-list-species
- neophytes
- wet specialists
- competitive and common species
- wooden species

The first two groups were classified according to the recent Austrian Red List of plant species. The following categories were considered (Schratt-Ehrendorfer et al., 2022):

- CR: Critically Endangered
- EN: Endangered
- VU: Vulnerable
- NT: Near Threatened
- LC: Least Concern
- N: Not Evaluated or Established Neophyte (used for classification of neophytes)

The nomination of wet specialists and competitive species was done by ecological indicator values and further literature research regarding habitat preferences (Karrer et al., 2024; Fischer et al., 2008; Naturschutzbund Burgenland, 2025; Info Flora, 2025; NHM Wien, 2025). Maps were generated in QGIS (QGIS.org, 2022).

3 Results

3.1 Changes in environmental factors

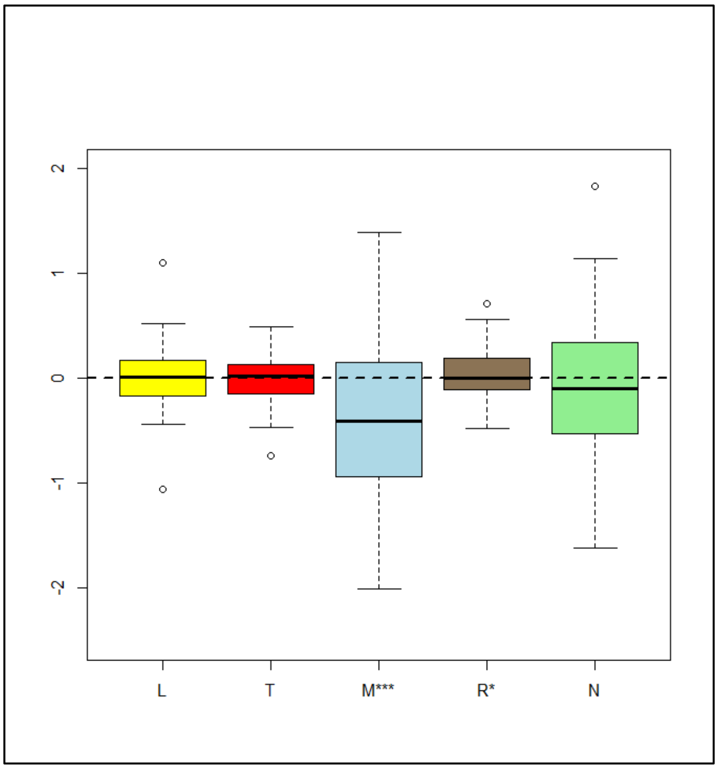

Figure 4: Changes in unweighted mean indicator values. X-axis: L = light, T = temperature, M = soil moisture, R = soil reaction, N = soil nitrogen. Y-axis: changes in respective ecological indicator values, parameter ylab = "-2,2".

Regardless of different management regimes or the simple comparison of the years, no temperature changes could be detected or statistically justified (see Figure 4).

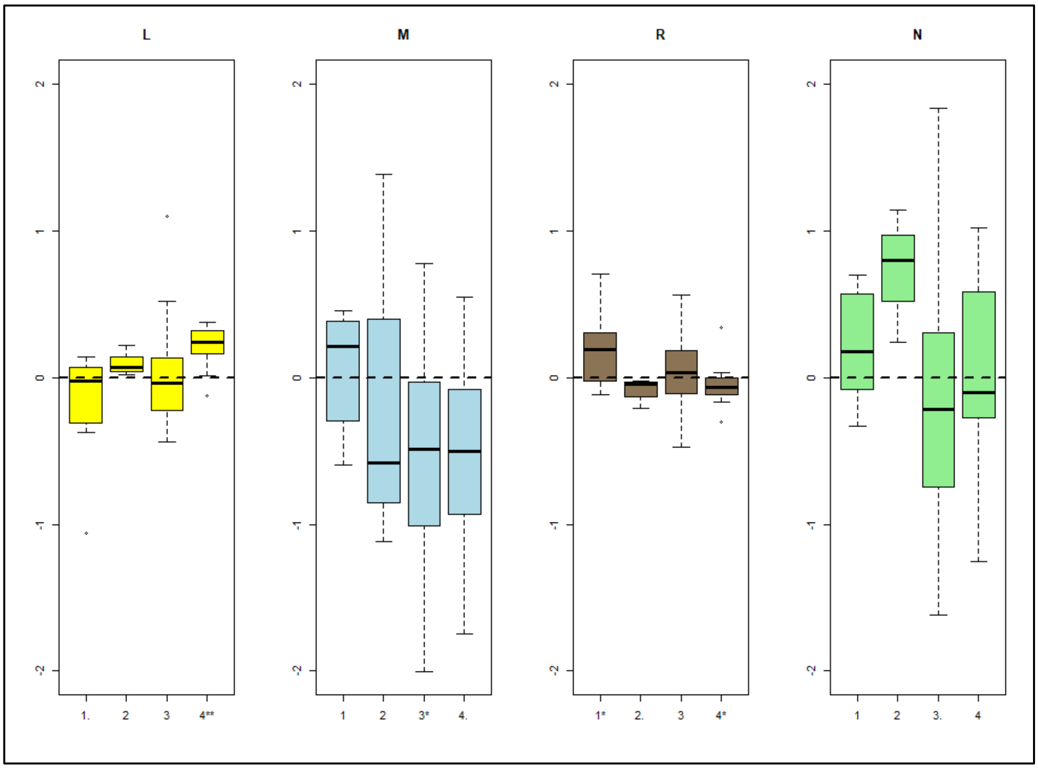

Figure 5: Changes in unweighted mean indicator values for light (L), soil moisture (M), soil reaction (R) and soil nitrogen (N) at 75 plots located at floodplain meadows depending on management classes. X-axis: 1 = abandoned, 2 = sporadically managed, 3 = once-mown a year, 4 = twice-mown a year. Y-axis: changes in ecological indicator values, parameter ylab="-2,2".

In terms of a possible drying out of floodplain meadows, a highly significant decrease in soil moisture was observed with a mean reduction of around -0,43. However, the significant decrease could only be justified for managed plots. The biggest decreases were found in regularly managed groups. Once-mown plots experienced a significant reduction of -0,50 on average. Twice-mown plots underwent a decrease of around -0,55 with a weak significance. For sporadically managed meadows, a smaller decrease with a mean of -0,11 was detected. Abandoned plots became slightly moistier with a mean rise of 0,06. The last two results are not statistically supported (see Figure 4 & 5).

For soil nitrogen, a general reduction was not statistically supported. However, a weakly significant decrease for generally managed plots was observed with a mean of -0,16. A mean rise of 0,21 for abandoned plots was not statistically supported. Regarding different management measures, the strongest increase in soil nitrogen was found for sporadically managed meadows with 0,73 on average, but without statistical evidence. Twice-mown meadows hardly changed. Once-mown plots experienced a weakly significant reduction in nitrogen with a mean of -0,23 (see Figure 4 & 5).

For light, no general changes could be statistically justified. The same was found when comparing general management. However, managed plots hardly changed, whereas abandoned ones slightly darkened. Depending on different management measures, the darkening with a mean of -0,18 on abandoned plots was weakly supported. Twice-mown plots showed a significant increase in light values with a mean of 0,21. Sporadically mown meadows might also have experienced a slight increase of 0,1 on average, but with no statistical support. Once-mown plots hardly changed (see Figure 4 & 5).

Even though no general changes in soil reaction were detected, a significant alkalinization for abandoned plots was proven with a mean rise of 0,19. Managed plots underwent minor changes (see Figure 4 & 5).

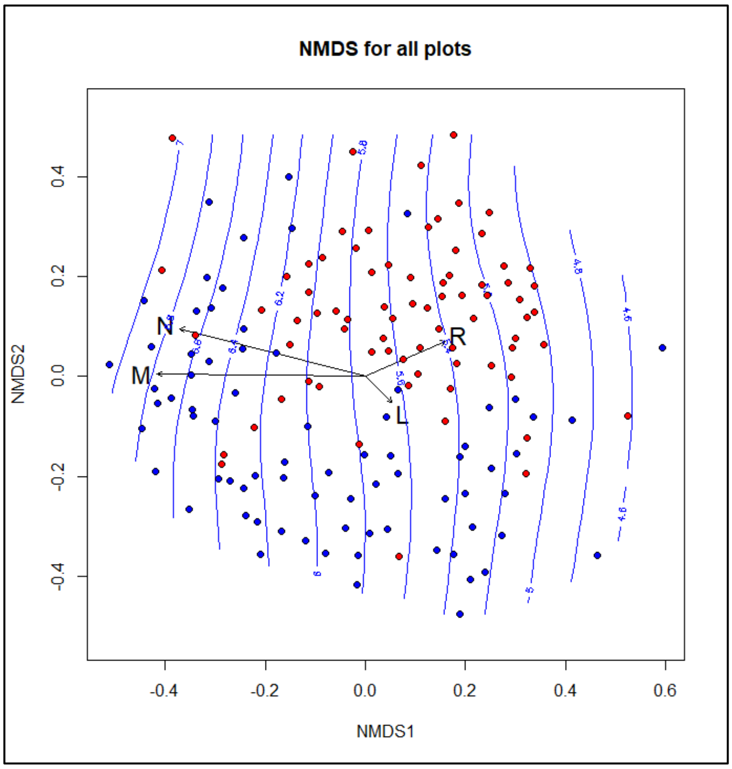

Figure 6: NMDS of all 150 plots in total with vector fit (based on unweighted mean values) and environmental fit of strongest supported EIV (=soil moisture): blue = 1990s, red = 2024, L = light, M = soil moisture, R = soil reaction, N = soil nitrogen.

The NMDS for all analyzed plots with two axes and the Bray-Kurtis-dissimilarity as distance measure also supported the previously explained developments of the original plots. As can be seen in Figure 6, the repeated plots tend to cluster on the upper right corner of the ordination. According to vector fit, soil moisture and nitrogen had the strongest effects on positioning in favor of the original plots. They are highly significant and correlated, also a linear regression model was proven. According to environmental fit, soil moisture was the most representative value for distinguishing between the years and shows a slightly curved scale in direction to the original plots. Light had the smallest influence and is not statistically supported. Soil reaction was significant rather in favor of the repeated plots. Further analyses regarding the development of the unique plots within the NMDS (i.e. position of original plot in contrast to respective repeated plot) proved a predominant change in position from the left half (more blue plots) of the ordination to the right one (more red plots). The chosen ordination, based on the distinguishment of the 1990s to 2024, is highly significant in total.

3.2 Changes in biodiversity values

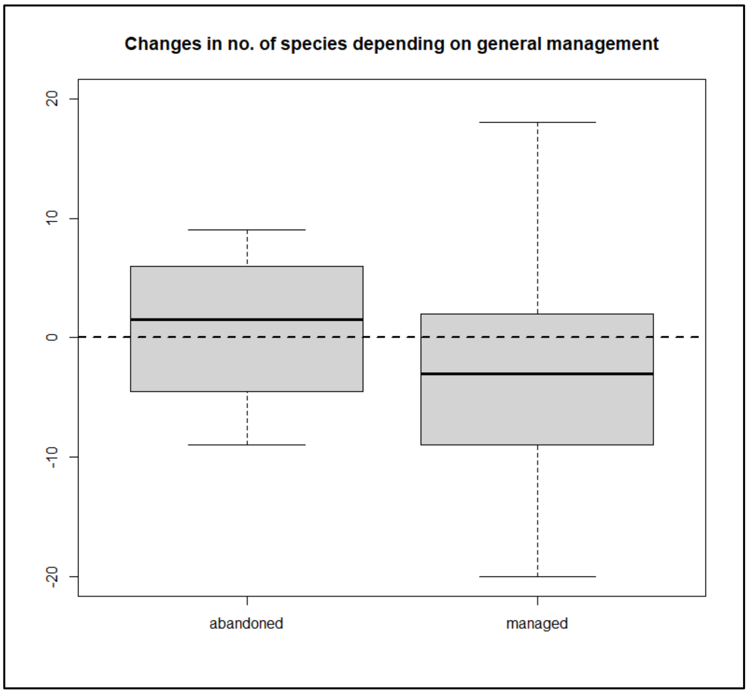

Figure 7: Changes in number of species depending on general management (abandoned or managed). Y-axis = changes in number of species for all plots, parameter ylab = "-20,20".

Generally, a significant reduction in species number with a mean of -2,87 was found from the 1990s to 2024 (see Figure 7). However, a slight increase on abandoned plots (mean = 0,75) and a decrease of around three species on average was observed for managed ones. This was not statistically supported. Also, the strongest reduction of species on managed plots was found one once-mown meadows (mean = -4,68), followed by twice-mown ones (mean = -2,95). Sporadically managed plots experienced an increase in species number with 3,58 on average.

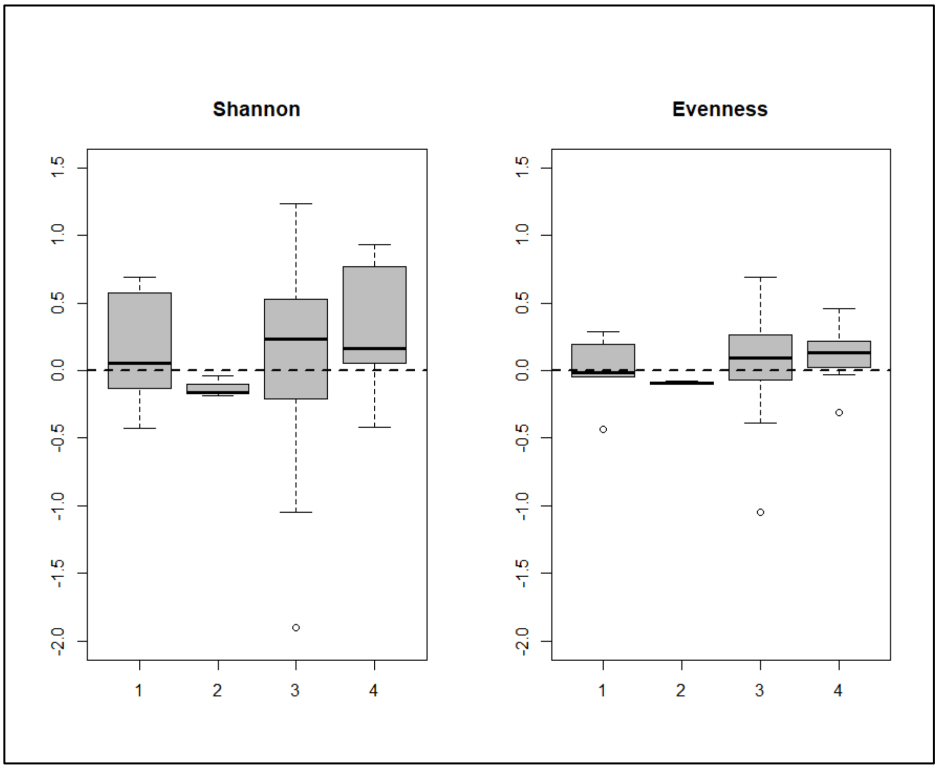

Figure 8: Changes in Shannon-Index and Evenness depending on management classes.
Y-axis = changes in respective biodiversity value, parameter ylab = "-2,1.5"

For Shannon-Index, a weakly significant rise was detected from the 1990s to 2024 with an increase of around 0,15 on average. When comparing abandoned and managed plots in 2024, the same development was found for each group with no statistical support. However, when comparing different management measures, only abandoned and twice-mown meadows experienced the calculated increase. On sporadically managed plots, a slight decrease was estimated. Once-mown meadows hardly changed (see Figure 8).

A similar development was calculated for Evenness. From the 1990s to 2024, this biodiversity value experienced a significant rise of 0,07 on average. The increase was stronger on managed plots than on abandoned ones, but without statistical evidence. Comparing different management measures, a reduction of Evenness was found on sporadically managed plots. The highest increase was calculated for twice-mown meadows with an average of 0,11. Abandoned and once-mown plots both experienced small rises of Evenness (see Figure 8).

3.3 Changes in species groups

Table 2: Changes in total numbers of species per group from the 1990s to 2024 (except management: here, general management is compared).

Species group	*1990s*	*2024*
Total species number	199	208
Species number according to management	101 (i.e. species on abandoned plots)	194 (i.e. species on managed plots)
Red list species (with LC)	174	173
Red list species (without LC)	41	36
neophytes	5	11
specialists	63	48
Competitive species	59	69
Wooden species	13	20

As can be seen in Table 2, a slight increase in the total number of species could be observed. Managed plots comprised around 75 per cent more species than abandoned ones. The number of red list species (including LC) has remained the same. Without not endangered species, there has been a reduction of classical red list species by around 12 per cent. Neophytes doubled from 5 species in the 1990s to 11 in 2024. Newly mapped species were *Ailanthus altissima*, *Impatiens parviflora*, *Lolium multiflorum*, *Malus domestica*, *Oxalis stricta* and *Veronica persica*. Specialists went down by around 20 per cent. For example, *Polygala amarella* and *Cirsium canum* could not be detected again. Competitive species increased by around 17 per cent with new species like *Bromus sterilis* or *Securigera varia*. The number of wooden species increased from 13 to 20 species. *Prunus domestica* or *Rubus fruticosus* agg. are examples of newly detected species.

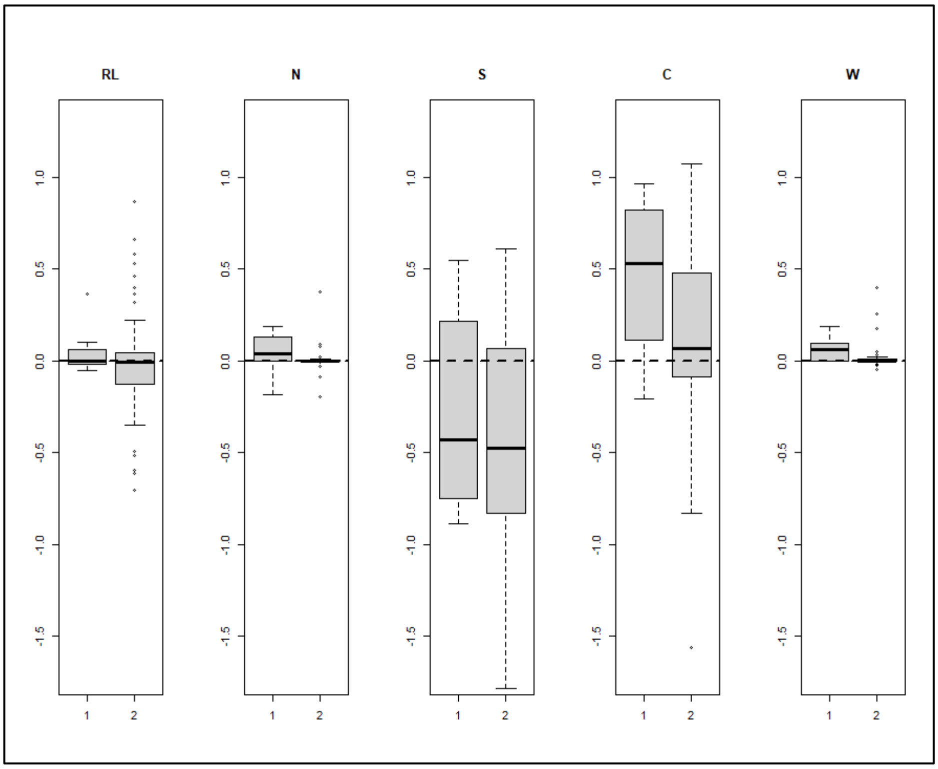

Figure 9: Changes in coverage of different species groups depending on existing management (RL = Red list species, N = neophytes, S = specialists, C = competitive species, W = wooden species. X-axis: 1 = abandoned plots, 2 = managed plots. Y-axis: decimal percentage value of changes in cover of groups, ylab = "-1.7,1.3".

Red list species predominantly decreased in coverage for managed and abandoned plots. The reduction of those species on managed plots is highly significant with a mean of -0,41. For abandoned plots, the reduction is around -0,35 (see Figure 9). The decline of red list species was only weakly significant for abandoned plots with a mean of -0,35. The smallest reduction was found on sporadically managed plots with a mean of -0,29. Regularly managed plots had a mean decline of -0,59 for twice-mown and -0,37 for once-mown ones.

Regarding detailed red list categories, not endangered species (=LC) decreased in coverage by around a third. Endangered species were nearly completely reduced. *Carex melanostachya*, *Leucojum aestivum* and *Thalictrum simplex* s. lat. could not have been detected again. *Viola elatior* and *Viola pumila* were still evident. *Achillea aspleniifolia*, *Malus sylvestris* s. str. and *Muscari tenuiflorum* were newly found with small coverage values. Vulnerable species quadrupled, even though *Carex acutiformis* and *Pentanema salicinum* made up most of the coverage. Nearly threatened ones were halved. For example, *Calamagrostis canescens* s. str. and *Cardamine pratensis* s. str. could not have been found again. Critically endangered species were hardly represented in both study periods with *Arabis nemorensis*, but this species went down strongly. *Achillea nobilis* was newly detected.

Figure 10: Viola pumila (EN) © Author

Neophytes slightly increased on abandoned plots and hardly changed on managed (see Figure 9). Covers of neophytes were low in general, the highest cover in 2024 was “2b” for *Erigeron annuus* on one plot. This species was the dominant neophyte in total, even though it strongly decreased from the 1990s to 2024 to a quarter of its former total coverage. It was followed by *Acorus calamus*, which could not be detected again in 2024. Considering different management measures, findings for sporadically managed plots were significant and those for abandoned ones weakly significant.

Specialists strongly decreased with a high significance on managed plots with a mean reduction of around 40 per cent. A similar development was found on abandoned plots, but with no statistical support (see Figure 9). Abandoned and sporadically managed plots underwent the weakest declines with -0,28 or -0,17 on average, but with no statistical support. Once-mown plots experienced a loss in coverage with a mean of -0,38. A reduction with -0,79 on average was weakly statistically supported for twice-mown meadows.

Dominant specialists in 2024 appeared to be *Alopecurus pratensis*, *Carex acutiformis* and *Colchicum autumnale*. The last two species experienced an increase in the last decades. A strong reduction was found for *Lolium arundinaceum*, *Poa palustris* and *Ranunculus repens*. In many cases, specialists were detected with reduced vitality (e.g. no flowering or comparatively small individuals).

Figure 11: Poa palustris (LC) © Author

Competitive species significantly emerged in general (see Figure 9). For managed plots, the increase was 17 per cent on average, the one for abandoned ones 46. For sporadically managed plots, a decline with a mean of -44 per cent was also significant. Regularly managed plots underwent smaller increases with no statistical support (mean for once-mown plots: -20 per cent, mean for twice-mown plots: -15 per cent).

Whereas species like *Scorzoneroides autumnalis* or *Tanacetum vulgare* could not be detected again on the respective plots, *Aegopodium podagraria* or *Clematis vitalba* were one of the newly mapped species. In the 1990s, general coverage of different competitive species was relatively low in comparison to 2024. Back then, *Taraxacum* sect. *Ruderalia, Lolium pratense* s. str., *Dactylis glomerata* or *Lathyrus pratensis* were prominent common species. In 2024 however, *Arrhenatherum elatius* led this list with the highest total coverage, followed again by *Dactylis glomerata* which had strongly emerged and *Lolium pratense* s. str. which had doubled.

Generally, wooden species significantly increased sixfold in coverage, but mainly on abandoned plots (see Figure 9). They were predominantly found as seedlings or juveniles. Abandoned plots experienced an average rise of 6 per cent, other management groups rather stayed the same. Dominant species did not change from the 1990s to 2024 with *Populus alba*, *Rubus caesius* and *Cornus sanguinea* leading the list. *Ligustrum vulgare*, *Prunus spinosa*, *Quercus robur*, *Rhamnus* *cathartica* and *Ulmus minor* could not be detected again. *Juglans regia, Salix alba* or *Sambucus nigra* were newly detected species.

3.4 Changes in plant communities

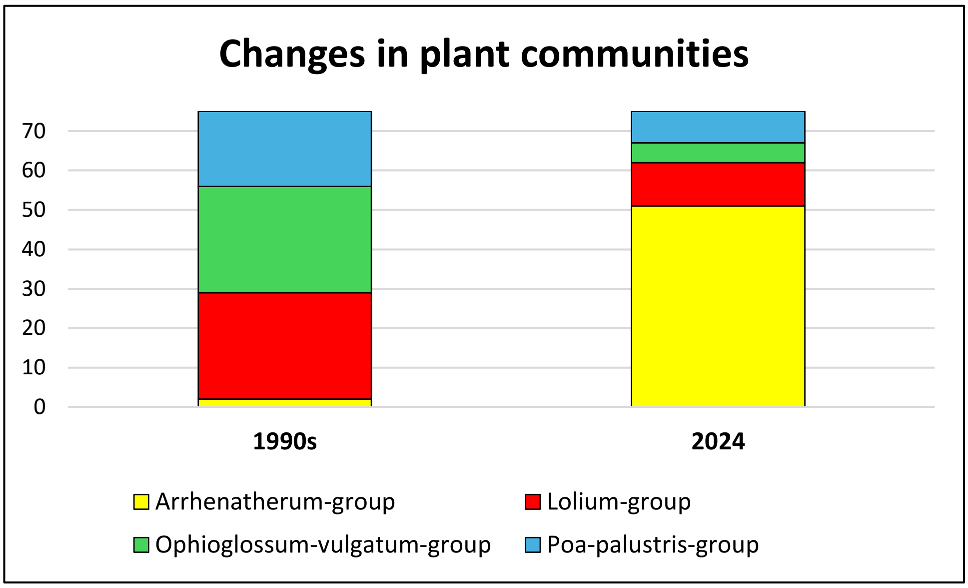

Figure 12: Column chart of TWINSPAN-groups for the 1990s and 2024. Y-axis: Total number of plots per TWINSPAN-group (75 in total for each chart).

Based on the TWINSPAN analysis, four groups were identified which represent a moisture gradient from rather fertile to wet conditions:

- *Arrhenatherum*-group
- *Lolium*-group
- *Ophioglossum-vulgatum*-group
- *Poa-palustris*-group

Despite namesake *Arrhenatherum elatius*, other (competitive) dominant species in the first group were *Erigeron annuus, Vicia tetrasperma, Fragaria vesca* and *Galium verum* s. str. *Serratula tinctoria* ssp. *tinctoria* was the specialist with the highest fidelity to this group. The *Lolium*-group was characterized by *Lolium arundinaceum*, *Lolium pratense* s. str., *Bromus hordeaceus* ssp. *hordeaceus, Veronica arvensis, Ajuga reptans* and other species which indicate slightly moistier conditions in this group. The highest representative species in the *Ophioglossum-vulgatum*-group were the namesake one, others were *Viola pumila, Agrostis stolonifera, Potentilla anserina, Carex brizoides* and *Equisetum arvense* ssp. *arvense*. The fourth group as the wettest one was mainly characterized by *Poa palustris, Persicaria amphibia, Ranunculus repens, Rumex crispus* and *Plantago major* ssp. *intermedia*.

In the 1990s, the *Arrhenatherum*-group was underrepresented with the other three groups making up a third respectively of the remaining plots. In the repeated mapping, a crucial decrease of wet meadow groups was detected. In total, the *Poa-palustris*-group was halved, the *Lolium*-group developed similarly, and the *Ophioglossum-vulgatum*-group underwent the strongest reduction to a fifth of its former plots. Around two thirds of the plots developed from a moistier group to the dryer *Arrhenatherum*-group, which made that cluster increase from former two plots to around fifty. Every fifth plot did not change. Only a few became moistier, i.e. were assigned to the next-wetter group. All abandoned plots are designated to the *Arrhenatherum*-type nowadays (see Figure 12).

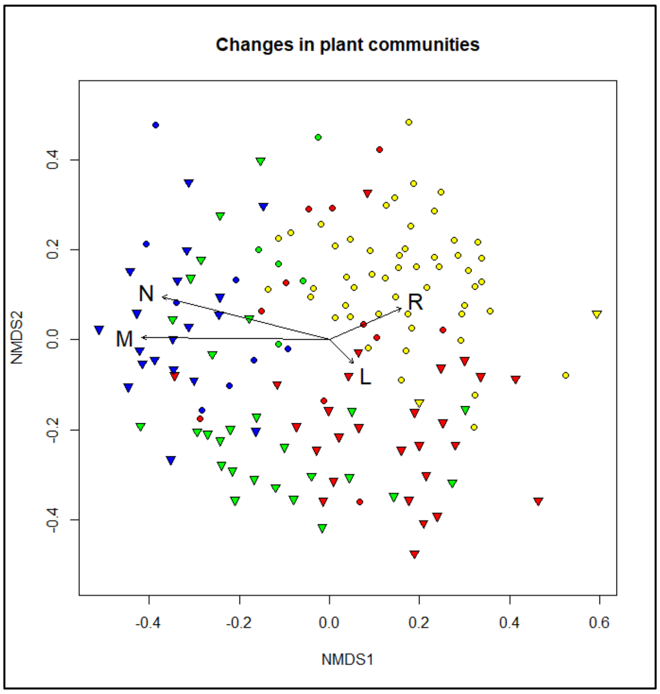

Figure 13: NMDS of all plots, illustrating changes in plant communities with a vector fit for unweighted means of ecological indicator values. Triangles = plots from the 1990s, circles = plots from 2024, yellow = Arrhenatherum-group, red = Lolium-group, green = Ophioglossum-vulgatum-group, blue = Poa-palustris-group, L = light, R = soil reaction, M = soil moisture, N = soil nitrogen.

A NMDS based on all plots and the detected TWINSPAN-groups further strengthens the results. Plots, assigned to the *Arrhenatherum*-group, seem to be located on more alkaline habitats. The moistiest groups, i.e. *Ophioglossum-vulgatum*- and *Poa-palustris*-group, are characterized by higher values for soil moisture and soil nitrogen. Light still appears to be a weaker factor in distinguishing groups (see Figure 13).

Regarding changes in environmental factors in different TWINSPAN-groups, nowadays plots of the *Arrhenatherum*-group underwent a highly significant decrease in soil moisture with a mean of -0,59. They were the only group with an increase in soil reaction (+0,12 on average), again with strong statistical evidence. In addition, *Arrhenatherum*-plots were the only ones with a (significant) nitrogen reduction with a mean of -0,29. For that ecological indicator value, an increase for *Lolium*- and *Poa-palustris*-plots was (weakly) significant. The same statistical support was found for minor acidization. Regardless of changes in soil reaction (mean = -0,43), similar developments for the *Ophioglossum-vulgatum*-group were not statistically evident. Looking at changes in soil moisture, these groups hardly changed with a weak significance. Minor changes in light values were not statistically supported in all four groups.

4. Discussion

4.1 Environmental factors

Despite ongoing climate change, the temperature values did not detect general trends for a warming of the respective plots. As the observed meadows were located throughout the whole NP (primarily on the Northern bank) and therefore covered the study area quite sufficiently, these findings seemed surprising. In general, a widely distributed rise in air temperature was detected for Central and Eastern Europe. Austria in particular underwent a rise in maximum and minimum temperature values in the last four decades. Longer growing seasons, the reduction of glaciers and more rain instead of snow in winter in the lowlands are additional indicators for this trend (Anders et al., 2014).

A survey conducted by the Provincial Administration of Lower Austria (2017) for the Pannonian region estimated a mean rise in temperature of 1,4°C in winter and 1,7°C in summer from 1961-2016. These ongoing trends will lead to a rise of heat days by eight until 2050 and will enlarge vegetation periods by twelve days. These trends are also supported by Neuwirth & Hofer (2013) and their claim for a higher future heat and drought risk for Austrian regions which are already severely threatened nowadays. Since the lowest depressions on the selected meadows were chosen for the plots in the 1990s and 2024, this topographic factor could have hidden rises in temperature based on the respective ecological indicator value, as these plots might have been less exposed.

Regarding soil moisture, the results largely fulfilled the corresponding hypothesis. In combination of the former described temperature trends and river regulations (despite promising restoration efforts), the detected drying out of meadows (even near the Danube) was expected. However, there was an increase of precipitation in the last decades (Amt der NÖ Landesregierung, Abteilung Umwelt- und Energiewirtschaft, 2017). So, this factor could not have been responsible for these results. However, a study by Klasz (2024) detected a general decrease in groundwater levels between 45 and 75 cm from 1996 to 2020 along the affected Danube route. The most important influences are decreasing trends in middle water levels throughout the whole watershed of the Danube because of climate change and the ongoing riverine sole erosion. For the plots in Fischamend, changes in groundwater levels are the main factor of being flooded (in pers. comm. Josef Jäger). Trends for a drying out of floodplain meadows were also detected in former studies with more different meadow types (Sauberer & Pfundner, 2019). Whereas that study found no correlation between soil moisture and soil nitrogen values, the opposite was detected in this master thesis. This indicates that management measures also seem to have a certain influence on the present results.

Regarding soil nitrogen, the results correlate with general findings of abandoned and managed meadows. An increase in nitrogen for sporadically managed plots is due to the mulching method and missing hay removal. A noticeable result was the weak statistical support for a nitrogen decrease on once-mown meadows, but not on twice-mown ones. This might be because on the latter ones, fertilizers could have been used occasionally in the last years (pers. comm. Josef Jäger). If hay is removed on managed plots after mowing, this enhances the removal of nutrients which is the main intention of regular management (Neuenkamp et al., 2013). Since water is necessary for the mineralization of nutrients like nitrogen, a correlation between soil moisture and soil nitrogen (especially in a wetland ecosystem) appears plausible (Sleutel et al., 2008). A rise in nitrogen on abandoned plots can be explained with a stronger occurrence of competitive species which are characterized by higher nitrogen values.

Regarding light values, a darkening trend for abandoned plots seems understandable since a stop of mowing strenghthens the emergence of common grass species. Also the halt of litter removal enhances the darkening. This way, herbaceous plants on the ground below have less light and therefore a smaller probability of seeding and further growing, which is also explained by the general darkening trend for abandoned plots. Under this aspect, a potential increase of light values on sporadically mowed meadows without hay removal seems surprising. Other noticeable findings are hardly any changes on once-mown plots and a significant increase of light values on twice-mown meadows. This could indicate that a higher mowing frequency would be favorable for preventing further abandonment or succession trends towards forest habitats.

For soil reaction, also Sauberer & Pfundner (2019) found no general change. When now comparing different management measures, the significant alkalinazation of abandoned plots seems conspicuous since there was no change in soil moisture. However, alkalinazation can be an indicator for a possible drying out. Other aspects like the calcarous bedrock or the decrease of specialists for wet conditions further strenghthen this assumption.

4.2 Biodiversity values

An overall significant decrease of around three species on average is supported by changes in plant communities. Current plots were predominantly assigned to the *Arrhenatherum*-type in contrast to the 1990s and that group was the only one with an average increase in more common and competitive species. Also, in the respective NMDS of TWINSPAN-groups, the plots of this group were closer to each other than the ones in other groups. This finding supports an ongoing homogenization regarding species and therefore a potential reduction in their richness.

A minor increase in the number of species on abandoned plots can be explained by ongoing disturbance effects. As more ambitious species from other habitats like forest or woodland start to inhabit the respective meadows when typical (specialist) ones are still detectable, their total number can rise for a period of time. Still, these plots will undergo further succession to reforest ones in the future (Huhta & Rautio, 1998), as could be seen on nowadays forest plots, which were excluded from the final analysis.

Regarding Shannon-Index, the general increase from the 1990s to 2024 might be pleasant. A weak reduction for sporadically managed plots can be due to the halt of hay removal or the general practice of mulching. For abandoned plots, a minor rise in Shannon-Index can be due to the slight increase in species richness due to disturbance factors. The highest increase for twice-mown plots is another indication for this management regime to be the more preferrable one in terms of general biodiversity.

As Shannon-Index and Evenness are linked because of the latter formula, parallel changes are not surprising. Even though a significant increase since the 1990s is only small, it is still positive as there is no general trend for an ongoing dominance of only a few species. A stronger positive development on managed plots further strengthens the need for necessary management measures. Again, sporadically managed plots underwent a minor reduction, which again supports regular management in general. When here having a closer look, again twice-mown plots had a stronger increase in Evenness than once-mown ones. These respective trends for the last two biodiversity values concerning regular management can be supported by Tälle et al. (2018) who, in their meta-analysis, found a potential need for mowing more than once year in grasslands with a higher productivity. This can also be true for the investigated meadows, which lie within a nutrient- and (rather) moistier study area as it is typical of a riverine wetland habitat.

4.3 Species groups

Referring the current Red List of Austrian Vascular Plants, there has been a rise in certain categories (RE = Regionally Extinct + CR + EN + VU) since the 1990s by 2 per cent. If this trend continues, this can be considered dreadful (Schratt-Ehrendorfer et al., 2022). For this master thesis, the categories “Critically Endangered”, “Endangered”, “Vulnerable” and “Near Threatened” were chosen for crucially endangered species. The total number of species of these groups was reduced by 12 per cent. This can be interpreted as an alarming trend when given a detailed look. This development has happened regardless of different management measures, even if the reduction was only (weakly) supported for abandoned plots. Around half of the species, which could not be detected again, are specialists indicating moist conditions (i.e. floodplain meadows). *Calamagrostis canescens* s. str. is one of them, although one original plot was named after that species because of its dominance back then. However, despite detailed observations, *Calamagrostis epigejos* was found in 2024 with high coverage. Also, *Iris sibirica* was not detected in contrast to the 1990s which is characteristic for wet meadows. Still, *Iris pseudacorus* could be found again, which normally appears under marshier conditions.

Newly detected endangered species in 2024 were mostly wooden ones like *Fraxinus excelsior*. Whereas ash trees were not threatened in the 1990s, they became nearly threatened due to ash die back (Nationalpark Donau-Auen GmbH, 2025a). The emerging trend of endangered wooden species is because of their risen coverage in contrast to the 1990s. Newly detected specialists were *Achillea aspleniifolia* (EN), *Carex distans* (VU), *Juncus conglomeratus* (NT), *Lotus maritimus* (VU) and *Scutellaria galericulata* (NT). However, these species were found with low coverage (except *Lotus maritimus*).

So, even though some new specialists could be detected, still an overall decrease of certainly endangered specialists is the dominating trend. In addition, a higher number of wooden species strengthens the indication that (former) floodplain meadow plots underwent certain changes to less specialized habitats.

This assumption is further supported by the severe reduction in coverage of specialists or their reduced vitality on both managed and abandoned plots. Since the early 2000s, species with limited niches for wet habitats strongly declined in different ecosystems. This is due to their limited spatial distribution matters which further decrease when such ecosystems are reduced in their variation and size number. Given these limitations, more specialized plants are at a higher risk of losing potential habitats and therefore are reduced in (Zechmeister et al., 2003). Considering the strongest reduction of specialists on even regular managed plots, it seems that the current management regimes do not appear to halt this ongoing trend.

In the Pannonian region of Austria, species of wet ecosystems generally experienced the highest declines since the 19th century. Whereas water bodies and closer linked habitats had the profound strongest reductions, wet grassland showed the second highest. Here, the proportion of respective species declined from 19 per cent before Danube regulation to around 7,1 per cent afterwards (Grass et al., 2014).

On the contrary, more common and competitive species (i.e. linked to higher nutrient values) emerged in coverage, which is also a general trend in Austria (Zechmeister et al., 2003). As recent studies prove, this trend could not have been reversed yet. These changes in species groups are also good indicators for severe abiotic changes (Staude et al., 2022), even though they might not have been statistically significant. As riverine wetland ecosystems are already nutrient-rich in general, this may further promote rising coverage of competitive species which rely on more beneficial situated habitats regarding nutrient levels. This could explain the ongoing increase in this species group on even managed plots, even though there has been an only slight increase in coverage of competitive species on once-mown plots and an even smaller rise on twice-mown ones. Even though the latter finding was not statistically supported, it might be a hint for the need for a higher mowing frequency to prevent the emergence of competitive species to a certain extent.

Whereas Zechmeister et al. (2003) already suggested further financial measurements for farmers to preserve specialized species on these meadows, Hülber et al. (2017) found similar results almost fifteen years later. Given these findings, this general trend could not have been put on hold.

Fortunately, neophytes have not increased in coverage in the last three decades, which was statistically supported for abandoned and sporadically managed plots. In general, European semi-natural grasslands inhabit neophytes on low levels compared to other ecosystems such as riparian forests or other habitats of anthropogenic origin. Still, the Pannonian region belongs to the ones which are strongly affected by the emergence of neophytes. Also, wet grassland habitats seem to be rather affected by non-European neophytes. This can also be supported by the present results with *Erigeron annuus* being the dominating neophyte in 2024 and *Acorus calamus* the one in the 1990s (Axmanová et al., 2021; Naturschutzbund Burgenland (Hrsg.), 2025).

Last but not least, changes in coverage of wooden species were expectable. The strongest emergence of this group on abandoned plots follows a general successional pattern as it was also found by Joyce (2014). Abandonment is generally a severe European problem, especially in central regions in particular. Within only a few years, species turnover can be detected with an increase of competitive species and an emergence of wooden species. This pattern could also be supported by the given results. Even though wooden species could only be found as seedlings or juveniles, these are also hints for a potential succession of the plots.

Similar changes in that study area regarding species were already found for the so-called "Dirndlwiese" in Eckartsau, an unmanaged former meadow within an abandoned wooden area, after around three decades of development (Zukrigl, 2024). Also in that study, wooden species like *Crataegus monogyna* or *Fraxinus excelsior* were new species with a higher emergence.

4.4 Plant communities

The former results and considerations further support the general trend of a predominant development from (former) plots of floodplain meadows to ones strongly covered by *Arrhenatherum elatius*. The NMDS with symbolized plant communities also visualizes the moisture gradient from the *Arrhenatherum*- and *Lolium*-group on the right to the *Ophioglossum-vulgatum*- and *Poa-palustris*-group on the left. Despite no statistical evidence for a general alkalinization of repeated plots, *Arrhenatherum*-plots were plotted along higher soil reaction values within the NMDS (see Figure 13). Since around two thirds of new plots were assigned to this group as the dryest detected one, this also supports an ongoing drying out of the meadows.

This can also be explained by environmental changes based on the TWINSPAN-groups as around two thirds of present plots are assigned to the *Arrhenatherum*-group and had the strongest decline in soil moisture. For similar German meadows, hydrology was again the strongest influencing factor on species composition. Here, variability in aquifers seems to be the most important subfactor, which has been reduced due to anthropogenic influences like regulation measurements or lengthening of dry seasons (Erzfeld et al., 2025).

The highly significant alkalinization of mainly abandoned plots assigned to the *Arrhenatherum*-group might also support such changes. A parallel decline in soil nitrogen, alongside soil moisture, can also be explained as in chapter 4.1. Again, these ecological indicator values seem to be the strongest parameters in certain developments since the 1990s.

5 Conclusion

In conclusion, floodplain meadows in the National Park Donau-Auen primarily changed as it was postulated in the hypotheses. Managed plots became dryer, hardly darker and less rich in nitrogen. Also, abandoned ones tend to dry out due to higher soil reaction values. In general, red list species and specialists went down, whereas competitive and common species further emerged. This can be seen as a reason for decreases in species richness, especially on managed plots. A strong rise of *Arrhenatherum*-plots at the expense of wet meadow types further supports a tendency of homogenization regarding species composition. Given that, original plots from the 1990s became less specialized habitats.

So, some targets of the National Park's meadow management are fulfilled (keeping clear of wooden species, reduction of nitrogen…). However, the achievement of the protective aim of endangered species and habitats appears questionable.

Still, twice-mown plots showed the least negative trends regarding biodiversity values. Also, light values were increased here. So, this management scheme tends to halt a further ruderalization of the grassland type analyzed and therefore seems to be more effective regarding these parameters.

However, the overall negative changes detected are an alarming signal for floodplain meadows integrated into a strongly protected riverine wetland ecosystem. The National Parks' main goal is the protection of natural processes; therefore, semi-natural grasslands are of weaker importance. However, the conservation of severely threatened meadow types and their threatened species in the management zone should also be fulfilled as it is part of the current management plan in the National Park Donau-Auen. Changes in current mowing regimes could halt future worsening and thus preserve floodplain meadow habitats in their total biodiversity for future generations.

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Appendix

Detailed list of all species in the 1990s and 2024, including assigned species groups, red list categories, year of detection and ecological indicator values according to Karrer et al. (2022). Species groups: w = wooden species, n = neophyte, s = specialist, c = competitive species. Red list category according to Schratt-Ehrendorfer et al. (2022): LC = Least Concern, n = Not Evaluated or Established Neophyte (used for classification of neophytes), EN = Endangered, CR = Critically Endangered, VU = Vulnerable NT = Near Threatened. No red list category means that this this species was not listed. EIV (Ecological Indicator Values): L = Light, T = Temperature, M = Soil Moisture, R = Soil Reaction, N = Soil Nitrogen. No EIV for certain species means that this species is indifferent regarding that value i.e. shows no clear preference.

Scientific species name	Species group	RL	year of detection	L	T	M	R	N
Acer campestre	w	LC	both	5	7	5	7	5
Acer negundo	w, n	n	both	6	7	6	7	7
Achillea aspleniifolia	s	EN	2024	8	6	7	7	4
Achillea collina	-	LC	both	8	6	4	6	4
Achillea millefolium agg.	c	-	both	8	-	-	-	-
Achillea nobilis	-	CR	2024	8	7	3	8	2
Achillea pratensis	-	LC	both	8	5	6	6	5
Acorus calamus	s, n	n	1990s	8	6	10	7	7
Aegopodium podagraria	c	LC	2024	5	5	6	7	8
Agrimonia eupatoria	-	LC	both	7	6	4	7	5
Agrostis sp.	-	-	2024	-	-	-	-	-
Agrostis stolonifera	s	LC	1990s	8	-	7	6	5
Ailanthus altissima	c, n	n	2024	7	8	5	7	7
Ajuga reptans	-	LC	both	5	5	6	6	6
Allium angulosum	s	VU	1990s	8	7	8	8	3
Allium scorodoprasum	-	LC	both	6	6	6	7	7
Allium ursinum	-	LC	2024	3	6	-	7	6
Allium vineale	c	LC	2024	7	7	4	7	6
Alopecurus pratensis	s	LC	both	8	5	6	6	7
Anthoxanthum odoratum s. str.	-	LC	both	7	5	5	5	4
Arabidopsis thaliana	c	LC	2024	7	6	4	4	4

Arabis hirsuta s. str.	-	LC	both	7	5	3	8	4
Arabis nemorensis	s	CR	both	8	6	7	8	4
Arctium lappa	c	LC	2024	8	6	5	7	8
Arctium sp.	-	-	both	-	-	-	-	-
Arenaria serpyllifolia s. str.	c	LC	1990s	8	5	4	7	5
Arrhenatherum elatius	c	LC	both	7	5	4	7	6
Asparagus officinalis	c	NT	2024	7	8	4	7	5
Asperugo procumbens	c	VU	2024	7	6	4	8	8
Asperula tinctoria	-	NT	1990s	6	6	4	8	3
Astragalus cicer	c	LC	both	7	6	4	7	4
Avenula pubescens	-	LC	2024	7	5	4	-	5
Bellis perennis	c	LC	both	8	5	5	5	6
Berula erecta	s	VU	1990s	7	6	10	8	6
Brachypodium pinnatum s. str.	-	LC	both	7	5	4	6	4
Brachypodium sylvaticum	-	LC	2024	4	5	5	6	6
Briza media	-	LC	both	8	-	-	3	2
Bromus erectus s. str.	-	LC	both	8	5	3	7	3
Bromus hordeaceus ssp. *hordeaceus*	c	LC	both	8	-	-	-	6
Bromus inermis	c	LC	both	8	6	5	7	5
Bromus japonicus	c	LC	2024	8	7	4	7	5
Bromus sterilis	c	LC	2024	6	6	4	6	7
Bromus tectorum	c	LC	2024	8	6	3	8	6
Calamagrostis canescens s. str.	s	NT	1990s	6	6	9	6	5
Calamagrostis epigejos	-	LC	both	7	5	5	-	6
Caltha palustris	s	LC	1990s	6	-	9	6	6
Campanula patula	-	-	1990s	7	6	5	6	5
Capsella bursa-pastoris	c	LC	both	7	5	5	6	-
Cardamine pratensis s. str.	s	NT	1990s	7	-	7	6	1
Carduus crispus	c	LC	1990s	6	6	6	7	8
Carduus nutans	c	NT	1990s	8	7	3	7	7
Carduus sp.	-	-	1990s	-	-	-	-	-
Carex acuta	s	VU	1990s	7	5	9	6	6
Carex acutiformis	s	NT	both	7	5	9	7	6
Carex brizoides	-	LC	1990s	5	5	6	4	3

Carex caryophyllea	-	LC	1990s	8	-	4	-	3
Carex distans	s	VU	2024	9	7	7	7	4
Carex disticha	s	VU	both	8	6	9	8	5
Carex elata mod. *dissoluta*	s	-	2024	-	-	-	-	-
Carex flacca	s	LC	both	7	-	-	7	3
Carex hirta	-	LC	both	7	6	6	-	5
Carex leporina	s	LC	2024	7	5	7	3	4
Carex melanostachya	s	EN	1990s	7	7	8	7	5
Carex panicea	s	LC	both	8	-	8	-	3
Carex praecox s. str.	-	NT	1990s	8	7	4	-	3
Carex riparia	s	VU	both	7	6	9	7	7
Carex sp.	-	-	both	-	-	-	-	-
Carex spicata	-	LC	both	7	5	5	5	6
Carex sylvatica	-	LC	2024	3	5	6	6	5
Carex tomentosa	-	NT	both	7	6	6	8	4
Carpinus betulus	w	LC	both	4	6	-	-	
Centaurea jacea s. str.	-	LC	both	7	-	5	6	5
Centaurium erythraea	-	LC	both	8	6	6	6	4
Cerastium brachypetalum s. str.	-	LC	2024	9	7	3	7	2
Cerastium glomeratum	c	LC	both	7	6	6	5	6
Cerastium holosteoides	c	LC	both	7	-	5	6	7
Cerastium pumilum s. str.	c	NT	2024	8	7	3	8	2
Cerastium sp.	-	-	1990s	-	-	-	-	-
Cerinthe minor	-	LC	both	8	6	4	8	4
Circaea lutetiana s. str.	-	LC	2024	4	5	6	7	7
Cirsium arvense	c	LC	both	8	-	-	6	7
Cirsium canum	s	VU	1990s	8	7	7	7	6
Cirsium oleraceum	s	LC	2024	6	5	8	7	7
Cirsium vulgare	c	LC	1990s	8	5	5	6	7
Clematis vitalba	c	LC	2024	7	6	5	7	6
Clinopodium vulgare	-	LC	2024	7	-	4	7	4
Colchicum autumnale	s	LC	both	6	5	6	7	5
Convolvulus arvensis	c	LC	both	7	6	4	7	6
Convolvulus sepium	c	LC	2024	7	6	7	7	8
Cornus sanguinea ssp. *sanguinea*	w	LC	both	6	5	5	7	5

Crataegus monogyna	w	LC	both	6	6	4	7	4
Cruciata pedemontana	-	VU	2024	8	8	3	7	2
Cynosurus cristatus	-	LC	2024	8	5	5	5	4
Dactylis glomerata	c	-	both	7	5	5	6	6
Daucus carota	c	LC	both	8	6	4	6	4
Deschampsia cespitosa s. str.	s	LC	both	6	5	7	5	5
Dianthus carthusianorum agg.	-	-	2024	8	6	8	7	3
Echium vulgare	c	LC	both	9	6	4	7	4
Eleocharis palustris	s	-	1990s	8	5	10	6	6
Eleocharis sp.	-	-	1990s	-	-	-	-	-
Elymus caninus	-	LC	2024	5	6	6	7	7
Elymus repens	s	LC	both	7	5	5	6	7
Epilobium sp.	-	-	2024	-	-	-	-	-
Epilobium tetragonum s. str.	-	LC	1990s	7	6	8	6	6
Equisetum arvense ssp. *arvense*	c	LC	1990s	-	5	6	-	-
Equisetum hyemale	s	LC	2024	5	5	7	7	6
Equisetum palustre	s	LC	both	7	-	8	-	3
Erigeron annuus	c, n	n	both	7	5	5	6	5
Euonymus europaeus	w	LC	both	6	5	5	7	5
Euphorbia esula s. str.	c	LC	both	8	6	4	7	4
Euphorbia lucida	s	VU	both	7	7	8	7	6
Festuca rubra agg.	c	-	both	-	-	-	-	-
Festuca rupicola	-	LC	both	8	6	3	7	3
Festuca sp.	-	-	2024	-	-	-	-	-
Ficaria verna s. str.	-	LC	both	-	5	6	7	7
Filipendula vulgaris	-	VU	both	7	6	4	8	3
Fragaria vesca	-	LC	2024	7	-	5	-	5
Fragaria viridis	-	NT	both	8	6	4	7	4
Fraxinus excelsior	w	NT	2024	6	5	-	7	-
Galium aparine s. str.	c	LC	both	7	6	5	6	8
Galium mollugo agg.	-	-	both	-	-	-	-	-
Galium palustre agg.	s	LC	both	7	6	5	7	3
Galium verum s. str.	-	VU	both	8	7	5	7	3
Galium wirtgenii	-	LC	2024	4	5	5	6	7
Glechoma hederacea s. str.	s	LC	both	6	-	-	7	6

Holcus lanatus	s	LC	both	8	6	5	6	5
Holcus mollis	s	LC	1990s	6	5	5	3	3
Hypericum perforatum	-	LC	both	7	6	4	-	4
Impatiens parviflora	n	n	2024	4	6	5	6	6
Iris pseudacorus	s	LC	both	7	6	9	6	7
Iris sibirica	s	VU	1990s	8	6	8	7	3
Juncus conglomeratus	s	NT	2024	8	5	8	4	4
Juncus gerardii	s	VU	1990s	8	7	7	8	4
Knautia arvensis	-	-	both	7	6	4	6	4
Lamium purpureum	c	LC	2024	7	5	5	7	7
Lamium sp.	-	-	2024	-	-	-	-	-
Lathyrus pratensis	c	LC	both	7	5	6	6	6
Leontodon hispidus ssp. hispidus	c	LC	1990s	8	-	5	6	6
Leucanthemum ircutianum	c	LC	1990s	8	5	4	6	4
Leucanthemum vulgare s. str.	-	NT	both	8	5	4	6	5
Leucojum aestivum	s	EN	1990s	7	8	8	7	7
Ligustrum vulgare	w	LC	1990s	6	6	4	7	4
Linaria vulgaris	c	LC	both	8	6	4	7	5
Linum catharticum	-	LC	both	8	5	5	7	3
Lolium arundinaceum	s	LC	both	8	6	7	7	6
Lolium multiflorum	c, n	n	2024	8	7	5	7	8
Lolium perenne	c	LC	2024	8	6	5	7	7
Lolium pratense s. str.	c	LC	both	8	5	6	6	7
Lotus corniculatus s. str.	-	LC	both	7	-	4	7	4
Lotus maritimus	s	VU	2024	8	7	6	8	3
Lychnis flos-cuculi	s	LC	1990s	7	5	7	5	4
Lycopus europaeus ssp. *europaeus*	-	LC	2024	7	6	9	7	7
Lysimachia nummularia	s	LC	both	4	6	7	6	6
Lysimachia vulgaris	s	LC	both	7	5	8	6	5
Lythrum salicaria	s	LC	both	7	5	9	6	6
Malus domestica	w, n	n	2024	7	7	5	5	5
Malus sylvestris s. str.	w	EN	2024	6	6	5	7	5
Medicago lupulina	c	LC	both	7	5	4	7	4
Mentha aquatica	s	LC	both	7	5	9	7	6

Mentha arvensis	-	LC	both	7	5	-	6	5
Mentha sp.	-	-	1990s	-	-	-	-	-
Muscari tenuiflorum	-	EN	2024	7	8	3	8	3
Myosotis arvensis	c	LC	both	7	6	5	6	6
Myosotis palustris agg.	s	-	both	-	-	-	-	-
Myosotis ramosissima	-	LC	2024	9	6	2	7	2
Ononis spinosa	-	G	both	8	6	4	7	3
Ophioglossum vulgatum	s	VU	both	6	6	7	7	3
Ornithogalum kochii subagg.	-	VU	1990s	8	8	-	7	3
Oxalis stricta	c, n	n	2024	6	6	5	5	7
Pastinaca sativa	c	LC	1990s	8	6	5	7	5
Pentanema britannicum	-	VU	1990s	8	6	6	8	5
Pentanema salicinum	-	NT	both	7	6	6	8	3
Persicaria amphibia	s	LC	both	7	6	10	6	7
Peucedanum oreoselinum	-	NT	1990s	6	6	3	-	2
Phalaris arundinacea	s	LC	1990s	7	5	8	7	7
Phleum pratense s. str.	c	LC	both	7	5	5	6	7
Phragmites australis	s	LC	both	7	5	10	7	6
Pimpinella major	c	LC	both	7	5	5	7	6
Pimpinella saxifraga s.str.	-	-	both	7	5	3	6	3
Plantago lanceolata	-	LC	both	7	5	5	6	-
Plantago major ssp. *intermedia*	-	LC	both	-	-	-	-	-
Plantago major ssp. *major*	c	LC	1990s	8	5	5	6	6
Poa angustifolia	-	LC	both	7	6	4	-	4
Poa annua s. str.	c	LC	2024	7	-	6	6	8
Poa palustris	s	LC	both	7	5	8	7	6
Poa pratensis s. str.	-	LC	both	7	5	-	-	-
Poa trivialis	s	LC	both	-	5	7	6	7
Polygala amarella	s	LC	1990s	8	-	-	8	2
Polygala vulgaris ssp. *vulgaris*	-	LC	1990s	8	5	4	4	3
Populus alba	w	LC	both	7	7	6	7	6
Potentilla anserina	c	LC	both	7	-	6	6	7
Potentilla recta	c	LC	2024	9	7	3	7	3
Potentilla reptans	s	LC	both	7	6	6	7	6
Prunella vulgaris	-	LC	both	7	-	6	6	-

Prunus domestica	w	-	2024	6	6	5	6	5
Prunus spinosa	w	LC	1990s	7	6	4	6	-
Pyrus communis agg.	w	NT	2024	-	-	-	-	-
Quercus robur	w	LC	1990s	7	6	-	-	-
Ranunculus acris	c	LC	both	7	-	6	-	-
Ranunculus bulbosus	-	LC	both	8	6	4	7	4
Ranunculus polyanthemos s. str.	-	NT	1990s	-	-	5	6	-
Ranunculus repens	s	LC	both	6	-	7	6	7
Rhamnus cathartica	w	LC	1990s	7	5	4	8	4
Rhinanthus minor	-	LC	both	7	5	5	-	3
Rorippa austriaca	c	LC	both	7	7	7	7	7
Rorippa palustris	c	LC	1990s	7	6	8	6	7
Rorippa sylvestris	c	LC	1990s	7	6	8	7	7
Rosa agrestis	w	VU	2024	8	6	3	8	3
Rosa micrantha	w	NT	2024	8	6	3	8	3
Rubus caesius	c, w	LC	both	7	6	6	6	6
Rubus fruticosus agg.	c, w	-	2024	-	-	-	-	-
Rubus idaeus	c, w	LC	2024	7	4	6	5	6
Rumex acetosa	c	LC	both	7	5	5	6	6
Rumex crispus	c	LC	both	8	6	6	6	7
Rumex sp.	-	-	both	-	-	-	-	-
Rumex thyrsiflorus	n	n	both	8	7	4	7	5
Salix cinerea	w	LC	2024	7	6	9	5	4
Salvia pratensis	-	NT	both	7	6	3	8	4
Sambucus nigra	c, w	LC	2024	7	5	6	7	8
Sanguisorba minor	-	LC	2024	7	6	3	8	3
Sanguisorba officinalis	s	NT	both	7	6	6	7	5
Saponaria officinalis	c	LC	2024	7	6	5	7	6
Scabiosa sp.	-	-	1990s	-	-	-	-	-
Scorzoneroides autumnalis	c	LC	1990s	7	5	5	5	5
Scutellaria galericulata	s	NT	2024	7	6	9	7	6
Scutellaria hastifolia	s	VU	both	7	7	8	7	5
Securigera varia	c	LC	2024	7	6	4	8	4
Sedum sexangulare	-	LC	2024	8	5	2	6	2
Serratula tinctoria ssp. *tinctoria*	s	T	both	6	6	5	7	3

Silaum silaus	s	VU	both	7	6	6	7	4
Solidago gigantea	c, n	n	both	7	6	6	6	7
Stachys palustris	s	LC	both	7	6	7	7	6
Stellaria aquatica	c	LC	1990s	7	6	8	7	8
Stellaria media s. str.	c	LC	both	7	5	5	7	8
Symphytum officinale	s	LC	both	7	6	7	7	8
Tanacetum vulgare	c	LC	1990s	8	6	5	7	6
Taraxacum sect. *Ruderalia*	c	-	both	-	-	-	-	-
Thalictrum flavum	s	VU	1990s	7	7	8	8	5
Thalictrum simplex s.lat.	s	EN	1990s	8	6	7	8	4
Thalictrum sp.	-	-	1990s	-	-	-	-	-
Tragopogon dubius	c	LC	2024	8	7	3	7	5
Tragopogon orientalis	c	LC	1990s	8	6	5	7	7
Trifolium campestre	c	LC	both	8	6	4	7	4
Trifolium dubium	-	LC	both	7	6	5	6	5
Trifolium hybridum	-	LC	2024	7	6	6	-	6
Trifolium pratense	c	LC	both	7	-	5	7	6
Trifolium repens	c	LC	both	8	-	-	6	6
Trisetum flavescens s. str.	-	LC	1990s	7	-	5	6	-
Ulmus minor	w	NT	1990s	6	7	-	7	-
Urtica dioica	c	LC	both	-	-	6	6	9
Valeriana officinalis	s	LC	both	7	-	6	6	-
Valerianella locusta	c	LC	1990s	7	6	4	7	6
Valerianella rimosa	c	VU	1990s	7	6	4	7	6
Verbena officinalis	c	LC	2024	8	6	5	7	6
Veronica arvensis	c	LC	both	7	6	4	6	-
Veronica chamaedrys	c	LC	both	6	-	5	7	6
Veronica maritima	s	VU	1990s	7	7	8	7	6
Veronica persica	n	n	2024	7	-	5	7	7
Veronica serpyllifolia	c	LC	1990s	7	-	5	5	7
Veronica sp.	-	-	2024	-	-	-	-	-
Vicia angustifolia	-	-	both	8	6	4	-	-
Vicia cracca s. str.	-	LC	both	7	5	5	6	5
Vicia hirsuta	-	LC	both	7	6	4	6	5
Vicia sepium	c	LC	1990s	6	-	5	6	6

Vicia tetrasperma	-	LC	both	7	6	5	5	5
Vicia villosa	c	LC	2024	8	6	3	7	5
Vincetoxicum hirundinaria	-	LC	1990s	6	5	3	7	3
Viola elatior	-	EN	both	7	7	8	8	4
Viola hirta	-	LC	both	6	6	4	7	3
Viola pumila	s	EN	both	8	7	7	7	4
Viola reichenbachiana	-	LC	2024	3	-	5	7	6
Viola sp.	-	-	2024	-	-	-	-	-

Synoptic table of TWINSPAN-groups of all 150 plots, according to respective fidelity of diagnostic species.

	Arrhenatherum -group	*Lolium* -group	*Ophioglossum-vulgatum*-group	*Poa-palustris*-group
No. of plots	53	40	32	31
Arrhenatherum elatius	70.4	---	---	---
Erigeron annuus	50.6	---	---	---
Vicia tetrasperma	48.5	---	---	---
Fragaria vesca	46.1	---	---	---
Galium verum s. str.	45.9	10.9	---	---
Dactylis glomerata	45.6	34.7	---	---
Vicia angustifolia	44.5	---	---	---
Convolvulus arvensis	42.9	---	---	---
Pentanema salicinum	41.4	---	0.5	---
Acer campestre	41	---	---	---
Vicia hirsuta	40.4	---	---	---
Viola pumila	---	---	42	---
Poa palustris	---	---	---	71.8
Persicaria amphibia	---	---	---	53.6
Ranunculus repens	---	---	27.1	44.8
Rumex crispus	---	---	---	39.3
Plantago major ssp. *intermedia*	---	---	---	34.2
Phragmites australis	---	---	---	33.6
Caltha palustris	---	---	---	31.6
Cardamine pratensis s. str.	---	---	---	31.6
Rorippa austriaca	---	1.8	---	29.2
Leucojum aestivum	---	---	7.6	28.2
Myosotis palustris agg.	---	---	---	28.2

Rorippa palustris	---	---	---	27.3
Rorippa sylvestris	---	---	---	26.2
Galium palustre agg.	---	---	0.1	23.7
Carex sp.	---	---	---	23.4
Mentha sp.	---	---	---	22.7
Phalaris arundinacea	---	---	---	22.7
Stellaria palustris	---	---	---	22.2
Eleocharis palustris	---	---	---	22.2
Lychnis flos-cuculi	---	---	---	22.2
Carex melanostachya	---	---	---	22.2
Symphytum officinale	---	---	22.7	21.8
Taraxacum sect. *Ruderalia*	---	17.1	4.7	21.5
Carex riparia	---	---	2.1	19.1
Galium aparine s. str.	1.7	---	---	18.2
Carex disticha	---	---	---	17.6
Arabis nemorensis	---	---	---	17.6
Carex acuta	---	---	---	17.6
Iris pseudacorus	---	---	16.1	17.4
Alopecurus pratensis	---	---	17.8	17.3
Carex acutiformis	---	---	15.2	16.4
Poa trivialis	---	---	6.9	16.3
Berula erecta	---	---	---	15.6
Epilobium tetragonum s. str.	---	---	---	15.6
Stellaria aquatica	---	---	---	15.6
Eleocharis sp.	---	---	---	15.6
Pastinaca sativa	---	---	---	15.6
Pentanema britannicum	---	---	---	15.6
Veronica persica	---	---	---	15.6
Acorus calamus	---	---	---	15.6

Stellaria media s. str.	---	13	---	13.9
Scutellaria galericulata	3.1	---	---	10
Cerastium pumilum s. str.	3.1	---	---	10
Rumex sp.	1.4	---	---	10
Lythrum salicaria	---	---	---	10
Phleum pratense s. str.	---	---	---	9.3
Euphorbia lucida	3.6	---	8	8.9
Lysimachia vulgaris	---	---	22.1	8.8
Arctium sp.	---	5.2	---	8.7
Potentilla reptans	7.6	---	20.9	8.4
Juncus gerardii	---	---	7.1	7.6
Thalictrum simplex s. lat.	---	---	7.1	7.6
Elymus repens	---	---	2.1	7.4
Bromus tectorum	8.9	---	---	6.5
Capsella bursa-pastoris	---	9.2	---	6.2
Carpinus betulus	---	---	13.9	5.7
Trifolium repens	---	6.1	4.7	5.4
Urtica dioica	3	---	4.6	5.1
Solidago gigantea	9.2	---	---	5
Veronica serpyllifolia	---	12	---	4.8
Lysimachia nummularia	---	---	6.6	4.2
Agrostis stolonifera	---	---	23.8	4.2
Thalictrum flavum	---	1.1	3.6	4
Mentha aquatica	13.5	---	---	3.9
Iris sibirica	---	---	14.7	3.3
Stachys palustris	5.3	0.5	---	3.2
Rubus caesius	---	---	13.4	2.8
Vicia cracca s. str.	---	7.3	11.1	2.6
Arctium lappa	---	9.1	---	2.6

Cornus sanguinea ssp. *sanguinea*	4.6	---	2.2	2.6
Equisetum palustre	1.3	---	9.2	2.2
Silaum silaus	---	4.5	---	1.9
Plantago major ssp. *major*	---	---	11	0.8
Potentilla anserina	---	---	30.4	---
Mentha arvensis	3.7	---	10.3	---
Cerastium glomeratum	---	14.4	2.5	---
Bromus hordeaceus ssp. *hordeaceus*	---	20.7	---	---
Ficaria verna s. str.	---	7.6	20.7	---
Impatiens parviflora	11.9	---	---	---
Viola reichenbachiana	11.9	---	---	---
Lolium perenne	11.9	---	---	---
Carex distans	11.9	---	---	---
Muscari tenuiflorum	11.9	---	---	---
Asperugo procumbens	11.9	---	---	---
Sanguisorba minor	11.9	---	---	---
Circaea lutetiana s. str.	11.9	---	---	---
Asperula tinctoria	11.9	---	---	---
Cruciata pedemontana	11.9	---	---	---
Equisetum hyemale	11.9	---	---	---
Ligustrum vulgare	11.9	---	---	---
Rosa micrantha	11.9	---	---	---
Arabidopsis thaliana	11.9	---	---	---
Cirsium oleraceum	11.9	---	---	---
Securigera varia	11.9	---	---	---
Veronica sp.	11.9	---	---	---
Elymus caninus	11.9	---	---	---

Allium vineale	11.9	---	---	---
Allium ursinum	11.9	---	---	---
Festuca sp.	11.9	---	---	---
Bromus japonicus	11.9	---	---	---
Agrostis sp.	11.9	---	---	---
Rubus idaeus	11.9	---	---	---
Carex sylvatica	11.9	---	---	---
Galium wirtgenii	11.9	---	---	---
Salix cinerea	11.9	---	---	---
Malus domestica	11.9	---	---	---
Asparagus officinalis	11.9	---	---	---
Carduus sp.	11.9	---	---	---
Achillea aspleniifolia	11.9	---	---	---
Trifolium hybridum	11.9	---	---	---
Dianthus carthusianorum agg.	11.9	---	---	---
Saponaria officinalis	11.9	---	---	---
Lamium sp.	11.9	---	---	---
Malus sylvestris s. str.	11.9	---	---	---
Achillea nobilis	11.9	---	---	---
Vincetoxicum hirundinaria	11.9	---	---	---
Rosa agrestis	11.9	---	---	---
Convolvulus sepium	11.9	---	---	---
Epilobium sp.	11.9	---	---	---
Sedum sexangulare	11.9	---	---	---
Peucedanum oreoselinum	11.9	---	---	---
Juncus conglomeratus	11.9	---	---	---
Ailanthus altissima	11.9	---	---	---
Prunus domestica	11.9	---	---	---
Carex elata mod. *dissoluta*	---	13. 7	---	---

Prunus spinosa	---	13.7	---	---
Tanacetum vulgare	---	13.7	---	---
Cirsium canum	---	13.7	---	---
Cynosurus cristatus	---	13.7	---	---
Carduus nutans	---	13.7	---	---
Cerastium sp.	---	13.7	---	---
Carex caryophyllea	---	13.7	---	---
Valerianella rimosa	---	13.7	---	---
Cirsium vulgare	---	13.7	---	---
Poa pratensis s. str.	27.2	---	---	---
Stellaria aquatica	---	---	15.4	---
Calamagrostis canescens s. str.	---	---	15.4	---
Quercus robur	---	---	15.4	---
Sambucus nigra	---	---	15.4	---
Thalictrum sp.	---	---	15.4	---
Leucanthemum ircutianum	---	---	15.4	---
Lycopus europaeus ssp. *europaeus*	---	---	15.4	---
Allium angulosum	---	---	15.4	---
Polygala amarella	---	---	15.4	---
Scorzoneroides autumnalis	---	---	15.4	---
Echium vulgare	16.9	---	---	---
Centaurium erythraea	16.9	---	---	---
Aegopodium podagraria	16.9	---	---	---
Viola sp.	16.9	---	---	---
Potentilla recta	16.9	---	---	---
Astragalus cicer	16.9	---	---	---
Avenula pubescens	4.4	7.8	---	---
Ononis spinosa	4.4	7.8	---	---

Poa annua s. str.	4.4	7.8	---	---
Scabiosa sp.	4.4	7.8	---	---
Rhamnus cathartica	4.4	7.8	---	---
Carex flacca	4.4	7.8	---	---
Ulmus minor	4.4	7.8	---	---
Lamium purpureum	---	19.5	---	---
Lolium multiflorum	---	19.5	---	---
Arenaria serpyllifolia s. str.	---	19.5	---	---
Trisetum flavescens s. str.	---	19.5	---	---
Holcus mollis	---	19.5	---	---
Sanguisorba officinalis	3.3	---	9.7	---
Ranunculus bulbosus	3.3	---	9.7	---
Scutellaria hastifolia	3.3	---	9.7	---
Oxalis stricta	20.8	---	---	---
Carduus crispus	---	---	21.8	---
Polygala vulgaris ssp. *vulgaris*	---	---	21.8	---
Deschampsia cespitosa s. str.	---	8.4	14.3	---
Daucus carota	0.7	14.6	---	---
Bromus inermis	0.7	14.6	---	---
Campanula patula	0.7	14.6	---	---
Bromus sterilis	32.8	---	---	---
Ajuga reptans	---	23.9	---	---
Achillea pratensis	0	2.6	5.3	---
Fraxinus excelsior	24	---	---	---
Verbena officinalis	24	---	---	---
Acer negundo	---	12.2	4.5	---
Tragopogon orientalis	---	12.2	4.5	---
Hypericum perforatum	---	---	17.2	---
Linaria vulgaris	14.8	1.9	---	---

Rubus fruticosus agg.	14.8	1.9	---	---
Valerianella locusta	---	1.2	16	---
Rumex thyrsiflorus	6.2	11.1	---	---
Arabis hirsuta s. str.	6.2	11.1	---	---
Carex brizoides	---	---	26.8	---
Euonymus europaeus	5.4	0.6	3	---
Myosotis ramosissima	26.9	---	---	---
Knautia arvensis	26.9	---	---	---
Clematis vitalba	26.9	---	---	---
Rumex acetosa	18.6	---	---	---
Cerastium brachypetalum s. str.	18.6	---	---	---
Valeriana officinalis	4.1	---	10.8	---
Equisetum arvense ssp. *arvense*	---	1.3	29.3	---
Anthoxanthum odoratum s. str.	17.5	---	1.6	---
Pimpinella major	3.8	15.8	---	---
Ornithogalum kochii subagg.	---	7.6	12	---
Fragaria viridis	3.3	16.3	---	---
Tragopogon dubius	29.6	---	---	---
Carex praecox s. str.	---	---	21.8	---
Leontodon hispidus ssp. *hispidus*	---	---	21.8	---
Carex spicata	21.9	---	---	---
Pimpinella saxifraga s. str.	21.9	---	---	---
Brachypodium sylvaticum	20.8	---	---	---
Festuca rubra agg.	18.6	9.1	---	---
Trifolium dubium	4.7	22	---	---
Clinopodium vulgare	32	---	---	---
Lotus maritimus	24.9	---	---	---
Cerinthe minor	---	---	16.3	---

Vicia villosa	10.8	3.2	---	---
Vicia sepium	---	17.4	6.4	---
Briza media	10.1	---	6.4	---
Medicago lupulina	14.9	9.4	---	---
Pyrus communis agg.	36.5	---	---	---
Brachypodium pinnatum s. str.	36.5	---	---	---
Viola elatior	---	8.8	5.3	---
Filipendula vulgaris	3.6	---	14.1	---
Carex leporina	8.3	8.2	---	---
Veronica chamaedrys	---	28.1	---	---
Carex panicea	---	0.4	20.6	---
Holcus lanatus	12.3	13.8	---	---
Agrimonia eupatoria	26.6	---	---	---
Festuca rupicola	---	31.3	---	---
Lotus corniculatus s. str.	18.3	10.4	---	---
Serratula tinctoria ssp. *tinctoria*	38.8	---	---	---
Ranunculus polyanthemos s. str.	---	28.2	0.8	---
Viola hirta	17.7	3.8	---	---
Linum catharticum	17.1	---	0.3	---
Salvia pratensis	26.2	3.3	---	---
Bromus erectus s. str.	30.7	---	---	---
Euphorbia esula s. str.	32.9	---	---	---
Bellis perennis	---	29.3	---	---
Populus alba	24.5	---	0.2	---
Lathyrus pratensis	6.2	1.4	8.9	---
Galium mollugo agg.	16.8	16.6	---	---
Plantago lanceolata	---	36.7	---	---
Centaurea jacea s. str.	4.9	12.3	0.9	---

Cerastium holosteoides	---	19.9	21.6	---
Carex hirta	---	8.6	13.2	---
Achillea collina	25.1	12.6	---	---
Rhinanthus minor	8.1	26.7	---	---
Prunella vulgaris	14.3	3.2	2.3	---
Achillea millefolium agg.	1	21.8	---	---
Veronica arvensis	---	30.1	---	---
Crataegus monogyna	33.1	---	---	---
Lolium pratense s. str.	---	37	---	---
Poa angustifolia	---	23.2	27.1	---
Myosotis arvensis	24.3	6.2	---	---
Ophioglossum vulgatum	---	4.3	39.7	---
Glechoma hederacea s. str.	22.5	10.8	---	---
Trifolium pratense	26.8	23.1	---	---
Allium scorodoprasum	31.4	---	---	---
Lolium arundinaceum	2.7	37.9	---	---
Trifolium campestre	26.4	13.9	---	---
Leucanthemum vulgare s. str.	21.8	16	---	---
Cirsium arvense	1	15.7	12	---
Calamagrostis epigejos	0.6	17.4	11.2	---
Carex tomentosa	7.5	---	24.4	---
Ranunculus acris	36.5	22.8	---	---
Colchicum autumnale	33.2	---	27.5	---

Recording sheet for repeated mapping in 2024.

MASTERARBEIT: WIEDERAUFNHAMEN FEUCHTWIESEN DONAU-AUEN

NR_2024		**NR_ORIG**		**Datum**	
Fläche (m^2)		**Locality**			
Cover					
Braun-Blanquet-Skala:		**Longitude**			
		Latitude			

Braun-Blanquet-Skala:

r	selten, 1 Exemplar, << 1%
+	wenige, 2 - 5 Exemplare, < 1%
1	viele (6 - 50 Exemplare), < 5%
2m	sehr viele (>50 Exemplare), < 5%
2a	5 - 12,5%
2b	12,5 - 25%
3	< 50%
4	< 75%
5	> 75%

Skizze der Fläche

Anmerkungen:

Header data of all unique plots and their respective changes: the sorting according to original Plot-ID . MM = Management measures, "Date" follows the numerology YYYYMMDD, Coverage = total coverage of plot with vascular plants, mean_X = unweighted mean of certain ecological indicator value for respective plot (L = light, T = temperature, M = soil moisture, R = soil reaction, N = soil nitrogen), No. of species = number of species, RL = coverage of red list species, N = coverage of neophytes, S = coverage of specialists, C = coverage of common and competitive species, W = coverage of wooden species.

PlotID	Plot size (m^2)	Management	MM	TWINSPAN-group	Latitude	Longitude	Coverage (%)	mean_L	mean_T	mean_M	mean_R	mean_N	No. of species	Shannon-Index	Evenness	RL	N	S	C	W
A011	40	no	none	*Arrhenatherum* -group	48.1694	16.9377	4	-1.06	0.36	-0.26	0.19	0.04	-4	-0.16	-0.02	-0.5025	0.0775	-0.45	-0.065	0.065
A017	12	yes	once-mown	*Arrhenatherum* -group	48.1732	16.9475	0	-0.15	0.28	-0.74	0.43	-1.30	-17	0.80	0.48	-0.3025	0	-0.94	0.89	0.01
A018	15	yes	once-mown	*Lolium* -group	48.1726	16.9457	10	0.32	-0.73	-0.55	-0.48	-0.48	-5	-0.39	-0.07	0.17	0	-0.0725	-0.045	0
A021	40	yes	once-mown	*Ophioglossum-vulgatum* -group	48.1715	16.9419	0	-0.32	-0.20	-0.41	-0.02	-0.10	-4	0.34	0.16	-0.6	0	-0.4825	-0.175	0.0225
A022	20	yes	once-mown	*Arrhenatherum* -group	48.1715	16.9424	2	0.01	-0.33	-0.33	-0.03	0.28	-4	0.16	0.10	-0.0275	0	0.2	0.3625	-0.01
A023	40	yes	once-mown	*Lolium* -group	48.1717	16.9451	100	0.19	-0.47	-0.06	-0.14	0.28	-4	0.12	0.07	-0.3975	0	0.37	0.2	0
A047	25	yes	once-mown	*Arrhenatherum* -group	48.1638	16.9376	4	0.25	0.09	-0.78	0.26	-0.25	0	-0.28	-0.09	0.05	0.01	-0.5925	0.86	0.255
A054	15	yes	once-mown	*Arrhenatherum* -group	48.1337	16.6645	0	-0.41	0.29	-0.38	0.09	0.68	-6	0.78	0.34	-0.4675	0	-0.29	0.565	0.0225
A059	40	yes	once-mown	*Arrhenatherum* -group	48.1331	16.6589	2	-0.03	0.23	-0.05	0.24	-0.19	-3	0.19	0.08	-0.1475	0.0225	-0.26	0.77	0.0225
A061	40	yes	once-mown	*Arrhenatherum* -group	48.1346	16.6531	0	-0.19	0.03	0.69	0.13	1.83	10	-0.67	-0.34	0.115	0	0.5425	-0.2675	0
A073	40	yes	once-mown	*Arrhenatherum* -group	48.1294	16.7138	0	-0.38	-0.03	0.10	-0.18	0.25	-13	0.20	0.18	0.065	0	0.4225	-0.4375	0
A128	8	yes	once-mown	*Arrhenatherum* -group	48.1352	16.8370	-10	1.10	0.05	-0.59	-0.11	-0.01	5	0.26	0.02	0.32	0	-0.01	0.995	0.4
A132	25	no	none	*Arrhenatherum* -group	48.1331	16.8361	0	0.14	0.25	-0.59	0.32	0.45	5	0.03	-0.02	-0.1275	0.1875	-0.7225	0.9325	0.1875
A165	25	yes	once-mown	*Arrhenatherum* -group	48.1294	16.7620	-5	0.39	-0.01	-0.99	0.01	-0.49	-8	0.13	0.09	-0.1225	0.02	-1.1375	1.075	-0.05
A166	15	yes	once-mown	*Arrhenatherum* -group	48.1295	16.7625	-1	0.17	-0.08	-1.52	0.07	-0.94	-15	0.58	0.30	-0.205	0.375	-0.87	0.995	-0.01
A174	40	yes	once-mown	*Arrhenatherum* -group	48.1336	16.7478	0	0.20	0.09	-1.22	-0.13	-0.35	-13	-0.22	0.04	-0.3275	0.01	-0.7875	0.0225	0.1775
B184	10	yes	once-mown	*Poa-palustris* -group	48.1649	16.9417	-5	0.19	-0.29	0.76	-0.02	0.51	18	-1.90	-1.05	-0.1	0	0.11	-0.065	0
B185	6	yes	once-mown	*Arrhenatherum* -group	48.1647	16.9148	4	-0.05	-0.06	-0.29	0.18	0.44	9	-0.31	-0.17	0.27	0	0.24	-0.3425	0
B188	15	yes	once-mown	*Lolium* -group	48.1721	16.9319	2	-0.23	-0.11	0.43	-0.11	-0.08	3	-0.12	-0.07	-0.1425	0	0.365	-0.0625	0
B189	8	yes	once-mown	*Arrhenatherum* -group	48.1718	16.9314	1	0.52	0.11	-1.19	0.56	-0.11	-1	-0.04	0.00	-0.495	0	-0.055	0.2325	0
B190	40	yes	once-mown	*Arrhenatherum* -group	48.1713	16.9314	3	0.25	0.14	-0.81	0.38	-0.93	-13	0.58	0.27	0.1725	0	-0.495	0.46	0
B196	14	yes	once-mown	*Arrhenatherum* -group	48.1399	16.8789	0	-0.05	-0.05	0.26	-0.35	0.65	8	-0.59	-0.23	-0.985	0	0.33	0.395	0.0475
B202	20	no	none	*Arrhenatherum* -group	48.1334	16.8358	-1	0.09	0.08	-0.34	0.29	-0.33	-9	0.69	0.29	-0.865	0.1875	-0.065	0.9625	0
B210	40	no	none	*Arrhenatherum* -group	48.1283	16.6980	0	0.04	-0.06	0.39	-0.12	-0.08	7	0.08	-0.05	-0.42	0	0.545	-0.205	0
B214	25	yes	once-mown	*Arrhenatherum* -group	48.1321	16.7679	-1	-0.11	0.14	-1.57	0.18	0.30	-3	-0.21	-0.04	-0.8825	0	-0.8375	0.98	-0.02
B221	40	yes	once-mown	*Arrhenatherum* -group	48.1291	16.7682	0	0.08	0.19	-1.09	-0.12	-1.16	-13	1.06	0.48	0.325	0.0225	0.1125	0.4	0
B222	25	yes	once-mown	*Arrhenatherum* -group	48.1288	16.7682	0	-0.40	-0.16	0.04	0.15	-0.83	1	0.46	0.14	-0.1575	0	0.4975	0.14	0.01
C016	20	yes	once-mown	*Arrhenatherum* -group	48.1347	16.7257	-2	-0.24	-0.07	-0.37	0.22	-0.32	-10	0.91	0.35	0.2025	-0.01	-0.83	0.17	0
C020	20	yes	once-mown	*Arrhenatherum* -group	48.1372	16.7367	2	-0.11	0.13	0.35	0.07	0.08	-15	0.58	0.33	0.055	0	-0.785	0.3125	0
C030	30	yes	once-mown	*Arrhenatherum* -group	48.1432	16.6926	0	0.14	0.08	-0.03	0.48	-0.73	-8	0.53	0.23	-0.7975	0	-0.785	-0.0875	0.01
C032	40	yes	once-mown	*Lolium* -group	48.1357	16.7009	0	-0.14	-0.01	0.78	-0.07	0.32	-4	0.67	0.22	-0.9175	-0.01	-0.49	-0.0875	0.01
C033	35	yes	once-mown	*Ophioglossum-vulgatum* -group	48.1357	16.7007	0	-0.39	0.07	0.64	-0.05	0.70	-1	-1.05	-0.33	-0.3625	0	0.25	-0.2175	0
C040	25	yes	once-mown	*Lolium* -group	48.1380	16.6954	0	-0.23	0.00	0.30	0.34	0.06	0	-1.03	-0.33	-0.2525	0	0.15	-0.2275	0
C044	30	yes	once-mown	*Arrhenatherum* -group	48.1414	16.6917	0	-0.08	0.08	-0.16	0.41	-0.38	-12	0.87	0.42	-0.3425	0	-0.3925	-0.26	0
C045	12	yes	once-mown	*Arrhenatherum* -group	48.1384	16.6902	2	-0.43	0.06	-0.33	0.18	0.74	14	-0.64	-0.39	0.2575	0	0.59	-0.005	0
C050	10	yes	once-mown	*Arrhenatherum* -group	48.1363	16.6794	2	-0.24	0.16	-0.62	0.50	0.31	3	-0.85	-0.31	-0.1675	0	-0.4425	0.0675	0
C054	40	yes	once-mown	*Poa-palustris* -group	48.1309	16.6689	0	-0.03	-0.34	-0.47	-0.19	0.20	-7	0.29	0.20	-0.5525	0	-0.4775	0.0375	0
C055	40	yes	once-mown	*Poa-palustris* -group	48.1307	16.6683	0	0.08	-0.14	0.21	-0.03	-0.22	-1	0.28	0.12	-0.4975	0	-0.0675	-0.4075	0

C063	40	yes	once-mown	*Ophioglossum-vulgatum* -group	48.1269	16.7173	0	0.00	0.03	-0.34	-0.03	0.38	1	-0.07	-0.04	-1.6725	0	-1.4475	0.035	0
C096	40	yes	once-mown	*Arrhenatherum* -group	48.1278	16.7644	-2	0.46	0.49	-0.51	-0.11	-0.29	-2	-0.13	-0.02	-0.3225	0	-0.6025	0.5875	0
C097	40	yes	once-mown	*Arrhenatherum* -group	48.1282	16.7643	0	0.12	-0.17	-0.74	-0.11	-0.86	-9	0.26	0.16	-0.31	0.01	-0.91	0.635	0.02
C098	26	yes	once-mown	*Arrhenatherum* -group	48.1282	16.7642	-3	-0.08	0.12	-1.01	0.03	-1.09	-1	0.10	0.04	-0.225	0.01	-0.56	0.5975	0.01
C103	40	no	none	*Arrhenatherum* -group	48.1264	16.7656	-20	-0.38	-0.31	0.21	-0.02	0.69	9	-0.43	-0.43	-0.77	-0.1875	-0.8875	0.29	0
C118	40	no	none	*Arrhenatherum* -group	48.1244	16.8089	0	0.00	0.35	0.22	0.19	0.31	1	0.57	0.16	0.2275	0.0775	-0.41	0.71	0.11
C120	30	no	none	*Arrhenatherum* -group	48.1243	16.8085	0	-0.04	0.11	0.46	0.71	0.70	-5	0.58	0.23	0.345	0	0.4975	0.7125	0.055
C126	30	yes	once-mown	*Arrhenatherum* -group	48.1334	16.7714	0	0.08	-0.22	-0.76	0.11	-1.35	-3	-0.22	-0.04	-1.62	0.0775	-0.965	0.67	0
C127	30	yes	once-mown	*Arrhenatherum* -group	48.1329	16.7725	-1	0.08	0.26	-1.14	0.45	-1.26	-11	0.65	0.35	-1.295	0	-1.785	0.18	0
C128	30	yes	once-mown	*Arrhenatherum* -group	48.1328	16.7724	0	-0.14	0.06	-0.71	0.19	-1.62	-20	1.24	0.69	0.0975	0	-0.3725	0.1775	-0.0225
C129	30	yes	once-mown	*Poa-palustris* -group	48.1324	16.7731	0	0.06	0.01	0.42	0.16	0.44	-3	0.35	0.17	0.515	0	0.61	-0.01	0
C130	30	yes	once-mown	*Arrhenatherum* -group	48.1323	16.7741	0	0.09	0.45	-0.72	0.10	-0.68	-13	1.21	0.56	-0.1875	0	0.05	0.0775	0.01
C131	25	yes	once-mown	*Arrhenatherum* -group	48.1315	16.7754	0	0.17	-0.33	-1.63	-0.26	-0.75	-13	0.35	0.33	-1.115	0.0225	-1.2925	-0.01	0
C132	30	yes	once-mown	*Arrhenatherum* -group	48.1317	16.7754	0	-0.08	-0.27	-2.00	-0.13	-1.02	-5	0.51	0.22	-1.41	0.0225	-1.78	0.0475	0
C133	40	yes	once-mown	*Arrhenatherum* -group	48.1323	16.7748	2	-0.20	-0.02	-1.08	0.31	-0.50	6	0.34	0.05	-1.265	0	-1.31	0.2475	0.0225
C135	40	yes	once-mown	*Arrhenatherum* -group	48.1309	16.7720	0	-0.22	0.31	-0.07	0.42	-0.18	-9	0.34	0.22	-0.485	0.0225	0.0475	-0.8325	0.01
C138	40	yes	once-mown	*Ophioglossum-vulgatum* -group	48.1308	16.7708	0	-0.01	0.04	-0.94	0.05	-0.54	2	-0.10	-0.07	-1.045	0	-0.455	-0.69	0.0225
C139	40	yes	once-mown	*Arrhenatherum* -group	48.1309	16.7703	-15	-0.44	-0.02	-1.34	-0.04	-1.20	-9	0.51	0.26	-0.2725	0	-0.755	0	0.01
C142	40	yes	once-mown	*Arrhenatherum* -group	48.1319	16.7703	-1	0.01	-0.08	-2.01	-0.26	-1.14	1	-0.20	-0.09	-1.095	0.01	-1.185	-0.2425	0
C143	30	yes	once-mown	*Arrhenatherum* -group	48.1334	16.7690	2	-0.31	-0.37	-1.18	-0.18	0.34	-13	0.90	0.38	-0.395	0.0875	-0.6175	0.7675	0
C145	30	no	none	*Arrhenatherum* -group	48.1285	16.8258	0	-0.24	0.02	0.38	-0.03	-0.08	2	-0.10	-0.04	-0.67	0	-0.78	0.35	0.0775
C154	25	yes	once-mown	*Arrhenatherum* -group	48.1433	16.8757	-2	-0.08	-0.10	0.31	-0.19	-0.21	6	-0.13	-0.07	-0.6025	0	0.53	0.5025	-0.01
C164	10	yes	once-mown	*Arrhenatherum* -group	48.1441	16.8748	0	0.16	0.48	-1.14	0.15	-0.53	-11	0.33	0.22	0.02	0	-0.44	0.3375	-0.01
C174	40	yes	once-mown	*Arrhenatherum* -group	48.1540	16.8951	0	-0.29	0.14	-0.33	0.00	0.35	3	-0.24	-0.08	-0.5175	-0.09	-0.225	0.7225	0.035
C179	40	yes	sporadic	*Poa-palustris* -group	48.1211	16.6427	0	0.02	-0.20	1.38	-0.21	0.80	2	-0.19	-0.10	-1.0525	0	0.265	-1.5625	0
C186	40	yes	twice-mown	*Lolium* -group	48.1244	16.6336	-1	0.32	-0.28	-0.30	-0.08	1.02	3	0.77	0.22	-1.2425	0	-1.2125	0.035	0
C188	40	yes	sporadic	*Ophioglossum-vulgatum* -group	48.1183	16.6502	0	0.22	-0.17	-1.12	-0.02	0.24	3	-0.16	-0.08	0.2575	-0.1975	-0.875	0.375	0
C189	40	yes	sporadic	*Poa-palustris* -group	48.1228	16.6528	0	0.07	0.03	-0.58	-0.04	1.14	8	-0.04	-0.09	-0.065	0.0225	0.0825	-0.1175	0
D048	40	yes	twice-mown	*Arrhenatherum* -group	48.1364	16.5891	0	0.01	0.08	-0.93	0.00	-0.68	-1	0.06	0.02	-0.3075	0	-1.1625	0.7525	0
D067	35	yes	twice-mown	*Arrhenatherum* -group	48.1408	16.5646	-2	0.31	0.20	-1.75	0.34	-1.25	-17	0.90	0.43	-0.565	0	-1.3425	1.0175	0
E002	20	yes	twice-mown	*Lolium* -group	48.1281	16.6185	-20	0.37	-0.33	-1.38	-0.17	-0.27	-7	0.93	0.46	-1.2825	0	-1.105	-0.1125	0
E003	30	yes	twice-mown	*Poa-palustris* -group	48.1283	16.6186	-3	0.38	-0.21	-0.82	-0.10	0.00	-3	0.21	0.19	-0.5825	0	-0.57	0.065	0
E004	35	yes	twice-mown	*Lolium* -group	48.1281	16.6169	-10	0.17	0.07	-0.50	-0.12	0.42	-3	0.13	0.08	-0.345	0.01	-0.3875	-0.045	0
E006	25	yes	twice-mown	*Poa-palustris* -group	48.1286	16.6173	0	0.30	0.41	-0.50	0.00	-0.20	-2	0.44	0.21	-0.2525	0	-0.1525	0.035	0
E007	25	yes	twice-mown	*Lolium* -group	48.1283	16.6167	-3	-0.13	0.07	0.55	-0.05	0.89	-1	0.05	0.03	-0.425	0.0225	-0.4925	0.0775	0
E010	30	yes	twice-mown	*Lolium* -group	48.1293	16.6149	-3	0.16	0.00	-0.08	0.03	0.58	6	-0.42	-0.31	-0.49	0	-0.75	-0.15	0
E011	40	yes	twice-mown	*Lolium* -group	48.1283	16.6151	0	0.18	-0.25	0.21	-0.30	-0.23	3	0.03	-0.03	-0.4125	-0.0325	-0.715	-0.175	-0.0225

Header data of all plots from the 1990s and 2024: the sorting follows the original Plot-ID and the year of mapping (either 1990s or 2024) so that original and their corresponding repeated plots are ranked next to each other. MM = Management measures, "Date" follows the numerology YYYYMMDD, Coverage = total coverage of plot with vascular plants, mean_X = unweighted mean of certain ecological indicator value for respective plot (L = light, T = temperature, M = soil moisture, R = soil reaction, N = soil nitrogen), No. of species = number of species, RL = coverage of red list species, N = coverage of neophytes, S = coverage of specialists, C = coverage of common and competitive species, W = coverage of wooden species.

PlotID	Census	Plotsize (m^2)	Management	MM	TWINSPAN-group	Date	Latitude	Longitude	Coverage (%)	mean_L	mean_T	mean_M	mean_R	mean_N	No. of species	Shannon-Index	Evenness	RL	N	S	C	W
A011	1990s	40	yes	once-mown	*Ophioglossum-vulgatum* -group	19910607	48.1688	16.9371	96	7.10	5.33	5.88	6.41	6.00	28	2.44	0.73	1.2375	0	0.8025	0.5925	0
A011	2024	40	no	none	*Arrhenatherum* -group	20240529	48.1694	16.9377	100	6.04	5.70	5.63	6.60	6.04	24	2.28	0.72	0.735	0.0775	0.3525	0.5275	0.065
A017	1990s	12	yes	once-mown	*Ophioglossum-vulgatum* -group	19910607	48.1731	16.9473	100	7.22	5.22	5.88	6.25	6.25	27	1.02	0.31	1.2325	0	1.005	0.1975	0
A017	2024	12	yes	once-mown	*Arrhenatherum* -group	20240529	48.1732	16.9475	100	7.08	5.50	5.14	6.68	4.95	10	1.82	0.79	0.93	0	0.065	1.0875	0.01
A018	1990s	15	yes	once-mown	*Ophioglossum-vulgatum* -group	19910607	48.1727	16.9455	90	6.86	6.27	6.42	6.83	5.23	19	1.91	0.65	1.0525	0	0.525	0.11	0
A018	2024	15	yes	once-mown	*Lolium* -group	20240529	48.1726	16.9457	100	7.18	5.54	5.87	6.36	4.75	14	1.52	0.57	1.2225	0	0.4525	0.065	0
A021	1990s	40	yes	once-mown	*Ophioglossum-vulgatum* -group	19910607	48.1714	16.9421	100	7.13	5.81	7.11	6.44	6.28	24	2.18	0.69	1.2925	0	1.0425	0.25	0.0225
A021	2024	40	yes	once-mown	*Ophioglossum-vulgatum* -group	20240529	48.1715	16.9419	100	6.81	5.61	6.70	6.42	6.18	20	2.53	0.84	0.6925	0	0.56	0.075	0.045
A022	1990s	20	yes	once-mown	*Ophioglossum-vulgatum* -group	19910607	48.1715	16.9425	98	6.94	5.77	6.71	6.50	5.47	21	1.78	0.59	1.2475	0	0.525	0.055	0.01
A022	2024	20	yes	once-mown	*Arrhenatherum* -group	20240529	48.1715	16.9424	100	6.94	5.44	6.39	6.47	5.75	17	1.94	0.69	1.22	0	0.725	0.4175	0
A023	1990s	40	yes	once-mown	*Ophioglossum-vulgatum* -group	19910607	48.1715	16.9451	0	6.90	6.00	6.20	6.44	5.42	25	1.92	0.60	1.7725	0	0.5875	0.1075	0.0225
A023	2024	40	yes	once-mown	*Lolium* -group	20240529	48.1717	16.9451	100	7.09	5.53	6.14	6.30	5.70	21	2.04	0.67	1.375	0	0.9575	0.3075	0.0225
A047	1990s	25	yes	once-mown	*Ophioglossum-vulgatum* -group	19910610	48.1642	16.9362	96	6.70	5.56	6.40	6.35	5.95	24	2.39	0.75	1.4	0	0.845	0.3375	0.02
A047	2024	25	yes	once-mown	*Arrhenatherum* -group	20240619	48.1638	16.9376	100	6.95	5.65	5.62	6.61	5.70	24	2.11	0.66	1.45	0.01	0.2525	1.1975	0.275
A054	1990s	15	yes	once-mown	*Lolium* -group	19910612	48.1337	16.6649	100	7.13	5.54	5.69	6.33	5.43	21	1.26	0.41	1.46	0	0.895	0.13	0
A054	2024	15	yes	once-mown	*Arrhenatherum* -group	20240528	48.1337	16.6645	100	6.72	5.83	5.32	6.42	6.11	15	2.05	0.76	0.9925	0	0.605	0.695	0.0225
A059	1990s	40	yes	once-mown	*Lolium* -group	19910612	48.1331	16.6588	98	7.29	5.56	5.10	6.26	5.24	28	1.91	0.57	1.15	0	0.655	0.135	0
A059	2024	40	yes	once-mown	*Arrhenatherum* -group	20240528	48.1331	16.6589	100	7.26	5.78	5.04	6.50	5.05	25	2.10	0.65	1.0025	0.0225	0.395	0.905	0.0225
A061	1990s	40	yes	once-mown	*Lolium* -group	19910612	48.1344	16.6521	100	7.35	5.47	4.74	6.33	5.00	15	2.32	0.86	0.9225	0	0.0875	1.05	0
A061	2024	40	yes	once-mown	*Arrhenatherum* -group	20240528	48.1346	16.6531	100	7.15	5.50	5.43	6.46	6.83	25	1.65	0.51	1.0375	0	0.63	0.7825	0
A073	1990s	25	yes	once-mown	*Lolium* -group	19910613	48.13	16.7146	100	7.14	5.43	5.62	6.38	5.69	31	2.08	0.61	1.77	0	0.345	1.1975	0
A073	2024	40	yes	once-mown	*Arrhenatherum* -group	20240617	48.1294	16.7138	100	6.76	5.40	5.71	6.20	5.94	18	2.28	0.79	1.835	0	0.7675	0.76	0
A128	1990s	8	yes	once-mown	*Arrhenatherum* -group	19910620	48.1351	16.8371	100	6.57	5.67	4.45	7.11	4.15	16	2.01	0.73	1.2475	0	0.01	0.02	0.0625
A128	2024	8	yes	once-mown	*Arrhenatherum* -group	20240619	48.1352	16.8370	90	7.67	5.71	3.86	7.00	4.14	21	2.27	0.75	1.5675	0	0	1.015	0.4625
A132	1990s	25	yes	once-mown	*Lolium* -group	19910620	48.1333	16.8357	100	7.06	5.45	5.59	6.38	5.23	31	2.49	0.72	1.285	0	0.9875	0.18	0
A132	2024	25	no	none	*Arrhenatherum* -group	20240603	48.1331	16.8361	100	7.20	5.71	5.00	6.70	5.68	36	2.52	0.70	1.1575	0.1875	0.265	1.1125	0.1875
A165	1990s	25	yes	once-mown	*Ophioglossum-vulgatum* -group	19910623	48.1295	16.7621	100	6.47	5.55	6.10	6.39	5.89	30	1.45	0.43	1.305	0	1.1925	0.03	0.05
A165	2024	25	yes	once-mown	*Arrhenatherum* -group	20240516	48.1294	16.7620	95	6.87	5.54	5.11	6.40	5.40	22	1.58	0.51	1.1825	0.02	0.055	1.105	0
A166	1990s	15	yes	once-mown	*Poa-palustris* -group	19910623	48.1297	16.7624	100	6.76	5.67	6.59	6.35	6.40	34	1.83	0.52	1.3575	0.01	1.2975	0.06	0.03
A166	2024	15	yes	once-mown	*Arrhenatherum* -group	20240516	48.1295	16.7625	99	6.94	5.58	5.07	6.42	5.46	19	2.41	0.82	1.1525	0.385	0.4275	1.055	0.02
A174	1990s	40	yes	once-mown	*Ophioglossum-vulgatum* -group	19910624	48.1334	16.7471	100	6.76	5.59	6.71	6.81	5.31	32	2.30	0.66	1.7375	0	0.945	0.1875	0.01
A174	2024	40	yes	once-mown	*Arrhenatherum* -group	20240603	48.1336	16.7478	100	6.97	5.68	5.48	6.68	4.96	19	2.08	0.71	1.41	0.01	0.1575	0.21	0.1875
B184	1990s	10	yes	once-mown	*Poa-palustris* -group	19920528	48.1644	16.9140	95	6.95	5.67	7.10	6.45	5.77	8	2.69	1.29	1.2025	0	0.9825	0.065	0
B184	2024	10	yes	once-mown	*Poa-palustris* -group	20240515	48.1649	16.9417	90	7.14	5.38	7.86	6.43	6.29	26	0.79	0.24	1.1025	0	1.0925	0	0
B185	1990s	6	yes	once-mown	*Ophioglossum-vulgatum* -group	19920528	48.1646	16.9140	96	7.10	5.70	6.04	6.61	4.68	21	2.44	0.80	1.0725	0	0.265	0.4075	0
B185	2024	6	yes	once-mown	*Arrhenatherum* -group	20240515	48.1647	16.9148	100	7.05	5.64	5.75	6.79	5.12	30	2.13	0.63	1.3425	0	0.505	0.065	0
B188	1990s	15	yes	once-mown	*Ophioglossum-vulgatum* -group	19920528	48.1719	16.9315	98	7.13	5.74	5.35	6.35	5.61	21	2.10	0.69	1.53	0	0.4925	0.2175	0
B188	2024	15	yes	once-mown	*Lolium* -group	20240515	48.1721	16.9319	100	6.90	5.63	5.78	6.24	5.53	24	1.98	0.62	1.3875	0	0.8575	0.155	0
B189	1990s	8	yes	once-mown	*Ophioglossum-vulgatum* -group	19920528	48.1717	16.9314	98	6.75	5.61	5.81	6.33	5.16	22	1.75	0.57	1.6075	0	0.45	0.1975	0
B189	2024	8	yes	once-mown	*Arrhenatherum* -group	20240515	48.1718	16.9314	99	7.27	5.72	4.62	6.89	5.05	21	1.71	0.56	1.1125	0	0.395	0.43	0

B190	1990s	40	yes	once-mown	*Ophioglossum-vulgatum* -group	19920528	48.1713	16.9311	96	6.75	5.50	5.94	6.14	5.93	31	1.31	0.38	1.265	0	0.935	0.2975	0
B190	2024	40	yes	once-mown	*Arrhenatherum* -group	20240515	48.1713	16.9314	99	7.00	5.64	5.13	6.52	5.00	18	1.90	0.66	1.4375	0	0.44	0.7575	0
B196	1990s	14	yes	once-mown	*Lolium* -group	19920531	48.1398	16.8787	100	6.97	5.71	5.07	6.71	5.22	26	2.44	0.75	2.0325	0.0875	0.1	0.7925	0.04
B196	2024	14	yes	once-mown	*Arrhenatherum* -group	20240612	48.1399	16.8789	100	6.92	5.67	5.33	6.36	5.87	34	1.84	0.52	1.0475	0.0875	0.43	1.1875	0.0875
B202	1990s	20	yes	once-mown	*Lolium* -group	19920531	48.1334	16.8357	100	6.95	5.57	5.38	6.50	5.63	29	1.55	0.46	1.415	0	0.23	0.17	0.01
B202	2024	20	no	none	*Arrhenatherum* -group	20240603	48.1334	16.8358	99	7.04	5.65	5.04	6.79	5.29	20	2.24	0.75	0.55	0.1875	0.165	1.1325	0.01
B210	1990s	40	yes	once-mown	*Ophioglossum-vulgatum* -group	19920603	48.1283	16.6983	100	6.96	5.56	5.68	6.45	6.21	18	2.01	0.70	1.9875	0	0.515	1.0425	0
B210	2024	40	no	none	*Arrhenatherum* -group	20240617	48.1283	16.6980	100	7.00	5.50	6.07	6.33	6.13	25	2.08	0.65	1.5675	0	1.06	0.8375	0
B214	1990s	25	yes	once-mown	*Ophioglossum-vulgatum* -group	19920608	48.1324	16.7682	100	6.80	5.65	6.70	6.56	5.04	30	2.33	0.68	2.0675	0	1.08	0.12	0.02
B214	2024	25	yes	once-mown	*Arrhenatherum* -group	20240522	48.1321	16.7679	99	6.69	5.79	5.13	6.73	5.35	27	2.12	0.64	1.185	0	0.2425	1.1	0
B221	1990s	40	yes	once-mown	*Poa-palustris* -group	19920608	48.1292	16.7682	100	6.92	5.40	6.80	6.45	6.45	28	1.34	0.40	1.34	0	1.11	0.0525	0
B221	2024	40	yes	once-mown	*Arrhenatherum* -group	20240522	48.1291	16.7682	100	7.00	5.59	5.71	6.33	5.29	15	2.40	0.89	1.665	0.0225	1.2225	0.4525	0
B222	1990s	25	yes	once-mown	*Lolium* -group	19920608	48.1287	16.7682	100	7.30	5.60	5.33	6.35	6.19	21	1.69	0.55	1.5375	0	0.33	0.3025	0
B222	2024	25	yes	once-mown	*Arrhenatherum* -group	20240522	48.1288	16.7682	100	6.90	5.44	5.38	6.50	5.35	22	2.15	0.70	1.38	0	0.8275	0.4425	0.01
C016	1990s	20	yes	once-mown	*Lolium* -group	19930517	48.1347	16.7254	100	7.17	5.62	4.83	6.43	5.00	30	1.17	0.35	1.0425	0.01	0.875	0.1275	0
C016	2024	20	yes	once-mown	*Arrhenatherum* -group	20240523	48.1347	16.7257	98	6.93	5.55	4.46	6.65	4.68	20	2.09	0.70	1.245	0	0.045	0.2975	0
C020	1990s	20	yes	once-mown	*Lolium* -group	19930517	48.1372	16.7371	98	7.21	5.62	4.57	6.58	5.00	29	1.29	0.38	1.275	0	0.875	0.1825	0
C020	2024	20	yes	once-mown	*Arrhenatherum* -group	20240523	48.1372	16.7367	100	7.11	5.75	4.92	6.65	5.08	14	1.87	0.71	1.33	0	0.09	0.495	0
C030	1990s	30	yes	once-mown	*Lolium* -group	19930520	48.1433	16.6924	100	7.11	5.40	5.21	5.94	5.44	30	1.83	0.54	1.7475	0	0.9275	0.6025	0
C030	2024	30	yes	once-mown	*Arrhenatherum* -group	20240510	48.1432	16.6926	100	7.24	5.48	5.18	6.42	4.71	22	2.36	0.76	0.95	0	0.1425	0.515	0.01
C032	1990s	40	yes	once-mown	*Lolium* -group	19930520	48.1355	16.7010	100	7.14	5.57	5.48	6.48	5.38	35	2.12	0.60	1.6975	0.01	1.08	0.3025	0
C032	2024	40	yes	once-mown	*Lolium* -group	20240510	48.1357	16.7009	100	7.00	5.56	6.26	6.41	5.70	31	2.79	0.81	0.78	0	0.59	0.215	0.01
C033	1990s	35	yes	once-mown	*Lolium* -group	19930520	48.1356	16.7007	100	7.33	5.53	6.21	6.50	5.45	23	1.93	0.61	1.4075	0	0.7425	0.27	0
C033	2024	35	yes	once-mown	*Ophioglossum-vulgatum* -group	20240510	48.1357	16.7007	100	6.95	5.60	6.85	6.45	6.15	22	0.88	0.28	1.045	0	0.9925	0.0525	0
C040	1990s	25	yes	once-mown	*Lolium* -group	19930520	48.1387	16.6951	100	7.18	5.53	5.95	6.11	5.74	22	2.55	0.83	1.3375	0	0.8475	0.2825	0
C040	2024	25	yes	once-mown	*Lolium* -group	20240510	48.138	16.6954	100	6.95	5.53	6.25	6.45	5.80	22	1.52	0.49	1.085	0	0.9975	0.055	0
C044	1990s	30	yes	once-mown	*Lolium* -group	19930520	48.1413	16.6918	100	7.19	5.44	6.00	6.15	5.62	29	2.01	0.60	0.895	0	0.6025	0.415	0
C044	2024	30	yes	once-mown	*Arrhenatherum* -group	20240513	48.1414	16.6917	100	7.11	5.52	5.84	6.56	5.24	17	2.88	1.02	0.5525	0	0.21	0.155	0
C045	1990s	12	yes	once-mown	*Ophioglossum-vulgatum* -group	19930520	48.1384	16.6901	98	7.07	5.37	5.75	6.21	5.19	15	2.74	1.01	0.835	0	0.15	0.3125	0
C045	2024	12	yes	once-mown	*Arrhenatherum* -group	20240513	48.1384	16.6902	100	6.64	5.43	5.42	6.38	5.92	29	2.11	0.63	1.0925	0	0.74	0.3075	0
C050	1990s	10	yes	once-mown	*Ophioglossum-vulgatum* -group	19930520	48.1362	16.6790	98	7.30	5.53	5.62	6.25	4.88	19	2.25	0.76	1.41	0	0.915	0.185	0
C050	2024	10	yes	once-mown	*Arrhenatherum* -group	20240513	48.1363	16.6794	100	7.06	5.69	5.00	6.75	5.19	22	1.39	0.45	1.2425	0	0.4725	0.2525	0
C054	1990s	40	yes	once-mown	*Poa-palustris* -group	19930521	48.1309	16.6688	100	7.09	5.78	6.82	6.60	6.27	19	1.41	0.48	1.895	0	1.765	0.03	0
C054	2024	40	yes	once-mown	*Poa-palustris* -group	20240524	48.1309	16.6689	100	7.06	5.44	6.35	6.41	6.47	12	1.70	0.68	1.3425	0	1.2875	0.0675	0
C055	1990s	40	yes	once-mown	*Poa-palustris* -group	19930521	48.1308	16.6682	100	7.00	5.56	6.64	6.33	6.83	14	1.42	0.54	2.0275	0	1.5775	0.4375	0
C055	2024	40	yes	once-mown	*Poa-palustris* -group	20240524	48.1307	16.6683	100	7.08	5.42	6.85	6.31	6.62	13	1.69	0.66	1.53	0	1.51	0.03	0
C063	1990s	40	yes	once-mown	*Ophioglossum-vulgatum* -group	19930521	48.1267	16.7174	100	7.00	5.31	6.27	6.33	6.00	15	2.01	0.74	2.94	0	2.2525	0.0425	0
C063	2024	40	yes	once-mown	*Ophioglossum-vulgatum* -group	20240513	48.1269	16.7173	100	7.00	5.33	5.92	6.31	6.38	16	1.93	0.70	1.2675	0	0.805	0.0775	0
C096	1990s	40	yes	once-mown	*Ophioglossum-vulgatum* -group	19930523	48.1279	16.7649	100	6.69	5.33	6.06	6.40	6.19	22	2.26	0.73	1.61	0	1.2625	0.2275	0
C096	2024	40	yes	once-mown	*Arrhenatherum* -group	20240516	48.1278	16.7644	98	7.15	5.82	5.55	6.29	5.89	20	2.13	0.71	1.2875	0	0.66	0.815	0
C097	1990s	40	yes	once-mown	*Ophioglossum-vulgatum* -group	19930523	48.1281	16.7646	100	6.94	5.75	5.59	6.57	5.94	30	2.05	0.60	1.5425	0	0.9775	0.07	0
C097	2024	40	yes	once-mown	*Arrhenatherum* -group	20240516	48.1282	16.7643	100	7.07	5.58	4.85	6.46	5.08	21	2.32	0.76	1.2325	0.01	0.0675	0.705	0.02
C098	1990s	26	yes	once-mown	*Ophioglossum-vulgatum* -group	19930523	48.1283	16.7649	100	7.19	5.50	5.64	6.47	5.90	26	2.21	0.68	1.63	0	0.5925	0.6325	0
C098	2024	26	yes	once-mown	*Arrhenatherum* -group	20240516	48.1282	16.7642	97	7.12	5.62	4.63	6.50	4.82	25	2.31	0.72	1.405	0.01	0.0325	1.23	0.01
C103	1990s	40	yes	once-mown	*Lolium* -group	19930523	48.1262	16.7657	100	7.38	5.64	5.13	6.42	5.14	7	1.80	0.93	1.4525	0.1875	0.8975	0.3825	0
C103	2024	40	no	none	*Arrhenatherum* -group	20240515	48.1264	16.7656	80	7.00	5.33	5.33	6.40	5.83	16	1.37	0.50	0.6825	0	0.01	0.6725	0
C118	1990s	40	yes	once-mown	*Lolium* -group	19930524	48.1244	16.8087	100	6.87	5.29	5.35	6.34	5.17	32	1.70	0.49	1.1925	0.01	0.95	0.1775	0.01
C118	2024	40	no	none	*Arrhenatherum* -group	20240617	48.1244	16.8089	100	6.86	5.64	5.57	6.54	5.48	33	2.27	0.65	1.42	0.0875	0.54	0.8875	0.12
C120	1990s	30	yes	once-mown	*Lolium* -group	19930524	48.1244	16.8085	100	7.00	5.60	4.94	6.00	4.88	26	1.77	0.54	0.9975	0	0.0525	0.1475	0
C120	2024	30	no	none	*Arrhenatherum* -group	20240617	48.1243	16.8085	100	6.96	5.71	5.40	6.71	5.58	21	2.35	0.77	1.3425	0	0.55	0.86	0.055
C126	1990s	30	yes	once-mown	*Ophioglossum-vulgatum* -group	19930526	48.1334	16.7710	100	7.10	5.75	6.19	6.45	6.00	24	2.19	0.69	2.3825	0.01	1.45	0.1625	0

C126	2024	30	yes	once-mown	*Arrhenatherum* -group	20240523	48.1334	16.7714	100	7.17	5.53	5.43	6.56	4.65	21	1.96	0.64	0.7625	0.0875	0.485	0.8325	0
C127	1990s	30	yes	once-mown	*Poa-palustris* -group	19930526	48.133	16.7724	100	7.07	5.36	6.46	6.27	6.17	26	1.81	0.55	2.38	0	2.2825	0.0525	0
C127	2024	30	yes	once-mown	*Arrhenatherum* -group	20240523	48.1329	16.7725	99	7.15	5.62	5.32	6.73	4.90	15	2.45	0.91	1.085	0	0.4975	0.2325	0
C128	1990s	30	yes	once-mown	*Poa-palustris* -group	19930526	48.1327	16.7724	100	7.11	5.56	6.40	6.44	6.50	31	1.38	0.40	1.22	0	1.1425	0.065	0.0225
C128	2024	30	yes	once-mown	*Arrhenatherum* -group	20240523	48.1328	16.7724	100	6.97	5.62	5.69	6.63	4.88	11	2.61	1.09	1.3175	0	0.77	0.2425	0
C129	1990s	30	yes	once-mown	*Ophioglossum-vulgatum* -group	19930526	48.1324	16.7732	100	7.00	5.56	6.08	6.44	5.50	17	1.49	0.52	1.265	0	1.1275	0.0425	0
C129	2024	30	yes	once-mown	*Poa-palustris* -group	20240523	48.1324	16.7731	100	7.06	5.56	6.50	6.60	5.94	14	1.83	0.69	1.78	0	1.7375	0.0325	0
C130	1990s	30	yes	once-mown	*Ophioglossum-vulgatum* -group	19930526	48.132	16.7743	100	6.91	5.40	6.08	6.56	6.00	26	1.04	0.32	1.5175	0	0.8625	0.0325	0
C130	2024	30	yes	once-mown	*Arrhenatherum* -group	20240522	48.1323	16.7741	100	7.00	5.85	5.36	6.65	5.32	13	2.25	0.88	1.33	0	0.9125	0.11	0.01
C131	1990s	25	yes	once-mown	*Poa-palustris* -group	19930526	48.1312	16.7751	100	7.00	5.86	7.44	6.63	6.22	24	1.77	0.56	2.1525	0	2.1425	0.0875	0
C131	2024	25	yes	once-mown	*Arrhenatherum* -group	20240522	48.1315	16.7754	100	7.17	5.53	5.81	6.37	5.48	11	2.13	0.89	1.0375	0.0225	0.85	0.0775	0
C132	1990s	30	yes	once-mown	*Poa-palustris* -group	19930526	48.1317	16.7757	100	7.17	5.87	7.41	6.56	6.44	24	1.85	0.58	2.315	0	2.2325	0.1175	0
C132	2024	30	yes	once-mown	*Arrhenatherum* -group	20240522	48.1317	16.7754	100	7.09	5.60	5.41	6.42	5.42	19	2.37	0.80	0.905	0.0225	0.4525	0.165	0
C133	1990s	40	yes	once-mown	*Ophioglossum-vulgatum* -group	19930526	48.1324	16.7746	98	7.20	5.72	6.13	6.52	5.39	21	2.07	0.68	1.9275	0	1.6175	0.1275	0
C133	2024	40	yes	once-mown	*Arrhenatherum* -group	20240522	48.1323	16.7748	100	7.00	5.71	5.05	6.83	4.89	27	2.42	0.73	0.6625	0	0.3075	0.375	0.0225
C135	1990s	40	yes	once-mown	*Lolium* -group	19930526	48.1308	16.7721	100	7.31	5.50	5.07	6.25	5.36	24	1.67	0.53	1.73	0	0.56	0.94	0
C135	2024	40	yes	once-mown	*Arrhenatherum* -group	20240516	48.1309	16.7720	100	7.09	5.81	5.00	6.67	5.18	15	2.01	0.74	1.245	0.0225	0.6075	0.1075	0.01
C138	1990s	40	yes	once-mown	*Poa-palustris* -group	19930526	48.1306	16.7706	100	7.09	5.60	7.27	6.45	6.45	13	1.81	0.71	2.8175	0	2.15	0.7225	0
C138	2024	40	yes	once-mown	*Ophioglossum-vulgatum* -group	20240516	48.1308	16.7708	100	7.08	5.64	6.33	6.50	5.92	15	1.72	0.63	1.7725	0	1.695	0.0325	0.0225
C139	1990s	40	yes	once-mown	*Poa-palustris* -group	19930526	48.1309	16.7703	100	7.20	5.82	7.21	6.36	6.29	25	1.63	0.51	1.85	0	1.82	0.0525	0
C139	2024	40	yes	once-mown	*Arrhenatherum* -group	20240516	48.1309	16.7703	85	6.76	5.80	5.88	6.32	5.09	16	2.14	0.77	1.5775	0	1.065	0.0525	0.01
C142	1990s	40	yes	once-mown	*Poa-palustris* -group	19930526	48.1319	16.7704	100	7.14	5.71	7.47	6.71	5.64	15	1.95	0.72	2.155	0	1.78	0.385	0
C142	2024	40	yes	once-mown	*Arrhenatherum* -group	20240522	48.1319	16.7703	99	7.15	5.64	5.46	6.45	4.50	16	1.75	0.63	1.06	0.01	0.595	0.1425	0
C143	1990s	30	yes	once-mown	*Ophioglossum-vulgatum* -group	19930526	48.1334	16.7690	98	7.28	5.92	6.67	6.79	4.81	31	1.33	0.39	1.2225	0	1.0375	0.01	0
C143	2024	30	yes	once-mown	*Arrhenatherum* -group	20240523	48.1334	16.7690	100	6.97	5.56	5.48	6.61	5.15	18	2.23	0.77	0.8275	0.0875	0.42	0.7775	0
C145	1990s	30	yes	once-mown	*Lolium* -group	19930530	48.1284	16.8257	100	6.92	5.53	5.21	6.42	5.96	28	2.13	0.64	2.1775	0	1.0025	0.705	0.01
C145	2024	30	no	none	*Arrhenatherum* -group	20240619	48.1285	16.8258	100	6.68	5.55	5.58	6.39	5.88	30	2.02	0.59	1.5075	0	0.2225	1.055	0.0875
C154	1990s	25	yes	once-mown	*Lolium* -group	19930531	48.1434	16.8760	100	7.14	5.77	4.88	6.81	5.00	32	2.71	0.78	2.3625	0	0.2625	0.5225	0.01
C154	2024	25	yes	once-mown	*Arrhenatherum* -group	20240612	48.1433	16.8757	98	7.07	5.67	5.19	6.62	4.79	38	2.58	0.71	1.76	0	0.7925	1.025	0
C164	1990s	10	yes	once-mown	*Lolium* -group	19930531	48.1433	16.8748	98	7.06	5.27	5.78	6.43	5.27	29	2.11	0.63	1.335	0	0.605	0.2475	0.01
C164	2024	10	yes	once-mown	*Arrhenatherum* -group	20240612	48.1441	16.8748	98	7.21	5.75	4.64	6.58	4.74	18	2.44	0.84	1.355	0	0.165	0.585	0
C174	1990s	40	yes	once-mown	*Arrhenatherum* -group	19930531	48.154	16.8951	100	7.14	5.70	5.24	6.58	5.03	36	2.72	0.76	1.635	0.1875	0.3575	0.115	0.01
C174	2024	40	yes	once-mown	*Arrhenatherum* -group	20240529	48.154	16.8951	100	6.85	5.83	4.91	6.57	5.38	39	2.48	0.68	1.1175	0.0975	0.1325	0.8375	0.045
C179	1990s	30	yes	sporadic	*Lolium* -group	19930602	48.1213	16.6427	100	7.07	5.50	5.62	6.55	5.50	13	1.73	0.67	1.98	0	0.1975	1.6525	0
C179	2024	40	yes	sporadic	*Poa-palustris* -group	20240509	48.1211	16.6427	100	7.09	5.30	7.00	6.33	6.30	15	1.54	0.57	0.9275	0	0.4625	0.09	0
C186	1990s	40	yes	twice-mown	*Ophioglossum-vulgatum* -group	19930602	48.1245	16.6338	100	6.95	5.58	5.94	6.31	5.81	18	1.86	0.64	1.7275	0	1.355	0.33	0
C186	2024	40	yes	twice-mown	*Lolium* -group	20240509	48.1244	16.6336	99	7.27	5.30	5.64	6.23	6.83	21	2.63	0.86	0.485	0	0.1425	0.365	0
C188	1990s	40	yes	sporadic	*Poa-palustris* -group	19930604	48.1183	16.6502	100	6.89	5.67	7.56	6.33	6.06	20	2.02	0.68	1.4775	0.1975	1.6	0.24	0
C188	2024	40	yes	sporadic	*Ophioglossum-vulgatum* -group	20240514	48.1183	16.6502	100	7.11	5.50	6.44	6.31	6.29	23	1.86	0.59	1.735	0	0.725	0.615	0
C189	1990s	40	yes	sporadic	*Poa-palustris* -group	19930604	48.1229	16.6529	100	7.09	5.47	6.67	6.40	5.86	17	1.90	0.67	1.4375	0	0.3125	1.105	0
C189	2024	40	yes	sporadic	*Poa-palustris* -group	20240514	48.1228	16.6528	100	7.15	5.50	6.08	6.36	7.00	25	1.85	0.58	1.3725	0.0225	0.395	0.9875	0
D048	1990s	40	yes	twice-mown	*Poa-palustris* -group	19940601	48.1366	16.5882	100	6.92	5.48	6.16	6.50	6.29	30	2.20	0.65	1.635	0	1.3925	0.255	0
D048	2024	40	yes	twice-mown	*Arrhenatherum* -group	20240521	48.1364	16.5891	100	6.93	5.56	5.23	6.50	5.61	29	2.26	0.67	1.3275	0	0.23	1.0075	0
D067	1990s	35	yes	twice-mown	*Poa-palustris* -group	19940601	48.1403	16.5643	100	6.88	5.50	6.65	6.27	6.44	34	1.61	0.46	1.6925	0	1.5975	0.0625	0
D067	2024	35	yes	twice-mown	*Arrhenatherum* -group	20240521	48.1408	16.5646	98	7.19	5.70	4.90	6.61	5.19	17	2.51	0.89	1.1275	0	0.255	1.08	0
E002	1990s	20	yes	twice-mown	*Poa-palustris* -group	19950530	48.1281	16.6185	100	6.83	5.64	7.00	6.45	6.82	19	1.38	0.47	1.7425	0	1.335	0.385	0
E002	2024	20	yes	twice-mown	*Lolium* -group	20240509	48.1281	16.6185	80	7.20	5.31	5.62	6.29	6.55	12	2.31	0.93	0.46	0	0.23	0.2725	0
E003	1990s	30	yes	twice-mown	*Poa-palustris* -group	19950530	48.1284	16.6185	100	6.63	5.43	6.57	6.43	6.71	11	1.49	0.62	1.4175	0	1.23	0	0
E003	2024	30	yes	twice-mown	*Poa-palustris* -group	20240509	48.1283	16.6186	97	7.00	5.22	5.75	6.33	6.71		1.70	0.82	0.835	0	0.66	0.065	0
E004	1990s	35	yes	twice-mown	*Lolium* -group	19950530	48.128	16.6168	100	6.89	5.43	6.00	6.53	6.31	23	2.27	0.72	0.8	0	0.5075	0.27	0
E004	2024	35	yes	twice-mown	*Lolium* -group	20240502	48.1281	16.6169	90	7.06	5.50	5.50	6.41	6.73	20	2.40	0.80	0.455	0.01	0.12	0.225	0

E006	1990s	25	yes	twice-mown	*Poa-palustris* -group	19950530	48.1285	16.6168	100	6.70	5.50	6.50	6.40	6.60	14	1.26	0.48	1.0425	0	0.745	0.0975	0
E006	2024	25	yes	twice-mown	*Poa-palustris* -group	20240502	48.1286	16.6173	100	7.00	5.91	6.00	6.40	6.40	12	1.70	0.69	0.79	0	0.5925	0.1325	0
E007	1990s	25	yes	twice-mown	*Lolium* -group	19950530	48.1284	16.6168	100	7.19	5.43	5.33	6.43	5.85	18	2.20	0.76	1.04	0	0.5825	0.24	0
E007	2024	25	yes	twice-mown	*Lolium* -group	20240502	48.1283	16.6167	97	7.06	5.50	5.88	6.38	6.73	17	2.25	0.79	0.615	0.0225	0.09	0.3175	0
E010	1990s	30	yes	twice-mown	*Lolium* -group	19950530	48.1292	16.6149	100	7.21	5.33	5.08	6.30	5.75	9	1.84	0.84	1.13	0	0.75	0.4375	0
E010	2024	30	yes	twice-mown	*Lolium* -group	20240502	48.1293	16.6149	97	7.38	5.33	5.00	6.33	6.33	15	1.42	0.53	0.64	0	0	0.2875	0
E011	1990s	40	yes	twice-mown	*Lolium* -group	19950530	48.1281	16.6149	100	7.13	5.62	5.29	6.67	6.33	16	1.89	0.68	1.1025	0.0325	0.8125	0.445	0.0225
E011	2024	40	yes	twice-mown	*Lolium* -group	20240502	48.1283	16.6151	100	7.31	5.36	5.50	6.36	6.10	19	1.91	0.65	0.69	0	0.0975	0.27	0