Environment and Rural Affairs Monitoring & Modelling Programme (ERAMMP)

ERAMMP Technical Annex-105TA1S3: Wales National Trends and Glastir Evaluation

Supplement-3: Vegetation

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Supplement-3: Vegetation

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Abbreviations Used in this Report

AES	Agri-Environment Schemes
AWI	Ancient Woodland Indicators
CI	Confidence Interval
CS	Countryside Survey
DSH	Density in Suitable Habitat
DbH	Diameter at Breast Height
GMEP	Glastir Monitoring and Evaluation Programme
HNV	High Nature Value
LCM	Land Cover Map
LW	Living Wales
PMGRP	Purple Moor Grass Rush Pasture
QA	Quality Assurance
QC	Quality Control
SoNaRR	State of Natural Resources Report
WLF	Woody Linear Feature

Contents

1 INTRODUCTION AND APPROACH

1.1 Data collection

1.1.1 Vegetation Surveys

In each 1km square, plant species presence and cover was recorded in different sizes and types of Vegetation plot (Emmett & the GMEP team, 2017). Random points marking the position of five random or 'nested' plots (X plots) in each square were determined prior to the field survey. The locations, type and numbers of other kinds of plot were determined based on a rule-set, using the 'nested' plots as a starting point (or based on other mapping exercises). In Countryside Survey (CS) and the first 2 years of GMEP the X plots were sampled using 200m^2 nested plots. This was discontinued from 2015 in all habitats except Woodlands where the larger plots continued to be used. For more information on GMEP square selection and Vegetation sampling methodology, see the GMEP reports and appendices[1]. Different plot types have been used to analyse different habitats in this report.

1.1.2 Most area Broad Habitats

1. Nested plots provide a random sample of common vegetation types (X plots). Only the inner 2x2m area of these plots is used here for consistency across plot types and survey years.
2. Targeted 2x2m plots sample Priority Habitats and locations eligible for Glastir (Y plots).
3. Unenclosed 2x2m plots sample unenclosed Broad Habitats (U plots).

1.1.3 Broadleaved Woodlands

1. Inner 2m x 2m of nested plots (X plots) represent woodland vegetation in the analyses.
2. Targeted 2x2m plots sample Priority Habitats and locations eligible for Glastir (Y plots).
3. Where possible the full 200m2 X plot sample is also analysed.

1.1.4 Hedgerows

1. Woody diversity plots (D) 1m x 30m
2. Hedge plots (H) 1m x 10m

1.1.5 Boundary plots

1. Boundary plots- nearest boundary to an X plot and also some targeting for Glastir. 1m x 10m

[1] www.gmep.wales/resources

1.1.6 Streamside plots

- SW plots 1m x 10m along stream or watercourse
- P plots- at right angles to stream to sample the riparian bank vegetation immediately adjacent to the watercourse but moving up-slope to capture any natural zonation or differences driven by management. 1m x 10m (nested)

Within each Vegetation plot a full census of plant species is carried out and cover estimated. This data is then used to calculate a series of indicators (see below).

Along with national trends from 2013-16 to 2021-23, we also provide information on long term historic trends by Broad Habitat where available, using data from the Countryside Survey for Wales. This dataset covers changes in vegetation condition from 1990 to 2007, depending on the indicator considered. Vegetation indicators in Countryside Survey were measured across a smaller number of sites relative to the GMEP (2013-16) and ERAMMP (2021-23) sampling programs. Despite a compatible sampling approach being used across programs to enable comparison, the difference in sampling effort resulted in the Countryside Survey samples being from a higher latitude on average, when compared to subsequent monitoring campaigns. Therefore, directly comparing means from the Countryside Survey for Wales to those published here for 2013-16 and 2021-23 requires caution although subsetting by a common broad habitat should reduce this background difference in latitude.

To understand change in Vegetation condition from the Countryside Survey to 2013-16, readers should consult the GMEP report (Emmett & the GMEP team, 2017) which explicitly examined change by tracking the same sites across both populations. As a result of this modelling approach, mean estimates for Wales and Broad Habitats in the GMEP report may differ to those reported here, as they are partially influenced by the historic dataset. National and Habitat means estimated using only the 2013-16 and 2021-23 surveyed (this report) are considered more representative of Wales.

1.1.7 Woody Mapping

Surveyors focussed on mapping woody features only using customised SWEET mapping software.

This consists of mapping areas of Broadleaved and Coniferous Woodland (>20m x 20m) (classified using the Broad and Priority Habitat classification (BRIG and Maddock 2008), and areas where woody features were scattered or consisted of small clumps e.g. scattered scrub. Additional attributes were recorded on all parcels using a range of pre-determined options which included species presence and cover and forest feature attributes.

Lengths, types, and structural attributes of woody linear features were also surveyed. The term ‘Woody Linear Features’ (WLFs) has been used to account for the diversity of wooded linear elements found in the countryside including everything from a traditionally managed hedge to a planted avenue of trees or a line of old scrub which may at one time have been a managed hedge. WLFs fall into two broad categories based on the extent to which the trees within them take their natural shape.

- (WNS) Woody ‘Natural Shape’ means unhindered/unmanaged growth for at least a decade. Where trees take their natural shape, the feature will essentially be **a line of trees or scrub**.
- (WUS) Woody ‘Un-Natural’ Shape - Where trees/scrub has been managed relatively recently the WLF will fall into the **managed hedge** category.

Point features were also mapped in each square, representing individual landscape elements that occupy less than an area of 20x20m. They include: forestry features such as individual trees, clumps of trees, patches of scrub, veteran trees with their associated species and DBH (Diameter at Breast Height – 1.3m from the ground). Additional attributes are also recorded for individual point features e.g. veteran tree condition. For more information on GMEP square selection and mapping methodology, see the GMEP reports and appendices[1].

1.2 Habitat Assignment

1.2.1 Within the 1km square

In Countryside Survey, GMEP and ERAMMP, the Broad and Priority Habitat classification for reporting (Jackson, 2000) has been used. It was introduced in 2000 so for previous CS surveys we needed to back allocate land to this classification. In the field we ask surveyors to select the habitat type using a bespoke CS Vegetation key that was updated for GMEP to include some new Priority Habitat types. This key forms the basis of UKHab.

There were some changes to our habitat classification post GMEP to better represent the way SoNaRR reports habitats e.g. creating a new category of Semi-Improved Grasslands.

In CS until 2007 and in GMEP, the field survey mapped every area polygon, linear and point feature within a 1km square (where permissions allowed). The area polygons were assigned a Broad or Priority Habitat as well as a complex series of attributes including land use and species composition. In ERAMMP, field survey of all Broad Habitats and features was stopped and field survey mapping focused on woody features (as mentioned above).

For Vegetation plots (and Soils) pre-ERAMMP, these were allocated through the spatial mapping and then a spatial overlay of mapping and plots. Since ERAMMP, the surveyor assigns the plot habitat and also the habitat of the adjacent polygon in the plot recording software.

To summarise, in ERAMMP we have mapped all woody features in a square, all habitats that contain a woody feature and where possible surveyors also recorded the Broad and Priority Habitat of the polygon (with no other attributes). This means that we do have some spatial data on non-Woodland habitats and the capacity to validate remotely sensed data through habitat assignment for the plots.

We calculated and reported on a series of habitat based metrics used previously e.g. habitat diversity, patch size, spatial configuration within the square. These were calculated from field survey (and also habitat diversity from the UKCEH Land Cover Map (UKCEH LCM)). For these we were able to go back in time to CS based on field survey mapping. However, with the reduction of the field survey we have had to adapt this method.

We explored using Living Wales (LW), however, this would require creating a new baseline, as we could not get data for 2013-16. The LW classification doesn't map directly to Broad and Priority Habitats and SoNaRR ecosystems, although we have a lookup (and a LW dataset with the ERAMMP habitat included).

UKCEH Land cover maps are available historically. Change has also been demonstrated in a change product, however, it should be noted that this was for a reduced aggregation of habitats not every Broad Habitat type. Habitat classification matches quite well to habitats surveyed within GMEP although there are some habitats that are difficult to map e.g. flushes, small biotopes, differentiating grassland types.

We created an updated habitat map taking field survey from ERAMMP woody mapping, polygon allocation from field syrvey and including LCM where data was missing to create a new layer, this was explored using aerial photography and comparing multiple habitat sources including aerial photography to validate and understand potential sources of error.

Land Cover Map has also been used to extrapolate beyond the square.

1.3 Quality Assurance and Quality Control

It is recognised that all field investigations involving a large number of surveyors must produce an inherent degree of variation despite the provision of a training course, a field handbook and on-site visits by supervisors. It is therefore important to attempt a measure of the consistency and reliability of the work done within the major components of the field programme (Quality Assurance).

Initially when data returns from the field there are a series of checks such as ensuring all species records are updated where surveyors added a subsequent identification as a note, all mapped features are checked, adding species not recorded previously to the growing species and trait library for the surveys. There are also further detailed QA/QC processes.

1.3.1 Vegetation Plots

The QA exercise follows the same methodology as used in previous exercises conducted during the 1990, 1998 and 2007 Countryside Surveys, Glastir surveys (2014-16) and more recent UKSCAPE (2019-23) and ERAMMP (2021-24) surveys. Each season, approximately 10% of the total number of squares surveyed that year are selected for re-survey by the QA team. Squares are allocated across ITE land classes in order to survey habitats that the survey teams are likely to encounter, with a representative sample of the plots within a square resurveyed to include all of the different types of plots.

The QA exercise investigates the efficiency of plot relocation, the reproducibility of species records made by the original surveyors and the accuracy of percentage cover estimates of species present. By highlighting specific recorder errors, adjustments can be made to ensure that data quality is at a high standard. This can be done through various means, including improved training at the start of the survey, pairing up new surveyors with experienced surveyors, or adjusting schedules to take into account species-rich or difficult to access squares.

QA Vegetation data is analysed each year to understand the differences and potential sources of error. A wider analysis across survey years was carried out to explore whether the QA data could be used to quantify errors for different years/habitats etc. The results in Figure 1-1 demonstrate that for most condition indicators such as Ellenberg values differences between QA recording and surveyor recordings were low so these did not influence the results. However, for species richness (bottom right) and other indicators based on richness e.g. nectar plants, there was a significant difference of approximately 1 species.

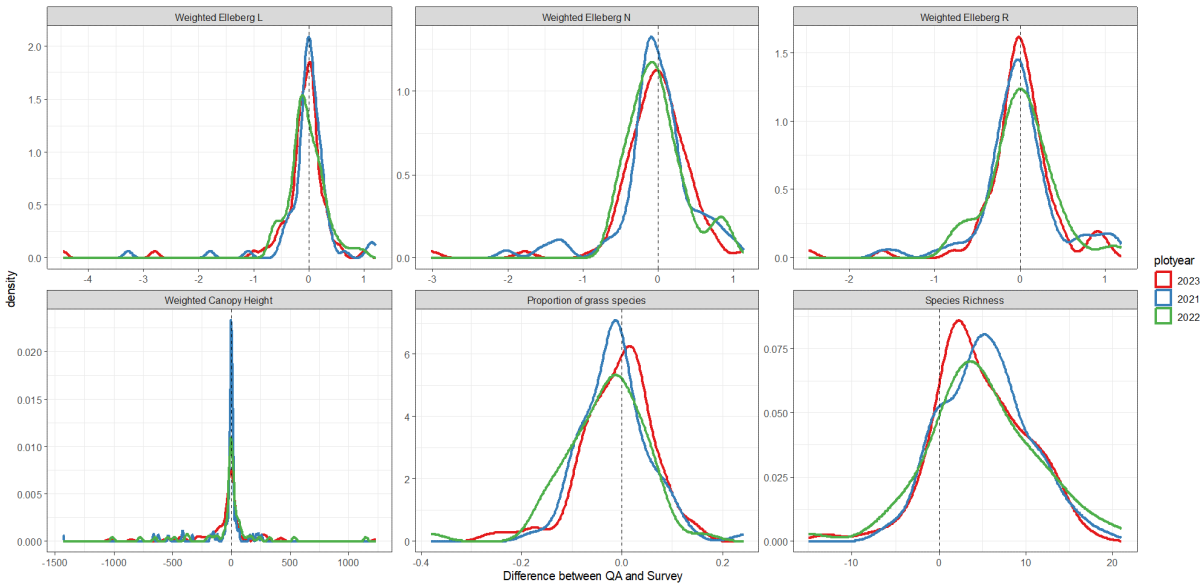

Figure 1-1 The difference between the QA survey and the field survey data for a number of indicators. Years are plotted separately.

We could draw randomly from a distribution based on these stats, calculated within groups of habitat & year and then use this to adjust the original data accordingly (Figure 1-2).

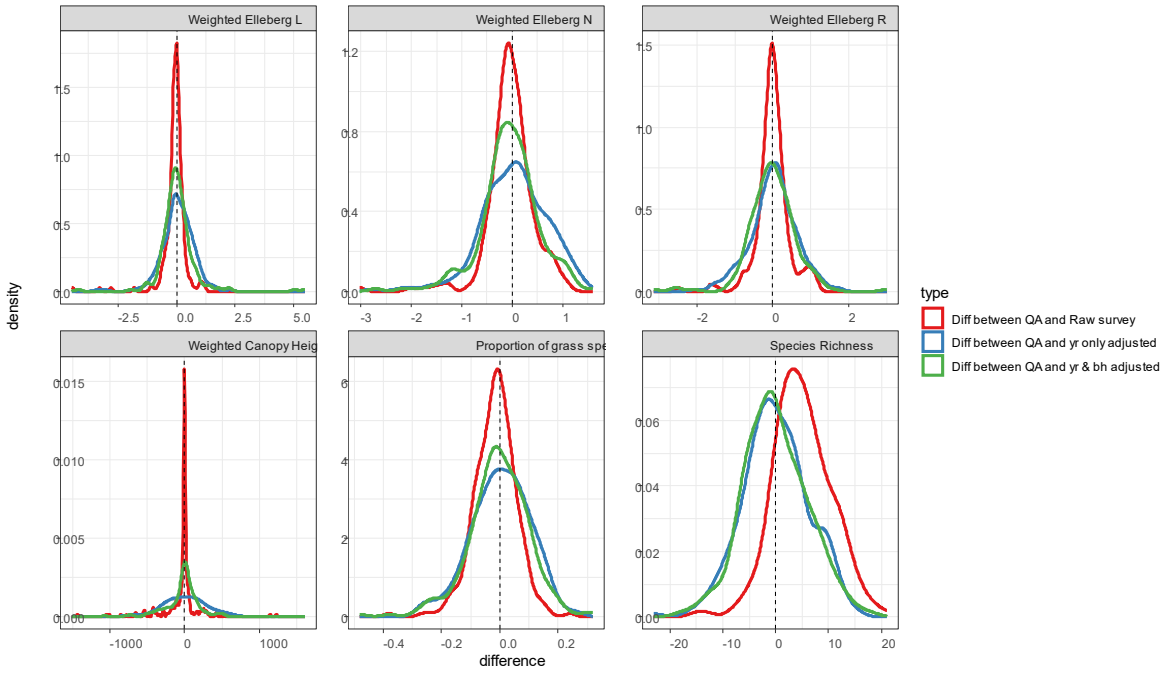

Figure 1-2 shows the difference between the QA and Raw survey data (red line) (as Figure 1-1) and also the adjusted values adjusted for year only and year and Broad Habitat.

However, because there are a limited number of QA plots in each habitat it's hard to produce a specific correction factor per year and per habitat, and the higher-level correction (i.e. for each survey year) doesn't add a huge amount of information compared to just being aware that there are differences.

1.3.2 Woody Mapping

QA/QC for woody mapping involves a field exercise with QA of 10% of mapped squares per year ensuring that all surveyor teams have been checked. The QA square is mapped blind and then a detailed analysis carried out back in the office. This involves checking Broad and Priority Habitat allocations, species composition and cover, identity, location and DBH of individual trees, Veteran tree attributes, location and all associated attributes for woody linears. Where appropriate the results are fed back to the surveyor, they are also noted to use in analysis and interpretation and the handbook is updated where there appears to be further clarification required.

1.4 Indicators

Many indicators have been derived from the raw data to analyse trends and Glastir impact.

1.4.1 Vegetation Plot Indicators

R scripts were used to that calculate all of the Vegetation indicators from all surveys.

- Indices relating to fertility, moisture, light and acidity status (Ellenberg scores) have been calculated for each plot (unweighted by cover). (Ellenberg, et al., 1991) (Hill, Roy, Mountford, & Bunce, 2000). An increase in fertility and acidity scores are considered negative indicators. Light levels are particularly important for Woodlands where an increase may indicate improved management in Broadleaved Woodland. High moisture scores are considered positive for wet habitats such as Bog and Fen, Marsh, Swamp. A decline could indicate impacts of climate variation and /or continued effects of historical drainage.

- Grass: Forb ratio; an increase is a negative indicator because it suggests that conditions which favour grass species have dominated at the expense of flowering plants (forbs). This is often linked to high grazing pressure and fertility levels.

- Species richness indicators
  - Total species richness- this has been calculated for some habitats where higher numbers of species are a positive indicator e.g. Improved and Semi-Improved Grassland, in others, particularly low nutrient habitats an increase in overall richness may not be a good thing if the incoming species are indicative of eutrophication and disturbance so instead we use indicator species.
  - Positive indicator richness or ‘appropriate diversity’ where a species is representative of the habitat in good condition. Indicators were initially collated from Common Standard Monitoring species (CSM) and then refined from discussions with NRW specialists.
  - Nectar plant richness – plant species that provide a nectar source for pollinating insects
  - Negative CSM indicator species richness – increases are interpreted as a negative impact.
  - Ancient Woodland Indicators (AWI) are plant species particularly prevalent in Ancient Woodlands and therefore indicative of good Woodland and woody feature (e.g. Hedgerow) condition. They may be associated with lower light levels but there will be a trade-off where excess growth of fertile plants excludes AWI
  - Vegetation indicators for Arable habitats include annual forbs in addition to positive and negative arable indicators.

- Dwarf Shrub cover and Sphagnum cover are recognised as particularly positive elements linked to good condition within Dwarf Shrub Heath, Bog and Acid Grassland habitats.

- Cover of non-native and invasive species, for most habitats this was non-native species (from a list of Neophytes, Alien casuals, Alien hybrids and those where native status unclear- plantATT). In Broadleaved Woodlands we included bramble (*Rubus fruticosus* agg.) and *Rhododendron* cover also. Results were presented excluding Arable and Coniferous habitats where non-native species are deliberately planted.

1.4.2 Woody Mapping

1.4.2.1 Hedgerows

There are a suite of indicators specific to hedgerows. Hedgerow condition assessment depends on recording hedgerow 'attributes', based on thresholds from the UKHAP Steering Group to indicate whether a particular hedgerow is in 'favourable condition'.

The basic attributes deemed to be indicative of hedgerows in 'favourable condition' include:

1. Structural only (Total Structured in condition)
    - Height >1m
    - Width >1.5m
    - Cross-sectional area (height x width) >3m
    - The degree of intactness of the hedgerow canopy
    - Vertical gappiness <10%
    - No gaps >5m wide
    - The height above ground at which the canopy starts <0.5m
    - <10% non-native species

2. Structural and margins (Total Structural + Margin in condition)
    - Width of perennial herbaceous vegetation >1m
    - Undisturbed ground >2m adjacent to the hedgerow (all land)

3. Structural and margins Total structured + Arable- on Arable land only
    - Width of perennial herbaceous vegetation >1m
    - Undisturbed ground >2m adjacent to the hedgerow

Hedge condition is calculated for woody diversity plots by assessing whether they meet the above criteria for good condition and then calculating the % of plots in condition for each measure.

Hedgerow length is analysed in two different ways. National estimates of hedgerows is a long-established method that uses the structure of the survey to derive nationally representative data (national estimates). The other method which is easier to use to analyse trends in relation to Glastir is to use the mean total length within a square corrected for the amount of land surveyed (i.e. accounting for permissions and land that can't be surveyed e.g. sea).

1.4.3 Landscape

Woodland connectivity is thought to improve the movement and dispersal of species across the landscape and overall improve condition for Woodland plants and mobile taxa. There is unlikely to be any benefit for soil. An increase in Woodland connectivity is therefore a positive outcome. Broadleaved connectivity was calculated as Euclidean distance between woodland patches using the programme fragstats. This was a different method to that used for GMEP reporting. The result was that a larger distance meant that connectivity was lower so the indicator was inversed for reporting. It was calculated for different datasets, for the trend analysis over time, field survey data only was used because this needed to align with CS, we also analysed connectivity including linear features mapped during field survey. For the landscape scale analysis, LCM data was used.

Habitat diversity was calculated by the Shannon diversity metric. Habitat diversity was calculated using field survey data and the Land Cover Map.

1.5 Glastir Data

1.5.1 Vegetation Plots

A Glastir bundle was present if any action within that bundle occurred at the site within the relevant time frame. For the baseline visit (2013-16) we considered actions present between the start of Glastir (2012) up to and including the year of sampling. For subsequent visits, we considered actions present since the previous sample (non-inclusive), up to and including the year of the current sample.

Data was also extracted for the presence of historic Agri-Environment Schemes (AES): Tir Cynnal and Tir Gofal. The presence of historic AES schemes was defined in the same fashion as Glastir, with the exception that the relevant timeframe was considered to be any year. As such, if a site was subject to historic agri-environment scheme management in the baseline survey, it would also by definition have been present for subsequent surveys. For additional context and information on Glastir data see the ERAMMP Technical Annex-105TA1S1: Wales National Trends and Glastir Evaluation. Supplement-1: Data Analysis Methods.

1.5.2 Field Mapping

Some of the response variables are calculated from the field mapping data and so it was more appropriate to identify the Glastir bundle either spatially by overlaying the appropriate bundles over a Hedgerow length (buffer) or by the amount of Glastir in the square.

Spatial analysis of Hedgerow Glastir options was carried out in ARCpro (using Python scripts). Options were allocated to bundles for management, restoration and planting. A buffer of 0.5m was used to overlay the Glastir data with the field survey linear Hedgerows. Inclusion of option data in a bundle was determined in a similar way to that described above.

Figure 1-3 shows the 0.5m buffer applied to Hedgerow demonstrating the intersection with Glastir options. The box on the left shows where the inset box on the right has been taken from.

For square level indicators e.g. Broadleaved connectivity the presence of a Glastir bundle in a 1km square was used as the Glastir measure.

1.6 Analysis and Model Structure

1.6.1 National Trend

National Trends were calculated using the nationally representative subset of 1km survey squares only. For most indicators representative historical data were also available from the Welsh Countryside Survey squares, these data were analysed in a similar way to GMEP/ERAMMP data. However, the two datasets were not combined i.e. CS data were modelled separately to data collected in GMEP and ERAMMP.

The basic form of the national trend models is:

Response ~ Year + (1|Unit) *Equation 1*

- **Response** is the indicator selected for analysis e.g. the number of CSM positive plant species in acid grassland.
- **Year** the time period of survey (e.g. 1990, 1998, 2016, 2022).
- **Unit** indicates the nesting or random effect structure required to account for the survey design. For Vegetation plots multiple Vegetation plots are nested within a survey square, and some plots will be repeat plots from a previous survey. The model structure needs to reflect this and the repeat plot ID is included as a factor in analysis. For variables at square level e.g. Broad leaved Woodland connectivity, the 1km Square is included as a random effect.

For most response variables we used the derived indicator value with the appropriate distribution e.g. Ellenbergs- gaussian, species richness- Poisson. To model cover values (Sphagnum, non-natives, Dwarf Shrub species) we tested several different models including removing zeros and modelling only positive integers, raw cover values (with 0.001

added) but determined on a zero inflation model where cover was re-scaled between 0 and 1. This approach was used to model all cover variables.

1.6.2 Glastir Impact

To answer the question as to whether the change between GMEP and ERAMMP survey periods is different for observation units (plots, etc) depending on the presence of a Glastir bundle intervention we used a model structure including a **Survey*Glastir** interaction term, this allows the change between survey periods to differ depending on whether relevant Glastir bundles are present. All models follow a core structure as follows:

$$\text{Response} \sim \text{Survey*Bundle1} + \text{Survey*Bundle2} + \ldots + (1|\text{Unit}) \qquad \textit{Equation 2}$$

For Vegetation plots the unit is the repeat plot ID.The difference in the change in estimated mean responses between surveys where the bundle is either present (or high) or absent (or low) is estimated by the interaction terms. Low and high values are set by each theme at appropriate values for the bundle or variable of interest. Positive values indicate a more positive change between surveys where the bundle is present (or high).

1.6.3 Field Mapping Data

There are some differences in the analyses carried out with field mapping data

1. The national estimate analysis is used to analyse areas and lengths (and condition measures associated with them) because it takes account the amount of land surveyed in each square including where different permissions in each survey impact on changes to the surveyed area, and areas of land that are not surveyable, such as sea. The nature of the model means that exact matches to previous estimates are unlikely. The model provides estimates of hedgerow length by Land Class which are multiplied by total Land Class areas in Wales to provide national estimates of the extents of different woody linear feature types (WUS- managed Hedges and WNS- lines of trees) (in ‘000s km) at national scales. Estimates for attributes recorded on the mapped features are analysed in a similar way to Vegetation plot indicators e.g. hedge height,

2. Changes in Hedge management categories calculated by proportion of mapped length were not analysed quantitatively.

2 RESULTS: ANALYSIS OF ALL HABITATS COMBINED

Here we present results across habitats for comparison. The data is the same as that used for the individual analyses so for most habitats this is the small 2m x 2m Vegetation plots.

Figure 2-1 shows the difference in Ellenberg fertility across the Broad Habitats with the highest values being in Arable and Improved Grassland habitats with the lowest values for Bog and Dwarf Shrub Heath as expected, these are low nutrient habitats.

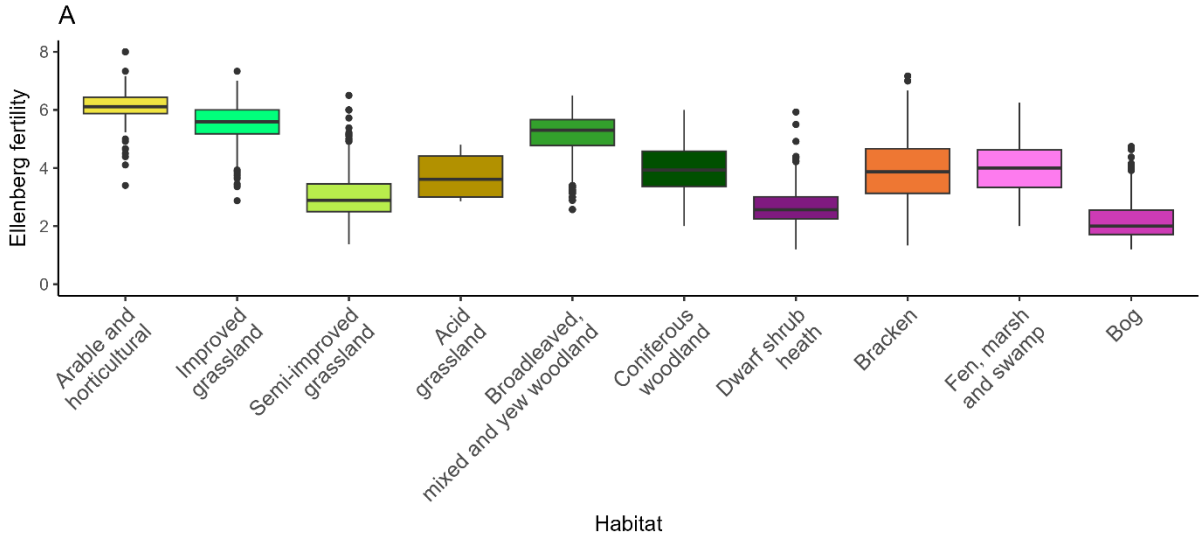

Figure 2-1 The difference in Ellenberg fertility across different Broad Habitat classes in 2021-23. The horizontal lines indicates the mid point, the boxes indicate where the mid 50% of all values sit and the vertical lines represent the full range of values observed.

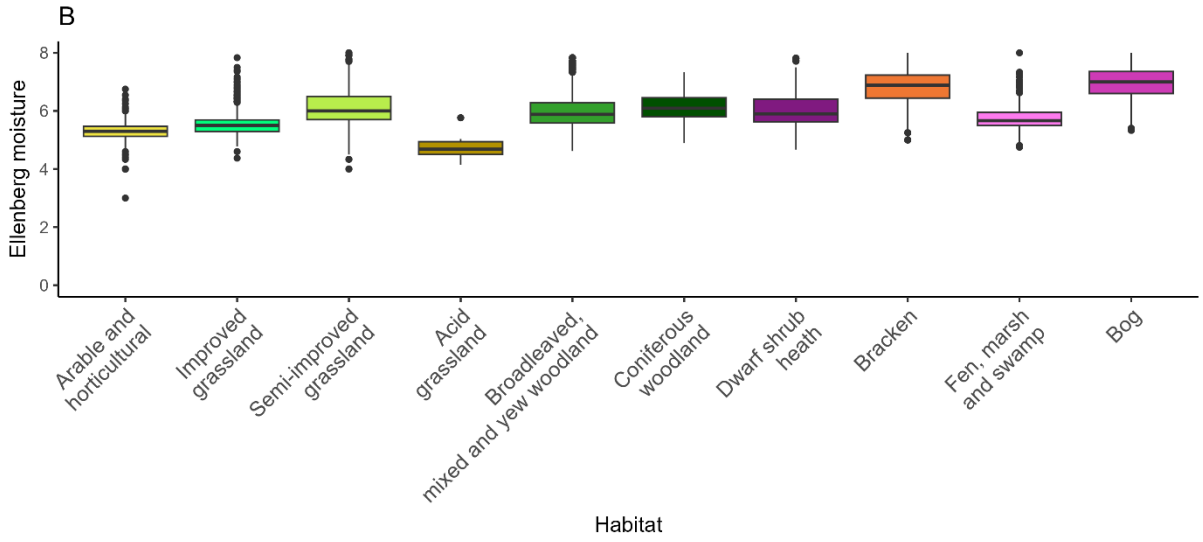

Figure 2-2 The difference in Ellenberg moisture across different Broad Habitat classes in 2021-23. The horizontal lines indicates the mid point, the boxes indicate where the mid 50% of all values sit and the vertical lines represent the full range of values observed.

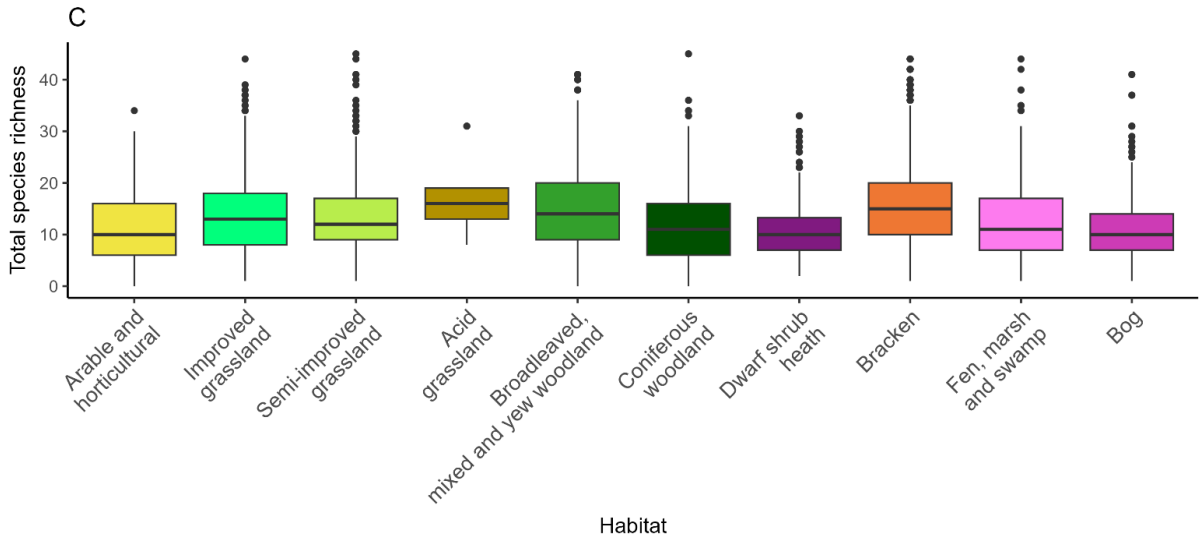

Figure 2-3 *The difference in total species richness across different Broad Habitat classes in 2021-23. The horizontal lines indicates the mid point, the boxes indicate where the mid 50% of all values sit and the vertical lines represent the full range of values observed.*

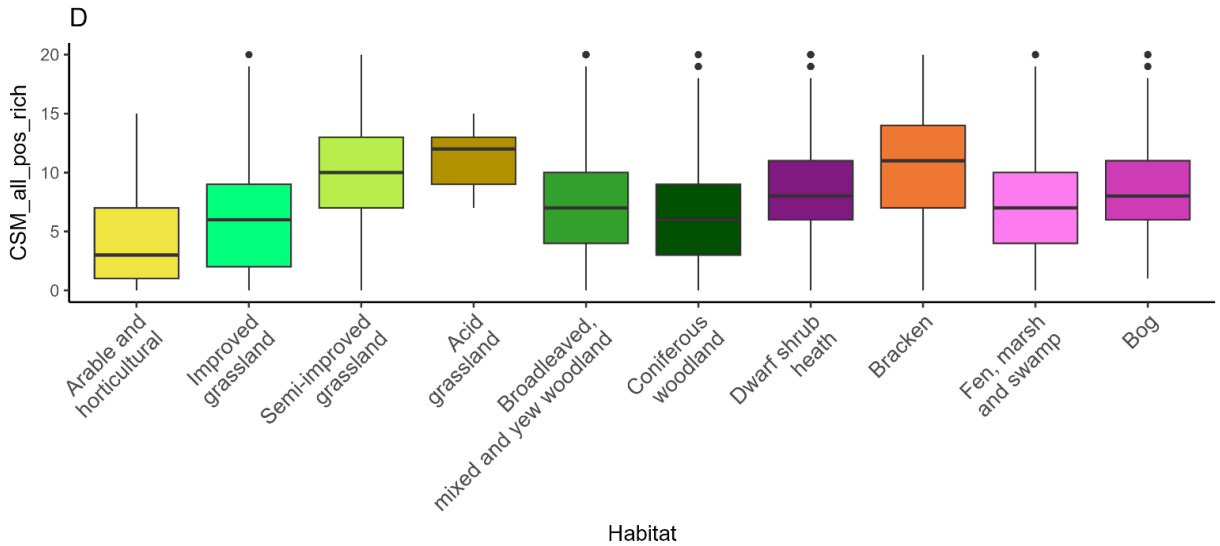

Figure 2-4 The difference in positive indicators (calculated across all habitats i.e. not habitat specific) across different Broad Habitat classes in 2021-23. The horizontal lines indicates

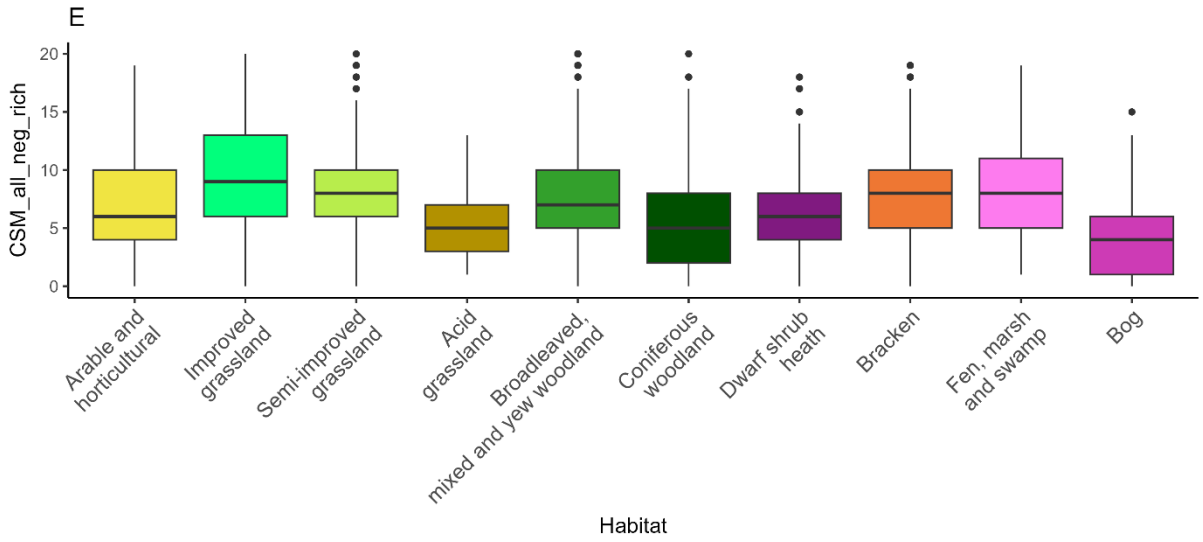

Figure 2-5 The difference in CSM negative indicators (calculated across all habitats i.e. not habitat specific across different Broad Habitat classes in 2021-23. The horizontal lines indicates the mid point, the boxes indicate where the mid 50% of all values sit and the vertical lines represent the full range of values observed.

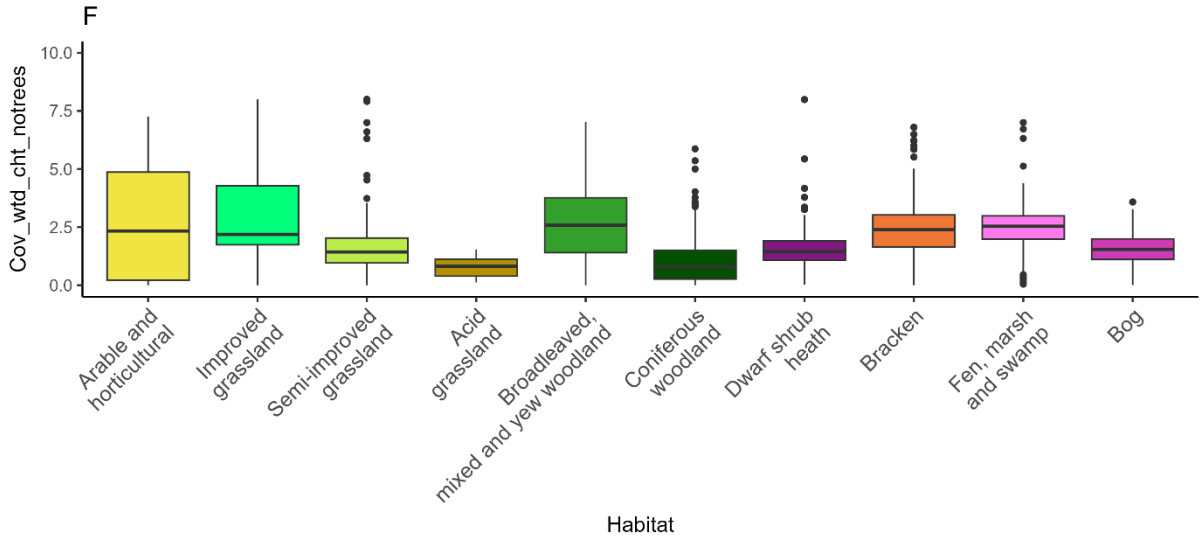

Figure 2-6 The difference in canopy height across different Broad Habitat classes in 2021-23. The horizontal lines indicates the mid point, the boxes indicate where the mid 50% of all values sit and the vertical lines represent the full range of values observed.

2.1.1 National Trends

*Table 2-1 Statistics for analysis of national trends in indicator variables across Wales across two different time intervals. Within year estimated means are shown as well as the mean change over each interval (Trend * - *).*

Indicator	1990	1998	2007	Trend 1990-2007	P value	2016	2022	Trend 2016-2022	P value
Ellenberg fertility	4.03	4.06	4.16	0.1	<0.01	4.4	4.35	0	0.75
Total species richness	10.31	10.2	9.45	-0.9	<0.01	11	10.1	-0.54	<0.01
Positive indicator richness	6.46	6.4	5.91	-0.6	<0.01	6.5	6.46	-0.06	0.54
NNS richness	0.05	0.05	0.06	0.01	0.18	0.09	0.11	0.02	<0.01
NNS cover (rescaled 0 to 1)	0.23	0.3	0.29	0.06	0.05	0.15	0.15	0	0.91

- Total plant species richness has declined slightly since 2013-16, whilst the number of positive indicators has remained stable.
- Under Glastir, the total number of plant species is lower, however, there is higher positive indicator richness. This may reflect appropriate diversity of low nutrient habitats
- Ellenberg fertility has not changed, land under Glastir has less fertile species than the wider countryside.

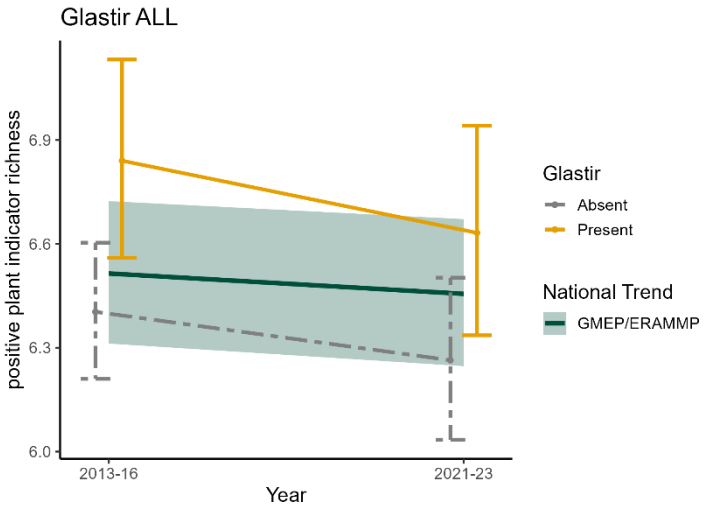

Figure 2-7 Trend in positive plant indicator richness between 2013-16 and 2021-23 in all habitats showing both national trends and effect of all Glastir.

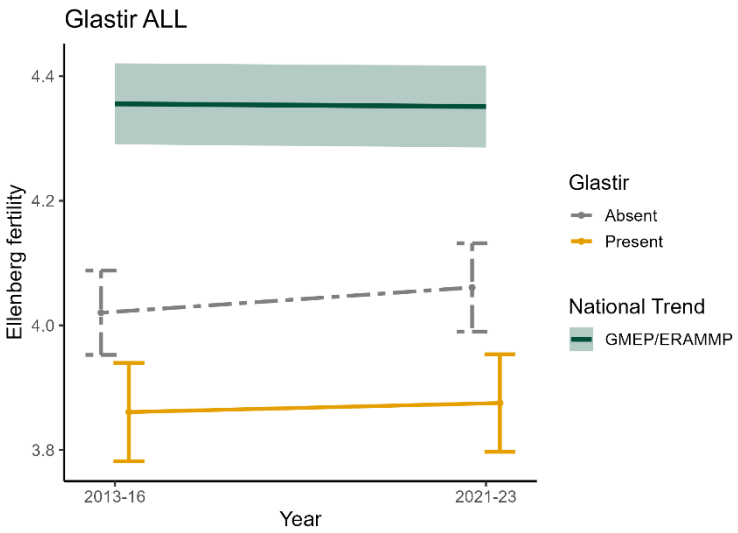

Figure 2-8 Trend in Ellenberg fertility between 2013-16 and 2021-23 in all habitats showing both national trends and effect of all Glastir.

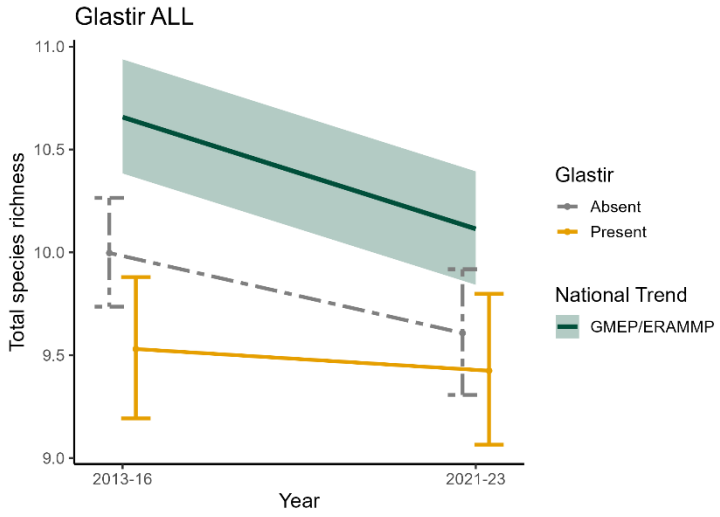

Figure 2-9 Trend in total species richness between 2013-16 and 2021-23 in all habitats showing both national trends and effect of all Glastir.

Table 2-2 Statistics for analysis of the conditional effect of coincidence with Glastir (Trend difference_GlastirALL) and coincidence with historic AES scheme (Trend difference historic aes) across Wales between the 2013-16 and 2021-23 surveys.

Indicator	Trend difference_ GlastirALL	P.value_ GlastirALL	Trend.difference_ historic_aes	P.value_ historic_ aes
EBERGN	-0.03	0.23	-0.02	0.32
tot_rich_yr	0.43	0.03	-0.21	0.41
CSM_all_pos_rich_yr	0.11	0.43	-0.06	0.76
Non native species richness	0	0.65	0	0.86
Non-native species cover	0	0.82	0.01	0.43

Table 2-3 Habitat Diversity

	Indicator	Glastir bundle	Trend difference	P value
1	HabDiv	B_Hab_Management_Gen_Bin	0.04	0.69
2	HabDiv	B_Wildlife_Corridors_Bin	0.03	0.39
3	HabDiv	B_Woodland_Creation_Bin	0.03	0.53
4	HabDiv	B_Hab_Management_Oth_Bin	-0.08	0.39
5	HabDiv	B_Grazing_input_Bin	-0.01	0.61
6	HabDiv	B_Hab_rev_Bin	-0.05	0.23
7	HabDiv	B_Organic_Bin	0	0.86
8	HabDiv	B_commons_Bin	0	0.95

3 RESULTS BY BROAD HABITAT

3.1 Broadleaved Mixed and Yew Woodland

3.1.1 National Trend

3.1.1.1 Positive Outcomes

- Total species richness, AWI indicators and nectar plant species richness were all higher in GMEP/ERAMMP than CS.
- Total species richness is now stable after a period of decline in the longer-term data.
- Ancient Woodland Indicator (AWI) plant species remained stable in the recent survey period continuing the long-term trend as do negative plant indicators.
- Nectar plant species richness was stable after a decline in the longer term.
- Strong declines in plant Ellenberg light score appear to be ongoing. This is in an indicator of a loss of plants which require higher levels of light and is likely to be a response to long-term increase in canopy cover due to long term lack of canopy disturbance and canopy growth.
- Ellenberg fertility was higher in the 2013-16 to 2021-23 than the long term CS 1990-2007. The trend between 2013-16 to 2021-23 was not significant, however the graph suggests that it may be stable.
- Broadleaved Woodland connectivity remains stable. Analysis including woody linear features increases the level of connectedness and there was an almost significant negative trend (p=0.06).

3.1.1.2 Areas for Concern / Need for Further Action

- There was an increase in the cover of Non-Native and invasive species in the small plots, however, this was not a significant increase in the large plots. There is a lot of variation in cover values which is likely to be why the large plots were not significant.

3.1.1.3 Complex signal requiring further analysis

- Total canopy height of the ground flora increased in the long-term survey in small plots and decreased significantly in the recent survey. This indicator was not reported previously.

*Table 3-1 **National Trend** analysis for Biodiversity indicators for **Broadleaved Mixed and Yew Woodland in Large plots** (X) and small plots (X,Y,U) Mean, mean change and p-values extracted from models for periods 2013-16 and 2021-23.*

	Indicator	1990	1998	2007	Trend 1990-2007	P value	Indicator	2016	2022	Trend 2016-2022	P value
Woodlands Large X plots	Ellenberg fertility	4.28	4.39	4.47	0.19	0.09	Ellenberg fertility	4.82	4.81	-0.01	0.82
	Ellenberg light	6.46	6.35	6.32	-0.14	0.06	Ellenberg light	5.87	5.83	-0.04	0.65
	Total species richness	22.49	18.63	18.23	-4.26	0.01	Total species richness	22.27	23.78	1.5	0.19
	Ancient Woodland indicators	1.77	1.43	1.37	-0.4	0.37	Ancient Woodland indicators	4.33	4.46	0.12	0.78
	Canopy height (no trees)	1.93	2.02	1.89	-0.04	0.97	Canopy height (no trees)	2.19	1.94	-0.26	0.19
	Nectar plant species richness	11.62	9.32	8.97	-2.65	0.02	Nectar plant species richness	11.75	12.39	0.64	0.42
	Negative indicators	0.03	0.26	0.18	0.15	0.14	Negative indicators	0.73	1.07	0.35	0.09
	Non- native species cover(re-scaled)	0.23	0.39	0.24	0.01	1	Non- native species cover(re-scaled)	0.21	0.27	0.07	0.13
Woodlands small plots (X,Y)	Ellenberg fertility	4.39	4.58	4.85	0.45	<0.01	Ellenberg fertility	5.12	5.1	-0.02	0.51
	Ellenberg light	6.19	6.17	5.95	-0.24	<0.01	Ellenberg light	5.87	5.81	-0.06	0.01
	Total species richness	10.66	10.77	10.12	-0.54	0.65	Total species richness	10.46	10.37	-0.09	0.78
	Ancient Woodland indicators	1.33	1.39	1.23	-0.1	0.83	Ancient Woodland indicators	1.85	1.79	-0.06	0.63
	Canopy height (no trees)	1.82	2.04	2.26	0.44	0.04	Canopy height (no trees)	2.69	2.43	-0.26	0.01
	Nectar plant species richness	5.06	5	5.25	0.19	0.9	Nectar plant species richness	5.59	5.49	-0.1	0.68
	Non- native species cover(re-scaled)		0.22	0.2	0.06	0.35	Non- native species cover(re-scaled)	0.16	0.22	0.06	0.01
1km square	BL Woodland connectivity-raw	0.1	0.1	0.1	0	0.73	BL Woodland connectivity-raw	0.11	0.1	0	0.71
	BL Woodland connectivity-inverse no linears	0.9	0.9	0.9	0	0.73	BL Woodland connectivity-inverse	0.88	0.87	-0.01	0.12
	BL Woodland connectivity inverse with linears						BL Woodland connectivity inverse with linears	0.94	0.93	-0.02	0.06
	BL Woodland connectivity +LCM data + no linears						BL Woodland connectivity +LCM data + no linears	0.9	0.89	-0.02	0.03
	BL Woodland connectivity +LCM data + linears						BL Woodland connectivity +LCM data + linears	0.97	0.85	-0.12	<0.01

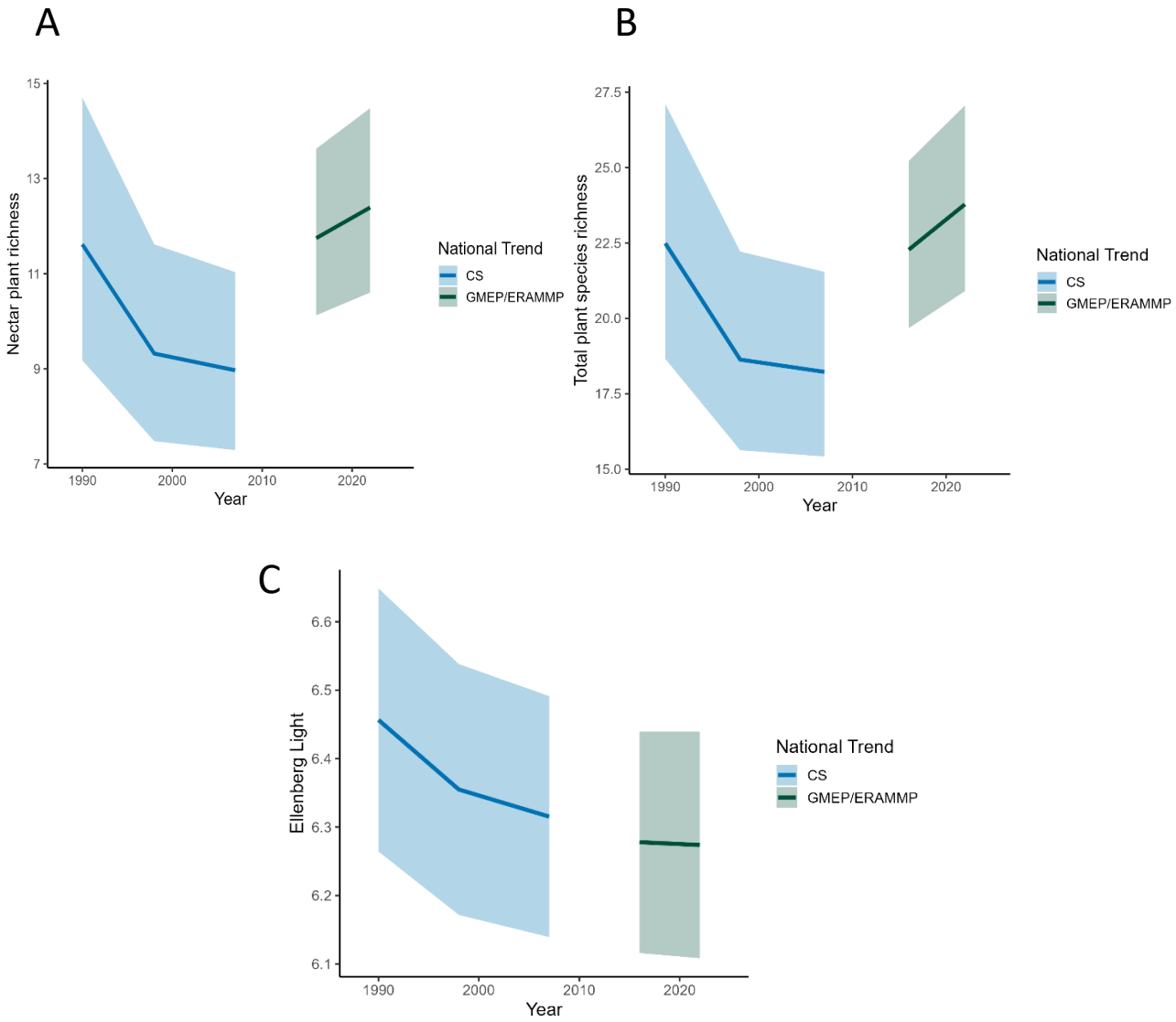

Figure 3-1 Long term national trends in A) Nectar count, B)Total species richness and C) Ellenberg light in Broadleaved Woodland indicators in Large plots from Countryside Survey squares in Wales 1990 to 2007 and GMEP/ERAMMP (2013 – 16 to 2021 – 2023) from nationally representative survey squares.

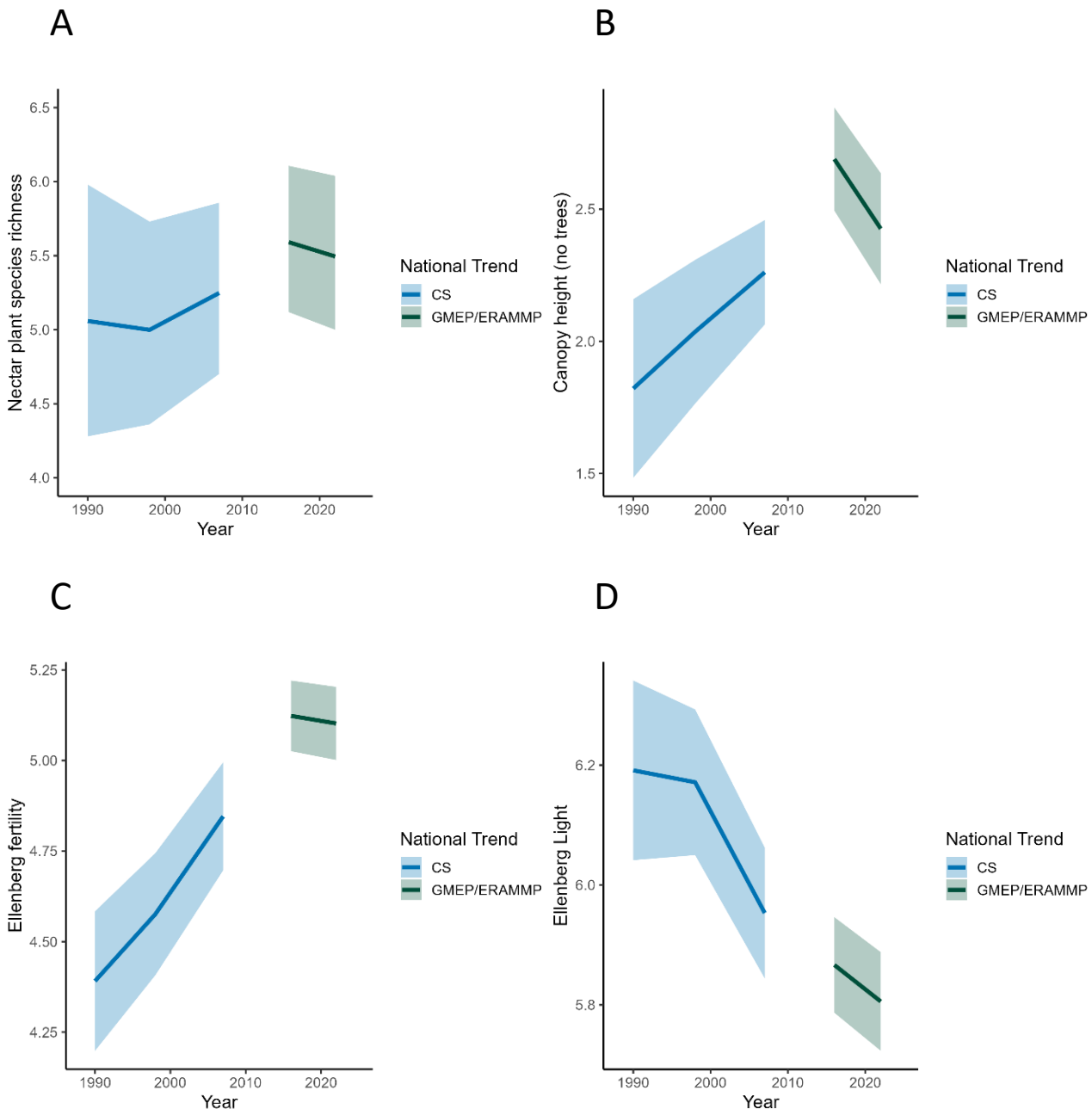

Figure 3-2 Long term national trends in A) Nectar count, B) Canopy Height (trees excluded) C) Ellenberg N, and D) Ellenberg L in Broadleaved Woodland indicators in small plots (X,Y) from Countryside Survey squares in Wales 1990 to 2007 and GMEP/ERAMMP (2013 – 16 to 2021 – 2023) from nationally representative survey squares.

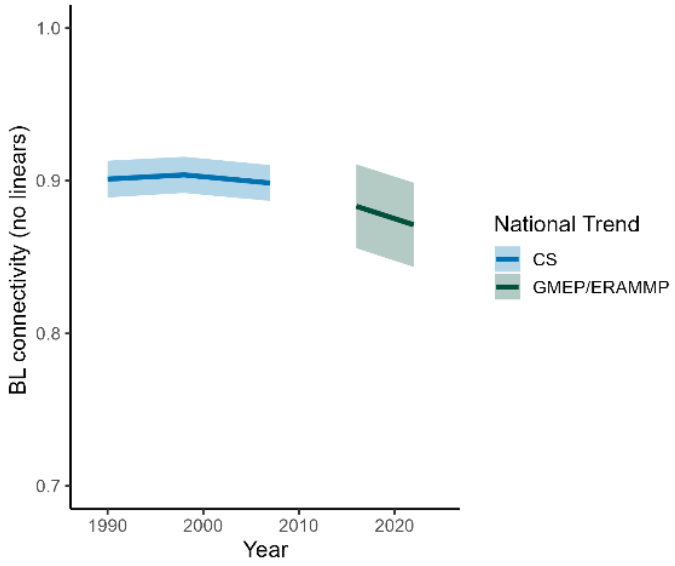

Figure 3-3 Long term national trends in Broadleaved Woodland connectivity from Countryside Survey squares in Wales 1990 to 2007 and GMEP/ERAMMP (2013 – 16 to 2021 – 2023) from nationally representative survey squares.

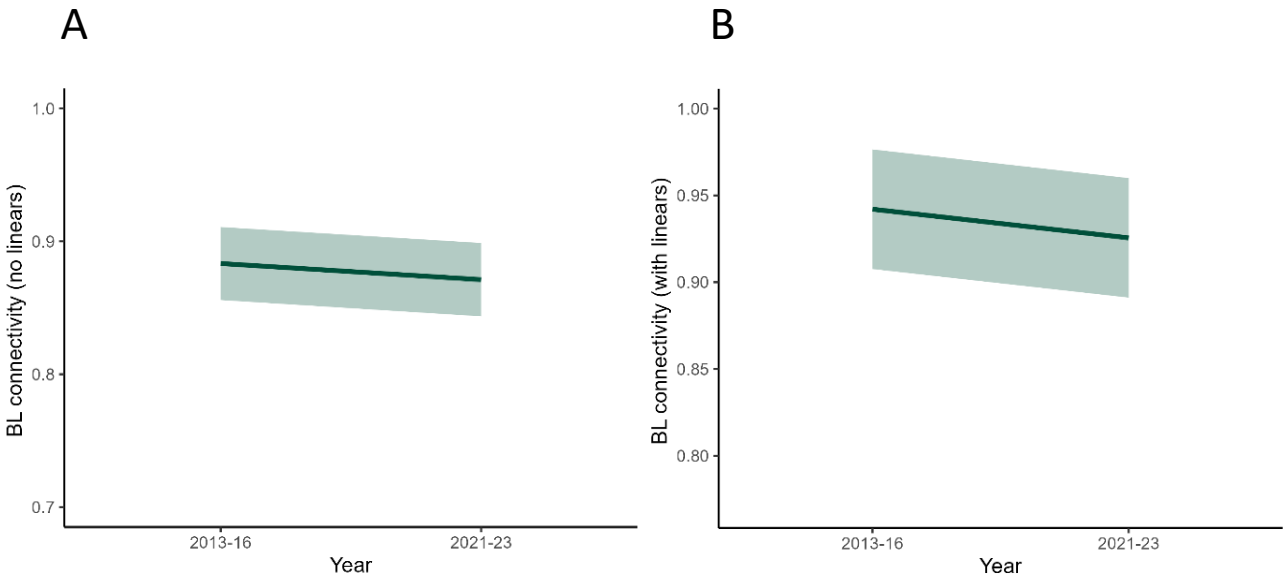

Figure 3-4 Trend in Broadleaved Woodland connectivity between 2013-16 and 2021-23 from nationally representative survey squares comparing A) No linears with B) Linears.

3.1.2 Glastir Impact

3.1.2.1 Positive Outcomes

- Ancient Woodland Indicator richness increased with Woodland Management.
- Broadleaved Woodland connectivity increased with the presence of Woodland Creation in the 1km survey square.

3.1.2.2 Outcomes not as intended, trade-offs and contextual dependencies

- There was no effect of Glastir Woodland Management on: cover weighted canopy height; plant Ellenberg light scores, nectar plant species richness, invasive and non-native species cover and total ground flora species richness.
- Historic AES reduced cover weighted canopy height, increased nectar species richness and increased ground flora species richness.

Table 3-2 Statistics for analysis of the conditional effect of coincidence with Glastir woodland management, stock exclusion from woodlands and coincidence with historic AES scheme across Wales between the 2013-16 and 2021-23 surveys.

	Indicator	Trend difference Woodland Management	P value Woodland Management	Trend difference Woodland Stock Exclusion	P value Woodland Stock Exclusion	Trend difference historic_aes	P value historic_aes
Broadleaved Woodland Large plots	Ellenberg fertility	0.01	0.98	0.03	0.94	0.12	0.38
	Ellenberg Light	-0.09	0.52	-0.06	0.85	0.1	0.31
	Total species richness	0.13	0.97	-11.65	0.1	5.46	0.01
	Ancient Woodland indicators	3.57	0.04	1.52	0.84	-0.25	0.89
	Canopy Height (no trees)	0.36	0.41	1.05	0.29	-1.02	<0.01
	Nectar plant species richness	1.91	0.55	-1.65	0.75	2.45	0.07
	Non Native species cover (rescaled)	-0.09	0.36	0.02	0.57	-0.01	0.7
Broadleaved Woodland small plots	Ellenberg fertility	-0.11	0.62	0.13	0.16	-0.02	0.77
	Ellenberg Light	0.1	0.6	-0.01	0.89	-0.05	0.29
	Total species richness	0.7	0.77	0.72	0.41	-0.63	0.3
	Ancient Woodland indicators	0.01	0.99	0.54	0.11	-0.06	0.78
	Canopy Height (no trees)	-0.2	0.75	-0.02	0.95	0.15	0.38
	Nectar plant species richness	1.7	0.29	0.68	0.26	-0.07	0.9
	Non Native species cover (rescaled)	-0.04	0.79	0.15	0.06	-0.05	0.41

Table 3-3 Statistics for analysis of the conditional effect on woodland connectivity of coincidence with Glastir woodland management, presence of wildlife corridors, woodland creation and hedge restoration calculated at the 1km square resolution and analysing change across Wales between the 2013-16 and 2021-23 surveys. No data is shown as grey boxes.

	Indicator	Trend.difference Woodland Management	P.value_ Woodland Management	Trend.difference Wildlife_corridors	P.value Wildlife corridors	Trend.difference Woodland Creation	P.value Woodland Creation	Trend Hedge restoration	P Hedge restoration
1km square	Broadleaved Woodland connectivity no linears-Inverse	0.01	0.35	-0.01	0.54	0.07	<0.01		
	Broadleaved Woodland connectivity linears-Inverse	0.01	0.47	0.02	0.26	0.02	0.51	0	0.89

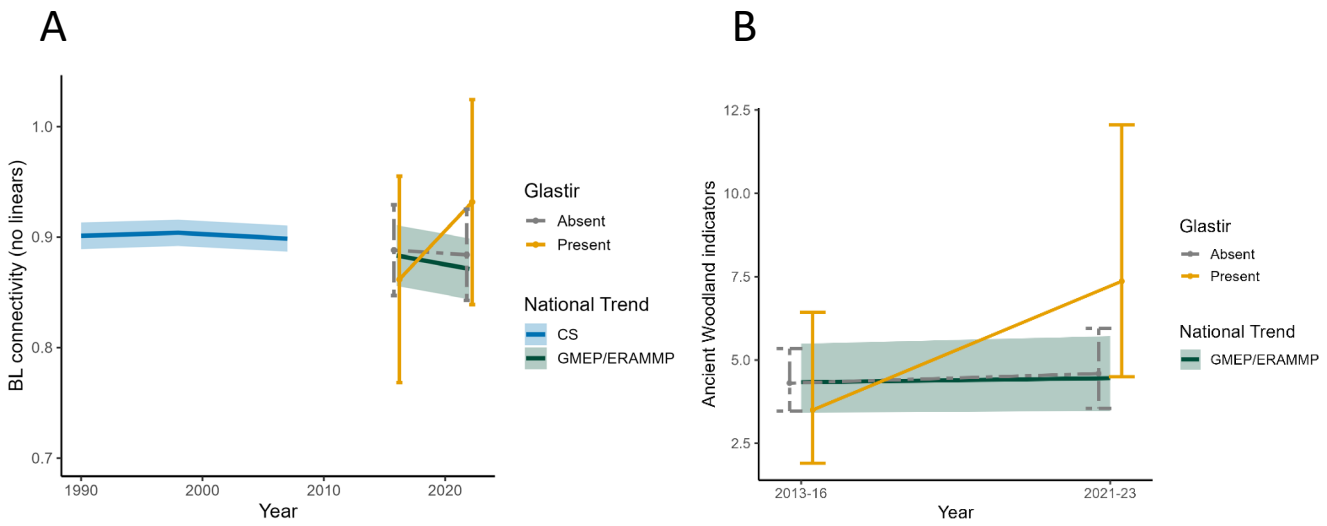

Figure 3-5 Trend in A) Broadleaved connectivity between 2013-16 and 2021-23 in Broadleaved Mixed and Yew Woodland showing both National Trends and effect of Woodland Creation bundle B) Ancient Woodland Indicator richness between 2013-16 and 2021-23 in Broadleaved Mixed and Yew Woodland showing effect of Woodland Management bundle.

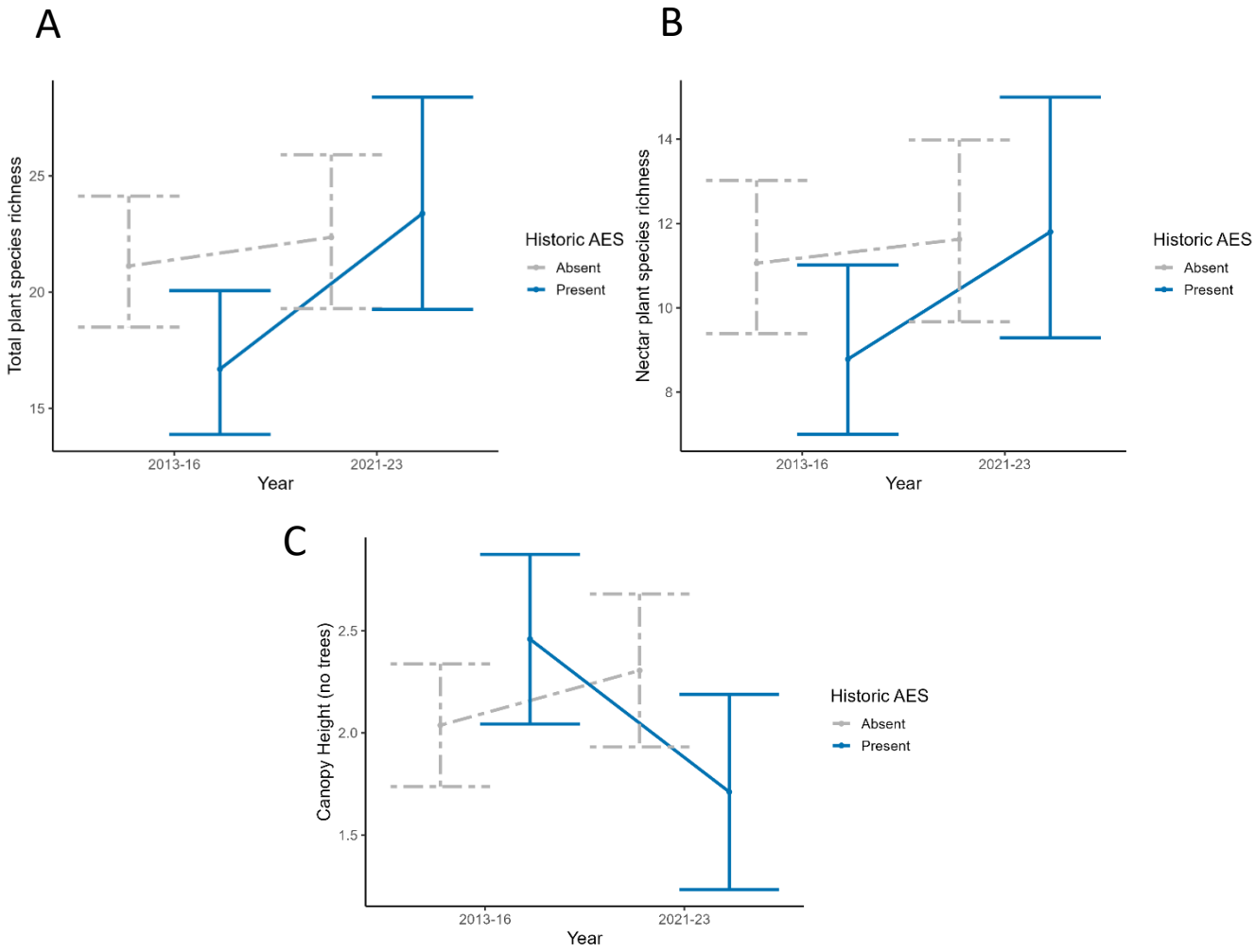

Figure 3-6 Trend in A) Total plant species richness between 2013-16 and 2021-23 in Broadleaved Mixed and Yew Woodland showing both National Trends and Historic AES bundle B) Canopy height between 2013-16 and 2021-23 in Broadleaved Mixed and Yew Woodland showing effect of Historic AES C) Nectar plant species richness.

3.2 Coniferous Woodland

3.2.1 National Trend

3.2.1.1 Positive Outcomes

- Total plant species richness and Ancient Woodland indicator species have remained stable.

3.2.1.2 Areas for Concern / Need for Further Action

- There has been an increase in the cover of plants favouring high nutrient status i.e. Ellenberg fertility scores in the short term.

3.2.1.3 Complex signal needing further analysis

- There has been no significant change in the cover weighted canopy height of the ground flora.

*Table 3-4 **National Trend** analysis for Biodiversity indicators for **Coniferous Woodland in Large plots** (X) Mean, mean change (Trend *-*) and p-values extracted from models for periods 1990-2007, 2013-16 and 2021-23.*

	Indicator	1990	1998	2007	Trend 1990-2007	P value	Indicator	2016	2022	Trend 2016-2022	P value
Coniferous Woodland	Ellenberg fertility	3.4	3.58	3.75	0.35	0.11	Ellenberg fertility	3.67	3.87	0.19	0.05
	Total species richness	7.92	11.28	9.91	1.99	0.61	Total species richness	12.89	14.1	1.21	0.16
	Canopy height (no trees)	0.84	1.02	0.76	-0.07	0.95	Canopy height (no trees)	0.64	0.77	0.13	0.13
	Ancient Woodland indicator richness	1.76	2.44	1.48	-0.29	0.75	Ancient Woodland indicator richness	2.17	2.56	0.39	0.23

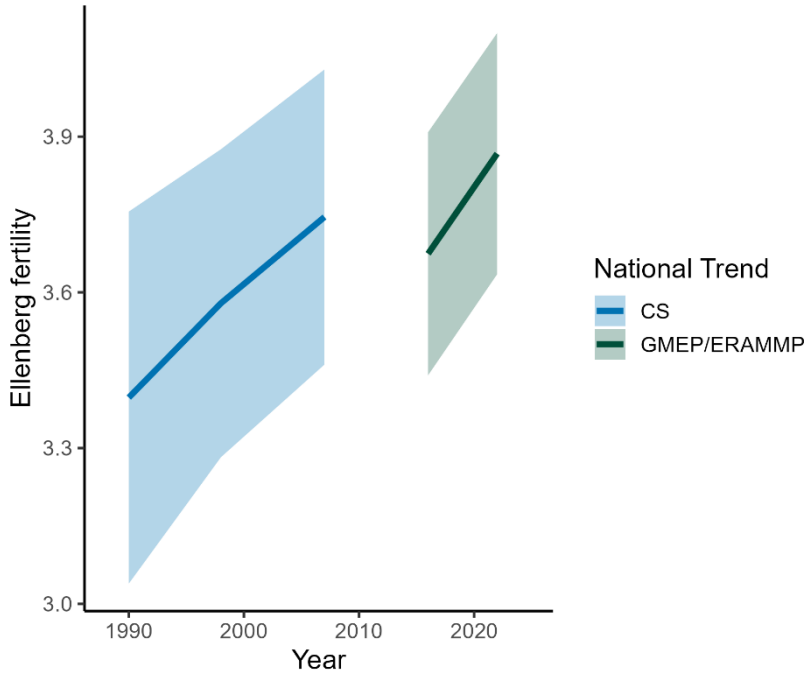

Figure 3-7 Long term national trends in Ellenberg fertility in Coniferous Woodland in Large plots from Countryside Survey squares in Wales 1990 to 2007 and GMEP/ERAMMP (2013 – 16 to 2021 – 2023) from nationally representative survey squares.

3.2.2 Glastir Impact

No overlap with Glastir.

3.3 Dwarf Shrub Heath

3.3.1 National Trend

3.3.1.1 Positive Outcomes

- The cover of Dwarf Shrub Heath shrubs has remained stable (although at a lower level than the trend between 1990 and 2007)
- There has been a recent decrease in plants which favour high nutrient status (i.e. Ellenberg fertility).
- There is a trend for a decreasing number of negative indicator species (not significant)

*Table 3-5 **National Trend** analysis for Biodiversity indicators for **Dwarf Shrub Heath** in 2x2m plots. Mean, mean change and p-values extracted from models for periods 2013-16 and 2021-23.*

	Indicator	1990	1998	2007	Trend 1990-2007	P value	Indicator	2016	2022	Trend 2016-2022	P value
Dwarf Shrub Heath	Ellenberg fertility	2.45	2.39	2.44	-0.01	0.98	Ellenberg fertility	2.72	2.57	-0.16	<0.01
	Ellenberg moisture	6.11	6.08	5.98	-0.14	0.21	Ellenberg moisture	6.06	6.01	-0.05	0.36
	DSH cover (raw)	49.12	50.34	46.75	-2.37	0.93	DSH cover (raw)	35.08	36.72	1.64	0.54
	DSH cover (rescaled)	0.3	0.35	0.34	0.04	0.78	DSH cover (rescaled)	0.3	0.31	0.01	0.84
	CSM positive indicators	2.39	2.98	2.83	0.45	0.58	CSM positive indicators	2.47	2.66	0.2	0.46
	Negative indicators	1.48	1.77	1.77	0.29	0.66	Negative indicators	2.37	1.97	-0.4	0.09

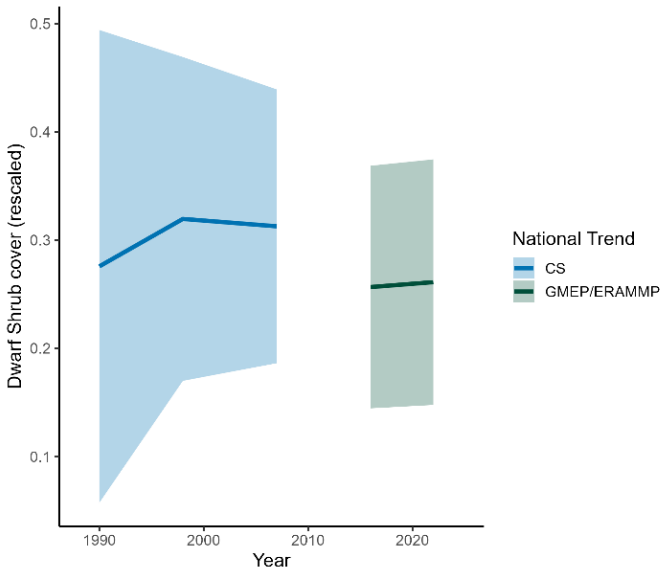

Figure 3-8 Long term national trends in Dwarf Shrub cover (rescaled from 0 to 1) in Dwarf Shrub Heath from Countryside Survey squares in Wales 1990 to 2007 and GMEP/ERAMMP (2013 – 16 to 2021 – 2023) from nationally representative survey squares.

3.3.2 Glastir Impact

3.3.2.1 Positive Outcomes

- None reported.

3.3.2.2 Outcomes not as intended, trade-offs and contextual dependencies

- There are no significant changes in the Vegetation indicators with Glastir although there was an almost significant increase in positive plant indicators with commons management (p=0.07).

3.3.2.3 Status of land coming into scheme and status of land where bundles / options are present

- Land under Grazing Lo/No Input options tends to have lower positive plant indicator species, higher negative indicators and an initially higher Ellenberg fertility suggesting payments have been targeted at habitat with poorer Vegetation condition.
- There is no significant effect from Glastir or historic AES schemes on Ellenberg values.
- There are no significant changes in the cover of Dwarf Shrub Heath shrubs with Glastir
- There is an almost significant increase in positive plant indicators with common management

*Table 3-6 **National Trend** analysis for Biodiversity indicators for **Dwarf Shrub Heath in 2m x 2m plots.** Mean, mean change and p-values extracted from models for periods 1990-2007, 2013-16 and 2021-23.*

	Indicator	Trend difference_Hab_Management	P value Hab Management	Trend difference commons	P value commons	Trend difference Grazing input	P value Grazing input	Trend difference historic aes	P value historic_aes
Dwarf Shrub Heath	Ellenberg fertility	0.04	0.64	-0.05	0.56	-0.15	0.14	0.06	0.44
	Ellenberg moisture	-0.1	0.17	-0.1	0.16	-0.09	0.3	-0.04	0.62
	DSH cover (rescaled 0 to 1)	-0.07	0.14	0.07	0.13	0.02	0.78	-0.03	0.51
	CSM positive indicators	-0.46	0.27	0.75	0.07	0.33	0.59	-0.17	0.75
	Negative indicators	0.53	0.09	0.21	0.54	-0.53	0.24	-0.15	0.65

3.3.2.4 Land under Grazing input bundle

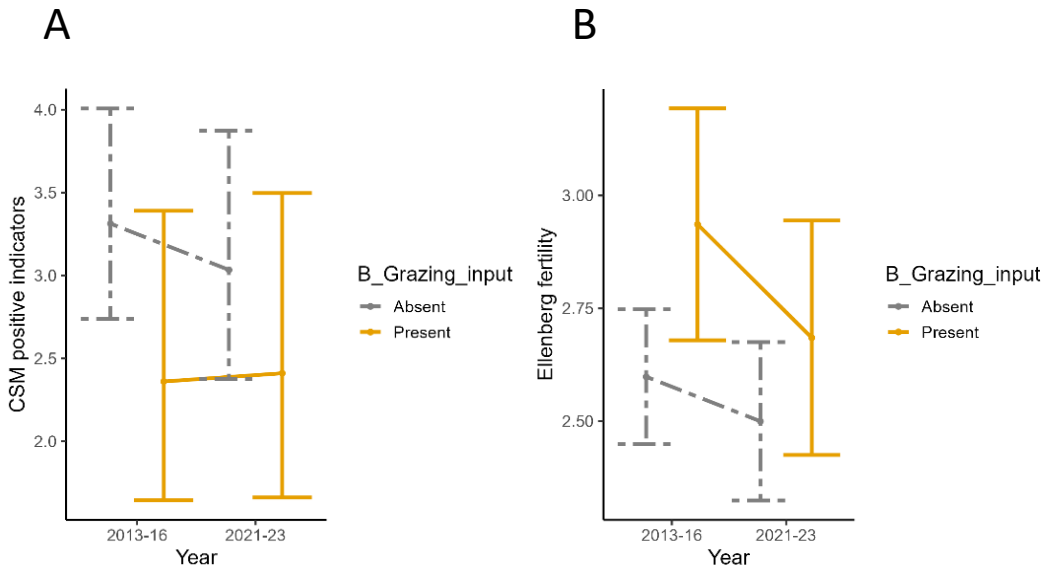

Figure 3-9 Trends in A) CSM positive indicators, B) Ellenberg fertility between 2013-16 and 2021-23 in Dwarf Shrub Heath showing effect of where Grazing Inputs are present or absent.

3.3.2.5 Positive indicators

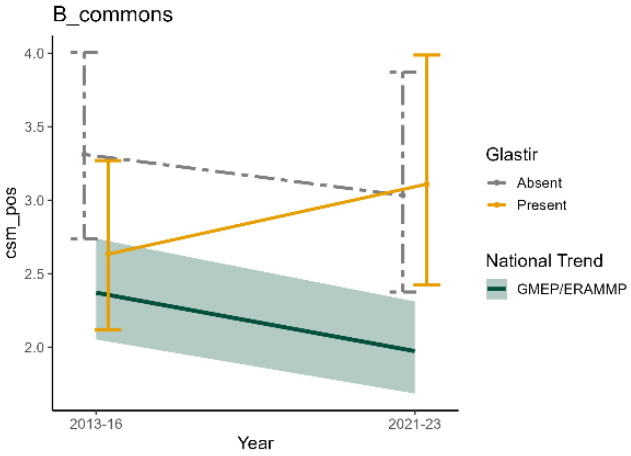

Figure 3-10 Trend in positive indicators between 2013-16 and 2021-23 in Dwarf Shrub Heath where Glastir Option is Commons management

3.4 Bog

3.4.1 National Trend

3.4.1.1 Positive Outcomes

- Most plant condition indicators for Bogs remained stable with one critical exception of Sphagnum cover.

3.4.1.2 Areas for Concern / Need for Further Action

- There has been a recent significant decline of 10% in *Sphagnum* cover in Bog between 2013-16 and 2021-23 by approx. 10%. This downwards trend returns to levels shown in the longer term Countryside Surveys.
- There was no significant change in ellenberg moisture score.
- There was no change in positive indicators.
- Blanket bogs in GMEP/ERAMMP had higher moisture scores, sphagnum cover and positive indicators than CS.

*Table 3-7 **National Trend** analysis for Biodiversity indicators for **Bog** in 2m x 2m plots. Mean, mean change and p-values were extracted from models for periods 1990-2007, 2013-16 and 2021-23.*

	Indicator	1990	1998	2007	Trend 1990-2007	P value	2016	2022	Trend 2016-2022	P value
Bog	Ellenberg fertility	2.2	2.06	2.1	-0.1	0.83	2.07	2.1	0.03	0.44
	Ellenberg moisture	6.93	7.3	7.3	0.36	0.07	7.2	7.19	0	0.96
	Sphagnum cover (rescaled)	0.35	0.23	0.4	0.05	0.91	0.18	0.12	-0.05	<0.01
	Sphagnum cover (raw)	22.22	21.41	26.33	4.1	0.92	32.55	22.98	-9.57	<0.01
	Dwarf Shrub cover (rescaled)	0.08	0.16	0.17	0.09	0.08	0.11	0.12	0.01	0.62
	Positive indicators	2.8	3.08	2.42	-0.38	0.78	3.53	3.17	-0.36	0.22
	Negative indicators	0.52	0.32	0.36	-0.16	0.73	0.16	0.17	0.01	0.85

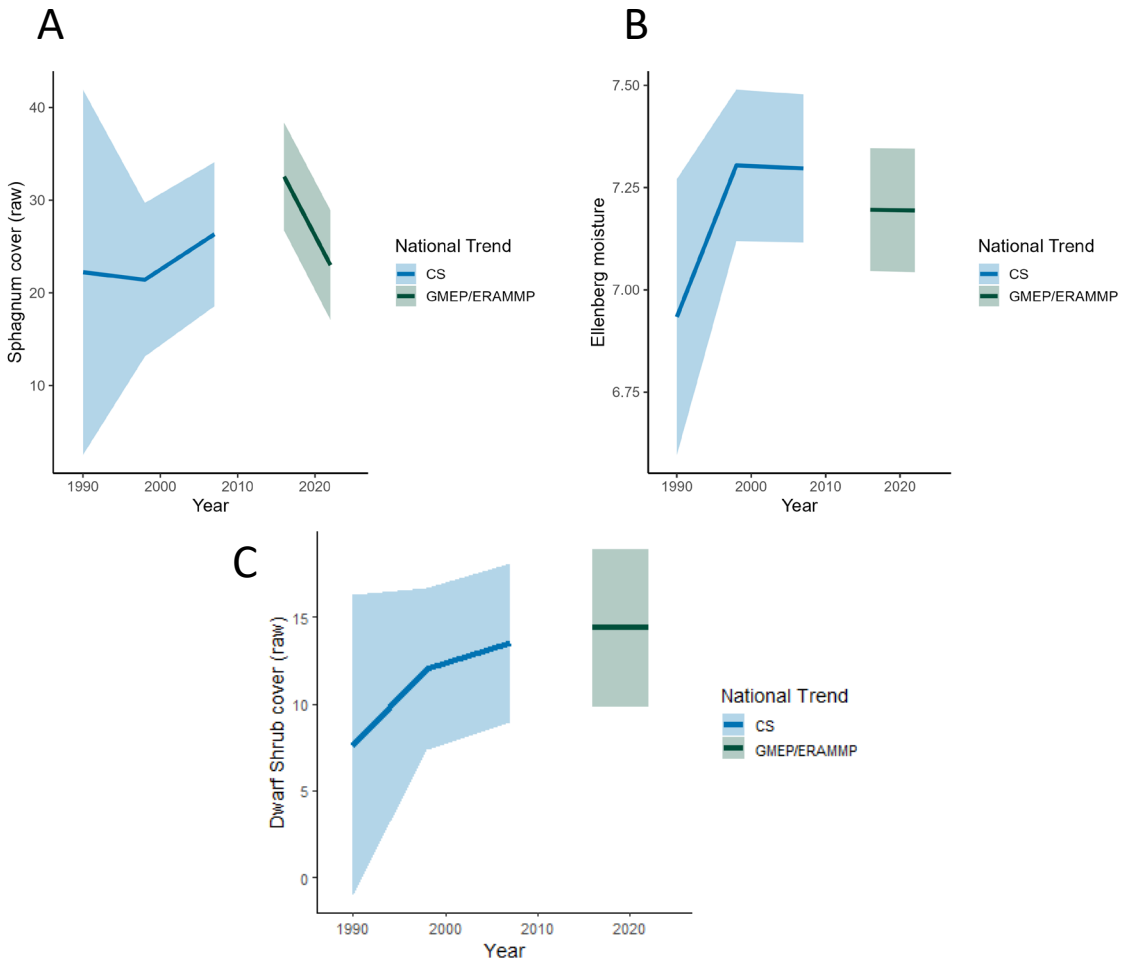

Figure 3-11 Long term national trends in A) Sphagnum cover, B) Ellenberg moisture and C) Dwarf Shrub cover in Bog from Countryside Survey squares in Wales 1990 to 2007 and GMEP/ERAMMP (2013 – 16 to 2021 – 2023) from nationally representative survey squares.

3.4.2 Glastir Impact

There were some positive outcomes for Vegetation, with the Habitat management bundle Ellenberg fertility decreased and Ellenberg moisture increased non-significantly (p=0.06).

3.4.2.1 Positive Outcomes

- Ellenberg fertility decreased in parcels subject to Habitat management ($p<0.01$).
- Ellenberg moisture showed an almost significant increase (p=0.06).
- An increase in Sphagnum cover with commons management was nearly significant (p=0.07).

3.4.2.2 Outcomes not as intended, trade-offs and contextual dependencies

- There were no reported positive outcomes for other plant indicators in the Habitat Management Commons or Grazing Lo/No Input Management bundles.

3.4.2.3 Status of land coming into scheme and status of land where bundles / options are present

- Land under Grazing Lo/No Input options tends to have higher negative indicators and an initially higher Ellenberg fertility and land under commons management has fewer positive indicators suggesting payments have been targeted at habitat with poorer Vegetation condition.

*Table 3-8 **Glastir analysis** for Biodiversity indicators for **Bog**. Glastir management bundles assessed for effects on Biodiversity indictors are shown, but greyed out where data did not allow for analysis. Context effect was tested using information related to participation in historic agri-environment schemes.*

Habitat	Indicator	Habitat Management-General		Commons		Grazing Input Management		Context: Historic AES	
		Glastir effect	P value	Glastir effect	P value	Glastir effect	P value	Glastir effect	P value
Bog	Ellenberg fertility	-0.18	0.01	0.05	0.53	0.13	0.19	0.1	0.13
	Ellenberg moisture	0.15	0.06	-0.03	0.78	0.07	0.51	-0.14	0.07
	Sphagnum cover (rescaled)	-0.04	0.23	0.07	0.07	0.06	0.13	0.03	0.35
	Sphagnum cover (raw)	-6.24	0.32	12.84	0.1	8.38	0.38	2.87	0.65
	Dwarf Shrub cover (rescaled)	0	0.74	0.05	0.46	0.09	0.21	0.02	0.92
	Dwarf Shrub cover	1.25	0.73	3.75	0.41	3.14	0.55	-0.27	0.94
	Positive indicators	0.43	0.27	0.95	0.13	-1	0.13	-0.04	0.95
	Negative indicators	-0.11	0.22	0.03	0.58	-0.09	0.93	0.07	0.43

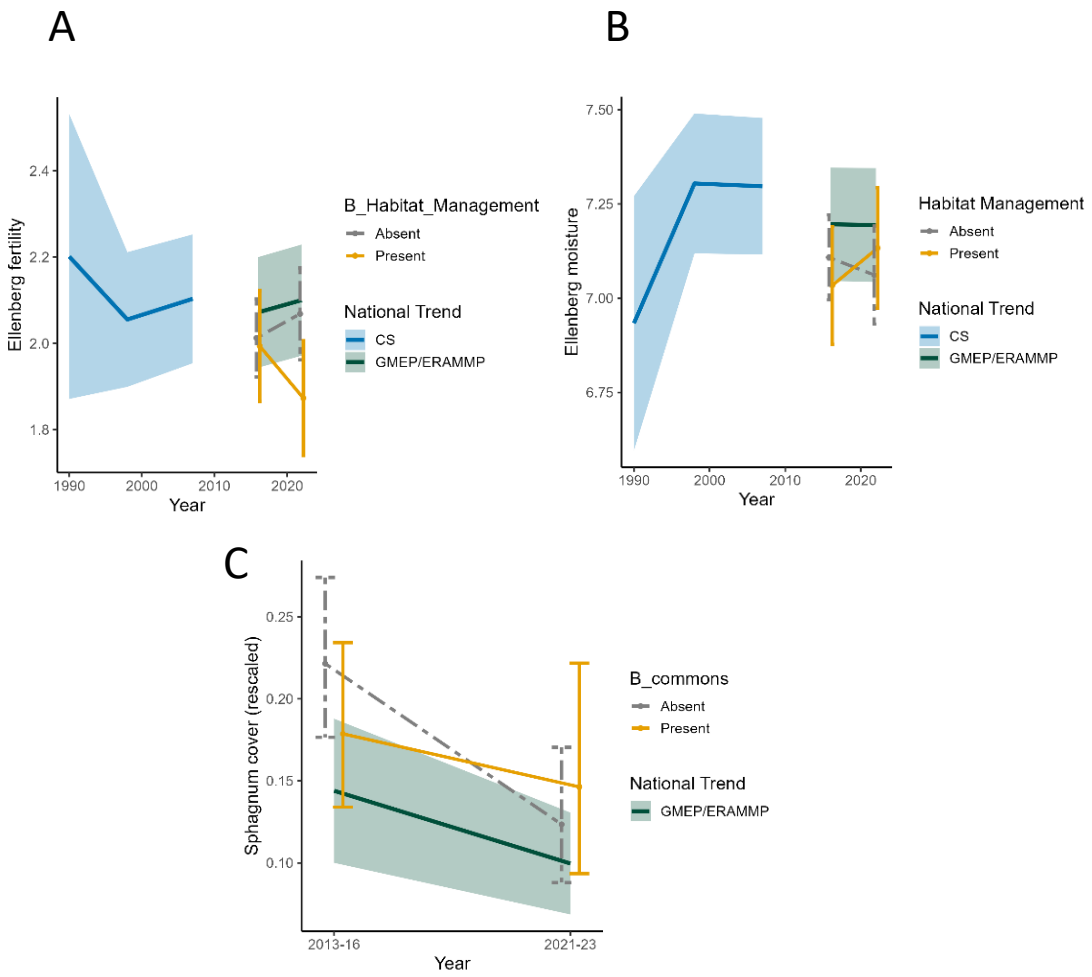

Figure 3-5 Trends between 1990 and 2021-23 in Bog showing both National Trends and effect of Glastir A in Ellenberg fertility and Habitat Management B Ellenberg moisture and Habitat management (not significant) and C Sphagnum cover (rescaled to between 0 and 1) and Commons.

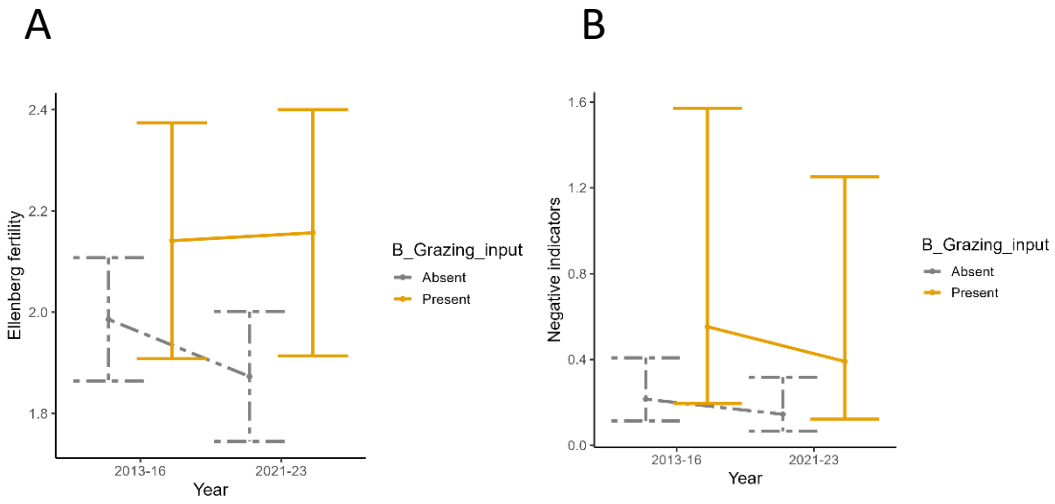

Figure 3-6 Trends between 2016 and 2021-23 in Bog showing the effects of Glastir grazing inputs. These are not significant but demonstrate the differences in values of land in and out of scheme A *Ellenberg fertility*, B Negative indicators..

3.5 Blanket Bog

3.5.1 National Trend

3.5.1.1 Positive Outcomes

- Most plant indicators remained stable (with the exception of *Sphagnum cover*).

3.5.1.2 Areas for Concern / Need for Further Action

- *Sphagnum* cover has significantly decreased by approx. 10% between 2013-16 and 2021-23. This downwards trend returns to levels shown in the longer term Countryside Survey. There is very high uncertainty in the Blanket Bog results probably due to low sample size (see supplement).

*Table 3-9 **National Trend** analysis for Biodiversity indicators for Blanket **Bog** in 2m x 2m plots. Mean, mean change and p-values were extracted from models for periods 1990-2007, 2013-16 and 2021-23.*

	Indicator	1990	1998	2007	Trend 1990-2007	P value	2016	2022	Trend 2016-2022	P value
Blanket bog	Ellenberg fertility	NA	2.13	2.13	0	1	2.02	2.05	0.03	0.48
	Ellenberg moisture	NA	6.9	6.9	0	0.97	7.21	7.19	-0.02	0.67
	Sphagnum cover (rescaled)	NA	0.22	0.22	0	0.97	0.17	0.12	-0.05	<0.01
	Sphagnum cover (raw)	NA	16.31	11.73	-4.58	0.4	32.81	21.71	-11.1	<0.01
	Dwarf Shrub cover (rescaled)	NA	0.2	0.34	0.14	0.13	0.13	0.14	0.01	0.59
	Positive indicators	NA	1.98	2.48	0.51	0.32	3.63	3.26	-0.37	0.3
	Negative indicators	NA	0.33	0.48	0.14	0.5	0.14	0.2	0.06	0.37

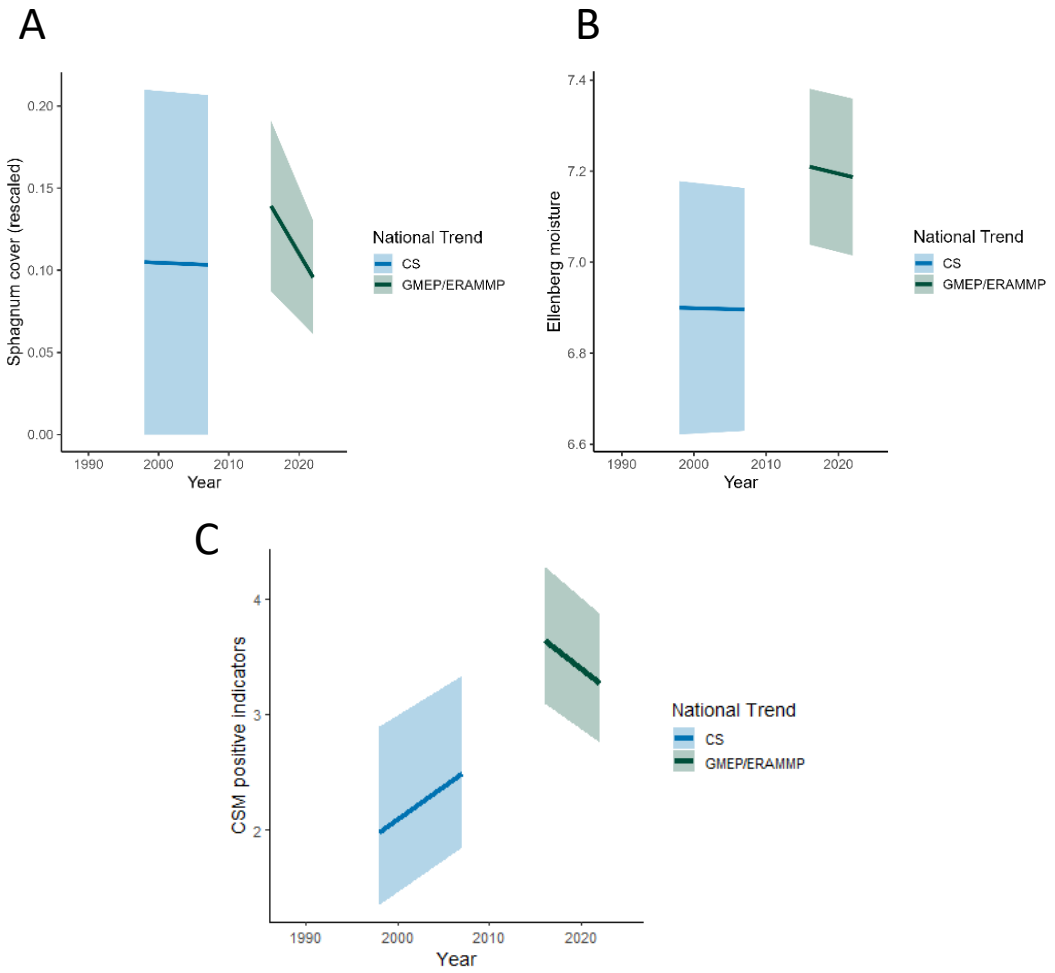

Figure 3-14 Long term National Trends in plants in Blanket Bog between 1998-2007, 2013-16 and 2021-23 for A) Sphagnum *cover, B) plants favouring high moisture conditions (i.e. Ellenberg moisture score), C) positive plant indicator (CSM) richness from Countryside Survey squares in Wales 1990 to 2007 and GMEP/ERAMMP (2013 – 16 to 2021 – 2023) from Nationally Representative squares.*

3.5.2 Glastir Analysis Impact

There were some significant effects of Glastir on condition indicators, i.e. Ellenberg fertility decreased with habitat management and positive and negative indicators, *Sphagnum* and DSH cover improved with commons management possibly assocaited withreduced stocking.

3.5.2.1 Positive Outcomes

- Ellenberg fertility decreased with Habitat management.
- There were several positive outcomes on land under commons management. *Sphagnum* cover, DSH cover and positive plant indicators increased with the commons bundle.

3.5.2.2 Outcomes not as intended, trade-offs and contextual dependencies

- There were no significant effects of change with the Glastir habitat management bundle on Blanket Bog for CSM positive indicators, moisture levels, sphagnum cover despite there being some re-wetting and habitat specific management..

3.5.2.3 Status of land coming into scheme and status of land where bundles / options are present

- Land under Grazing Low/No Input options tends to have higher negative indicators and an initially higher Ellenberg fertility, lower DSH cover and land under commons management has lower DSH cover suggesting payments have been targeted at habitat with poorer Vegetation condition. The Habitats management bundle had higher DSH cover.

Table 3-5 Statistics for analysis of the conditional effect of coincidence with Glastir options and historic AES schemes on indicator variables across Wales between 2013-16 and 2021-23.

Habitat	Indicator	Habitat Management-General		Commons		Grazing Input Management		Context: Historic AES	
		Glastir effect	P value	Glastir effect	P value	Glastir effect	P value	Glastir effect	P value
Blanket Bog	EBERGN	-0.22	0.01	-0.09	0.52	0.2	0.13	0.06	0.49
	EBERGW	0.15	0.15	-0.07	0.68	0.02	0.91	-0.08	0.39
	Sphagnum cover (rescaled)	-0.02	0.65	0.09	0.03	0.07	0.2	0	0.93
	Sphagnum cover (raw)	-3.63	0.6	22.92	0.01	8.08	0.46	0.01	1
	DSH cover (rescaled)	-0.01	0.96	0.19	0.03	0.12	0.29	0.03	0.98
	Positive indicators	0.76	0.11	1.72	0.01	-0.88	0.17	-0.09	0.85
	Negative indicators	-0.16	0.08	-0.07	0.61	0.14	0.88	0.07	0.33

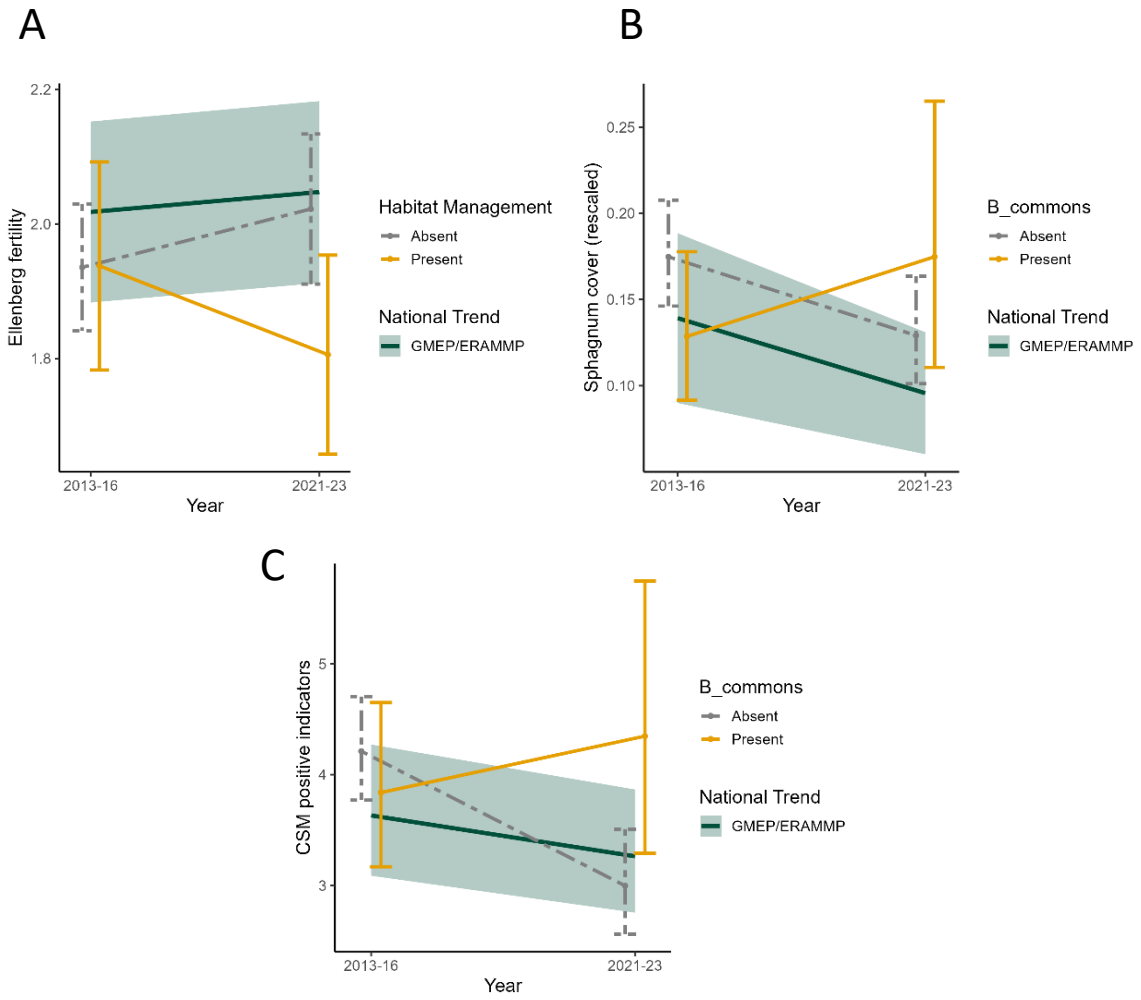

Figure 3-15 Trends between 2013-16 and 2021-23 in Blanket Bog showing both National Trends and effect of A. Ellenberg fertility and the Habitat management bundles B Sphagnum *cover (rescaled from 0 to 1) and C Positive plant indicators with the commons bundle.*

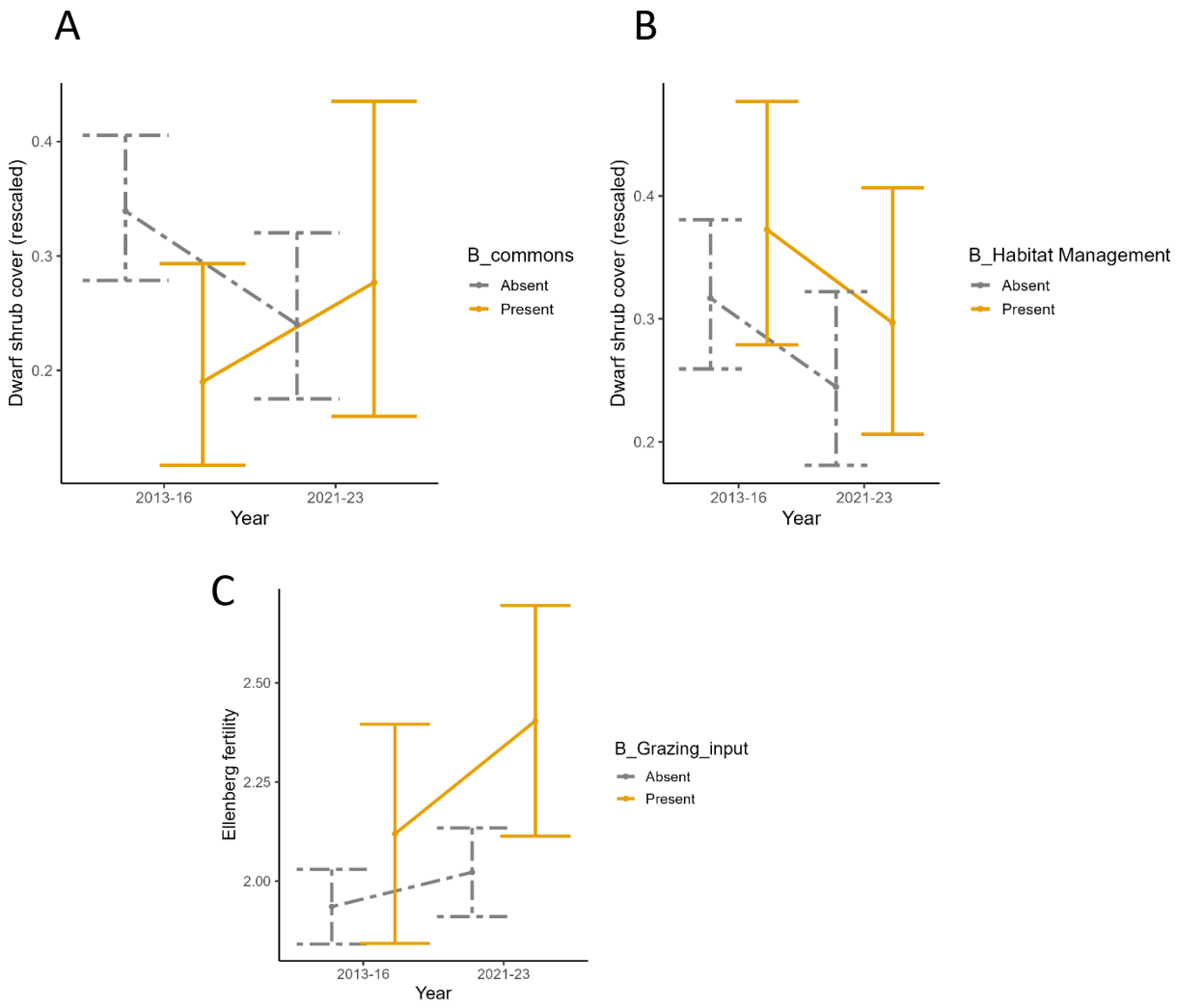

Figure 3-7 Trends between 2013-16 and 2021-23 in Blanket Bog showing that although there are no significant effects there are differences in the values of indicators in and out of scheme in A. Dwarf Shrub cover (rescaled from 0 to 1) with the commons bundle B Dwarf Shrub cover (rescaled from 0 to 1) with the Habitat management bundle C Ellenberg fertility with the Grazing inputs bundle

3.6 Bracken

3.6.1 National Trend

Bracken results in CS Wales were based only on analysis of large X plots

- The trend in total species richness remained stable
- There was no significant trend in Ellenberg fertility
- There was no significant trend in Grass: Forb ratio

*Table 3-6 **National Trend** analysis for Biodiversity indicators for Bracken in 2m x 2m plots. Mean, mean change and p-values were extracted from models for periods 1990-2007, 2013-16 and 2021-23.*

	Indicator	1990	1998	2007	Trend 1990-2007	P value	Indicator	2016	2022	Trend 2016-2022	P value
Bracken	Ellenberg fertility	3.64	3.39	3.72	0.08	0.88	Ellenberg fertility	4.21	4.17	-0.03	0.67
	Grass Forb ratio	1.03	1.7	1.22	0.2	0.61	Grass Forb ratio	1.13	1.35	0.22	0.31
	Total species richness	9.5	8.11	7.77	-1.72	0.19	Total species richness	7.89	7.92	0.02	0.96

3.6.2 Glastir Impact

For Vegetation, the Glastir effect was assessed using the Grazing Low/No Input bundle. Habitat management was divided into Habitat Management (General) (reduced stocking, bracken control) and Habitat Management (Other) grazing management and habitat specific management.

Grazing Low/No Input management was found to increase total plant species richness. Grass:Forb ratio increased with habitat management.

3.6.2.1 Positive Outcomes

- Grazing Low/No Input Management increased plant total species richness.

3.6.2.2 Outcomes not as intended, trade-offs and contextual dependencies

- There was a significant increase in Grass: Forb ratio with Habitat management and a near significant increase with reduction in Grazing Low/No Inputs (p=0.06)..
- There was a decline in species richness with historic AES.

Table 3-12 Statistics for analysis of the conditional effect of coincidence with Glastir options and historic AES schemes on indicator variables in Bracken across Wales between 2013-16 and 2021-23.

Indicator	Trend. difference B_Habitat. Management.	P.value B_Habitat. Management.	Trend. difference B_Habitat. Management. Other	P.value B_Habitat. Management. Other	Trend. difference_B _commons	P.value_B_c ommons	Trend. difference B_Grazing.I nputs	P.value B_Grazing. Inputs	Trend. difference historic_aes	P.value_ historic_ aes
EBERGN	-0.02	0.92	-0.23	0.13	-0.23	0.13	-0.19	0.26	-0.25	0.08
G_F_ratio	0.76	0.04	0.44	0.26	0.44	0.26	0.75	0.06	-0.38	0.27
tot_rich_yr	0.94	0.26	-0.52	0.58	-0.52	0.58	2.04	0.04	-1.61	0.05

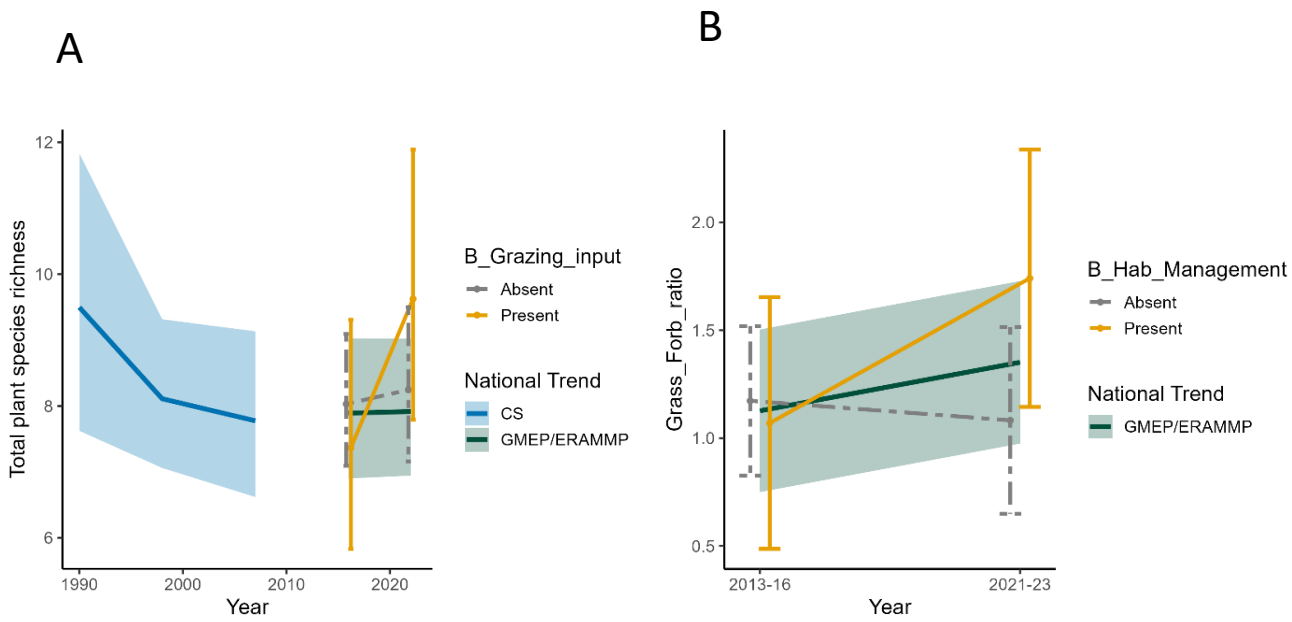

Figure 3-8 Trend in A total plant species richness between 2013-16 and 2021-23 in Bracken showing both National Trends and effect of Grazing Lo/No Inputs management bundle and B Grass forb ratio with habitat Management bundle.

3.7 Montane

Insufficient data for robust analysis of the Montane broad habitat.

3.8 Fen, Marsh, Swamp

3.8.1 National Trend

3.8.1.1 Positive Outcomes

- Plants which favour high nutrient status (i.e. Ellenberg fertility score) have remained stable as have positive plant species indicators.

3.8.1.2 Areas for Concern / Need for Further Action

- There has been a significant decrease in total plant species richness.
- There has been an increase in Grass: Forb ratio which is a negative indicator of condition (signalling the increase of grasses at the expense of flowering plants), but it was at a lower level than in the long term survey.
- There has been a decrease in plant Ellenberg moisture score, however, the starting value was higher than the long term survey.

*Table 3-13 **National Trend** analysis for Biodiversity indicators for Fen, Marsh & Swamp in 2m x 2m plots. Mean, mean change and p-values were extracted from models for periods 1990-2007, 2013-16 and 2021-23.*

	Indicator	1990	1998	2007	Trend 1990-2007	P value	Indicator	2016	2022	Trend 2016-2022	P value
Fen, Marsh, Swamp	Ellenberg fertility	3.78	3.81	3.95	0.17	0.21	Ellenberg fertility	3.98	4.02	0.04	0.25
	Ellenberg moisture	6.88	6.96	6.95	0.06	0.79	Ellenberg moisture	7.14	7.04	-0.1	0.01
	Total species richness	13.91	12.87	12.16	-1.76	0.18	Total species richness	13.44	12.43	-1.01	0.02
	Grass forb_ratio	1	1.28	1.1	0.1	0.94	Grass forb_ratio	0.14	0.78	0.63	<0.01
	CSM positive indicators	8.4	8.48	7.97	-0.43	0.79	CSM positive indicators	9.29	8.78	-0.52	0.17

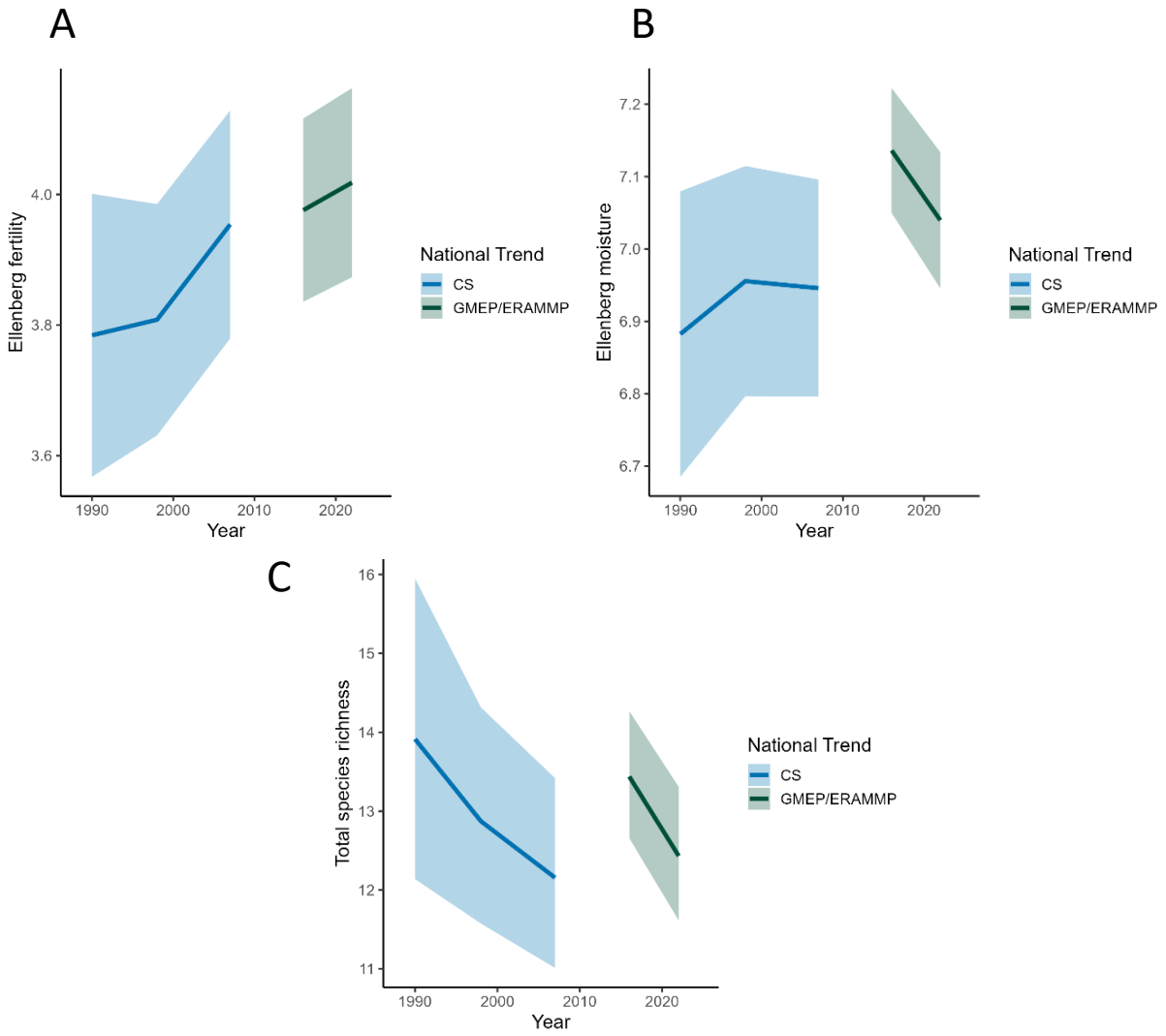

Figure 3-9 Long term national trends in A) Ellenberg fertility, B) Ellenberg moisture and C) Total species richness in Fen, Marsh, Swamp from Countryside Survey squares in Wales 1990 to 2007 and GMEP/ERAMMP (2013 – 16 to 2021 – 2023) from nationally representative survey squares.

3.8.2 Glastir Impact

3.8.2.1 Positive Outcomes

- There was a near significant decrease in Grass: Forb ratio (a negative condition indicator) with Grazing Low/No Inputs management that could be an early signal of an improvement in Vegetation condition.

3.8.2.2 Outcomes not as intended, trade-offs and contextual dependencies

- Plants which favoured high nutrient conditions (i.e. Ellenberg fertility score) increased under Habitat management although fertility was lower in land in scheme than wider Wales. Ellenberg moisture was also higher in land under habitat management so targeting appears to have been towards higher quality land.
- There was no impact of Organic management on Vegetation condition.
- There were increases in the Grass: Forb ratio (a negative indicator) with Commons management.

Table 3-7 Statistics for analysis of the conditional effect of coincidence with Glastir options and historic AES schemes on indicator variables in Fen, Marsh & Swamp across Wales between 2013-16 and 2021-23.

		Indicator	Trend difference Habitat Management	P value Hab Management	Trend. difference commons	P.value commons	Trend difference Grazing_ input	P.value Grazing_ input	Trend difference_ Organic	P.value B_Organic	Trend difference_ historic_aes	Pvalue Historic aes
Fen, Marsh, Swamp		Ellenberg fertility	0.14	0.05	-0.17	0.15	-0.13	0.11	-0.07	0.59	-0.04	0.56
		Ellenberg moisture	-0.01	0.92	0.05	0.69	0.12	0.14	0.04	0.75	0.03	0.69
		Total species richness	0.43	0.71	-0.14	0.82	0.73	0.36	0.17	1	0.64	0.32
		CSM positive indicators	-0.22	0.63	-0.37	0.64	0.91	0.16	0.71	0.53	1.14	0.05
		Grass Forb ratio	0.19	0.43	0.76	0.05	-0.48	0.07	0.49	0.23	0.41	0.06

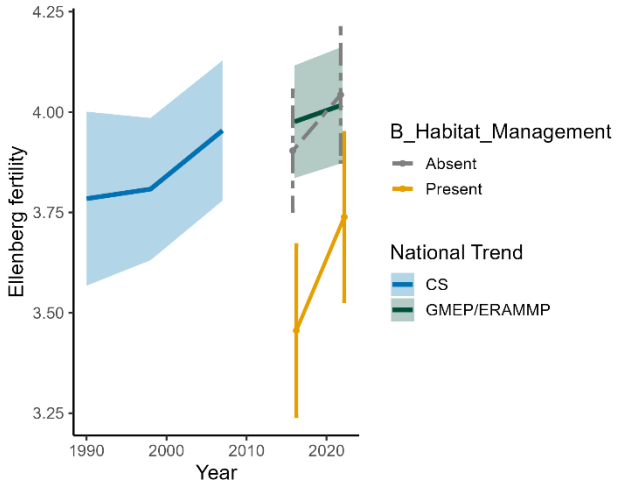

Figure 3-10 Trend in Ellenberg fertility between 2013-16 and 2021-23 in Fen, Marsh, Swamp where Glastir Option Habitat Management present or absent.

3.9 Purple Moor Grass and Rush Pasture

3.9.1 National trend

There are early indicators of a decline in condition of this habitat after a period of stability. This is indicated by an increase in the Grass: Forb ratio (a negative indicator) and a decline in plants which favour high moisture status (i.e. Ellenberg moisture scores).

3.9.1.1 Positive Outcomes

- The total species richness, number of positive indicators and number of plants which favour high nutrient status have remained stable.

3.9.1.2 Areas for Concern / Need for Further Action

- Plant Ellenberg moisture scores have decreased which is a negative indicator for this wet habitat.
- The plant Grass: Forb ratio has increased which is a negative indicator of Vegetation condition.

*Table 3-8 **National Trend** analysis for Biodiversity indicators for Purple Moor Grass and Rush Pasture in 2m x 2m plots. Mean, mean change and p-values were extracted from models for periods 1990-2007, 2013-16 and 2021-23.*

	Indicator	1998	2007	Trend 1998-2007	P value	Indicator	2016	2022	Trend 2016-2022	P value
Purple Moor Grass Rush Pasture	Ellenberg fertility	3.56	3.89	0.33	0.11	Ellenberg fertility	3.91	3.88	-0.03	0.56
	Ellenberg moisture	6.79	6.85	0.06	0.64	Ellenberg moisture	7.1	7	-0.11	0.01
	Total species richness	14.37	13.25	-1.12	0.58	Total species richness	14.86	13.98	-0.89	0.12
	Grass forb_ratio	1.8	1.45	-0.35	0.48	Grass forb_ratio	0.24	0.99	0.75	<0.01
	CSM positive indicators	3.36	2.82	-0.54	0.56	CSM positive indicators	3.36	3.29	-0.07	0.79

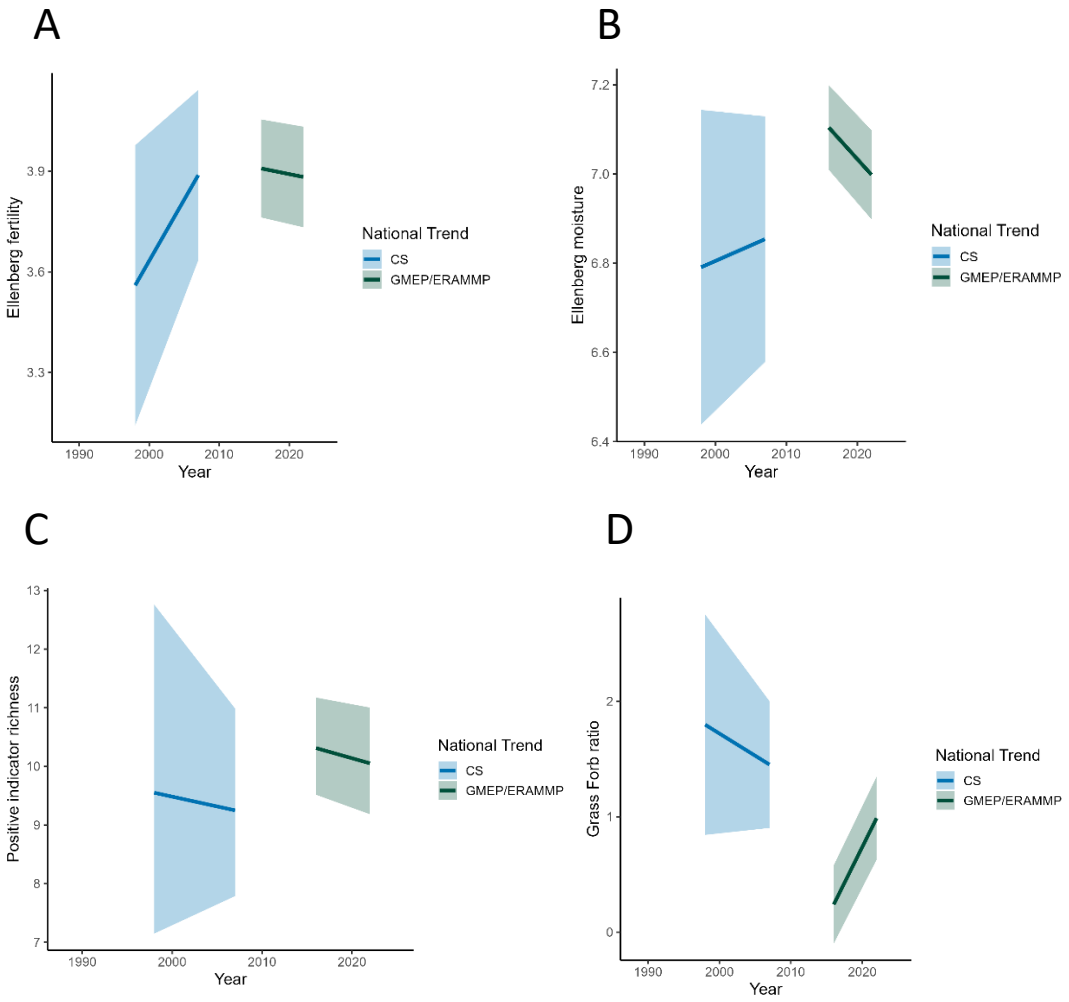

Figure 3-11 Long term national trends in A) Ellenberg fertility,B) Ellenberg Moisture Score C) positive indicator richness and D)Total species richness in Purple Moor Grass and Rush Pasture from Countryside Survey squares in Wales 1990 to 2007 and GMEP/ERAMMP (2013 – 16 to 2021 – 2023) from nationally representative survey squares.

3.9.2 Glastir Impact

There is little evidence Glastir has improved this Priority Habitat with no change in most plant indicators.

3.9.2.1 Positive Outcomes

- None recorded

3.9.2.2 Outcomes not as intended, trade-offs and contextual dependencies

- No improvement in positive Ellenberg indicators, plant indicator richness, species richness or decline in Grass: Forb ratio with Glastir bundles. A nearly significant decrease in positive indicator species with commons management.

Table 3-9 Statistics for analysis of the conditional effect of coincidence with Glastir options and historic AES schemes on indicator variables in Purple Moor Grass and Rush Pasture across Wales between 2013-16 and 2021-23.

	Indicator	Trend. difference Habitat Management	P.value Habitat Management	Trend. difference commons	P.value commons	Trend. Grazing Inputs	P.value Grazing Inputs	Trend. Organic	P value Organic	Trend. Historic aes	P.value Historic aes
PMGRP	Ellenberg fertility	0.02	0.81	-0.29	0.29	-0.02	0.86	-0.31	0.33	-0.05	0.61
	Ellenberg moisture	0.05	0.6	-0.07	0.75	0.06	0.57	-0.19	0.45	0	0.99
	Total species richness	-0.22	0.63	-4.67	0.12	0.33	0.77	1.47	0.61	1.58	0.12
	Positive indicator richness	-0.02	0.85	-2.35	0.09	0.55	0.3	0.01	0.95	0.53	0.24
	Geass Forb ratio	0.21	0.51	0.68	0.36	-0.57	0.09	1.68	0.04	0.05	0.85

3.10 Inland Rock

3.10.1 National Trend

There is a low sample size for this habitat (21 plots in 2021-23) but the data available has identified this habitat is showing a decline in overall plant species richness.

3.10.1.1 Positive Outcomes

- Most plant indicators are stable.

3.10.1.2 Areas for Concern / Need for Further Action

- There has been a recent decline in total plant species richness, with lower values than the long term trend.

*Table 3-10 **National Trend** analysis for Biodiversity indicators for Inland Rock in 2m x 2m plots. Mean, mean change and p-values were extracted from models for periods 1990-2007, 2013-16 and 2021-23.*

	Indicator	1990	1998	2007	Trend 1990-2007	P value	Indicator	2016	2022	Trend 2016-2022	P value
Inland rock	Ellenberg fertility	2.33	3.14	3.22	0.89	0.73	Ellenberg fertility	4.04	3.69	-0.35	0.06
	Ellenberg	2.92	3.86	3.78	0.87	0.79	Ellenberg	4.56	4.58	0.02	0.88
	Total species richness	11.64	9.59	9.46	-2.18	0.92	Total species richness	7.96	5.74	-2.22	0.05

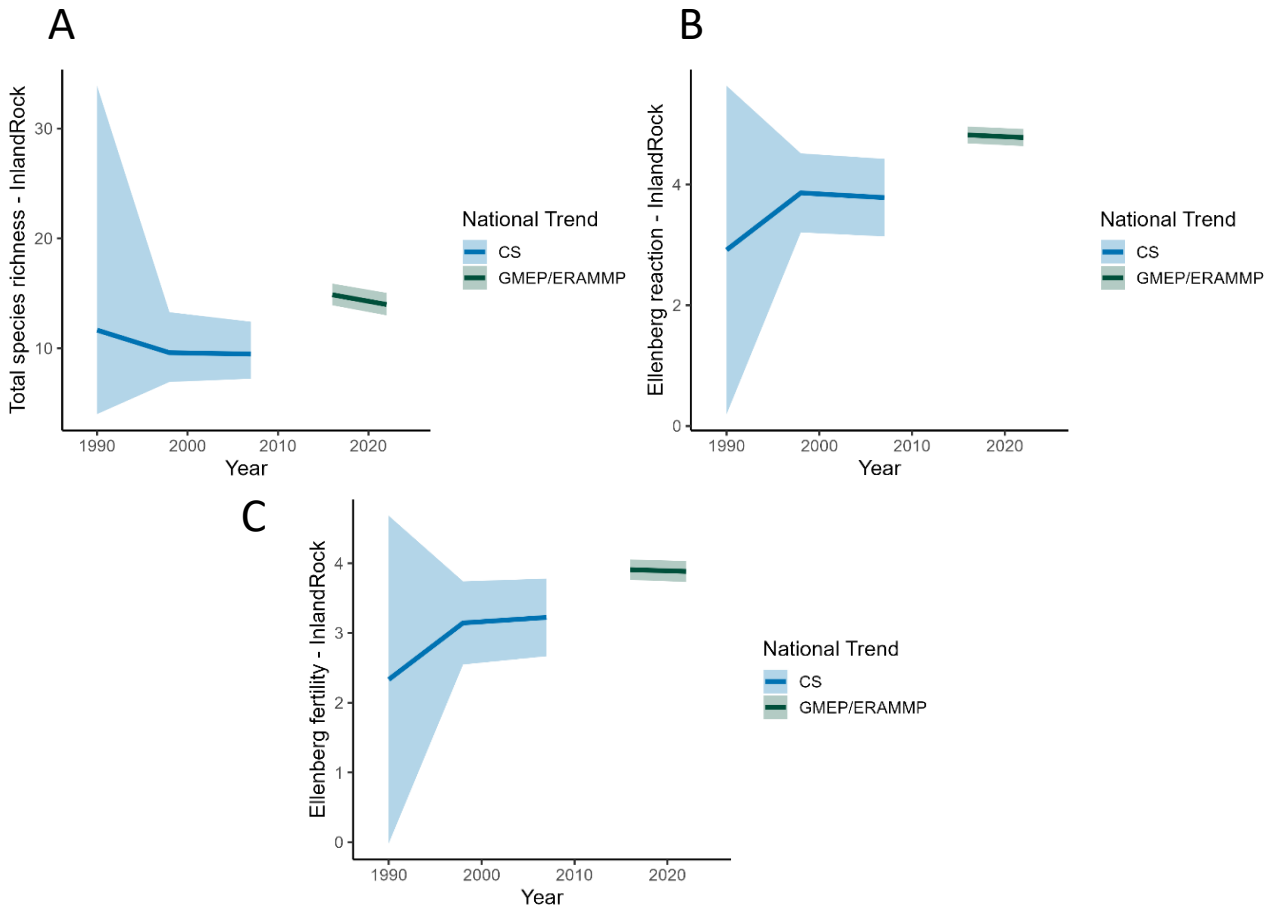

Figure 3-21 Long term national trends in A) Ellenberg reaction, B) Ellenberg fertility and C) Total species richness in Inland Rock from Countryside Survey squares in Wales 1990 to 2007 and GMEP/ERAMMP (2013 – 16 to 2021 – 2023) from nationally representative survey squares.Glastir results

3.10.1.3 Positive Outcomes

- Commons Management resulted in a decline in plants which favour more alkaline conditions i.e. towards acidic species (Ellenberg reaction scores).
- There were no other significant results.

*Table 3-11 **Glastir analysis** for Biodiversity indicators for **Inland rock** Glastir management bundles assessed for effects on Biodiversity indictors are shown, but greyed out where data did not allow for analysis. Context effect was tested using information related to participation in historic agri-environment schemes.*

		Habitat Management		Grazing Input Management		Commons	
	Indicator	Glastir effect	P value	Glastir effect	P value	Glastir effect	P value
Inland rock	Ellenberg fertility	0.02	0.88	-0.04	0.75	-0.27	0.32
	Ellenberg reaction	0.02	0.83	-0.05	0.64	-0.47	0.04
	Total species richness	-0.13	0.82	0.5	0.7	-4.99	0.09

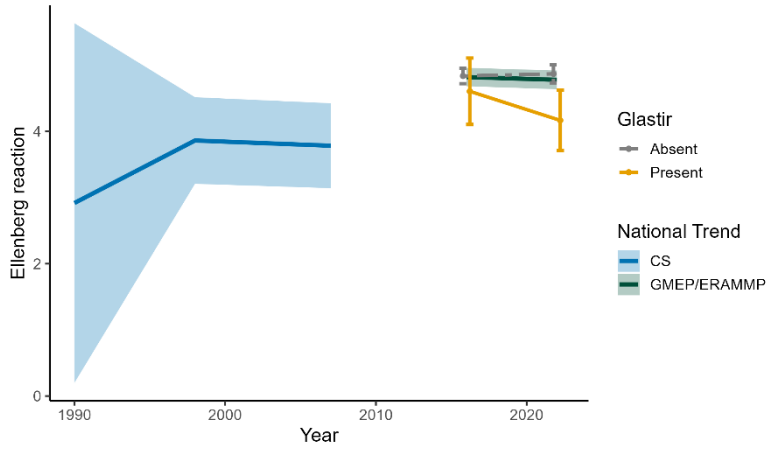

Figure 3-12 Trend in plants which favour more acidic conditions (i.e. Ellenberg R reaction scores) between 2013-16 and 2021-23 in Inland Rock plots showing both national trends and effect of Commons management.

3.11 Unimproved Neutral Grassland (Upland/Lowland Hay Meadow)

Previous work (ERAMMP report 30) determined that the amount of high quality grassland was low in the 2013-16 sample, this represents wider Wales where low quality semi-improved grassland is more abundant. That work identified grassland communities by allocating each plot to an NVC category. Here we identified high quality grassland plots where the surveyors had assigned the sampled location to upland and lowland hay meadow Priority Habitat. The sample size was quite small – 31 plots in 2021-23.

3.11.1 National Trend

3.11.1.1 Positive Outcomes

- Positive and negative Common Standard Monitoring plant species remain stable
- Plants which favour high nutrient status (i.e. Ellenberg fertility scores) and acidic conditions (i.e. Ellenberg reactive scores) have remained stable.

3.11.1.2 Areas for Concern / Need for Further Action

- There has been a decline in total plant species richness.

*Table 3-19 **National Trend** analysis for Biodiversity indicators for Unimproved Neutral Grassland in 2m x 2m plots. Mean, mean change and p-values were extracted from models for periods 1990-2007, 2013-16 and 2021-23.*

	Indicator	2016	2022	Trend 2016-2022	P value
Neutral grassland (PH30 &31)	CSM positive indicator richness	2.23	1.57	-0.67	0.12
	Negative indicators *	6	6.26	0.26	0.71
	Ellenberg fertility	4.36	4.55	0.19	0.22
	Ellenberg reaction	5.63	5.66	0.02	0.73
	All species richness	19.78	16.91	-2.86	0.02

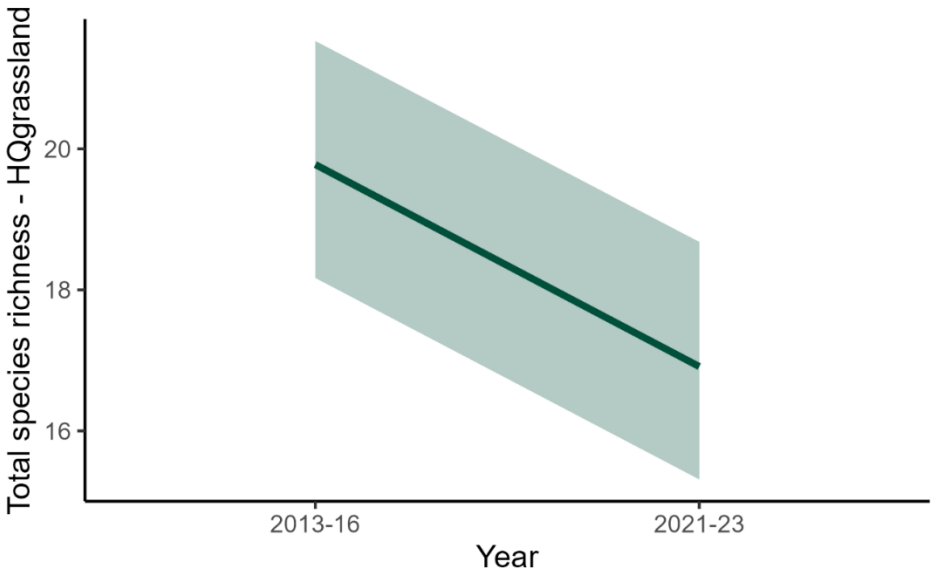

Figure 3-23 Trend between 2013-16 and 2021-23 in total species richness from nationally representative survey squares.

3.11.2 Glastir Impact

The bundles Grazing Lo/No Input management and Habitat management were the main Glastir effect tested here, this was due to low sample size so not many options were represented.

There was an increase in positive plant indicators with Habitat management although it should be noted that initially positive indicators were lower in land under habitat management.

Positive Outcomes

- There was an increase in positive plant indicators with Habitat management

Outcomes not as intended, trade-offs and contextual dependencies

- There were no significant effects for other indicators

*Table 3-20 **Glastir analysis** for Biodiversity indicators for Priority Habitats 30 and 31: Upland and Lowland Hay meadow Neutral grassland. Glastir management bundles assessed for effects on Biodiversity indictors are shown, but greyed out where data did not allow for analysis. Context effect was tested using information related to participation in historic agri-environment schemes.*

		Habitat management		Grazing Input Management		Context: Historic AES	
	Indicator	Glastir effect	P value	Glastir effect	P value	Glastir effect	P value
Neutral grassland (PH30 &31)	Positive indicator richness	2.03	0.03	-0.56	0.75	0.52	0.44
	Negative indicators	-0.16	0.92	1	0.61	-1.16	0.36
	Ellenberg fertility	-0.3	0.38	0.05	0.86	-0.03	0.88
	Ellenberg reaction	0.06	0.66	0.13	0.23	0.03	0.81
	Total species richness	5.4	0.06	0.59	0.76	-1.44	0.51

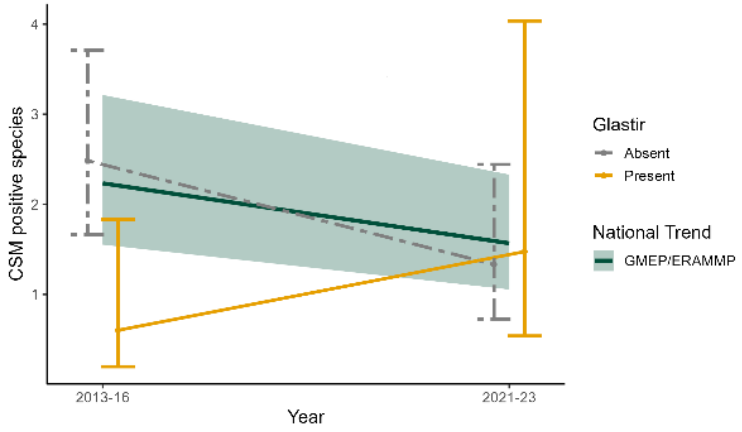

Figure 3-13 Trend in positive plant indicators between 2013-16 and 2021-23 in unimproved neutral grassland plots showing both national trends and effect of Habitat management.

3.12 Calcareous Grassland

Calcareous Grassland is a relatively uncommon habitat in Wales (and in Britain as a whole). Because the habitat type is so scarce and unevenly distributed, it is not well sampled by this survey. Hence, we do not have sufficient Vegetation data to analyse Calcareous Grasslands

3.13 Acid grassland

3.13.1 National Trend

There are early signs of a decline in Acid Grassland after a longer term period of stability with an increase in the Grass: Forb ratio (a negative indicator).

3.13.1.1 Positive Outcomes

- Plant positive indicators are stable.
- There has been a slight reduction in Ellenberg fertility in upland Acid Grassland.
- Although there was no significant trend for Dwarf Shrub cover and Positive indicators the results indicate stability.

3.13.1.2 Areas for Concern / Need for Further Action

- The Grass: Forb ratio has increased which indicates a decline in condition in both Lowland Dry Acid Grassland and Upland Acid Grassland.
- There has been a slight reduction in Ellenberg moisture.

*Table 3-12 **National Trend** analysis for Biodiversity indicators for Unimproved Neutral Grassland in 2m x 2m plots. Mean, mean change and p-values were extracted from models for periods 1990-2007, 2013-16 and 2021-23.*

	Indicator	1990	1998	2007	Trend 1990-2007	P value	Indicator	2016	2022	Trend 2016-2022	P value
Upland Acid grassland	Ellenberg fertility	2.89	2.88	2.94	0.05	0.7	Ellenberg fertility	3.13	3.05	-0.08	0.03
	Ellenberg moisture	6.28	6.32	6.32	0.04	0.74	Ellenberg moisture	6.04	5.99	-0.05	0.04
	Dwarf Shrub cover (rescaled from 0 to 1)	0.05	0.04	0.06	0.01	0.41	Dwarf Shrub cover (rescaled from 0 to 1)	0.07	0.08	0.01	0.6
	Grass Forb ratio	2.43	2.69	2.46	0.03	0.98	Grass Forb ratio	2.1	2.4	0.3	<0.01
	CSM positive indicator richness	0.83	0.94	0.93	0.1	0.79	CSM positive indicator richness	0.86	0.9	0.05	0.68
	Negative indicators	1	0.87	1	0	1	Negative indicators	1.4	1.22	-0.18	0.18
Lowland Acid grassland	Ellenberg fertility						Ellenberg fertility	3.7	3.23	-0.48	0.13
	Ellenberg moisture						Ellenberg moisture	5.19	5.61	0.43	0.3
	Dwarf Shrub cover (rescaled from 0 to 1)						Dwarf Shrub cover (rescaled from 0 to 1)	0.01	2.23	2.22	0.42
	Grass Forb ratio						Grass Forb ratio	0.48	1.66	1.18	<0.01
	CSM positive indicator richness						CSM positive indicator richness	1.67	0.89	-0.78	0.27

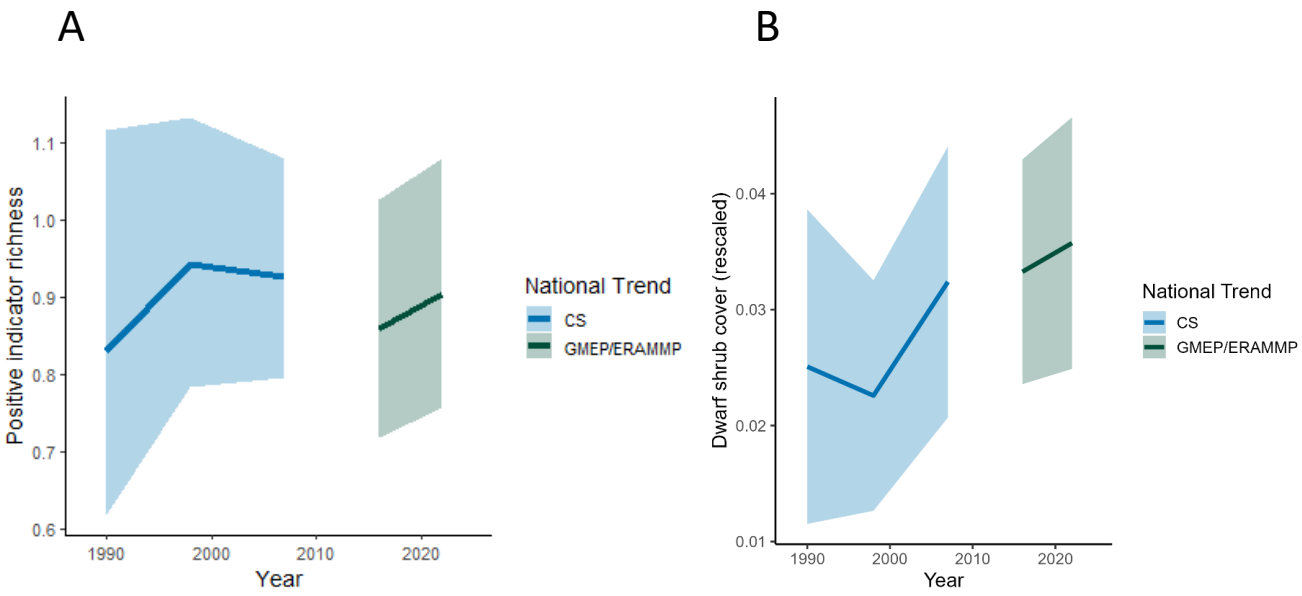

Figure 3-14 Trend between 2013-16 and 2021-23 in A Positive indicator plant species richness and B Dwarf Shrub cover (rescaled from 0 to 1) from nationally representative survey squares.

3.13.2 Glastir Impact

3.13.2.1 Positive Outcomes

- Grass: Forb ratio (a negative indicator) decreased with Habitat management.

3.13.2.2 Outcomes not as intended, trade-offs and contextual dependencies

- There were no significant effects of Glastir management on most Vegetation indicators.

3.13.2.3 Status of land coming into scheme and status of land where bundles / options are present

- Land under Grazing Lo/No Input options tends to have lower positive plant indicator species and higher negative indicators suggesting payments have been targeted at habitat with poorer Vegetation condition.

Table 3-13 Statistics for analysis of the conditional effect of coincidence with Glastir options and historic AES schemes on indicator variables in Acid Grassland across Wales between 2013-16 and 2021-23.

	Indicator	Trend. Habitat. Management General	P.value Habitat. Management General	Trend difference Commons	P.value Commons	Trend. Grazing Inputs	P.value Grazing Inputs	Trend difference Historic aes	P.value Historic aes
Upland acid grassland	Ellenberg fertility	-0.05	0.42	0.09	0.32	-0.01	0.95	-0.02	0.71
	Ellenberg moisture	-0.05	0.29	0.03	0.65	-0.02	0.74	-0.03	0.5
	Dwarf Shrub cover	0	0.96	0	0.91	0.01	0.94	0.03	0.05
	Grass Forb ratio	-0.39	0.02	0.28	0.21	-0.09	0.66	0	0.98
	Positive indicator richness	0.05	0.72	0.08	0.72	-0.07	0.73	0.09	0.69
	Positive indicator richness	-0.11	0.6	0.1	0.52	0.17	0.85	-0.17	0.38

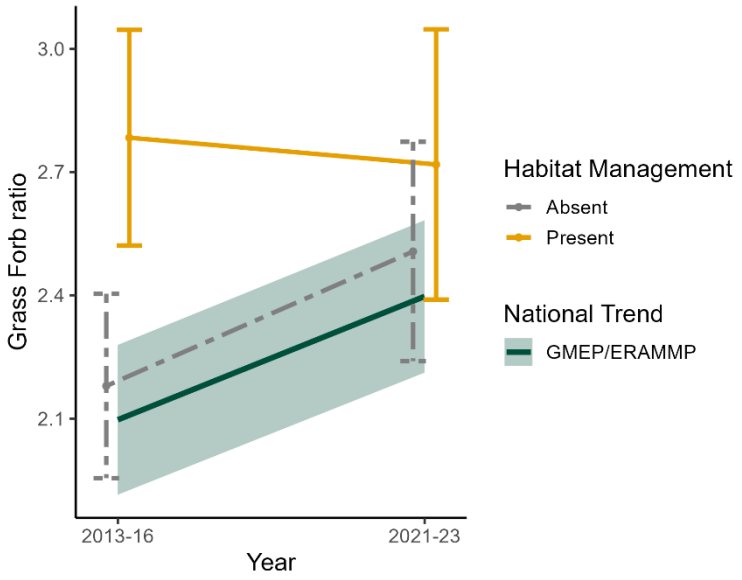

Figure 3-26 Trend in Grass:forb ratio between 2013-16 and 2021-23 in Acid Grassland showing both national trends and effect of Habitat Management.

3.14 Arable and Horticultural

Vegetation analysis was carried out on random plots within the field (X plots) and the 2m x 2m Margin (M) plots located on Arable field margins. Sample size was 51 plots in 2021-2023.

3.14.1 National Trend

There was no change in indicators of Vegetation condition in Arable and Horticultural Broad Habitat.

3.14.1.1 Positive Outcomes

- There were no significant trends in the Arable plant indicators including those for; Ellenberg fertility, total plant species richness, Arable forbs, positive and negative Arable indicator richness.

3.14.1.2 Areas for Concern / Need for Further Action

The abundance of arable Bird species (guild) declined. It is important to understand which arable Bird species are driving the guild-level decline in the national trend, but this is likely to reflect an ongoing, well-known trend at UK level in this Bird community, as is shown by the analogous indicator from the national BBS for lowland farmland Birds. The declines among both upland and lowland farmland Birds seem to have halted in the 2021

*Table 3-23 **National Trend** analysis for Biodiversity indicators in the Arable & Horticultural broad habitat. Mean, mean change and p-values were extracted from models for periods 1990-2007, 2013-16 and 2021-23.*

Indicator	1990	1998	2007	Trend 1990-2007	P value	2016	2022	Trend 2016-2022	P value
Ellenberg fertility	6.46	6.32	6.31	-0.15	0.32	6.3	6.39	0.09	0.53
Total species richness	7.94	6.99	6.96	-0.98	0.91	9.49	8.66	-0.82	0.39
Arable forb count	2.7	1.87	2.1	-0.6	0.82	1.87	1.79	-0.08	0.82
Positive indicator richness	0.46	0.13	0.1	-0.37	0.13	0.12	0.09	-0.04	0.53
Negative indicator richness	1.43	1.81	1.61	0.18	0.94	1.87	1.75	-0.12	0.75

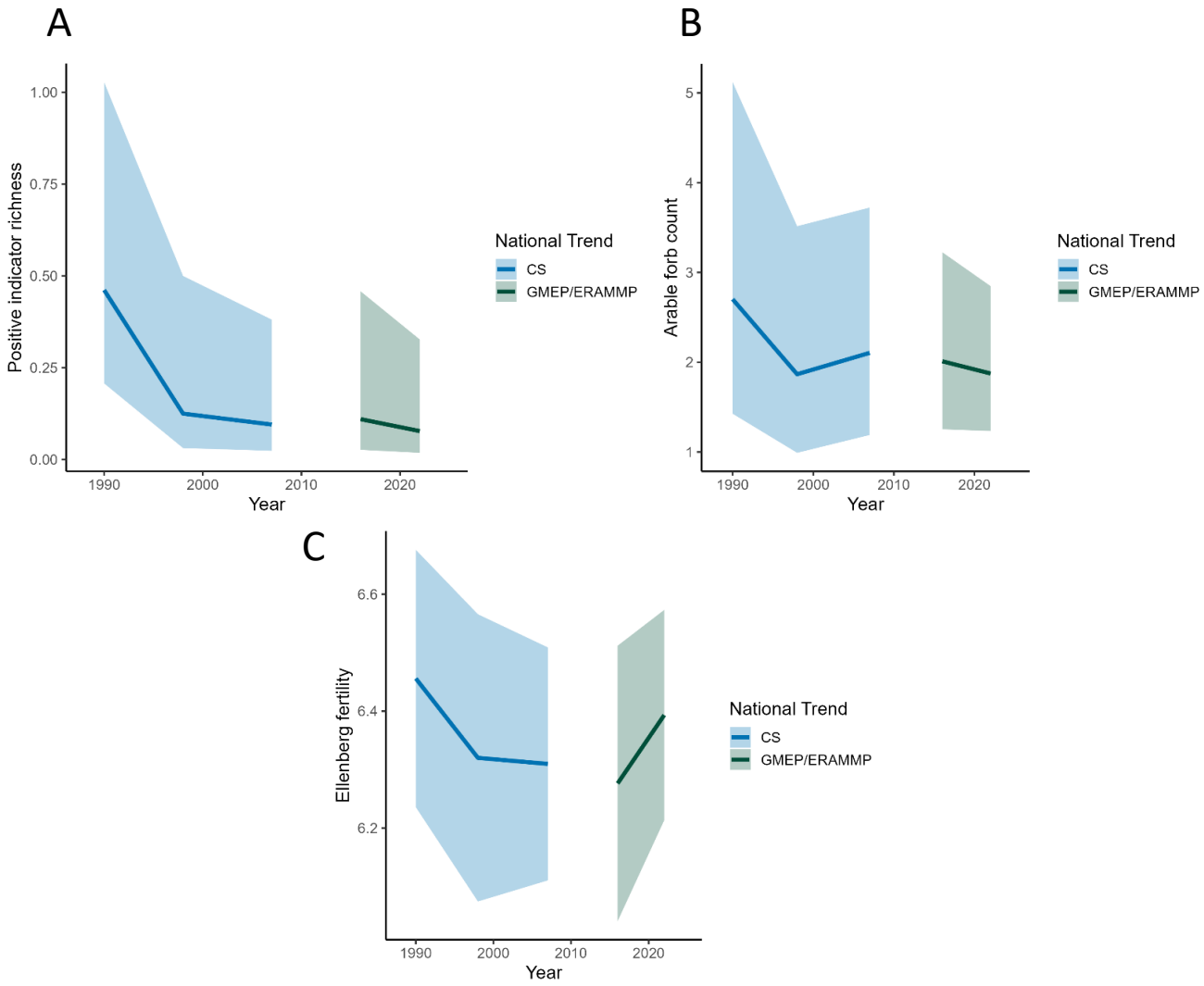

Figure 3-15 Long term national trends in A) positive indicators and B) Arable forb count C) Ellenberg fertility in Arable and Horticultural from Countryside Survey squares in Wales 1990 to 2007 and GMEP/ERAMMP (2013 – 16 to 2021 – 2023) from nationally representative survey squares.

3.14.2 Glastir Impact

Table 3-14- Statistics for analysis of the conditional effect of coincidence with Glastir options and historic AES schemes on indicator variables in Bracken across Wales between 2013-16 and 2021-23. Note that the model for positive indicators would not converge.

Indicator	Trend. difference Arable Management	P.value Arable Management	Trend. difference Hab_ Management	P.value Hab_ Management	Trend difference Organic	P.value Organic	Trend. difference historic_aes	P.value historic_aes
Ellenberg fertility	0.1	0.74	0.95	0.11	-0.13	0.82	0	0.99
Total species richness	-0.18	0.94	3.9	0.52	-3.8	0.51	-7.44	<0.01
Arable forbs	0.77	0.55	2.13	0.51	-0.35	0.99	-2.13	<0.01
Negative indicators	0.04	0.92	1	0.6	-2.54	0.12	-0.36	0.49

3.15 Improved Grassland

This is an extensive Broad Habitat comprising low botanical quality grassland with high grazing value used as pasture, silage or occasionally hay. Consequently there is a large sample in the field survey data representing its greater extent (N=312 in ERAMMP). Analyses use the small 2m x 2m plots.

3.15.1 National trend

3.15.1.1 Positive Outcomes

- There has been an increase in positive plant indicator richness reversing a long term decline.
- There has been a decrease in Ellenberg fertility score.
- Although there has been no increase in total species richness a previously reported decline (1990-07) has been stabilised at a higher level. (NB the total species richness reported here is higher than in (Alison, et al., 2020) but here negative indicators haven't been excluded).

3.15.1.2 Areas for Concern / Need for Further Action

- 72% of Improved Grassland has a top-soil pH below 6 in 2021-23, identified as a trigger point to grassland productivity on mineral Soils (down from 75% in 2013-16).

*Table 3-15 **National Trend** analysis for Biodiversity indicators for Improved Grassland in 2x2m plots. Mean, mean change and p-values were extracted from models for periods 1990-2007, 2013-16 and 2021-23.*

	Indicator	1990	1998	2007	Trend 1990-2007	P value	2016	2022	Trend 2016-2022	P value
Improved Grassland	Ellenberg fertility	5.28	5.3	5.32	0.04	0.79	5.48	5.39	-0.08	0.03
	Total species richness	10.98	11.6	9.67	-1.31	0.01	10.06	10.26	0.19	0.54
	Grass forb ratio	1.39	1.79	1.66	0.27	0.1	1.52	1.63	0.12	0.27
	Positive indicator richness	1.15	0.97	0.74	-0.41	<0.01	0.83	1.99	1.16	<0.01
	Negative indicators	3.01	3.02	2.87	-0.14	0.77	3.06	3.24	0.18	0.56

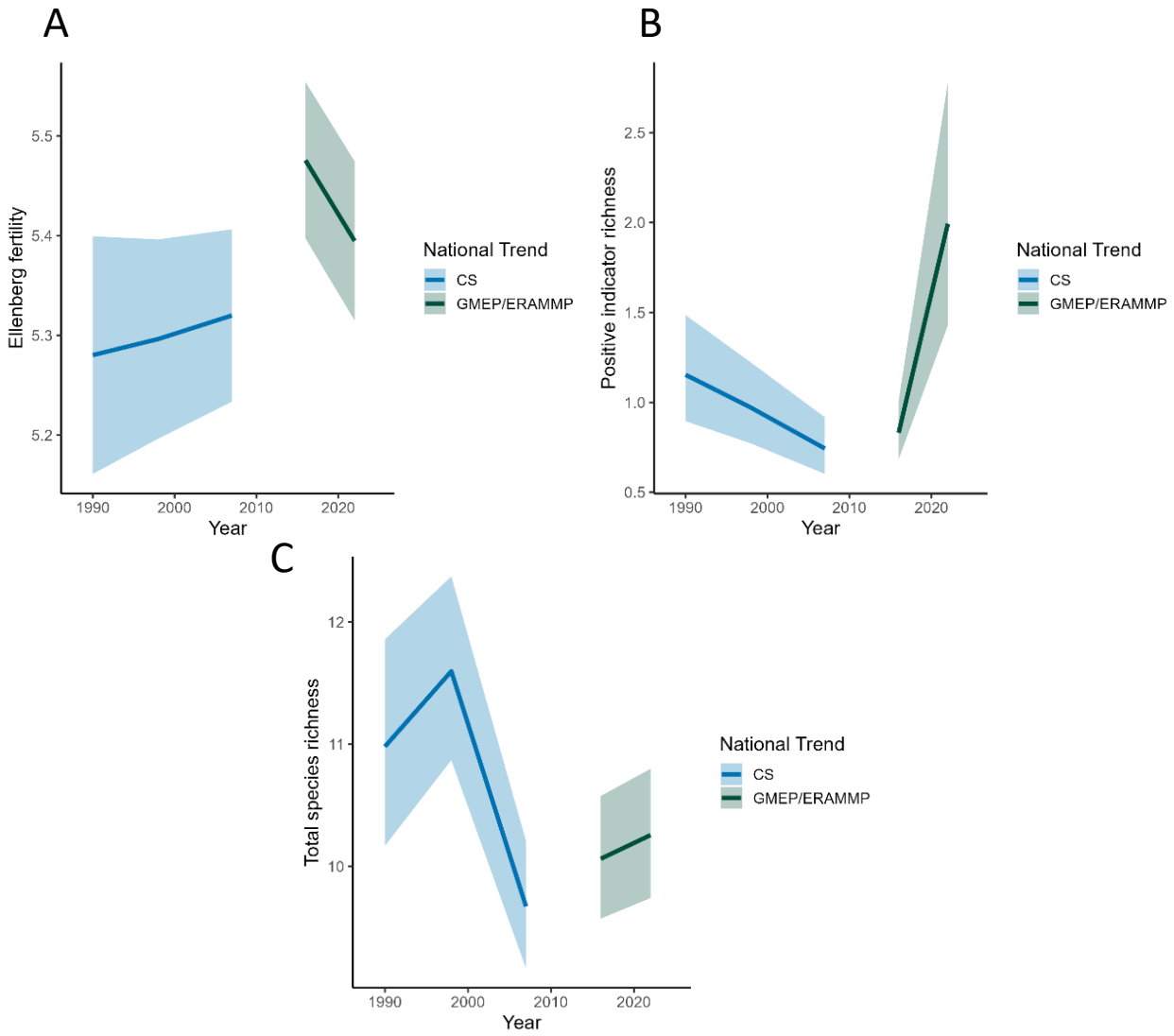

Figure 3-16 Long term national trends in A) Ellenberg fertlity, B) positive indicators, and C) total species richness in Improved Grassland from Countryside Survey squares in Wales 1990 to 2007 and GMEP/ERAMMP (2013 – 16 to 2021 – 2023) from nationally representative survey squares.

3.15.2 Glastir Impact

- There are no significant results associated with Glastir impact.
- However, the land under the grazing input bundle appears to have lower starting values of Ellenberg fertility, lower grass forb ratio and higher total species richness suggesting that land coming into the scheme is of higher quality than wider Wales.
- There is a lot of variability in response variables, for example, positive indicators with Glastir options (grazing and organic)

Table 3-26 Statistics for analysis of the conditional effect of coincidence with Glastir options and historic AES schemes on indicator variables in Improved Grassland across Wales between 2013-16 and 2021-23.

Indicator	Trend difference Hab_ Management	P.value Hab_ Management_ Gen	Trend difference Grazing input	P.value Grazing input	Trend.difference Organic	P.value Organic	Trend difference Historic aes	P.value Historic aes
Ellenberg fertility	-0.04	0.75	0.14	0.11	0.07	0.6	0.01	0.91
Total species richness	-0.43	0.66	-0.26	0.66	-1.93	0.06	0.05	0.94
Positive indicator richness	0.2	0.73	-0.23	0.09	-0.08	0.96	-0.43	0.27
Negative indicators	-0.64	0.45	0.02	0.97	-0.09	0.93	0.42	0.51
Grass forb ratio	-0.43	0.21	0.21	0.37	0.56	0.14	0.02	0.9

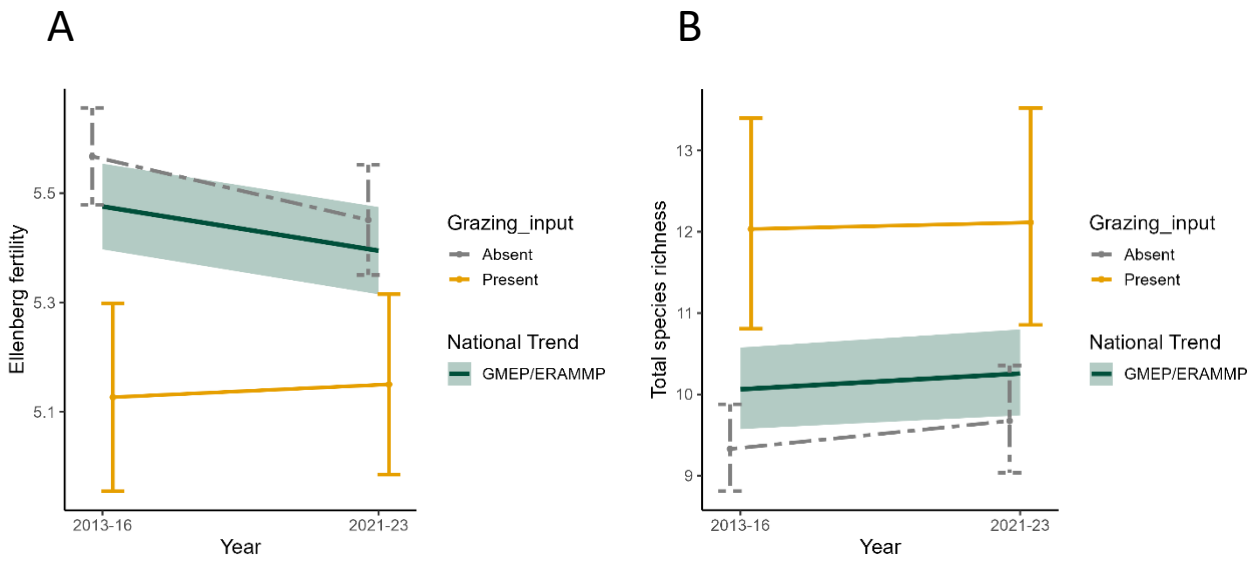

Figure 3-17 Trend in A Ellenberg fertility B total species richness between 2013-16 and 2021-23 in Improved Grassland showing both national trends and effect of uptake of Grazing Lo/No Inputs

3.16 Semi-Improved Grassland

3.16.1 National Trend

There are some early indicators of a decline in the condition of Semi-Improved Grassland after a period of stability. Whilst the number of negative plant indicators is decreasing, total plant species richness has declined together with an increase in Grass: Forb ratio (a negative indicator).

3.16.1.1 Positive Outcomes

- There has been a decrease in negative plant indicators.
- Positive plant indicators have remained stable.

3.16.1.2 Areas for Concern / Need for Further Action

- Grass: Forb ratio increased which is a negative plant indicator.
- There was a decline in total plant species richness. This trend is reversed where there was High Nature Value Farmland Type II within the 1km survey square. This suggests decline in this habitat is more likely where land is isolated e.g. from potential seed sources.

*Table 3-16 **National Trend** analysis for Biodiversity indicators for Semi-improved Grassland in 2m x 2m plots. Mean, mean change and p-values were extracted from models for periods 1990-2007, 2013-16 and 2021-23.*

	Indicator	1990	1998	2007	Trend 1990-2007	P value	2016	2022	Trend 2016-2022	P value
Semi-improved grassland	Ellenberg fertility	4.57	4.68	4.69	0.12	0.35	4.74	4.68	-0.07	0.13
	Grass Forb ratio	0.94	1.21	1.22	0.28	0.38	0.94	1.44	0.5	<0.01
	Positive indicator richness	4.02	3.97	3.23	-0.79	0.1	3.21	3.13	-0.08	0.68
	Negative indicators	2.11	2.34	2.09	-0.02	1	2.8	2.33	-0.47	<0.01
	Total species richness	14.08	16.13	13.88	-0.2	0.96	14.93	14.07	-0.86	0.03

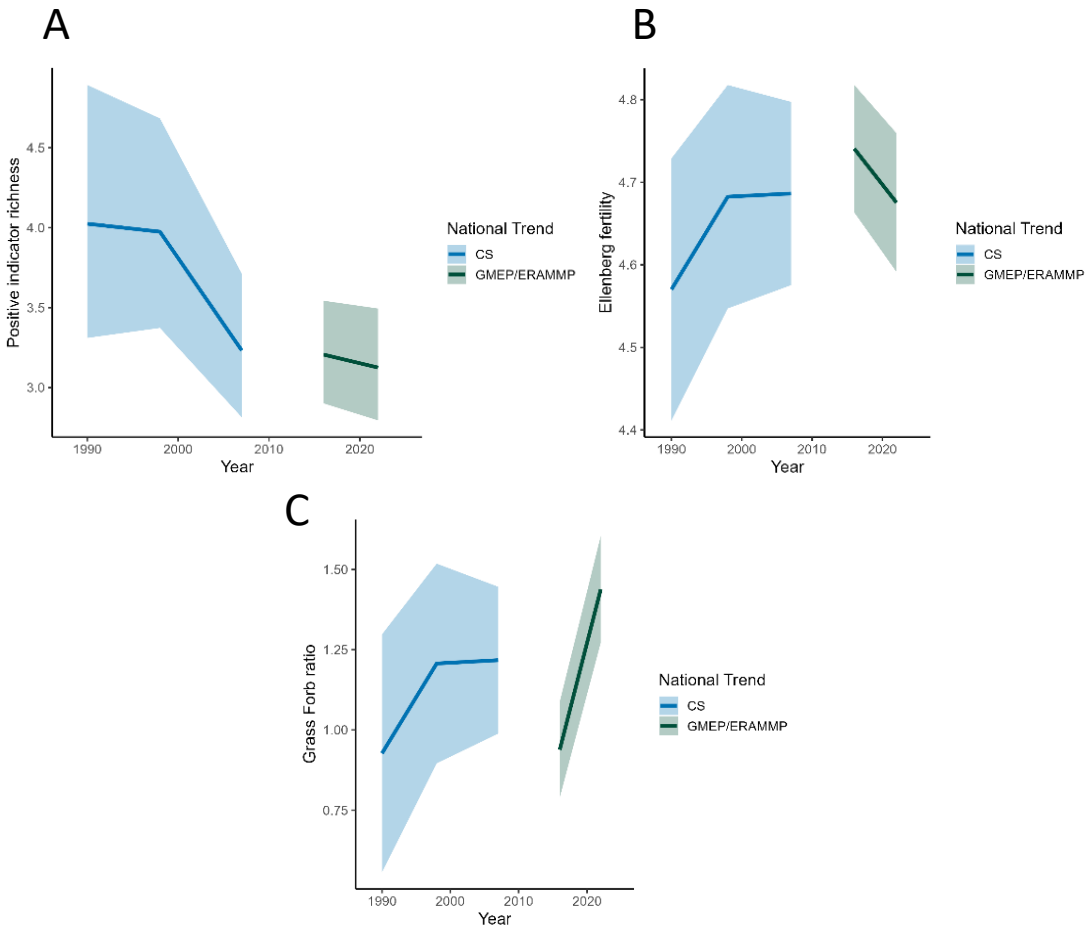

Figure 3-30 Long term national trends in A) positive indicators, B) Ellenberg fertility, and C) grass:forb ratio in Semi-improved Grassland from Countryside Survey squares in Wales 1990 to 2007 and GMEP/ERAMMP (2013 – 16 to 2021 – 2023) from nationally representative survey squares.

3.16.2 Glastir Impact

3.16.2.1 Positive Outcomes

- There were no significant impacts for indicators of Vegetation condition. .

3.16.2.2 Outcomes not as intended, trade-offs and contextual dependencies

- Interesting that negative species higher in organic

3.16.2.3 Historic AES

- Grass: Forb ratio (a negative indicator) was reduced with historic AES suggesting a possible lag time in benefits realised from previous schemes

Table 3-17 Statistics for analysis of the conditional effect of coincidence with Glastir options and historic AES schemes on indicator variables in Semi-improved grassland across Wales between 2013-16 and 2021-23.

Indicator	Trend difference Hab_ Management	P.value Hab_ Management	Trend difference commons	P.value commons	Trend. Grazing _input	P.value Grazing _input	Trend Organic	P.value Organic	Trend historic_ aes	P.value historic_ aes	HNV type 2 trend	HNV type 2 P value
Ellenberg fertility	0.14	0.13	0.37	0.09	-0.11	0.17	0.03	0.85	-0.11	0.08	0.01	0.94
Grass Forb ratio	0.12	0.62	-0.67	0.26	-0.08	0.69	-0.1	0.79	-0.49	<0.01		
Positive indicator richness	-0.09	0.85	-0.36	0.78	0.27	0.51	0.17	0.82	0.29	0.37	0.4	0.37
Negative indicators	0.15	0.72	-0.46	0.63	-0.2	0.47	-0.38	0.6	-0.33	0.25		
Total species richness	-0.2	0.81	1.31	0.64	0.38	0.66	-0.37	0.83	0.28	0.72	1.91	0.04

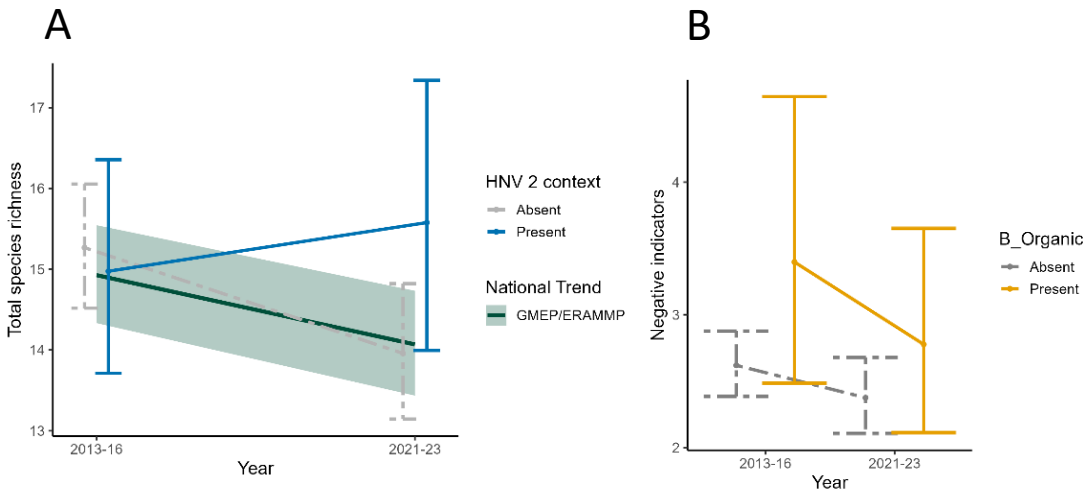

Figure 3-31 Trend in total plant species richness between 2013-16 and 2021-23 in Semi-Improved Grassland showing both national trend and where HNV2 (heterogeneous land) as context is present or absent B Trend in negative indicators with Organic management

3.17 Hedgerows

3.17.1 National Trend

*Table 3-29 **National Trend** analysis for Biodiversity indicators in **Hedgerows**. Mean, mean change and p-values were extracted from models for periods 2013-16 and 2021-23.*

	Indicator	1990	1998	2007	Trend 1990-2007	P value	2016	2022	Trend 2016-2022	P value
Hedgerows	Ellenberg fertility	5.73	5.79	5.76	0.03	0.88	5.8	5.8	0	0.93
	Ellenberg Light	6.17	6.14	6.13	-0.05	0.41	6.12	6.05	-0.08	<0.01
	Ground Flora species richness	18.56	18.62	17.64	-0.92	0.51	19.49	17.8	-1.7	<0.01
	Woody species richness	NA	5.47	6.42	0.96	<0.01	5.52	5.83	0.31	0.02
	Width						2.1	2.29	0.2	0.01
	Mean Length per square (adjusted by permission)	3728.5	3515.76	3629.23	-99.27	0.89	3337.87	3067.07	-270.8	0.18
	Height	1.99	1.93	1.93	-0.06	0.08	1.86	2.03	0.17	<0.01
	Ancient Woodland indicators	2.16	2.05	1.75	-0.41	0.15	2.18	2.04	-0.14	0.38
	Nectar plant richness	11.45	12.15	11.58	0.13	0.97	12.87	11.98	-0.89	0.03

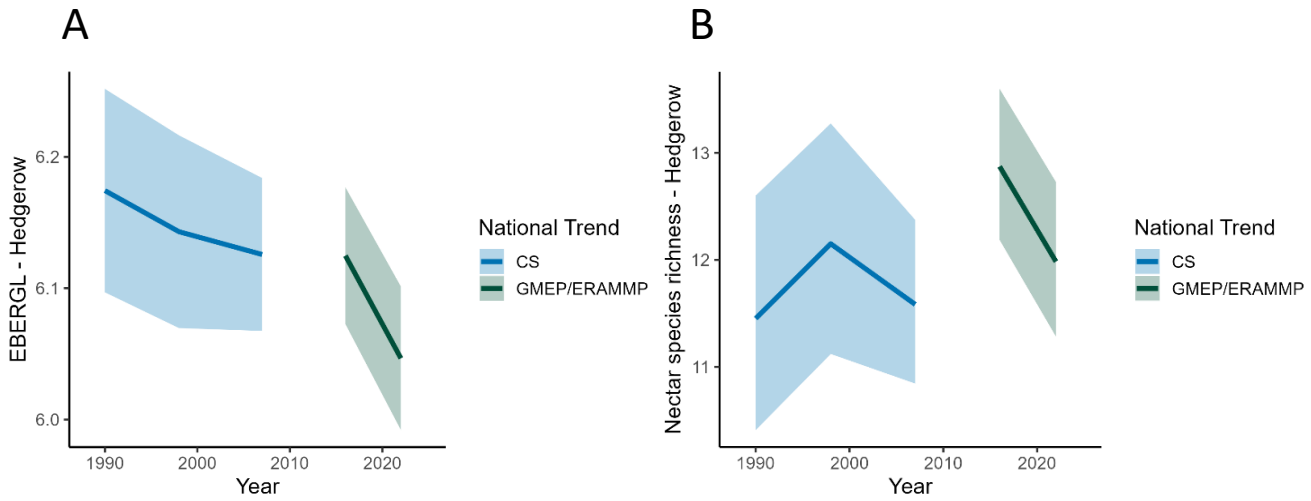

Figure 3-32 Long term national trends in A) Ellenberg light on Hedgerows B) Nectar species richness on Hedgerows from Countryside Survey squares in Wales 1990 to 2007 and GMEP/ERAMMP (2013 – 16 to 2021 – 2023) from nationally representative survey squares.

Table 3-18 National estimates of woody linear feature length (scaled by land class to represent Wales).

	WUS			WNS			Total WLF		
	Estimated Length ‘000 km	Lower 95%	Upper 95%	Estimated Length ‘000km	Lower 95%	Upper 95%	Estimated Length ‘000km	Lower 95%	Upper 95%
CS1990	58	46.24	69.76	29	*	*	91	76.104	105.896
CS1998	57	45.24	68.76	46	*	*	107	91.32	121.896
CS2007	54	43.024	64.976	49	*	*	106	90.516	120.896
2013-16	50.5	31.1	66.1	48.4	31.1	60	98.9	63.9	127.9
2021-23	52.7	33.9	60.7	46.6	29.7	57	105.4	75.1	132.3

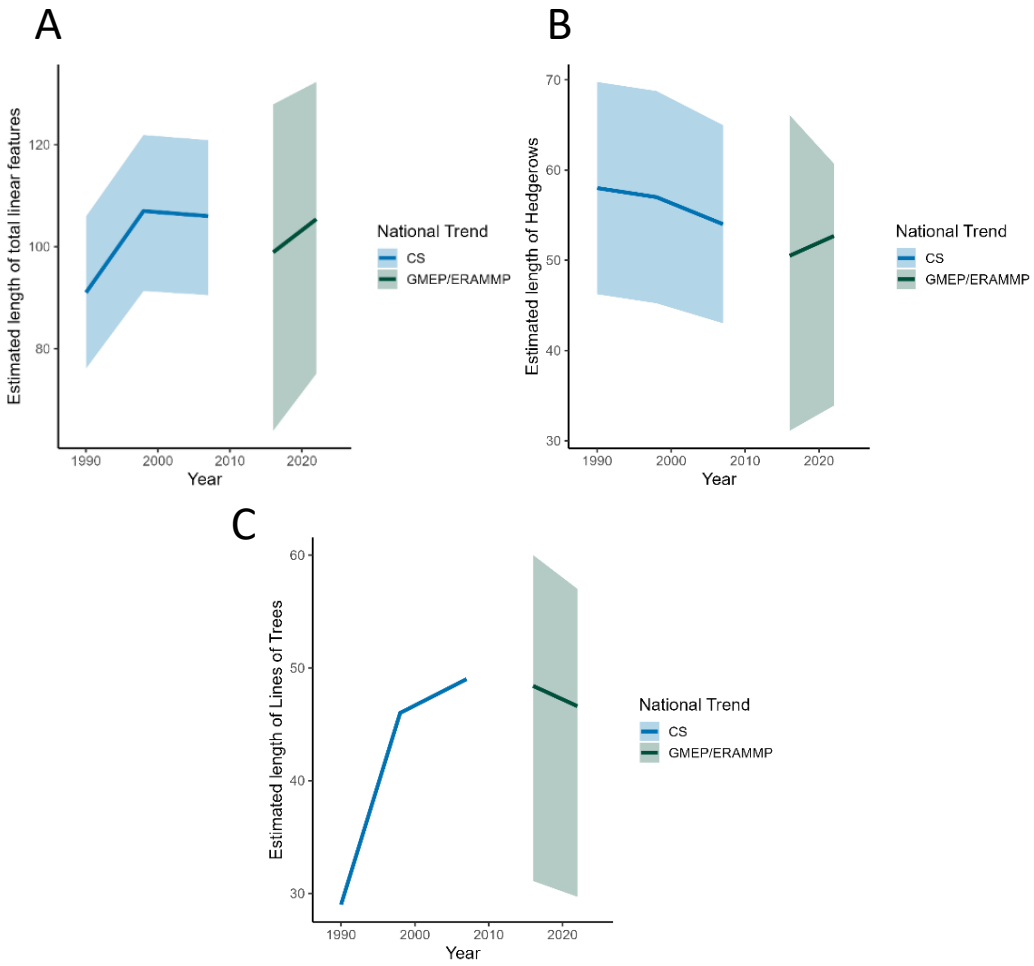

Figure 3-33 Long term national trends in Length of Hedgerows from Countryside Survey squares in Wales 1990 to 2007 and GMEP/ERAMMP (2013 – 16 to 2021 – 2023) from nationally representative survey squares. A) Total length of wooded linear features. B) Length of hedgerow. C) Length of lines of trees.

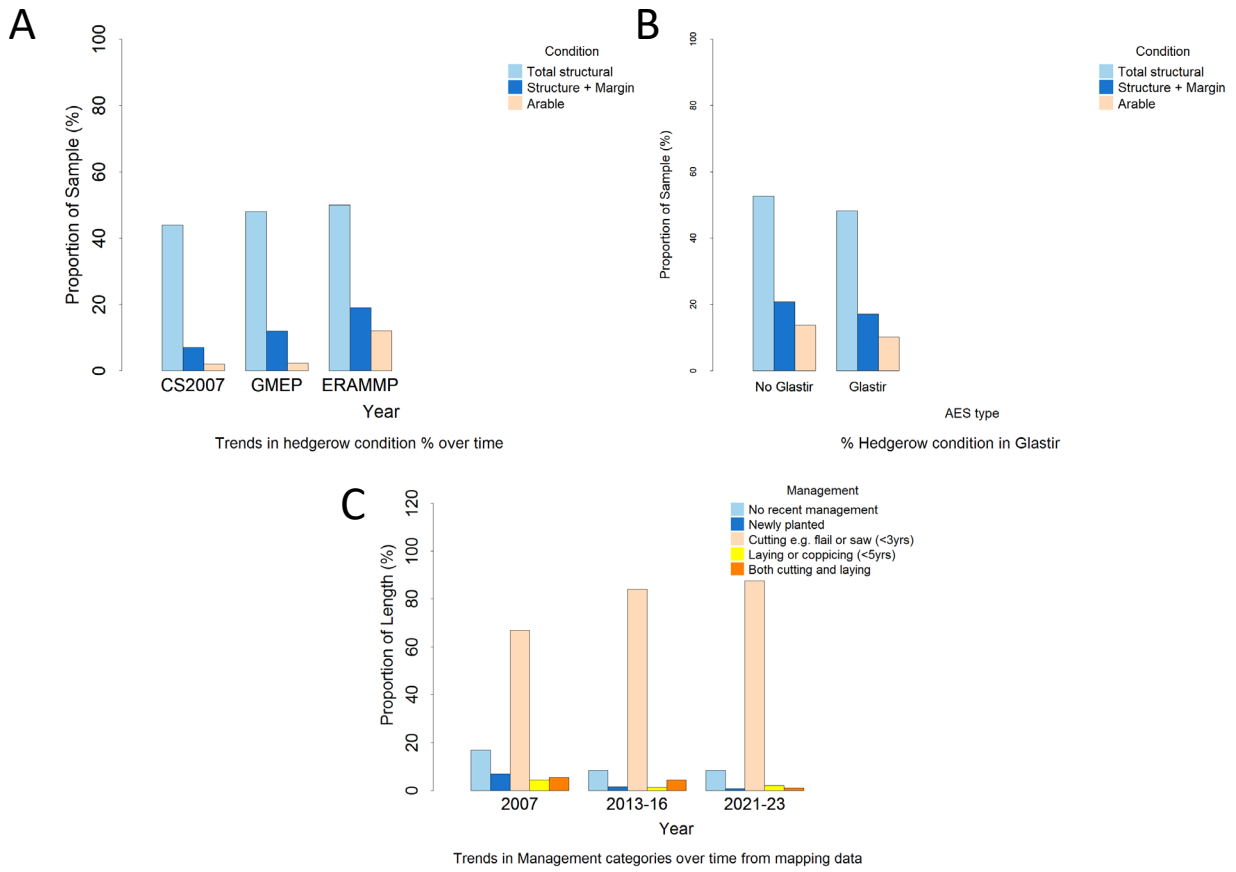

Figure 3-18 Recorded evidence of management indicated that most woody linear features (67% of sampled Hedges) had been cut in the last 3 years, 7% had been newly planted and 17% showed no sign of recent management.

Table 3-19 The percentage of Hedgerow plots meeting different condition criteria

	2007	Hedges 2013-2016	2021-2023	2013-2016		2021-2023	
				No AES	Managmnt	No AES	Management
Height >1m	99.2	96.8	98	97.1	94.74	97.7	96.6
Width >1.5m	66.7	78.2	86	78.71	71.05	83.5	86.2
Height of base of canopy <0.5m	84.1	81.7	68	81.94	81.58	72.3	72.4
Non-native species at <10% cover	99.2	99.7	99	100	100	100	100
Cross-sectional area >3m2	65.5	167	80	70.32	57.89	75.8	79.3
<10% gaps	83.3	95.6	95	95.48	73.68	86.5	93.1
Vertical gappiness <5m	83.7	82	84	82.9	73.68	95.8	82.8
Undisturbed ground (2m) (Not Arable)	4.5	3.2	4.4	3.55	0	3.8	13.8
perennial herbaceous cover (1m)	26.1	57.5	51	58.71	42.11	47.7	48.3
Total Structured in condition	43.9	47.8	50	48.71	42.11	52.7	48.3
Total Structured + Margin in condition (includes Arable)	13.3	12.1	19	12.58	7.89	20.8	17.2
Total structured + Arable	6.1	2.4	12	2.26	2.63	13.8	10.3

Table 3-20 Change in percentage of plots meeting criteria

Condition Thresholds	Change in percentage of plots meeting criteria from 2013-16 to 2021-23	
	No Glastir	Glastir
Structural condition indicators		
Height >1m	0.60	1.81
Width of woody component >1.5m	4.75	15.15
Height of base of canopy <0.5m	-9.63	-9.17
Non-native species cover <10%	0.00	0.00
Cross-sectional area (height x width) >3m^2	5.45	21.42
The degree of intactness of the Hedgerow canopy <10%	-8.95	19.42
No gaps over 5m wide	12.87	9.07
Margin condition indicators		
undisturbed ground >2m adjacent to the Hedgerow (all land)	0.30	13.79
Width of perennial herbaceous cover >1m	-11.02	6.17
Composite condition metrics		
Structured in condition	3.98	6.17
Structured + Margin in condition (all land uses)	8.19	9.35
Structured + Margin in condition (arable land)	11.59	7.71

Table 3-21 showing the percentage of veteran trees in different condition categories

Category	2007	2016	2022
Tree dead	1.7	1.1	1.8
Missing limbs	77.9	79.8	77.1
Dead wood	84.2	75	74.3
Lightning strike	50.8	55.9	47.3
Hollow trunk	16.7	25	31.6
Epiphytes - Rare	45.8	70.7	46.3
Epiphytes - Present	33.3	24.5	41.1
Epiphytes - Abundant	20.8	4.8	10.4
Canopy live 90-100%	55.8	77.7	71.5
Canopy live 50-89%	39.2	17.6	20.1
Canopy live 25-49%	2.9	3.2	5.6
Canopy live <25%	2.1	1.6	2.5
Standard	66.25	85.1	75.1
Lay	6.3	3.7	5.3
Pollard	27.5	11.2	19.3

Table 3-34 % of trees recorded as veteran in each condition category by species in 2007 (<4 trees removed).

										Epiphytes			% of canopy live				Type of tree		
Species	No of trees	Buffer	Tree dead	Missing limbs	Dead wood	Dead missing bark	Lightning strikes	Hollow trunk	Ivy cover >30%	rare	present	abund	<25	25-49	50-89	90-100	Lay	Pollard	Standard
Oak	79	3.8	3.8	84.8	91.1	64.6	58.2	17.7	8.9	38.0	34.2	27.8	3.8	1.3	45.6	49.4	1.3	21.5	77.2
Ash	63	4.8	0.0	87.3	87.3	49.2	50.8	25.4	25.4	41.3	41.3	17.5	1.6	4.8	49.2	44.4	9.5	23.8	66.7
Hawthorn	35	0.0	0.0	62.9	85.7	71.4	48.6	22.9	2.9	34.3	25.7	40.0	0.0	0.0	54.3	45.7	22.9	20.0	57.1
Alder	23	0.0	0.0	73.9	82.6	60.9	43.5	8.7	8.7	52.2	34.8	13.0	0.0	4.3	47.8	47.8	4.3	39.1	56.5
Beech	21	0.0	0.0	66.7	81.0	57.1	47.6	9.5	0.0	61.9	28.6	9.5	0.0	0.0	14.3	85.7	4.8	38.1	57.1
Rowan	19	5.3	0.0	68.4	78.9	63.2	63.2	42.1	0.0	73.7	10.5	15.8	0.0	10.5	63.2	26.3	10.5	15.8	73.7
Birch	18	0.0	5.6	55.6	55.6	50.0	38.9	16.7	0.0	61.1	0.0	38.9	0.0	11.1	16.7	72.2	5.6	11.1	83.3
Willow	18	0.0	0.0	83.3	94.4	72.2	55.6	11.1	16.7	50.0	44.4	5.6	5.6	0.0	16.7	77.8	22.2	61.1	16.7
Field maple	9	0.0	0.0	55.6	77.8	44.4	66.7	22.2	0.0	22.2	33.3	44.4	0.0	0.0	22.2	77.8	22.2	11.1	66.7
Sycamore	9	0.0	0.0	44.4	55.6	22.2	22.2	0.0	11.1	66.7	11.1	22.2	0.0	0.0	44.4	55.6	11.1	33.3	55.6
Elm	6	0.0	0.0	66.7	83.3	83.3	83.3	0.0	16.7	33.3	66.7	0.0	33.3	0.0	0.0	66.7	0.0	83.3	16.7
Hazel	5	0.0	0.0	60.0	60.0	20.0	20.0	0.0	20.0	60.0	40.0	0.0	0.0	0.0	20.0	80.0	40.0	60.0	0.0
Holly	5	0.0	20.0	40.0	100.0	60.0	40.0	0.0	20.0	40.0	60.0	0.0	0.0	0.0	20.0	80.0	0.0	0.0	100.0
Lime	5	20.0	0.0	40.0	60.0	40.0	40.0	20.0	0.0	60.0	40.0	0.0	0.0	0.0	0.0	100.0	0.0	20.0	80.0
Sweet chestnut	5	20.0	0.0	80.0	80.0	60.0	80.0	40.0	0.0	0.0	80.0	20.0	0.0	0.0	40.0	60.0	0.0	40.0	60.0
Crab apple	4	0.0	0.0	75.0	100.0	75.0	75.0	0.0	25.0	0.0	50.0	50.0	0.0	0.0	75.0	25.0	0.0	0.0	100.0

Table 3-35 % of trees recorded as veteran in each condition category by species in 2013-16 (<4 trees removed).

										Epiphytes			% of canopy live				Type of tree		
Species	No of trees	Buffer	Tree dead	Missing limbs	Dead wood	Dead missing bark	Lightning strikes	Hollow trunk	Ivy cover >30%	rare	present	abund	<25	25-49	50-89	90-100	Lay	Pollard	Standard
Oak	96	2.1	2.1	86.5	87.5	70.8	59.4	21.9	9.4	71.9	25.0	3.1	1.0	4.2	22.9	71.9	0	4.2	95.8
Ash	37	2.7	0	81.1	67.6	43.2	48.6	27.0	16.2	73.0	21.6	5.4	0	5.4	18.9	75.7	2.7	18.9	78.4
Beech	16	6.3	0	81.3	50.0	43.8	50.0	12.5	0	50.0	43.8	6.3	6.3	0	0	93.8	25.0	18.8	56.3
Sycamore	15	6.7	0	73.3	53.3	26.7	66.7	26.7	6.7	73.3	26.7	0	6.7	0	20.0	73.3	13.3	13.3	73.3
Alder	6	0	0	83.3	83.3	50.0	33.3	66.7	0.0	83.3	16.7	0	0	0	0	100	0	50.0	50.0
Lime	6	0	0	16.7	50.0	0.0	50.0	16.7	0.0	83.3	16.7	0	0	0	0	100	0	16.7	83.3
Birch	4	0	0	75.0	50.0	50.0	75.0	50.0	0.0	25.0	25.0	50.0	0	0	25.0	75.0	0	0	100
Crab apple	4	0	0	100	75.0	75.0	25.0	50.0	25.0	75.0	0	25.0	0	0	0	100	0	0	100
Willow	4	0	0	0	75.0	0.0	75.0	25.0	0	100	0	0	0	0	0	100	0	25.0	75.0

Table 3-22 % of trees recorded as veteran in each condition category by species in 2021-23 (<4 trees removed)

							% of canopy live				Type of tree			Epiphytes		
Species	Total Number of trees	Tree dead	Missing limbs	Dead wood	Lightning strikes	Hollow trunk	<25	25-49	50-89	90-100	Lay	Pollard	Standard	rare	present	abund
Oak	152.0	0.0	79.6	78.9	38.8	21.7	1.3	5.9	21.7	71.1	0.0	11.8	88.2	46.7	40.1	11.8
Hawthorn	100.0	0.0	40.0	80.0	30.0	50.0	0.0	10.0	30.0	60.0	10.0	10.0	80.0	70.0	30.0	0.0
Ash	90.0	4.4	80.0	77.8	52.2	31.1	5.6	11.1	23.3	58.9	3.3	24.4	71.1	36.7	50.0	10.0
Beech	39.0	2.6	79.5	59.0	59.0	41.0	0.0	0.0	5.1	94.9	12.8	30.8	56.4	46.2	46.2	7.7
Sycamore	30.0	0.0	73.3	63.3	56.7	43.3	3.3	3.3	13.3	80.0	13.3	23.3	63.3	66.7	30.0	3.3
Alder	14.0	7.1	78.6	78.6	42.9	50.0	7.1	7.1	14.3	71.4	7.1	35.7	57.1	57.1	28.6	7.1
Willow	9.0	0.0	55.6	55.6	44.4	44.4	11.1	0.0	11.1	77.8	11.1	22.2	66.7	22.2	44.4	22.2
Lime	9.0	33.3	11.1	11.1	0.0	0.0	0.0	0.0	0.0	22.2	0.0	0.0	22.2	0.0	11.1	11.1
Rowan	8.0		50.0	75.0	37.5	62.5	0.0	0.0	50.0	50.0	0.0	12.5	87.5	37.5	37.5	25.0
Birch	7.0	0.0	85.7	57.1	57.1	28.6	0.0	0.0	28.6	71.4	0.0	0.0	100.0	28.6	28.6	42.9

3.17.2 Glastir Impact

Table 3-37 Glastir analysis for Biodiversity indicators in Hedgerows. Glastir management bundles assessed for effects on Biodiversity indictors are shown, but greyed out where data did not allow for analysis. Context effect was tested using information related to participation in historic agri-environment schemes.

		Hedgerow Management		Hedgerow restoration		Wildlife corridors		Woodland creation		Context: Historic AES	
Habitat	**Indicator**	**Glastir effect**	**P value**	**Glastir effect**	**P value**	**Glastir effect**	**P value**	**Glastir effect**	**P value**	**Glastir effect**	**P value**
Hedgerows	Height	0.02	0.83	-0.87	0.15						
	Length	-237.74	0.54	-441.88	0.53	-355.31	0.37	-33.09	0.95		
	Width	0.25	0.14	0.09	0.74	-0.09	0.58	0.11	0.62		
	Ground flora species richness	0.55	0.67							0.07	0.88
	Woody species richness	0.25	0.45							0.16	0.45
	AWI	-0.36	0.33							0.07	0.71
	Nectar plant richness	0.44	0.66							0.46	0.49

For height only management and restoration bundles were used because of the overlay with spatial data.

3.17.2.1 Hedgerow height

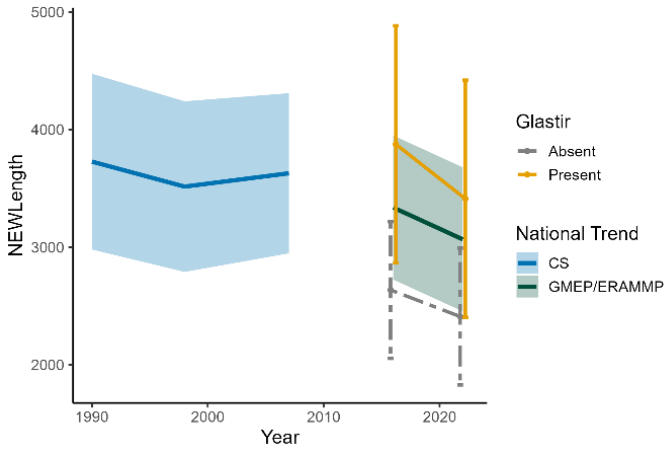

Figure 3-19 Trend in Hedgerow height between 2013-16 and 2021-23 in Hedgerows where Woodland Management is present or absent.

3.18 Boundaries

3.18.1 National Trend

*Table 3-23 **National Trend** analysis for Biodiversity indicators in **Boundary plots**. Mean, mean change and p-values were extracted from models for periods 2013-16 and 2021-23.*

		Trend 1990-2007						Trend 2016-2022			
	Indicator	1990	1998	2007	Mean change	P value	Indicator	2016	2022	Mean change	P value
Boundary plots	EBERGN	5.07	5.22	5.27	0.2	<0.01	EBERGN	5.15	5.15	0	0.97
	EBERGR	5.56	5.67	5.68	0.12	<0.01	EBERGR	5.58	5.57	-0.01	0.39
	EBERGL	6.7	6.64	6.52	-0.18	<0.01	EBERGL	6.51	6.51	-0.01	0.86
	All species richness	15.25	14.99	14.16	-1.09	0.04	All species richness	16.57	15.84	-0.73	<0.01
	Nectar species	7	6.72	7	0	1	Nectar species	8.15	7.7	-0.45	0.01
	AWI species	0.64	0.54	0.57	-0.07	0.47	AWI species	0.95	0.96	0.01	0.84
	CSM pos species	8	7.82	7.36	-0.64	0.05	CSM pos species	8.64	8.53	-0.11	0.54
	CSM neg species	10.45	10.33	10.15	-0.3	0.61	CSM neg species	11.5	11.13	-0.38	0.08
	Canopy height	2.21	2.44	2.57	0.36	<0.01	Canopy height	2.57	2.58	0.02	0.7

- Increasing trends for Ellenberg N and R through CS seem to have reduced more recently (Top left and right of figure 3-36 and significant trend only for CS).
- Canopy height also appears to been stable during ERAMMP in boundary plots (bottom left panel below).
- Species richness (total bottom right panel) declining, but recently less of a decline for positive indicator species

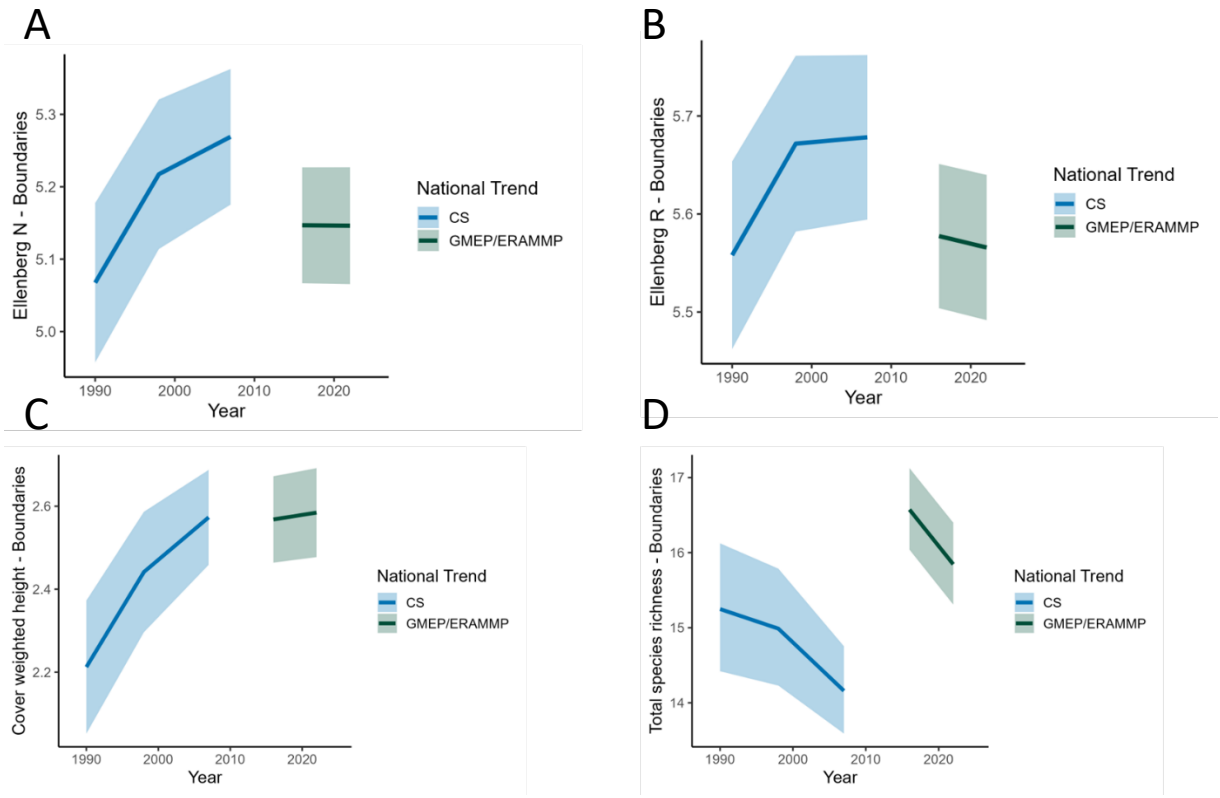

Figure 3-20 Long term national trends in A) Ellenberg fertility, B) Ellenberg reaction, C) cover weighted height, and D) total species richness from Countryside Survey squares in Wales 1990 to 2007 and GMEP/ERAMMP (2013 – 16 to 2021 – 2023) from nationally representative survey squares.

3.18.2 Glastir Impact

Table 3-39 Glastir analysis for Biodiversity indicators for Boundary plots. Glastir management bundles assessed for effects on Biodiversity indictors are shown, but greyed out where data did not allow for analysis. Context effect was tested using information related to participation in historic agri-environment schemes.

		Habitat Management-General		Grazing Input Management		Wildlife Corridor Management		Context: Historic AES	
	Indicator	Glastir effect	P value	Glastir effect	P value	Glastir effect	P value	Glastir effect	P value
Boundaries	EBERGN	0.08	0.09	0.02	0.64	-0.03	0.76	-0.11	<0.01
	EBERGR	0.09	0.06	0.07	0.13	-0.06	0.57	-0.08	0.01
	EBERGL	-0.08	0.49	0.14	0.06	-0.23	0.36	-0.15	0.05
	All species richness	0.67	0.3	1.27	0.02	-0.72	0.52	-0.85	0.03
	AWI species	0.13	0.59	0.13	0.58	0.4	0.4	-0.07	0.7
	Nectar species	0.87	0.07	0.16	0.74	-0.23	0.73	-0.74	0.02
	CSM pos species	-0.1	0.72	0.39	0.2	-0.42	0.56	-0.31	0.17
	CSM neg species	0.12	0.88	0.58	0.1	0.14	0.89	-0.5	0.06
	Canopy height	0.1	0.32	0	0.98	-0.29	0.2	0.05	0.52

- Ellenberg N and R seem to be levelling off more in ERAMMP in plots which were in historic AES schemes.

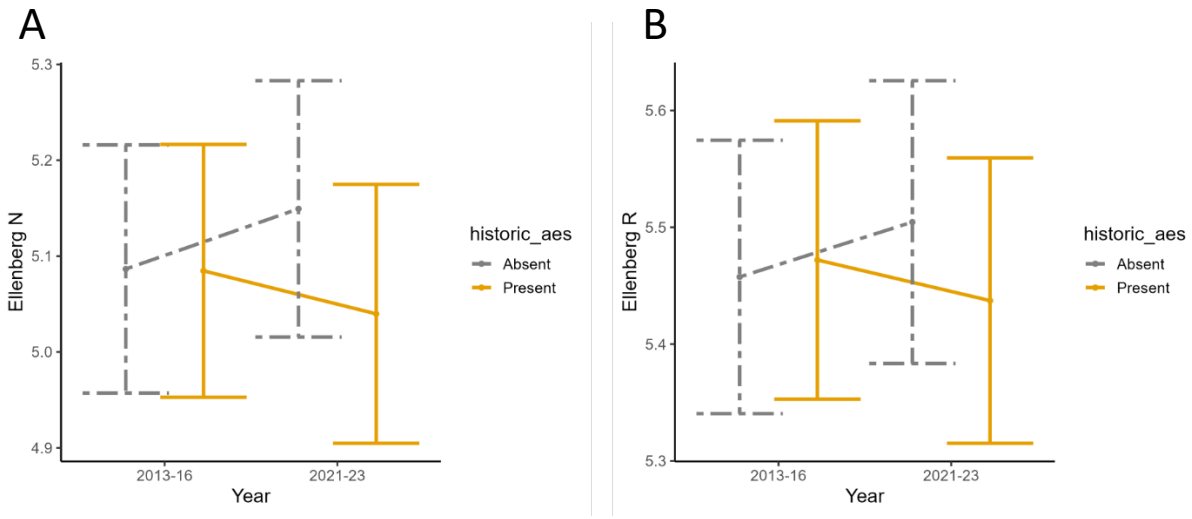

Figure 3-37 Trend in A) Ellenberg fertility and B) Ellenberg reaction between 2013-16 and 2021-23 in Boundaries where historic AES schemes are present or absent.

- Presence in the grazing inputs bundle seems to move boundary plots away from the overall trend of losing total species richness.

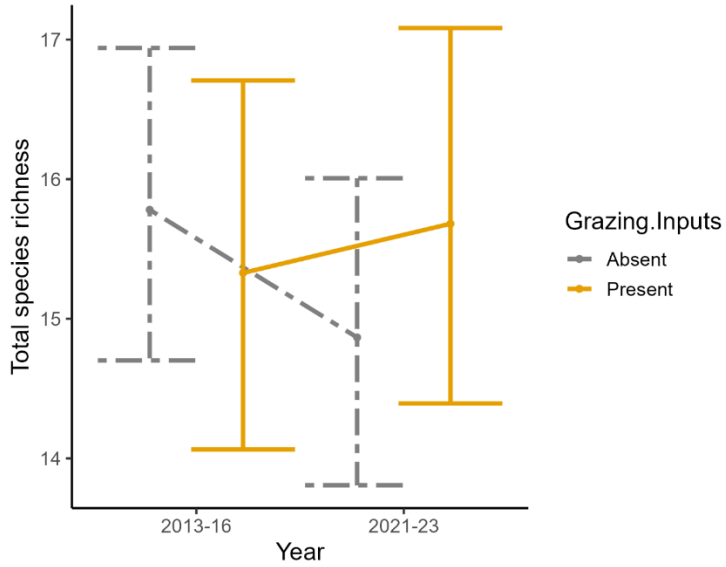

Figure 3-38 Trend in total species richness between 2013-16 and 2021-23 in Boundaries where Grazing Inputs is present or absent.

3.19 Streamsides

3.19.1 National Trend

*Table 3-24 **National Trend** analysis for Biodiversity indicators in **Streamside plots**. Mean, minimum confidence interval (CI) and maximum CI, mean change and p-values were extracted from models for periods 2013-16 and 2021-23.*

		Trend 1990-2007						Trend 2016-2022			
	Indicator	1990	1998	2007	Mean change	P value	Indicator	2016	2022	Mean change	P value
Streamside plots	EBERGN	4.85	4.89	4.95	0.1	0.02	EBERGN	4.97	5	0.03	0.07
	EBERGR	5.33	5.38	5.4	0.07	0.03	EBERGR	5.42	5.4	-0.02	0.27
	EBERGL	6.53	6.46	6.33	-0.19	<0.01	EBERGL	6.33	6.23	-0.11	0.03
	All species richness	18.62	17.42	16.91	-1.71	<0.01	All species richness	20.48	19.41	-1.07	<0.01
	Nectar species	8.81	8.24	7.92	-0.89	0.02	Nectar species	10.15	9.22	-0.93	<0.01
	AWI species	1.72	1.53	1.56	-0.15	0.29	AWI species	2.26	2.43	0.17	0.09
	CSM pos species	10.94	10.26	9.54	-1.4	<0.01	CSM pos species	11.62	11.26	-0.36	0.15
	CSM neg species	9.65	9.25	8.88	-0.77	0.02	CSM neg species	10.89	10.44	-0.45	0.06
	Canopy height	1.89	2.32	2.44	0.55	<0.01	Canopy height	2.64	2.79	0.15	0.01

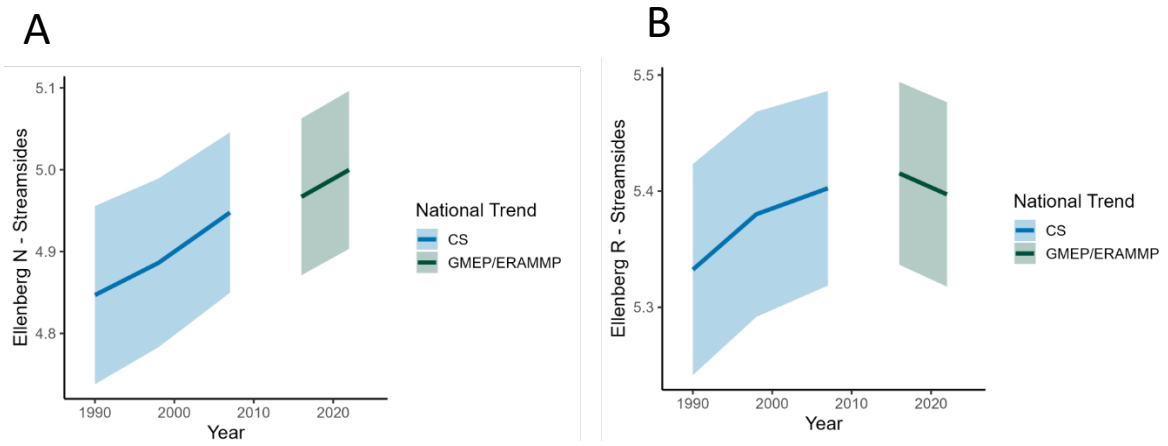

Figure 3-39 Long term national trends in A) Ellenberg N and B) Ellenberg R in Streamside plots from Countryside Survey squares in Wales (1990 to 2007) and GMEP/ERAMMP (2013 – 16 to 2021 – 2023) from nationally representative survey squares.

- Figure 3-39 shows Ellenberg N continuing to rise consistently. Ellenberg R seems to have levelled off.
- Figure 3-40 shows increasing canopy height continuing through recent years.
- Opposite trend for mean Ellenberg light score, indicating greater shading. Also an ongoing reduction in total species richness.
- AWI species richness increasing in recent years. Altogether suggesting a shift to more shade tolerant species as the canopy closes, favouring a gradual colonisation of slow dispersing AWI species but not yet at a rate to offset loss of more light demanding species.

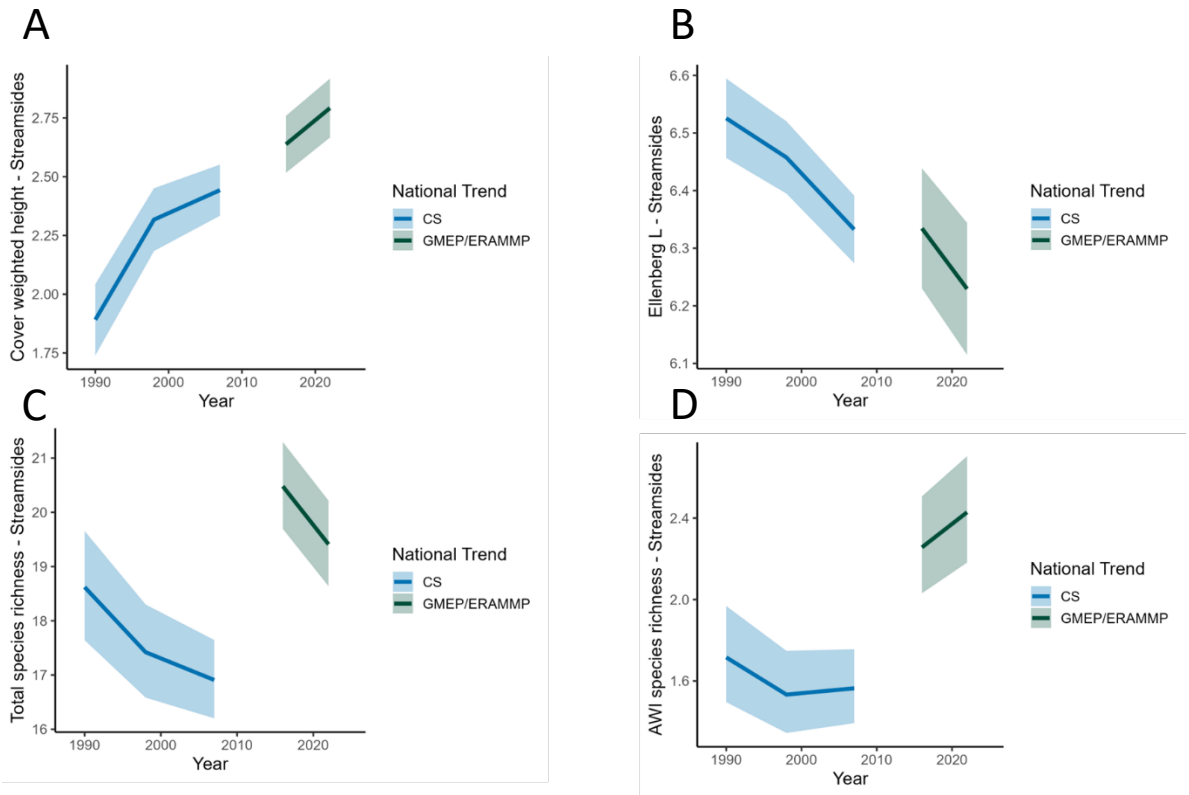

Figure 3-40 National trends in indicators in streamside (S and W) plots.

3.19.2 Glastir Impact

Table 3-25 Glastir analysis for Biodiversity indicators for Streamside plots. Glastir management bundles assessed for effects on Biodiversity indictors are shown, but greyed out where data did not allow for analysis. Context effect was tested using information related to participation in historic agri-environment schemes.

		Habitat Management - General		Grazing Input Management		Wildlife Corridor Management		Context: Historic AES	
	Indicator	**Glastir effect**	**P value**	**Glastir effect**	**P value**	**Glastir effect**	**P value**	**Glastir effect**	**P value**
Streamsides	EBERGN	-0.09	0.16	-0.04	0.52	-0.11	0.28	-0.03	0.52
	EBERGR	-0.04	0.37	-0.06	0.21	-0.01	0.89	-0.03	0.4
	EBERGL	0.22	0.24	0.07	0.55	0.01	0.97	-0.13	0.22
	All species richness	-0.56	0.38	-0.22	0.84	-1.97	0.15	0.7	0.17
	Nectar species	-0.16	0.6	-0.49	0.44	-1.15	0.35	0.45	0.21
	AWI species	-0.08	0.87	0.09	0.81	-0.18	0.8	-0.13	0.62
	CSM pos species	-0.1	0.82	-0.15	0.84	-0.77	0.35	0.22	0.48
	CSM neg species	-0.63	0.13	-0.06	0.91	-2.28	0.01	0.6	0.08
	Canopy height	0.12	0.32	-0.15	0.22	0.07	0.76	0	0.98

Few Glastir effects were detected, possibly because the effect of long-term canopy cover increases on the Vegetation is just too strong to pick up any more subtle management effects happening underneath. CSM negative species do seem to be declining in wildlife corridor plots.

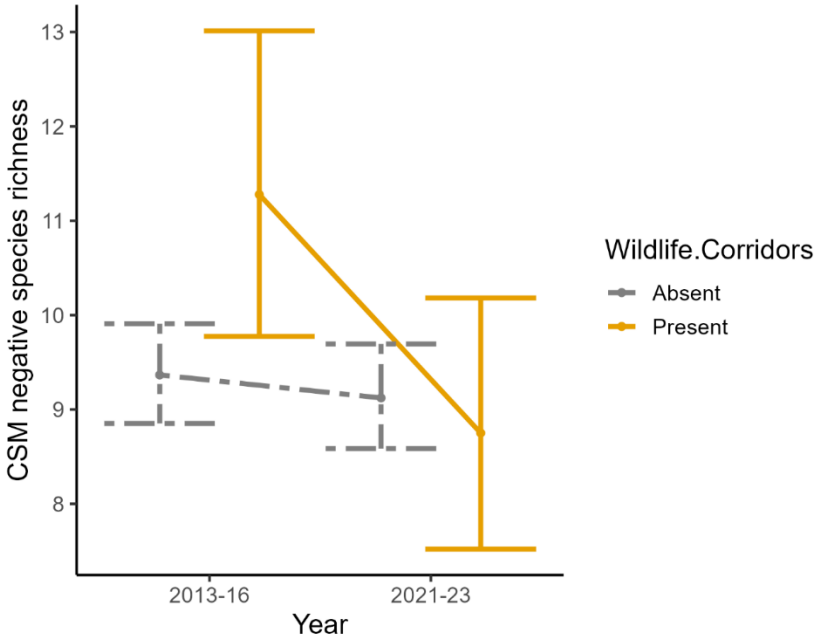

Figure 3-41 Change in CSM negative indicator richness in S plots with wildlife corridor Glastir interventions present versus absent,

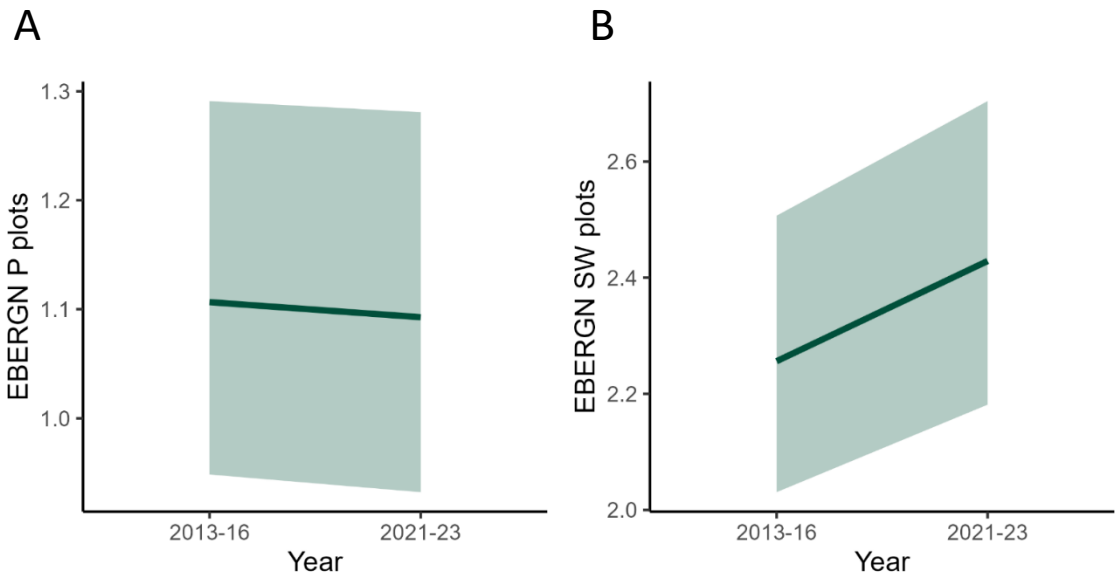

Figure 3-21 Change in mean Ellenberg fertility in A) P plots and B) S & W plots on streamsides in GMEP/ERAMMP.

Note on P vs S plots: This difference in terms of wildlife corridors is much stronger in SW plots for CSM negative species (below) but looks like a stronger negative trend for CSM positive species in wildlife corridors in the P plots (further below) although quite big error bars and different axes. P plots have more species to start with reflecting much higher beta diversity across the often zoned vegetation captured by this plot type moving up the bank. Trends were separately for P versus S and W plots.

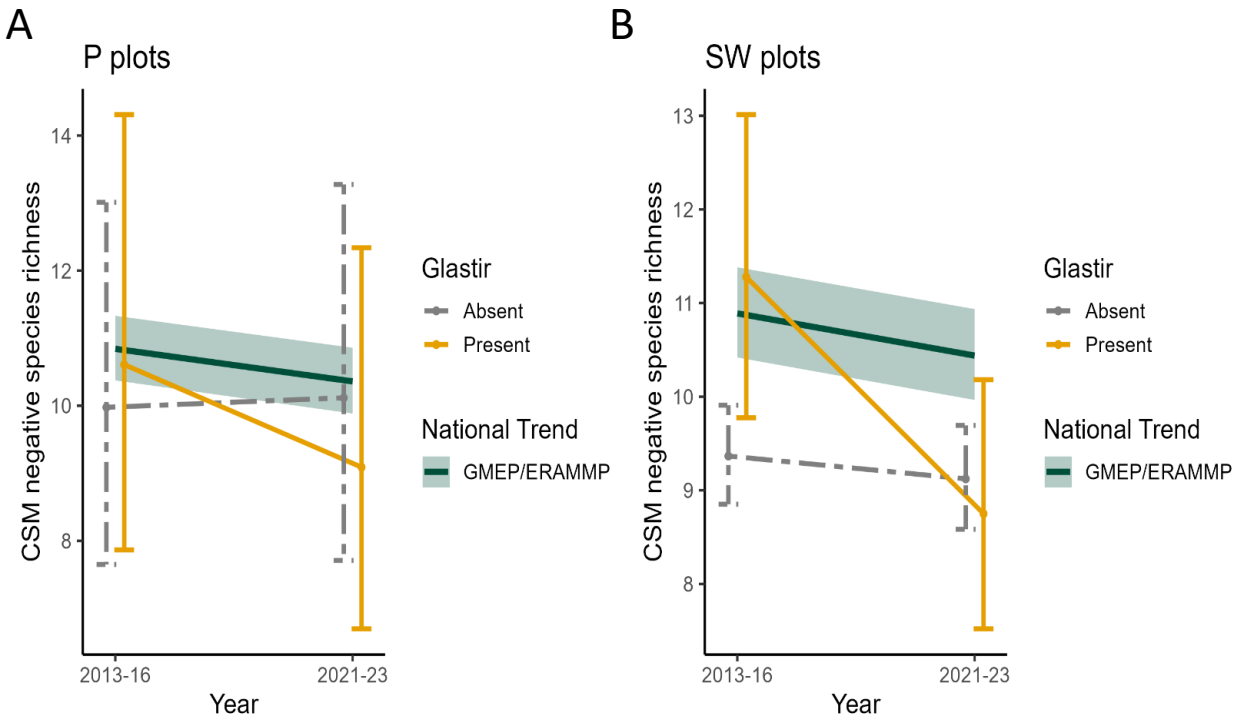

Figure 3-43 Comparison of trends in CSM negative species in plots in Wildlife corridors bundle (present, yellow lines) vs not (absent, grey lines) overlaid onto national trends. For A) P plots and B) SW plots separately.

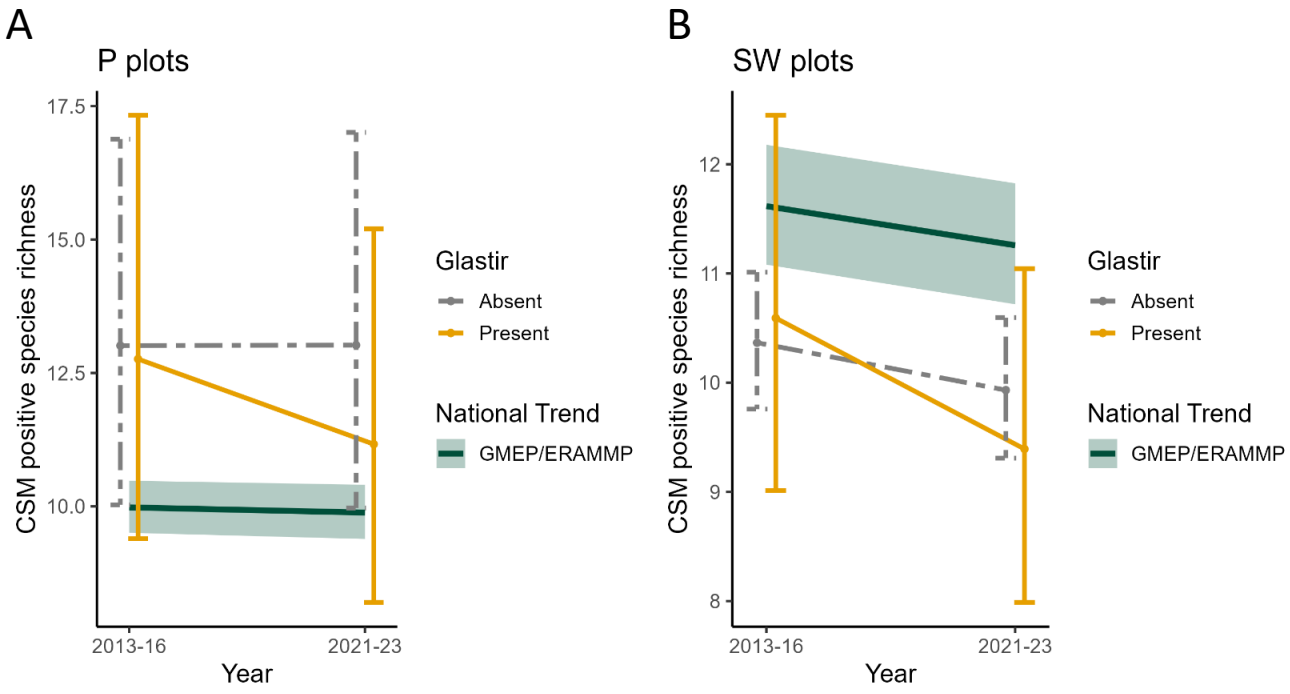

Figure 3-22 Comparison of trends in CSM positive species in plots in Wildlife corridors bundle (present, yellow lines) vs not (absent, grey lines) overlaid onto national trends. For A) P plots and B) SW plots separately.

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