Environment and Rural Affairs Monitoring & Modelling Programme (ERAMMP)

ERAMMP Report-30TA1:
Analysis of National Monitoring Data in Wales for the State of Natural Resources Report 2020 - TECHNICAL ANNEXES

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Contents

1 Annex 1: Addendum to ERAMMP Year 1 Report 20: Reanalysis of data for SoNaRR

The Glastir Monitoring and Evaluation Programme (GMEP) final report (https://gmep.wales/sites/default/files/GMEP-Final-Report-2017.pdf) presented an analysis of trends in condition and soil properties of woodland, improved land and "habitat" land ("habitat" representing all non-woodland, non-improved land; Emmett and the GMEP team, 2017).

A later report (https://erammp.wales/sites/default/files/ERAMMP%20Rpt%2020%20SoNaRR%20v1.0.pdf) presented in year 1 of the Environment and Rural Affairs Monitoring & Modelling Programme (ERAMMP) increased the relevance of reported land use categories to SoNaRR 2020, while incorporating all four years of GMEP data (Maskell et al., 2019). This analysis divided "habitat" land into semi-natural grassland (SNG) and mountain moor & heath (MMH).

This annex aims to answer some key questions relayed to UKCEH by NRW about the ERAMMP year 1 report:

1) What is the breakdown of data in the four reported categories – woodland, improved land, SNG and MMH – in terms of broad habitats?
2) How should the values in tables and graphs of the report be represented by NRW? Where do the numbers come from, and what do they mean?

We present the breakdown of numbers of reported vegetation plots and soil samples across broad habitats, and across surveys, within each of the four reported categories. We provide a statement to aid interpretation of graphs and tables in ERAMMP Report 20. We aim to provide such information during further, in-depth analysis requested by NRW technical leads.

SoNaRR category breakdowns

Table 1. *Survey breakdown of vegetation plots included in the biodiversity analysis of ERAMMP Report 20. 1990-2007 plots are from CS; 2016 plots are from GMEP 2013-2016. 3,120 plots total.*

	SNG	Improved	MMH	Woodland
1990	109	105	85	50
1998	193	146	234	81
2007	308	265	260	155
2016	267	313	353	196

Table 2. *Broad habitat breakdown of vegetation plots included in the biodiversity analysis of ERAMMP Report 20. 3,120 plots total.*

	SNG	Improved	MMH	Woodland
Acid grassland	545	0	0	0
Calcareous grassland	5	0	0	0
Neutral grassland	327	119	0	0
Improved grassland	0	710	0	0
Bog	0	0	157	0
Bracken	0	0	199	0
Dwarf shrub heath	0	0	221	0
Fen, marsh and swamp	0	0	317	0
Inland rock	0	0	11	0
Montane habitats	0	0	4	0
Broadleaved, mixed and yew woodland	0	0	0	482

Table 3. *Survey breakdown of soil samples included in the soils analysis of ERAMMP year 1 report 20. 1978-2007 plots are from CS; 2016 plots are from GMEP 2013-2016. 1,266 soil samples total.*

	SNG	Improved	MMH	Woodland
1978	16	46	6	15
1998	16	46	10	15
2007	95	234	50	62
2016	162	326	79	88

Table 4. *Broad habitat breakdown of soil samples included in the soils analysis of ERAMMP Report 20. 1,266 soil samples total.*

	SNG	Improved	MMH	Woodland
Acid Grassland	132	0	0	0
Calcareous Grassland	1	0	0	0
Neutral Grassland	156	102	0	0
Arable and horticultural	0	42	0	0
Improved Grassland	0	508	0	0
Bog	0	0	29	0
Bracken	0	0	31	0
Dwarf Shrub Heath	0	0	41	0
Fen, Marsh and Swamp	0	0	40	0
Inland Rock	0	0	2	0
Montane habitats	0	0	1	0
Broadleaved, mixed and yew woodland	0	0	0	85
Coniferous Woodland	0	0	0	95

Statement on interpretation of graphs and table values

Values presented in the ERAMMP Report 20, as well as the GMEP final report, should be called “estimates”.

They are slightly different to simple means within a given category in a given survey period. Simple means are often useful, but in this analysis they are not optimal to summarise survey data over time across multiple categories. This is because of the spatio-temporal structure of sampling within Countryside Survey (CS) and GMEP. For example, many soil samples/vegetation plots were recorded in each 1km square, and some (but not all) 1km squares were visited multiple times from 1978-2016. We account for spatial structure and repeated measures by using Generalised Linear Mixed Models to analyse the data (Scott, 2008).

As such, the values in graphs and figures represent the average of a given variable (e.g. soil carbon, species richness) within a given land use category given the spatial structure and repeated measures in CS and GMEP data. More specifically, the values presented are predictions (+/- 95% confidence intervals) from GLMMs.

Discussion

The above results should add clarity to, and aid interpretation of, the trends shown in both the ERAMMP Report 20 (Maskell et al., 2019) and the GMEP final report (Emmett and the GMEP team, 2017). For example, 610 grassland soil samples were included in the trend for improved land (i.e. enclosed farmland) as compared with only 42 arable soil samples. This elucidates how the trends in that category are underpinned largely by improved and neutral grassland rather than arable land.

References

Emmett, B.A., the GMEP team, 2017. Glastir Monitoring & Evaluation Programme. Final Report to Welsh Government. Contract reference: C147/2010/11. NERC/Centre for Ecology & Hydrology (CEH Projects: NEC04780/NEC05371/NEC05782).

Maskell, L.C., Alison, J., Smart, S.M., 2019. ERAMMP Year 1 Report 20: GMEP Outstanding Analysis Part 1 - Re-analysis of data for SoNaRR. Report to Welsh Government (Contract C210/2016/2017). Centre for Ecology & Hydrology Project NEC06297.

Scott, W.A., 2008. CS Technical Report No. 4/07: Statistical Report. NERC/Centre for Ecology & Hydrology, (CEH Project Number: C03259).

2 Annex 2: Analysis of habitat extent from GMEP

This appendix presents analysis of broad habitat extent that has been done since GMEP. Results for neutral grassland are under review, while results for priority habitats are currently only available for the GMEP period from 2013-2015. Note that broad and priority habitat definitions here do not always align with those used by NRW. Graphs display estimates and 95% bootstrap confidence intervals for habitat extent over time. References are (1) Blackstock, T.H., Howe, E.A., Stevens J.P., Burrows, C.R. & Jones, P.S. (2010) Habitats of Wales: A Comprehensive Field Survey, 1979-1997. University of Wales Press and (2) Jones, P.S., Stevens, D.P., Blackstock, T.H., Burrows, C.R. & Howe, E.A. (2003). Priority Habitats of Wales - a Technical Guide. Countryside Council for Wales, Bangor.

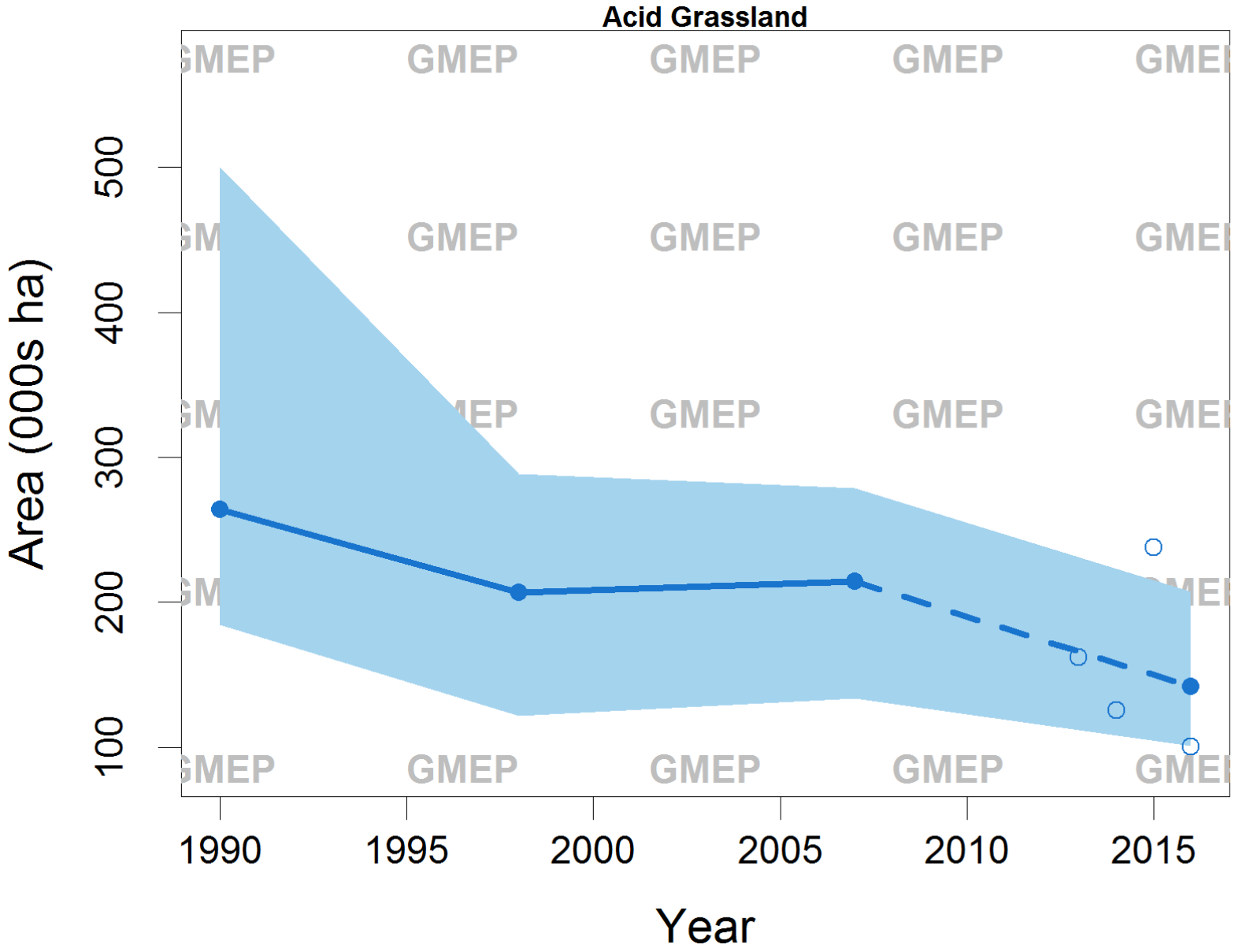
Table A2.1: National estimates of Broad Habitat extents from GMEP 2013-2016 data ('000's ha)

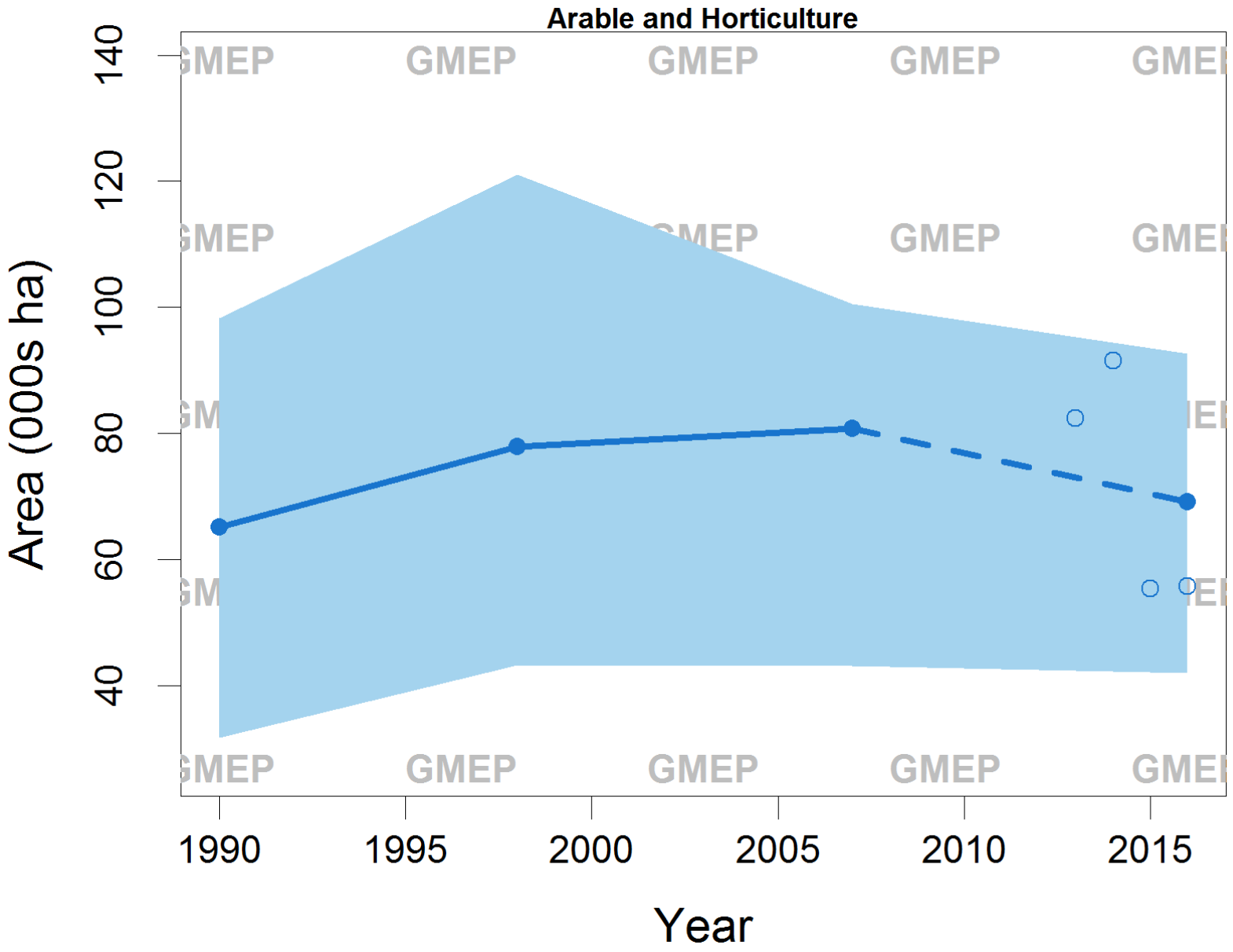
Broad Habitats	1998			2007			GMEP 2013/14/15			Direction of significant changes 1998-2007	FC estimates 2014	Blackstock et al 2010
	Area Estimate	*Lower_est*	*Upper_Est*	**Area Estimate**	*Lower_est*	*Upper_Est*	**Area Estimate**	*Lower_est*	*Upper_Est*			
Broadleaved, Mixed & Yew Woodland	178.0	130.4	247.8	175.0	132.2	186.4	173.4	142.2	207.7	ns	**156**	**112.4**
Coniferous Woodland	137.9	43.5	201.5	144.8	64.9	193.6	129.4	92.2	208.4	**ns**	**150**	**172.1**
Arable & Horticulture	77.9	43.2	121.1	80.8	43.1	100.5	69.1	42.0	92.6	ns		
Improved Grassland	778.6	496.9	782.5	799.4	616.0	837.5	539.6	503.8	667.5	↓2007-GMEP		**1026**
Neutral Grassland	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A		**35.1**
Calcareous Grassland	0.9	0.0	2.1	1.0	0.0	2.5	0.5	0.0	1.2	ns		**1.8**
Acid Grassland	206.5	121.8	288.3	214.5	133.6	278.9	141.8	100.7	207.3	ns		**152.7**
Bracken	87.1	38.1	154.5	41.0	26.4	63.8	55.9	30.2	80.4	ns		**62.7**
Dwarf Shrub Heath	92.9	56.5	187.6	111.2	61.2	180.2	93.0	43.3	123.8	**ns**		**91.6**
Fen, Marsh & Swamp	48.1	25.8	82.9	47.0	23.8	62.1	72.6	52.5	103.0	↑2007-GMEP		**20.9**
Bog	54.0	21.4	86.3	57.1	21.7	84.7	52.7	28.0	77.3	ns		**58**
Montane	0.1	0.0	0.3	0.1	0.0	0.2	3.1	0.0	9.3	↑2007-GMEP		**?**
Inland rock	7.5	2.8	12.4	7.2	3.3	12.5	3.5	1.1	6.8	**ns**		**7.6**
Built up Areas and gardens	**128.9**	*61*	*211.2*	**143.8**	*103.5*	*189.8*	**99.9**	*72.5*	*130.2*	↓2007-GMEP		**146.3**

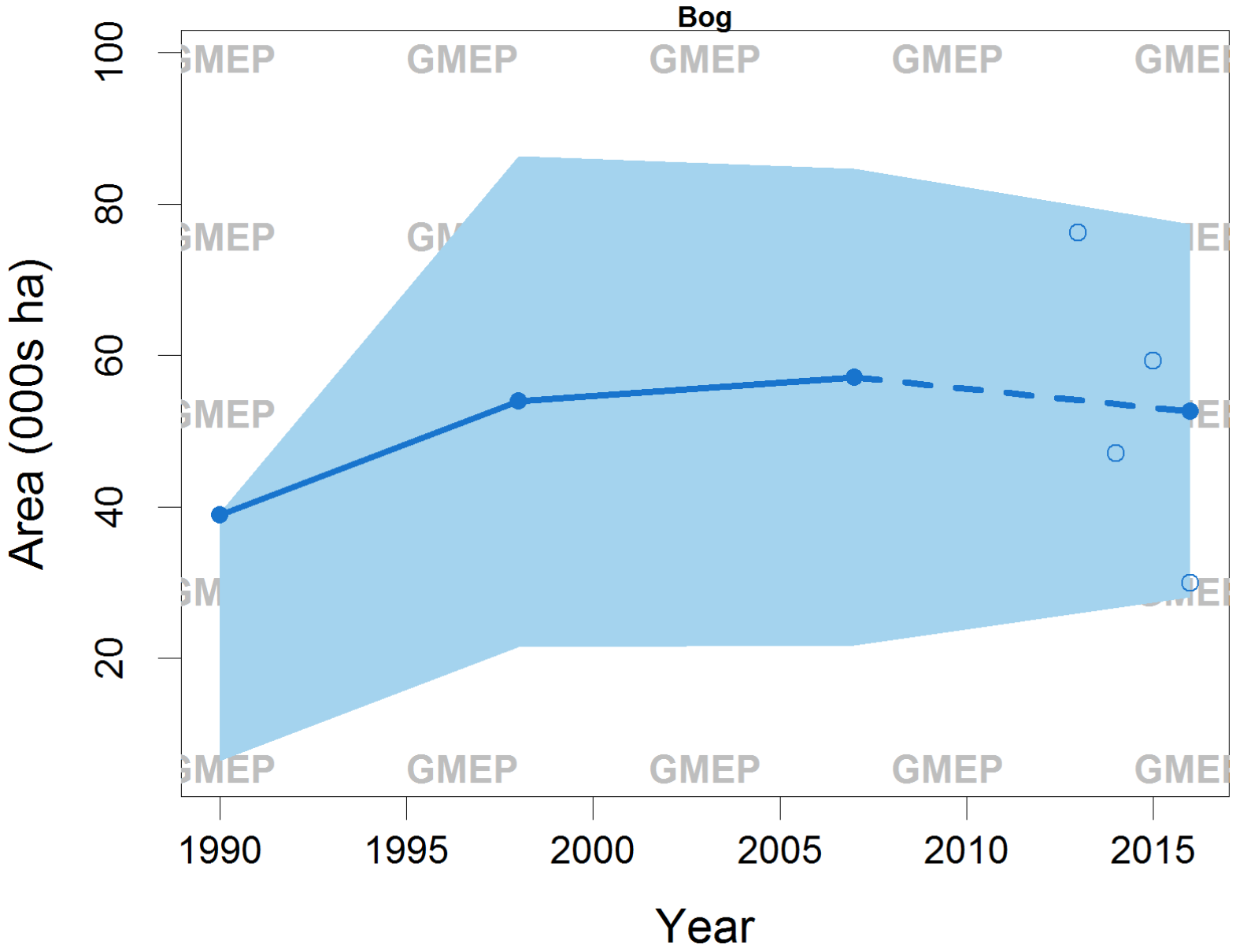
Table A2.2: National estimates of Priority Habitat extents from GMEP 2013-2015 data '000's ha

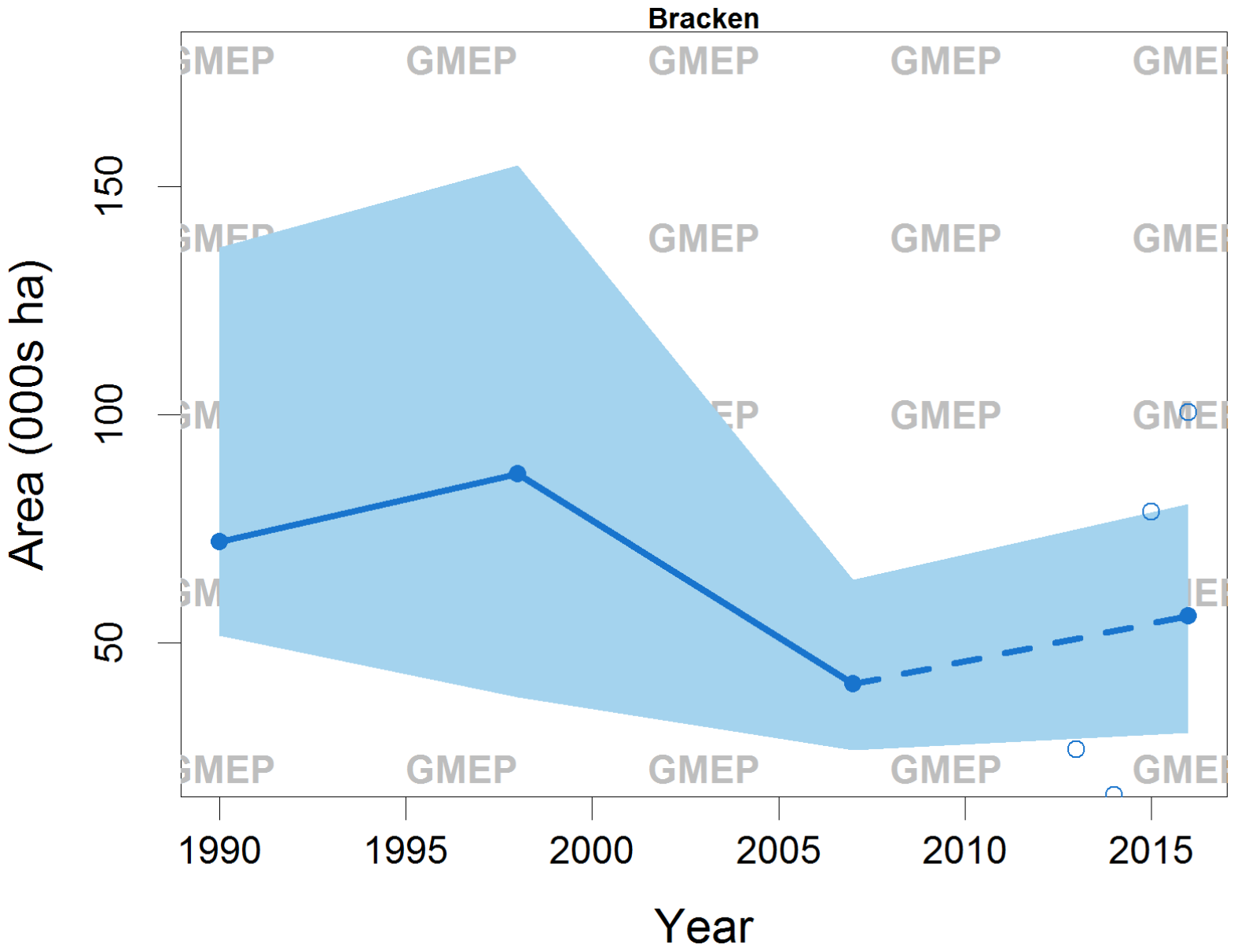
Priority Habitat	2013/14/15	*Lower est.*	*Upper est.*	Jones et al 2003 estimate
Upland Oakwood	**8.60**	*3.20*	*15.12*	**39**
Upland mixed ashwood	**1.03**	*0.20*	*2.10*	**17**
Wet woodland	**27.90**	*17.30*	*40.40*	**9**
Lowland mixed deciduous woodland	**42.10**	*25.70*	*61.10*	**12**
Lowland beech and yew woodland	**3.01**	*0.7*	*6.1*	**4**
Lowland meadows (30)	**4.80**	*2.20*	*8.00*	**1.7**
Purple moor-grass and rush pasture	**56.50**	*32.8*	*86.9*	**34.7**
Lowland heathland	**4.80**	*1.7*	*9.1*	**12.5**
Fen	**14.30**	*6*	*26.2*	**6.2**
Upland heathland	**55.30**	*20.4*	*97*	**79**
Blanket bog	**41.60**	*17.5*	*72.2*	**56.2**
Saltmarsh	**2.80**	*0*	*8.3*	**5.8**
Maritime cliff and slope	**2.70**	*0*	*8.1*	**3.5**
Coastal vegetated shingle	**1.1**	*0.03*	*2.4*	**0.11**
Upland Flush[1]	**11.6**	*2.43*	*24.3*	
Traditional orchards[1]	**2.73**	*0.09*	*6.47*	
Inland rock outcrops and screes[1]	**1.02**	*0.3*	*1.9*	
Upland Calcareous grassland				**0.65**
Limestone pavement				**0.05**
Coastal sand dunes				
Montane				
Cereal field margins[3]				
reedbeds				
Calaminarian grassland				
Lowland calcareous grassland				
Lowland dry acid grassland				
Lowland raised bog				
Coastal and floodplain grazing marsh				

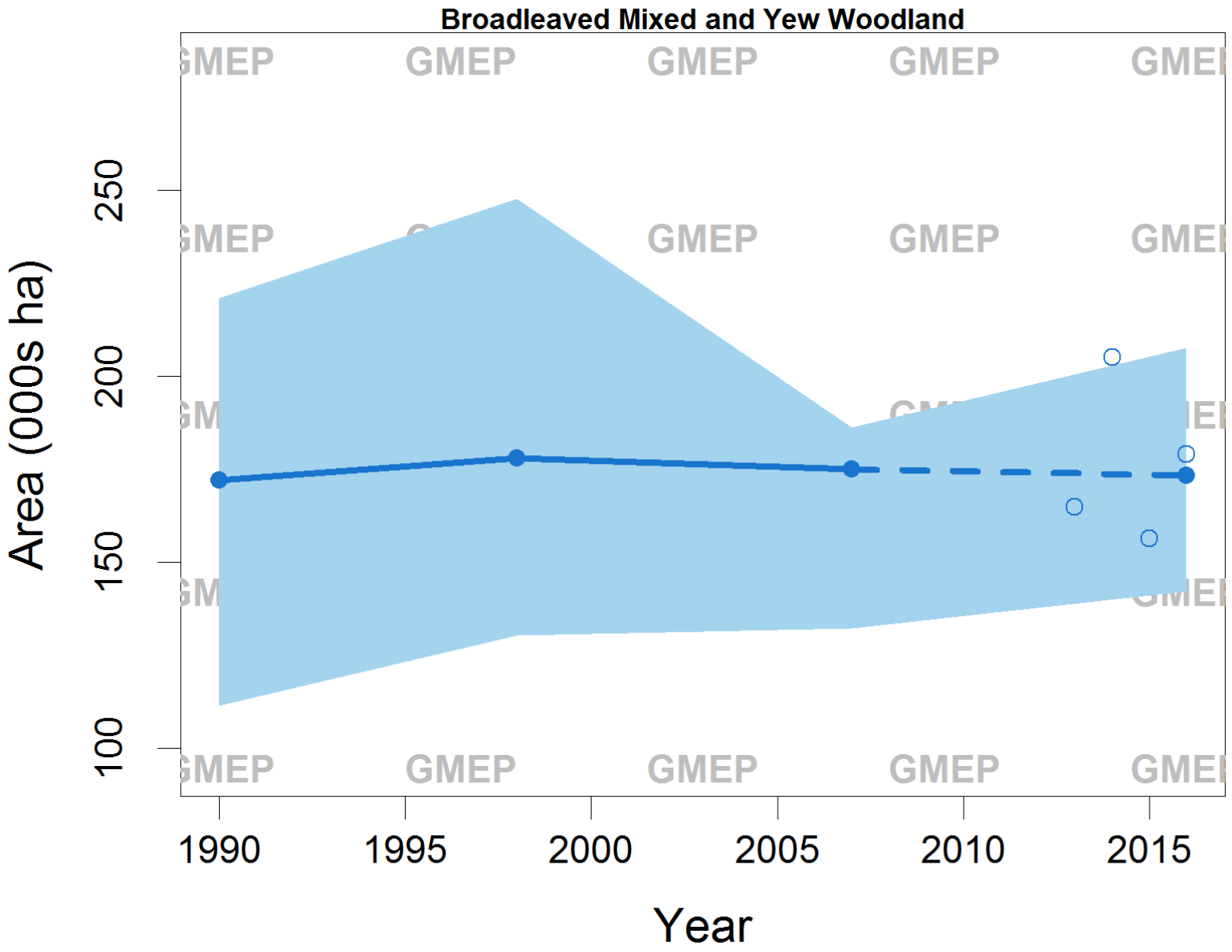
[1]these habitats were calculated using GMEP survey data only, they have mostly been defined since CS2007 so are not present/difficult to define in previous years.
[2]We can report on these habitats but they haven't yet been calculated
[3] We can report on cereal field margin condition from vegetation plots but can't do extent

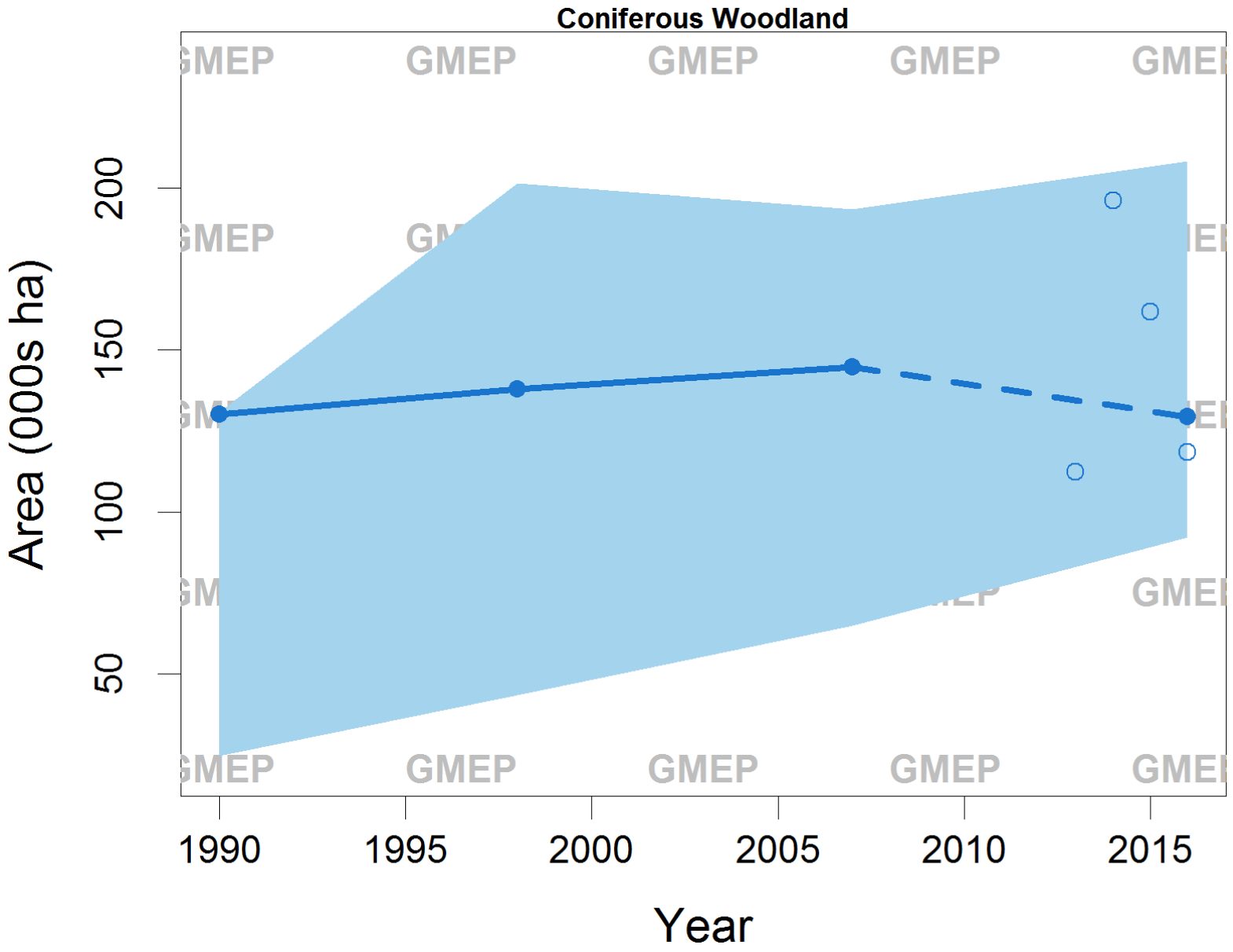

Acid Grassland
Area (000s ha)
100
200
300
400
500
1990
1995
2000
2005
2010
2015
Year
GMEP

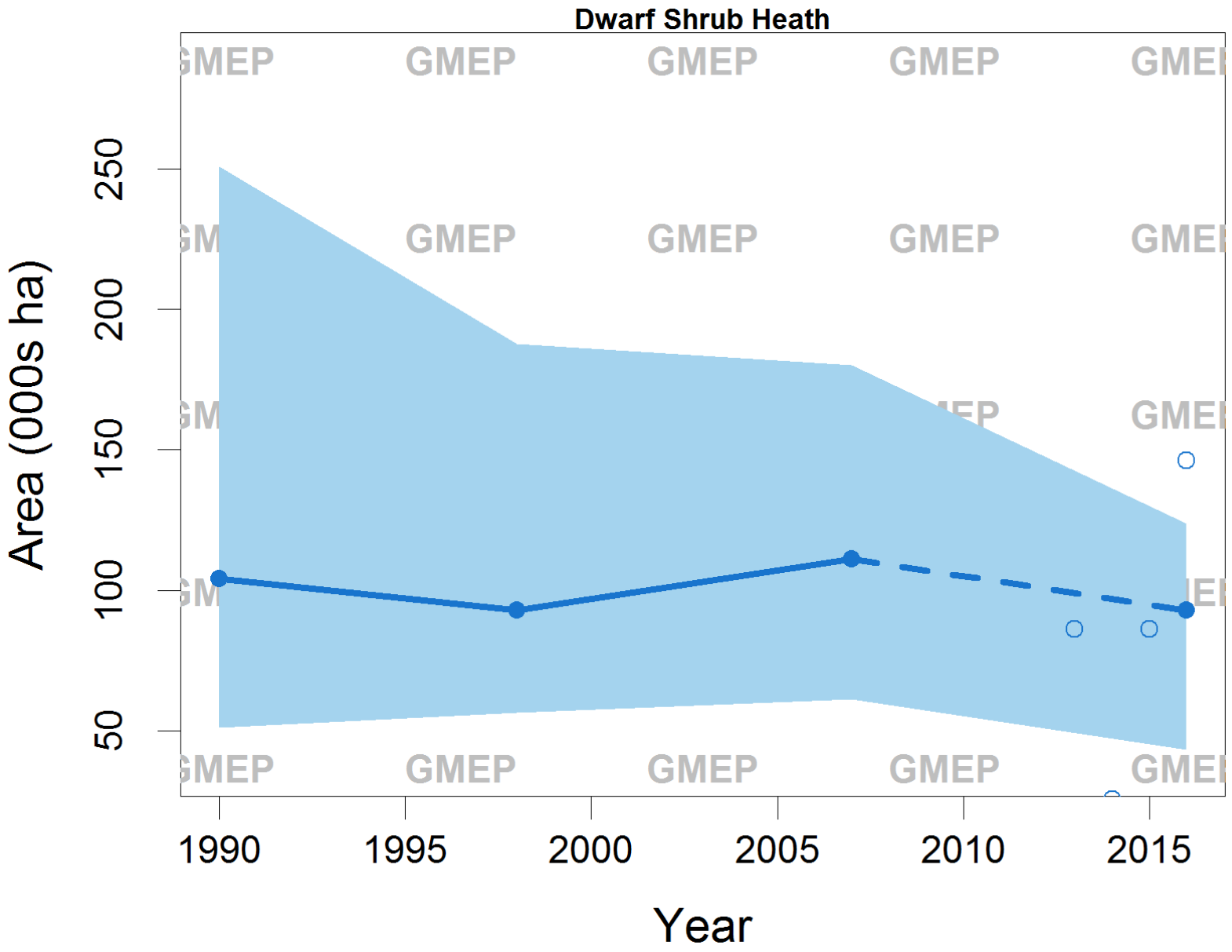

Arable and Horticulture
Area (000s ha)
140
120
100
80
60
40
1990
1995
2000
2005
2010
2015
Year
GMEP

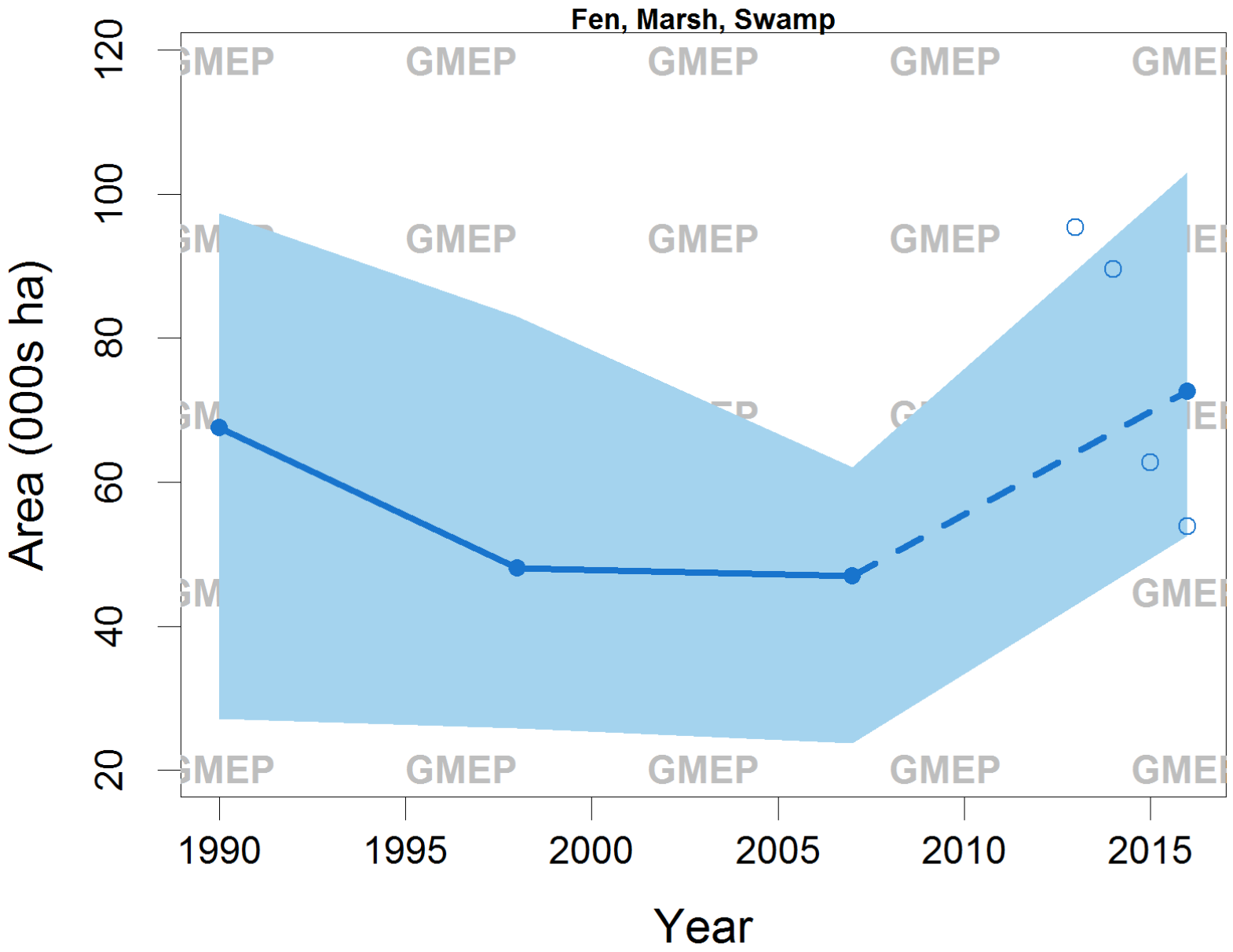

Bog
Area (000s ha)
100
80
60
40
20
1990
1995
2000
2005
2010
2015
Year
GMEP

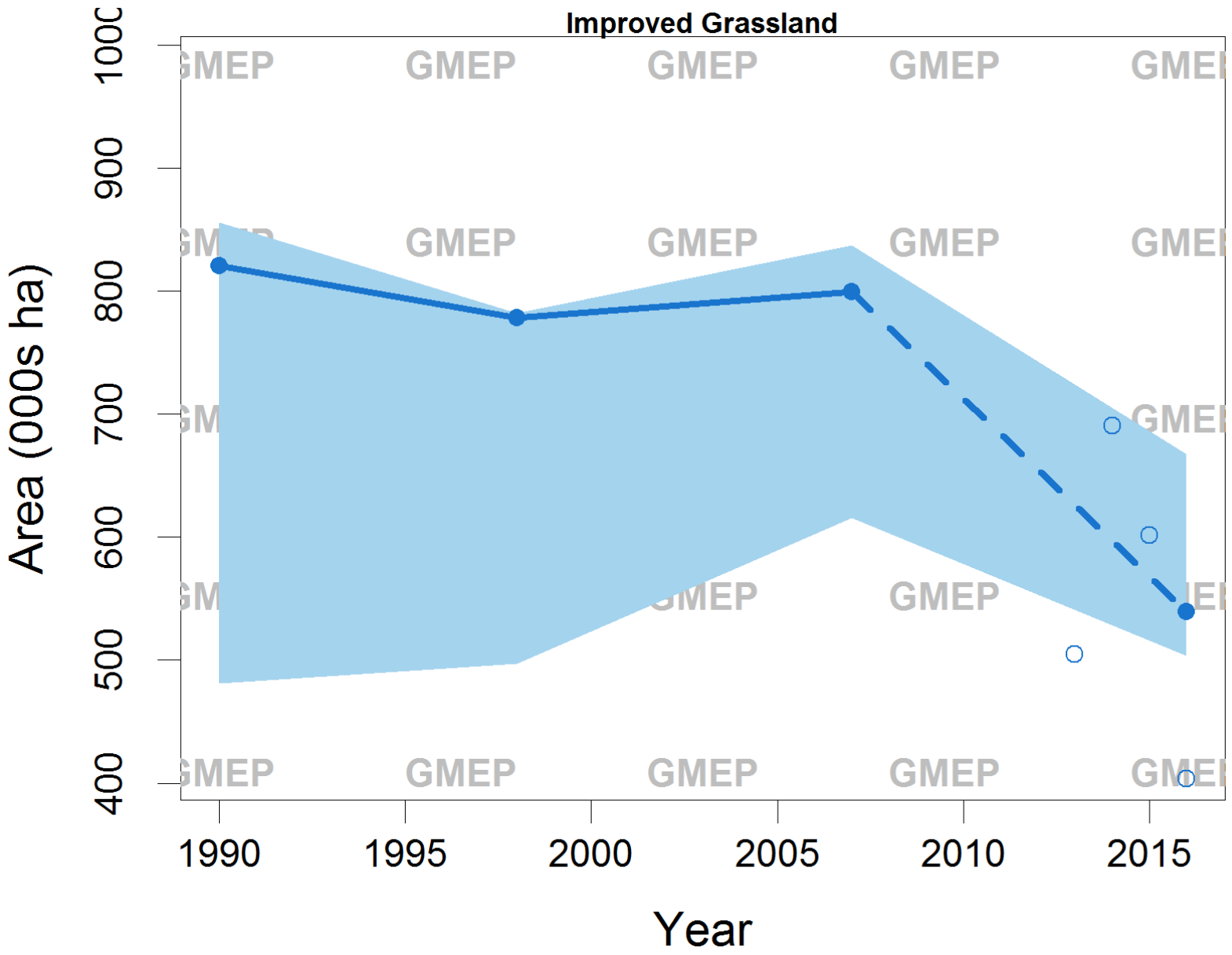

Bracken
Area (000s ha)
150
100
50
1990
1995
2000
2005
2010
2015
Year
GMEP


Broadleaved Mixed and Yew Woodland
Area (000s ha)
100
150
200
250
1990
1995
2000
2005
2010
2015
Year
GMEP


Coniferous Woodland
Area (000s ha)
50
100
150
200
1990
1995
2000
2005
2010
2015
Year
GMEP


Dwarf Shrub Heath
Area (000s ha)
50
100
150
200
250
1990
1995
2000
2005
2010
2015
Year
GMEP


Fen, Marsh, Swamp
Area (000s ha)
20
40
60
80
100
120
1990
1995
2000
2005
2010
2015
Year
GMEP


Improved Grassland
Area (000s ha)
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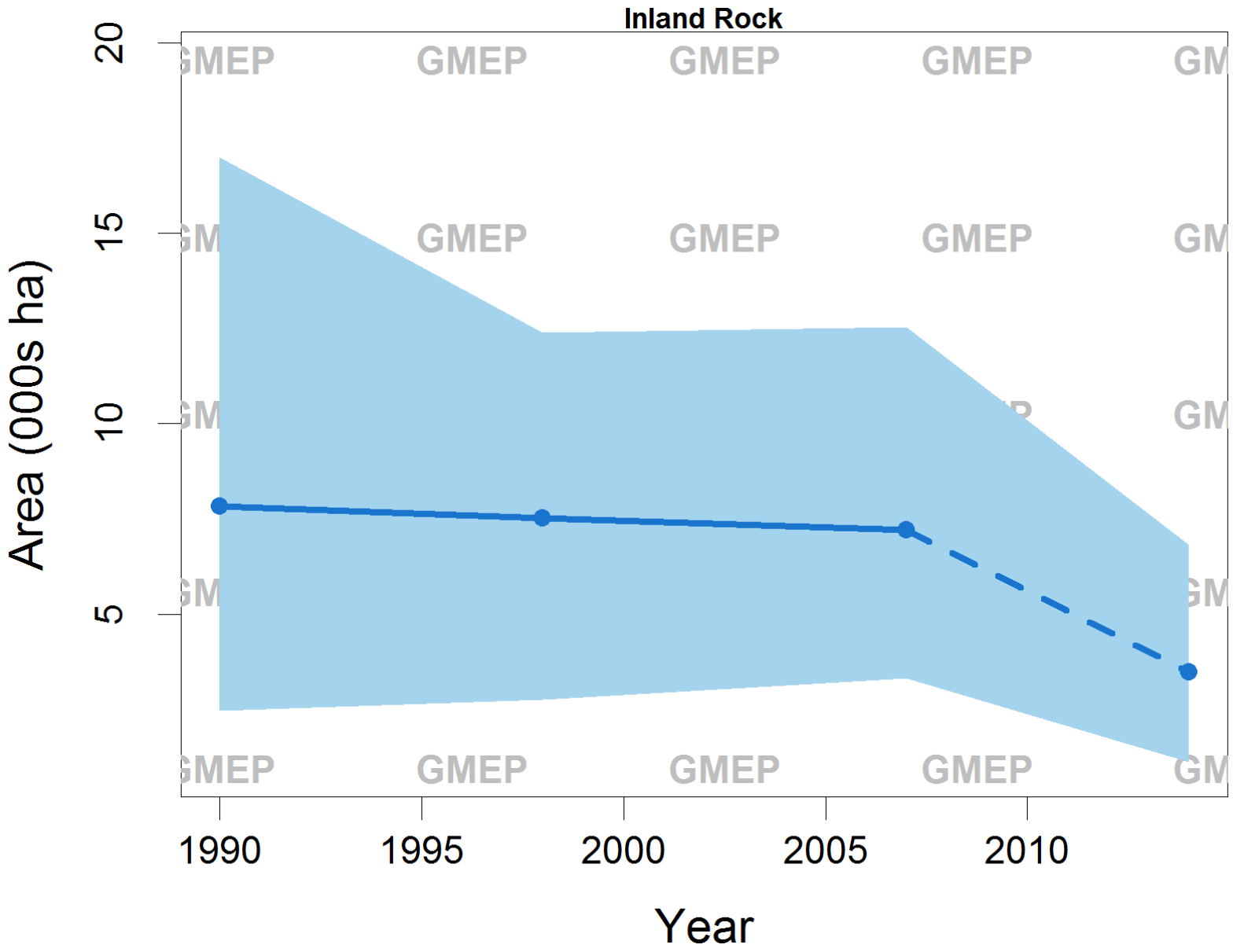
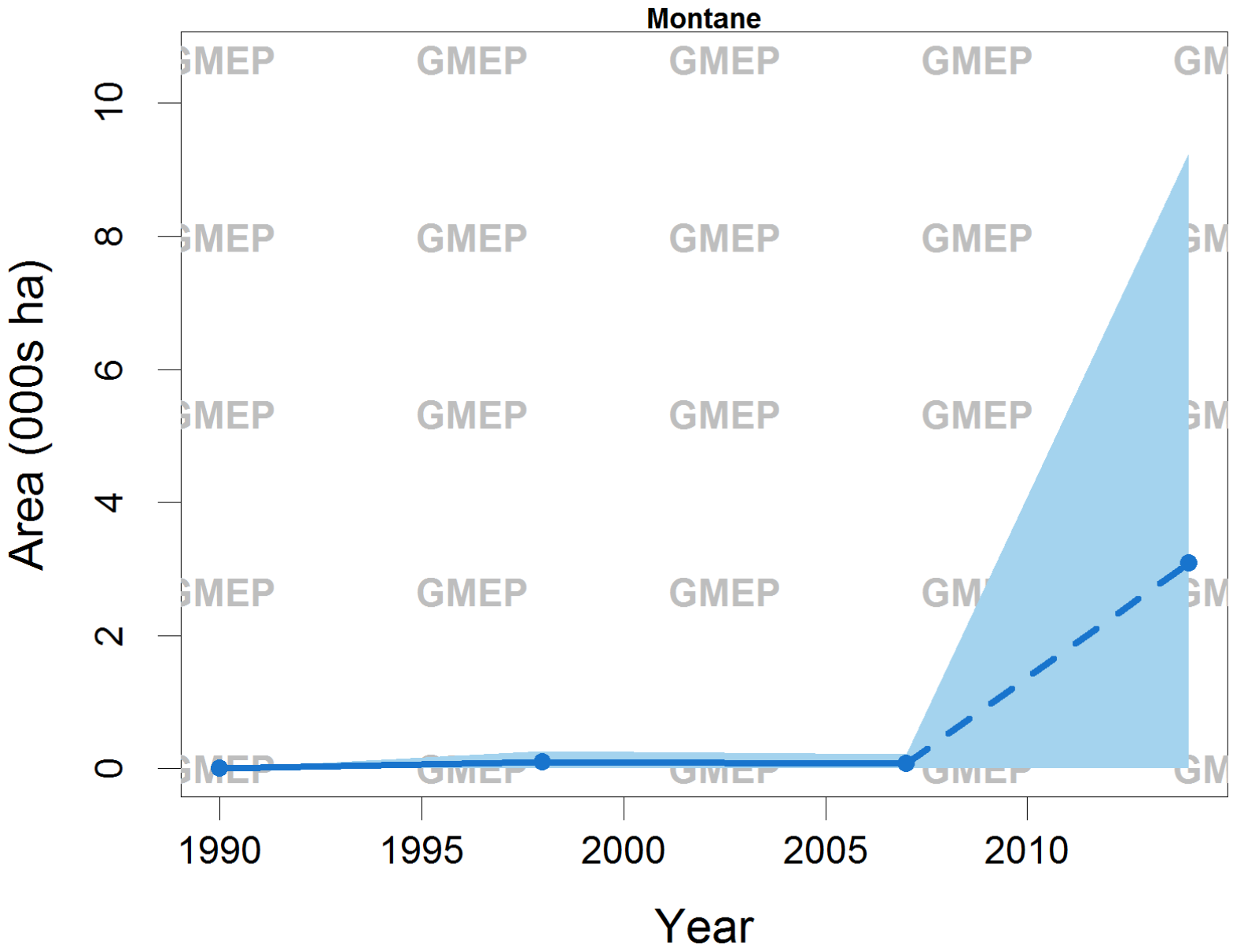
500
600
700
800
900
1000
1990
1995
2000
2005
2010
2015
Year
GMEP


Inland Rock
Area (000s ha)
20
15
10
5
1990
1995
2000
2005
2010
Year


Montane
Area (000s ha)
0
2
4
6
8
10
1990
1995
2000
2005
2010
Year

3 Annex 3: Counts of butterfly species in different groupings

Grouping	Common name	Latin name	Count
Woodland	Ringlet	*Aphantopus hyperantus*	3731
Woodland	Speckled Wood	*Pararge aegeria*	335
Woodland	Small Pearl-bordered Fritillary	*Boloria selene*	37
Woodland	Holly Blue	*Celastrina argiolus*	14
Woodland	High Brown Fritillary	*Argynnis adippe*	5
Woodland	Silver-washed Fritillary	*Argynnis paphia*	5
Woodland	Brimstone	*Gonepteryx rhamni*	4
Woodland	Purple Hairstreak	*Favonius quercus*	4
Woodland	Purple Hairstreak	*Favonius quercus*	4
Woodland	White-letter Hairstreak	*Satyrium w-album*	3
Grassland	Meadow Brown	*Maniola jurtina*	8093
Grassland	Small Heath	*Coenonympha pamphilus*	1514
Grassland	Small Skipper	*Thymelicus sylvestris*	871
Grassland	Common Blue	*Polyommatus icarus*	410
Grassland	Large Skipper	*Ochlodes sylvanus*	273
Grassland	Wall	*Lasiommata megera*	171
Grassland	Small Copper	*Lycaena phlaeas*	150
Grassland	Dark Green Fritillary	*Argynnis aglaja*	116
Grassland	Essex Skipper	*Thymelicus lineola*	32
Grassland	Essex Skipper	*Thymelicus lineola*	32
Grassland	Brown Argus	*Aricia agestis*	13
Grassland	Marbled White	*Melanargia galathea*	11
Grassland	Green Hairstreak	*Callophrys rubi*	1
Garden and hedgerow	Green-veined White	*Pieris napi*	3057
Garden and hedgerow	Gatekeeper	*Pyronia tithonus*	1592
Garden and hedgerow	Small Tortoiseshell	*Aglais urticae*	1115
Garden and hedgerow	Small White	*Pieris rapae*	910
Garden and hedgerow	Large White	*Pieris brassicae*	610

Garden and hedgerow	Peacock	*Aglais io*	497
Garden and hedgerow	Peacock	*Aglais io*	497
Garden and hedgerow	Red Admiral	*Vanessa atalanta*	251
Garden and hedgerow	Comma	*Polygonia c-album*	78
Garden and hedgerow	Painted Lady	*Vanessa cardui*	54
Garden and hedgerow	Clouded Yellow	*Colias croceus*	2
Garden and hedgerow	Brown Hairstreak	*Thecla betulae*	1
Garden and hedgerow	Orange-tip	*Anthocharis cardamines*	0

4 Annex 4: Resources given to surveyors to identify veteran trees

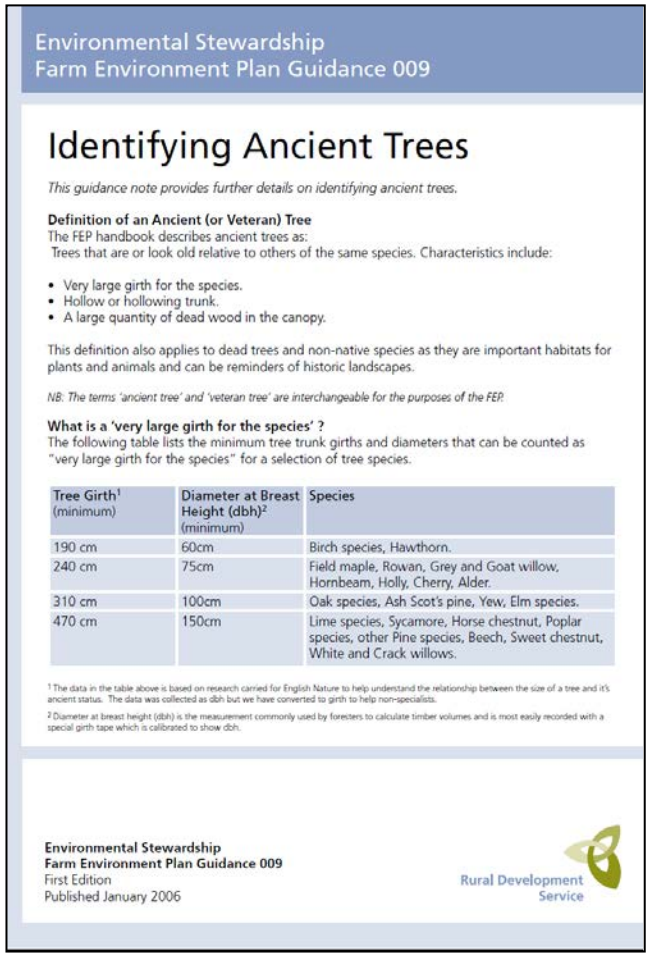
Information given to surveyors to identify veteran trees in 2007:

Species	Max girth (m)	Potentially interesting (32% of max girth)	Valuable (47% of max girth)	Truly ancient (62.5% of max girth)	Rule of thumb if species over girth value = notable
Buxus sempervirens	0.8	0.26	0.38	0.50	> 0.5
Arbutus unedo	1.2	0.38	0.56	0.75	> 0.5
Mespilus germanica	1.5	0.48	0.71	0.94	> 0.5
S. x thuringiaca	1.5	0.48	0.71	0.94	> 0.5
Ilex aquifolium	1.8	0.58	0.85	1.13	>1
Sorbus aria agg	1.9	0.61	0.89	1.19	>1
Sorbus intermedia agg	2	0.64	0.94	1.25	>1
Pyrus pyraster	2	0.64	0.94	1.25	>1
Alnus incarna	2	0.64	0.94	1.25	>1
Populus alba	2	0.64	0.94	1.25	>1
Sorbus aucuparia	2.5	0.80	1.18	1.56	>1
Sorbus latifolia agg	2.7	0.86	1.27	1.69	>1
Sorbus torminalis	2.8	0.90	1.32	1.75	>1
Malus sylvestris	3	0.96	1.41	1.88	>1
Crataegus monogyna	3	0.96	1.41	1.88	>1
Acer campestre	3	0.96	1.41	1.88	>1
Betula pubescens	3	0.96	1.41	1.88	>1
Betula pendula	3	0.96	1.41	1.88	>1
Salix fragilis	3.5	1.12	1.65	2.19	> 2
Alnus glutinosa	3.7	1.18	1.74	2.31	> 2
Salix caprea	4	1.28	1.88	2.50	> 2
Acer platanoides	4	1.28	1.88	2.50	> 2
Carpinus betulus	4	1.28	1.88	2.50	> 2
Quercus ilex	4.3	1.38	2.02	2.69	> 2
Prunus avium	4.5	1.44	2.12	2.81	> 2
Robinia pseudoaccacia	5	1.60	2.35	3.13	> 3
Populus nigra	5	1.60	2.35	3.13	> 3
U. x hollandica	5	1.60	2.35	3.13	> 3
P. x canescens	5	1.60	2.35	3.13	> 3
Pinus sylvestris	5	1.60	2.35	3.13	> 3
U. x vegeta	5.5	1.76	2.59	3.44	> 3
Tilia platyphyllos	5.8	1.86	2.73	3.63	> 3
Juglans regia	6	1.92	2.82	3.75	> 3
Tilia cordata	6	1.92	2.82	3.75	> 3
Fraxinus excelsior	6	1.92	2.82	3.75	> 3
P. x canadensis var serotina	6	1.92	2.82	3.75	> 3
Ulmus minor	6.1	1.95	2.87	3.81	> 3
Fagus sylvatica	6.2	1.98	2.91	3.88	> 3
Aesculus hippocastanum	6.4	2.05	3.01	4.00	> 4
Acer pseudoplatanus	7	2.24	3.29	4.38	> 4
Ulmus procera	7	2.24	3.29	4.38	> 4
Ulmus glabra	7	2.24	3.29	4.38	> 4

T.x europea	7	2.24	3.29	4.38	> 4
Quercus cerris	8	2.56	3.76	5.00	> 4
Quercus petraea	8.9	2.85	4.18	5.56	> 4
Taxus baccata	10	3.20	4.70	6.25	> 4
Castanea sativa	10	3.20	4.70	6.25	> 4
Quercus robur	10	3.20	4.70	6.25	> 4

Girth data from Mitchell, A. F. 1974 A field guide to the trees of Britain & N. Europe. Categories from Read, H. 2000 Veteran trees: a guide to good management. English Nature. Proportions calculated assuming overall 10m max girth and girth classes from Read: 3.2 m potentially interesting (1 m dbh), 4.7 m valuable (1.5 m dbh), 6.25 m truly ancient (2.0 m dbh). Compiled by Heather Robertson, English Nature.

Additional information given to surveyors to identify veteran trees in GMEP (2013-2016):



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Identifying Ancient Trees

This guidance note provides further details on identifying ancient trees.

Definition of an Ancient (or Veteran) Tree
The FEP handbook describes ancient trees as:
Trees that are or look old relative to others of the same species. Characteristics include:

- Very large girth for the species.
- Hollow or hollowing trunk.
- A large quantity of dead wood in the canopy.

This definition also applies to dead trees and non-native species as they are important habitats for plants and animals and can be reminders of historic landscapes.

NB: The terms 'ancient tree' and 'veteran tree' are interchangeable for the purposes of the FEP.

What is a 'very large girth for the species' ?
The following table lists the minimum tree trunk girths and diameters that can be counted as "very large girth for the species" for a selection of tree species.

Tree Girth[1] (minimum)	Diameter at Breast Height (dbh)[2] (minimum)	Species
190 cm	60cm	Birch species, Hawthorn.
240 cm	75cm	Field maple, Rowan, Grey and Goat willow, Hornbeam, Holly, Cherry, Alder.
310 cm	100cm	Oak species, Ash Scot's pine, Yew, Elm species.
470 cm	150cm	Lime species, Sycamore, Horse chestnut, Poplar species, other Pine species, Beech, Sweet chestnut, White and Crack willows.

[1] The data in the table above is based on research carried for English Nature to help understand the relationship between the size of a tree and it's ancient status. The data was collected as dbh but we have converted to girth to help non-specialists.

[2] Diameter at breast height (dbh) is the measurement commonly used by foresters to calculate timber volumes and is most easily recorded with a special girth tape which is calibrated to show dbh.

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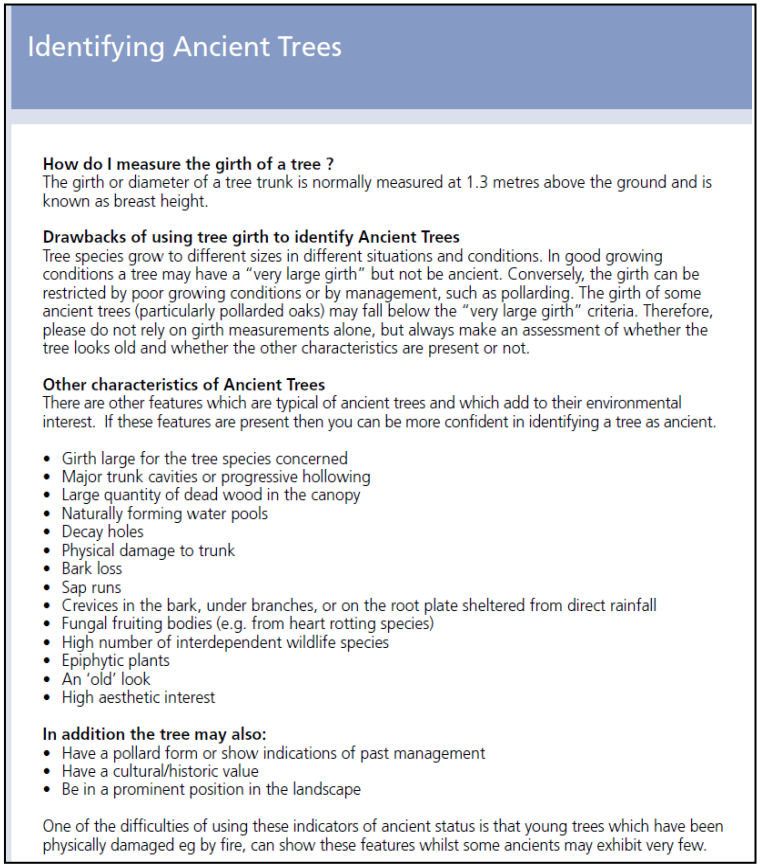

Identifying Ancient Trees

How do I measure the girth of a tree ?
The girth or diameter of a tree trunk is normally measured at 1.3 metres above the ground and is known as breast height.

Drawbacks of using tree girth to identify Ancient Trees
Tree species grow to different sizes in different situations and conditions. In good growing conditions a tree may have a "very large girth" but not be ancient. Conversely, the girth can be restricted by poor growing conditions or by management, such as pollarding. The girth of some ancient trees (particularly pollarded oaks) may fall below the "very large girth" criteria. Therefore, please do not rely on girth measurements alone, but always make an assessment of whether the tree looks old and whether the other characteristics are present or not.

Other characteristics of Ancient Trees
There are other features which are typical of ancient trees and which add to their environmental interest. If these features are present then you can be more confident in identifying a tree as ancient.

- Girth large for the tree species concerned
- Major trunk cavities or progressive hollowing
- Large quantity of dead wood in the canopy
- Naturally forming water pools
- Decay holes
- Physical damage to trunk
- Bark loss
- Sap runs
- Crevices in the bark, under branches, or on the root plate sheltered from direct rainfall
- Fungal fruiting bodies (e.g. from heart rotting species)
- High number of interdependent wildlife species
- Epiphytic plants
- An 'old' look
- High aesthetic interest

In addition the tree may also:
- Have a pollard form or show indications of past management
- Have a cultural/historic value
- Be in a prominent position in the landscape

One of the difficulties of using these indicators of ancient status is that young trees which have been physically damaged eg by fire, can show these features whilst some ancients may exhibit very few.

5 Annex 5: Positive and negative vegetation condition indicator species lists

5.1 Acid grassland: Positive indicators

Agrostis curtisii
Aira caryophyllea
Aira praecox
Anemone nemorosa
Aphanes arvensis sens.str.
Aphanes inexspectata
Calluna vulgaris
Campanula rotundifolia
Centaurium erythraea
Coeloglossum viride
Erica cinerea
Erica tetralix
Erodium cicutarium agg.
Galium saxatile
Galium verum
Genista tinctoria
Gymnadenia conopsea
Lathyrus linifolius
Leontodon saxatilis
Lotus corniculatus
Ornithopus perpusillus
Pedicularis sylvatica
Pilosella officinarum
Pimpinella saxifraga
Plantago coronopus
Polygala oxyptera
Polygala serpyllifolia
Potentilla erecta
Rumex acetosella
Sanguisorba major
Sedum acre
Sedum anglicum
Serratula tinctoria
Stachys officinalis
Succisa pratensis
Thymus polytrichus
Thymus serpyllum
Vaccinium myrtillus
Veronica officinalis
Vicia orobus
Viola lutea
Viola palustris
Viola riviniana

5.2 Acid grassland: Negative indicators

Alnus glutinosa
Alopecurus geniculatus
Anthriscus sylvestris
Arrhenatherum elatius
Bellis perennis
Brachypodium pinnatum
Bromopsis erecta
Bromus hordeaceus
Carduus crispus
Carduus nutans
Carex acutiformis
Carex otrubae
Carex riparia
Cerastium fontanum
Chamerion angustifolium
Cirsium arvense
Cirsium vulgare
Cotoneaster integrifolius
Crataegus monogyna
Cynosurus cristatus
Dactylis glomerata
Deschampsia cespitosa
Equisetum arvense
Fraxinus excelsior

Galium aparine
Glyceria fluitans
Glyceria maxima
Helictotrichon pubescens
Heracleum sphondylium
Holcus lanatus
Juncus conglomeratus
Juncus effusus
Juncus inflexus
Lolium perenne
Parietaria judaica
Phalaris arundinacea
Phleum pratense sens.lat.
Phragmites australis
Plantago major
Poa trivialis
Prunus spinosa
Pteridium aquilinum
Quercus robur
Ranunculus acris
Ranunculus repens
Rhododendron ponticum
Rosa canina agg.
Rubus fruticosus agg.
Rumex conglomeratus
Rumex crispus
Rumex obtusifolius
Rumex sanguineus
Salix cinerea
Sambucus nigra
Sedum album
Senecio jacobaea
Sonchus arvensis
Sonchus asper
Sonchus oleraceus
Stellaria media
Trifolium repens
Trisetum flavescens
Ulex europaeus
Ulex gallii
Ulex minor
Urtica dioica

5.3 Bog: Positive indicators

Andromeda polifolia
Arctostaphylos alpinus
Calluna vulgaris
Carex bigelowii
Cornus suecica
Drosera intermedia
Drosera longifolia
Drosera rotundifolia
Empetrum nigrum
Erica cinerea
Erica tetralix
Eriophorum angustifolium
Eriophorum vaginatum
Menyanthes trifoliata
Myrica gale
Narthecium ossifragum
Rhynchospora alba
Rubus chamaemorus
Trichophorum cespitosum
Vaccinium myrtillus
Vaccinium oxycoccos
Vaccinium vitis-idaea

5.4 Bog: Negative indicators

Agrostis capillaris
Betula pendula
Betula pubescens
Cirsium arvense
Cirsium palustre
Cirsium vulgare
Deschampsia cespitosa
Epilobium hirsutum
Glyceria maxima
Holcus lanatus
Juncus effusus
Phalaris arundinacea
Phragmites australis
Pinus contorta
Pinus nigra
Pinus pinaster
Pinus sylvestris
Pteridium aquilinum
Ranunculus repens
Rhododendron ponticum
Rubus fruticosus agg.
Salix aurita
Salix caprea
Salix cinerea
Urtica dioica

5.5 Broadleaved and coniferous woodland: Positive indicators (ancient woodland indicators)

Aconitum napellus
Adoxa moschatellina
Alchemilla filicaulis
Allium ursinum
Anemone nemorosa
Aquilegia vulgaris
Athyrium filix-femina
Blechnum spicant
Brachypodium sylvaticum
Bromopsis ramosa
Calamagrostis canescens
Calamagrostis epigejos
Campanula latifolia
Campanula trachelium
Cardamine amara
Cardamine impatiens
Carex acutiformis
Carex digitata
Carex laevigata
Carex pallescens
Carex pendula
Carex remota
Carex strigosa
Carex sylvatica
Cephalanthera longifolia
Ceratocapnos claviculata
Chrysosplenium alternifolium
Chrysosplenium oppositifolium
Cirsium heterophyllum
Colchicum autumnale
Conopodium majus
Convallaria majalis
Daphne laureola
Daphne mezereum
Dryopteris aemula
Dryopteris affinis
Dryopteris carthusiana
Dryopteris dilatata/carthusiana
Elymus caninus
Epipactis helleborine
Epipactis leptochila
Epipactis purpurata
Equisetum sylvaticum
Equisetum telmateia
Euphorbia amygdaloides
Festuca altissima
Festuca gigantea
Fragaria vesca

Galium odoratum
Geranium robertianum
Geranium sanguineum
Geranium sylvaticum
Geum rivale
Gnaphalium sylvaticum
Gymnocarpium dryopteris
Holcus mollis
Hordelymus europaeus
Hyacinthoides non-scripta
Hymenophyllum wilsonii
Hypericum androsaemum
Hypericum hirsutum
Hypericum pulchrum
Hypericum tetrapterum
Iris foetidissima
Lamiastrum galeobdolon
Lathyrus linifolius
Lathyrus sylvestris
Listera ovata
Lithospermum officinale
Lonicera periclymenum
Luzula pilosa
Luzula sylvatica
Lysimachia nemorum
Lysimachia vulgaris
Lythrum portula
Melampyrum pratense
Melampyrum sylvaticum
Melica nutans
Melica uniflora
Melittis melissophyllum
Mercurialis perennis
Milium effusum
Moehringia trinervia
Myosotis sylvatica
Narcissus pseudonarcissus
Ophioglossum vulgatum
Orchis mascula
Oreopteris limbosperma
Oxalis acetosella
Paris quadrifolia
Phegopteris connectilis
Phyllitis scolopendrium
Pimpinella major
Platanthera chlorantha
Poa nemoralis
Polygonatum multiflorum
Polygonatum odoratum
Polypodium vulgare sens.lat.
Polystichum aculeatum
Polystichum setiferum
Polystichum setiferum/aculeatum
Potentilla sterilis
Primula elatior
Primula vulgaris
Pulmonaria longifolia
Pyrola minor
Radiola linoides
Ranunculus auricomus
Ribes nigrum
Ribes nigrum/rubrum
Ribes rubrum
Rosa arvensis
Rubus caesius
Rubus saxatilis
Ruscus aculeatus
Sanicula europaea
Scirpus sylvaticus
Scrophularia nodosa
Scutellaria minor
Sedum telephium
Serratula tinctoria
Sibthorpia europaea
Silene dioica
Solidago virgaurea
Stachys officinalis
Stachys sylvatica
Stellaria holostea
Stellaria neglecta
Stellaria nemorum
Tamus communis
Trollius europaeus
Vaccinium myrtillus
Valeriana officinalis
Veronica montana
Vicia sepium
Vicia sylvatica
Viola odorata
Viola palustris
Viola reichenbachiana
Viola riviniana
Viola riviniana/reichenbiana
Wahlenbergia hederacea

5.6 Heath: Positive indicators

Agrostis canina sens.lat.
Agrostis curtisii
Agrostis stolonifera
Aira praecox
Ammophila arenaria
Anagallis tenella
Andromeda polifolia
Antennaria dioica
Anthyllis vulneraria
Arctostaphylos alpinus
Arctostaphylos uva-ursi
Armeria maritima
Calluna vulgaris
Carex arenaria
Carex binervis
Carex caryophyllea
Carex dioica
Carex echinata
Carex flacca
Carex hostiana
Carex nigra
Carex panicea
Carex pilulifera
Carex pulicaris
Carex viridula subsp.oedocarpa
Carex viridula subsp.viridula
Danthonia decumbens
Drosera intermedia
Drosera longifolia
Drosera rotundifolia
Eleocharis multicaulis
Empetrum nigrum
Erica ciliaris
Erica cinerea
Erica tetralix
Erica vagans
Eriophorum angustifolium
Erodium cicutarium agg.
Euphrasia officinalis agg.
Festuca filiformis
Filago minima
Filipendula vulgaris
Galium verum
Genista anglica
Genista pilosa
Helianthemum nummularium
Hypochaeris radicata
Juncus acutiflorus
Juncus articulatus
Koeleria macrantha
Linum catharticum
Loiseleuria procumbens
Lotus corniculatus
Minuartia verna
Myrica gale
Narthecium ossifragum
Phleum arenarium
Pinguicula lusitanica
Pinguicula vulgaris
Plantago lanceolata
Plantago maritima
Polygala serpyllifolia
Rhynchospora alba
Rubus chamaemorus
Rubus saxatilis
Rumex acetosella
Sanguisorba minor
Schoenus nigricans
Scilla verna
Sedum acre
Selaginella selaginoides
Serratula tinctoria
Silene uniflora
Succisa pratensis
Thalictrum alpinum
Thlaspi caerulescens
Thymus polytrichus
Trichophorum cespitosum
Ulex gallii
Vaccinium myrtillus
Vaccinium uliginosum
Vaccinium vitis-idaea
Viola riviniana

5.7 Heath: Negative indicators

Alnus glutinosa
Alopecurus geniculatus
Anthoxanthum odoratum
Apium nodiflorum
Arrhenatherum elatius
Bellis perennis
Betula pendula
Betula pubescens
Chamerion angustifolium
Cirsium arvense
Cirsium vulgare
Cytisus scoparius
Dactylis glomerata
Deschampsia cespitosa
Deschampsia flexuosa
Digitalis purpurea
Elytrigia repens
Epilobium brunnescens
Epilobium ciliatum
Epilobium hirsutum
Epilobium lanceolatum
Epilobium montanum
Epilobium obscurum
Epilobium parviflorum
Epilobium roseum
Epilobium sp.
Epilobium tetragonum
Fallopia japonica
Festuca arundinacea
Festuca rubra agg.
Glyceria fluitans
Hippophae rhamnoides
Holcus lanatus
Holcus mollis
Juncus effusus
Juncus squarrosus
Lolium perenne
Nardus stricta
Oenanthe crocata
Phalaris arundinacea
Phleum pratense sens.lat.
Phragmites australis
Pinus contorta
Pinus nigra
Pinus pinaster
Pinus sylvestris
Poa annua
Poa humilis
Poa trivialis
Prunus spinosa
Pteridium aquilinum
Quercus cerris
Quercus petraea
Quercus robur
Ranunculus acris
Ranunculus repens
Rhododendron ponticum
Rubus fruticosus agg.
Rumex conglomeratus
Rumex crispus
Rumex obtusifolius
Rumex sanguineus
Salix aurita
Salix caprea
Salix cinerea
Senecio jacobaea
Senecio squalidus
Senecio sylvaticus
Senecio viscosus
Senecio vulgaris
Sorbus aucuparia
Stellaria media
Typha angustifolia
Typha latifolia
Ulex europaeus
Urtica dioica

5.8 Improved grassland and semi-improved grassland: Positive indicators

Achillea millefolium
Achillea ptarmica
Agrimonia eupatoria
Alchemilla filicaulis
Alchemilla glabra
Alchemilla xanthochlora
Anacamptis pyramidalis
Anagallis tenella
Anemone nemorosa
Angelica sylvestris
Anthoxanthum odoratum
Berula erecta
Calluna vulgaris
Caltha palustris
Cardamine pratensis
Carex flacca
Carex panicea
Carum verticillatum
Centaurea nigra
Cephalanthera longifolia
Cirsium dissectum
Cirsium heterophyllum
Coeloglossum viride
Conopodium majus
Crepis paludosa
Dactylorhiza fuchsii
Dactylorhiza incarnata
Dactylorhiza maculata
Dactylorhiza majalis
Dactylorhiza majalis praetermissa
Dactylorhiza purpurella
Dactylorhiza sp.
Danthonia decumbens
Epipactis atrorubens
Epipactis helleborine
Epipactis leptochila
Epipactis purpurata
Erica tetralix
Eupatorium cannabinum
Festuca ovina agg.
Festuca pratensis
Festuca pratensis x Lolium perenne (x Festulolium loliaceum)
Filipendula ulmaria
Filipendula vulgaris
Galium palustre
Galium uliginosum
Galium verum
Genista tinctoria
Geranium sylvaticum
Geum rivale
Geum rivale x urbanum (G. x intermedium)
Goodyera repens
Gymnadenia conopsea
Hydrocotyle vulgaris
Hypochaeris radicata
Iris pseudacorus
Juncus articulatus
Juncus articulatus/acutiflora
Juncus inflexus
Lathyrus linifolius
Lathyrus pratensis
Leontodon autumnalis
Leontodon hispidus
Leontodon hispidus/saxatilis
Leontodon saxatilis
Leucanthemum vulgare
Lotus corniculatus
Lotus pedunculatus
Luzula campestris
Luzula campestris/multiflora
Lychnis flos-cuculi
Lythrum salicaria
Mentha aquatica
Narthecium ossifragum
Oenanthe silaifolia
Ophrys apifera
Orchis mascula
Orchis morio
Orchis sp.
Pedicularis palustris

Pedicularis sylvatica
Persicaria bistorta
Pimpinella saxifraga
Plantago lanceolata
Platanthera bifolia
Platanthera chlorantha
Platanthera sp.
Polygala vulgaris/serpyllifolia
Potentilla erecta
Potentilla palustris
Primula veris
Prunella vulgaris
Pseudorchis albida
Ranunculus bulbosus
Ranunculus flammula
Rhinanthus minor
Rumex acetosa
Salix repens agg.
Sanguisorba minor
Serratula tinctoria
Silaum silaus
Spiranthes spiralis
Stachys officinalis
Succisa pratensis
Thalictrum flavum
Trifolium pratense
Trifolium pratense/medium
Trollius europaeus
Valeriana dioica
Valeriana officinalis
Viola palustris

5.9 Improved grassland and semi-improved grassland: Negative indicators

Cirsium arvense
Cirsium vulgare
Festuca pratensis x Lolium perenne (x Festulolium loliaceum)
Lolium perenne
Phleum pratense sens.lat.
Pteridium aquilinum
Ranunculus repens
Rubus fruticosus agg.
Rumex crispus
Rumex crispus x obtusifolius (R. x pratensis)
Rumex obtusifolius
Rumex obtusifolius x sanguineus (R. x dufftii)
Trifolium repens
Urtica dioica

5.10 Neutral unimproved grassland: Positive indicators

Agrimonia eupatoria
Alchemilla filicaulis
Alchemilla glabra
Alchemilla xanthochlora
Anacamptis pyramidalis
Anemone nemorosa
Briza media
Caltha palustris
Carex caryophyllea
Carex flacca
Carex panicea
Carum verticillatum
Centaurea nigra
Cephalanthera longifolia
Cirsium dissectum
Cirsium heterophyllum
Coeloglossum viride
Conopodium majus
Dactylorhiza fuchsii
Dactylorhiza incarnata
Dactylorhiza maculata
Dactylorhiza majalis
Dactylorhiza majalis praetermissa
Dactylorhiza purpurella
Dactylorhiza sp.
Danthonia decumbens
Epipactis atrorubens
Epipactis helleborine
Epipactis leptochila
Epipactis purpurata
Festuca ovina agg.
Filipendula ulmaria
Filipendula vulgaris
Galium palustre
Galium uliginosum
Galium verum
Genista tinctoria
Geranium sylvaticum
Geum rivale
Goodyera repens
Gymnadenia conopsea
Lathyrus linifolius
Lathyrus pratensis
Leontodon hispidus
Leontodon saxatilis
Lotus corniculatus
Oenanthe silaifolia
Ophrys apifera
Orchis mascula
Orchis morio
Orchis sp.

Pedicularis sylvatica
Persicaria bistorta
Pimpinella saxifraga
Platanthera bifolia
Platanthera chlorantha
Platanthera sp.
Polygala oxyptera
Potentilla erecta
Primula veris
Pseudorchis albida
Ranunculus flammula
Sanguisorba major
Sanguisorba minor
Serratula tinctoria
Silaum silaus
Spiranthes spiralis
Stachys officinalis
Succisa pratensis
Thalictrum flavum
Trollius europaeus
Valeriana dioica
Viola riviniana
Viola riviniana/reichenbiana

5.11 Neutral unimproved grassland: Negative indicators

Alnus glutinosa
Alopecurus geniculatus
Anthriscus sylvestris
Arrhenatherum elatius
Bellis perennis
Brachypodium pinnatum
Bromopsis erecta
Bromus hordeaceus
Carduus crispus
Carduus nutans
Carex acutiformis
Carex otrubae
Carex riparia
Cerastium fontanum
Chamerion angustifolium
Cirsium arvense
Cirsium vulgare
Cotoneaster integrifolius
Crataegus monogyna
Cynosurus cristatus
Dactylis glomerata
Deschampsia cespitosa
Equisetum arvense
Fraxinus excelsior
Galium aparine
Glyceria fluitans
Glyceria maxima
Helictotrichon pubescens
Heracleum sphondylium
Holcus lanatus
Juncus conglomeratus
Juncus effusus
Juncus inflexus
Lolium perenne
Parietaria judaica
Phalaris arundinacea
Phleum pratense sens.lat.
Phragmites australis
Plantago major
Poa trivialis
Prunus spinosa
Pteridium aquilinum
Quercus robur
Ranunculus acris
Ranunculus repens
Rhododendron ponticum
Rosa canina agg.
Rubus fruticosus agg.
Rumex conglomeratus
Rumex crispus
Rumex obtusifolius
Rumex sanguineus
Salix cinerea
Sambucus nigra
Sedum album
Senecio jacobaea
Sonchus arvensis

Sonchus asper
Sonchus oleraceus
Stellaria media
Trifolium repens
Trisetum flavescens
Ulex europaeus
Ulex gallii
Ulex minor
Urtica dioica

5.12 Purple moor grass and rush pasture (marshy grassland): Positive indicators

Achillea ptarmica
Anacamptis pyramidalis
Anagallis tenella
Angelica sylvestris
Calluna vulgaris
Caltha palustris
Carex echinata
Carex flacca
Carex hostiana
Carex hostiana x viridula (C. x fulva)
Carex nigra
Carex panicea
Carex pulicaris
Carex pulicaris/serotina
Carum verticillatum
Centaurea nigra
Cephalanthera longifolia
Cirsium dissectum
Coeloglossum viride
Crepis paludosa
Dactylorhiza fuchsii
Dactylorhiza incarnata
Dactylorhiza maculata
Dactylorhiza majalis
Dactylorhiza majalis praetermissa
Dactylorhiza purpurella
Dactylorhiza sp.
Danthonia decumbens
Epipactis atrorubens
Epipactis helleborine
Epipactis leptochila
Epipactis purpurata
Erica tetralix
Eupatorium cannabinum
Festuca ovina agg.
Filipendula ulmaria
Galium palustre
Galium uliginosum
Geum rivale
Goodyera repens
Gymnadenia conopsea
Hydrocotyle vulgaris
Hypericum tetrapterum
Juncus subnodulosus
Leontodon hispidus
Lotus pedunculatus
Lychnis flos-cuculi
Lythrum salicaria
Mentha aquatica
Narthecium ossifragum
Ophrys apifera
Orchis mascula
Orchis morio
Orchis sp.
Pedicularis palustris
Pedicularis sylvatica
Platanthera bifolia
Platanthera chlorantha
Platanthera sp.
Potentilla erecta
Potentilla palustris
Pseudorchis albida
Ranunculus flammula

Salix repens agg.
Sanguisorba major
Serratula tinctoria
Spiranthes spiralis
Succisa pratensis
Thalictrum flavum
Triglochin palustre
Trollius europaeus
Valeriana dioica
Valeriana officinalis
Viola palustris

5.13 Purple moor grass and rush pasture (marshy grassland): Negative indicators

Alnus glutinosa
Alopecurus geniculatus
Anthriscus sylvestris
Arrhenatherum elatius
Bellis perennis
Brachypodium pinnatum
Bromopsis erecta
Bromus hordeaceus
Carduus crispus
Carduus nutans
Carex acutiformis
Carex otrubae
Carex riparia
Cerastium fontanum
Chamerion angustifolium
Cirsium arvense
Cirsium vulgare
Cotoneaster integrifolius
Crataegus monogyna
Cynosurus cristatus
Dactylis glomerata
Deschampsia cespitosa
Equisetum arvense
Fraxinus excelsior
Galium aparine
Glyceria fluitans
Glyceria maxima
Helictotrichon pubescens
Heracleum sphondylium
Holcus lanatus
Juncus conglomeratus
Juncus effusus
Juncus inflexus
Lolium perenne
Parietaria judaica
Phalaris arundinacea
Phleum pratense sens.lat.
Phragmites australis
Plantago major
Poa trivialis
Prunus spinosa
Pteridium aquilinum
Quercus robur
Ranunculus acris
Ranunculus repens
Rhododendron ponticum
Rosa canina agg.
Rubus fruticosus agg.
Rumex conglomeratus
Rumex crispus
Rumex obtusifolius
Rumex sanguineus
Salix cinerea
Sambucus nigra
Sedum album
Senecio jacobaea
Sonchus arvensis
Sonchus asper
Sonchus oleraceus
Stellaria media
Trifolium repens
Trisetum flavescens
Ulex europaeus
Ulex gallii
Ulex minor
Urtica dioica

6 Annex 6: Species data for 51 quadrats identified as unimproved semi-natural grassland

Table A5.1: Species % cover in 2x2m quadrats identified as MG4 semi-natural grassland by MAVIS software. Each column is a quadrat, while rows (species) are presented in order of NVC constancy for MG4 grassland.

Species	NVC constancy	1990	1998			2007			2013		2014			2016	Absent
Cynosurus cristatus	5	5	15	5	1	1	20	1	1	1				5	
Festuca rubra agg.	5	5		5	5	15		30	1	5	5			5	
Filipendula ulmaria	5				1							1			
Plantago lanceolata	5	15		15		45		15				20		10	
Ranunculus acris	5	1		1	1	5	5	5	5	1	5	1	1	5	
Rumex acetosa	5	5	5	5	1	5		1	5	1	10	1	5	1	
Sanguisorba officinalis	5														x
Taraxacum agg.	5	15	1	15				1	1	1		1	1	1	
Trifolium pratense	5	1		1		15		10						20	
Alopecurus pratensis	4									15			30	1	
Cerastium fontanum	4	5	1	5	5	1			1	1	1	1		1	
Holcus lanatus	4	40	20	40	15	10	20	5	1	15	5		30	1	
Lathyrus pratensis	4				5	5					5				
Leontodon autumnalis	4											5		10	
Lolium perenne	4	15	50	15	1	1	20		5	5		1	10		
Trifolium repens	4	1	10	1			10	1				1	10	1	
Anthoxanthum odoratum	3	15	5	15	5	10		5	1	5	10		5	10	
Bellis perennis	3		1												
Brachythecium rutabulum	3								1				1		
Centaurea nigra	3					25	5							15	
Dactylis glomerata	3				5	1		1			5				

Species	NVC constancy	1990	1998			2007			2013		2014			2016	Absent
Fritillaria meleagris	3														x
Lotus corniculatus	3						1								
Ranunculus repens	3	5	1	5	10	10	5		60		5	5	10	1	
Rhinanthus minor	3	1		1				10	15					25	
Silaum silaus	3														x
Trisetum flavescens	3														x
Agrostis capillaris	2		50			15	1	1		45	1	1		20	
Agrostis stolonifera	2	40	20	40	30		5		5			35			
Arrhenatherum elatius	2														x
Bromus hordeaceus	2	1		1					35						
Calliergon cuspidatum	2														x
Cardamine pratensis	2		1		1					1	1	1	1	1	
Carex acutiformis	2														x
Deschampsia cespitosa	2				10										
Eurhynchium praelongum	2		1								15	1			
Festuca arundinacea	2														x
Festuca pratensis	2				1							5			
Juncus articulatus	2														x
Leontodon hispidus	2														x
Leucanthemum vulgare	2	5		5											
Luzula campestris	2														x
Primula veris	2														x
Prunella vulgaris	2											1		1	
Succisa pratensis	2														x
Trifolium dubium	2							5	5					1	
Vicia cracca	2							1			5				
Achillea millefolium	1										1			1	
Briza media	1														x

Species	NVC constancy	1990	1998			2007			2013		2014			2016	Absent
Bromopsis erecta	1														x
Bromus hordeaceus subsp.thominei	1														x
Caltha palustris	1														x
Carex hirta	1											1			
Carex panicea	1				1		10								
Cirsium arvense	1					1					5				
Cirsium palustre	1		1												
Equisetum arvense	1										1				
Galium verum	1														x
Heracleum sphondylium	1							1							
Hypochaeris radicata	1							1	1					1	
Juncus inflexus	1						1								
Phleum pratense sens.lat.	1	1		1	1			1	1			1			
Plagiomnium elatum	1														x
Poa pratensis sens.lat.	1		5		1						10				
Poa trivialis	1	1		1	1				20	10	1		20		
Potentilla anglica	1														x
Ranunculus bulbosus	1														x
Serratula tinctoria	1														x
Stachys officinalis	1														x
Thalictrum flavum	1														x
Veronica serpyllifolia	1								1						
Vicia sepium	1														x
Agrostis canina sens.lat.	0				1						5				
Alopecurus geniculatus	0								5						
Brachythecium sp.	0	1	10	1	1									1	
Cardamine flexuosa	0								1						
Cardamine hirsuta/flexuosa	0		1												

Species	NVC constancy	1990	1998			2007			2013		2014			2016	Absent
Carex disticha	0											15			
Carex nigra	0				1										
Carex ovalis	0				1										
Crepis sp.	0							1							
Dactylorhiza fuchsii	0				1										
Elymus sp.	0	1		1											
Elytrigia repens	0	1		1							30				
Epilobium sp.	0				1										
Euphrasia officinalis agg.	0					5								10	
Eurhynchium sp.	0		1											1	
Galium palustre	0											1			
Galium uliginosum	0				1										
Holcus mollis	0					10									
Juncus articulatus/acutiflora	0				35							1			
Juncus conglomeratus	0				1										
Juncus effusus	0		1		25										
Lolium multiflorum	0												1		
Lotus pedunculatus	0				5	15					1				
Luzula campestris/multiflora	0				1					1					
Lychnis flos-cuculi	0											1			
Myosotis discolor	0								1						
Plantago major	0											1			
Potentilla anserina	0										1	1			
Ranunculus ficaria	0									1					
Rhinanthus sp.	0	30		30											
Rhytidiadelphus squarrosus	0													1	
Rumex obtusifolius	0	15		15					1				1		
Senecio aquaticus	0											1			

Species	NVC constancy	1990	1998			2007			2013		2014			2016	Absent
Stellaria graminea	0				1						1				
Stellaria media	0								1						
Stellaria uliginosa	0											1			

Table A5.2: Species % cover in 2x2m quadrats identified as MG5 semi-natural grassland by MAVIS software. Each column is a quadrat, while rows (species) are presented in order of NVC constancy for MG5 grassland.

Species	NVC constancy	1990	1998				2007		2013			2014					2015							2016		Absent
Cynosurus cristatus	5	10	10	15	10	15	10	15		5	10	1	5		5	15	1	20	10	10	5		5	50	10	
Festuca rubra agg.	5	10	50	20	10	20	15	20	25	40	15	10	10		10		5	15	15	40	35	5		5	5	
Lotus corniculatus	5	5	5	5	5	10	1	5		5	5	5		20	5	15		1	20	5	10	5		15	1	
Plantago lanceolata	5	1	10	15	1	1	10	15	5	20	1	30	10	20	5	35	20		5	5	1	1	10	40	1	
Agrostis capillaris	4	30	5	25	30	35	35	25	15	30	5	20	50	5	30	20	20	15	20	25	10	40	15	20	25	
Anthoxanthum odoratum	4	10	1	1	10	15	5	1	10	15	10	20	20	20	5	1	35	1		1	20	30	50	20	25	
Centaurea nigra	4	10		1	10	5	10	1	35	5	10	25	1	1	5		5		1					1		
Dactylis glomerata	4	5	10	10	5	5		10			5		1			1	1			1	5	1	1		1	
Holcus lanatus	4	1	5	1	1	10	1	1	5	10	5	15	30	5	5	1	10	15		1	1	1	5	15	5	
Trifolium pratense	4	1	5	10	1	1	1	10	5		1	1	10	1	20	1	1							10	5	
Trifolium repens	4	5	5	5	5	5	10	5	1		1	1	10	10	5	1	1	10	1	1	5	15	10		10	
Achillea millefolium	3	1	1	5	1	1	1	5	5		10		1			1	1		5	10	1				1	
Brachythecium rutabulum	3								5				1				1									
Hypochaeris radicata	3	1	5	5	1	1	15	5	5	1		1	5		5	20	1			5		10		1	5	
Leontodon autumnalis	3	5		1	5	1	1	1					5			1	5		5	1	1	1			5	
Lolium perenne	3	5	15	5	5	15	20	5						1			1	5	1	1	1		1	1	1	

Species	NVC constancy	1990	1998				2007		2013			2014					2015							2016		Absent
Luzula campestris	3									1	1					1				1					1	
Prunella vulgaris	3	1	1	1	1	1	1	1			1			1		1	1	1		5				1	5	
Ranunculus acris	3	5			5	1	1			1		1	1		1	1	5					10	1		1	
Ranunculus bulbosus	3			1			1	1						5		5	5	5		1	1		10			
Rumex acetosa	3	1	1		1	1				1	1			1			5				1		5		1	
Taraxacum agg.	3	1	5	5	1	5	5	5				5		1	1	5	1	1	1		1	1	1	1	1	
Trisetum flavescens	3	1	5	5	1			5																		
Arrhenatherum elatius	2										10															
Bellis perennis	2	1	10	1	1		10	1			5					1			1						1	
Briza media	2										5															
Cerastium fontanum	2	1	1	1	1			1	1					1			1	1	1	1					1	
Cirsium arvense	2					15												10			1					
Eurhynchium praelongum	2									1							1	1	1	1		1	1			
Galium verum	2		5																							
Heracleum sphondylium	2																									x
Lathyrus pratensis	2	1			1	1					1	1												5		
Leontodon hispidus	2	5	5	1	5			1			15			1		1										
Leucanthemum vulgare	2			1				1			5															
Poa pratensis sens.lat.	2	1		1	1			1						1												
Poa trivialis	2																	1	1				1			
Primula veris	2			1				1																		
Rhinanthus minor	2									5							15						10			
Rhytidiadelphus squarrosus	2	1			1	10	1		5	15	10	1	5		1	1		1	1	5	1	35		1	5	
Trifolium dubium	2		5				1											1	5	1						
Veronica chamaedrys	2	1		1	1	10		1			1				1										1	
Agrimonia eupatoria	1																									x
Agrostis stolonifera	1		5	5		5		5			1			1										5		
Alchemilla filicaulis subsp.filicaulis	1																									x

Species	NVC constancy	1990	1998				2007		2013			2014					2015							2016		Absent
Alchemilla glabra	1																								x
Alchemilla xanthochlora	1																								x
Alopecurus pratensis	1																								x
Bromus hordeaceus	1		1																			5			
Calliergon cuspidatum	1	5			5						1		1		1	5					1	1			
Cardamine pratensis	1																								x
Carex caryophyllea	1		1				1																		
Carex flacca	1		1	5			1	5			10			1											
Carex panicea	1		1	15				15								10									
Colchicum autumnale	1																								x
Conopodium majus	1	1			1																1	10			
Crepis capillaris	1		1	1				1																	
Danthonia decumbens	1		1																						
Festuca arundinacea	1																								x
Festuca ovina agg.	1	5			5											20		1		5	1				
Festuca pratensis	1																								x
Filipendula ulmaria	1																								x
Helictotrichon pubescens	1	1			1																				
Juncus articulatus	1											30													
Juncus effusus	1																							1	
Juncus inflexus	1																								x
Knautia arvensis	1																								x
Koeleria macrantha	1		5	1				1																	
Ophioglossum vulgatum	1																								x
Phleum bertolonii	1		1																						
Phleum pratense sens.lat.	1			1			1	1											1						
Pimpinella saxifraga	1	1			1						10								1						
Plantago media	1			5				5																	

Species	NVC constancy	1990	1998				2007		2013			2014					2015							2016		Absent
Potentilla erecta	1	1			1								1			1						5			1	
Potentilla reptans	1	1			1		1							5										10		
Pseudoscleropodium purum	1	1		1	1			1		5	65				1	1					1				1	
Ranunculus repens	1	1	5	1	1	15	1	1	1			1	1	1							1	15	1		1	
Sanguisorba minor	1			5				5																		
Senecio jacobaea	1		5	5		1	1	5						1	1											
Silaum silaus	1																									x
Stachys officinalis	1																									x
Succisa pratensis	1																									x
Vicia cracca	1													1												
Agrostis canina sens.lat.	0						30																			
Asperula cynanchica	0		1																							
Brachypodium sylvaticum	0		10																							
Brachythecium sp.	0	1	1	1	1			1			1			1				5	1	1	1		1	1	1	
Calliergon sp	0											1														
Campanula rotundifolia	0																				1					
Carex hirta	0												1													
Carex ovalis	0											1														
Carex seedling/sp	0																								1	
Carum verticillatum	0																1									
Centaurium erythraea	0			1				1																		
Cirsium palustre	0														1										1	
Cirsium vulgare	0		5	1				1												1						
Cladonia sp.	0	1			1															1						
Convolvulus arvensis	0		1																							
Crataegus monogyna	0			1				1			5															
Crepis sp.	0	1			1																					
Dactylorhiza fuchsii	0												1													

Species	NVC constancy	1990	1998				2007		2013			2014					2015							2016		Absent
Daucus carota	0		1																						
Euphrasia officinalis agg.	0																5								5	
Eurhynchium sp.	0		5				1																			
Fragaria vesca	0	1			1																					
Fraxinus excelsior	0	1			1	1					1											1				
Geranium dissectum	0		1																							
Geranium molle	0		1																							
Glechoma hederacea	0		5																							
Hylocomium splendens	0										1															
Hypericum hirsutum	0			1				1																		
Hypericum perforatum	0			1				1																		
Hypericum sp.	0	1			1																					
Hypochaeris glabra	0																	1								
Juncus articulatus/acutiflorus	0																							25		
Juncus bufonius sens.lat.	0						1																			
Juncus conglomeratus	0																							1		
Juncus tenuis	0						1																			
Leontodon saxatilis	0			5			1	5																		
Lophocolea bidentata sens.lat.	0											1														
Luzula campestris/multiflora	0	5	1	1	5	5		1	1			1		5	1			1			5	1		1		
Luzula sp.	0		1																							
Medicago lupulina	0		1																							
Myosotis seedling/sp	0																1									
Phleum sp.	0																							1		
Pilosella officinarum	0		5																1							
Plagiomnium undulatum	0										5															
Plagiothecium undulatum	0																								1	
Plantago coronopus	0		1																							

Species	NVC constancy	1990	1998				2007		2013			2014					2015							2016		Absent
Plantago major	0	5			5		1																			
Pleurozium schreberi	0		1																							
Poa annua	0		1	1				1						1												
Potentilla sterilis	0		1	1		1		1			15															
Primula vulgaris	0					1																				
Prunus spinosa	0		1																							
Pteridium aquilinum	0		5																							
Quercus seedling/sp	0			1				1												1						
Rosa seedling/sp	0			1				1																		
Rubus fruticosus agg.	0		1																							
Rumex acetosella	0								1																	
Sagina sp.	0		1																							
Senecio vulgaris	0		1																							
Spiranthes spiralis	0		1																							
Stellaria graminea	0					1								1												
Thuidium tamariscinum	0																								1	
Thymus polytrichus	0		10																							
Trifolium micranthum	0															1										
Trifolium seedling/sp	0															1										
Ulex europaeus	0		15																							
Veronica officinalis	0																				1					
Veronica serpyllifolia	0			5				5									1									
Viola hirta	0			1				1																		
Viola reichenbachiana	0		1																							

Table A5.3: Species % cover in 2x2m quadrats identified as MG8 semi-natural grassland by MAVIS software. Each column is a quadrat, while rows (species) are presented in order of NVC constancy for MG8 grassland.

Species	NVC constancy	1998		2007	2013				2014					2016		Absent
Caltha palustris	5	1														
Cynosurus cristatus	5	5	10	1		1	15	10	5	10	1	10	15	20	10	
Festuca rubra agg.	5		20	15	20	10		5		1		5			1	
Holcus lanatus	5	20	5	10	25	1		5	40	1	1	1	5	20	5	
Ranunculus acris	5	1	1	5	1	1	5		1	1	1	10	10	1		
Trifolium repens	5	10	1	1		10	15	1	15	5		1		5	1	
Anthoxanthum odoratum	4	5	1	10	5	20	10	40	10	15	1	10	45	20	1	
Cerastium fontanum	4		1	1	1	1	1	1	1					1		
Leontodon autumnalis	4	1		1				1	1	20		1				
Poa trivialis	4	1	1		1	10	5						1	5		
Rumex acetosa	4	5		10	1	1				1			1	1		
Bellis perennis	3		1									1			1	
Carex panicea	3		25	1							1	1			5	
Filipendula ulmaria	3		1	5							10					
Plantago lanceolata	3	5	1				5	20	5	10	5	1	15	1	10	
Ranunculus repens	3	5	5	5	10	1	5	1	30	5			5	10		
Trifolium pratense	3	1				1	15	5	1		15	5		10		
Agrostis stolonifera	2	35	20	15	10				10		1	15		5	20	
Calliergon cuspidatum	2	5	5						5	10	35	1				
Cardamine pratensis	2	1	1	1	5				1				1			
Carex disticha	2															x
Eleocharis palustris	2		1													
Euphrasia nemorosa	2															x
Festuca pratensis	2										1					

Species	NVC constancy	1998		2007	2013				2014					2016		Absent
Juncus articulatus	2						10	10		1						
Leontodon hispidus	2														15	
Lolium perenne	2						1	1	30	1		1	1	5	5	
Prunella vulgaris	2	1		5			1		1	1	1	1		1	1	
Rhinanthus minor	2	5				5	10						1	5		
Sanguisorba officinalis	2															x
Taraxacum agg.	2	1		1		1	1	5	1		1	1	1	1	1	
Veronica chamaedrys	2							1							1	
Achillea ptarmica	1															x
Agrostis capillaris	1	20				20	5	1		50	1	60	1	25	10	
Alchemilla glabra	1															x
Alchemilla xanthochlora	1															x
Angelica sylvestris	1			1												
Brachythecium rutabulum	1					15										
Briza media	1		1									5				
Bromus hordeaceus	1															x
Carex flacca	1		1					1	1		1	1				
Carex nigra	1		5		5						55					
Carex ovalis	1						10									
Carex viridula subsp.oedocarpa	1			1												
Centaurea nigra	1	1		5				1	1			5			1	
Cirsium palustre	1			5	1				1	1		1			1	
Crepis paludosa	1															x
Dactylis glomerata	1							1			1					
Equisetum arvense	1										1					
Equisetum palustre	1		10													
Eurhynchium praelongum	1								1			1				
Galium palustre	1	5	1	1	1				1		1					

Species	NVC constancy	1998		2007	2013				2014					2016		Absent
Galium uliginosum	1															x
Geum rivale	1															x
Glyceria declinata	1															x
Helictotrichon pubescens	1															x
Juncus acutiflorus	1				35											x
Juncus effusus	1	5		30	5					1					1	
Leucanthemum vulgare	1															x
Lotus corniculatus	1			15	20		15	1				5			5	
Lotus pedunculatus	1	1	1	5						1	5					
Luzula campestris	1									5						
Lychnis flos-cuculi	1				1						1					
Mentha aquatica	1		1	5												
Myosotis scorpioides	1															x
Plagiomnium rostratum	1															
Senecio aquaticus	1	10														x
Succisa pratensis	1	1									1	1				
Trollius europaeus	1															x
Valeriana dioica	1															x
Achillea millefolium	0					1				1						
Agrostis canina sens.lat.	0			1												
Ajuga reptans	0	1						1			1					
Alopecurus geniculatus	0	1														
Alopecurus pratensis	0					1										
Anagallis sp.	0		1													
Anagallis tenella	0		10													
Apium nodiflorum	0		1													
Atrichum undulatum	0									1						
Brachythecium sp.	0				1					1			1	1	1	

Species	NVC constancy	1998		2007	2013				2014					2016		Absent
Cardamine hirsuta	0					1										
Carex echinata	0			1												
Carex hirta	0								15	1	1					
Carex viridula subsp.brachyrrhyncha	0								1							
Cirsium arvense	0									1						
Crepis sp.	0	1														
Ctenidium molluscum	0											1				
Dactylorhiza sp.	0										1					
Danthonia decumbens	0							1				1				
Deschampsia cespitosa	0	5														
Dicranum majus	0			1												
Epilobium ciliatum	0	1														
Epilobium palustre	0	1														
Epilobium sp.	0				1											
Euphrasia officinalis agg.	0					5										
Eurhynchium sp.	0			1										1	1	
Festuca ovina agg.	0	1				5										
Fraxinus excelsior	0			1												
Geum urbanum	0											1				
Gnaphalium uliginosum	0	1														
Holcus mollis	0	1														
Hypericum tetrapterum	0										1					
Hypnum cupressiforme sens.lat.	0	1														
Hypochaeris radicata	0			10				1		5		1	1	5	15	
Juncus bufonius sens.lat.	0								1							
Juncus bulbosus	0	10							5							
Juncus inflexus	0		25								10					
Juncus subnodulosus	0			20												

Species	NVC constancy	1998		2007	2013				2014					2016		Absent
Lathyrus pratensis	0			1			1					1				
Luzula campestris/multiflora	0	1						1							1	
Mentha sp.	0	5														
Mnium hornum	0			1												
Molinia caerulea	0	1		10												
Myosotis discolor	0					1										
Myosotis secunda	0			1												
Oenanthe crocata	0													1		
Pellia sp.	0			1												
Persicaria maculosa	0				1											
Phleum pratense sens.lat.	0								1				1			
Plagiomnium undulatum	0		1	1										1		
Plantago major	0												1			
Pleurozium schreberi	0							1								
Poa annua	0							1								
Poa pratensis sens.lat.	0							1								
Polytrichum commune	0			1												
Polytrichum juniperinum	0			1												
Polytrichum sp.	0	1														
Potentilla anserina	0		1													
Potentilla erecta	0			5				1							1	
Potentilla reptans	0											1				
Pseudoscleropodium purum	0						1					1			1	
Pulicaria dysenterica	0		1													
Ranunculus bulbosus	0					10						1				
Ranunculus ficaria	0		1													
Ranunculus flammula	0	1		1												
Rhytidiadelphus squarrosus	0	1		5		1	10	5		1					1	

Species	NVC constancy	1998		2007	2013				2014					2016		Absent
Rumex acetosella	0	1														
Sagina sp.	0		1													
Stachys officinalis	0														1	
Stellaria uliginosa	0										1					
Thalictrum flavum	0			5												
Thuidium tamariscinum	0			1											1	
Trifolium dubium	0					1								1		
Veronica serpyllifolia	0					1									1	
Vulpia myuros	0	1														

7 Annex 7: Model parameters for analysis of non-native and faunal indicator vegetation in woodlands

7.1 Count of native species analysis

Deviance residuals:

Minimum	1Q	Median	3Q	Maximum
-4.1651	-1.0412	-0.0947	0.7688	4.6322

Coefficients:

	Estimate	Std. error	z value	Pr(>|z|)	
Broadleaved X1 (intercept)	2.16032	0.05006	43.152	< 2e-16	***
Broadleaved Y	0.26598	0.05467	4.865	1.14e-06	***
Coniferous all	-0.41447	0.07656	-5.413	6.18e-08	***

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

(Dispersion parameter for poisson family taken to be 1)

Null deviance: 897.21 on 280 degrees of freedom

Residual deviance: 746.75 on 278 degrees of freedom

AIC: 1847.3

Number of Fisher Scoring iterations: 5

7.2 Count of food plants for butterfly larvae analysis

Deviance residuals:

Minimum	1Q	Median	3Q	Maximum
-2.7738	-1.0380	-0.2740	0.5616	2.9677

Coefficients:

	Estimate	Std. error	z value	Pr(>|z|)	
Broadleaved X1 (intercept)	1.25276	0.07881	15.896	<2.00E-16	***
Broadleaved Y	0.09453	0.08736	1.082	0.279	
Coniferous all	-0.58889	0.12693	-4.639	3.5e-06	***

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

(Dispersion parameter for poisson family taken to be 1)

Null deviance: 461.98 on 280 degrees of freedom

Residual deviance: 413.15 on 278 degrees of freedom

AIC: 1203.2

Number of Fisher Scoring iterations: 5

7.3 Count of nectar plants analysis

Deviance residuals:

Minimum	1Q	Median	3Q	Maximum
-2.6115	-1.5383	-0.2266	0.5253	3.6080

Coefficients:

	Estimate	Std. error	z value	Pr(>|z|)	
Broadleaved X1 (intercept)	1.11300	0.08452	13.169	< 2e-16	***
Broadleaved Y	0.11366	0.09352	1.215	0.224	
Coniferous all	-0.81575	0.14638	-5.573	2.51e-08	***

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

(Dispersion parameter for poisson family taken to be 1)

Null deviance: 582.53 on 280 degrees of freedom

Residual deviance: 512.98 on 278 degrees of freedom

AIC: 1222.8

Number of Fisher Scoring iterations: 5

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