Carbon storage in floodplain soils

Dr Clare Lawson

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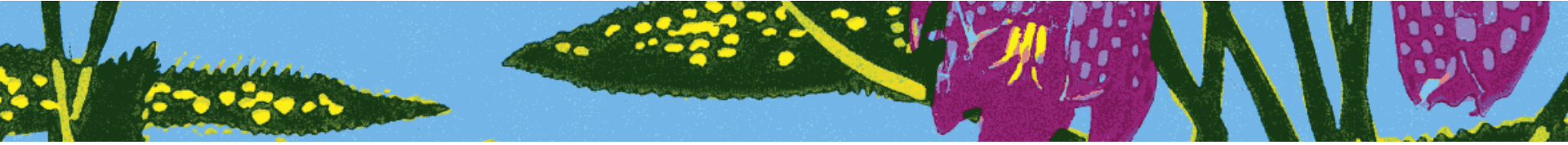
The Open University

Floodplain of the River Thames as a flood returns to the channel



The extent (km^2) of different land uses within the floodplain (Flood zone 2).

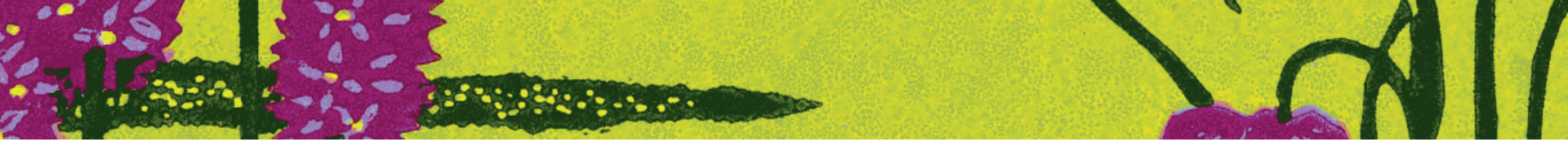
Land Use	England*		Wales#		Total	
	extent	% cover	extent	% cover	extent	% cover
Arable and Horticulture	2350	35.6	114	9.3	2464	31.5
Improved Grassland	2200	33.3	613	49.9	2813	35.9
Broadleaved, mixed and yew woodland	450	6.8	130	10.6	580	7.4
Coniferous woodland	30	0.5	12	1.0	42	0.5
Neutral Grassland	200	3.0	19	1.6	219	2.8
Fen, Marsh and Swamp	20	0.3	25	2.0	45	0.6
Urban & suburban	650	9.8	98	8.0	748	9.6
Total floodplain	6600		1229		7829	

Land use categories are from the CEH Land Cover Map 2015.

** Data from England is based on 2007 data, from Heritage & Entwistle, 2017.*

 # Data from Wales, unpublished data, Floodplain Meadow Partnership.

VALUING NATURE

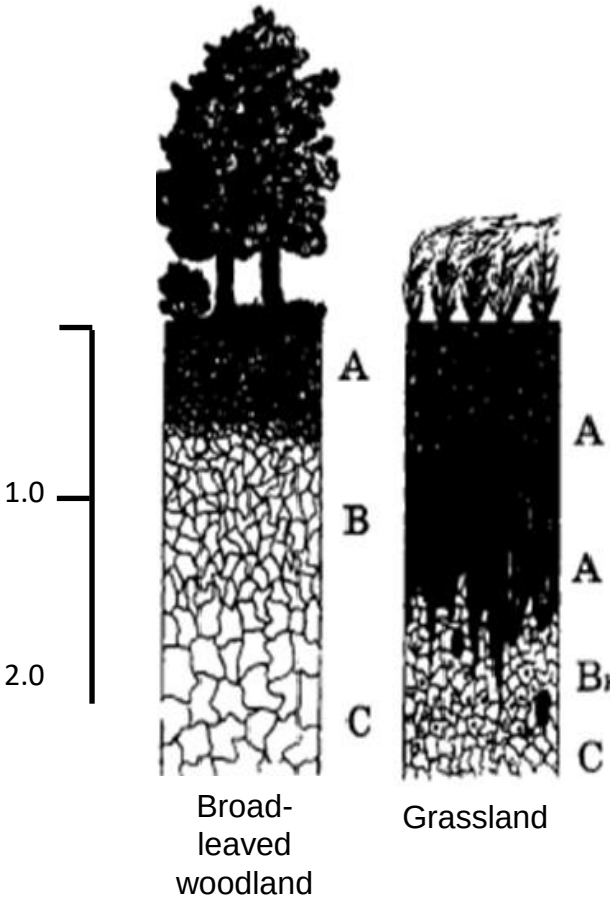


How do grasslands compare to other habitats?

Broad Habitat	Mean C density (t ha^{-1})
Arable & horticulture	47.3
Improved grassland	67.2
Broadleaved, mixed and yew woodland	73.0
Neutral grassland	68.7

Topsoil (0-15 cm) carbon density (t C ha^{-1}) Countryside Survey

Grassland soils can be a very effective carbon store in the long term



Distribution of humus along the soil profile of different ecosystems (Rozanov, 2004). Dark areas show density and depth of humus.

How much carbon is stored in the soil of floodplain meadows?

- Species-rich meadows
  - 4 sites
- Soil samples taken to depth of 50 cm to measure carbon
- Additional samples (15 cm)
  - pH, phosphorus
- Botanical data

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NERC SCIENCE OF THE ENVIRONMENT

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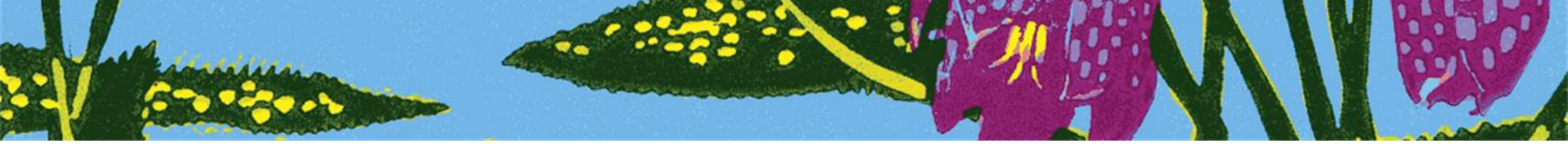
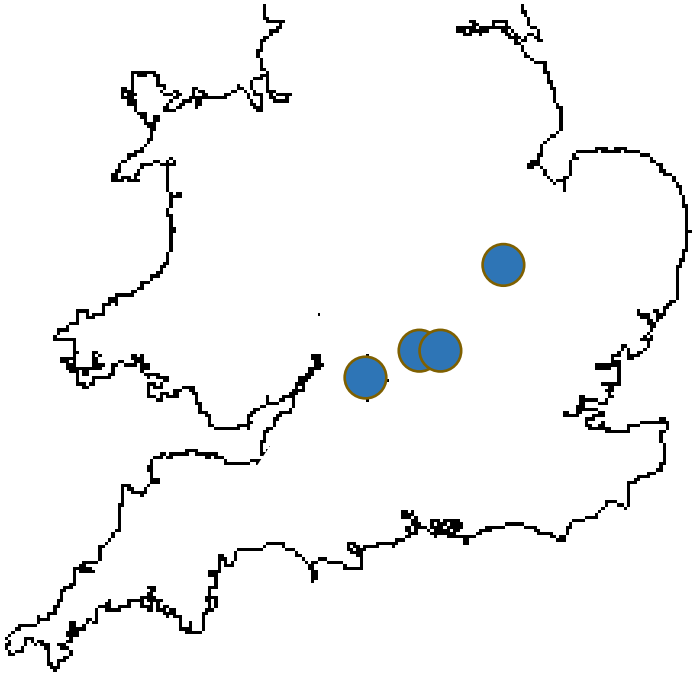


Floodplain Meadows support a range of plant communities

Site	Plant Communities							
	MG4a *Dactylis glomerata*	MG4b Typical	MG4c *Holcus lanatus*	MG4d *Agrostis stolonifera*	MG15a *Agrostis stolonifera*	MG4/MG8a	MG8a *Sanguisorba officinalis*	MG16
Cricklade	+	+	+	+				+
Yarnton Mead	+					+	+	
Oxey Mead	+	+			+			
Portholme	+		+		+			



MG4 – Alopecurus pratensis-Sanguisorba officinalis grassland
MG8 – *Cynosurus cristatus-Carex panicea-Caltha palustris* grassland
MG15 – *Alopecurus pratensis-Poa trivialis-Cardamine pratensis* grassland
MG16 – *Agrostis stolonifera-Eleocharis palustris* inundation grassland

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Plant communities characterised in the field
75 quadrats across 4 sites

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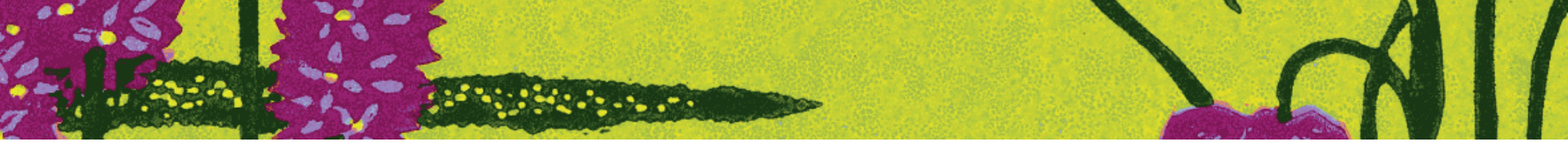
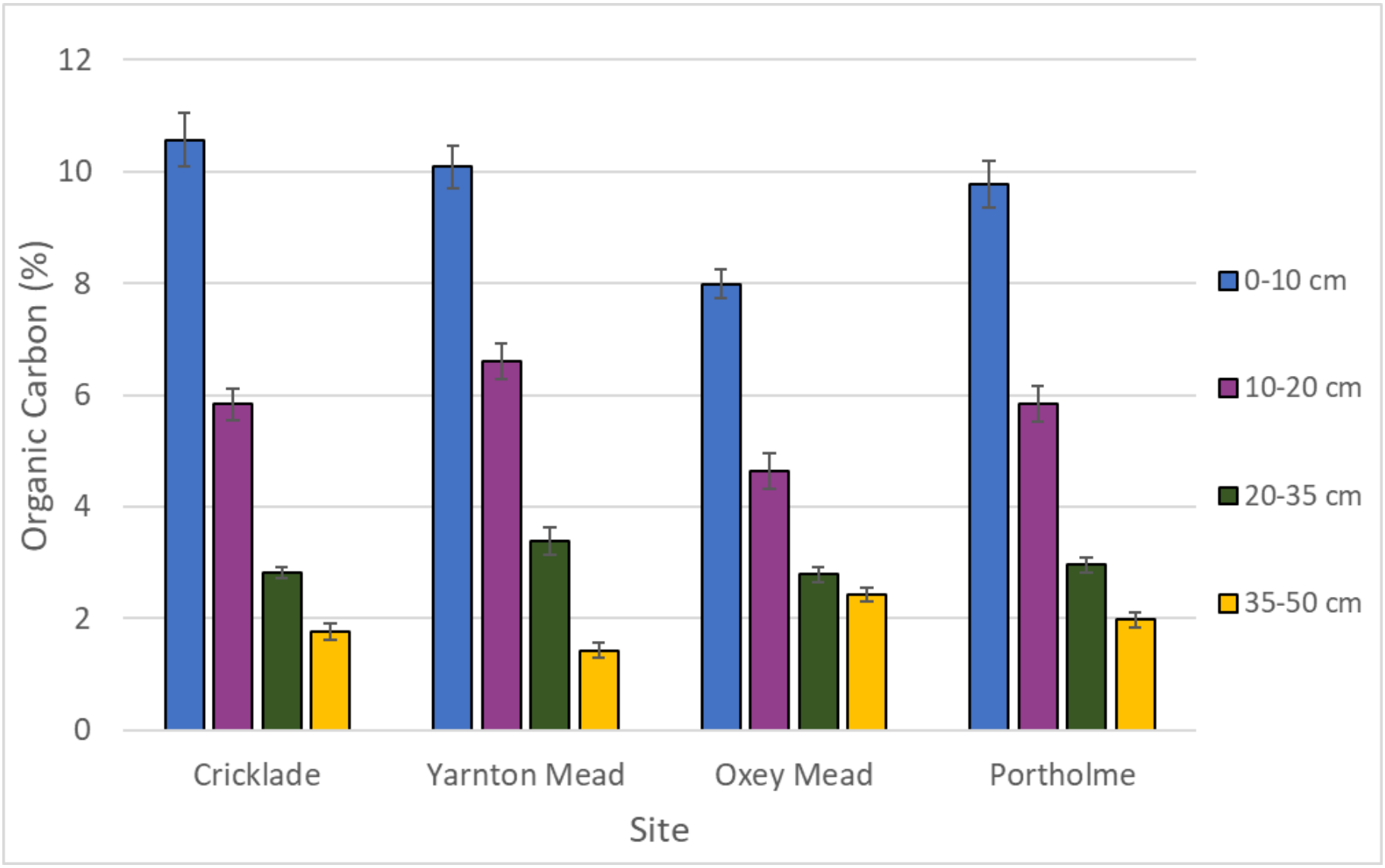


Organic carbon (% w/w) declines with soil depth



How do species-rich floodplain grasslands compare to other habitats?

Broad Habitat	Mean C density (t ha^{-1})
Arable & horticulture	47.3
Improved grassland	67.2
Broadleaved, mixed and yew woodland	73.0
Neutral grassland	68.7

Topsoil (0-15 cm) carbon density (t C ha^{-1})
Countryside Survey

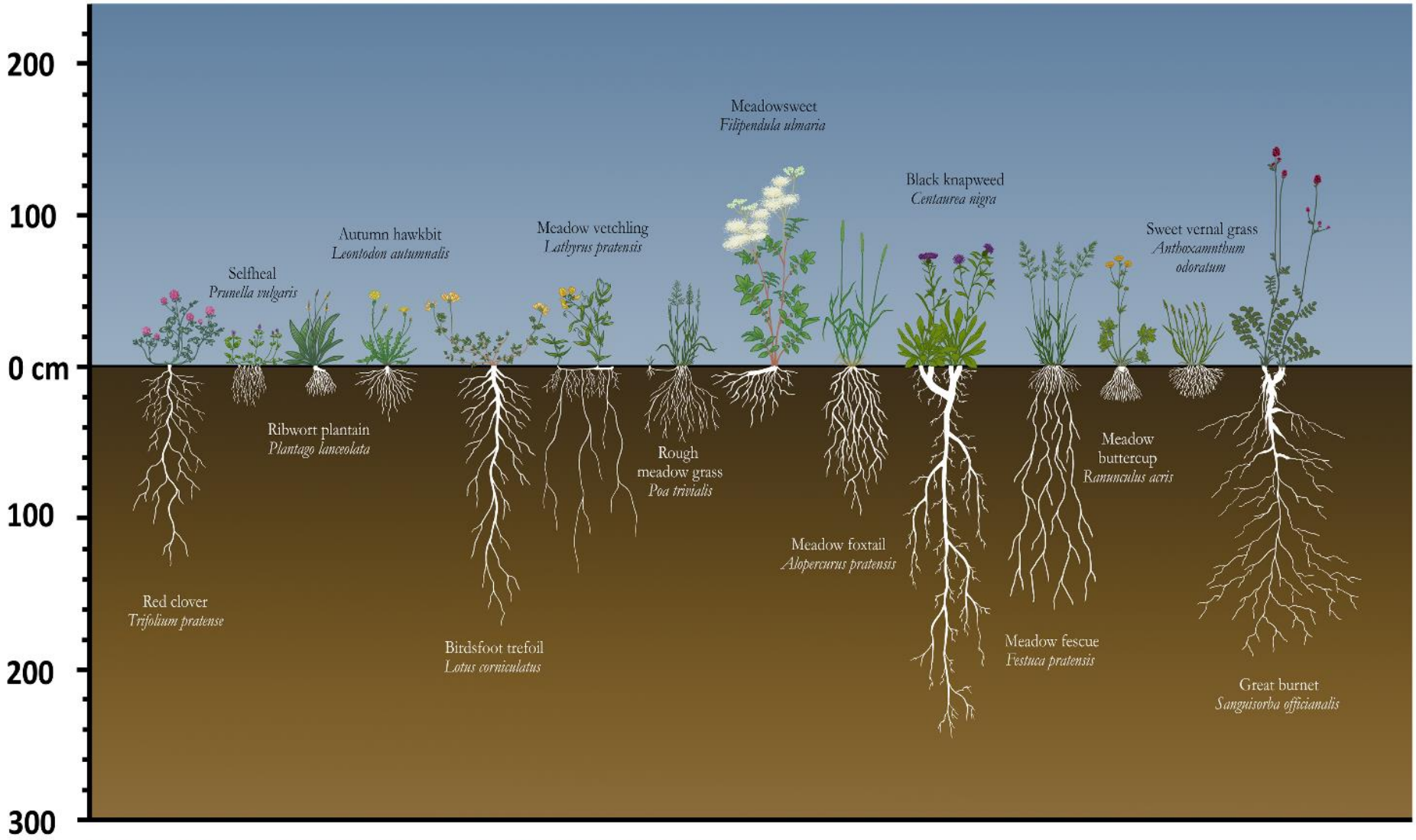
Species-rich floodplain meadow

(0 – 10 cm) n = 75
82.6 t C ha^{-1}

(0 – 50 cm) n = 75
207.9 t C ha^{-1}

North Meadow, Cricklade n = 15
109.4 t C ha^{-1}
217.6 t C ha^{-1}

Rooting structures of floodplain meadow plants



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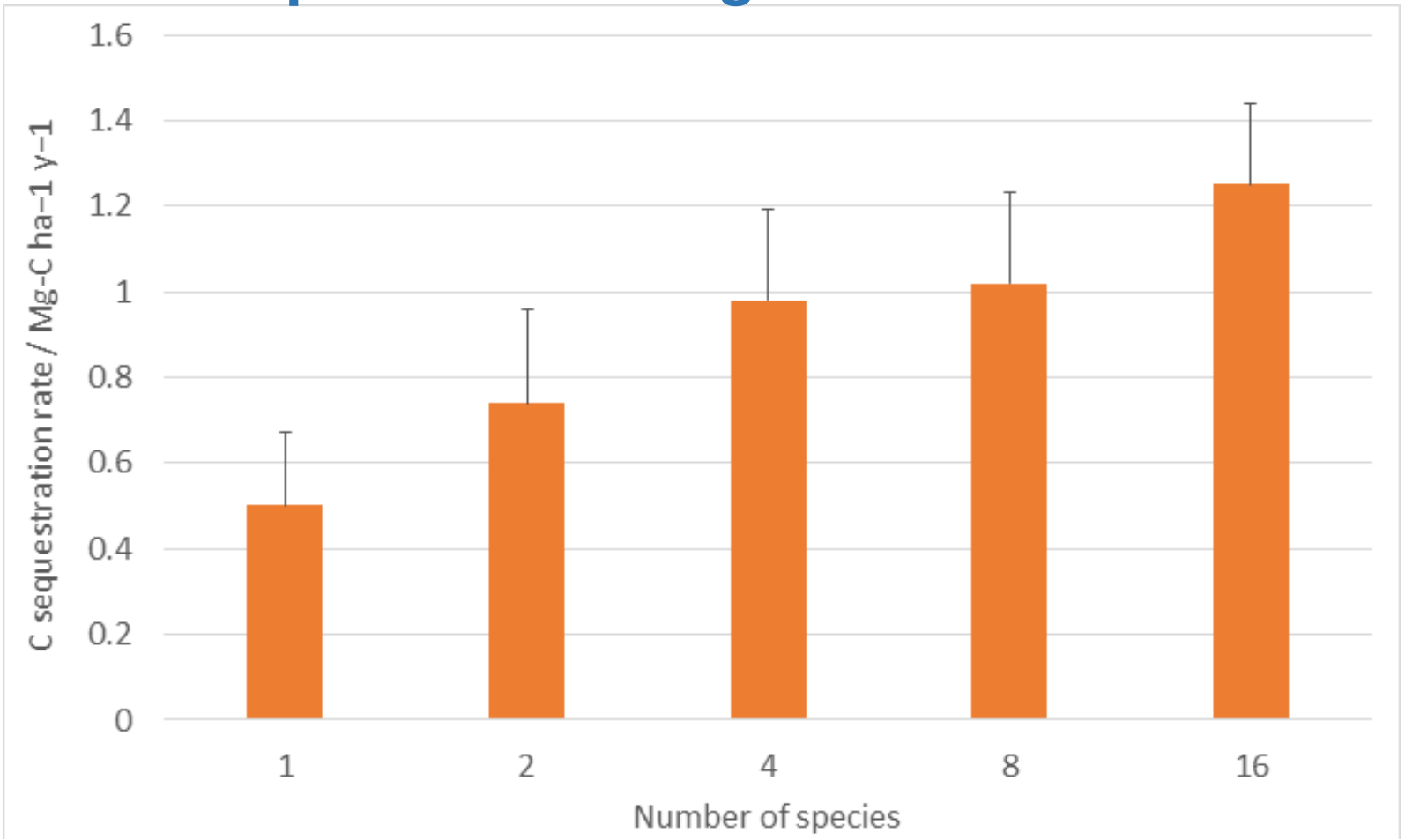
www.floodplainmeadows.org.uk
www.open.ac.uk/eees
Artwork by www.vickybowskill.com with botanical expertise from Irina Tatarenko.

References:
Diagnoses and keys for the age states of meadow plants. Parts 2 & 3 (1983), Moscow State Pedagogical Institute. Moscow
Diagnoses and keys for the age states of grasses (1997), Moscow
Biological Flora of Moscow Oblast (1974-2002)

Higher species-richness increases the rate of carbon sequestration in grassland communities



Source: C sequestration rate in top 60 cm of restored prairie grassland (Data from Yang, Tilman et al 2019, Nature Communications)

Fertilise the Future

Land Use categories

- Species-rich ancient meadows
- Meadow restoration sites

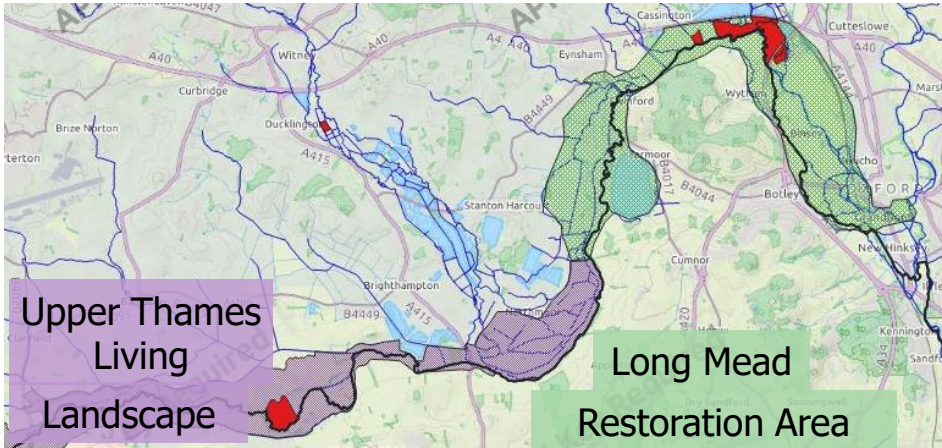
  > 10 years
- Meadow restoration sites

  < 10 years
- Arable sites

FERTILISE THE FUTURE

THE LOWDOWN ON NATURE-BASED SOLUTIONS

ECO VER



LONG MEAD

Berkshire Buckinghamshire Oxfordshire

The Wildlife Trusts

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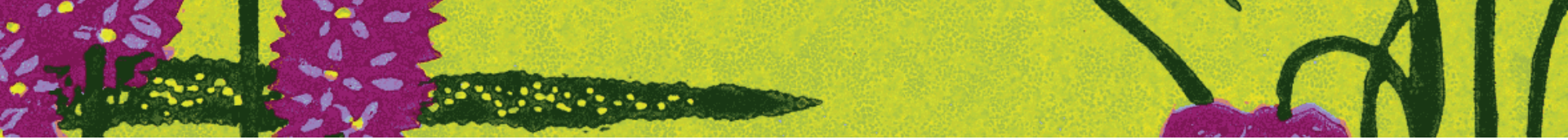
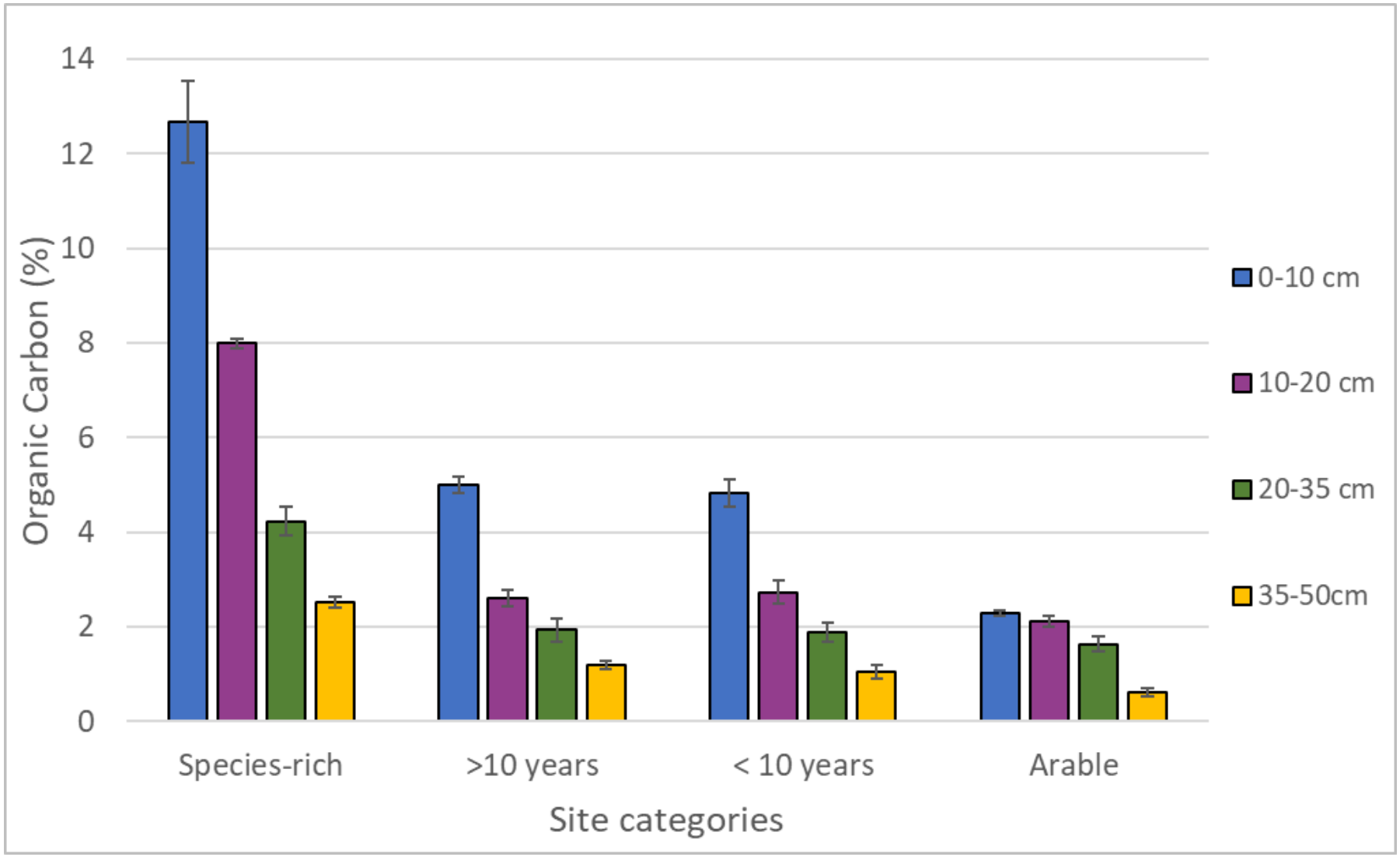
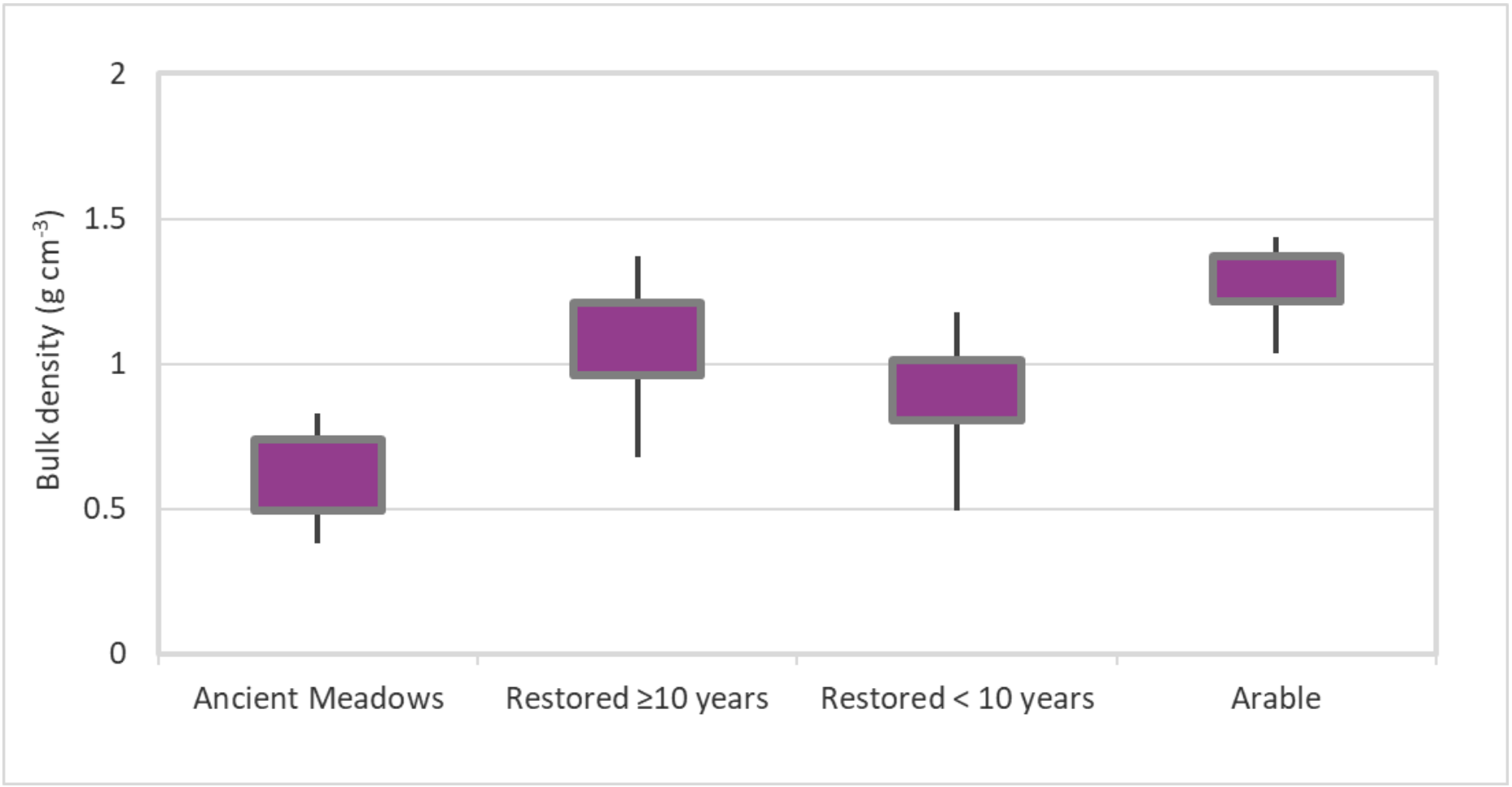


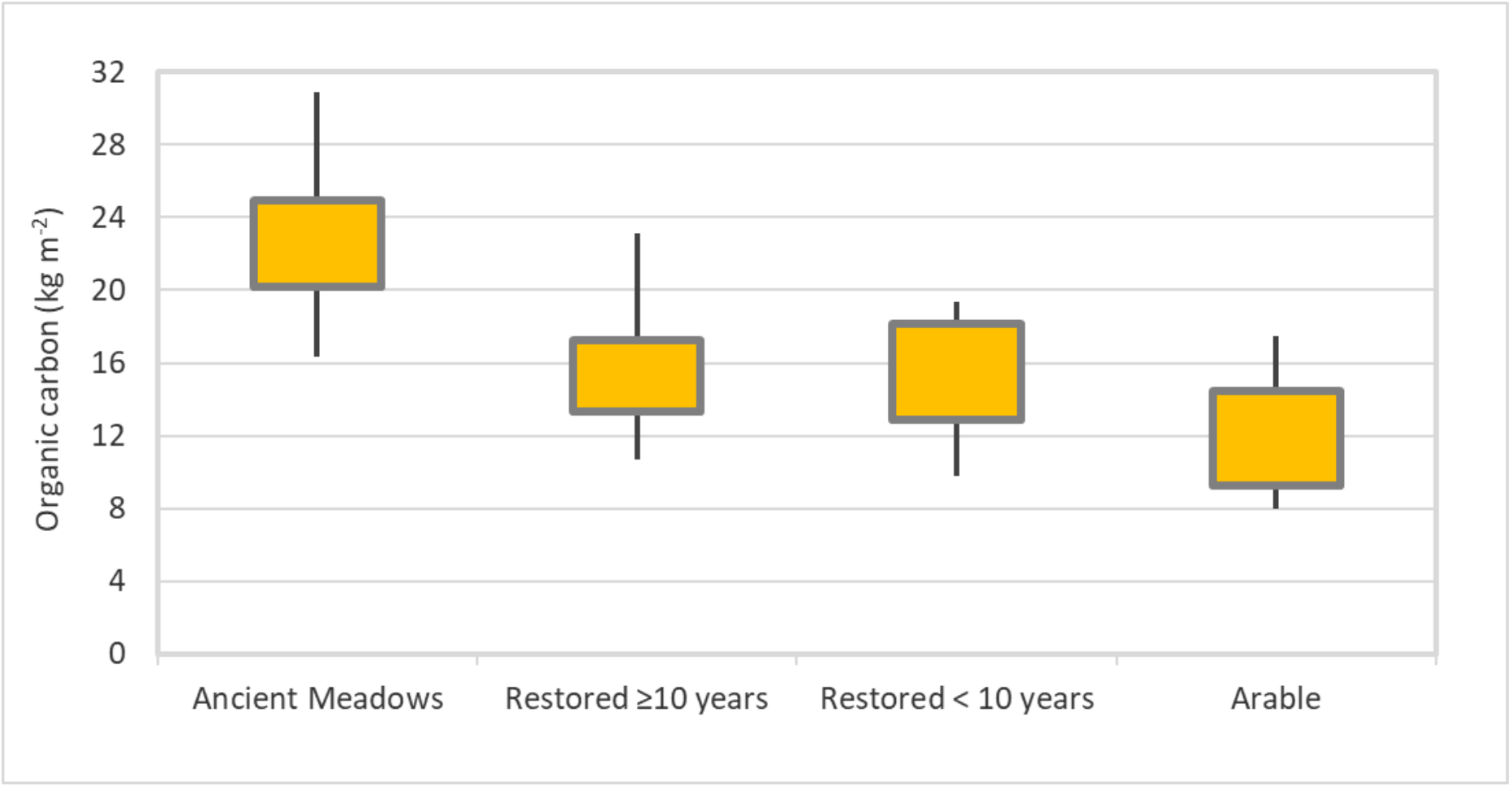
Preliminary results – Organic carbon (% w/w)



Preliminary results – Bulk density (g/m^3) 0 - 20 cm



Preliminary results – Organic carbon (kg/m^2) 0 - 50 cm



GRCF

Flourishing floodplains

Land Use categories

- Species-rich ancient meadows
- Meadow restoration sites
- Other grassland
- Arable sites

WWT

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FWAG SouthWest

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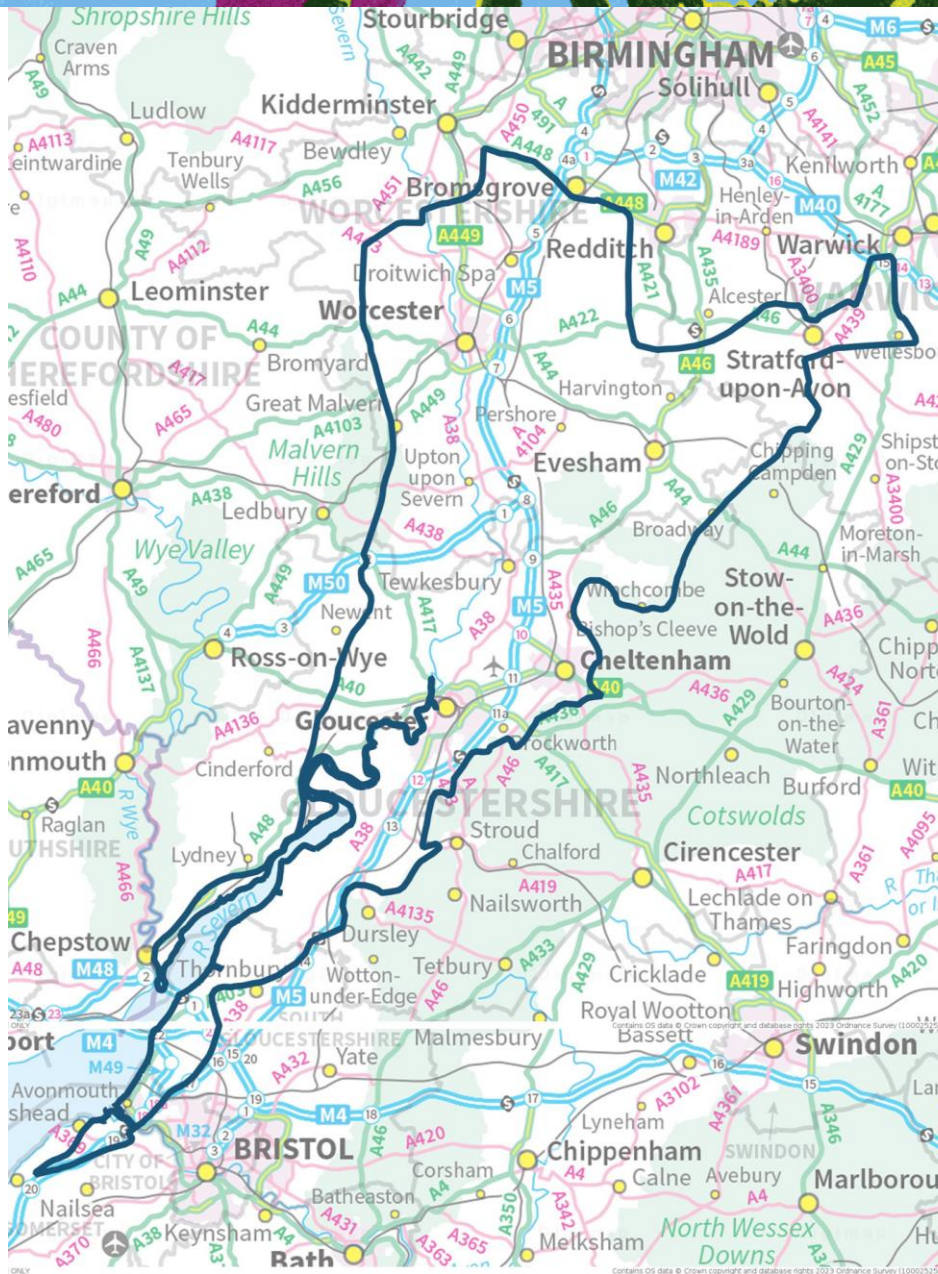
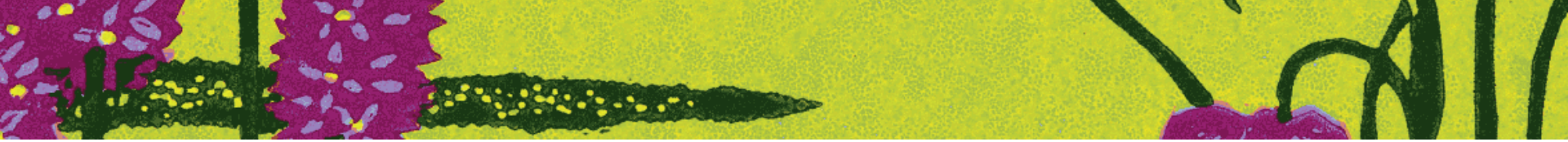
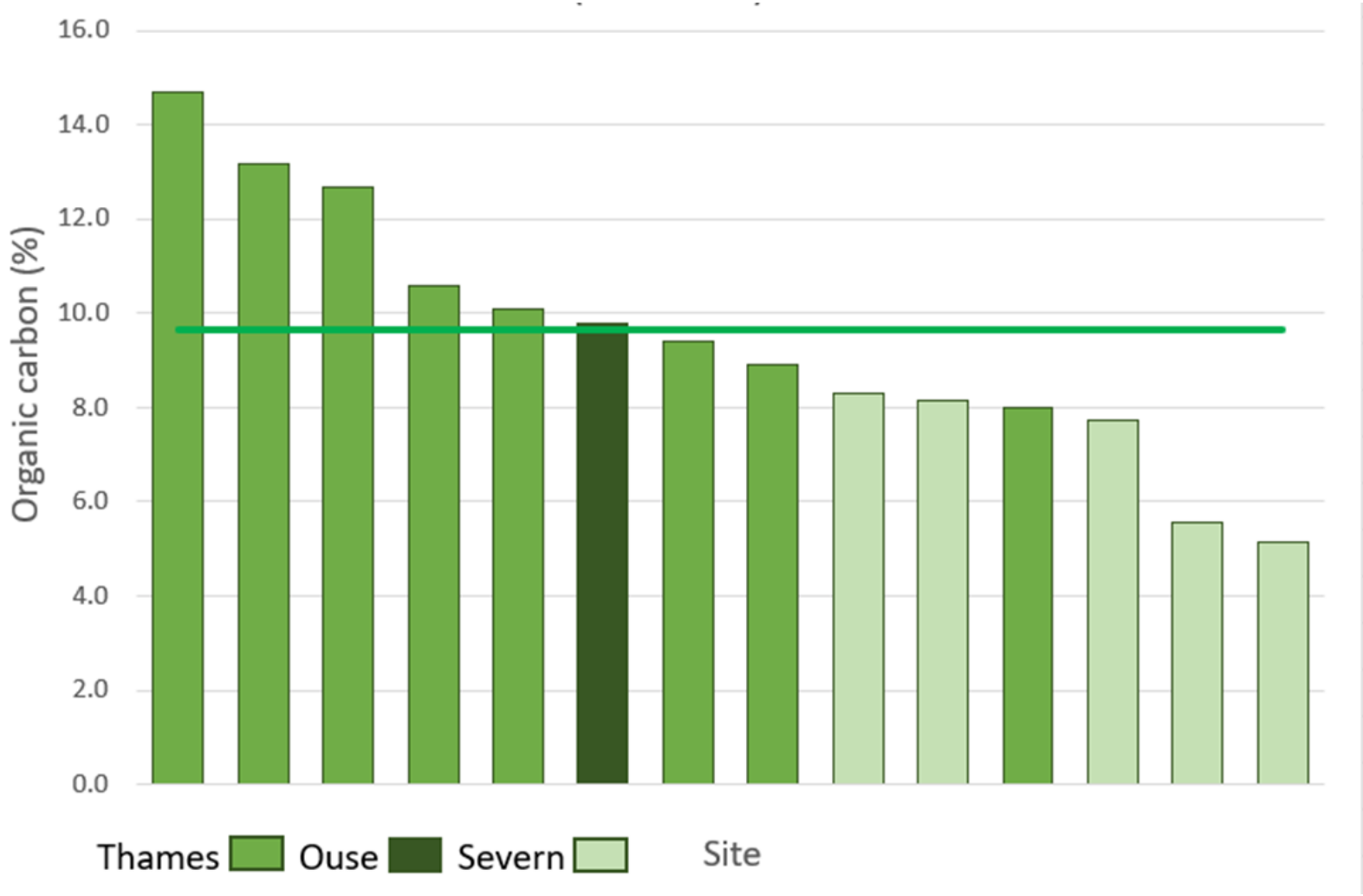




Organic carbon (% w/w) in floodplain meadows (0 – 10 cm)



8. Hay Cutting
Must be timed to balance crop quality with conservation goals

1. Rising soil nutrients = falling botanical diversity
Hay crop removes soil nutrients from the system, balancing inputs from flooding

2. Aftermath grazing in the autumn

3. Flooding deposits nutrients that enrich soils

4. Meadow is closed up when too wet for grazing to protect soil structure and allow plants to grow in spring

5. Sunshine hours drive growth once temperatures rise above about 4.5 °C

6. Plant growth transfers soil nutrients to biomass

7. Meadow species progress through their lifecycles, whilst hay nutritional content peaks after seed production and begins to decline

Future work - opportunities for floodplain meadows

- Evidence carbon storage
  - Plant community
  - Hydrology

- Value of restoring species-rich floodplain meadows
  - Carbon
  - Biodiversity

- Recognition of this value in policy

Thank you for listening

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Website

https://floodplainmeadows.org.uk/

Floodplain Meadows Partnership

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