



An Overview of National Soil Monitoring Schemes Across the Four Nations of the UK

Developed by Prof. Bridget Emmett (UKCEH), Ellen Fay (SSA) and Theo Heaton-Davies (SSA)
for the LUNZ Topic Advisory Group on Soil Health and Carbon Dynamics



**UK Research
and Innovation**



Department
for Environment
Food & Rural Affairs



Department for
Energy Security
& Net Zero



Department for
Science, Innovation,
& Technology



Scottish Government
Riaghaltas na h-Alba
gov.scot

INTRODUCTION

The following slides provide a visualisation of the research and findings from the LUNZ Soil TAG project to assess the technical detail behind the national soil measuring and monitoring programmes of England, Scotland, Northern Ireland and Wales.

They draw on the examination of 75 scheme characteristics from 17 government-led national soil monitoring schemes.

This visualisation of the technical detail of the UK's soil monitoring schemes identifies technical similarities and divergences and may be used to facilitate conversations about opportunities for harmonisation, alignment and where possible, standardisation.

SECTION 01

Overview of schemes submitted

Schemes submitted to the overview analysis

Country	Commissioning organisation	Delivery organisation(s)	Name of scheme	Abbreviated name
Northern Ireland	Department Agriculture, Environment and Rural Affairs	Agri-Food and Biosciences Institute	Soil Nutrient Health Scheme - Core Baseline Sampling and Analysis Programme	SNHS
Northern Ireland	Department Agriculture, Environment and Rural Affairs	Agri-Food and Biosciences Institute	Soil Nutrient Health Scheme - Research Work Programme on Carbon	SNHS
Northern Ireland	Department Agriculture, Environment and Rural Affairs		Countryside Survey NI	CSNI
GB	Not directly commissioned but funded by UKRI/NERC under National Capability (1978 funded by ITE; 1998& 2007 CS consortium of governments and CEH)	UKCEH	Countryside survey GB	CS
Wales	Welsh Government	UKCEH	Glastir Monitoring and Evaluation Programme and Environment and Rural Affairs Monitoring and Modelling Programme	ERAMMP
England	Defra	Natural England..... Etc	England Ecosystem Survey/ NCEA etc	EES
England	Defra	Royal Botanic Gardens Kew	Fungal Health Survey - Natural Capital and Ecosystem Assessment Programme	Kew-NCEA
UK	EU (70% funded), FC (30% funded) BioSoil 2006, BioSoil 2021-2026 -DEFRA NCEA (100% England BioSoil sites), Scottish Government and DEIZN (100% Scotland sites)	Forest Research	BioSoil -soil and biodiversity network	FR BioSoil
European Union	European Commission	EC JRC EU Soil Observatory	Land Use Change Area-frame Survey Soil Module	LUCAS Soil
UK	EU (70% funded until 2010), FC (30% funded until 2010) FC funded %100 since 2010 to now NCEA (funds 2 ICP Forest Level II sites)	Forest Research	ICP Forest Level II Intensive forest monitoring network	FR II
UK	EU (70% funded until 2006), FC (30% funded until 2006)	Forest Research	ICP Forest Level I forest monitoring network	FR I
England & Wales		Cranfield University	NSI E&W	NSI E&W
Scotland	Not directly commissioned but funded under RESAS	James Hutton Institute	National Soil Inventory of Scotland	NSIS
Scotland	Not directly commissioned but funded under RESAS	James Hutton Institute	Trends in pollution of Scottish Soils	TiPSS
Scotland	Not directly commissioned but funded under RESAS	James Hutton Institute	Birse and Robertson Survey soils	R&B
Scotland	Forestry Commission Scotland	James Hutton Institute	Afforested soils	Afforested
Scotland	Not directly commissioned but funded under RESAS	James Hutton Institute	East of Scotland Farm Survey	East Farm

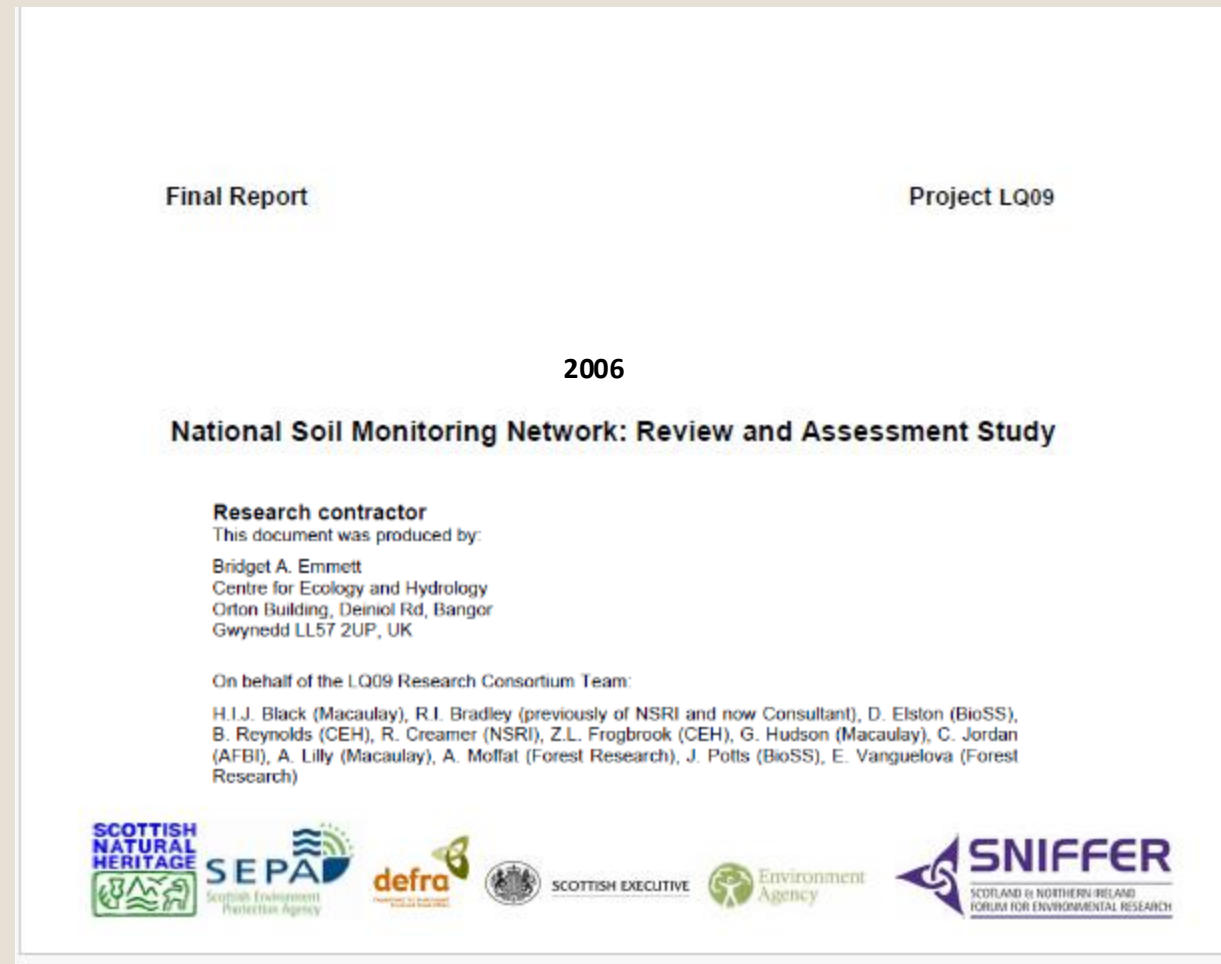
Division of schemes

- Of a total these 17 schemes, 7 have funding and cover all habitats and soils nationally using a sampling design and number of samples to capture a national representative unbiased sample (EES in England, NSI in England and Wales, NSI in Scotland, ERAMMP in Wales, CS in Northern Ireland, CS in Great Britain and LUCAS in the EU)
- 3 schemes are large schemes with design to capture unbiased sample but target specific habitats:
 - Agriculture (SNHS/S)
 - Forestry (Biosoil & BioD/UK)
 - Non-arable soils (B&R survey/S)
- 5 schemes are networks based on 'typical' sites along gradients or to capture a range of vegetation or geological / soil classes
- None (5) in Scotland are currently active – work is ongoing to develop new schemes
- One (NSIE&W) in England and Wales with no current funding.
- LUCAS/EU assumed not to be continuing for the UK

This leaves 9 active schemes in total with funding going forward currently

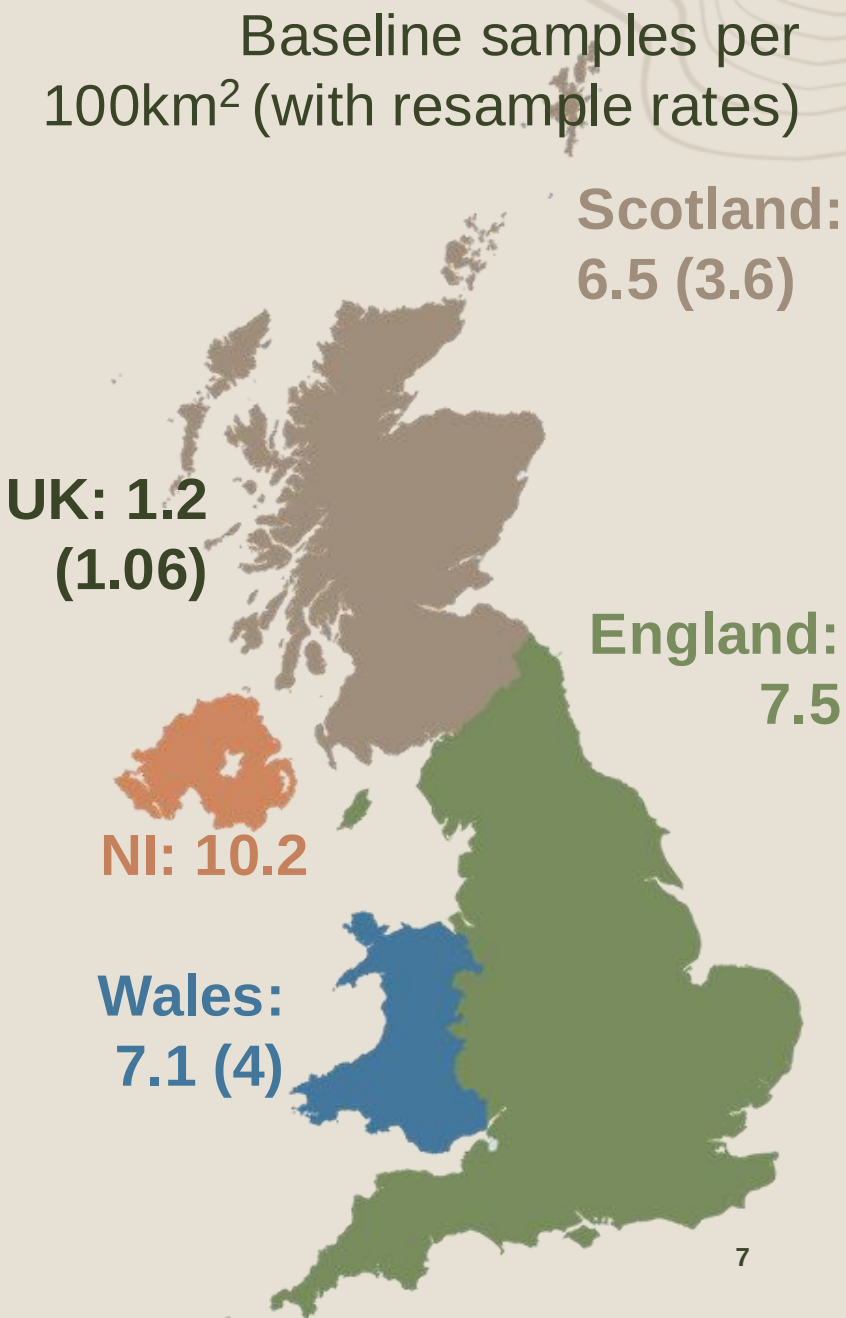
There are many other soil monitoring programmes which have no specific funding in place but are a massive potential resource....

- NSI E&W (Cranfield) being the most obvious largest scheme
- 29 schemes were identified and reported in this report back in 2006 (Emmett et al. LQ09).
- There is a linked excel file database on specific design and indicators for each scheme....



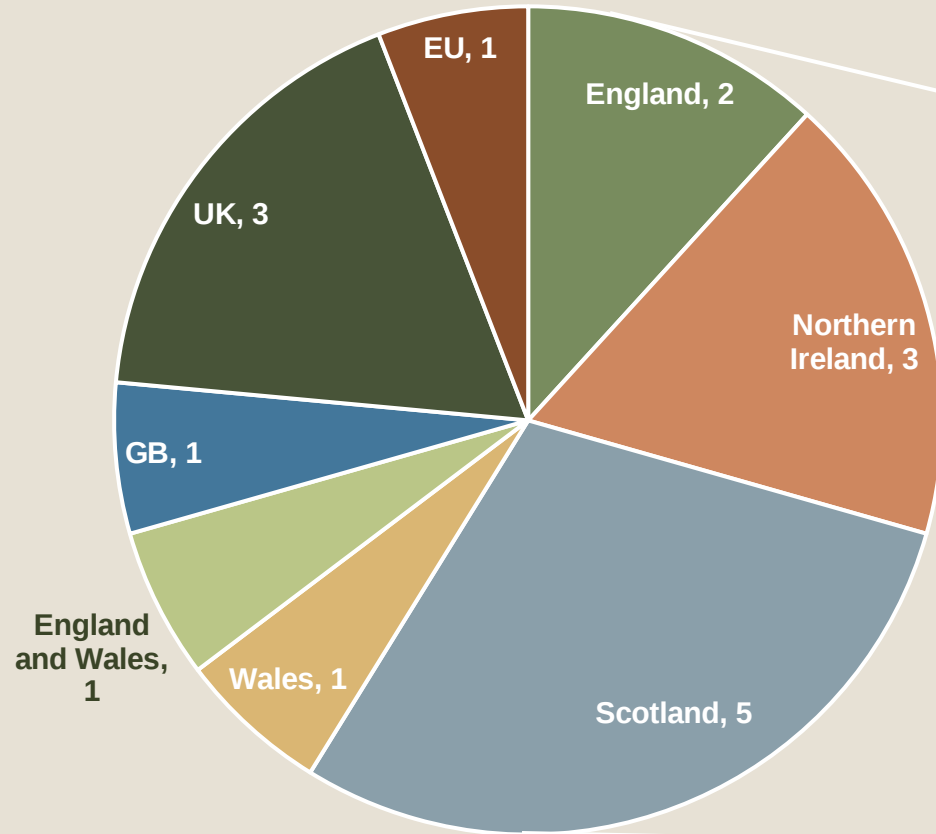
Sampling rates for the 4 main national monitoring programmes

	England	NI	Scotland	Wales	UK
Current national monitoring scheme in place	Yes (EES)	Yes (CSNI)	No but in prep (NSIS previously)	Yes (ERAMMP)	Yes CS (+ CSNI makes it UK)
Change reporting period possible	None 2024-8 onwards only	None 2024 onwards only	1978 onwards likely	2013 - 2023 (links to 1978 possible)	1978 - 2026
Sample No. for baseline (and for repeat sampling)	10,000	1,440	5222 (2848)	1500 (840)	2975 (2500)
Country area (000 km ²)	133	14	80	21	234

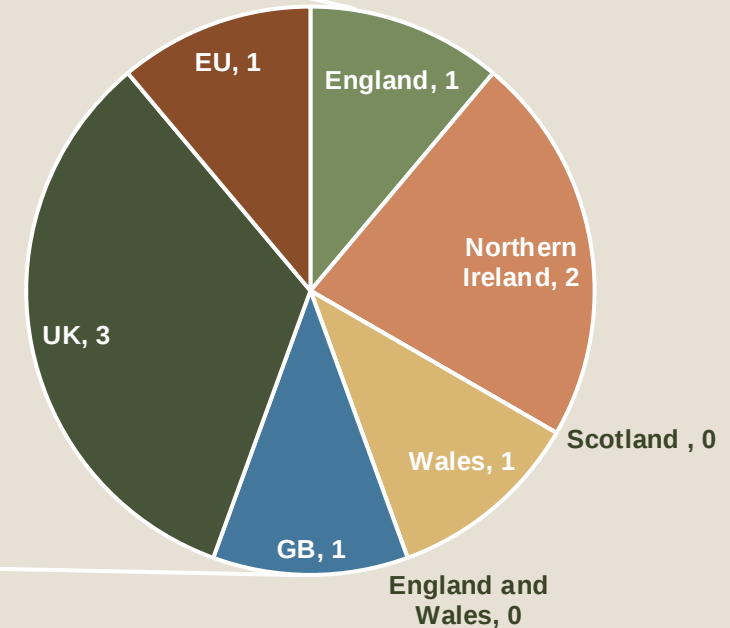


Number of monitoring schemes per nation...

... with ongoing funding

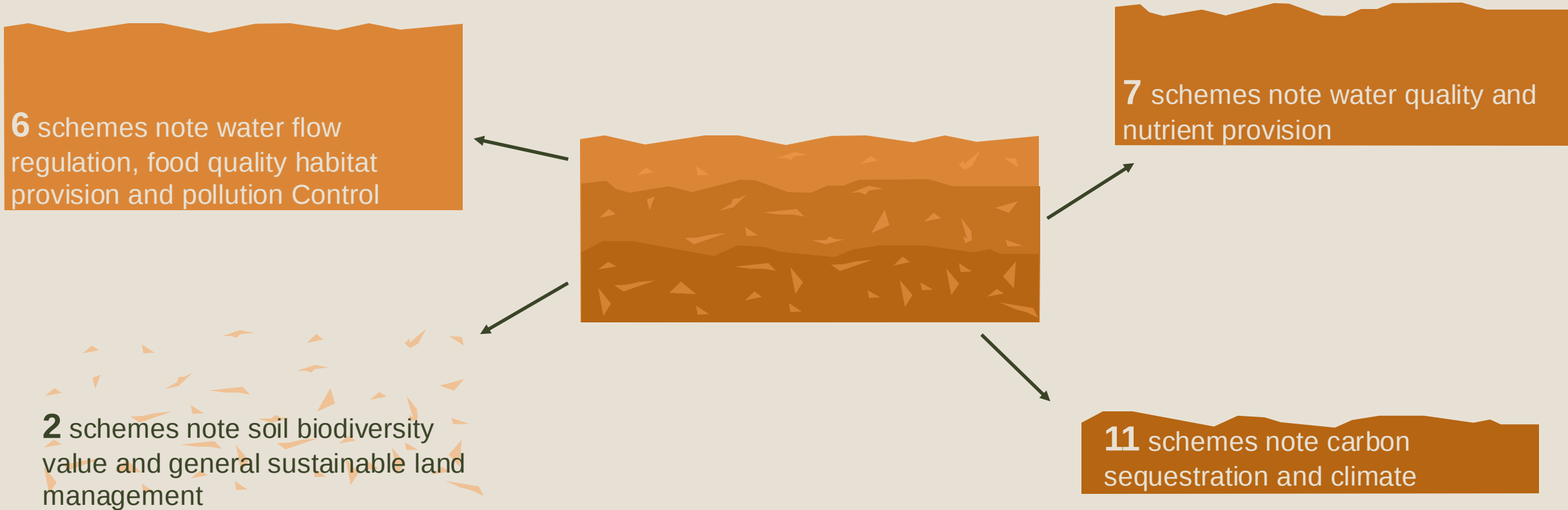


17 in total across the UK...

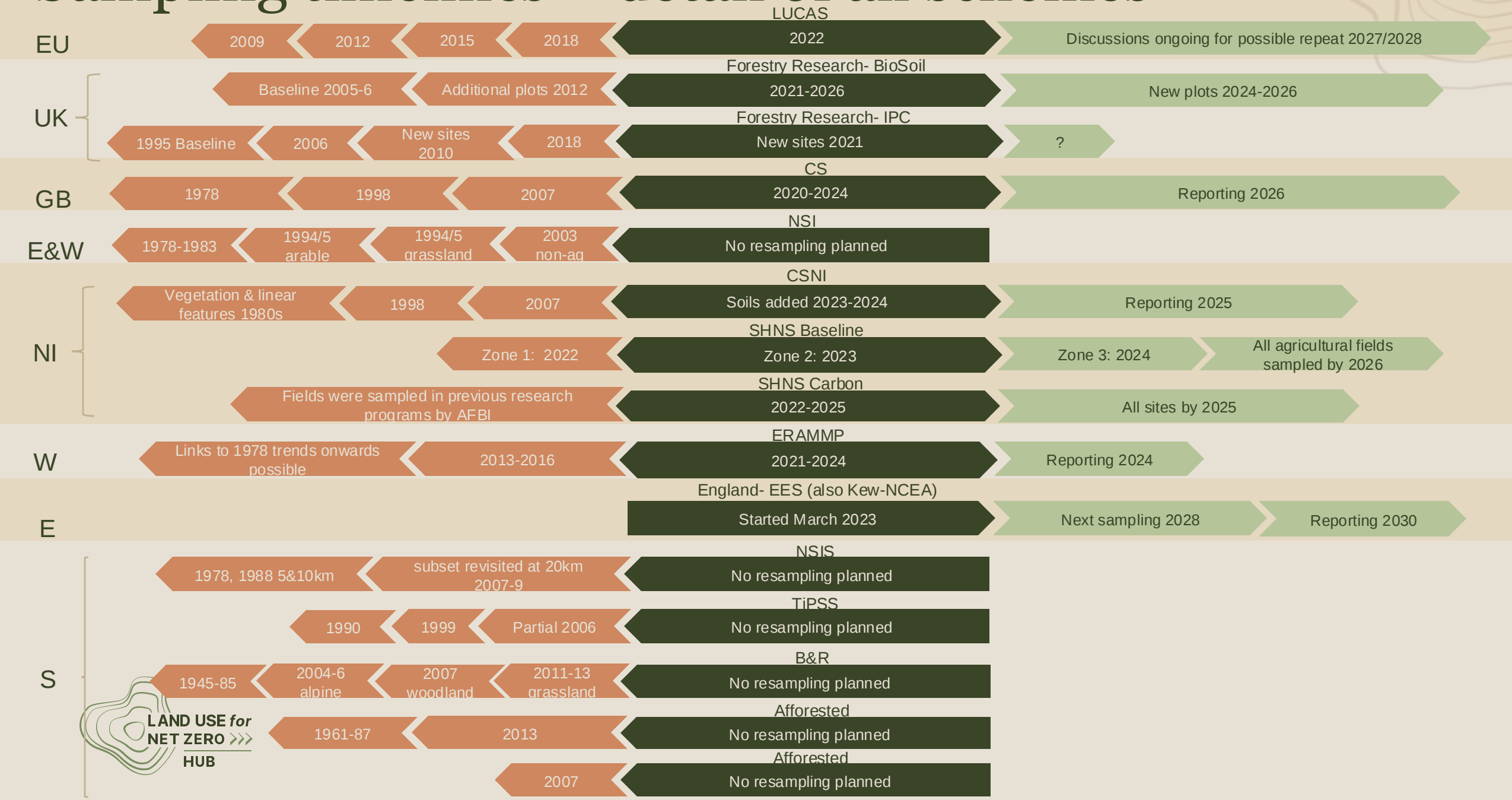


...9 in total across the UK

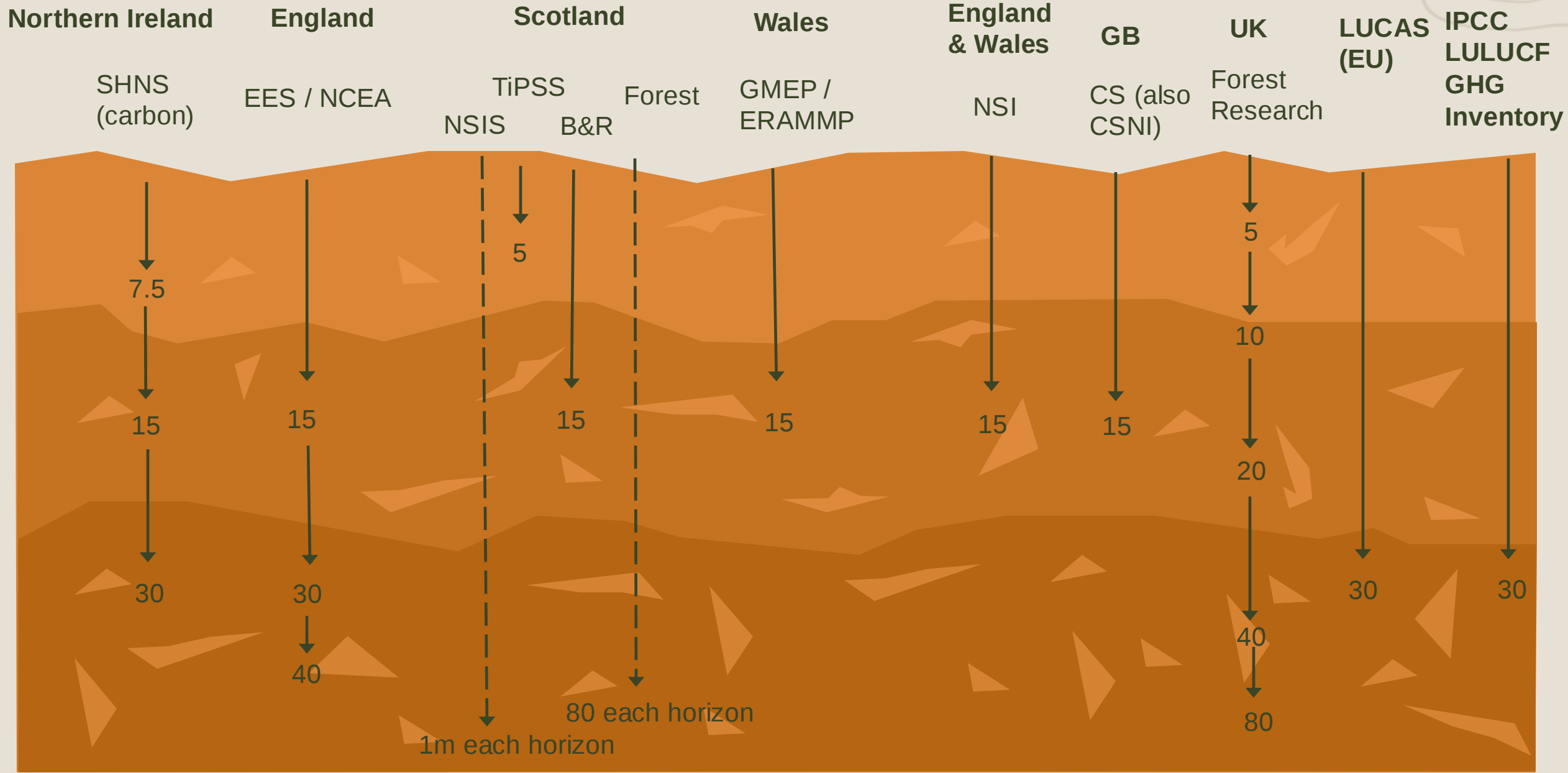
Environmental priorities driving different monitoring schemes



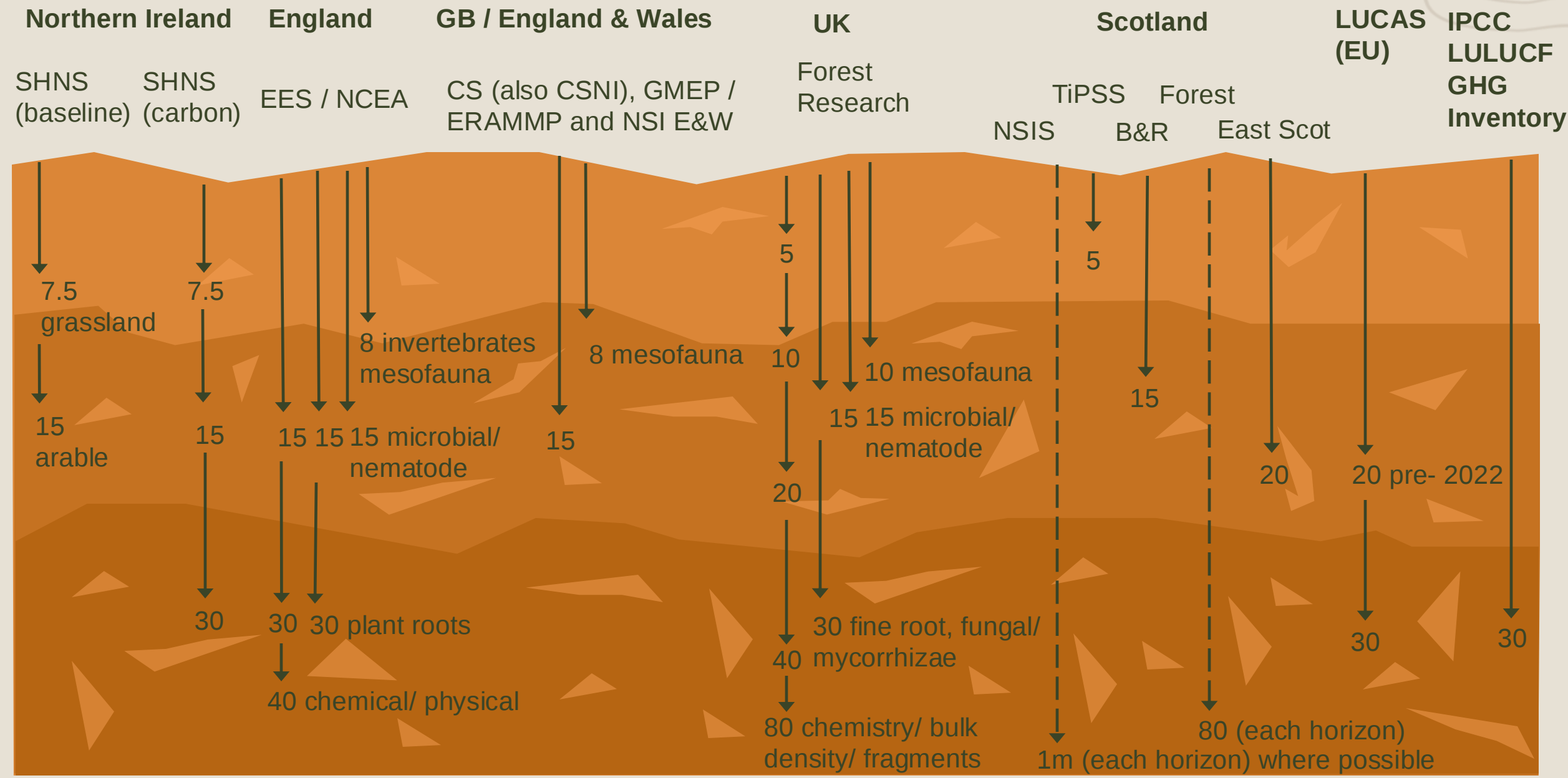
Sampling timelines – detail of all schemes



Sampling depths - organic matter



Sampling depths – for variety of indicators



Pollutants monitored

	Northern Ireland			Scotland					England		Wales	E/W	GB	UK	UK	UK	EU
Scheme	SNHS	SNHS-C	CSNI	NSIS	TiPSS	R&B	Afforested	East Farm	EES	Kew-NCEA	GMEP / ERAMMP	NSI E&W	CS	FR BioSoil	FR Level II	FR Level I	LUCAS Soil
Plastics				From 2007										Could on archived samples	Could on archived samples		100 sample test
Pesticides																	3300 samples, 120 active ingredients
Persistent organic pollutants					Organic Pollutants (PAH, PCB, PBDE)	Total and 16 individual PAHs; Total and 13 PCB congeners	Alpine sites only						1998 only				
Heavy metals													Yes				

Soil Biodiversity including eDNA

- MBC = Metabarcoding
- TF = Tullgren Funnels
- BF = Baermann Funnel

	Northern Ireland			Scotland					England		Wales	E/W	GB	UK	UK	UK	EU
Scheme	SNHS	SNHS	CSNI	NSIS	TiPSS	R&B	Afforested	East Farm	EES	Kew-NCEA	GMEP / ERAMMP	NSI E&W	CS	FR BioSoil	FR Level I	FR Level II	LUCAS Soil
PLFA		Yes		Yes									1998 only				
Microbial community		Yes		Yes (eDNA)				Yes	Yes, MBC	Yes, root and fungal sequencing	GMEP only 2016		Yes, MBC	Yes, MBC		Yes, MBC	Yes, MBC
Root associated mycorrhiza fungi				Yes													
Functional genes / metagenomes		Yes		Yes									Yes				
Anti-microbial resistance				Subsequent analyses													Yes
Mesofauna		Metagenomics bioinformatics	Yes, TF						Yes - TF and MBC with emphasis on springtails and mites		GMEP only- TF		1998 and 2007 only- TF	Yes - TF and MBC with emphasis on springtails and mites		Yes - TF and MBC with emphasis on springtails and mites	
Earthworms		Yes							Yes, BF and MBC					Yes, BF and MBC		Yes, BF and MBC	
Nematodes				Some sites sampled 1978-88 had Nematode populations identified					Yes, Morphological identification, fresh weight and ecological groups					Yes, Morphological identification, fresh weight and ecological groups		Yes, Morphological identification, fresh weight and ecological groups	

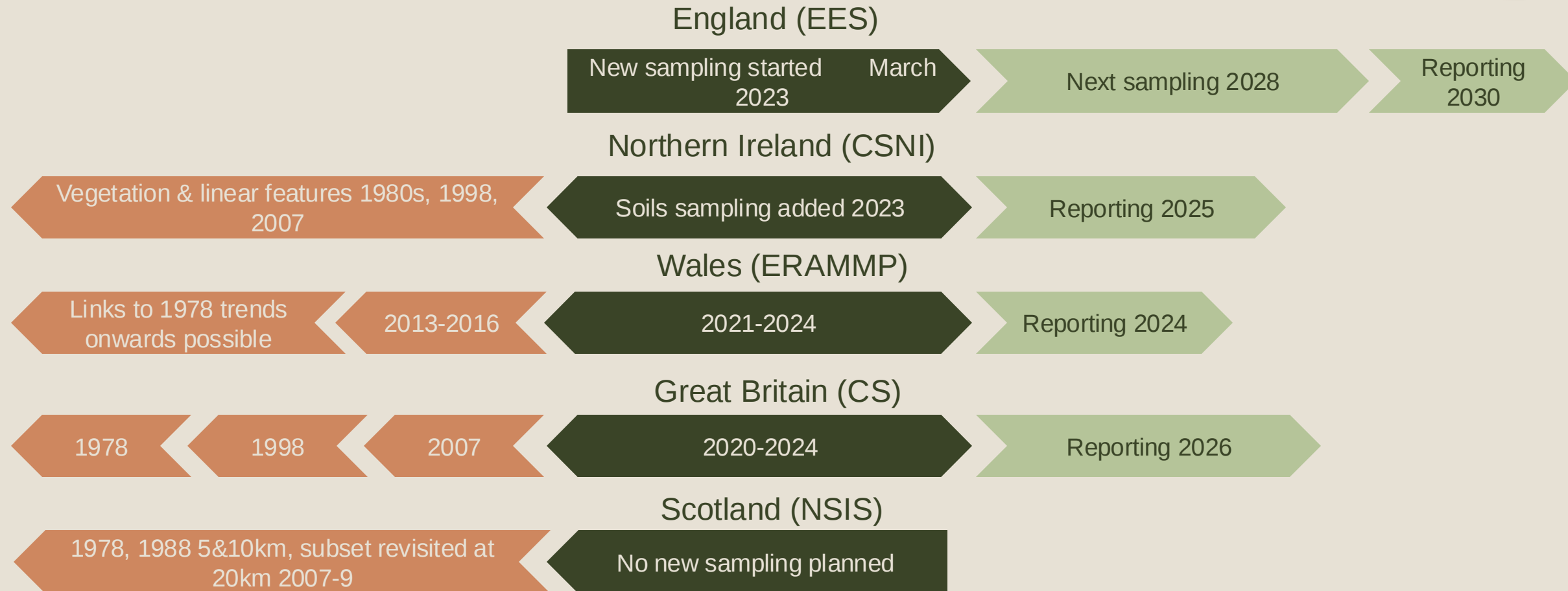
Soil processes and functions

	Northern Ireland			Scotland					England		Wales	E/W	GB	UK	UK	UK	EU
Scheme	SNHS	SNHS	CSNI	NSIS	TiPSS	B & R	Afforested	East Farm	EES	Kew-NCEA	GMEP / ERAMMP	NSIE&W	CS	FR BioSoil	FR Level I	FR Level II	LUCAS Soil
Hot water extractable carbon									Yes					Yes		Yes	
Potential N mineralisation				Yes									2007 only	Some sites		Some sites	
Basal respiration				Yes									2007 only			Some sites, chamber method	Yes
C substrate use									Yes, colormetric method				2007 only				

SECTION 02

Schemes with ongoing funding

Sampling timelines - UK overview



Sampling design

Country	Scheme	Sampling
All habitats / soils		
England	EES	Each monad will have one of the 21 soil classes (ITE/Institute of Terrestrial Ecology soil classes). 70% percent were randomly selected but with equal number of ITE soil classes. 30% of monads were selected by probability inclusion score (PI). 5 priority typologies to be covered by EES with probabilities: Broad habitats, priority habitats, landscape character types, HOST classes and NUTS1 (geographical regions).
GB	CS	Stratified random sample of 1km squares according to land class but enhanced to allow for national reporting for the 4 nations.
NI	CS	Stratified random sample of 1km squares according to land class. In-line with GB Countryside Survey methods.
Wales	ERAMMP	Stratified random sample of 1 km squares according to ITE land class, contains subset of CS squares.
EU	LUCAS	Stratified random sample according to land cover. Slight bias for agricultural land
Habitat specific		
UK	BioSoil	Part of a EU forest soil and biodiversity survey with more 220 in the UK. Sites were selected on the basis of the presence of woodland of >0.5 ha on a 16 x 16 km national grid and covers a wide range of tree species and soil types.
NI	SNHS	All NI Agricultural land subject to voluntary participation from farm businesses (subset of min 250 sites across on different soil types specifically to model carbon dynamics)

Approaches to interpretation frameworks

Country	Scheme	Soil identification
All habitats / soils		
England	EES	Soil classification to Defra 12 soil groups, soil subgroup (Avery, 1980), and, where possible, soil series. Based on EES soil classification survey carried out according to Soil Survey Field Handbook (Hodgson, 2022). The soil classification survey (SC) is carried out on the same plots on which soil sampling and assessment (SSA) are carried out, alongside VESS.
GB	CS	1990 soil survey mapped at 1:25 000. Criteria used for mapping units in Scotland: Soil association - a group of soils developed on similar parent material Soil series - soils with a similar type and arrangement of horizons developed on similar parent material Criteria used for mapping units in England and Wales: Soil series - soils with a similar type and arrangement of horizons developed on similar parent material.
NI	CS	Full soil survey of Northern Ireland was conducted during the 1990s. Published as 1:50,000 and 1:250,000 soil maps and described by Cruickshank et al "Soil and Environment: Northern Ireland".
Wales	ERAMMP	Not assessed?
EU	LUCAS	Not assessed?
Habitat specific		
UK	BioSoil	Soil type described by England and Wales and Scottish national soil classification, also by World Reference Base 2016 classification and FC Forest Soil classification
NI	SNHS	Cruickshank et al. as above

Methodology for SOM and SOC

Country	Scheme	Depth	Bulk density?	Soil organic matter method	Carbon fractions	Soil organic carbon
	All habitats / soils					
England	EES	Variable but 40cm max and 0-15cm available	Yes	TGA	?	Combustion
GB	CS	0-15cm	Yes	LOI (375deg.C for 16 hours) until 2007 but now TGA	Subset of samples (POM and MAOM)	Combustion
NI	CS	0-15cm	Yes	LOI (375deg.C for 16 hours)	?	Combustion
Wales	ERAMMP	0-15cm	Yes	LOI (375deg.C for 16 hours) in 2016 now TGA	?	Combustion
EU	LUCAS	0-20cm previously but now 0-30cm but layers	Yes	No	Yes (POM and MAOM)	Combustion
Habitat specific						
UK	BioSoil	Variable but 80cm max	Yes?	LOI (375deg.C for 16 hours)	?	Combustion
NI	SNHS	7.5cm(grass); 15cm (arable)	No?	No?	?	No?

Other variables

Country	Scheme	pH	Nitrogen	Phosphorus	Biodiversity
All habitats / soils					
England	EES	Yes (water)	Total-N by combustion	Olsen-P and total-P	Metabarcoding (bacteria, fungi and mycorrhiza)
GB	CS	Yes (water and CaCl)	Total-N (previous mineralizable, extractable NO3-N)	Olsen-P (improved soils only) and total-P	Metabarcoding (bacteria, eukaryotic, fungi, AM, plant) on subset 2007; Metagenome (2020)
NI	CS	Yes (water and CaCl)	Total-N by combustion	Olsen-P (improved soils only) and total-P	No
Wales	ERAMM P	Yes (water and CaCl)	Total-N by combustion	Olsen-P (improved soils only) and total-P	Metabarcoding (bacteria, fungi, eukaryotic) 2016 only
EU	LUCAS	Yes (water and CaCl)	Total-N by combustion	Olsen-P and total-P	Metabarcoding (bacteria and fungi)
Habitat specific					
UK	BioSoil	Yes (water and CaCl)	Total-N by combustion	Mehlich method and total-P	Metabarcoding for bacteria, fungi and mycorrhiza, eukaryotes
NI	SNHS	Yes	Total-N by combustion	Olsen-P	Metabarcoding and metagenomes on subset

Other infrequently measured variables in funded soil schemes



Archiving



- CS (&CSNI), GMEP, ERAMMP, FR BioSoil, LUCAS, FR LVI&II, NSIS, TiPSS, B&R and Afforested all dry samples
- CS from 2019 (&CSNI), GMEP, ERAMMP, Kew NCEA, LUCAS and NSIS freeze samples
- *SHSN Freezes and dries, while SNHS (carbon) dries on 6 month temporary basis*
- Number of schemes are interested in exploring freezing



Aggregate stability

- CS: Measured on ~ 400 samples from 2019 using conventional wet sieving and aggregate size distribution using the laser analyser.
- *(Was done for topsoils only in NSIS)*



Peat Depth

- CS: 2019 onwards Peat rod for depth measured in 3 locations
- CSNI: 2023 & 2024 Peat rod for depth measured in 3 locations
- ERAMMP: 2021 onwards Peat rod for depth measured in 3 locations
- EES: Peat depth when thickness of organic horizon, if more than 2 cm thick
- FR BioSoil: Peat depth is measured by the depth sampling by coring, only down to 1m depth



Erosion

- SHNS: Individual site assessment
- CSNI: Recorded via visual assessment at sampling plots
- *(NSIS: Erosion within 50m of the sample location was recorded)*



Acoustics

- No schemes using so far



SUSTAINABLE
SOILS
ALLIANCE



UK Centre for
Ecology & Hydrology

Thank you

This resource was created from work undertaken by Prof. Bridget Emmett of the UK Centre for Ecology and Hydrology, and Ellen Fay and Theo Heaton-Davies from the Sustainable Soils Alliance, to understand soil monitoring initiatives across the four nations of the UK, including historical work by Prof. Emmett in this field.



UK Research
and Innovation



Department
for Environment
Food & Rural Affairs



Department for
Energy Security
& Net Zero



Department for
Science, Innovation,
& Technology



Scottish Government
Riaghaltas na h-Alba
gov.scot