IMPACT OF CULM GRASSLANDS UPON WATER & SOIL QUALITY

Future Project Outcomes

By January 2014, the current phase of the research project will have collected over a year's worth of monitoring data. The data collected will be used to:

- Quantify the quality of water in Culm grasslands in relation to that of other land uses (wet woodland, scrub and intensively managed agricultural grassland).
- At Stowford Moor, quantify the quality of water leaving the catchment via stream discharge.
- Quantify the quality of soils in Culm grasslands and the role they play in soil resource storage, particularly carbon.
- Undertake further analysis to scale-up findings across the Culm NCA. Upscaling work will be used to ascertain the role played by Culm grasslands in improving water quality and storing carbon at the catchment scale.
- Highlight the ecosystem services provided by Culm grassland, notably in relation to water quality and carbon storage. This can inform future management policy and practices by government, landowners and stakeholders, including payment for ecosystem services.

Stowford Moor following snow in January © Alan Puttock

This project has been supported by the Environment Agency, the Higher Education Innovation Fund and the Northern Devon Nature Improvement Area programme supported by Defra, DCLG, Environment Agency, Forestry Commission and Natural England

Further Information

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Department for Environment Food & Rural Affairs · Natural England · North Devon's Biosphere Reserve world class by nature · Upstream Thinking A South West Water Initiative · Environment Agency

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Devon Wildlife Trust

Orchids at Stowford Moor © Devon Wildlife Trust

Key Ecosystem Services Addressed:

Water quality

Soil quality

Carbon storage

Additional Ecosystem Services:

Water regulation

Wildlife habitats

Green spaces

Service Beneficiaries:

General public

UK Government

Water suppliers

Wildlife

Service Providers:

Landowners

Intermediates & knowledge providers:

Devon Wildlife Trust

University of Exeter

Natural England

Environment Agency

This research project seeks to:

Understand the impact Culm grassland has on water quality and soil resource storage, relative to other land uses in the Culm NCA (wet woodland, scrub and intensively managed grassland)

Culm Grassland at Stowford Moor © Gary Pilkington

Part of an ongoing research project led by the University of Exeter, the Environment Agency and the Devon Wildlife Trust, aimed at increasing understanding of the role played by Culm grasslands in the provision of key ecosystem services.

Rationale for research

Culm grassland (purple moor grass and rush pasture), is a habitat of international conservation importance found in North Devon and North Cornwall. The Culm National Character Area (NCA) covers 3500 km^2 in South West England, with Devon supporting over 80% of the remaining Culm grassland found in England. Over the last 200 years, efforts to intensify agriculture have led to the drainage of large areas of land in South West England. Consequently, wet Culm grasslands have become highly fragmented, now covering only 1.4% of the Culm NCA, a reduction of 90% since the 1950s. Traditionally, these Culm grasslands have been managed by light grazing and scrub management. Since 2008, Devon Wildlife Trust's Working Wetlands project has been working with farmers and landowners to manage, restore and recreate Culm grassland. It is part of South West Water's Upstream Thinking initiative and is now augmented by the Northern Devon Nature Improvement Area programme.

Intensive drainage of agricultural land increases the volume and rate at which water leaves the landscape, leading to greater soil erosion and nutrient losses, which in turn reduces stream water quality. Maintaining and improving our water quality is an essential environmental objective, providing benefits to the general public, through cleaner drinking water, water companies through savings on treatment plant operating costs, and providing wider environmental improvements to streams and wetland biodiversity.

Wetland unimproved grasslands, such as Culm are thought to be slowly draining and act as a filter, potentially playing a role in the sustainable supply of clean water. However, little is known about the hydrological functioning of these fragile ecosystems. As an added benefit, soils under Culm grasslands are thought to have a high potential to store and sequester carbon. Under the 2008 climate act, the UK government aims to achieve an 80% reduction in greenhouse gas emissions by 2050 (relative to 1990 baseline) and enable the UK to become a low carbon economy. Research investigating the effects land use has on soil carbon levels is required to support policy recommendations, with the management of land to maximize carbon sequestration being seen as an increasingly valuable ecosystem service.

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Experimental framework

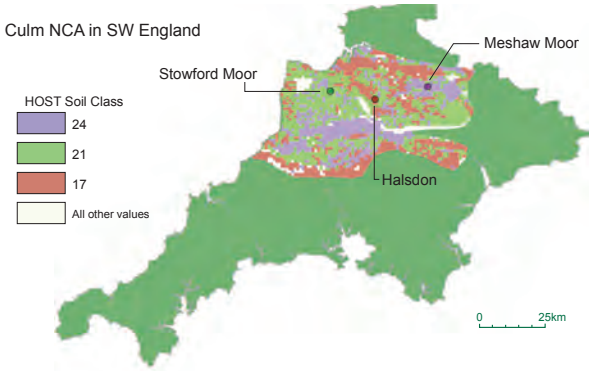
Analysis across all 571 existing Culm grassland, revealed sites to be located across a variety of soil types, which it is hypothesised will act as a key control on the storage of soil resources and the role played by soils in hydrological functioning.

Soil type influences hydrology via its impact upon rainfall infiltration, storage, subsurface drainage and surface runoff. The hydrology of soils type (HOST) system is used to classify soils according to their physical characteristics. Our analysis has revealed over 90 % of Culm grassland sites are located on three main HOST types which formed the basis of site selection. Sites were selected so the functioning of Culm could be compared to other key land uses within the Culm NCA - wet woodland, scrubland and intensively managed agricultural grassland.

The location of study sites is illustrated in the figures to the right. At each study site; 10x10m plots have been created (3 replicates at each site) and sampled for soil resource concentrations and characteristics influencing water storage and quality (carbon, nitrogen, phosphorous, soil depth, bulk density, organic matter, soil moisture and particle size).

Each study site has 9 dipwells (3 within each plot), 6 of which are used to monitor the water table level and how this changes in response and relation to rainfall events, whilst the remaining 3 are used for water sample collection. Additionally, Stowford Moor is equipped with an instrumented flume which allows the amount of water leaving the catchment to be quantified and the collection of water samples for quality analysis. Water samples are sampled for dissolved organic carbon, nitrogen, phosphates, potassium, suspended sediment, colour and pH.

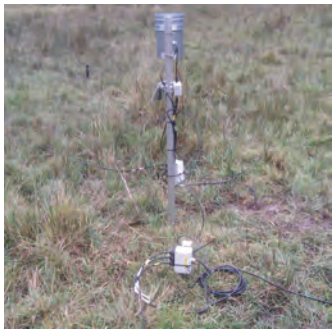
All monitoring equipment connects to a 3G telemetry network, providing researchers at the University of Exeter with a 'live' data feed and the ability to remotely trigger the pump sampler, allowing sampling through a range of conditions.



Stowford Moor

Halsdon

Meshaw Moor



Telemetry base station © Alan Puttock

Instrumented flume for collection of water samples © Alan Puttock

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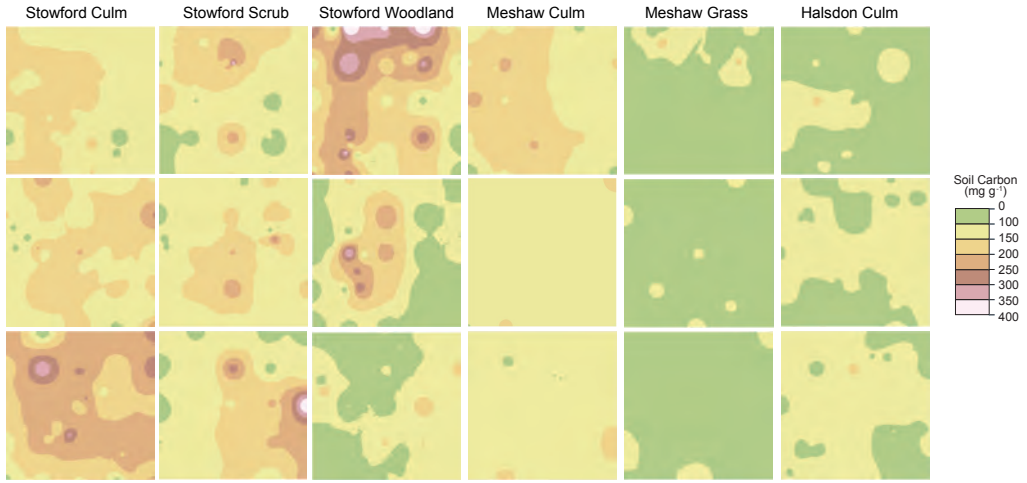
A snapshot of early results:

Soil Quality

Soil characteristics show variation between study sites with different soil type and land use.The figure below shows extrapolated soil carbon concentrations across the study sites. Results from Meshaw show mean soil carbon content to be significantly higher ($p<0.05$) under Culm grassland (133 mg g^{-1}) than their intensively managed counterpart (86 mg g^{-1}). Furthermore, at Stowford carbon levels are higher under Culm (166 mg g^{-1}) than either scrub (140 mg g^{-1}) or woodland (144 mg g^{-1}). Thus, early results suggest that intensively managed grasslands may only store ca. 65% of the carbon that their Culm grassland counterparts store.

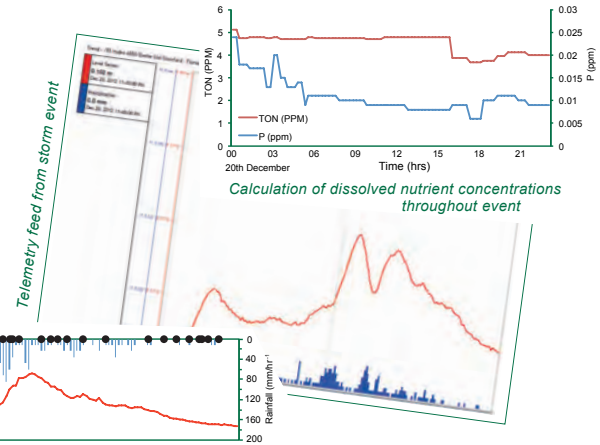
Mean phosphorus concentrations in soil were found to be significantly higher ($p<0.05$) under intensively managed grassland (1.37 mg g^{-1}), than Culm (0.87 mg g^{-1}), scrub (0.73 mg g^{-1}) or woodland (0.72 mg g^{-1}). These results reflect the additions of phosphorus that intensively managed grassland receive as a fertiliser. They also reflect the greater potential of intensively managed grassland soils to act as a source for pollution of surface waters following rainfall and overland flow.

Soil characteristics also show spatial variation within study sites with the degree of spatial heterogeneity varying with soil type and land use. This variability is important as more uniform soil characteristics tend to support less biodiversity. Results illustrate that soil characteristics are most uniform under intensively managed grassland, followed by Culm, then scrub, whilst woodland showed the greatest degree of heterogeneity.



Water Quality

Water samples collected from the instrumented flume, are allowing investigation into how water quality varies with rainfall event characteristics. Results from instrumentation measuring rainfall and flow depth are combined with laboratory analysis of collected water samples to examine how nutrient concentrations vary throughout an event hydrograph.



Calculated storm event hydrograph