



High quality Culm grasslands such as here at Dunsdon NNR are internationally significant for biodiversity as well as providing a range of other benefits to society.

Carbon Storage

The deeper and richer organic soils of the Culm are shown to store more carbon than the shallower soils of the more intensive agricultural landscape. Across all the Culm sites studied, the mean Carbon concentrations were 133mg/g, whilst the intensively managed grasslands levels were 88mg/g. Once the greater depth and lower density of Culm soils are taken into account, the total amounts of carbon in a given surface area are 1.8g/cm² compared with 1.5g/cm² in the agriculturally improved field.

The remaining Culm grassland resource has been calculated to be storing an estimated 715,000 tonnes of carbon. If the Culm extent was at 1900 levels (an increase of 25,574ha), the carbon stored could be in the region of 5.37million tonnes.



Heath spotted orchids in the sward at Dunsdon.

This document is intended to summarise some of the findings of a more detailed report; The Culm Grasslands Proof of Concept Study – Developing an understanding of the hydrology, water quality and soil resources of unimproved grasslands (Alan Puttock and Richard Brazier, 2014). It should not be quoted more widely without reference to the original document to ensure relevant constraints and caveats are understood.

This research work was led by the Richard Brazier, Associate Professor of Earth Surface Processes, and Mark Elliott from the Devon Wildlife Trust. The principle researcher was Dr Alan Puttock. It was funded by the Environment Agency, The Higher Education Innovation Fund, Devon Wildlife Trust and the Northern Devon Nature Improvement Area.

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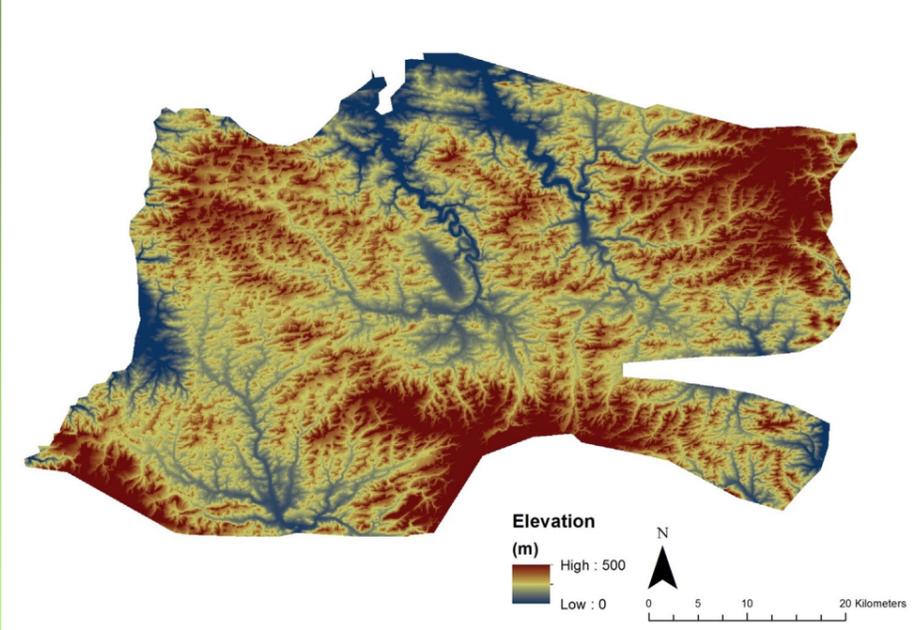
The Ecosystem Services provided by Culm Grasslands



Low hydrological connectivity with few drainage ditches is a common feature of extensive Culm grasslands such as here at Bursdon.

The link between land-use and the health of our rivers is already well established. However proving to society the important role that extensive wetland habitats play in our upper river catchments is becoming more urgent if we are to secure a future for them.

The Devon Wildlife Trust (DWT) has been working to protect the Culm grasslands of northern Devon since the early 1990s. The Culm National Character Area (NCA) includes the Torridge and Taw rivers, as well as parts of the upper Tamar and Exe catchments. The wet tussocky semi-natural grasslands characteristic of the area are a much diminished and fragmented resource. **In 1900 there were estimated to be 29,500ha, but this has since shrunk by 87% to just 3,926ha.** Since 2008, DWT's Working Wetlands Project has restored and re-created over 4,000ha of grassland habitat across the Culm, with the Northern Devon Nature Improvement Area (NIA) adding a further emphasis on the Torridge catchment since 2012. Some of this is new habitat, but much work has been focused on preventing some of the last existing areas of Culm being lost to scrub encroachment.



This map of the topography of the Culm National Character Area (NCA) clearly shows the 4 river systems draining the area; the Taw, Torridge, Tamar and a small part of the Exe. The higher elevation on the edges of Exmoor, Dartmoor and Bodmin Moors also show up clearly.



Working closely with Professor Richard Brazier's team at Exeter University, DWT were keen to demonstrate the important role Culm grasslands play in storing water in the landscape, reducing flooding and the impacts of droughts downstream.

In addition we were keen to demonstrate that rivers draining wetland habitats were much cleaner than those emanating from more intensively farmed landscapes, and finally show the role that Culm soils play in trapping carbon.



The Working Wetlands Project is a key part of South West Water's Upstream Thinking Programme.

Their support for this work is based on the principle that restoring wetlands in the headwaters of our key river catchments ensures a more constant and clean flow of water downstream where they abstract drinking water.

Resolving issues at source by working with farmers and landowners is more cost effective and should result in savings to SWW customers in the long term.

Impacts on the Hydrology

At Meshaw in the Taw catchment, an area of pristine Culm grassland is situated adjacent to an intensively managed grassland (used for silage cropping) with only a Devon hedge-bank separating them. Detailed analysis of the soils were undertaken and dipwells installed in both of these fields to monitor soil water levels. The differences were staggering, with **the Culm soils storing a massive 277 litres of water per m² compared with only 61 litres /m² being stored in the soils of the adjacent silage field.** The main reason for this is the depth of soil, with the Culm soils being 47cm deep, compared with just 27cms for the heavily compacted silage field. Not surprisingly then, the research suggests that **11 times more water leaves intensively managed grasslands than Culm grasslands during storms, increasing the risk of flooding downstream.**

Stowford Moor SSSI is a DWT reserve in the headwaters of the Weasel Water in the Torridge catchment. Its discrete geography allowed a flume to be installed to monitor run-off from the site in great detail without inputs from surrounding land-use. If a 20mm rainfall event were to occur at Stowford, the total storm-flow discharge would be around 4 Mega (million) litres, but if a similar event were to occur in an intensively managed catchment of similar size, it is suggested the total discharge would be around 44 MI.

The rough tussocky nature of the habitat, and the low hydrological connectivity means that, even when saturated, much of the rain that falls simply cannot run-off quickly into the rivers and gets trapped between and within the tussocks in the landscape. This is particularly significant for reducing flooding risks downstream during the winter months when soils across the catchments are already waterlogged.

It is estimated that a total of 9,430MI of water can be stored in the current Culm grassland resource across the 4 catchments. It is suggested that at their 1900 extent these wet grasslands would have stored 70,852 MI.

For the relatively small part of the Exe catchment within the Culm NCA, the loss of the Culm from 1900 levels has reduced the water storage capacity of the upper catchment by 1,946MI. Similar losses on the Devon side of the Tamar has decreased storage from 12,171MI, to the current 1,620 MI.



Much of the excess water is actually stored above the ground level in Culm.

Impacts on Water Quality

As expected, the studies of water quality downstream of a Culm grassland dominated headwater stream showed considerably less evidence of diffuse water pollution than in similar sized agriculturally dominated catchments.

The flume at Stowford Moor collected water quality samples during rainfall events and allowed comparison with two similar but more agriculturally improved catchments; Den Brook and Aller. Median phosphorous levels recorded below Stowford between July 2010 and January 2013 were only 30µg /l and ranged between 0 and 398µg/l. These compared with Aller, where median levels were 45µg/l and the Den Brook catchment where they ranged from 90 to a massive 5870µg/l.

The situation for suspended sediment is similarly impressive. **In the Culm dominated area, the median levels for sediment were 24mg/l compared with a distinctly turbid 78mg/l in the Aller agricultural catchment.**

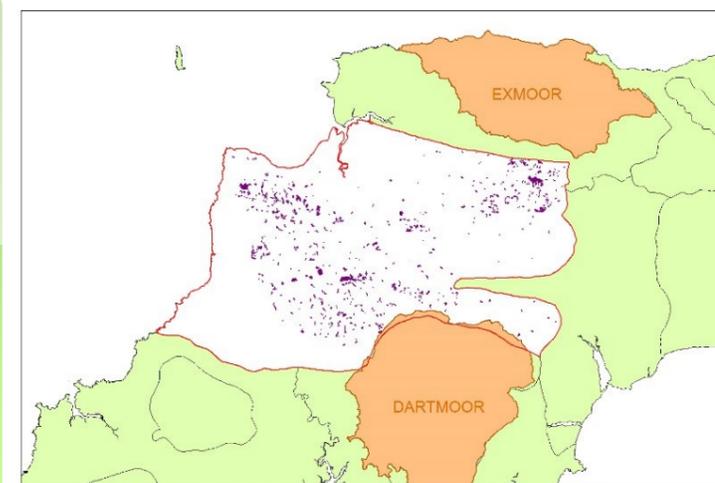
They ranged from 6 to 410mg/l in water from Stowford Moor, to 20 – 925mg/l in the Den Brook catchment. With intensively managed grasslands losing 11 times more water as storm flow than Culm grasslands, and the suspended sediment concentrations 3 times greater from improved grasslands, it is suggested that **a 20cm rainfall event could release 33 times more sediment from an agricultural catchment than a Culm dominated one.**

Whilst there are some locations where Culm grasslands do actually buffer watercourses from the impacts of intensive agriculture further up the slope, in most cases the network of land-drains from intensive farmland land by-passes the Culm and directs flow straight into the headwater streams. However diffuse pollution is reduced simply by increasing the proportion of the catchment in semi-natural low-input habitat. Furthermore the dilution of pollutants during low flows as a result of water seeping from these wetlands is a very important benefit.



V-notch weirs measure flow and water quality from Culm grasslands.

The remaining fragments of Culm grassland are shown here in purple



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Wading through water is a common winter experience in Culm grasslands once the deeper soils finally reach saturation point. The rough, tussocky landscape with few drainage ditches means that surplus water simply cannot reach the river network, and so sits on the surface amongst the tussocks. This is in contrast to the flat and uniform soils of more intensively managed grasslands where run-off of muddy water from compacted farmland is a common winter issue.



Roadford Reservoir case study

Detailed land-use data have been collated for the Upper Wolf catchment above Roadford Reservoir. They show the Culm grassland resource was 455ha in 1947, but had reduced to just 132ha by 2007.

Over the course of a year, the upper Wolf catchment supplies Roadford with around 3,000MI. If the level of Culm was at 1947 levels (an increase of 345% from the current) the mean water storage in the Culm soils above the reservoir would increase from 316MI to 1,093MI. During a 20mm rainfall event, the storm-water discharge would be reduced by roughly 7,325m³ (7.3MI).

Critically all this storage increase would occur in the wet winter months, increasing the volume of water being released to the reservoir during the dryer periods of the year when it is of most use to South West Water.

It is estimated that 230 tonnes of phosphate-laden sediment enter Roadford reservoir annually. The study suggested that an extra 30 tonnes of sediment runs off the catchment every year than would be the case if the Culm was at 1947 levels. This reduces the useful life of the reservoir and increases the risks of algae blooms and the growth of invasive plants like *Crassula helmsii*.

