How does ditch blocking in a shallow peatland affect emissions of carbon dioxide and methane in the short term?

- Wetter, *Sphagnum* spp. and cotton grass (*Eriophorum* spp.) dominated areas hold carbon for longer than drained, purple moor grass (*Molinia caerulea*) dominated areas.
- Where vegetation communities were completely dominated by purple moor grass (*Molinia caerulea*) they were not significantly altered by restoration in the short-term (<5 years).
- Restoration did not significantly alter photosynthesis (CO_2 drawdown), ecosystem respiration (CO_2 release) or below-ground (heterotrophic) respiration of the peat store.
- In the short-term (4-5 years) ditch blocking has not resulted in the high enough or stable enough water tables needed to promote the spread of *Sphagnum* spp. required to restore carbon sequestration.

Carbon dioxide monitoring.

Peatlands are the largest terrestrial carbon store. In a degraded state, peatlands lose carbon to the atmosphere and rivers, exacerbating the current climate emergency. Peatland restoration aims to raise and stabilise water tables. This promotes the growth of *Sphagnum* mosses required to shift the carbon balance towards carbon sequestration (drawdown and storage of carbon from the atmosphere).

Over the last 75 years, significantly greater ($p<0.039$) apparent rates of carbon accumulation (determined by Pb^{210} dating) were found in cores from a wetter, *Sphagnum* spp. and cotton grass (*Eriophorum* spp.) community compared to a drained, purple moor grass (*Molinia caerulea*) dominated community (Figure 38). The age of the peat at the bottom of the cores was younger than expected (ca.1920s) indicating long-term carbon storage is not occurring in these shallow peats. Despite this, the amount of carbon in the peat in the wet area (10.8±3.2 $kgCm^{-2}$) was double that of the dry area (4.6±0.4 $kgCm^{-2}$)[1].

Pre-restoration, the monitoring locations were dominated by purple

Figure 38 **Greater apparent rate of carbon accumulation ($gC\ m^{-2}\ yr^{-1}$) for all ages of peat in cores from a wet (*Sphagnum* spp. and *Eriophorum* spp. community) compared to a dry (*Molinia caerulea* dominated community).**

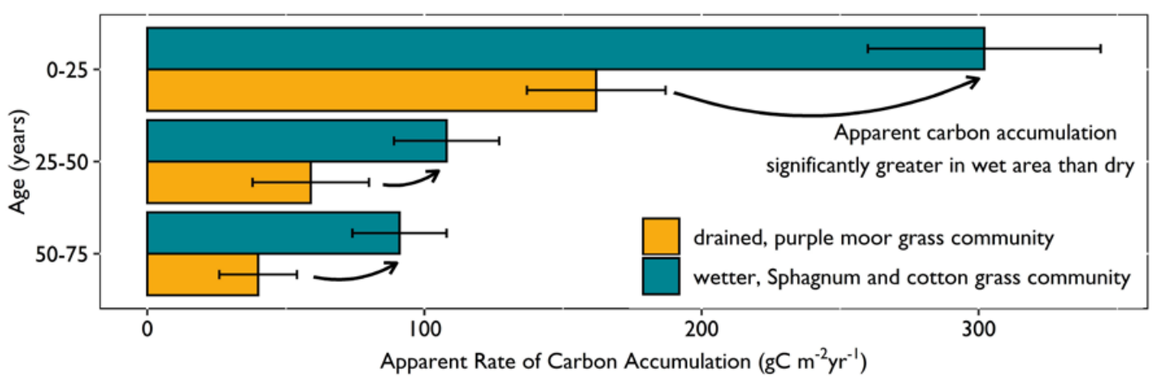

Figure 39 **Greenhouse gas monitoring locations (foreground) within Aclands catchment.**

Aclands' drainage ditches visible in the distance.

EXMOOR: SHALLOW PEAT GREENHOUSE GAS FLUXES

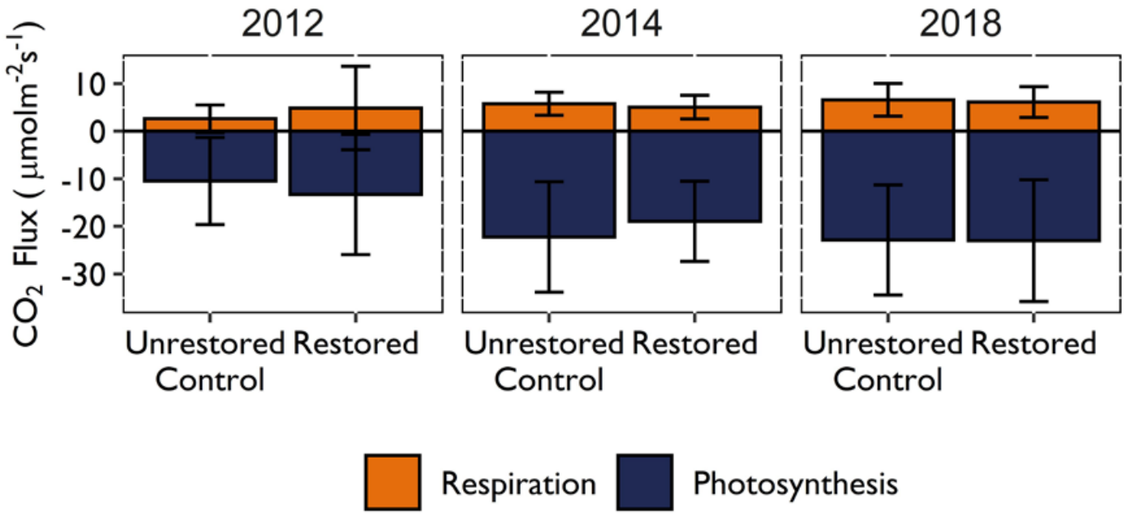

Figure 41 **Growing season photosynthesis (CO_2 drawdown) and respiration (CO_2 release) (µmol m^{-2} s^{-1}) pre- (2012) and post- (2014 & 2018) restoration showing no significant effect of restoration.**

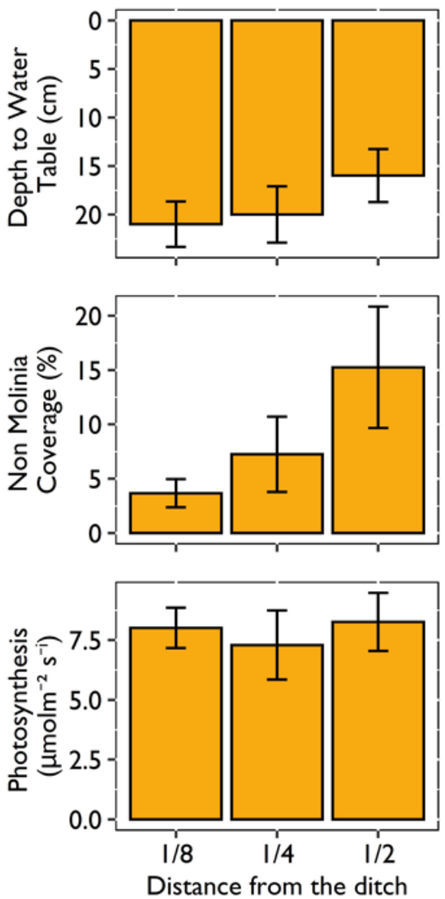

Figure 40 **Closer to the ditch water tables were deeper and vegetation diversity (non-*Molinia*) lower but this did not result in a clear pattern in photosynthesis (CO_2 drawdown).**

moor grass (*Molinia caerulea*) (86 ± 3 %)[2], representative of the wider catchment (Figure 39). Non-*Molinia* species coverage was significantly greater ($p<0.024$) and photosynthesis significantly less ($p=0.034$) where water tables were higher (wetter conditions). Although instantaneous water tables tended to be lower closer to the ditch (Figure 40), this pattern was not significant ($p=0.197$)[2].

Photosynthesis (CO_2 drawdown) significantly decreased during cooler and wetter periods ($p=0.002$) reflecting poor growing conditions[3]. As a result, the cool and wet summer of 2012 was modelled as a smaller CO_2 sink (126 gCO_2m^{-2}) than subsequent growing seasons (146 and 234 gCO_2m^{-2} in 2013 and 2014 respectively)[3].

Unfortunately the pre-restoration period (2012), was unusually wet (1901mm) and 2018 unusually dry (958 mm) with 2014 (1098 mm) and 2016 (1108 mm) intermediate (see Figure 15). This meant that at the sites studied, water tables fell following restoration due to drier climatic conditions. Allowing for climatic variability by comparing control and restored locations showed restoration had no

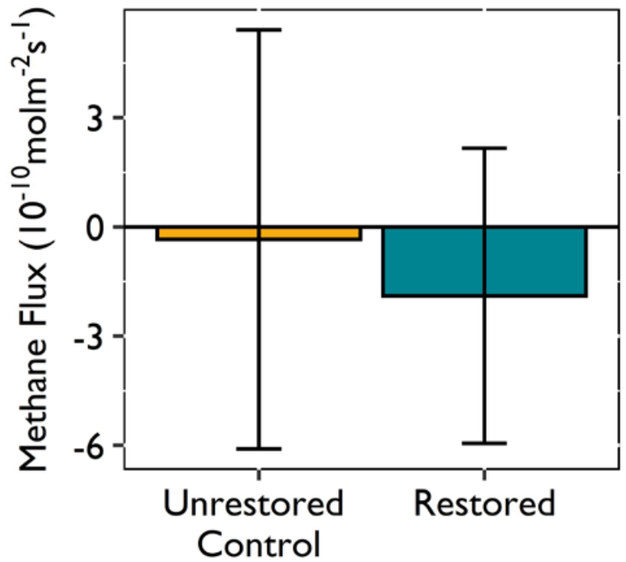

Figure 42 **Methane fluxes (10-9molm^{-2}s^{-1}) over the summer of 2016 showing a more negative flux (oxidation) of methane from the atmosphere at the restored locations.**

significant effect on water tables ($p=0.369$)[4].

There was no significant change in purple moor grass (*Molinia caerulea)* coverage ($p=0.855$), non-*Molinia* coverage ($p=0.387$) or species richness ($p=0.746$) 4-5 years after restoration[4]. Consequently, there was no change in photosynthesis (CO_2 drawdown) ($p=0.109$, Figure 41), respiration (CO_2 release) ($p=0.471$, Figure 41) or below-ground (heterotrophic) respiration of the peat store ($p=0.292$).

Significantly more methane ($p=0.039$) was being oxidised at the restored sites than the control sites (Figure 42) contrary to expectations, however, fluxes were small with most of the measurements (213 out of 242) below the level of detection (zero flux)[4]. This variation is most likely due to initial differences in vegetation composition rather than restoration.

In the short-term (<5 years), ditch blocking in these shallow peatlands has not delivered high enough and stable enough water tables required to protect the existing peat and perturb the existing *Molinia caerulea*-dominated ecosystem sufficiently to bring about the shift in vegetation community required to restore carbon sequestration. Additional restoration techniques, such as mowing of purple moor grass (*Molinia caerulea*) or *Sphagnum* re-seeding, may be required alongside ditch blocking, to restore carbon sequestration.

REFERENCES

The appendices are available to view at **www.exeter.ac.uk/creww/research/casestudies/miresproject**

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