Upstream Thinking
By South West Water

Exmoor mires Partnership

Peatland restoration on the shallow blanket mires of Exmoor: measuring the effects on ecology, farming, hydrology and climate

Dr. David Smith, Upstream Thinking Manager
South West Water

Environment Agency

University of BRISTOL

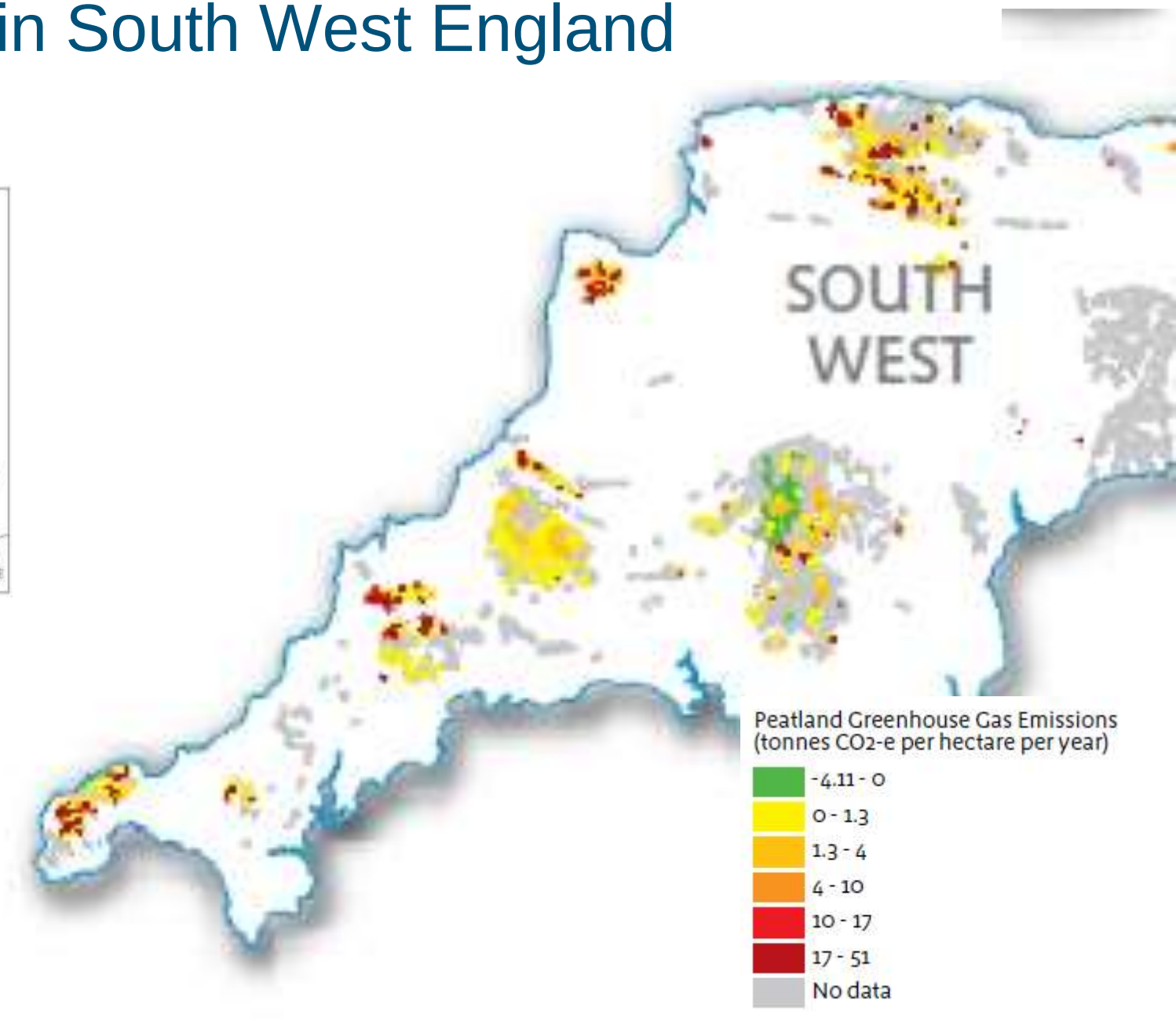
UNIVERSITY OF EXETER

southwestwater.co.uk

CIEEM Chartered Institute of Ecology and Environmental Management

SOUTH WEST WATER

Distribution of upland peatlands in South West England



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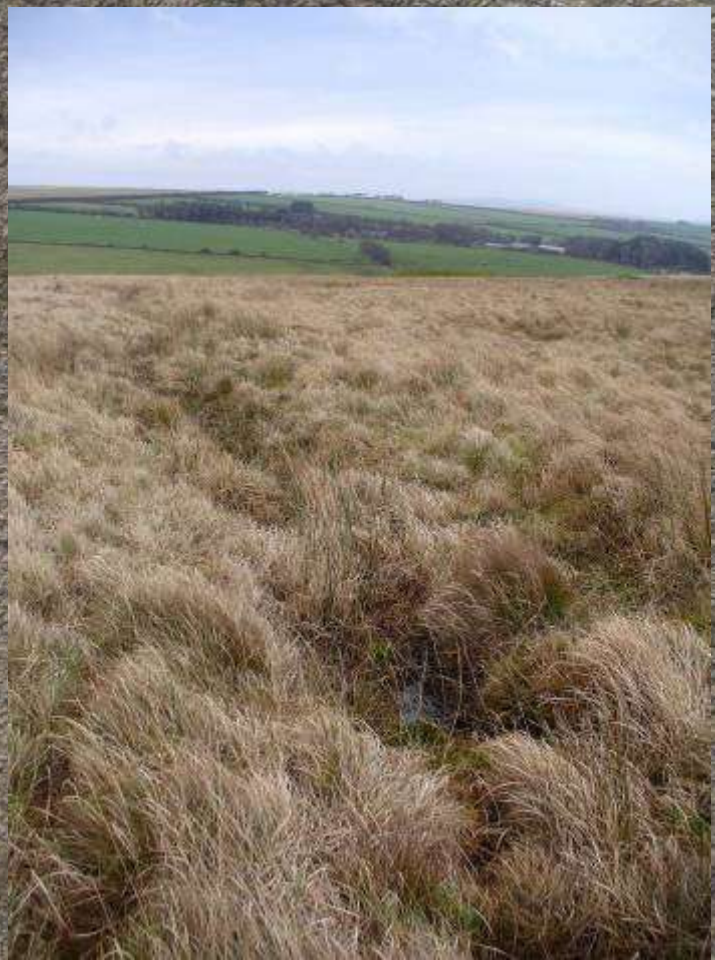
Exmoor's peatland

Heavily modified, dry and dominated by *Molinia grass.*



peat-cutting, drainage, lime, past over-burning and over-grazing.

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Extensive peat cutting for fuel

Start date unknown until late 20c

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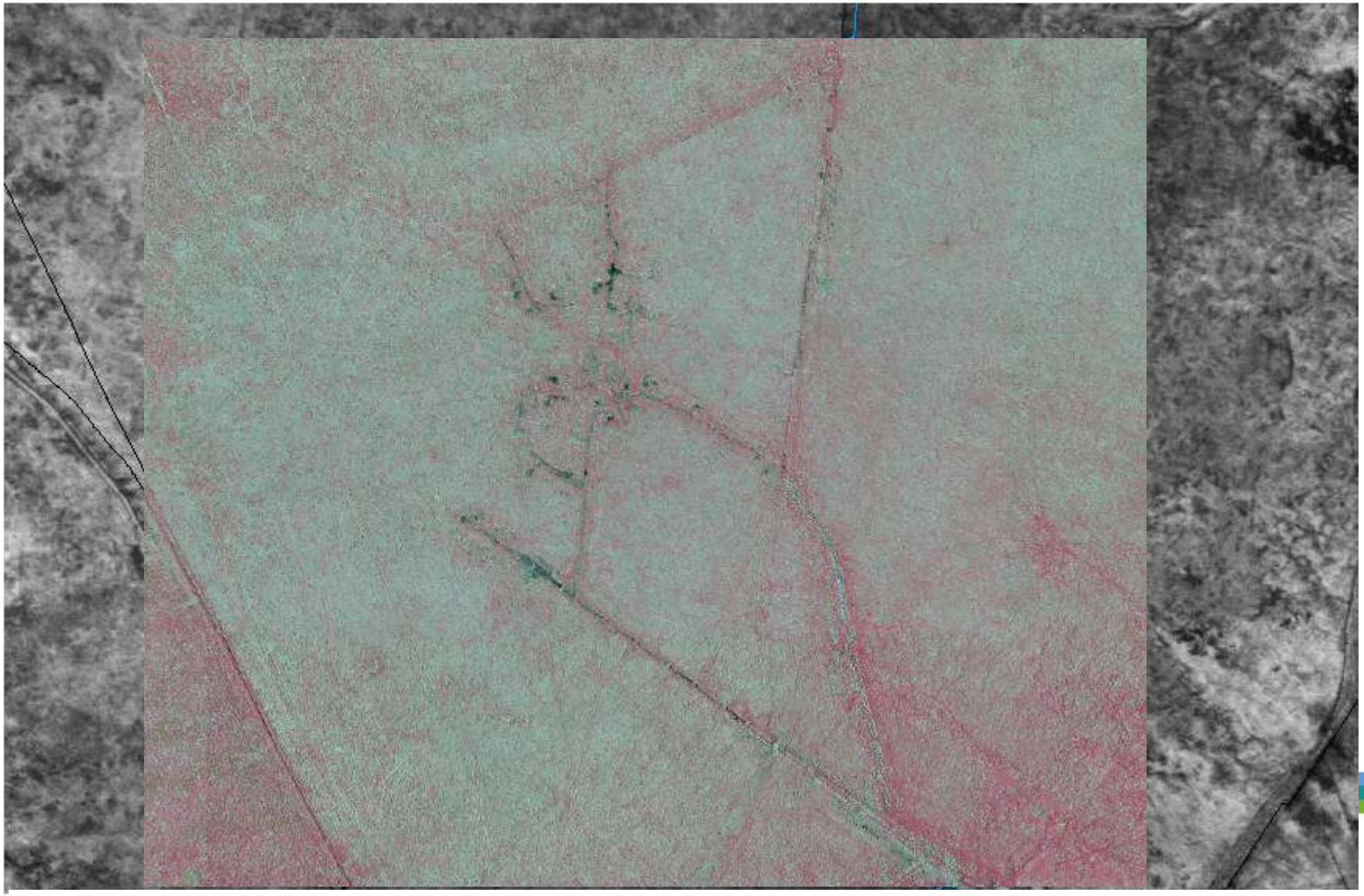
19c drainage for agricultural improvement

Modern (post 1946) drainage



Hydrological restoration was initiated in 1998

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Simple practical solution: Blocking up ditches and cuttings

Wood, Bales, Peat blocks,

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Initial Impact Monitoring

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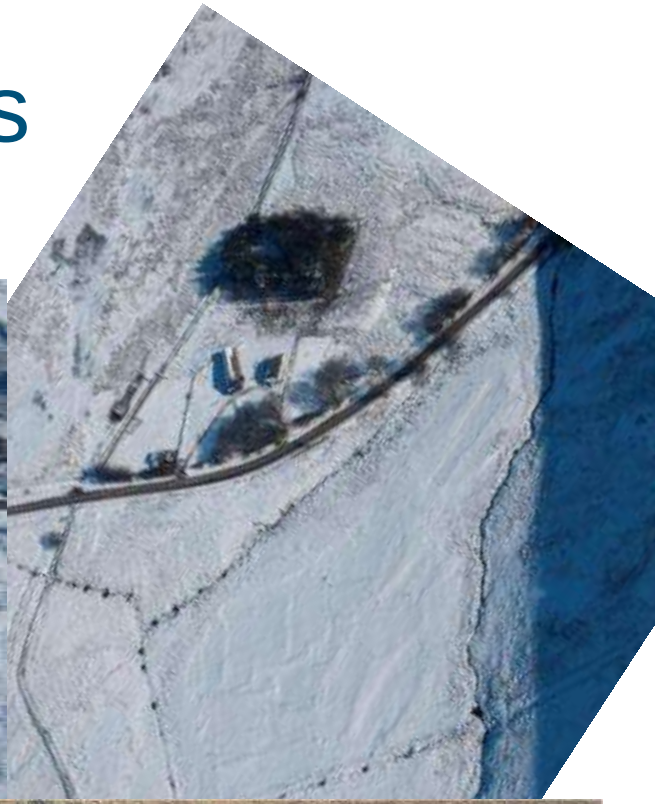
Over 200 new pools



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Ditch blocks on big ditches = big Pools

SOUTH WEST WATER

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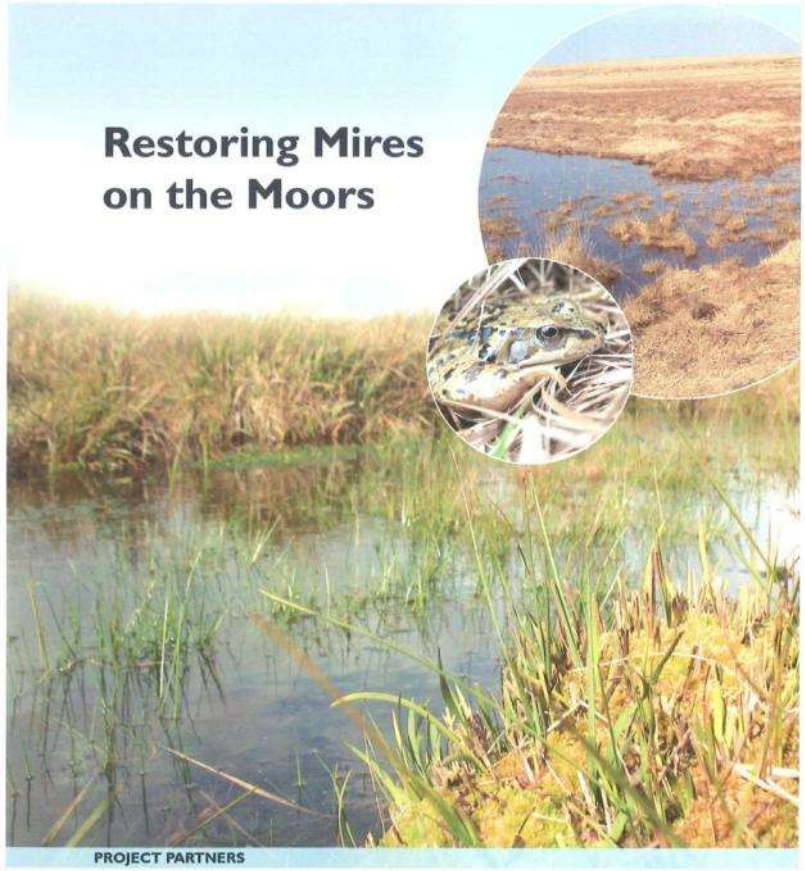
Peat and wooden block - 6 weeks after restoration

Why is SWW involved?

- 2006 – Exmoor Mires, licence considerations and a Biodiversity on the River Exe driver. Co-funding from ENPA, NE (HLS and other) and EA.
- 2010 (AMP5) – Exmoor Mires on NEP as investigations projects, plus part of Upstream Thinking Project with water quality, supply and biodiversity objectives. Co-funding from NE (HLS) and EA (several sources).
- 2015-20 (AMP6) – Exmoor Mires (Upstream Thinking) for water quality, supply and wider catchment benefits. NE and EA Co-funding.

The successful PR09 bid created an opportunity for a comprehensive restoration and monitoring programme in 2010



Exmoor mires Project

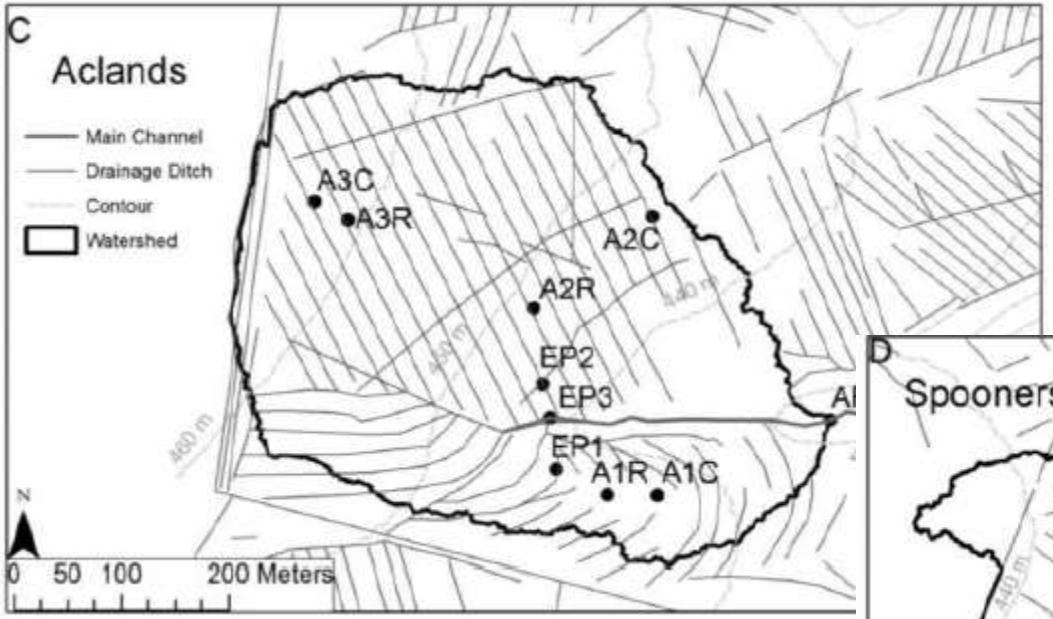
Dartmoor mires PROJECT

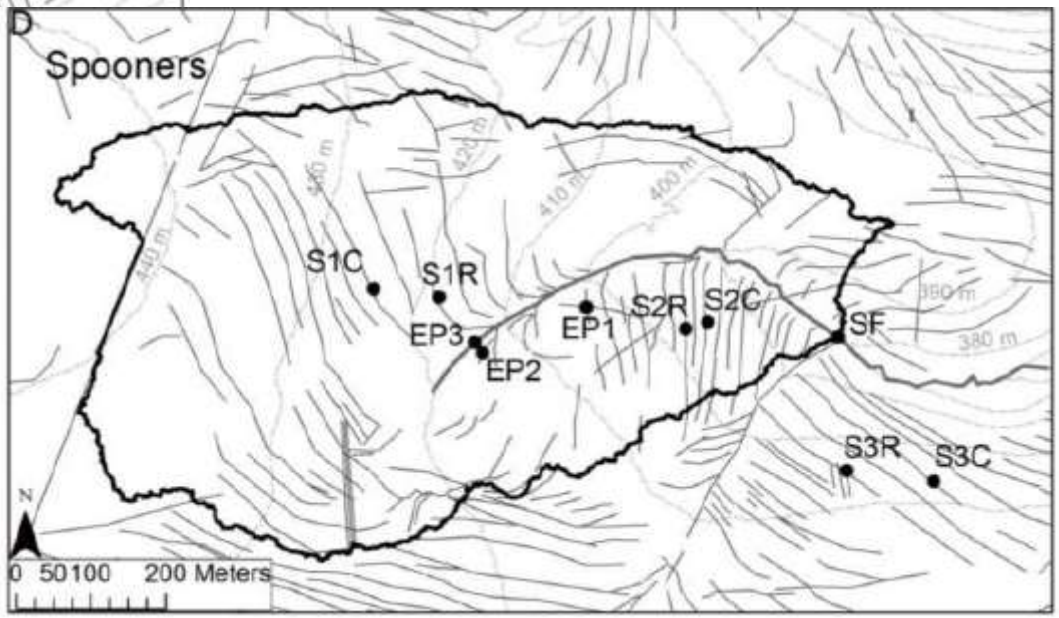
Aimed at understanding how restoration of the mires in the South West impacts on:

- Water quality
- Water storage, stream flow and flood risk
- Biodiversity
- Agricultural management and productivity
- Peat accumulation, carbon storage and greenhouse gas fluxes

Detailed studies of all the variables at the monitoring sites

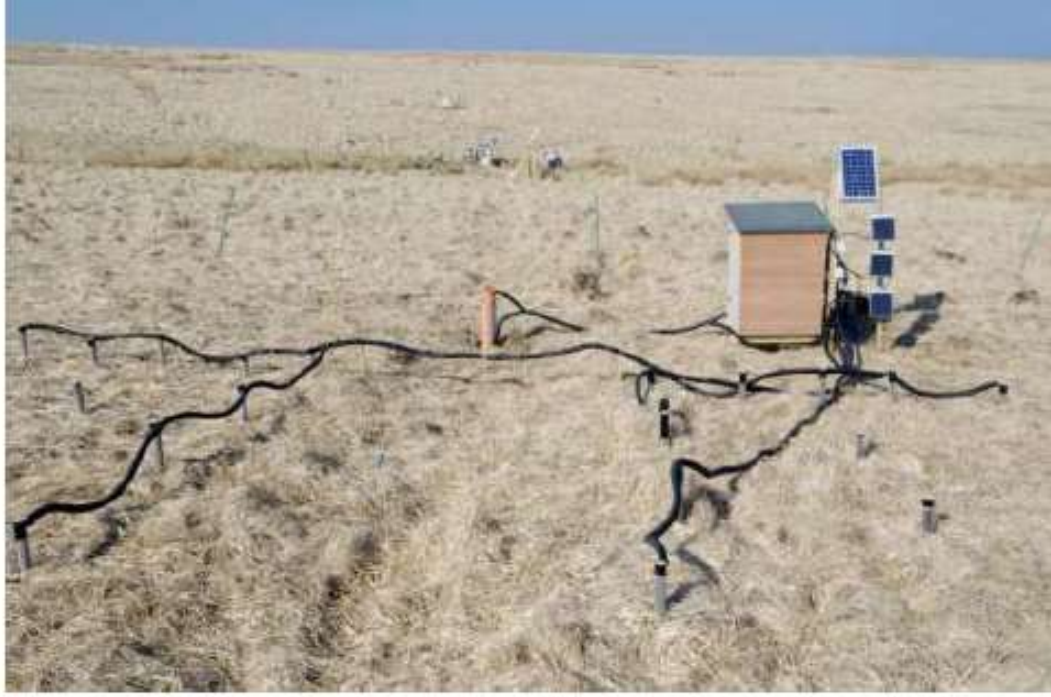
Exmoor Monitoring sites at Aclands and Spooners

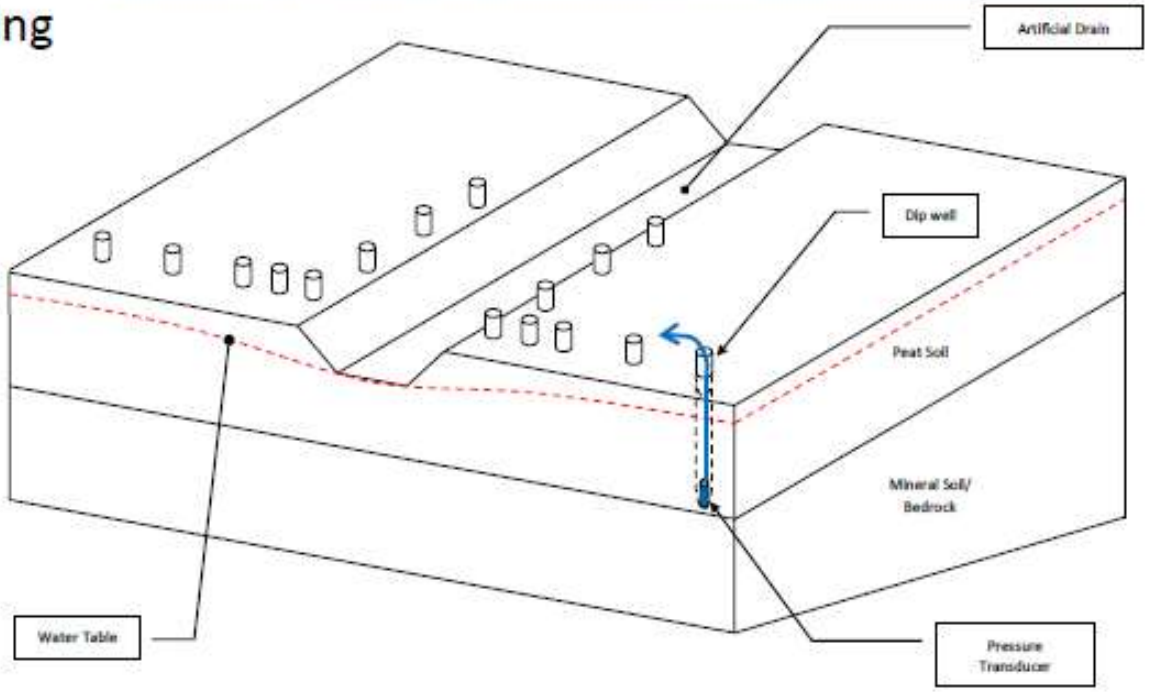




Hydrological Monitoring

- Flow monitored at 8 locations
- Depth to water table measured at 96 locations across 6 experimental pools (EP's)
- Geospatially distributed sampling network recording every 15 minutes
- For 1288 days… (and counting)
- 13.1 million measurements of rainfall, flow and water table depth





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Restoration of Spooners: monitoring catchment, April 2013

Water quality – Research questions

Quantifying the effects of drainage and restoration on:

- How much carbon and colour is leaving the sites at different times of year?
- What environmental factors control water quality?
- How much carbon is leaving the catchment?
- What are the characteristics of this DOC?

Lead researcher - Emilie Grand-Clement,

University of Exeter

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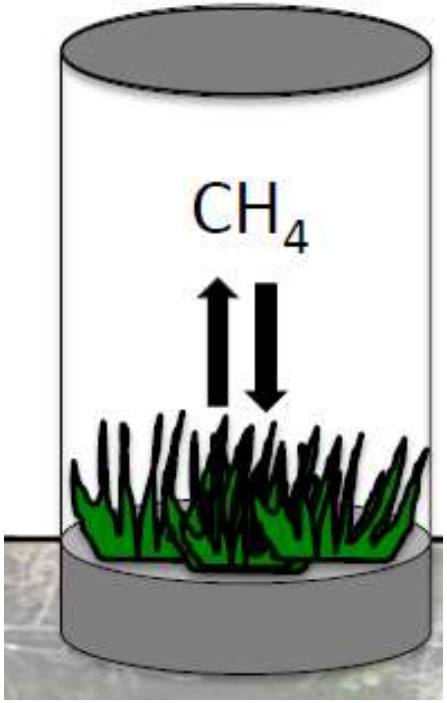
Water quality - Experimental approach

- Storm flow sampling:
  - Dissolved Organic Carbon (DOC) measured by UV – spectrophotometer
  - Colour - UV-Vis spectrometry
  - pH
- Characterisation of DOC
  - Humification index (E4/E6)
  - SUVA

GHG fluxes –research questions



- What are the temporal and spatial controls on CO_2 fluxes in a drained *Molinia caerulea* dominated peatland?
- In a drained condition, what is the net ecosystem exchange? Is it a carbon sink or source?
- What are the spatial and temporal effects, if any, of ditch blocking on CO_2 fluxes?
- What is the methane response to restoration?

....and it's role in the total GHG exchange?

Lead researchers

Naomi Gatis, University of Exeter

Adam McAleer, University of Bristol

Agricultural productivity – Research questions

- Determine how restoration affects key components of productivity
- Predict how rewetting will change land in terms of agricultural productivity
- Provide accurate information to landowners and tenant farmers

Lead researcher –Guy Freeman, University of Exeter

Biodiversity - research questions

- What is the impact of restoration on mire plant and animal communities
- What is the impact on individual and key species and groups
- How can the monitoring of vegetation and key animal species such as birds or insects be used as a tool for interpreting changes to other eco-hydrological factors at landscape scales

Research led by the Mires Projects Teams

Surveying by RSPB, Consultants, Students and Volunteers

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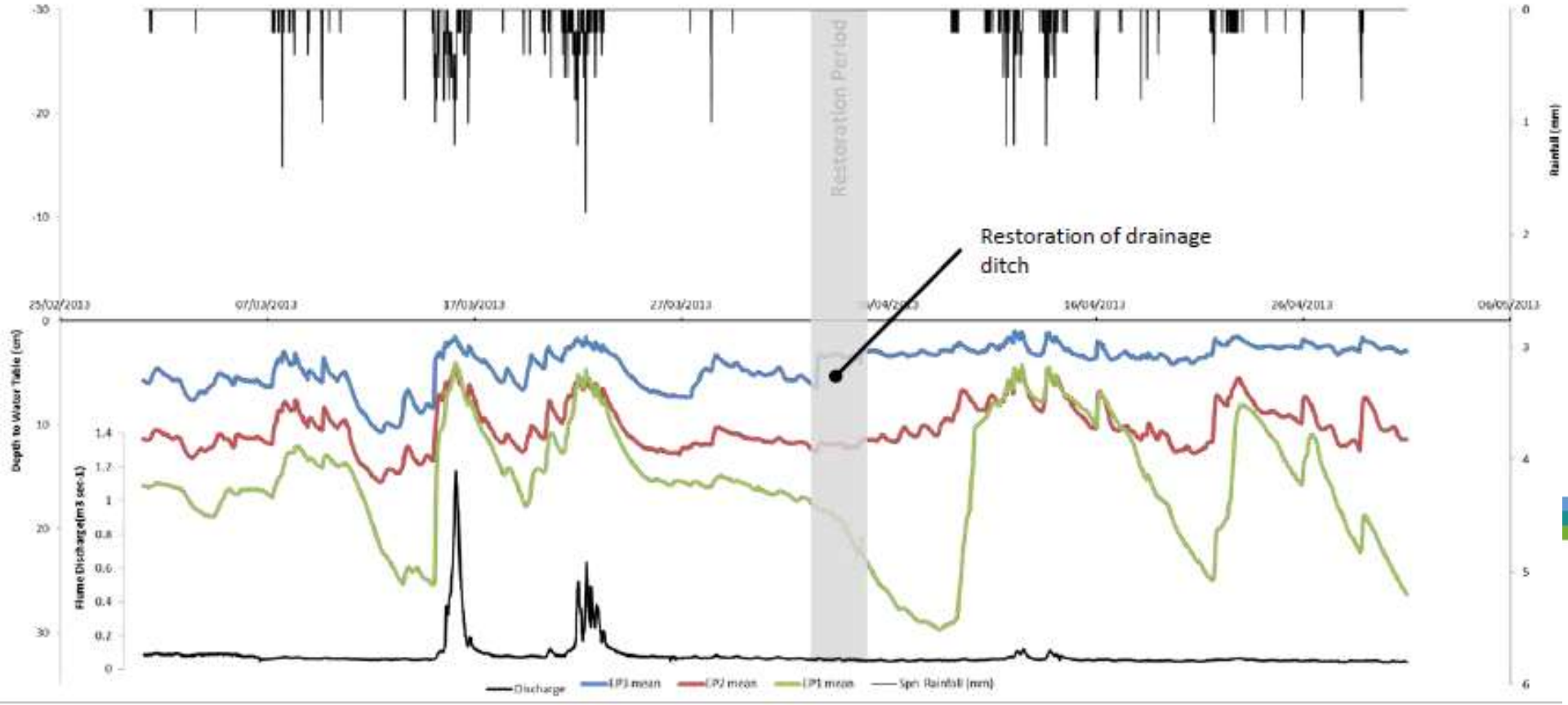
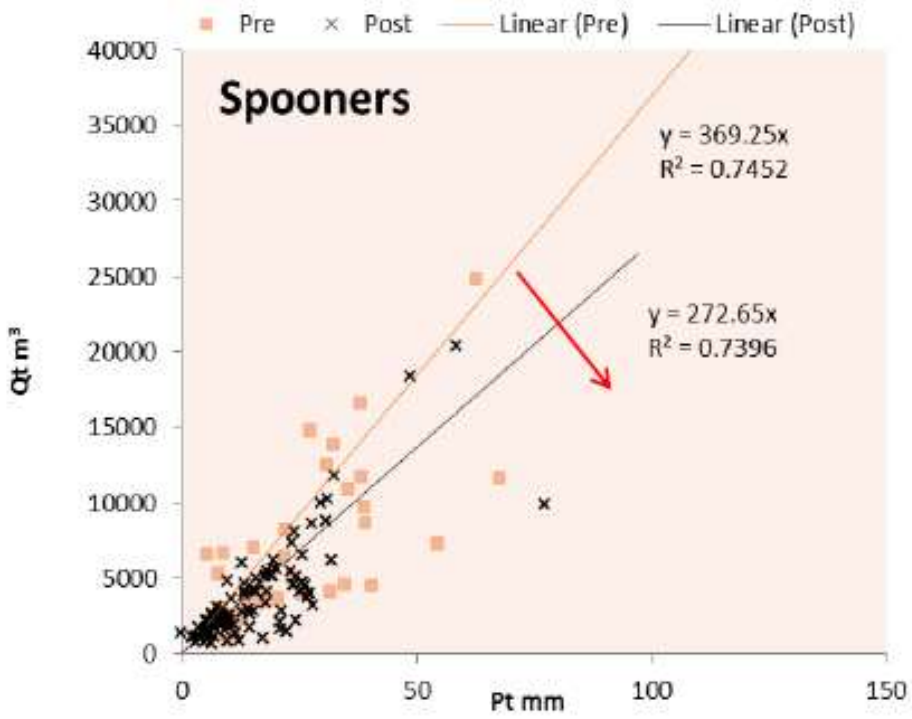
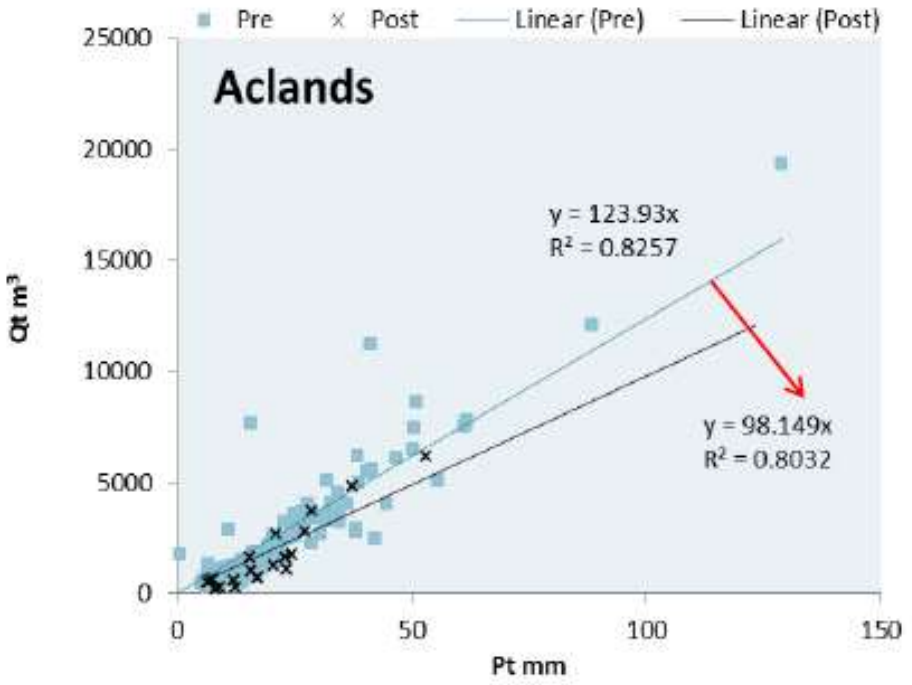
Monitoring Results

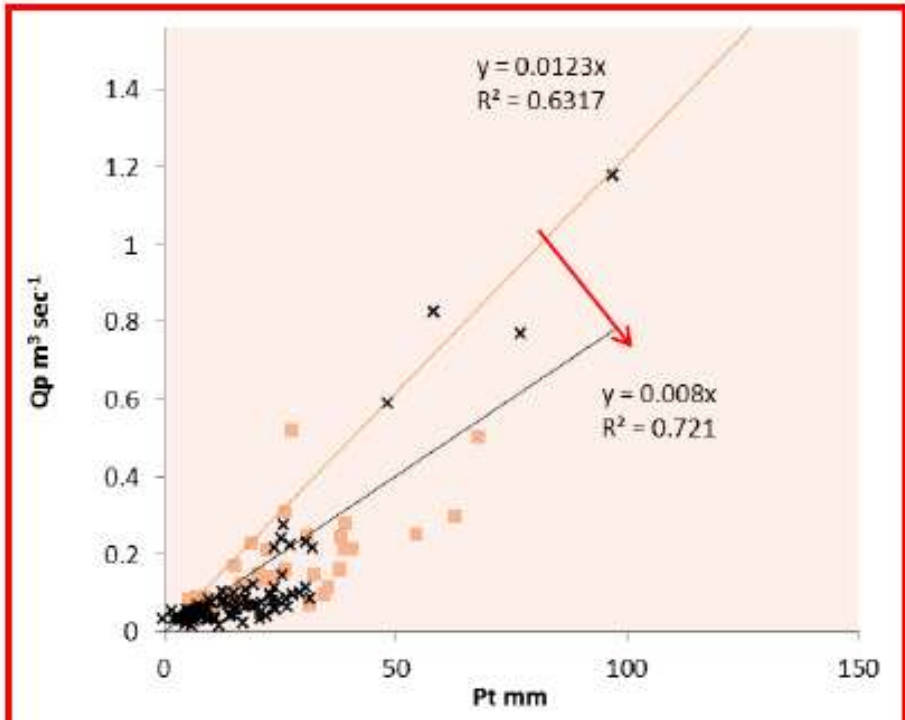
Ground Water Storage

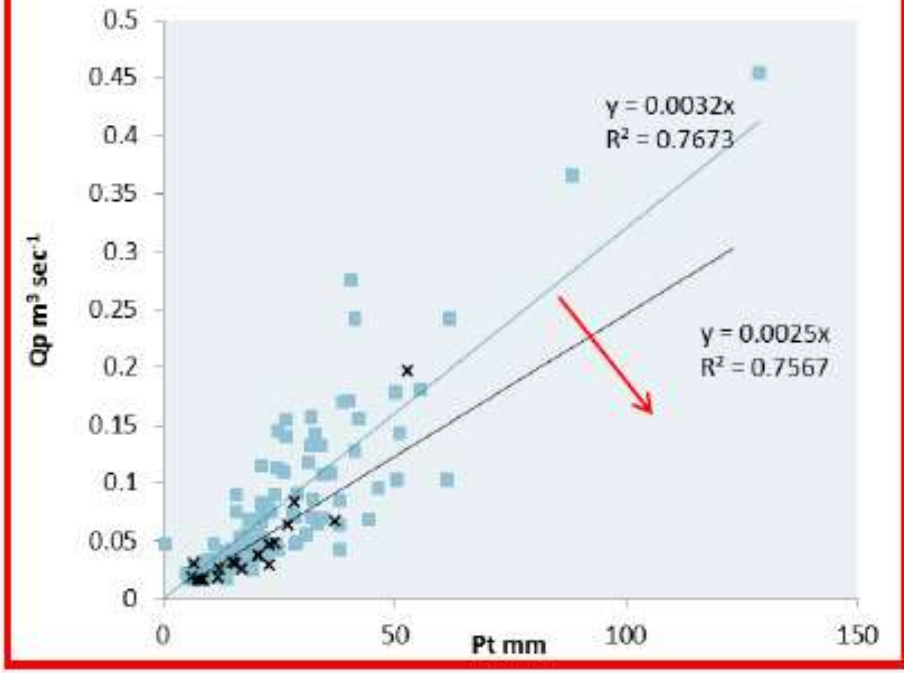
EP Number	Instantaneous Change (cm)
S1	n/a
S2	-0.8
S3	-3.1



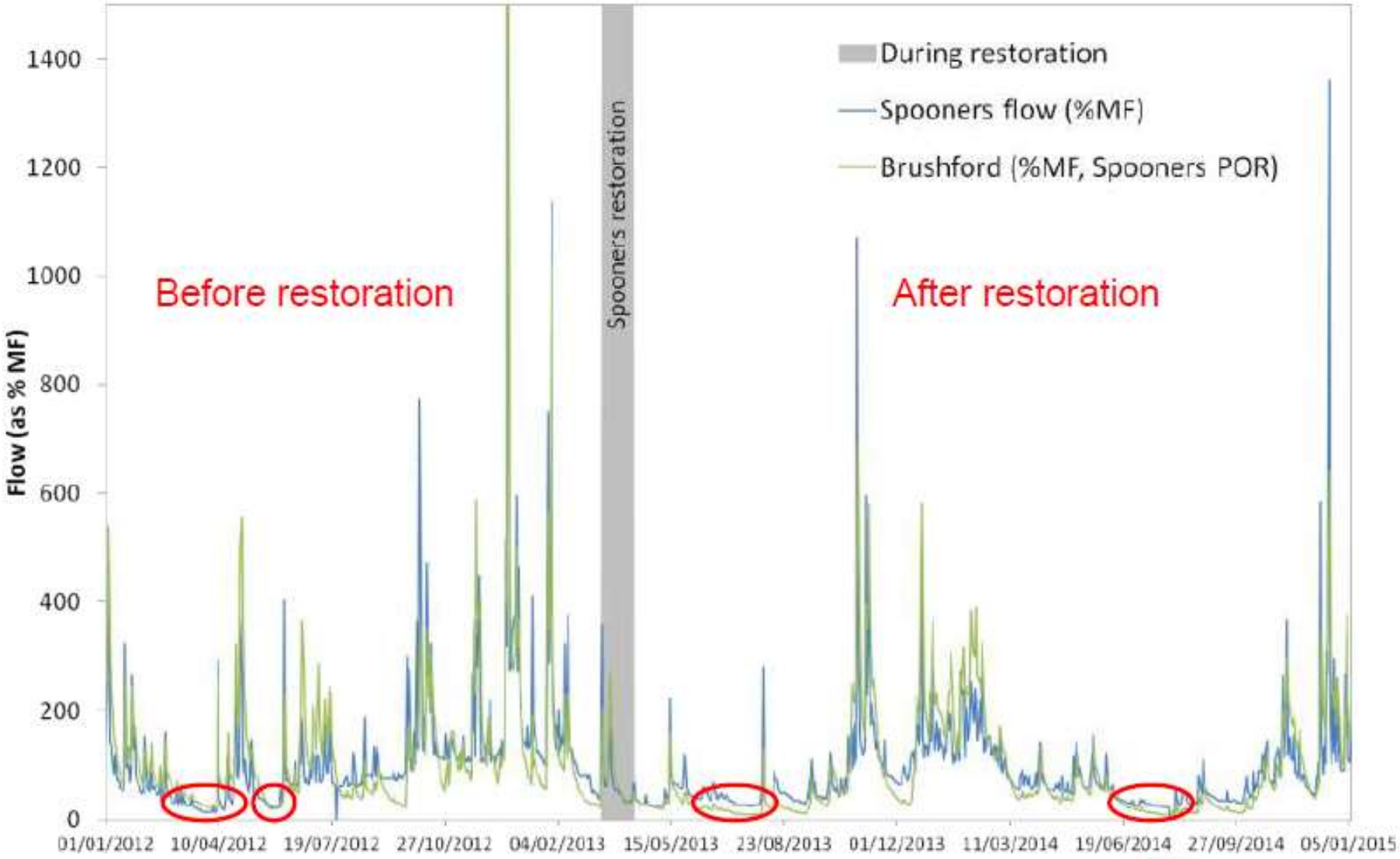

Pre
Post
Linear (Pre)
Linear (Post)
Spooners
y = 369.25x
R² = 0.7452
y = 272.65x
R² = 0.7396
Qt m³
Pt mm
0
5000
10000
15000
20000
25000
30000
35000
40000
0
50
100
150


Pre
Post
Linear (Pre)
Linear (Post)
Aclands
y = 123.93x
R² = 0.8257
y = 98.149x
R² = 0.8032
Qt m³
Pt mm
0
5000
10000
15000
20000
25000
0
50
100
150


y = 0.0123x
R² = 0.6317
y = 0.008x
R² = 0.721
Qp m³ sec⁻¹
Pt mm
0
0.2
0.4
0.6
0.8
1
1.2
1.4
0
50
100
150

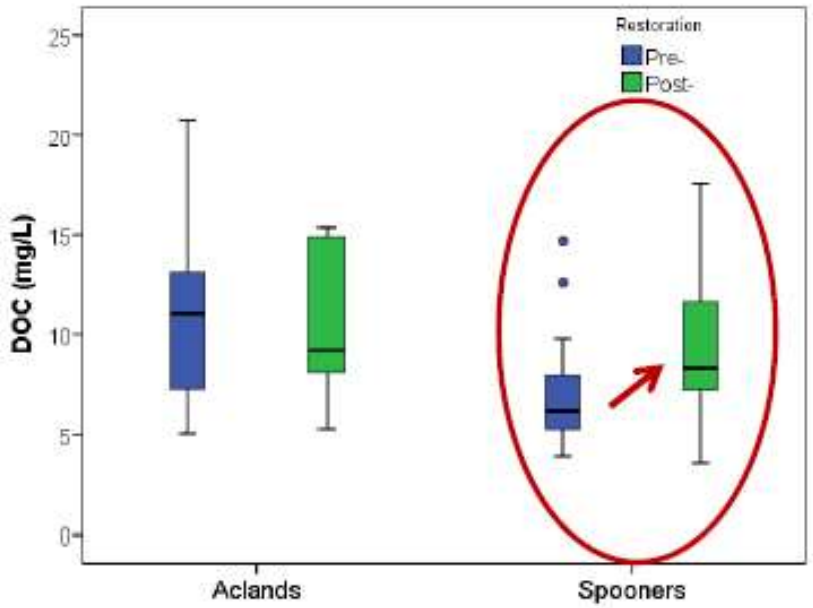

y = 0.0032x
R² = 0.7673
y = 0.0025x
R² = 0.7567
Qp m³ sec⁻¹
Pt mm
0
0.05
0.1
0.15
0.2
0.25
0.3
0.35
0.4
0.45
0.5
0
50
100
150

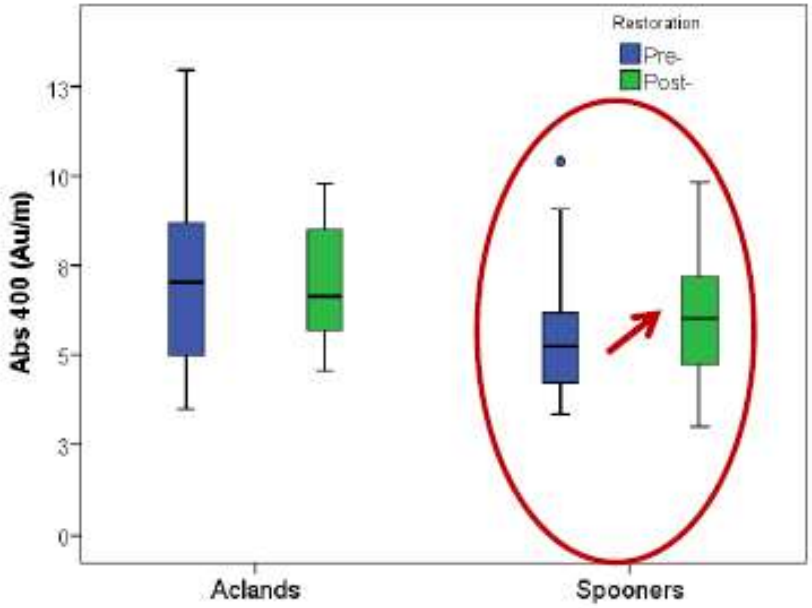
Hydrological response

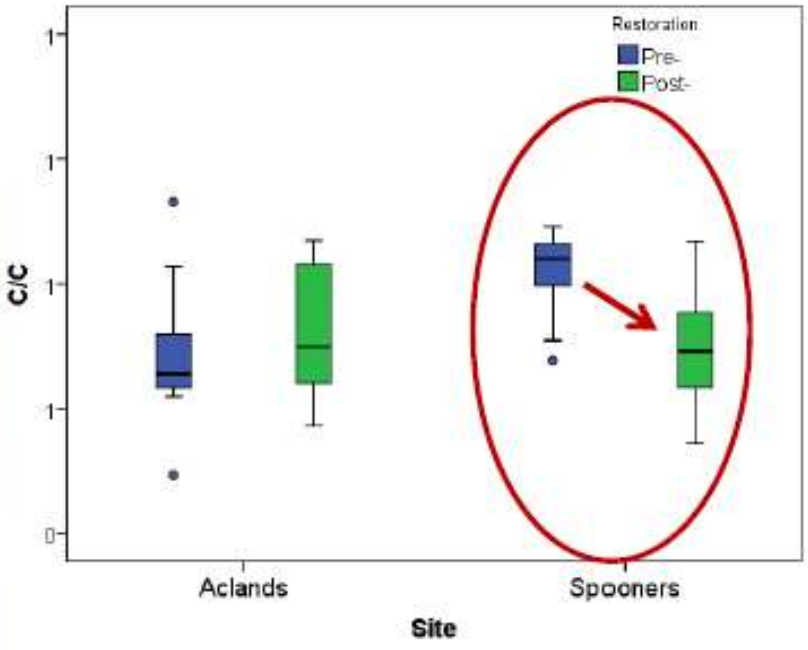


Environment Agency

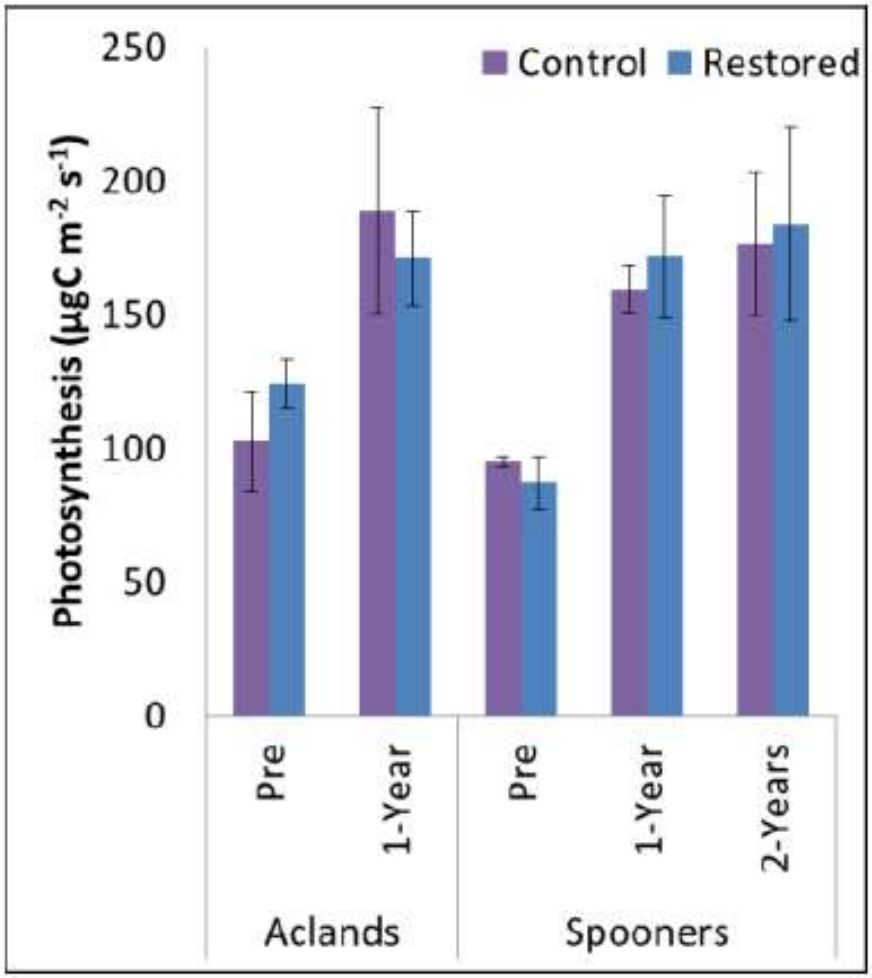
Water Quality pre and post restoration

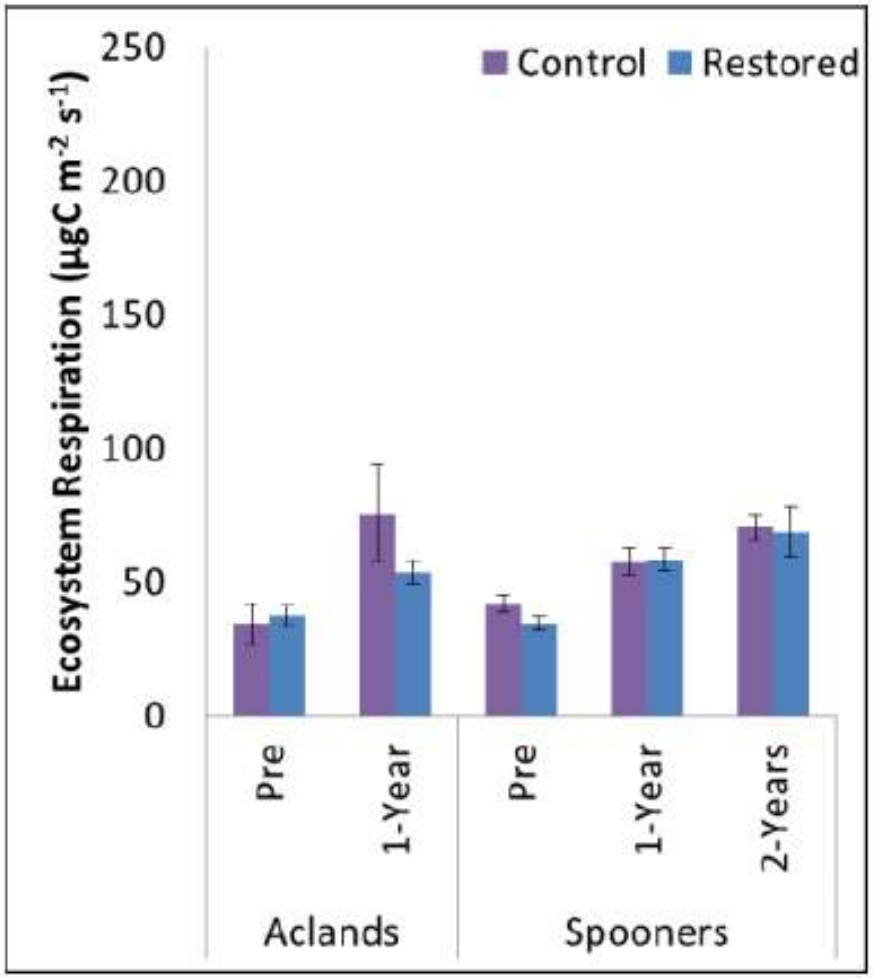






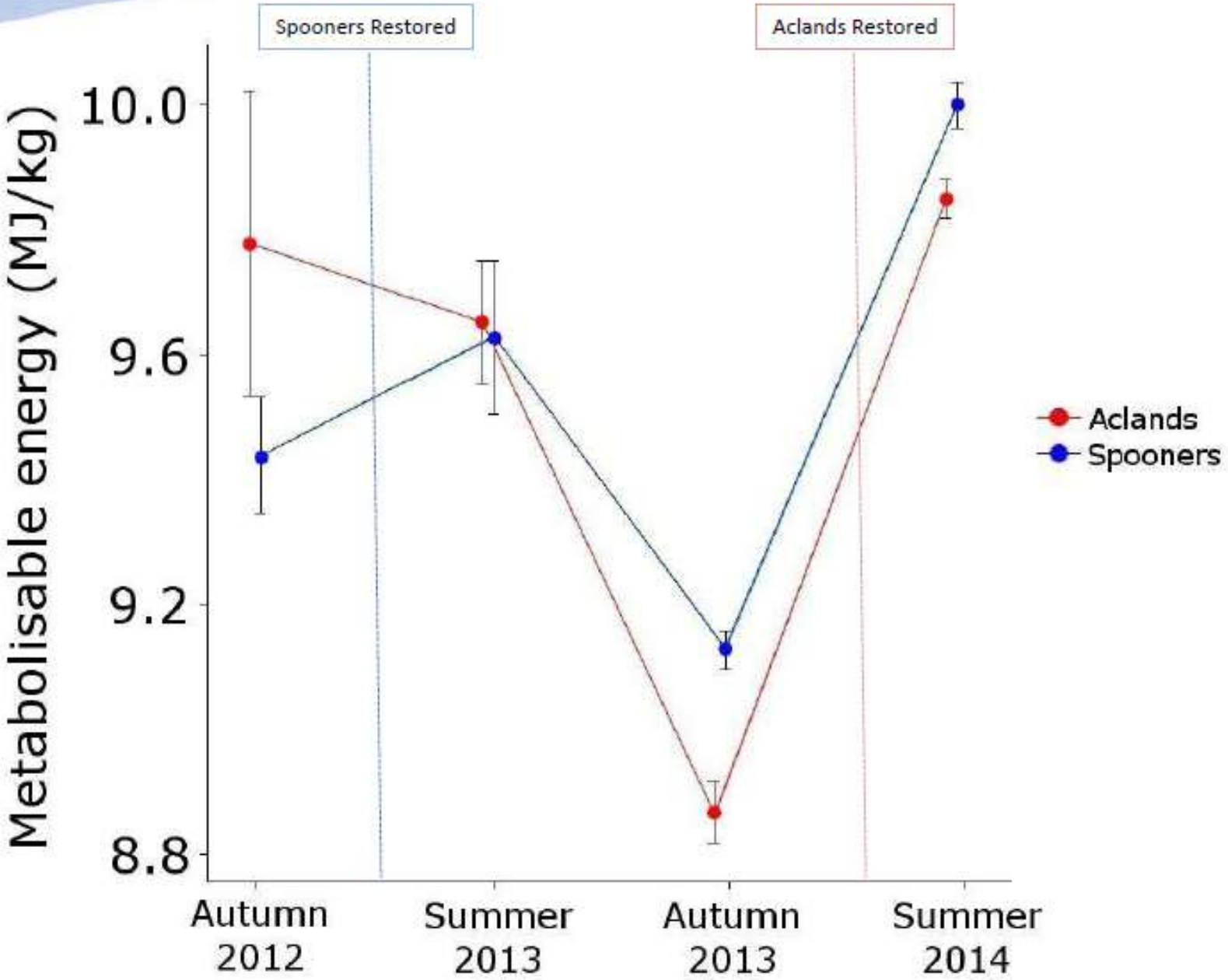
Effect of Restoration on CO_2 Fluxes



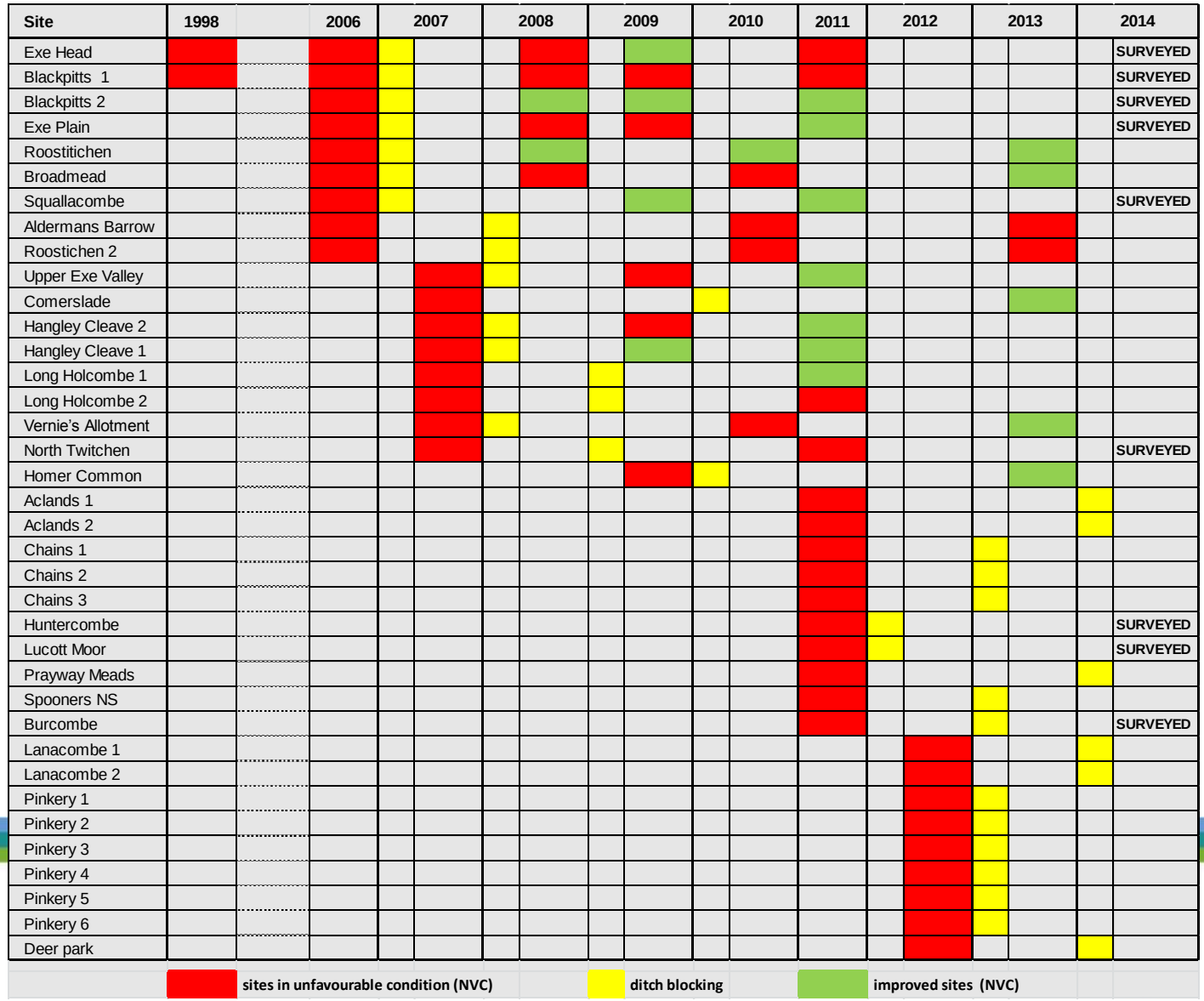



40
35
30
25
20
15
10
5
0
-5
CH4 flux (g CH4-C m-2 a-1)
VAU-1
VAU-2
SP4
SP9
AC7
AC11
SP2
SP11
LHR-1
LHR-2
VAR-1
VAR-2
HC-1
HC-2
SQ-1
SQ-2
LHC-1
LHC-2
BP-1
BP-2
BP-3
Unrestored
Restored
Wet Control
Restoration age
Youngest
(6 months)
Oldest
(~ 7 years)

Site Results: Metabolisable Energy



Vegetation monitoring



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PEATLANDCODE

The carbon emissions gains from peatland restoration can now be calculated and verified under the terms of the newly developed UK Peatland Code, an initial step towards carbon valuation.

IUCN | UK Committee

Peatland Programme

Find out more:
http://www.iucn-uk-peatlandprogramme.org/peatland-gateway/uk/peatland-code

upstreamthinking.org

- Click on the Exmoor Mires page and find the conference link...

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Upstream Thinking

16 years of Exmoor mire vegetation surveying; a volunteer's perspective

Andy Glendinning & Anne Hand
Exmoor Mires Project

Understanding the ecohydrology of Exmoor's peatlands before and after restoration

Dr David J. Luscombe[1], Dr Emilie Grand-Clement[1], Naomi Gatis[1], Pia Benaud[1], Josie Ashe[1], Dr Karen Anderson[2], Dr David Smith[3] and Prof Richard E. Brazier[1]

[1]School of Geography, University of Exeter, Amory Building, Rennes Drive, Exeter.
[2]Environment and Sustainability Institute, University of Exeter, Penryn Campus, Falmouth.
[3]South West Water Limited, Peninsula House, Rydon Lane, Exeter, Devon.

University of Exeter
Exmoor mires Project
Upstream Thinking by South West Water
South West Water

Changes in the invertebrate fauna of Exmoor's mires

David Boyce

Carbon Dioxide fluxes from a drained *Molinia caerulea* dominated bog – how damaged was it, and has ditch blocking made a difference?

Naomi Gatis,
David J. Luscombe,
Emilie Grand-Clement,
Pia Benaud, Josie Ashe, Iain P. Hartley,
Karen Anderson, David Smith and Richard E. Brazier

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The effect of peatland restoration on baseflow

Kate Bowers
Hydrologist
18 March 2015

Methane emissions from restored mires within Exmoor National Park

Adam McAleer
Email: gladama@bristol.ac.uk

Supervisors: Edward Hornibrook (University of Bristol)
David Smith (South West Water, plc.)

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University of
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Assessing the impact of mire restoration on agricultural productivity

Guy Freeman, University of Exeter

rspb giving nature a home
Exmoor mires Project
UPSTREAM THINKING
A South West Water Initiative

Four years of water quality measurements on Exmoor: Initial changes in water quality after restoration

E. Grand-Clement, N. Gatis, D. Luscombe, K. Anderson, J. Ashe, P. Benaud, D. Smith, R. Brazier

Breeding Birds of Exmoor Mires

Helen Booker