Climate change mitigation

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JNCC review

- Understand the current role of UK peatlands in climate change
- Appropriate management of peatlands for climate change mitigation
- Inform restoration practice
- Emissions trading
    - Can we improve on current emissions factors?
- Create a case for a 5 year programme

Scope of this review

- Focused on UK deep peats
- Includes lowland and upland peats but not wetlands with open waters
- Focus is on management types
- “pristine” areas are considered as a baseline but are not considered for change in GHG
- All definitions must of necessity be flexible as studies are often rare
- Capacity and resilience
- Policy potential

Approach - Literature

(Worrall, Bell & Bhogal, 2010)

- Meta-analysis
  - Count the number of studies for each component
  - Count the number of studies showing an improvement
  - Weight the proportions according to pristine stoichoimetry

$$100C_{pp} \Rightarrow 35C_{R} + 26C_{DOC} + 4C_{CH4} + 4C_{dissco2} + 9C_{POC} + 22C_{RES}$$

  - The weighted proportions can be summed to give the probability of improvement

Table 1. Summary of literature data on effects of afforestation of peat. Studies are ordered so that studies from the UK are listed first separated by a

Author:	Soil Respiration of CO_2	Primary productivity	Methane	DOC	POC	Dissolved CO_2	Net ecosystem exchange
Byrne and Milne (2006)	↔		↓				
Byrne and Farrell (2005)	↔	↑					
Cannell et al. (1993)	↑	↑	↓				
Cannell (1999)	↑		↓				
Burt et al. (1983)					↑		
Hargreaves et al. (2003)	↑	↑	↓				
Neal et al (2001)				↑			
(2002)							↑
Minkkinen et al (2007)	↑	↑					↑
Minkkinen et al (2002)	↑	↑	↓				↑
Vompersky et al (1992)	↑	↑					↑
Makiranta et al (2009)	↔						
Alm et al (1999)		↑					
Domisch et al (1998)	↑	↑					↑
Gorham (1990)	↑		↓				
Armentano and Menges (1986)	↑						
Tolonen and Turunen (1996)							↓
Jandl et al (2007)	↑	↑	↓	↑			
No of studies	13	9	7	2	1	0	2
No. with improvement	0	9	7	0	0	0	1

Example for afforestation

(Worrall, Bell & Bhogal, 2010)

Component	Proportion from Equation (i)	Proportion for GHG budget	Proportion from afforestation	Weighted proportion
Primary productivity	100/178	100/248	11/11	0.56
Respiration	35/178	35/248	0/15	0
DOC	26/178	9/248	0/2	0
CH4	4/178	96/248	7/7	0.02
POC	9/178	4/248	1/1	0.05
Diss. CO2	4/178	4/248	0/0	0
			Total	0.62

Summary table (Worrall, Bell & Bhogal, 2010)

Management	Effective sample size	Effective sample size (GHG)	Probability of improvement	Probability of improvement (GHG)	Cost (/km2 or /km of ditch)
Afforestation	9.6	9.4	63 (±19)	81 (±28)	?
Managed burning	5.6	4.1	7 (±0.4)	40 (±2)	12800 – 20000
Cessation of burning	5.6	4.1	93 (±0.4)	60 (±2)	-12800 - -20000
Deforestation	0.8	0.3	19 (±14)	14 (±13)	?
Drainage	12.1	14.7	19 (±1)	47 (±6)	3000
Drain-blocking	10.3	11.3	55 (±11)	34 (±5)	3000
Grazing	3	2.3	65 (±27)	78 (±32)	?
Revegetation	5.8	6.4	70 (±28)	45 (±9)	8800 - 270000
Vegetation cutting	0	0	50 (±50)	50 (±50)	12800 - 20000
Vegetation change	0	0	50 (±50)	50 (50)	22300 - 110000
Wildfire suppression	0	0	50 (±50)	50 (±50)	?

Approach - fieldwork

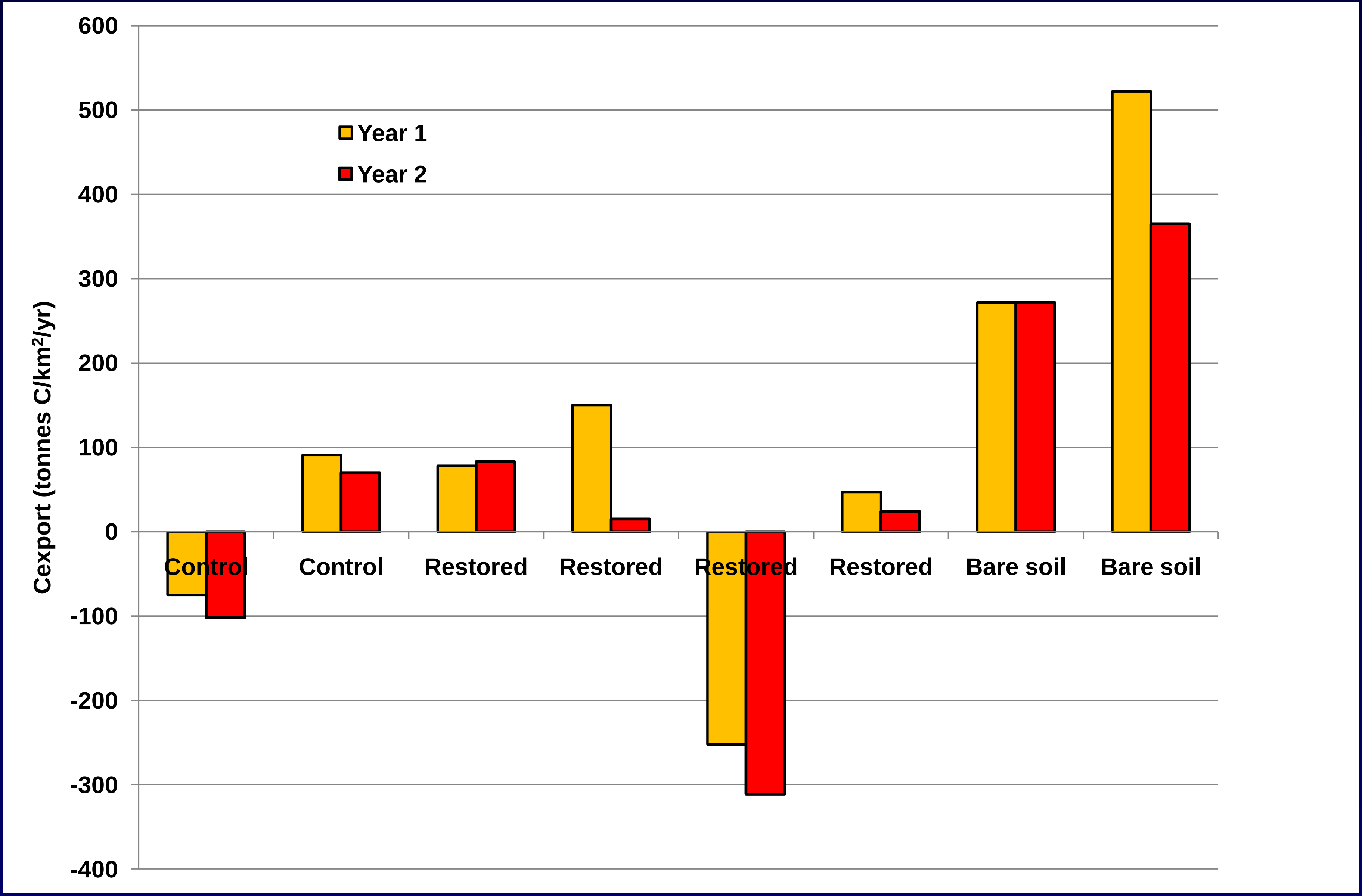

Control


Geojuted gully


Bare peat gully

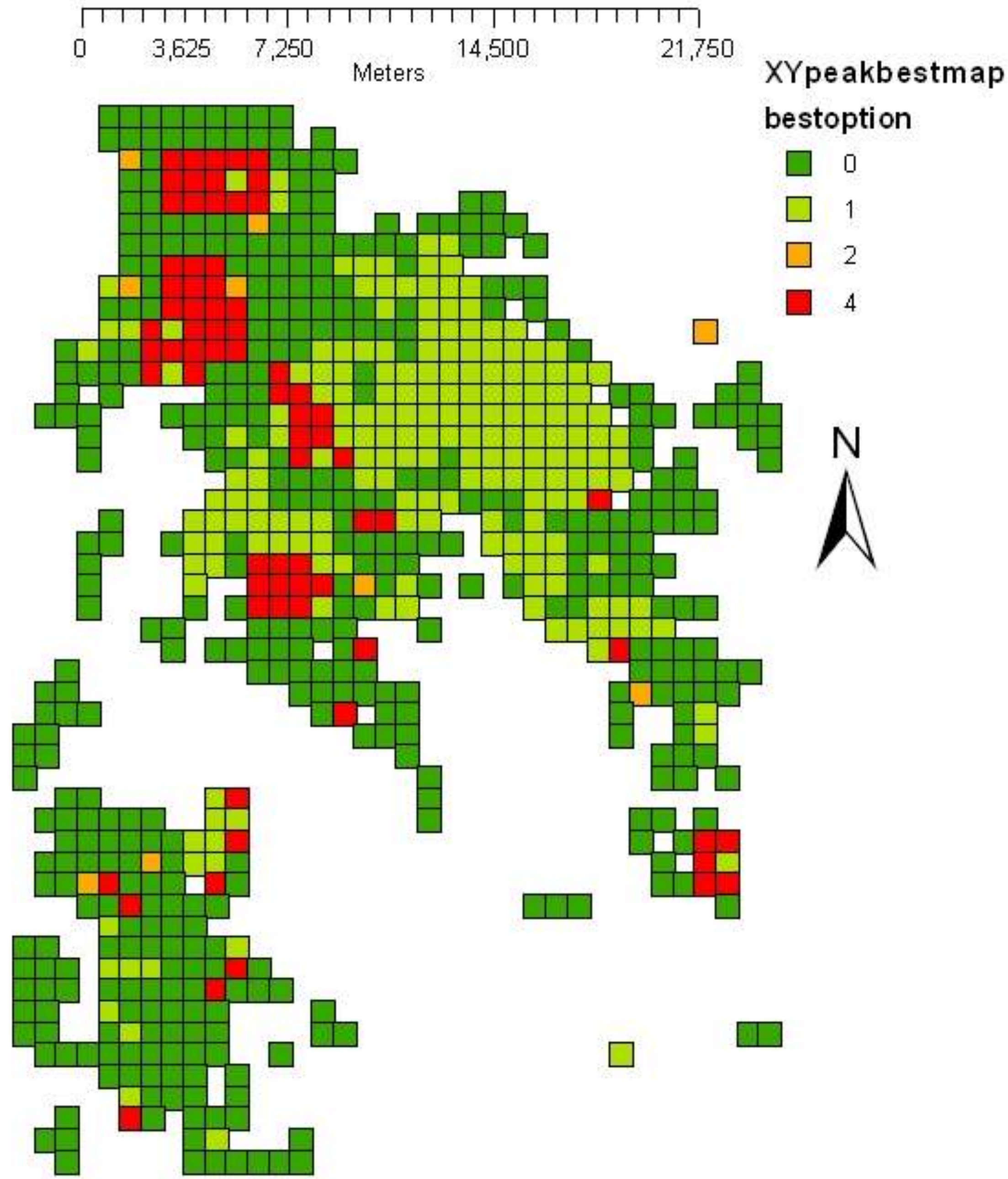

Limed & seeded

Total C budget



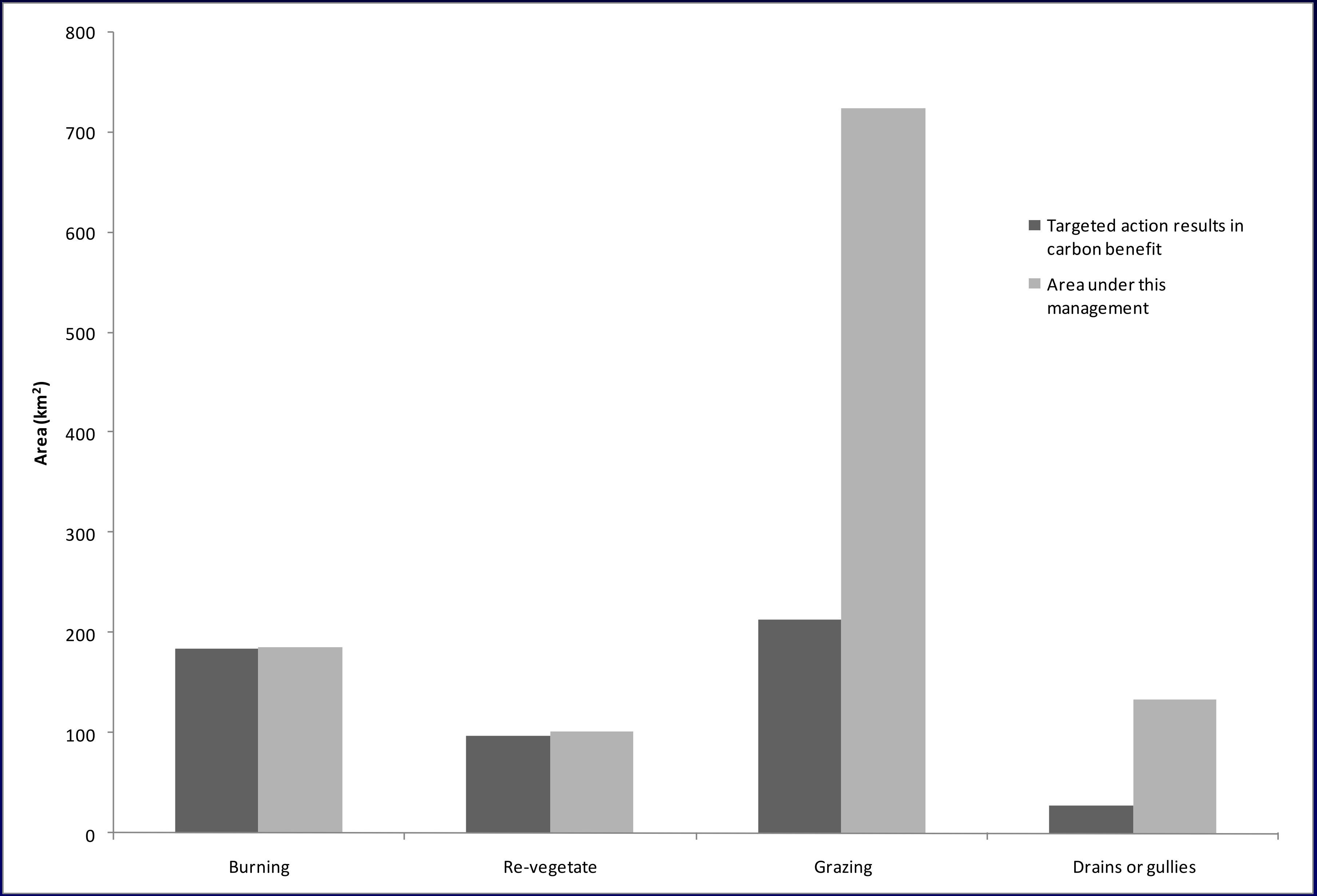
Approach - Modelling

- What are the carbon budgets for the Peak District National Park?
- Covered 725km^2 including 550 km^2 of peat soil
- Calibration and validation is for Moor House
- Covered 10 years - 1997-2006
- Scenarios considered
  - Cessation of grazing
  - Cessation of managed burning
  - Grip/gully blocking
  - All of the above


0
3,625
7,250
14,500
21,750
Meters
XYpeakbestmap
bestoption
0
1
2
4
N

What is the capacity?

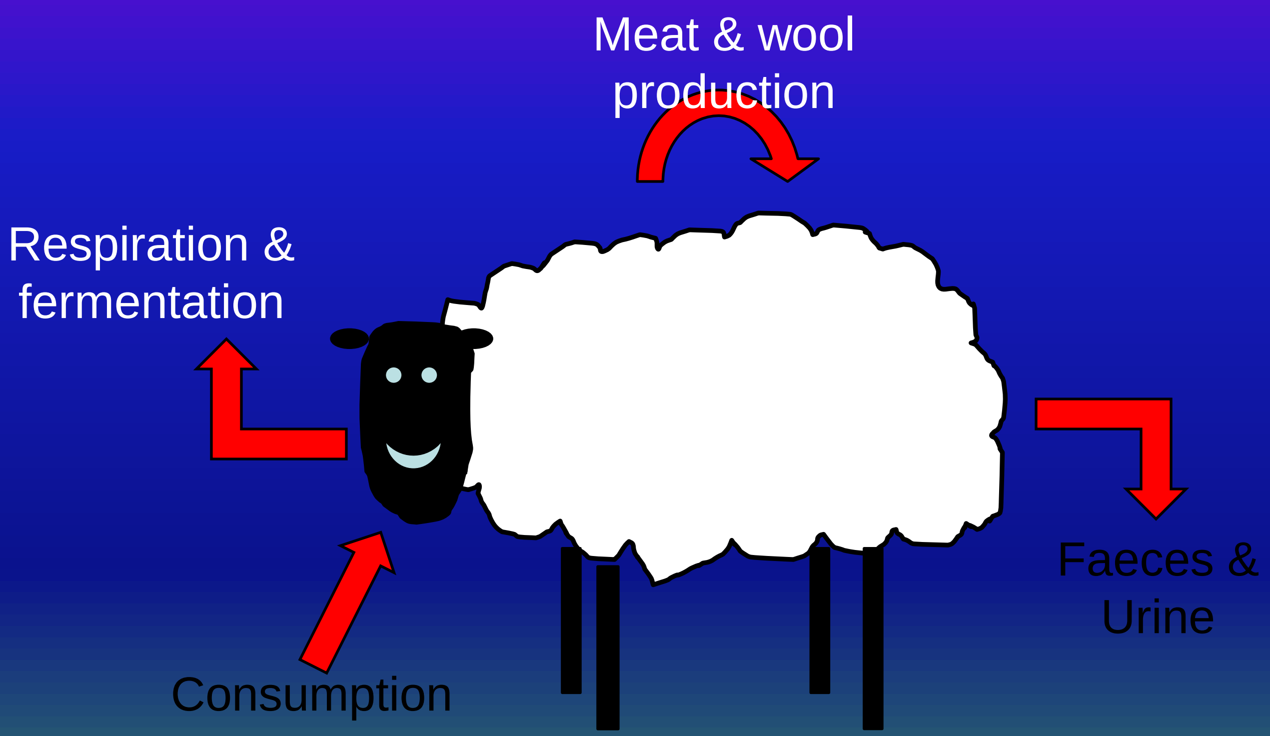
- The study region is presently a net sink of CO_2
  - -62 Ktonnes CO_2 equivalent
  - -136 tonnes CO_2 eq/km^2/yr
- Under optimised conditions
  - -160 Ktonnes CO_2 equivalent
  - -219 tonnes CO_2 eq/km^2/yr


800
700
600
500
400
300
200
100
0
Area (km²)
Targeted action results in carbon benefit
Area under this management
Burning
Re-vegetate
Grazing
Drains or gullies

The Problem

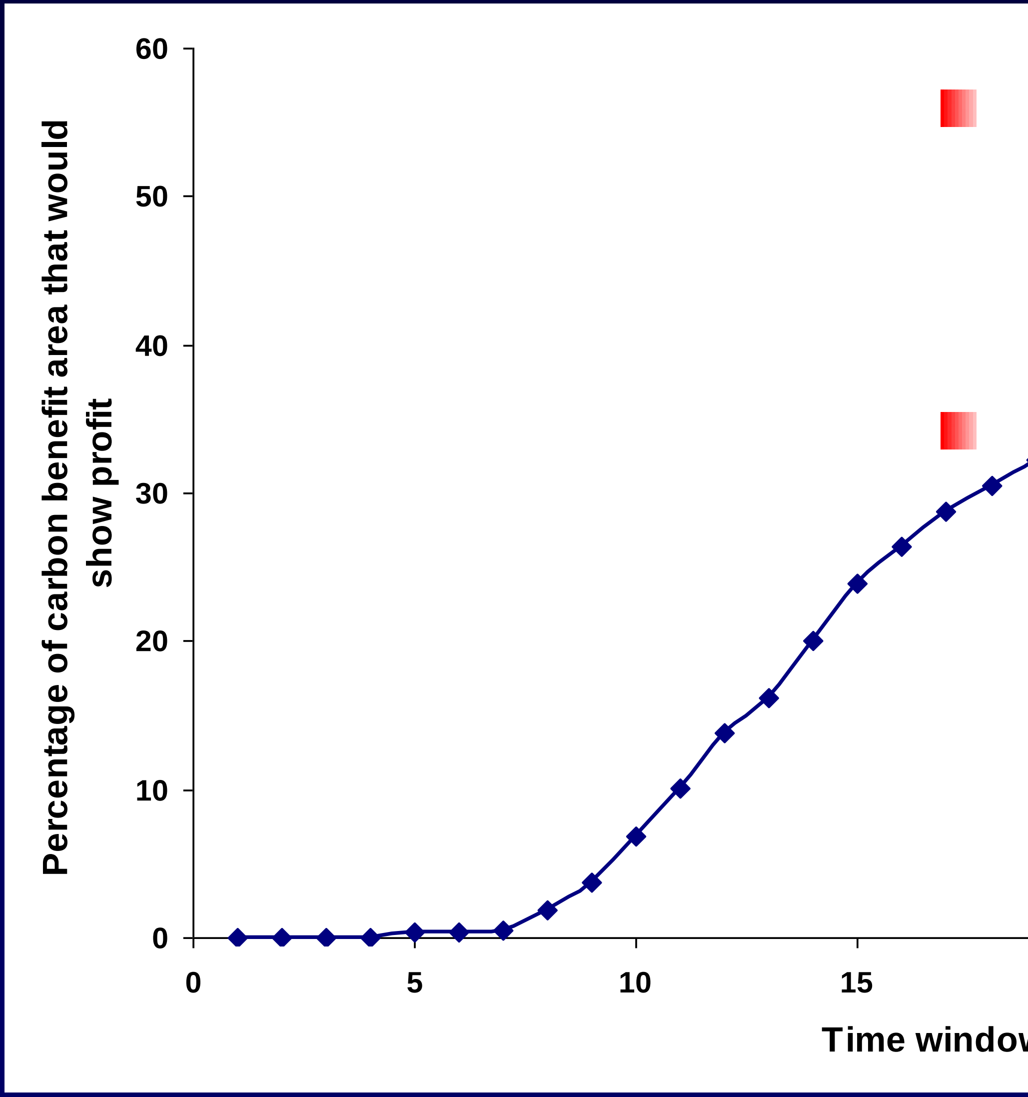
- Re-wetting of peatlands often means big increases in CH_4
- The knowledge gaps
  - Restoration is good at preventing such things as erosion but does POC contribute to GHG flux?
  - Life cycle analysis
    - Many components of the carbon cycle are accounted for separately in GHG inventories

The Mass Balance of a Sheep



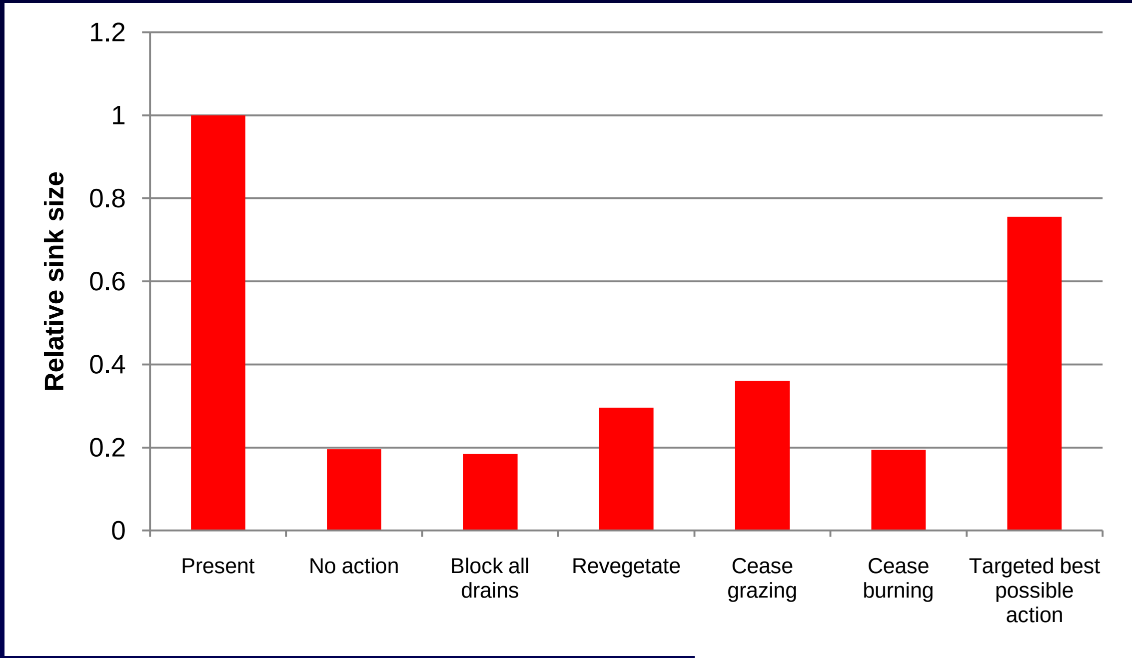
1 ewe/ha = 2.2 tonnes C/km^2/yr = 14.3 tonnes CO_2 eq./km^2/yr

The profit from peatland restoration?

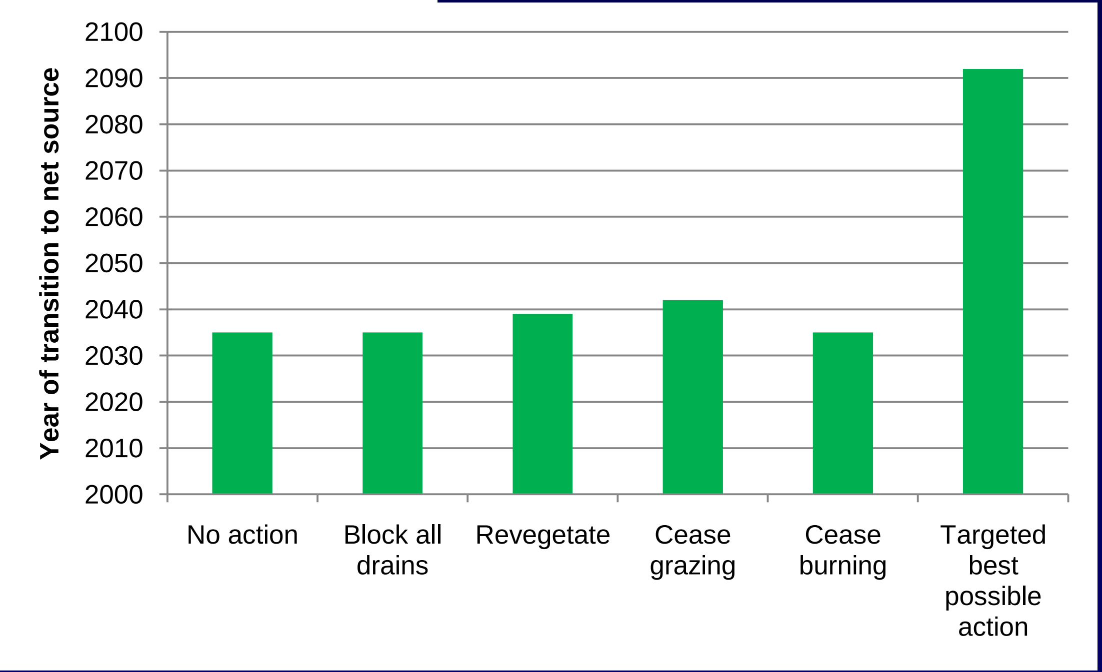


- Restoration cost of £2250/ha
- Shadow price of carbon between £13 and £39 /tonne CO_2
- Restoration rates of upto 39 years

Climate change resilience



Targeted restoration buys lots of time



Conclusions

- Evidence that restoration could
  - Provide additional GHG storage
  - Prove financial viable for some sites
  - Not all actions on all ground would prove beneficial
  - Targeted action would bring resilience against climate change

Gaps in understanding

- The number of complete budget studies is very limited
  - The number for managed sites is effectively zero
  - There is only 1 published before and after studies
- For some land-use/management types the effective sample size < 1

Natural England (2010) – 73% of English peatland GHG emissions come from peat converted for arable or pasture