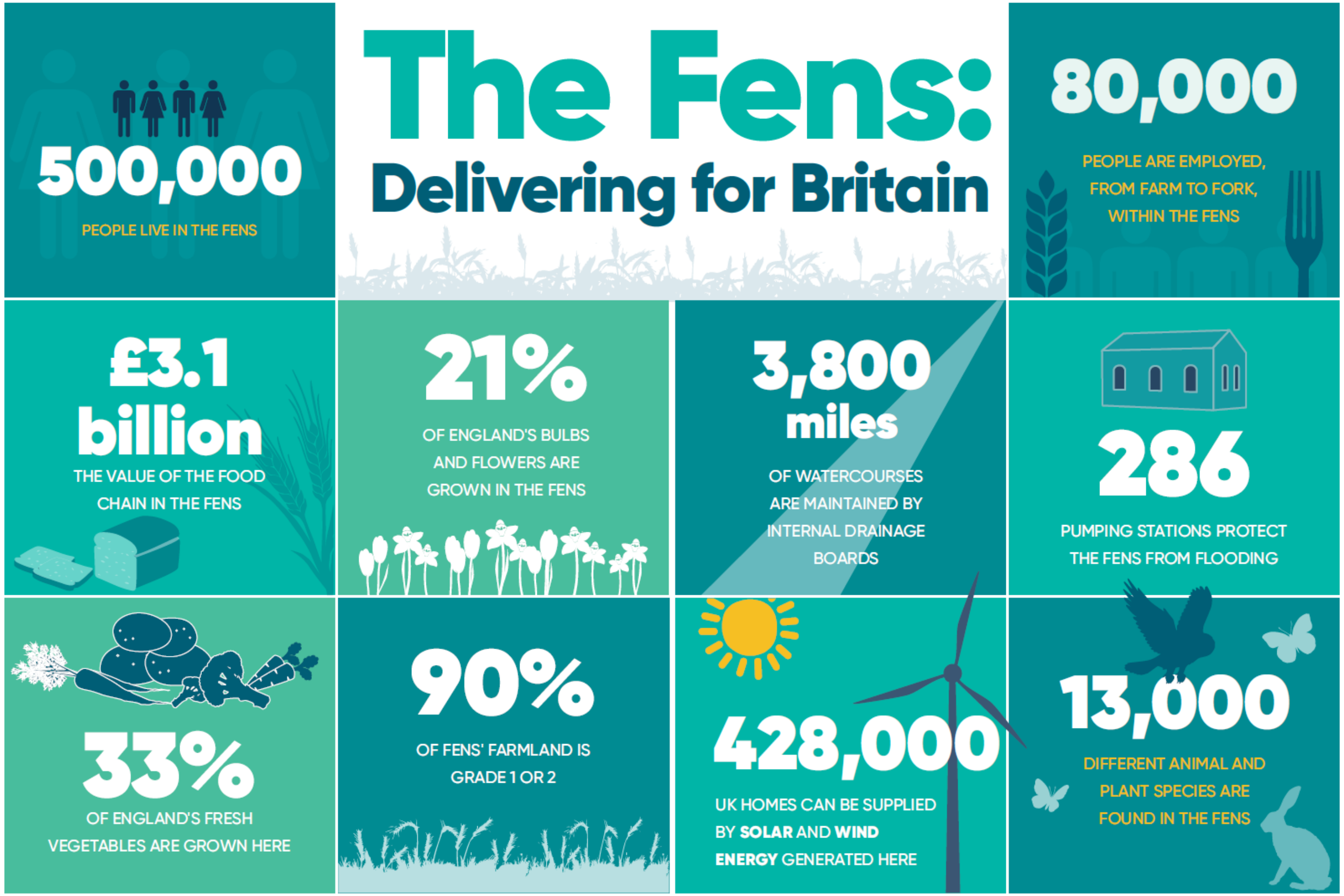
How do we reduce emissions from highly productive lowland peatlands?

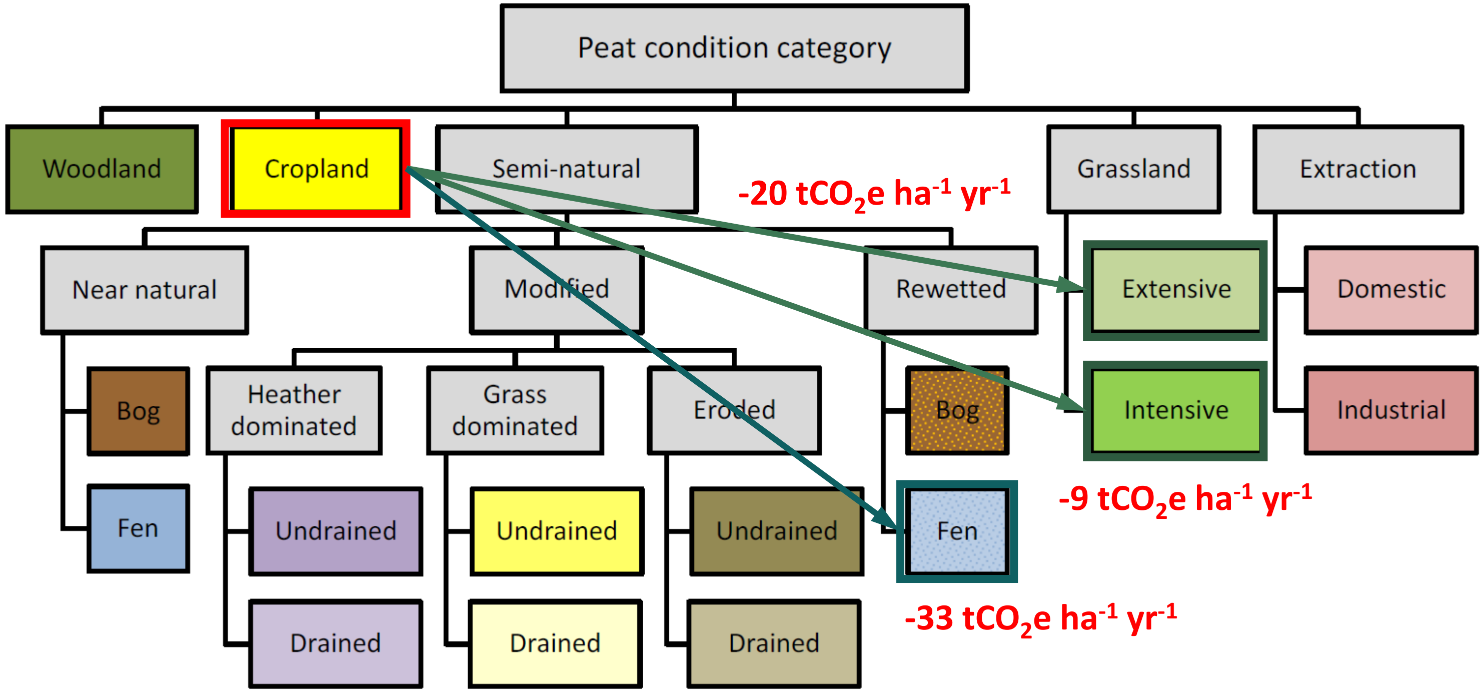
UK Centre for
Ecology & Hydrology

Food and Farming



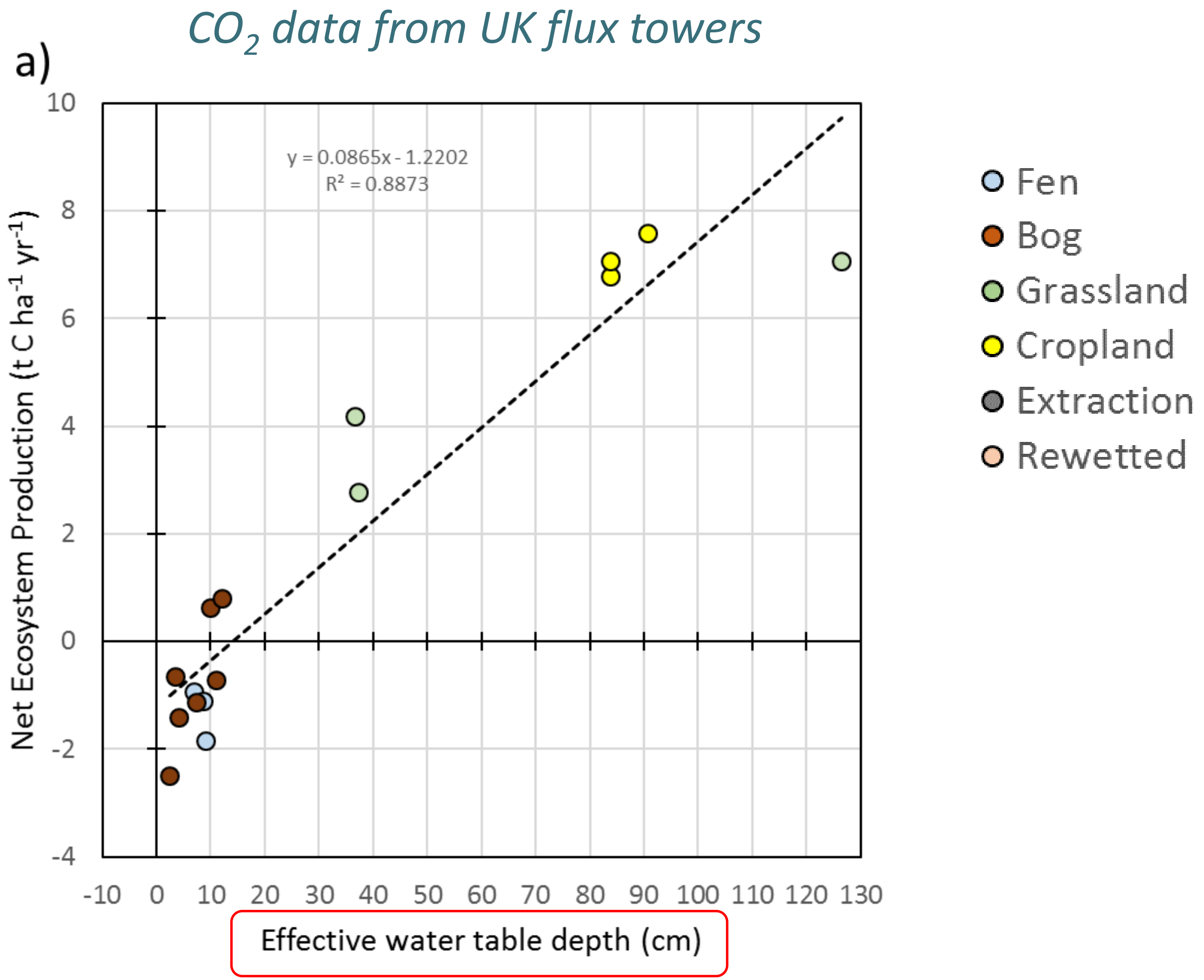
Source: National Farmers Union

Mitigating emissions – all or nothing?



- This is a barrier to change: Most farmers do not want to stop farming; we still need food; paludiculture is still some way from economic viability; and there is currently no reward for raising water levels in conventional farmland – so why do anything?

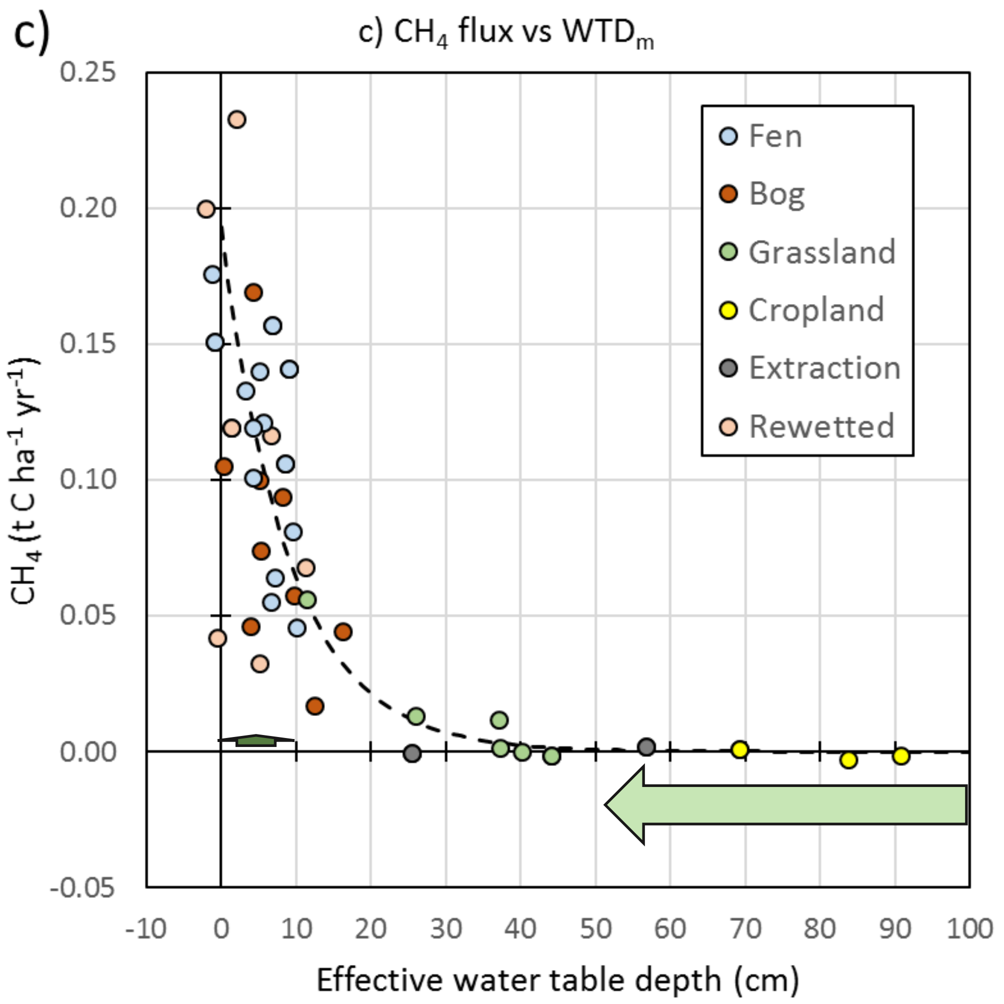
How much mitigation is possible?



Evans et al (in prep)

Will methane cancel out the benefits?

CH_4 fluxes from 41 UK/Irish chamber studies



Evans et al (in prep)

New(ish) Projects:

Lowland Peat 2

Department for Environment Food & Rural Affairs

Wasted peats

Department for Business, Energy & Industrial Strategy

Project team

UNIVERSITY OF LEEDS

ADAS

UEL University of East London

UK Centre for Ecology & Hydrology

PRIFYSGOL BANGOR UNIVERSITY

UNIVERSITY OF LEICESTER

The James Hutton Institute

Rodney Burton

Project advisory group

NFU

The wildlife Trusts

Office for National Statistics

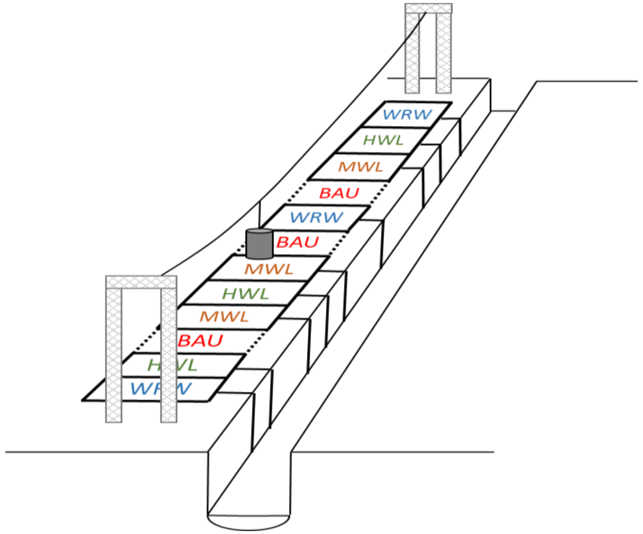
Naturally G's Fresh

Committee on Climate Change

Natural England

1) Field Mitigation Trial Experiment

Seasonal and long-term water level manipulation

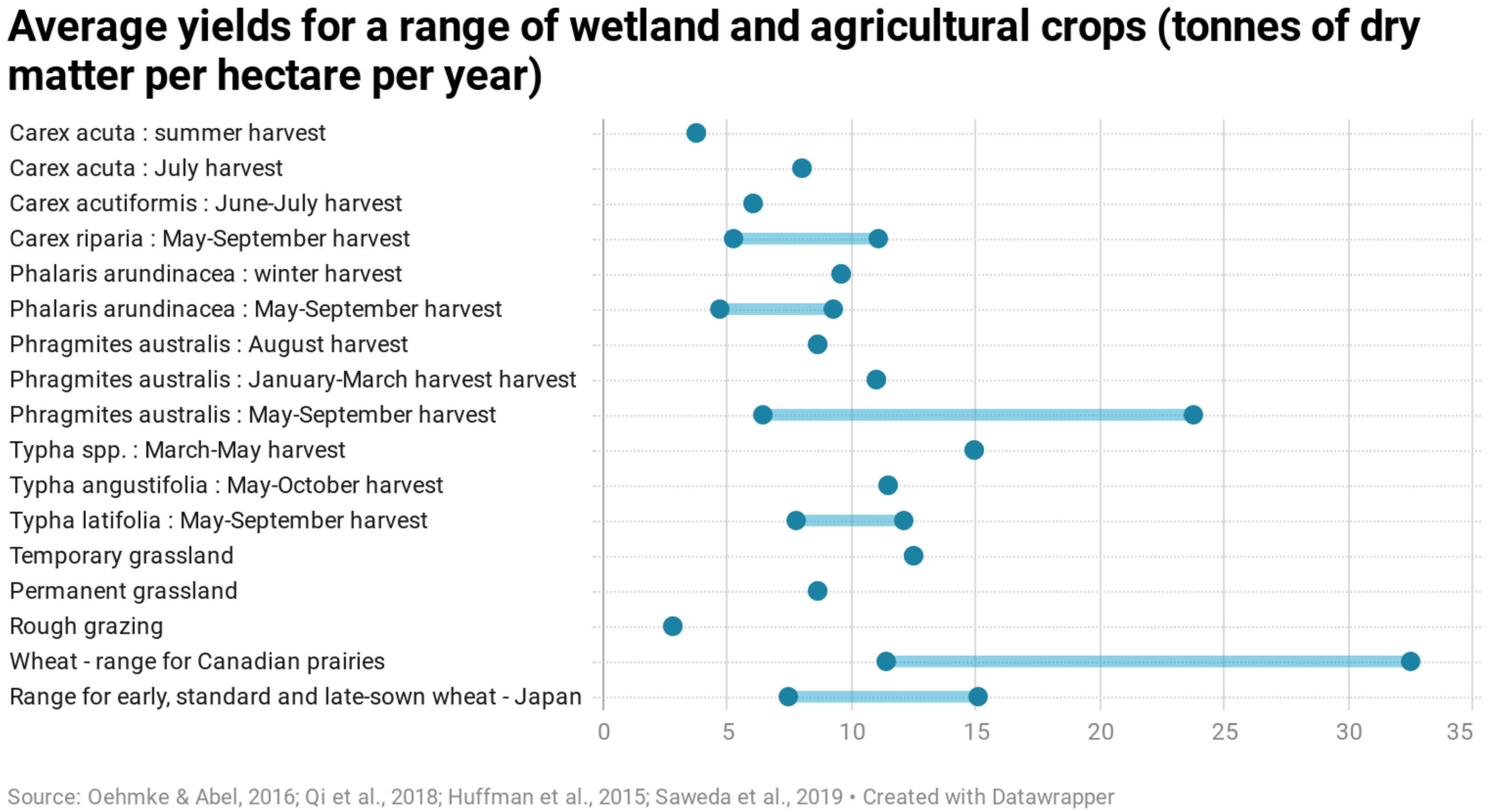


Emissions measurement

Assessment of crop yield, disease and soil structure

UK Cen
Ecology

2) Paludiculture Review



Source: Richard Lindsay

2) Paludiculture Review

Impacts of different land management scenarios on ecosystem services

	Land & water management scenarios			
Ecosystem co-benefits	BAU	Modified BAU (e.g. high winter WT)	High WT cultivation (high WT all year; modification of crops & land management)	Restoration to fen wetland
Food production	↔ / ↙ [a]	↗	↓	↓
Fibre/biomass production	↔	↔	↑	↔
Carbon storage	↓	↙	↔	↗
Climate benefit [b]	↓	↙	↗	↑
Flood storage/water retention	**UNKNOWN**	**UNKNOWN**	**UNKNOWN** [c]	↑
Water quality	↓	↙	↗ [d]	↑ [d]
Biodiversity	↙	↙	↔ [e]	↑
Recreation/tourism	↓	↓	↔	↑
Education	↓	↓	↔	↑
Landscape aesthetics	↔	↔	↗	↑

Reduced provision	↓
Some reduction	↙
Neutral	↔
Some increase	↗
Increase	↑

2) Paludiculture Review

"Paludiculture emissions calculator" (work in progress)

CROP	SITE PROPERTIES			EMISSIONS/REMOVALS						MITIGATION		
	WTD	Peat depth	Effective WTD	CO_2	CO_2	CH_4	CH_4	C balance	GHG	CO_2	CH_4	GHG
	cm	cm	cm	t C ha^{-1} yr^{-1}	t CO_2 ha^{-1} yr^{-1}	t C ha^{-1} yr^{-1}	t CO_2e ha^{-1} yr^{-1}	t C ha^{-1} yr^{-1}	t CO_2e ha^{-1} yr^{-1}	t CO_2e ha^{-1} yr^{-1}		
Deep peat example data												
Paludiculture crop 1	**0**	**100**	0	-1.58	-5.78	0.17	6.51	-1.40	0.73	-13.1	6.2	-6.9
Conventional crop 1	**40**	**100**	40	2.00	7.33	0.01	0.27	2.01	7.59			
Paludiculture crop 2	**10**	**100**	10	-0.68	-2.51	0.08	2.93	-0.61	0.42	-16.4	2.9	-13.5
Conventional crop 2	**60**	**100**	60	3.79	13.88	0.00	0.05	3.79	13.94			
Paludiculture crop 3	**20**	**100**	20	0.21	0.77	0.04	1.32	0.25	2.09	-19.7	1.3	-18.4
Conventional crop 3	**80**	**100**	80	5.57	20.44	0.00	0.01	5.57	20.45			
Paludiculture crop 4	**30**	**100**	30	1.10	4.05	0.02	0.59	1.12	4.64	-22.9	0.6	-22.4
Conventional crop 4	**100**	**100**	100	7.36	27.00	0.00	0.00	7.36	27.00			
Shallow peat example data												
Paludiculture crop 1	**0**	**30**	0	-1.58	-5.78	0.17	6.51	-1.40	0.73	-9.8	5.9	-3.9
Conventional crop 1	**40**	**30**	30	1.10	4.05	0.02	0.59	1.12	4.64			
Paludiculture crop 2	**10**	**30**	10	-0.68	-2.51	0.08	2.93	-0.61	0.42	-6.6	2.3	-4.2
Conventional crop 2	**60**	**30**	30	1.10	4.05	0.02	0.59	1.12	4.64			
Paludiculture crop 3	**20**	**30**	20	0.21	0.77	0.04	1.32	0.25	2.09	-3.3	0.7	-2.6
Conventional crop 3	**80**	**30**	30	1.10	4.05	0.02	0.59	1.12	4.64			
Paludiculture crop 4	**30**	**30**	30	1.10	4.05	0.02	0.59	1.12	4.64	0.0	0.0	0.0
Conventional crop 4	**100**	**30**	30	1.10	4.05	0.02	0.59	1.12	4.64			

3) Subsidence Review

Isle of Axeholme, Lincolnshire/Nottinghamshire
(with thanks to James Brown for the tour)

3) Subsidence Review

Contents lists available at ScienceDirect
Geoderma
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Rates and spatial variability of peat subsidence in *Acacia* plantation and forest landscapes in Sumatra, Indonesia

Chris D. Evans[a,*], Jennifer M. Williamson[a], Febrio Kacaribu[b], Denny Irawan[b], Yogi Suardiwerianto[c], Muhammad Fikky Hidayat[c], Ari Laurén[d], Susan E. Page[e]

Subsidence rates in drained temperate and boreal peatlands

Land-use type	Location	N sites	Duration (years)	Mean WTD (cm)	Subsidence ($cm\ yr^{-1}$)	Reference
Arable	Canada (Ontario)	1	3	102	−3.30	Mirza and Irwin (1964)
Arable	Canada (Quebec)	1	10	ND	−2.50	Mathur et al. (1982)
Arable	Canada (Quebec)	1	38	ND	−2.07	Millette (1976)
Arable	Germany	2	12	98	−2.15	Eggelsmann and Bartels (1975)
Arable	Italy	1	4	50	−0.75	Zanello et al. (2011)
Arable	Switzerland	15	141	110	−1.26	Leifeld et al. (2011)
Arable	UK (England)	7	30	ND	−1.37	Richardson and Smith (1977)
Arable	UK (England)	117	22	ND	−1.48	Dawson et al. (2010)
Arable	UK (England)	1	53	120	−1.56	Hutchinson (1980)
Arable	USA (California)	13	8	90	−1.25	Deverel et al. (2010, 2016)
Arable	USA (Florida)		20	ND	−1.45	Shih et al. (1998)
Arable	USA (Florida)	15	88	ND	−1.82	Aich et al. (2013)
Arable	USA (Florida)	1	76	ND	−1.40	Wright and Snyder (2009)
Arable	USA (Florida)				−3.00	Stephens et al. (1984)
Arable	USA (Indiana)	3	6	75	−2.26	Jongedyk et al. (1950)
Forest	Finland	273	60	ND	−0.37	Minkinnen and Laine (1998)
Forest	Finland	4	30	ND	−0.48	Minkinnen et al. (1999)
Forest	UK (Scotland)	101	29	55	−1.91	Shotbolt et al. (1998)
Grassland	Germany	1	40	80	−0.83	Kluge et al. (2008)
Grassland	Germany	1	66	80	−0.67	Eggelsmann and Bartels (1975)
Grassland	Germany	1	35	ND	−0.50	Eggelsman (1976)
Grassland	Netherlands	8	6	64	−0.53	Schothorst (1977)
Grassland	Netherlands	1	88	15	−0.06	Schothorst (1977)
Grassland	New Zealand	66	80	ND	−2.56	Fitzgerald and McLeod (2004)
Grassland	New Zealand	10	40	ND	−3.40	Schipper and McLeod (2002)
Grassland	New Zealand	119	12	ND	−1.90	Pronger et al. (2014)
Grassland	Norway	11	28	ND	−2.00	Grønlund et al. (2008)
Grassland	Norway	5	31	ND	−1.04	Grønlund et al. (2008)
Grassland	Poland	18	38	53	−0.17	Grzywna (2017)
Grassland	UK	ND	10	ND	−0.62	Brunning (2001)
Grassland	USA (California)	34	28	ND	−2.20	Deverel and Leighton (2010)

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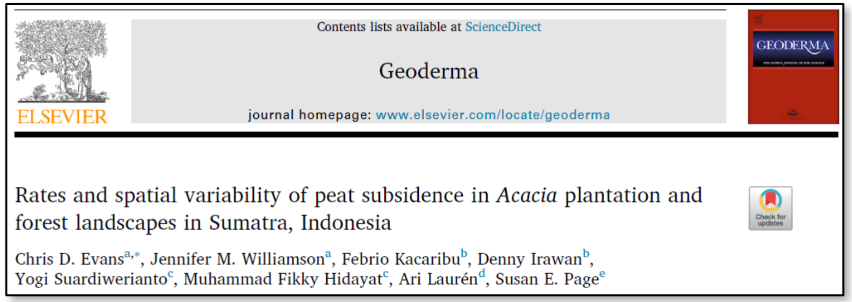
3) Subsidence Review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Rates and spatial variability of peat subsidence in *Acacia* plantation and forest landscapes in Sumatra, Indonesia

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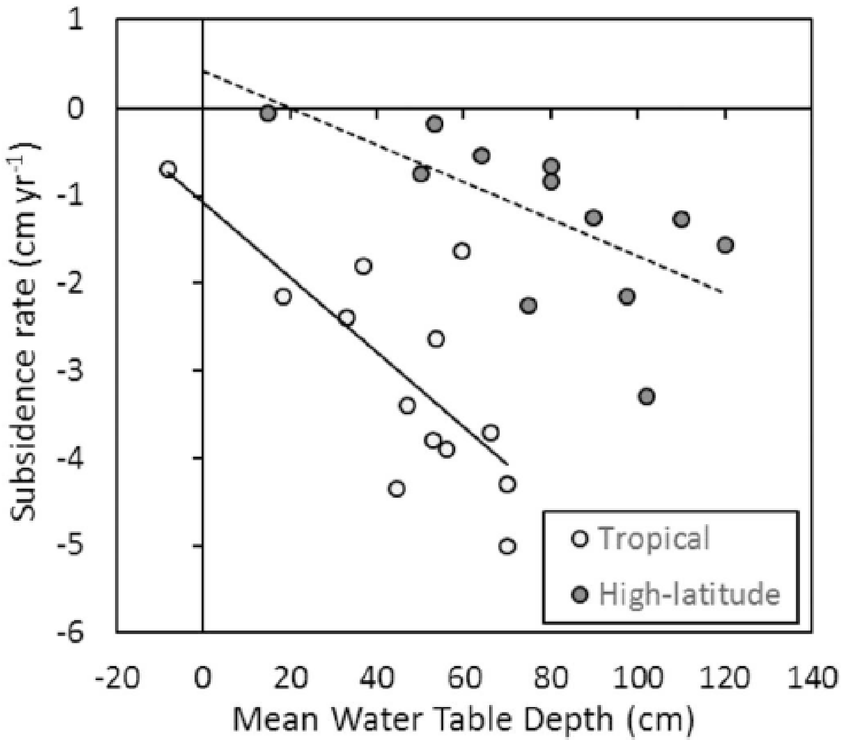
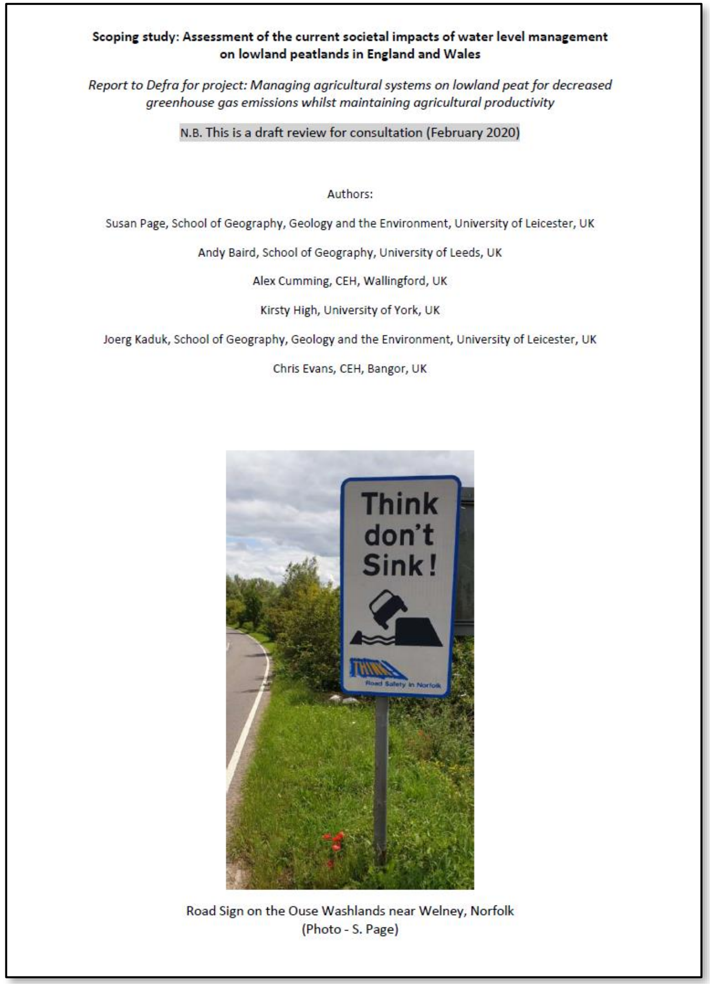
Subsidence versus drainage depth



- Deeper drainage leads to faster subsidence
- So raising water levels within farmland would reduce subsidence, reduce CO_2 emissions and extend the productive lifetime of the peat
- Reducing wind erosion (e.g. using cover crops and soil stabilisers) could also reduce subsidence and carbon loss (Ben Freeman's PhD)

3) Subsidence Review


Scoping study: Assessment of the current societal impacts of water level management on lowland peatlands in England and Wales

Report to Defra for project: Managing agricultural systems on lowland peat for decreased greenhouse gas emissions whilst maintaining agricultural productivity

N.B. This is a draft review for consultation (February 2020)

Authors:

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Alex Cumming, CEH, Wallingford, UK

Kirsty High, University of York, UK

Joerg Kaduk, School of Geography, Geology and the Environment, University of Leicester, UK

Chris Evans, CEH, Bangor, UK

Road Sign on the Ouse Washlands near Welney, Norfolk
(Photo - S. Page)

"Subsidence calculator"
(also work in progress)

CROP	SITE PROPERTIES			SUBSIDENCE		
	C content	Bulk density	C balance	Oxidative	Total	Mitigation
	%	$g\ cm^{-3}$	$g\ C\ m^{-2}\ yr^{-1}$	$cm\ yr^{-1}$	$cm\ yr^{-1}$	$cm\ yr^{-1}$
Paludiculture crop 1			*-140*	0.00	0.00	-0.33
Conventional crop 1	**40**	**0.3**	*201*	0.17	0.33	
Paludiculture crop 2			*-61*	0.00	0.00	-0.54
Conventional crop 2	**35**	**0.4**	*379*	0.27	0.54	
Paludiculture crop 3			*25*	0.02	0.04	-0.95
Conventional crop 3	**45**	**0.25**	*557*	0.50	0.99	
Paludiculture crop 4			*112*	0.11	0.22	-1.25
Conventional crop 4	**50**	**0.2**	*736*	0.74	1.47	

UK Centre for Ecology & Hydrology

Sue Page et al, Draft Report to Defra (2020)

4) Socio-economic opportunities and barriers

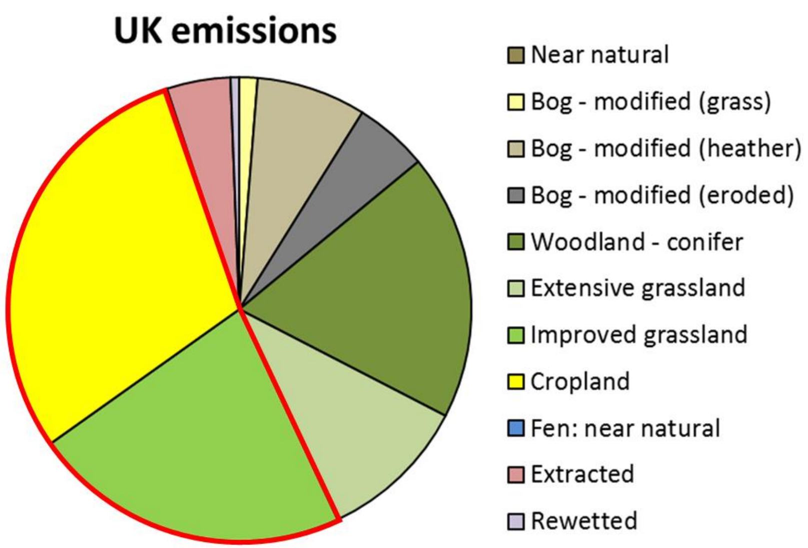
Davey Jones, Bangor Uni

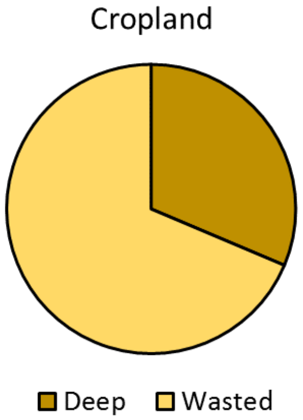
Aims:

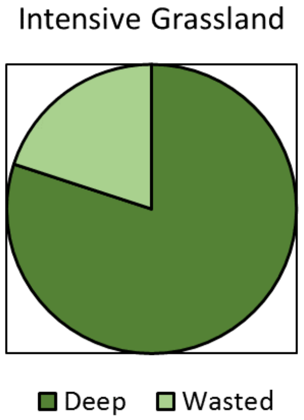
- Identify the practical barriers and opportunities associated with adoption of mitigation strategies by famers
- Identify the main socioeconomic barriers
- Evaluate ecosystem service trade-offs
- Evaluate social and environmental impacts of different farm-scale mitigation options at the regional scale.
- Identify barriers in the market supply chain.
- Identify how long it will take to implement the mitigation measures.
- Produce a roadmap for mitigating the loss of agricultural peatlands, whilst minimising impacts on society, economy and food security

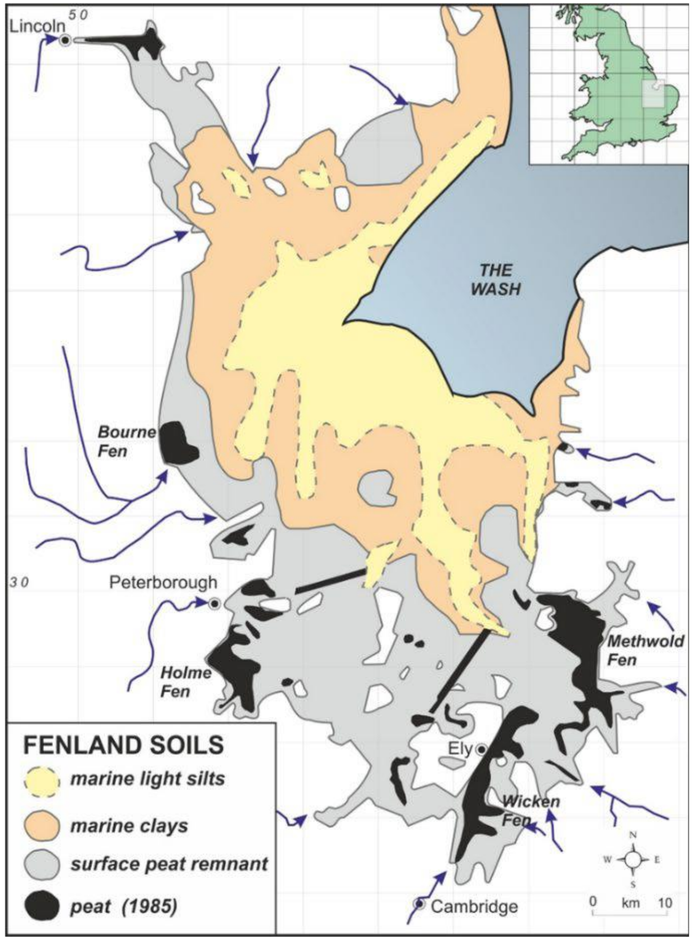
Emissions from Wasted Peat

Department for Business, Energy & Industrial Strategy







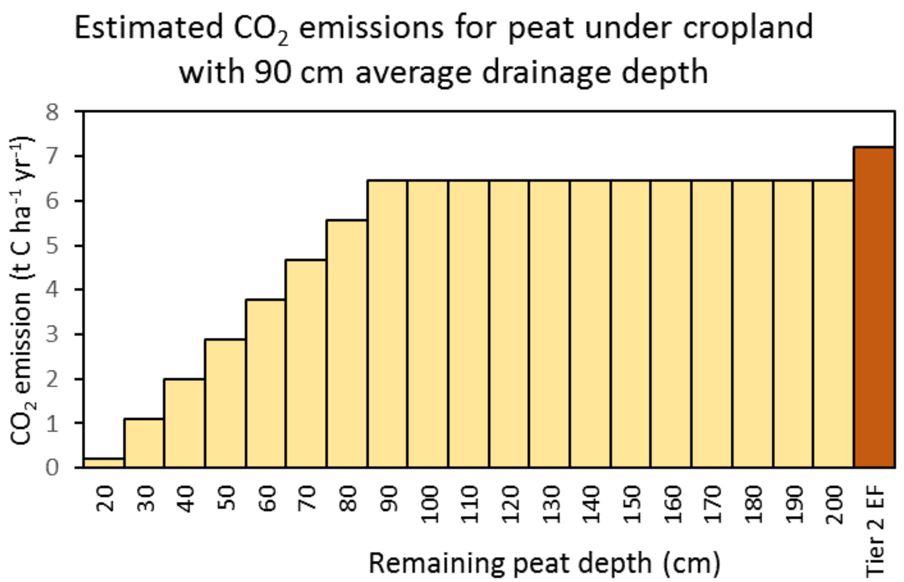


Source: Rodney Burton

- A large fraction of currently estimated emissions are from wasted peat under cropland – are these real?

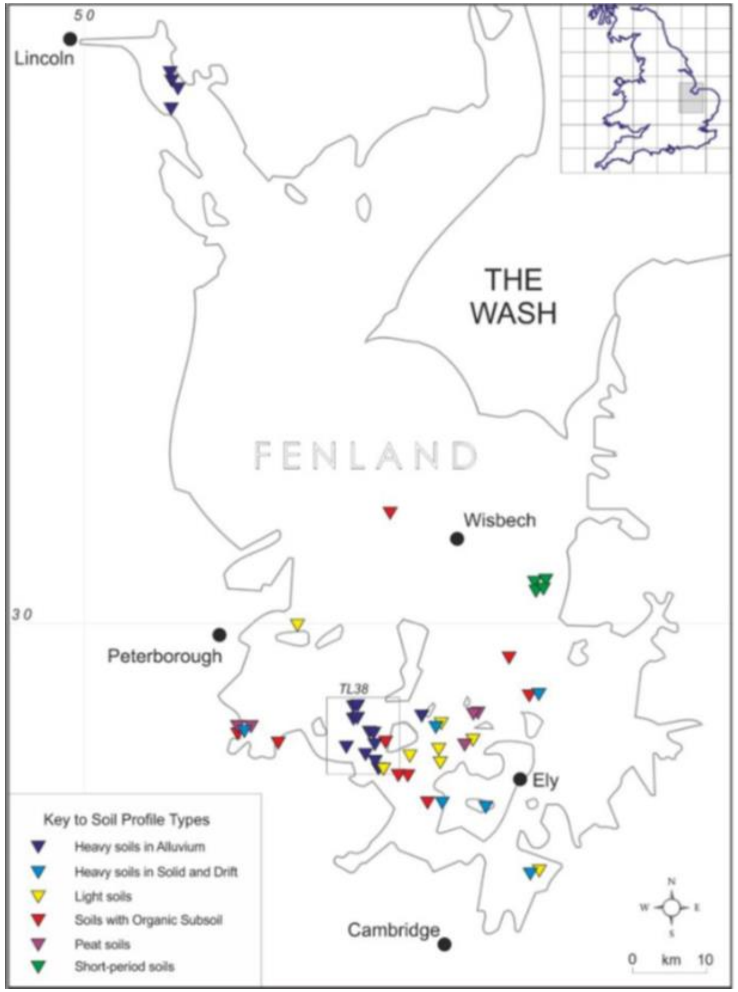
UK Centre Ecology &

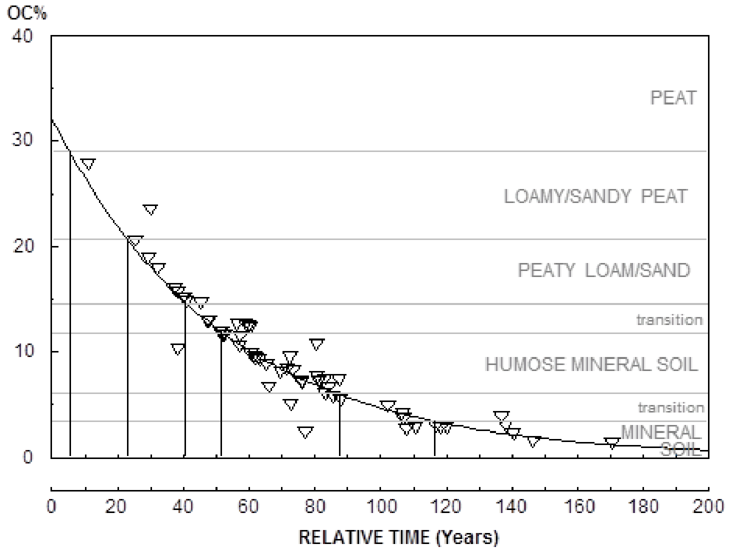
Emissions from Wasted Peat



- Shallow wasted peat (skirt soils) *may* emit less CO_2 than remaining deep peat
- But data from Germany suggest that as the organic content of the peat declines, decomposition rates speed up, so CO_2 emissions *could* stay high until the peat is lost
- Answering this question will help us to correctly estimate total UK peat emissions, prioritise protection and restoration measures to maximise emission reductions, and minimise impacts on food production

Emissions from Wasted Peat





- 50 skirt soil sites around the Fens were surveyed in the 1960s-70s, and again in the early 1990s
- Sites will be re-surveyed by the previous surveyor (Rodney Burton) to provide a > 60 year time series of measured peat loss
- If any of these sites are on your land, we would be keen to talk to you!

Source: Burton (1995)

Committee on Climate Change:
Scenarios for the 6th Carbon Budget

Measure / Scenario	"Net zero" report	"Government led"	"People led"	"Innovation led"
Indoor horticulture	10-50%	10%	Off peat	100%
Reduced meat consumption	20-50%	20%	50%	50% (lab meat)
Upland peat restoration	50-75%	75-100%?	75-100%?	75-100%?
Lowland peat full restoration (grassland)	25-50%	?	?	?
Lowland peat full restoration (cropland)	25-50%	?	?	?
Lowland peat paludiculture	0%	?	?	?
Lowland peat raised water levels	0%	?	?	?
Lowland peat seasonal high water levels	0%	?	?	?
Lowland peat cover crops	0%	?	?	?

Thoughts?