Highlights from

AN ILLUSTRATED BOOK OF PEAT

THE LIFE AND DEATH OF BOGS: A NEW SYNTHESIS

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The Moss of Achnacree

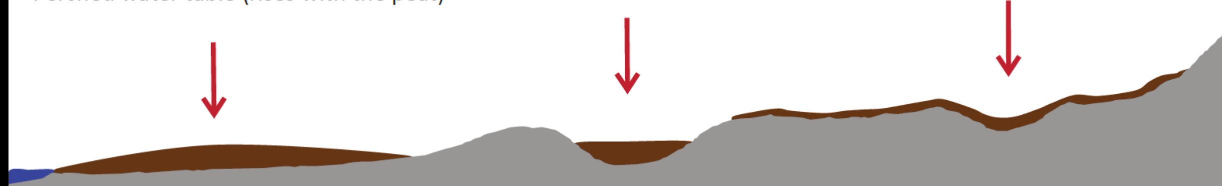
The simplified classification used here

The book discusses the dynamics of temperate ombrotrophic peatlands (raised & blanket bogs)

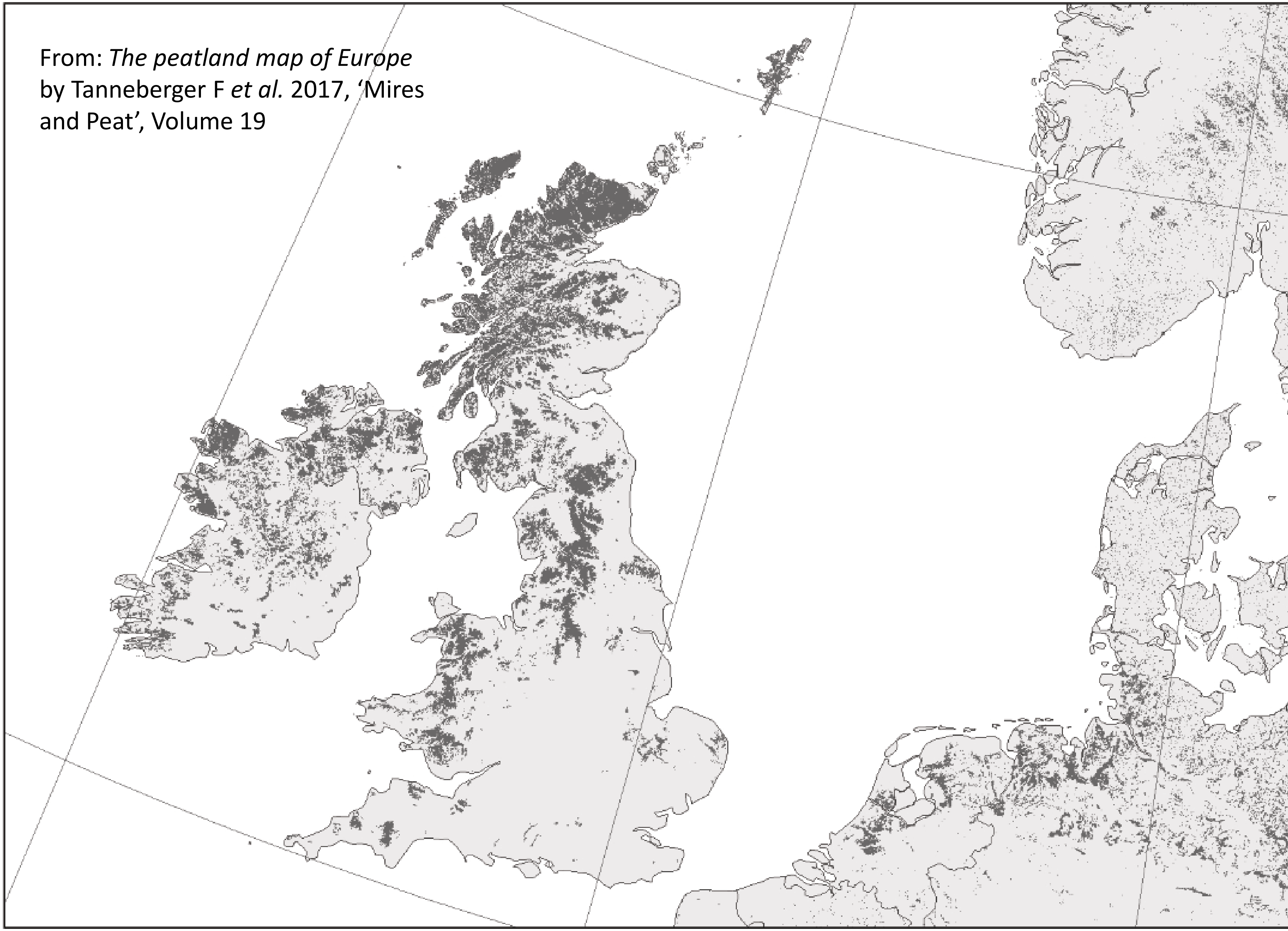
RAISED BOGS
– Originate on level ground
– Centre of bog higher than edges
– **OMBROTROPHIC: Water & minerals from rainfall only**
– Perched water table (rises with the peat)

VALLEY BOGS
– In hollows & valleys
– **RHEOTROPHIC** (mesotrophic): **Water enters from surrounding land, bringing in minerals**

BLANKET BOGS
– Blankets the landscape
– **OMBROTROPHIC: Water & minerals from rainfall only**
– Perched water table



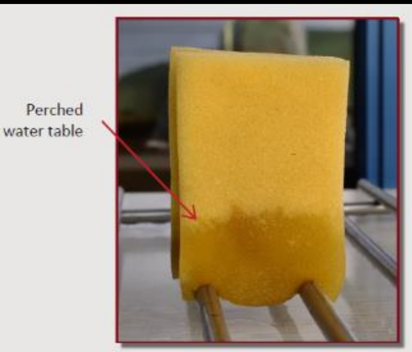
The Flow Country of Scotland: a landscape of peat



Distribution of peat in Britain & Ireland

1. Why ombrotrophic peat forms (capillary action greater than gravitational drainage)

The smaller the pore size, the higher water can rise [from Appendix A]



2. Water is absorbed by the paper and rises upwards (the 'wick effect')

3a. If the toilet roll is first compressed, so that the pore size is smaller, then the whole thickness becomes saturated

Water is held in place and does not drain out

CATOTELM EQUIVALENT

Saturation of the compressed toilet roll is demonstrated by squeezing the paper, causing water to ooze out

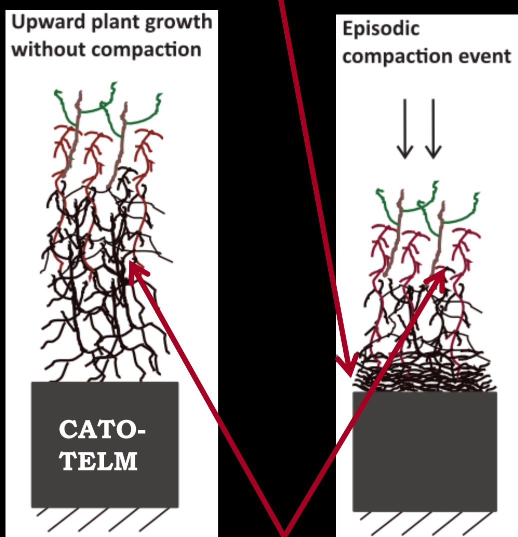
Water poured onto the surface does not flow through the saturated compressed layers, but over the surface

Water is held in place by capillary action & does not drain out

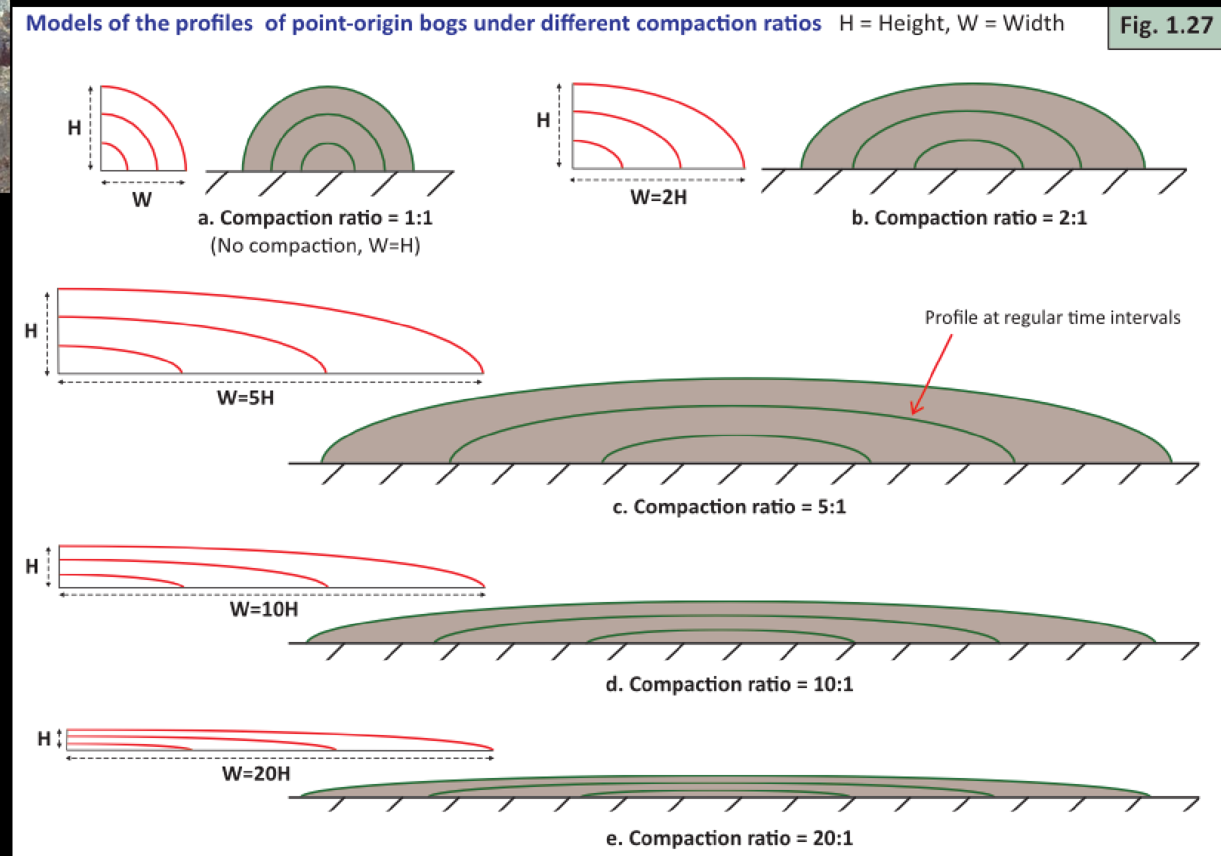
2. The sudden transition from acrotelm to catotelm, and the importance of compaction ratios [from Part 1]

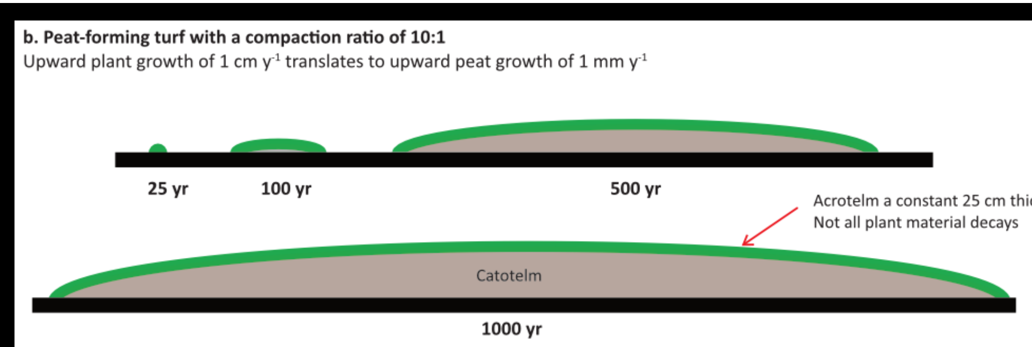
The ratio between upward plant growth and upward peat growth

Compaction zone

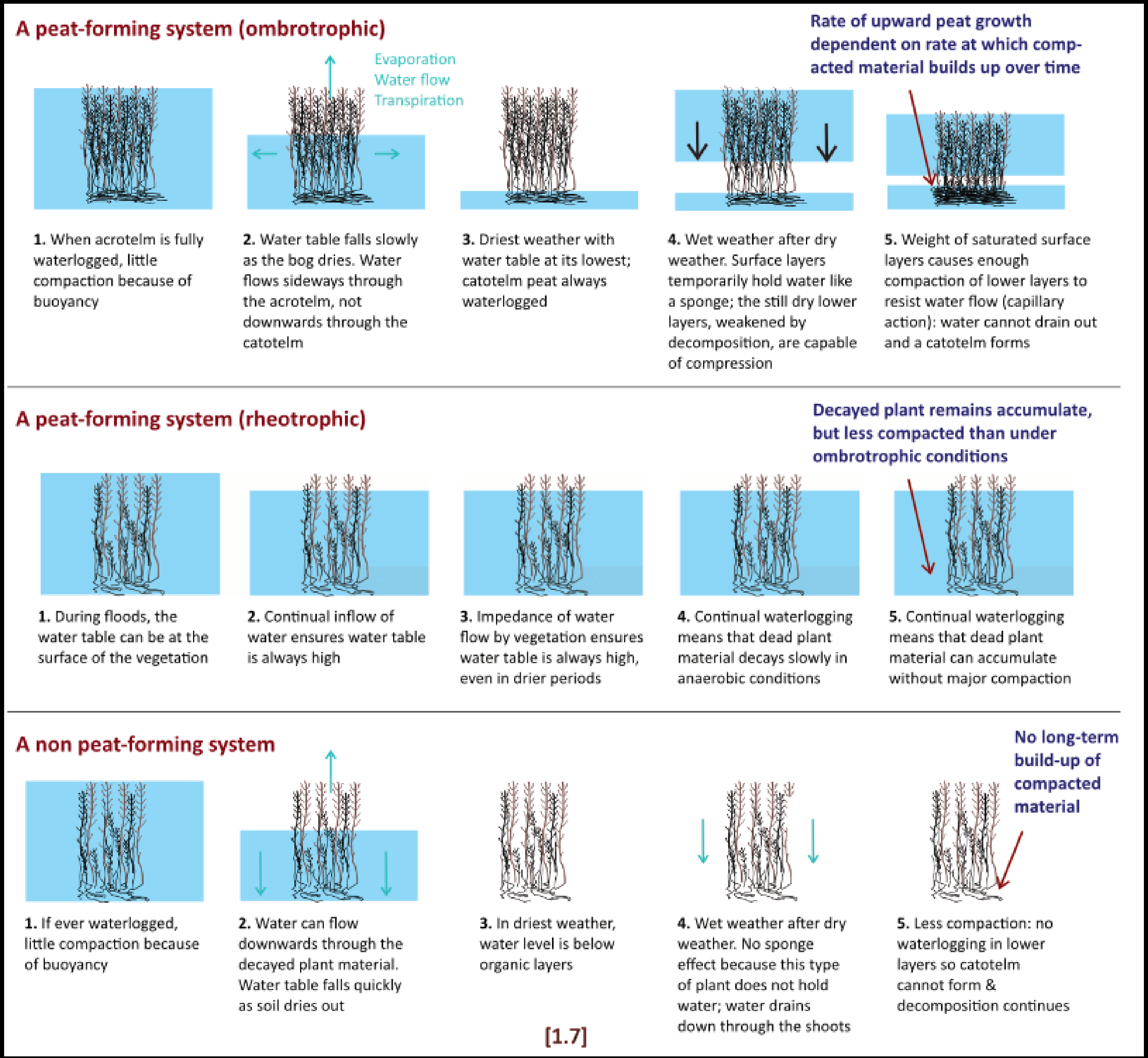


Uncompacted





3. The difference between peat formation in ombrotrophic and rheotrophic conditions [from Part 1]



OMBROTROPHIC peat can only form if enough compression for capillary action to hold water *in situ* permanently

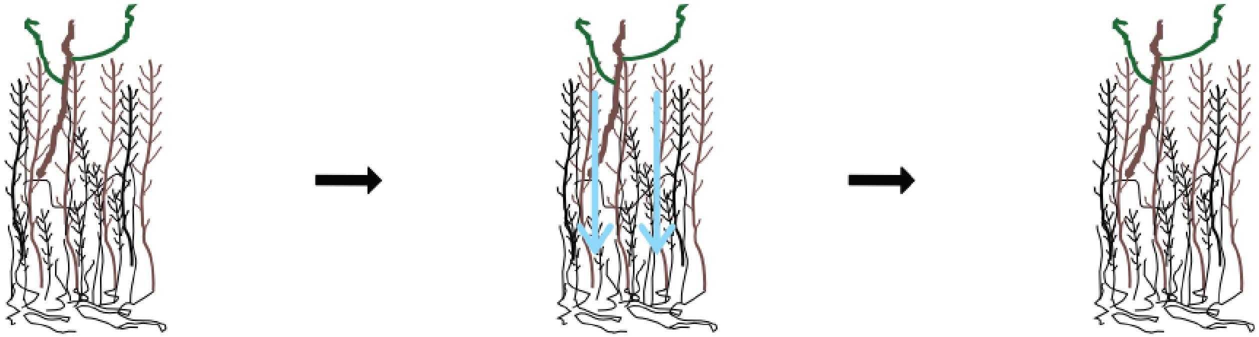
RHEOTROPHIC peat can accumulate at any density because not dependent on capillary action, but continual input of allocthonous water

In NON-PEAT-FORMING SYSTEMS, there is never enough compression for capillary action to prevent gravitational water drainage

4. Why Sphagnum assists peat formation, but is not essential [from Part 1]

***Sphagnum* is mostly absent in Falkland Island peatlands**

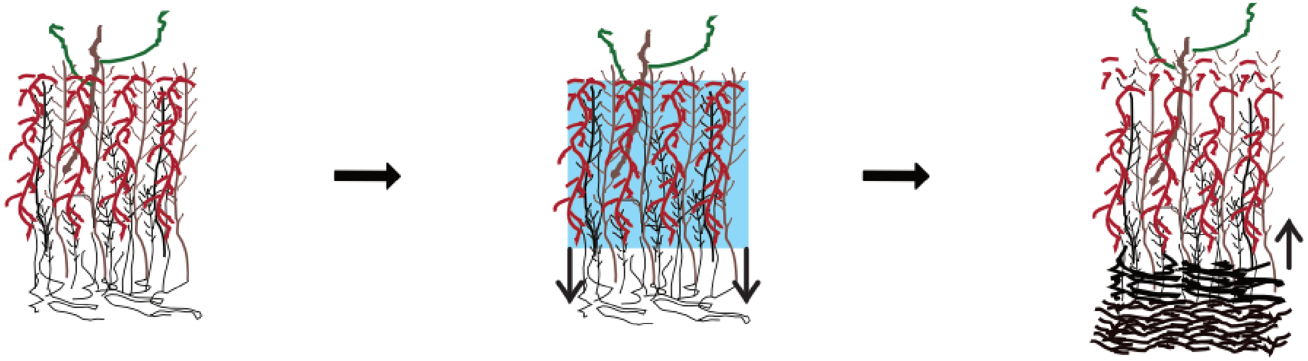
Illustration of why the presence of *Sphagnum* can instigate peat growth — Fig. 1.



1. Dry turf of non peat-forming plants

2. Rainfall easily percolates through the turf

3. No compaction from rainfall and no peat



1. Dry turf containing *Sphagnum*. As well as drainage and evaporation, lower layers can also lose water through root transpiration

2. After rain, water held by sponge-like nature of *Sphagnum*

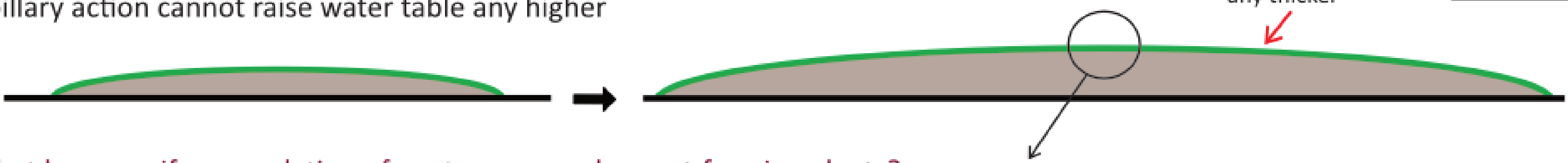
3. Weight of saturated surface layers causes compaction of lower, drier layers, allowing catotelm (peat) to form

5. A maximum depth attainable by ombrotrophic peat? [from Part 3]

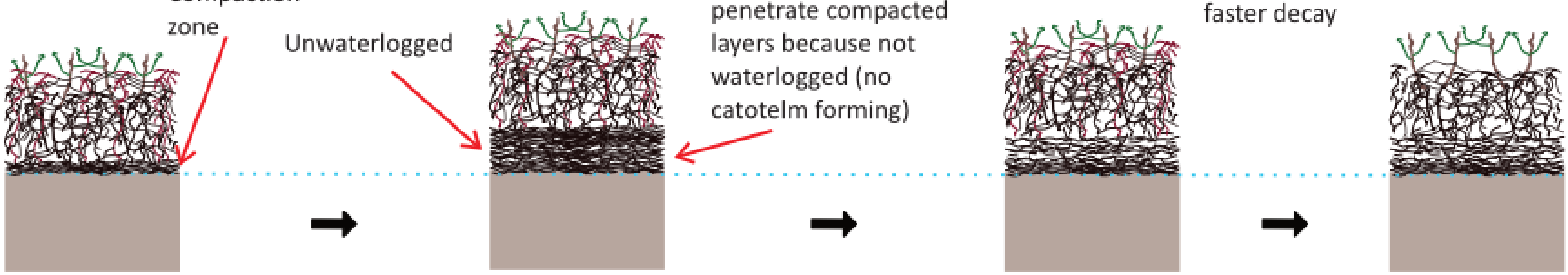
Fig. 3.18

A possible scenario: cessation of peat growth because maximum depth reached

Capillary action cannot raise water table any higher



What happens if accumulation of peat ceases under peat-forming plants?
The diagrams below are an attempt to understand what might occur



1. Catotelm reaches maximum thickness for capillary action to continue

Compaction zone can no longer become permanently waterlogged

2a. Acrotelm growth and compaction continues as before

Lower layers of unwaterlogged compacted decayed plants become thicker, with decay continuing

2b. Over time plant roots can penetrate deeper, especially dwarf shrubs, drying out lower layers through transpiration

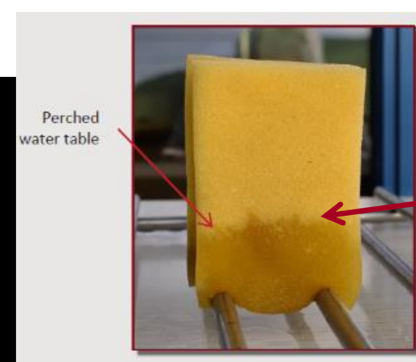
3. Lower layers decay faster because now drier

Catotelm remains stable because capillary action keeps it waterlogged

4. Plants characteristic of drier conditions now dominate

Acrotelm now equivalent to the humus of a podsol

Peat formation has ceased, but original catotelm remains



Max. height water can reach in this sponge

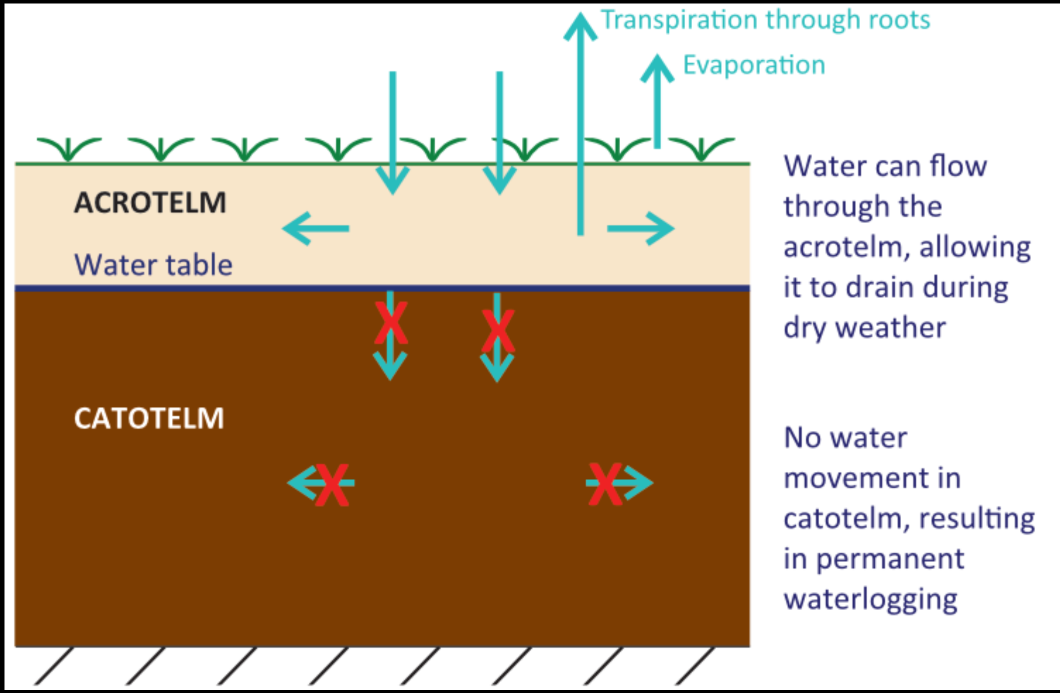
Max. height depends on pore size

Should not have over-high expectations for older peatlands as CARBON SEQUESTRATORS, although large CARBON STOREs

6. Why ombrotrophic peatlands are not good at flood mitigation [from Parts 1 & 4]

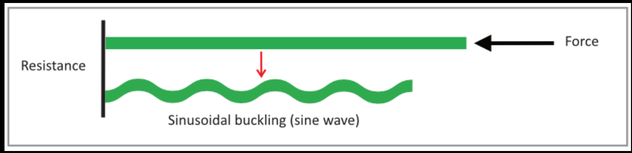
Water is held in place by capillary action & does not drain out

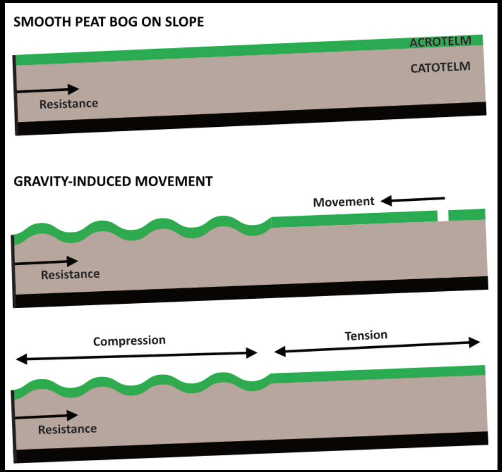
Only water held in the acrotelm can flow out; hence only this water can influence downstream flows



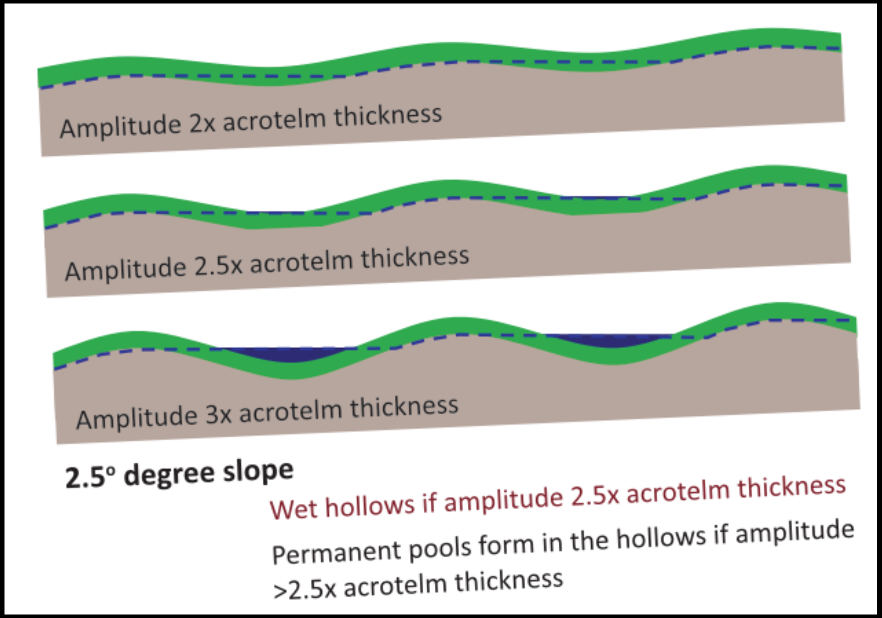
Two ditches, dug over 100 years ago, have only influenced the vegetation at the immediate edges, implying a minimal drainage effect

7. Why patterned bogs form (acrotelm movement over a stationary catotelm) [from Part 2]

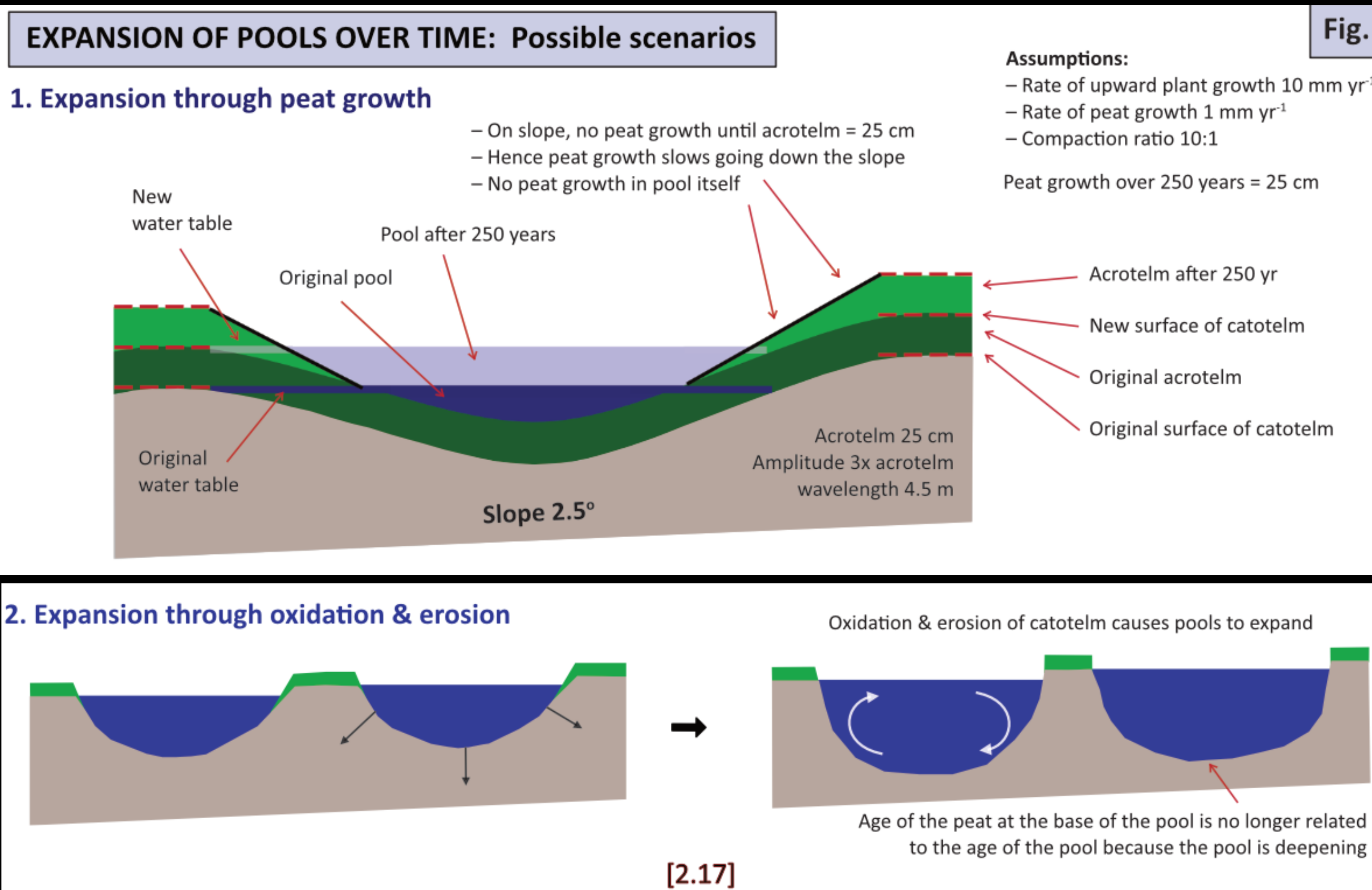




Pools form where surface of acrotelm pushed down below water table



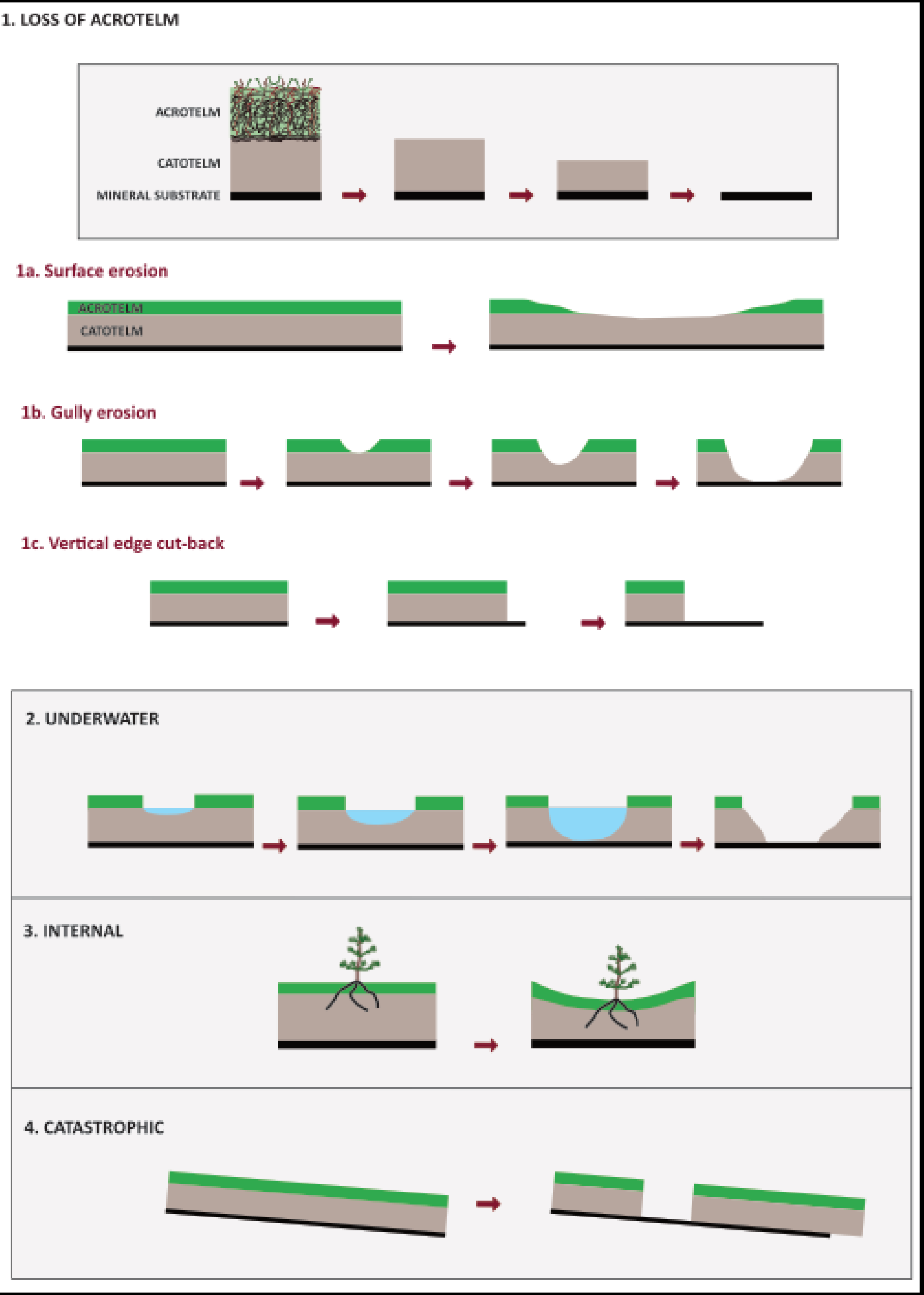
8. Pools as erosion features: pools expand and deepen over time [from Part 2]

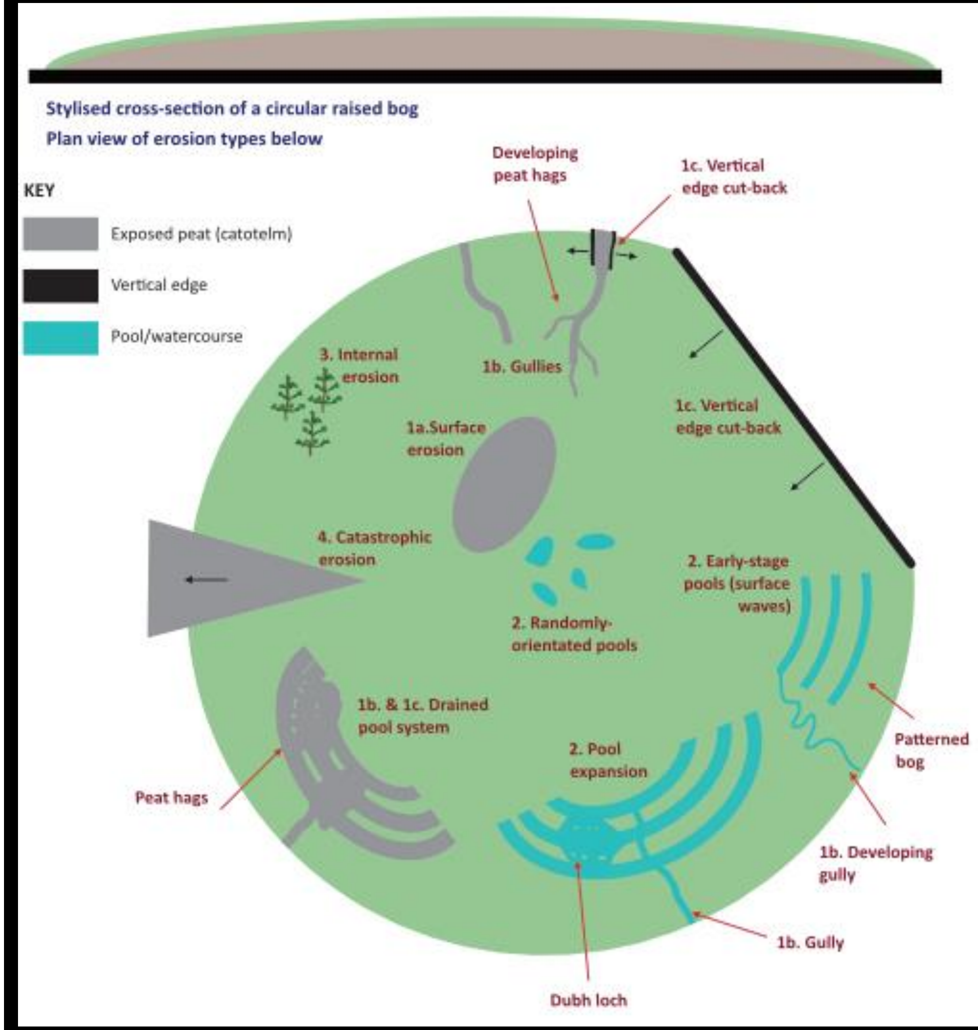


Peat growth continues on the ridges, and slows or ceases in the hollows, causing deepening over time

Once deep enough, wind/wave action and oxidation from water circulation take over as the main cause of expansion

9. A new classification of erosion into six basic types [from Part 3]





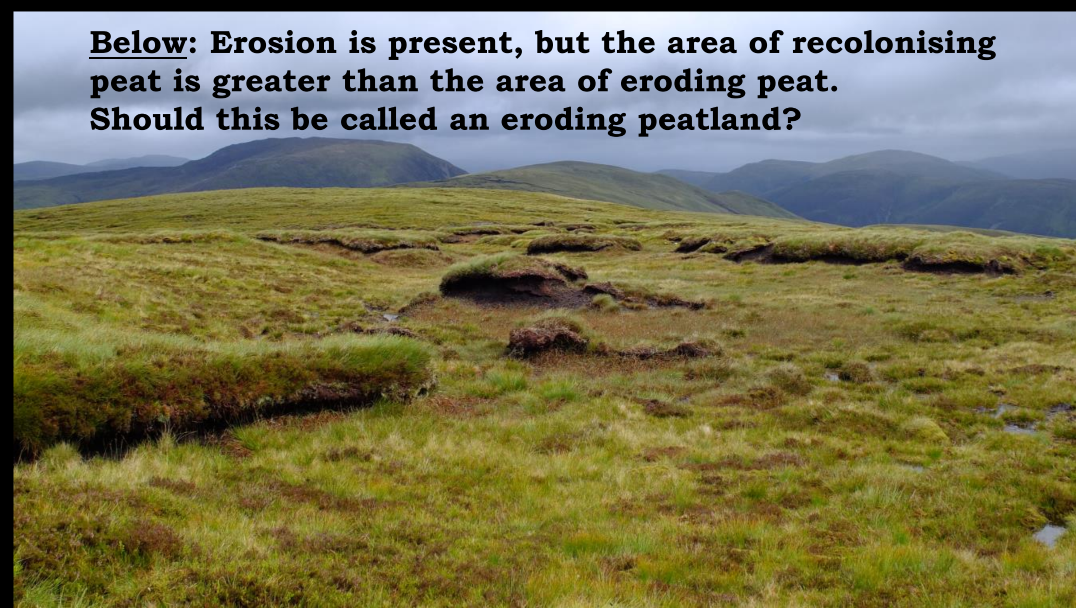
10. Erosion as both natural and anthropogenic; what is meant by an 'eroding peatland'? [from Part 3]

NATURAL EROSION:
<u>Left</u>: Surface erosion on Antarctic peat
<u>Right</u>: Naturally-drained pool system

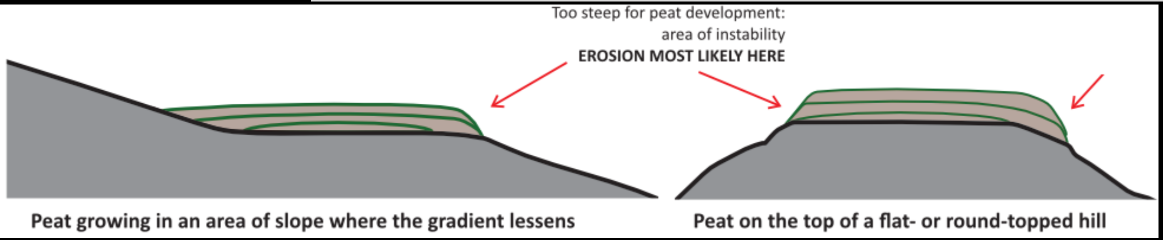
HUMAN-CAUSED EROSION:
<u>Left</u>: An eroding moor-grip
<u>Right</u>: Vehicle damage

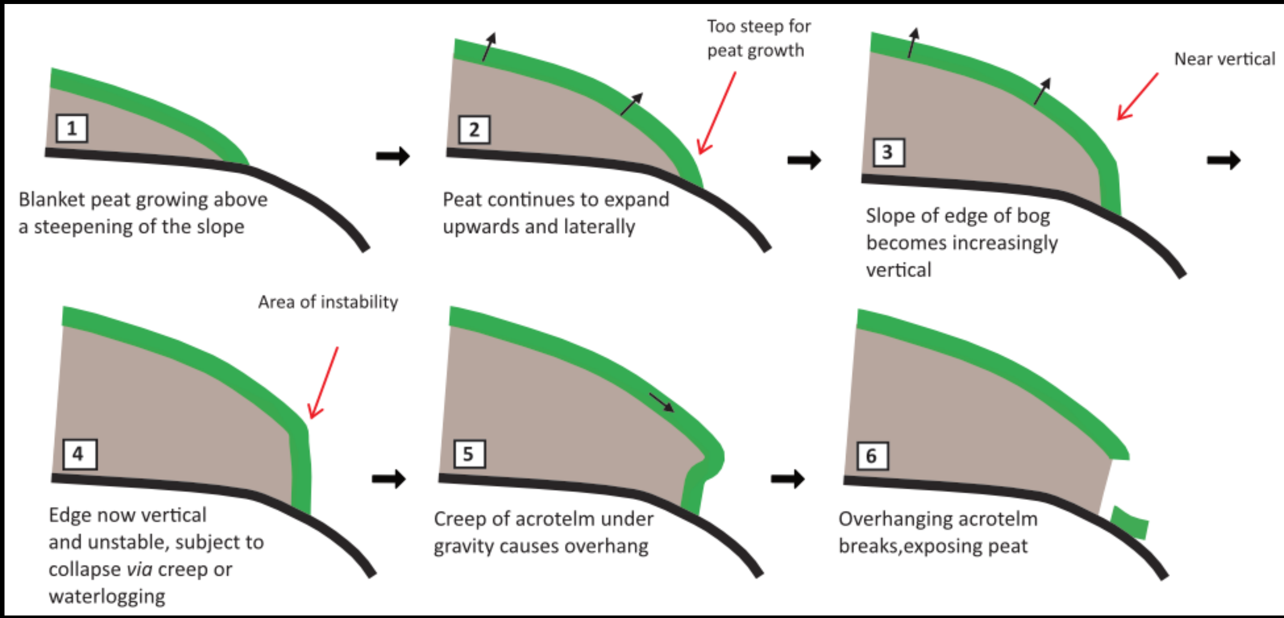
<u>Vertical edge cut-back</u>: in this case the area of exposed peat remains constant, with erosion backwards matched by recolonisation below

<u>Below</u>: Erosion is present, but the area of recolonising peat is greater than the area of eroding peat. Should this be called an eroding peatland?

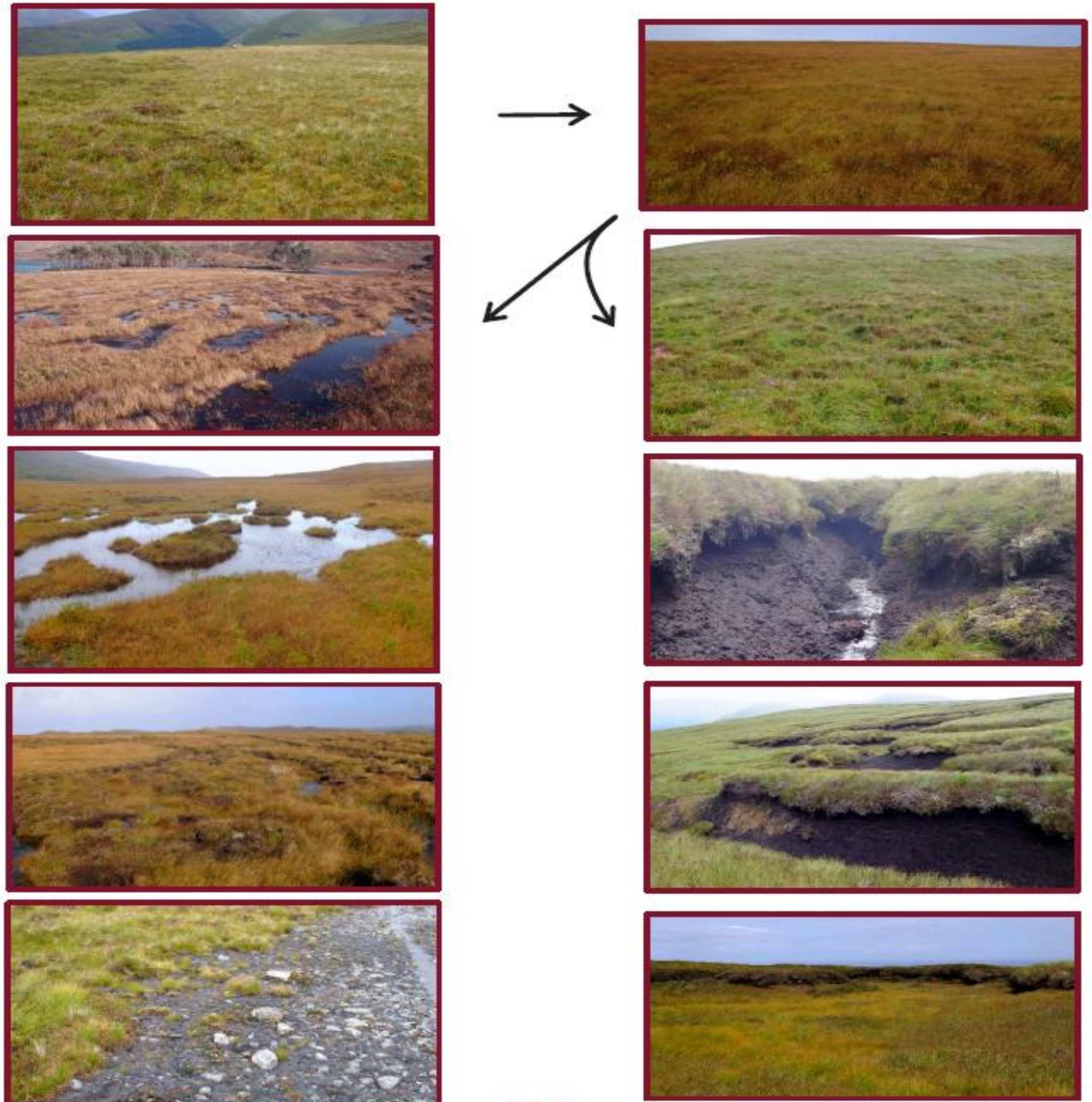


11. Vertical edges can form through downhill movement of the acrotelm over the catotelm [from Part 3]





12. Ombrotrophic peatland life cycle; all stages should be seen as equally important in <u>conservation</u> terms [from inside back cover]



1. Peat-forming plants colonise (here expanding left to right)

2. Smooth peatland expands to cover the whole landscape

3a. On gentle slopes pools are likely to form

3b. Peat continues to deepen on steeper slopes, with no pools

4a. Over time pools expand and coalesce

4b. The older the peat, the greater the probability of erosion setting in

5a. Pools drain, resulting in peat hags

5b. Erosion of first cycle peat continues

6a. Old peat erodes away, second cycle peat growth commences

6b. Second cycle peat starts to grow in once eroded areas

[4.2]

13. A maximum carbon storage potential for blanket peatlands? [from Part 4]

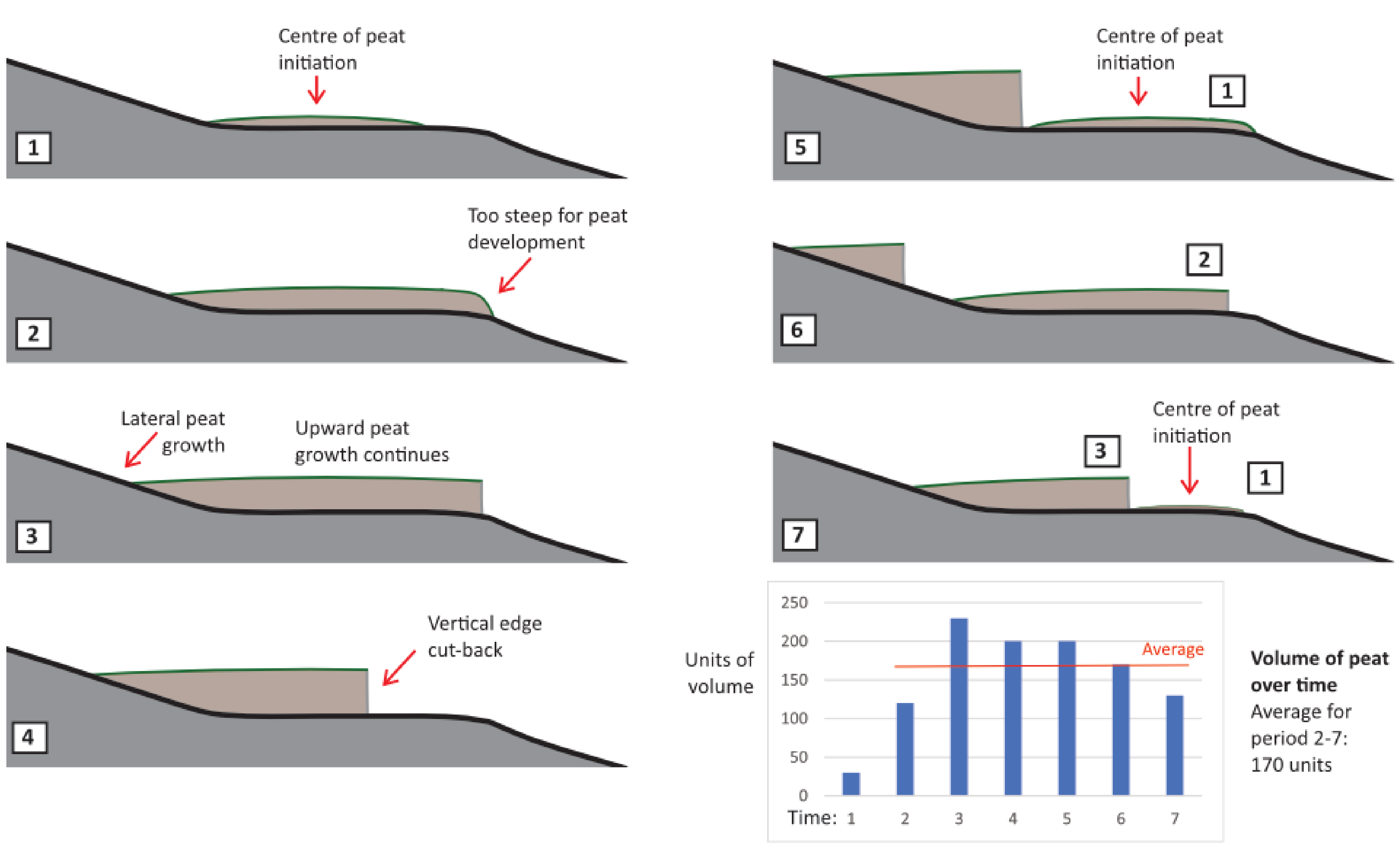
In long-established peat landscapes, further increase in peat depth may be impossible (capillary action no longer works);

And there may come a balance between growth and erosion

Long-term peat cycling: diagrammatic example of peat bog growth and erosion on a hill slope

Here modelled with the rate of vertical edge cut-back the same as the rate of the lateral growth of the peat

Fig. 4.8



Volume of peat over time
Average for period 2-7: 170 units

14. Proxy measures of carbon sequestration [from Part 4]

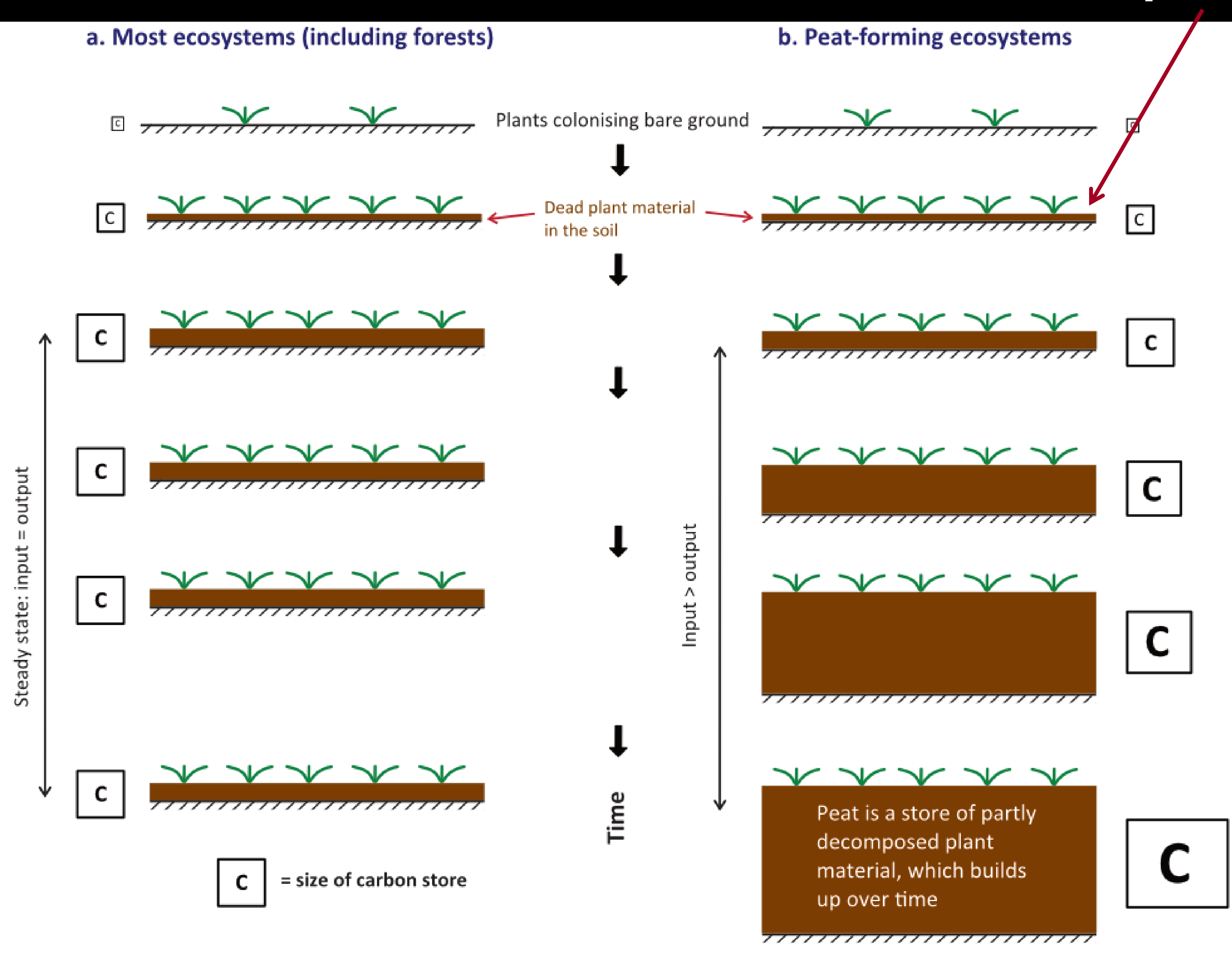
Scenario	Carbon balance	Example
Uniform, smooth surface of continuous vegetation without pools, hummocks, hollows or exposed peat	Positive	
Diverse short vegetation with short numerous lichens and often small unvegetated areas	Neutral, or possibly negative	
Diverse short vegetation with numerous lichens and often small unvegetated areas – with eroded locations	Negative	
Area of exposed catotelm less than area of vegetated active peat	Positive	
Area of exposed catotelm exceeds area of vegetated active peat	Negative	
Pools present, but surface area less than area of peat-forming vegetation	Assumed positive	
Pools present, but surface area greater than area of peat-forming vegetation	Assumed negative	
Colonising trees present	Could become negative in the long-term	

Ideally this should be assessed at the landscape scale, because in adjacent localities a given bog can be growing and eroding

15. Shallow peat best for long-term carbon storage: trees should not be planted on it [from Parts 1 & 4]

Choice of any particular depth is arbitrary

Best long-term potential for carbon sequestration



16. Conflicts between peatland conservation and climate mitigation [from Part 4]

The late stage of a blanket bog, showing erosion of first cycle peat and start of second cycle peat

From a NATURE CONSERVATION perspective, it should be left to develop naturally, including the acceptance of erosion

From a CLIMATE CHANGE perspective, it may be best to reprofile & revegetate the eroding edges, accepting a loss of naturalness

Where erosion is definitively anthropogenic, there is a case for restoration. Where natural (a common situation in Scotland), then should we be interfering in natural processes in an area which is a world centre of blanket peat?

17. A calculator for assessing carbon balance, using an Excel spreadsheet [from Appendix G]

	A	B	C	D	E	F
1	ESTIMATING THE CARBON BUDGETS OF PEATLANDS					
2	Input the measurements in red. Default figures: Bulk density 0.13 g cm^{-3}; Organic matter 95%; Carbon 55%	Extent of peat (ha)	Rate of peat growth (mm yr^{-1})	or Rate of peat growth (g dry wt/m^2/yr)	Erosion: area exposed surface peat (m^2)	Erosion: length exposed vertical peat (m)
3	Input value in units as in header row	Area of bog	Annual depth increase	Annual weight gain	Area exposed surface peat	Length of exposed vertical edge
4	Rate of erosion (mm depth lost yr^{-1})	X	X	X	Annual depth loss	Annual rate of cut-back
5	Depth of peat (m)	Av. depth of peat	X	X	X	Height of vertical edge
6	Volume of wet peat (m^3)	*Calculated automatically*	*Calculated automatically*	X	*Calculated automatically*	*Calculated automatically*
7	Dry bulk density (g cm^{-3})	0.13 = Default	0.13 = Default	X	0.13 = Default	0.13 = Default
8	Dry weight peat (t)	*Calculated automatically*	*Calculated automatically*	*Calculated automatically*	*Calculated automatically*	*Calculated automatically*
9	Organic matter content (%)	95 = Default	95 = Default	95 = Default	95 = Default	95 = Default
10	Dry weight organic matter (t)	*Calculated automatically*	*Calculated automatically*	*Calculated automatically*	*Calculated automatically*	*Calculated automatically*
11	% carbon	55 = Default	55 = Default	55 = Default	55 = Default	55 = Default
12	Amount of carbon gain/loss (t yr^{-1})	X	*Calculated automatically*	*Calculated automatically*	*Calculated automatically*	*Calculated automatically*
13	Total carbon store (tonnes)	*Calculated automatically*	*Use only one of these two columns; ignore figure below in unused column*		X	X
14	Net carbon balance (growth minus erosion) (t yr^{-1}) *assumes all eroded peat lost to the system*	X	*Calculated automatically*	*Calculated automatically*	X	X

Can be used to estimate impact of eroded areas on carbon sequestration

It also includes a calculator for estimating the carbon stored in a commercial forest.

This indicates that 12cm of peat can store as much as a commercial forest

Estimating the carbon balance of peatlands is not an exact science

You need to know both the rate of peat accumulation at the landscape scale and the rate of erosion (if present), neither of which is certain for most locations

ESTIMATING THE CARBON BUDGETS OF PEATLANDS	
Input the measurements in red. Default figures: Bulk density 0.13 g cm^{-3}; Organic matter 95%; Carbon 55%	Extent of peat (ha)
Input value in units as in header row	1.00
Rate of erosion (mm depth lost yr^{-1})	X
Depth of peat (m)	0.12
Dry bulk density (g cm^{-3})	0.13
Organic matter content (%)	95
Dry weight organic matter (t)	148
% carbon	55
Amount of carbon gain/loss (t yr^{-1})	X
Total carbon store (tonnes)	82

Note that the peat depth figures are for the catotelm only. The additional carbon in the acrotelm is not included

ESTIMATING THE CARBON BUDGETS OF COMMERCIAL WOODLANDS	
Input the measurements in red. Default figures for Sitka spruce *Picea sitchensis*: Density dry wood 0.35 g cm^{-3}; Biomass Expansion Factor 1.4; Carbon 46%	
Yield class (m^3 green wood ha^{-1} yr^{-1})	12
Density dry timber (g cm^{-3})	0.35
Length of rotation (yr)	60
Biomass Expansion Factor (BEF): *the additional biomass in roots, leaves & branches* (proportion to multiply)	1.4
% carbon	46
Average carbon standing crop (t ha^{-1})	81
Average amount carbon fixed *per* year (t ha^{-1})	1
Total area of woodland (ha)	1
Average total carbon store (tonnes)	81

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James H C Fenton

Publication supported by

Royal Scottish Geographical Society

VOLUME ONE
Summary
Part 1. Instigation and growth
Part 2. Development of pool systems
Part 3. Peat erosion
Part 4. Implications for climate change and land use

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The focus of this book is temperate raised and blanket bogs, but also includes Antarctic moss peat. It is for both the specialist and non-specialist.

"The study of peatlands is critical for understanding changes in our climate as well as in our landscapes and ecosystems. Fenton's book presents an accessible introduction that will be of value to all with interests in peatlands."

Professor Peter Convey, Senior Terrestrial Ecologist, British Antarctic Survey

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CONTENTS

The carbon calculator in Appendix G can be used to estimate the carbon stored in peatland, the impact of erosion on carbon balance, and the comparison between the carbon sequestration potential of peatland and woodland