‘The Meres of Dead Faces’ - Does this Peatland meet government approval?

Introduction to Peatlands-- or everything you need to know for determining reclamation success in peatlands

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Peatlands Workshop, Peace River, AB

Disturbance in Alberta's boreal forest

Lets define the term ‘peatland’

A peatland is an area covered by peat to a minimal depth of 40 cm. Or another definition is:

An area with or without vegetation with a naturally accumulated peat layer at the surface.

Functionally, peatlands are ecosystems wherein plant production exceeds decomposition that over the long term accumulate organic matter as a deposit of peat.

Lets consider an alternative term: Mire

- A mire is a wet area dominated by living, peat-forming plants.

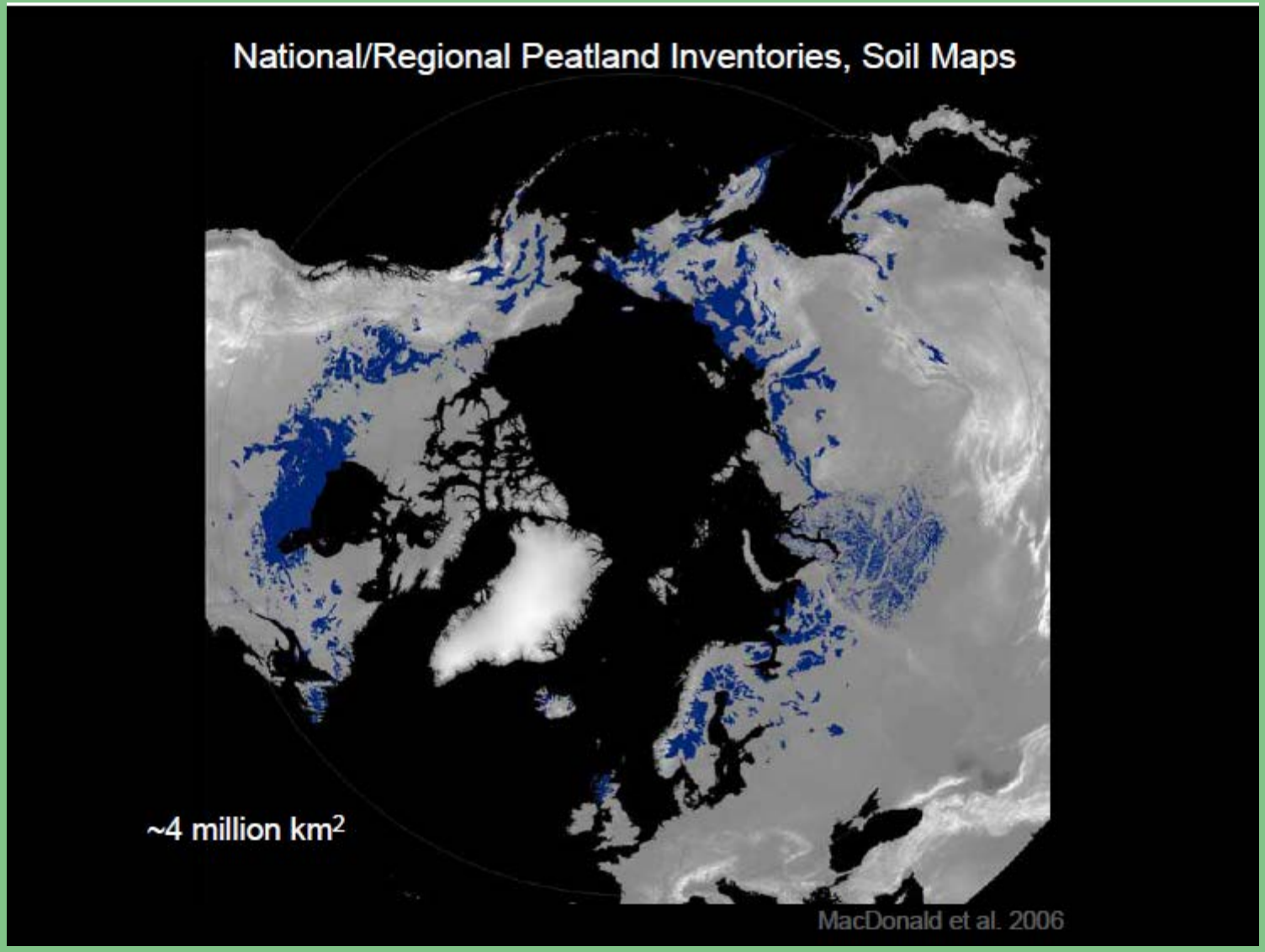
- Fens and Bogs are peatlands and also mires: Reclaiming to mires takes 3-4 years, reclaiming to peatlands takes longer.

Peatlands: Why do we care?

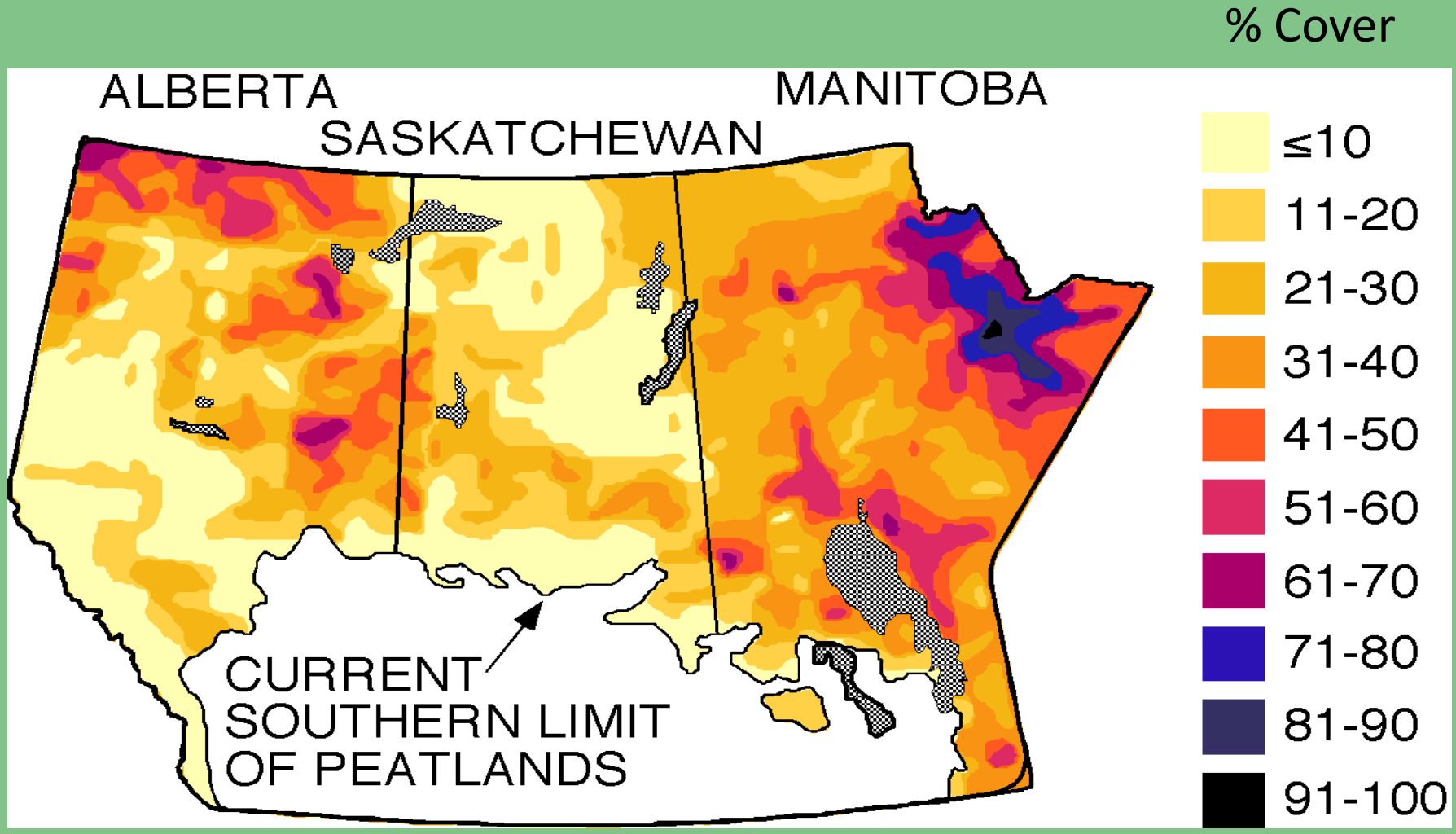
- Abundant on the Alberta landscape
- Carbon/nitrogen stores
- Habitat for rare and endangered species
- Sensitive to disturbances
- Priority areas for First Nations Peoples
- Natural environmental filters

Important??

- In Britain, 45% of public water comes from watersheds draining peatlands.
- Historically, peat was used as litter for cavalry: One of Napoleon's armies had 13,500 horses and needed 22,000 tonnes of peat in a year.
- Surgical dressings were made from *Sphagnum* in the Franco-Prussian War; by the Japanese in the 1904-05 war with Russia; and in World War I by both sides.
- And of course the peaty flavor of Scotch whisky is imparted by slowly drying 'green malt' over a smoldering peat fire.


National/Regional Peatland Inventories, Soil Maps
~4 million km2
MacDonald et al. 2006

Peatland Distribution



Total peatland area = 365,160 km^2 or 21% land base

Vitt et al. (2000)

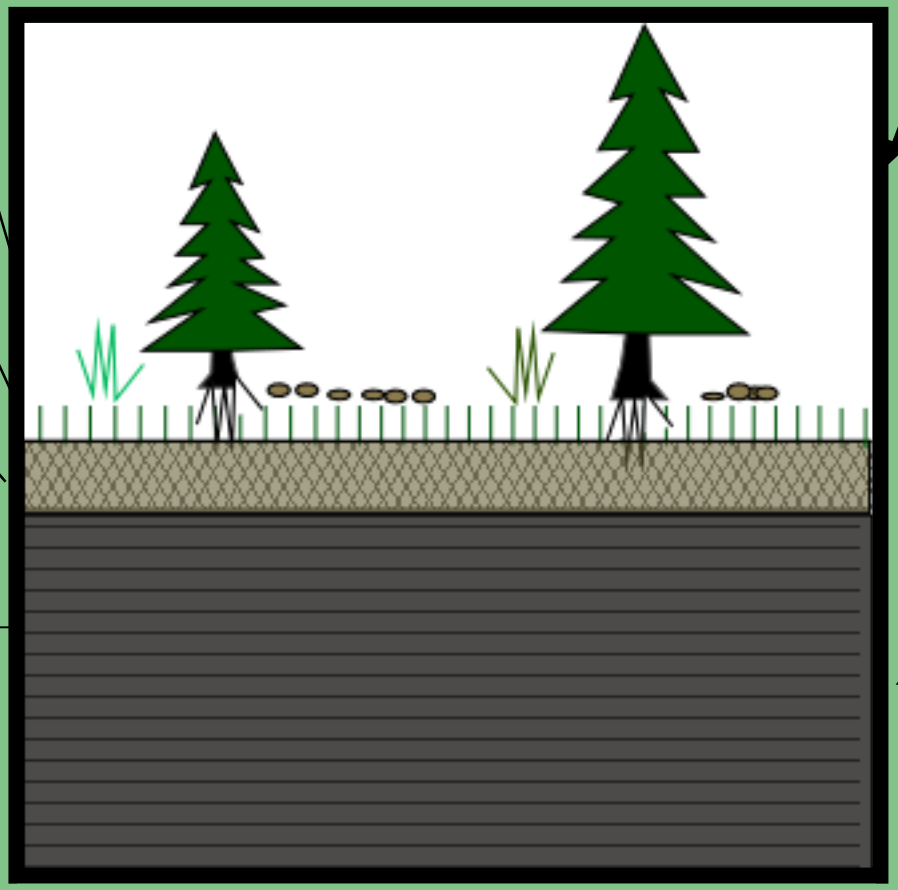
STRUCTURAL ELEMENTS

Trees
Shrubs
Herbs
Gramioids

Brown Mosses
Sphagnum

Roots:
Ectomycorrhizal
Ericoid
Non-infected

Moss and Peat
Roots



Above Ground Vascular Plant Production

Vascular Plant Litter Ground Layer Annual NPP

Acrotelm with Roots

Catotelm

What are the conditions for forming peat?

▪Acidity	but rich fens are not acid
▪Cold climate	but large peatlands in the tropics
▪Oceanic climate	but continental Siberia and Canada have large peatlands
▪Mosses	but some peatlands are dominated by woody or herbaceous plants
▪*Sphagnum*	but rich fens have little or none
▪Anaerobic conditions	TRUE for all peatlands

Anaerobic conditions

- Acrotelm – aerobic upper layer (surface to 50 cm)
- Catotelm – Anaerobic peat column (from 5-50 cm to bottom of peat column)
- Estimated that catotelm receives 5-10% of plant material after decomposition in acrotelm.

Peatland (Mire) Site-types

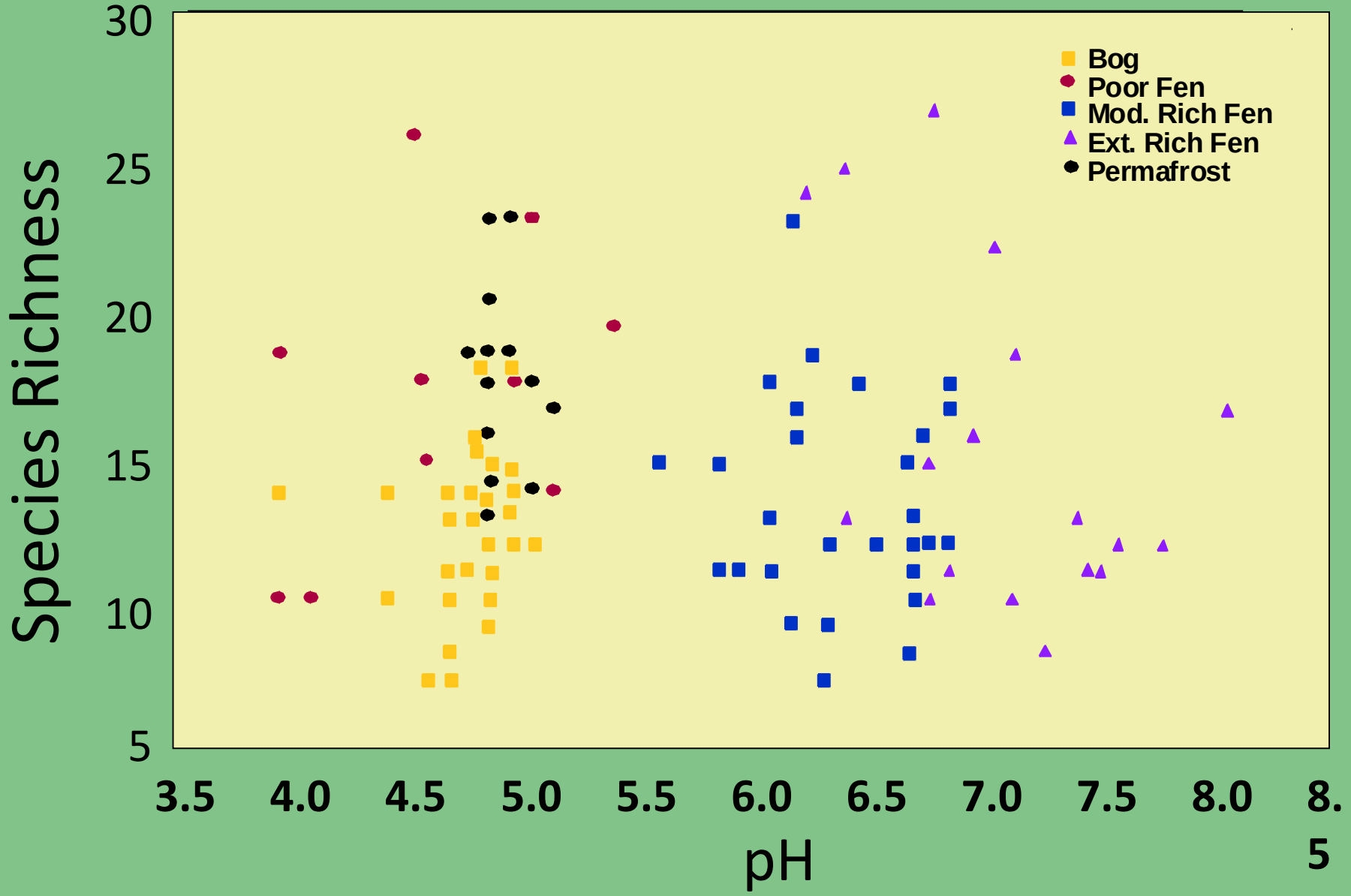
- Historically peatlands were divided into
  - Hochmoore (bogs) and Niedermoore (fens) by Weber in 1906.
  - Heinar DuRietz in the the 1940's observed that fens could be dominated by either *Sphagnum* or by true mosses. He called these poor fens and rich fens, but why????
  - Then Hugo Sjors, in the 1950's, related chemistry to flora – and further recognized two types of rich fens (moderate and extreme) – but why these words???

Since then people have thought:

Poor vs. Rich: could mean –

- Poor or rich in nutrients
- Poor or rich in base cations
- Poor or rich in species richness **
- But DuRietz and Sjors meant none of these things – they defined fens meaning poor and rich ‘in species with high fidelity’ to the fen type and secondly by chemistry (moderate vs. extreme).

Species richness



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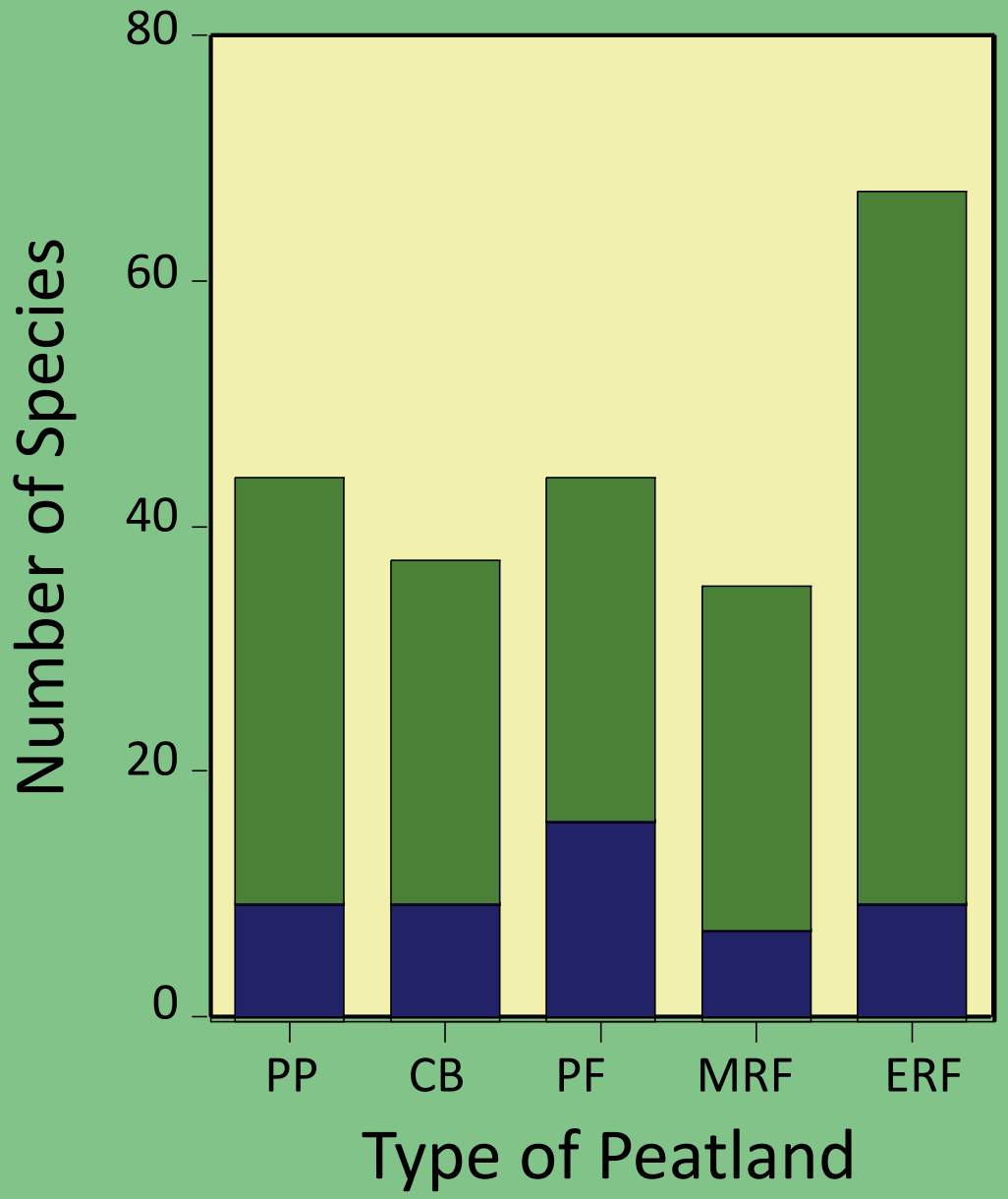
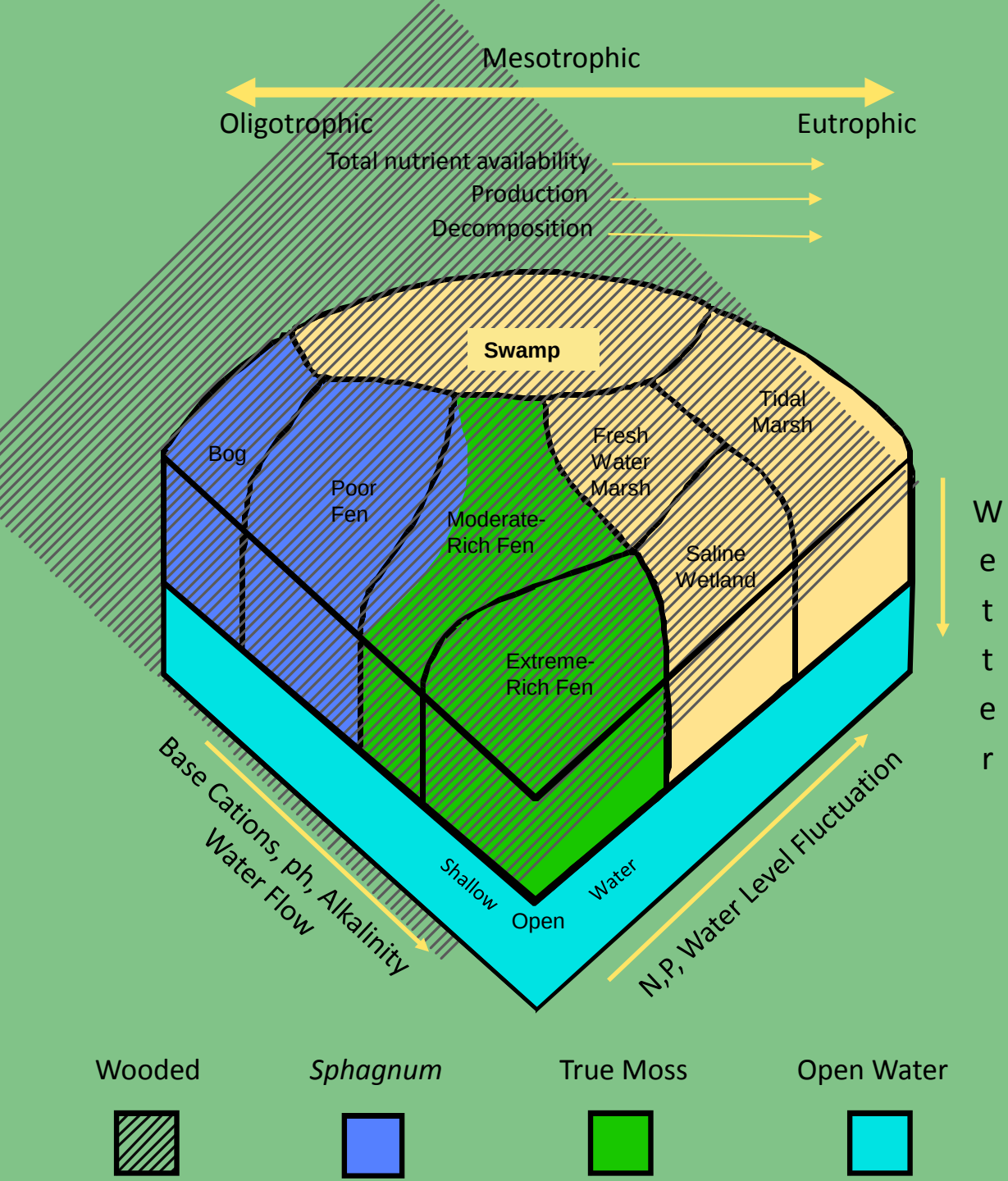
Peatland Gamma Diversity



Sphagnum
Total Species = 20

Bryophytes
Total Species = 110

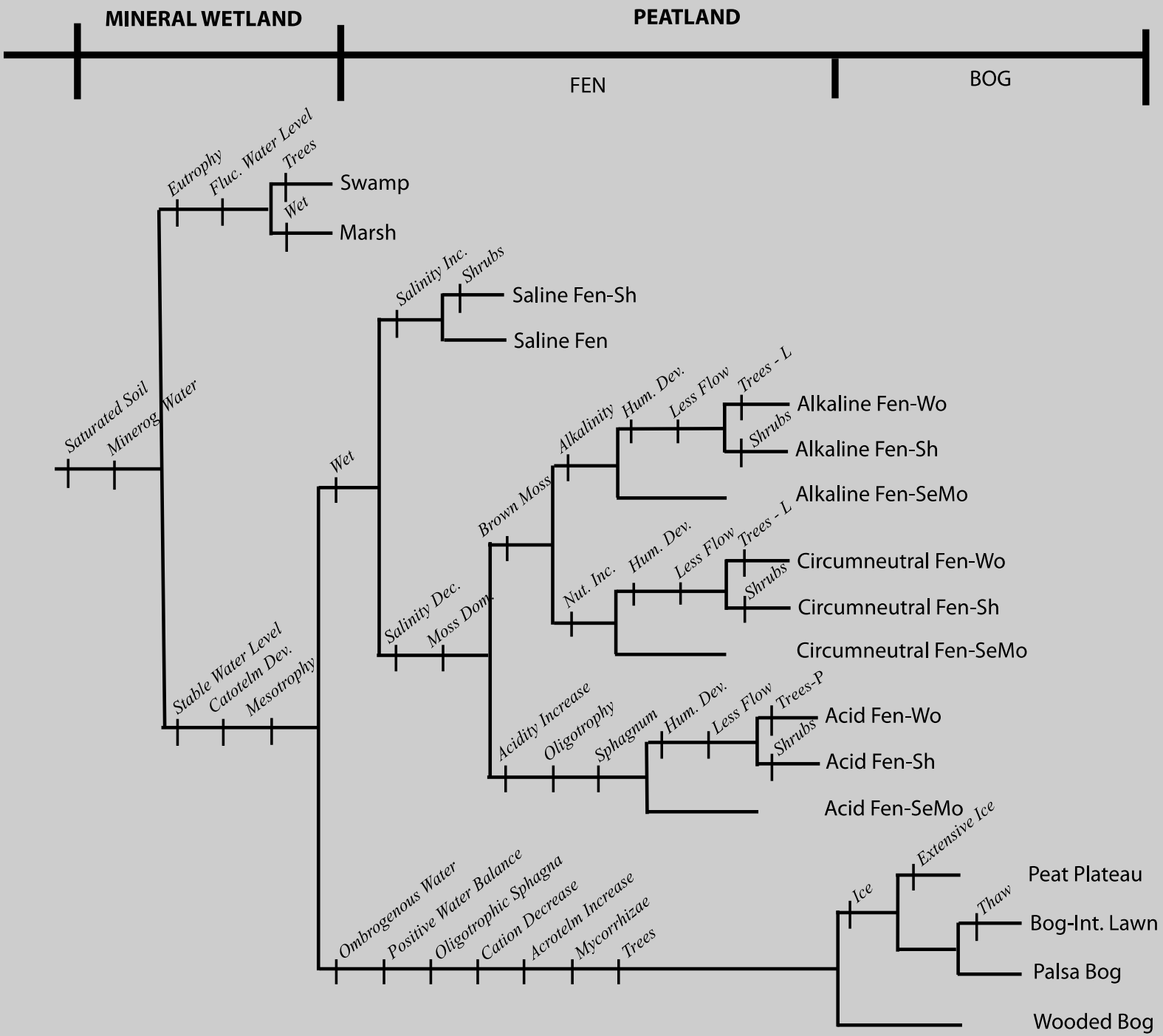
PP = Permafrost Peatland
n = 13
CB = Continental Bog
n = 35
PF = Poor Fen
n = 8
MRF = Moderate Rich Fen
n = 25
ERF = Extreme Rich Fen
n = 15



Functional Attributes of Wetlands

Wetland site-types:

- Bogs
  - Continental bogs
  - Peat plateaus
  - Bogs with internal lawns
- Fen
  - Poor fens (= acid fens)
  - Rich fens (= circumneutral and alkaline fens)
    - Moderate-rich fens (transitional-rich fens) = circumneutral fens
    - Extreme-rich fens (calcareous fens) = alkaline fens
- Saline wetlands
- Marshes
- Swamps
- Shallow open waters


MINERAL WETLAND
PEATLAND
FEN
BOG
Eutrophy
Fluc. Water Level
Trees
Wet
Swamp
Marsh
Saturated Soil
Minerog. Water
Salinity Inc.
Shrubs
Saline Fen-Sh
Saline Fen
Wet
Brown Moss
Alkalinity
Hum. Dev.
Less Flow
Trees - L
Shrubs
Alkaline Fen-Wo
Alkaline Fen-Sh
Alkaline Fen-SeMo
Salinity Dec.
Moss Dom.
Nut. Inc.
Hum. Dev.
Less Flow
Trees - L
Shrubs
Circumneutral Fen-Wo
Circumneutral Fen-Sh
Circumneutral Fen-SeMo
Stable Water Level
Catotelm Dev.
Mesotrophy
Acidity Increase
Oligotrophy
Sphagnum
Hum. Dev.
Less Flow
Trees-P
Shrubs
Acid Fen-Wo
Acid Fen-Sh
Acid Fen-SeMo
Ombrogenous Water
Positive Water Balance
Oligotrophic Sphagna
Cation Decrease
Acrotelm Increase
Mycorrhizae
Trees
Ice
Extensive Ice
Thaw
Peat Plateau
Bog-Int. Lawn
Palsa Bog
Wooded Bog

What are the ways we can determine what type of peatland one has?

- Basic criteria are inferred from:
  - Hydrology
  - Chemistry
  - Flora
  - Vegetation (Structure)

Hydrology:

- Source of water and trophic status
- Position on landscape
- Flow and patterning

Source of Water

- Minerogenous (Fens)
  - –Topogenous
  - –Soligenous
  - –Limnogenous
- Ombrogenous (Bogs)

Photos from Rose Bloise

Landscape Position

Landscape Position


Flow

Secondary Bog and water track development

Trophic Status:

Ombrotrophic vs. Minerotrophic

Nutrient Availability

Oligotrophic (bogs and poor fens)

Mesotrophic (rich fens) – peat-forming ecosystems

Eutrophic -- non-peat-forming wetlands


Oligotrophic - Bog


Mesotrophic – Alkaline Fen


Eutrophic - Marsh
Photo: Sara Koropchak

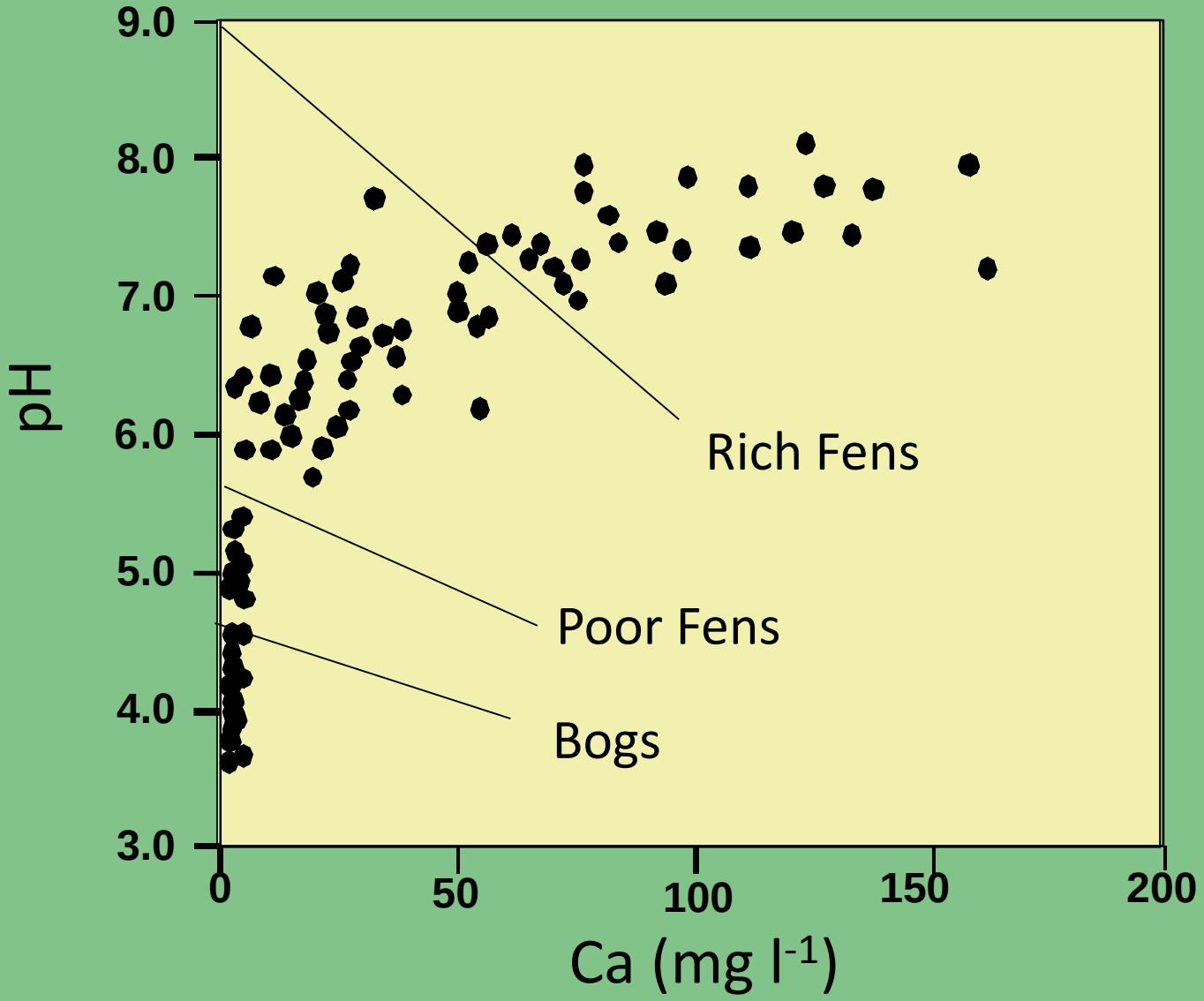
So, hydrology gives us two fundamental types of peatlands: Bogs and Fens.

Further separation is based on chemistry, flora, and vegetation.

Chemistry

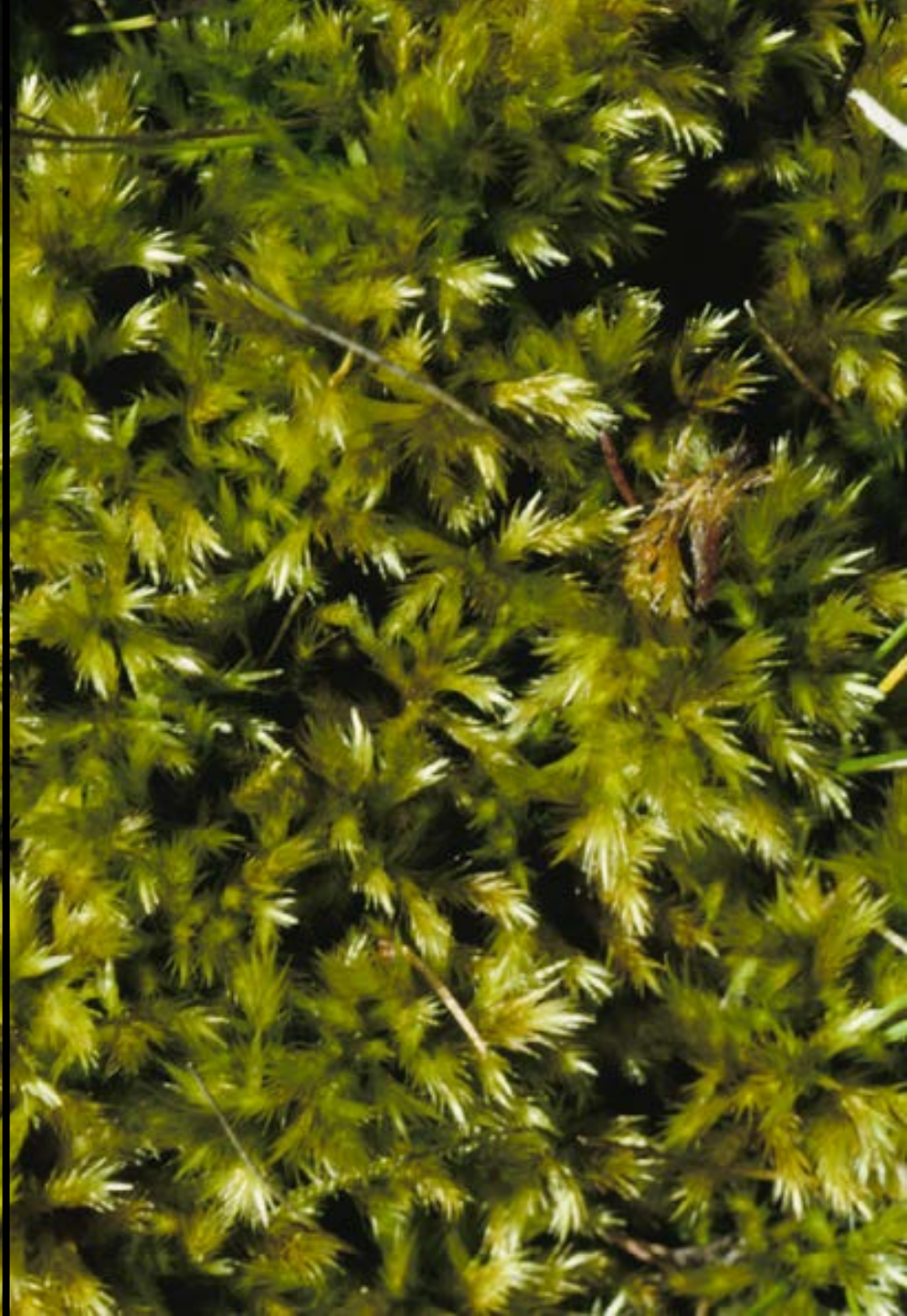
Acidity	H^+
Alkalinity	HCO_3^-
Base Cations	Na^+, K^+, Ca^{2+}, Mg^{2+}
Nutrients	N, P

Relationship of Calcium to pH in Peatland Surface Water

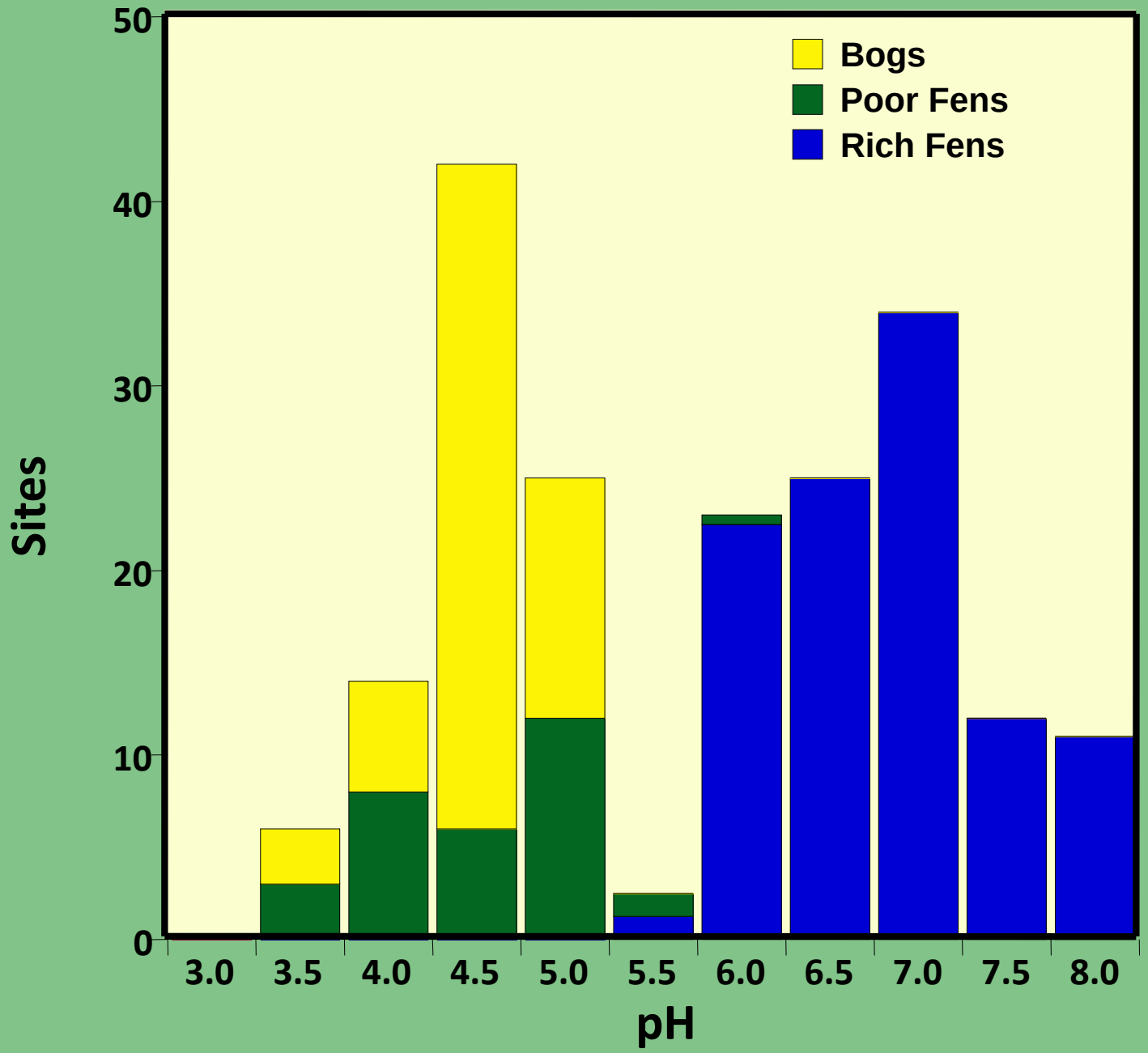


Flora:

Sphagnum vs. true mosses



The Importance of *Sphagnum*



The Importance of Mosses

- Sequester nearly all atmospheric deposition (N,P) – ‘”gatekeepers”
- Resistant to decomposition
- Maintain water levels
- Form the base topography of the site
- Form majority of the peat column
- *Sphagnum*: inorganic acidity

Identification made easy: Vitt, D.H. 2014. **A key and review of bryophytes common in North American peatlands. Evansia 31: 121-156.**

- Indicators: Species that have high fidelity to particular site types

  — Fens: “Bog Birch” [*Betula glandulosa*]

  — Rich (circumneutral and alkaline) Fen: True mosses, *Larix laricina*

  — Poor (acid) Fen: ‘wet’ *Sphagnum*, *Picea mariana*

  — Bog: Cloudberry [*Rubus chamaemorus],* *‘*hummock*’ Sphagnum [S. fuscum]* and lack of sedges

Vegetation: 4 layers

- Tree layer: single-stem woody plants
- Shrub layer: multiple-stemmed woody plants
- Field layer: herbaceous sedges/grasses
- Ground layer: bryophytes - pools / carpets / lawns / hummocks

Initiation

- Key to reclamation of disturbed sites is to base reclamation strategies on natural occurring events.

So how did peatlands in Alberta form in the past?

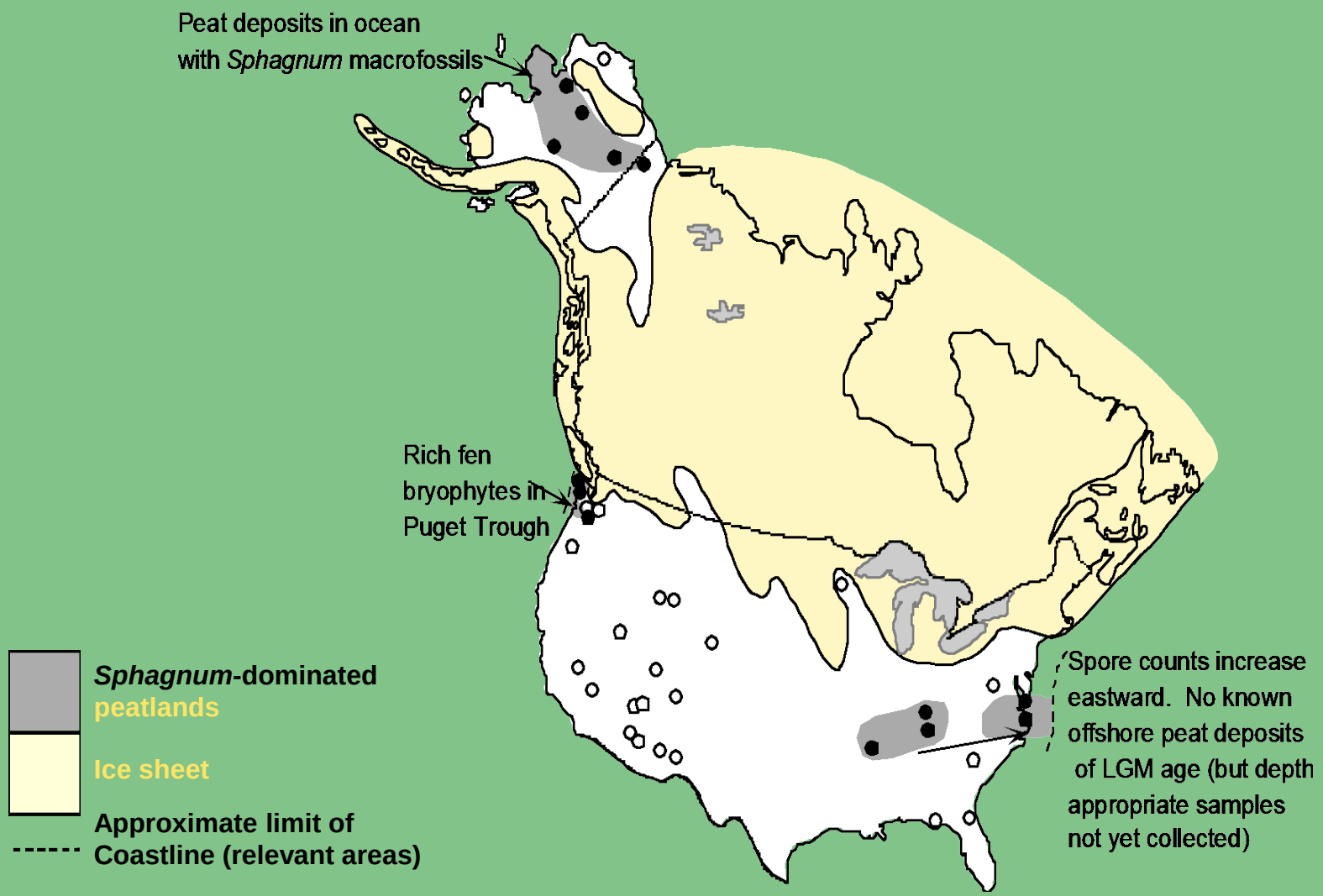
Initiation

Succession

Initiation

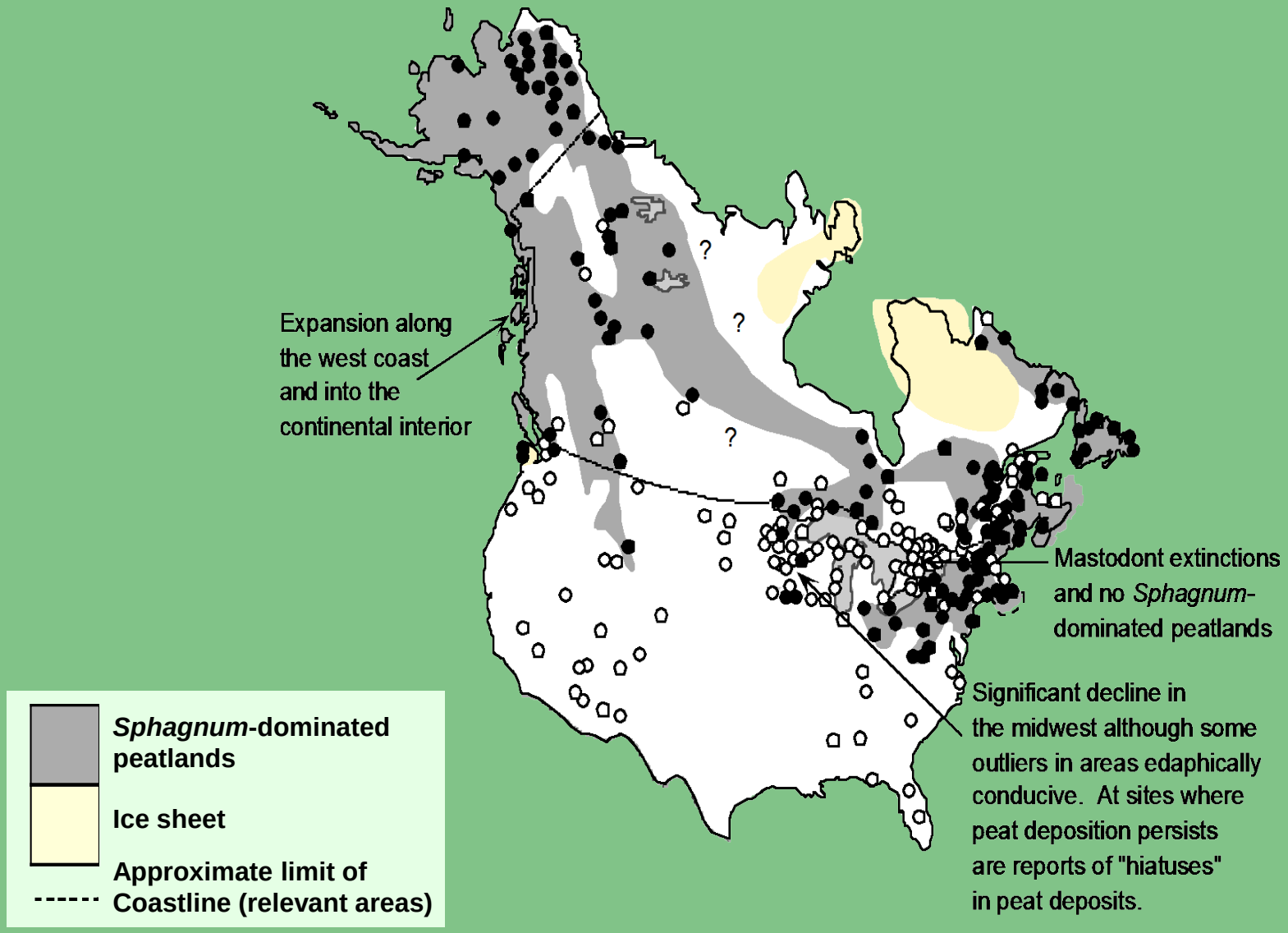
- Terrestrialization
- Paludification
- Primary Peat Formation

Distributions of *Sphagnum*-dominated Peatlands During the LGM (ca. 20-22 ka BP)



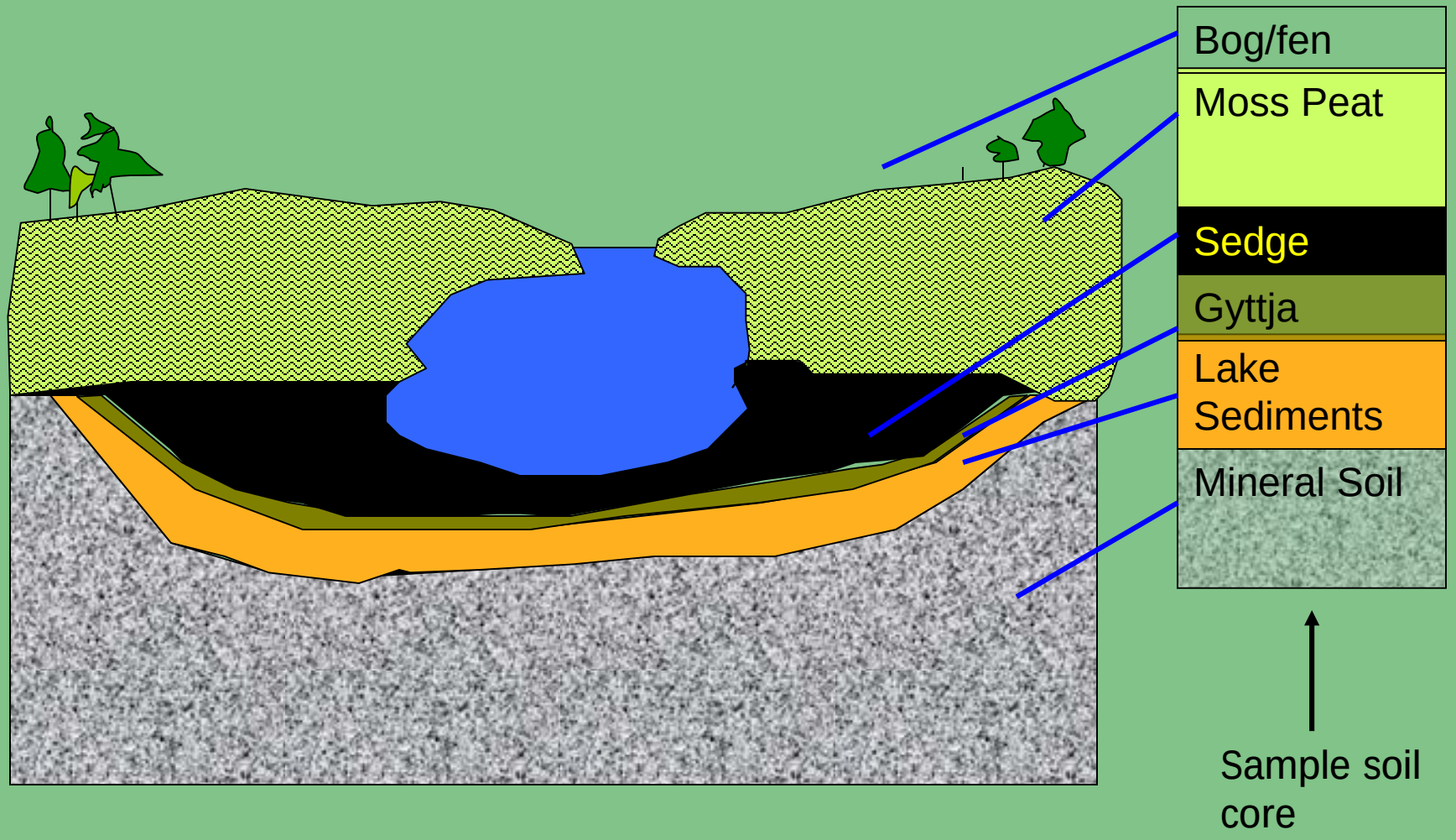
Halsey et al. 2000

Distributions of *Sphagnum*-dominated Peatlands (ca. 8-10 ka BP)



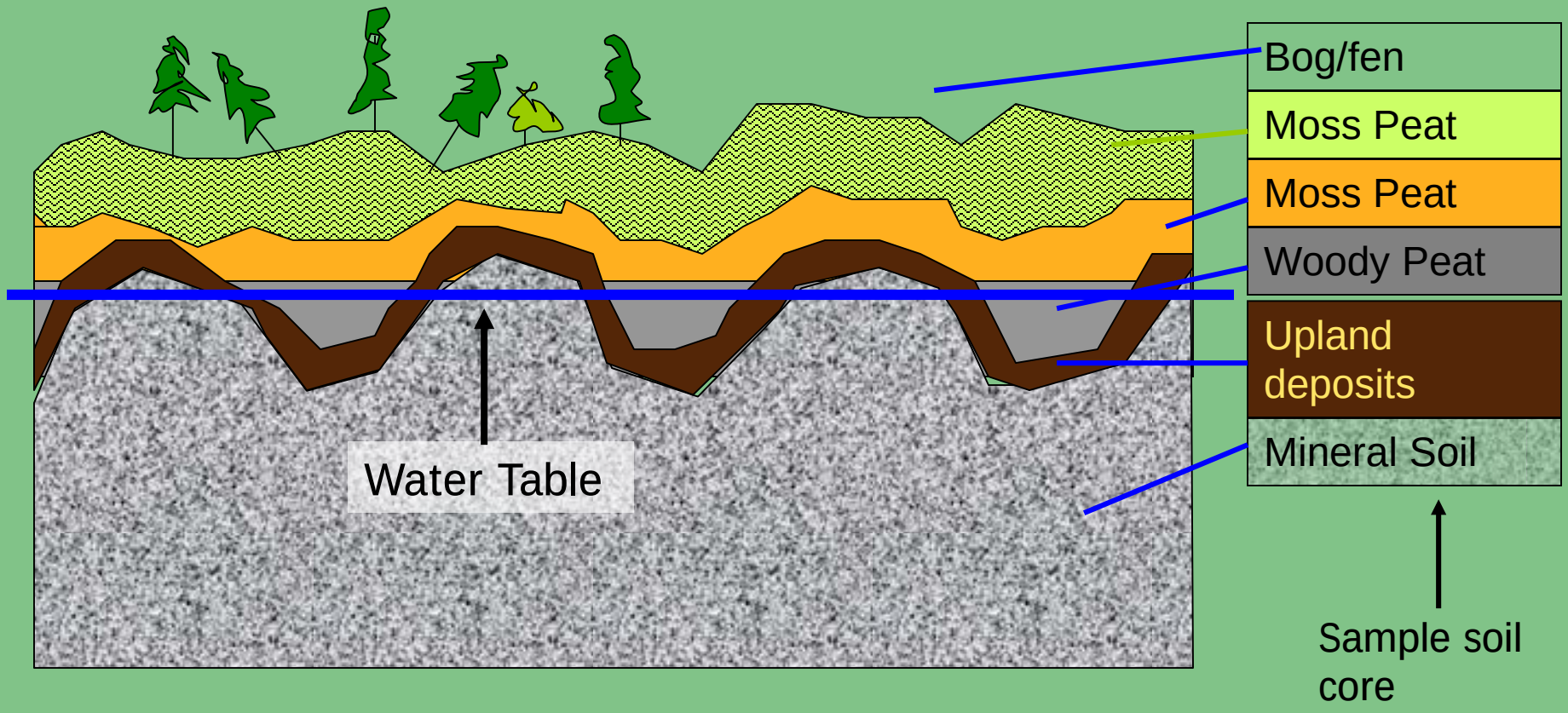
Halsey et al. 2000

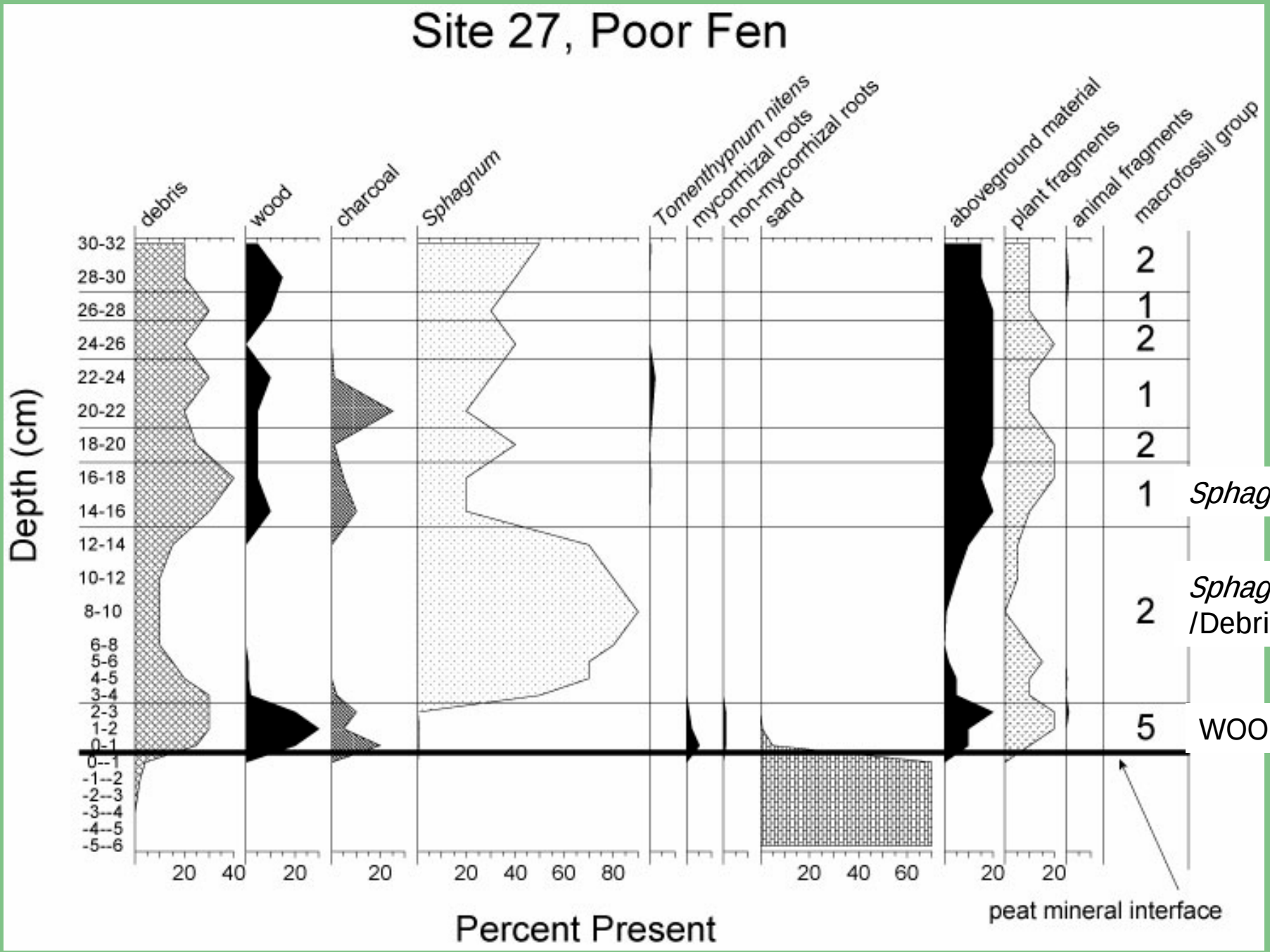
Terrestrialization



Sharp transition to mineral soil

Paludification




Site 27, Poor Fen
debris
wood
charcoal
Sphagnum
Tomenthypnum nitens
mycorrhizal roots
non-mycorrhizal roots
sand
aboveground material
plant fragments
animal fragments
macrofossil group
Depth (cm)
30-32
28-30
26-28
24-26
22-24
20-22
18-20
16-18
14-16
12-14
10-12
8-10
6-8
5-6
4-5
3-4
2-3
1-2
0-1
0--1
-1--2
-2--3
-3--4
-4--5
-5--6
20 40
20
20
20 40 60 80
20 40 60
20
20
2
1
2
1
2
1
2
5
Sphagnum
Sphagnum /Debris
WOOD
peat mineral interface
Percent Present

Developmental pathways

- Marshes
- Initial fens dominated by true mosses
- Secondary fens and bogs dominated by *Sphagnum*

The first communities

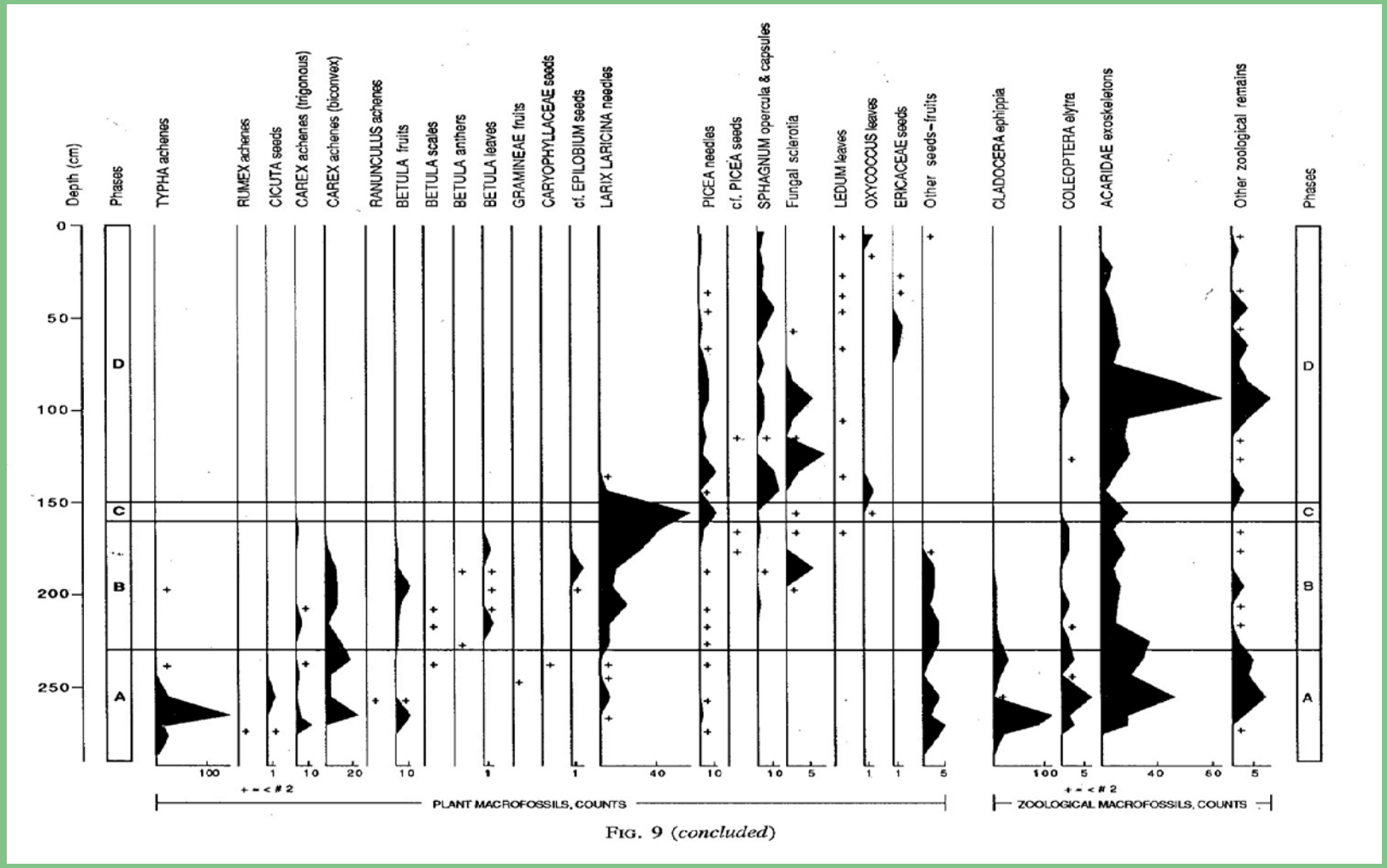


FIG. 9 (*concluded*)

FROM: P. KUHRY, L. HALSEY, S. BAYLEY, & D. VITT. 1992

Conversion to carbon accumulation

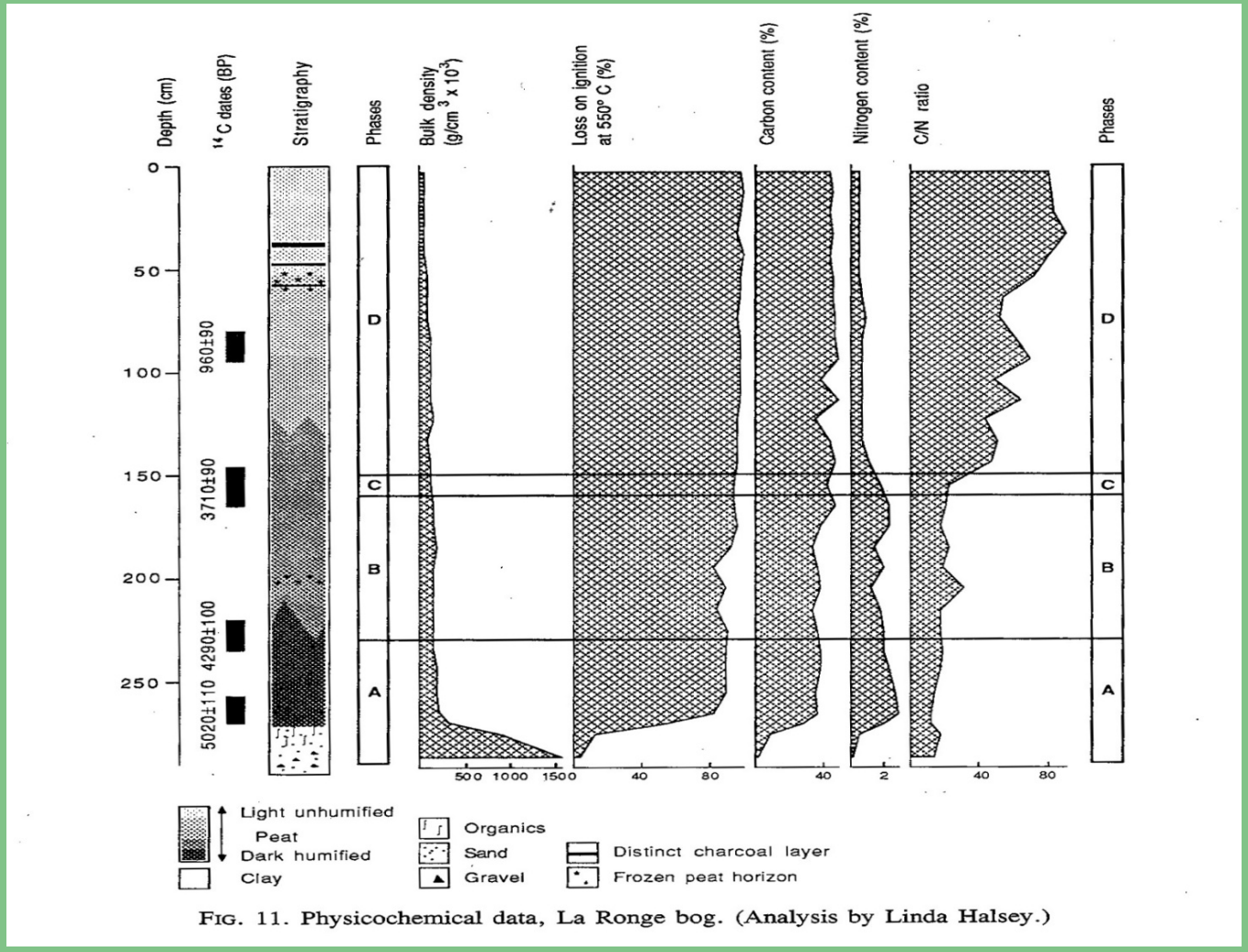
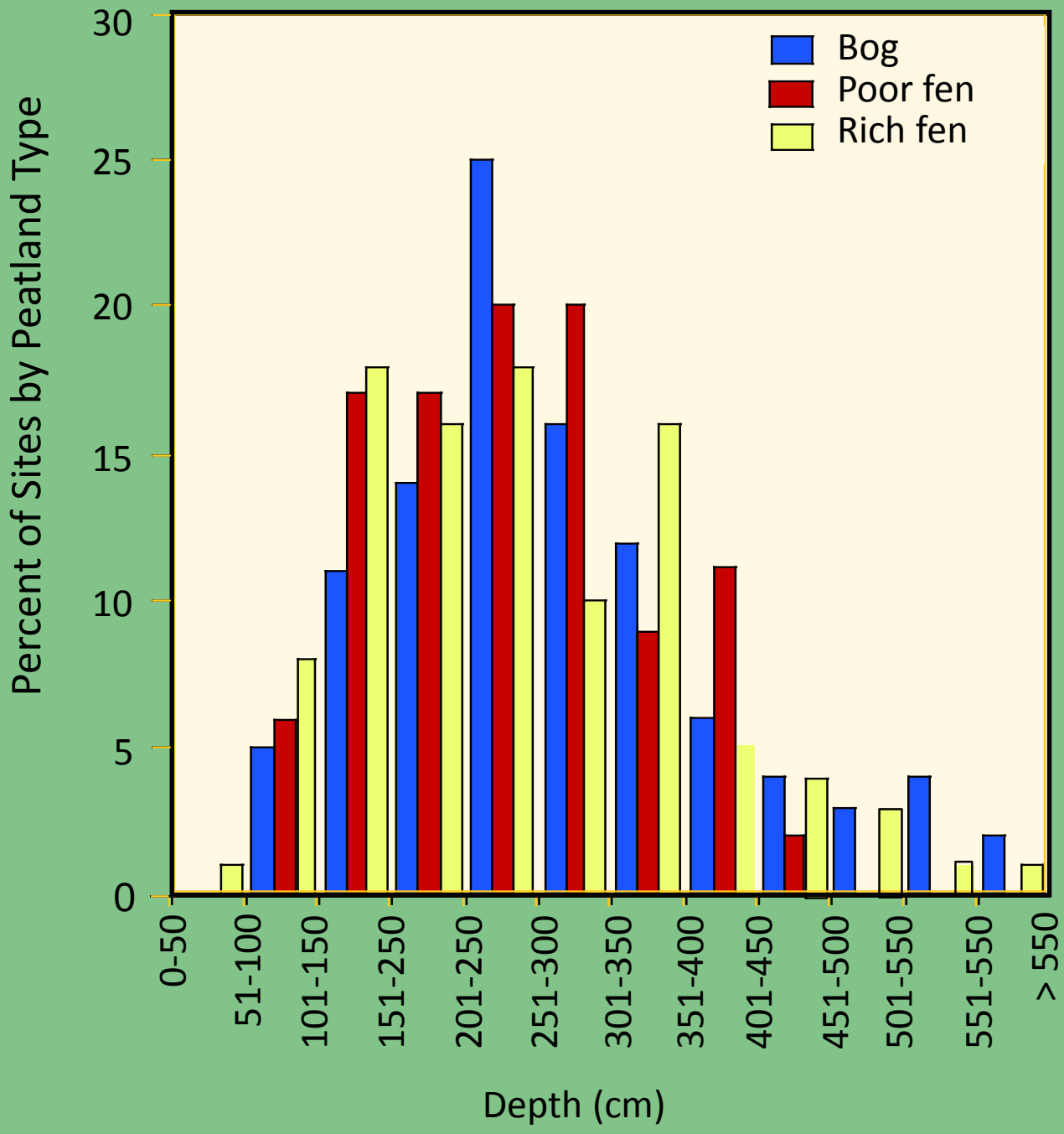


FIG. 11. Physicochemical data, La Ronge bog. (Analysis by Linda Halsey.)

FROM P. KUHRY, L. HALSEY, S. BAYLEY, & D. VITT. 1992


Questions,
Discussion
© David Wall


Percent of Sites by Peatland Type
30
25
20
15
10
5
0
Bog
Poor fen
Rich fen
0-50
51-100
101-150
151-250
201-250
251-300
301-350
351-400
401-450
451-500
501-550
551-550
> 550
Depth (cm)