‘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

Dale H. Vitt

Peatlands Workshop, Peace River, AB
Disturbance in Alberta’s boreal forest

- Mining
- Peat harvesting
- Reservoir creation
- Linear disturbance

- Forestry
- Agriculture
- Beaver
- Fire

- Permafrost thaw
- N deposition
- CO₂ fertilization
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.
Let's 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

\(~4\, \text{million km}^2\)
Total peatland area = 365,160 km² or 21% land base

Peatland Distribution

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 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).
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Peatland Gamma Diversity

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<thead>
<tr>
<th>Type of Peatland</th>
<th>( n )</th>
</tr>
</thead>
<tbody>
<tr>
<td>PP = Permafrost Peatland</td>
<td>13</td>
</tr>
<tr>
<td>CB = Continental Bog</td>
<td>35</td>
</tr>
<tr>
<td>PF = Poor Fen</td>
<td>8</td>
</tr>
<tr>
<td>MRF = Moderate Rich Fen</td>
<td>25</td>
</tr>
<tr>
<td>ERF = Extreme Rich Fen</td>
<td>15</td>
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</tbody>
</table>

Number of Species

- **\( Sphagnum \)**: Total Species = 20
- Bryophytes: Total Species = 110

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<th>( Sphagnum )</th>
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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
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

Topogenous

Soligenous

Limnogenous
Landscape Position
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.
<table>
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<tr>
<td>Acidity</td>
<td>$H^+$</td>
</tr>
<tr>
<td>Alkalinity</td>
<td>$\text{HCO}_3^-$</td>
</tr>
<tr>
<td>Base Cations</td>
<td>$\text{Na}^+, \text{K}^+, \text{Ca}^{2+}, \text{Mg}^{2+}$</td>
</tr>
<tr>
<td>Nutrients</td>
<td>$\text{N}, \text{P}$</td>
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Relationship of Calcium to pH in Peatland Surface Water

![Graph showing the relationship between pH and calcium concentration in Peatland Surface Water, with data points for Rich Fens, Poor Fens, and Bogs.]
Flora:

*Sphagnum* vs. true mosses
The Importance of *Sphagnum*

![Graph showing pH levels for Bogs, Poor Fens, and Rich Fens](image-url)
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

Indicator 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)

Peat deposits in ocean with *Sphagnum* macrofossils

Rich fen bryophytes in Puget Trough

*Spore counts increase eastward. No known offshore peat deposits of LGM age (but depth appropriate samples not yet collected)*

Halsey et al. 2000
Distributions of *Sphagnum*-dominated Peatlands (ca. 8-10 ka BP)

Expansion along the west coast and into the continental interior

Mastodont extinctions and no *Sphagnum*-dominated peatlands

Significant decline in the midwest although some outliers in areas edaphically conducive. At sites where peat deposition persists are reports of "hiatuses" in peat deposits.

Halsey et al. 2000
Terrestrialization

Mineral Soil

Lake

Sediments

Gyttja

Sedge Peat

Moss Peat

Bog/fen

Sample soil core

Terrestrialization

Mineral Soil

Lake Sediments

Gyttja

Sedge

Moss Peat

Bog/fen
Sharp transition to mineral soil
Developmental pathways

- Marshes
- Initial fens dominated by true mosses
- Secondary fens and bogs dominated by *Sphagnum*
The first communities
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
Percent of Sites by Peatland Type

Depth (cm)

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
> 550