Wetland Loss and Degradation: The Hidden Costs of Ethical Oil

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Ethical oil

• Ezra Levant (2010) Ethical oil: the case for Canada’s oil sands
  – Political oppression
  – Human rights
  – Canada vs. OPEC

• How to prioritize human and environmental ethical factors?

• Oil companies operating in Alberta are the same ones in China and the middle east.

• What are the costs?
Wetlands in the oil sands area


- Boreal Plain
- 475,000 ha is mineable
- 99% leased
- ~170,000 ha approved (10)
Oil sands accessed by strip mining

Edward Burtynsky
0.33 and 0.63 m² of land

1 m³ of oil produced

49,700,000 m³ produced in 2010

> 16.4 km²
Public liability
Uncertainty of reclamation success

The area of disturbed land that still needs to be reclaimed

Data from Alberta Environment and Sustainable Resources Development
• Lots of peatland
• Little upland
• Little open water

Pre-mining, the region is 62% peatland
• No peatland
• Mainly upland
• End pit lakes and stream network
Wetland loss

1) Peatland dominated landscape will be replaced with a few, sub-saline, shallow open water marshes.
It will take time for trees to mature
Constructed riparian area
Constructed marsh
• 4 mines provided comparable baseline and closure habitat area numbers
  • Horizon
  • Muskeg River
  • Jackpine 1
  • Kearl
• 42% of land approved for mining
Wetland loss: mainly peatland

Scale up:
~30,000 ha of peatland destroyed
~4000 ha of marsh created
~5500 ha of riparian shrubland created

But, no operational scale evidence that reclamation efforts will succeed.

What is the cost?
Biodiversity: > 300 plant species

Photo: Dave Locky 2004
Traditional use

Habitat for species at risk

Water storage

Carbon storage

Reclaimed

Natural

Bog Cranberry

Traditional use
Integrated risk assessment for Boreal Caribou

Environment Canada (2011)
Ottawa, Ontario, Canada. 102 pp.
2) The shallow open water marshes built for reclamation do not resemble natural shallow open water marshes

- Physical and chemical environment
- Plant community
Difficulties in wetland construction

- Water quality
  - Salt
  - Metals
  - Hydrocarbons
Reclamation wetlands

Small (1-20 ha)
Elevated salinity (~ 1000 μS/cm)
Shallow open water wetlands
3 vegetation zones
Similar range in salinity, surface area, depth, and turbidity.

Ref sites ranged north and south / east and west of the reclamation wetlands.
E.g., same range of salinity

![Graph showing total dissolved solids (g/L) vs. order. The graph includes three categories: Tailings contaminated, Physically disturbed, and Reference. The values for total dissolved solids increase as the order increases.](image-url)
1) Environmental stress?

Driver

Usually abiotic
Stress
Response

Usually biotic
Stress
Response
Are reclamation wetlands under greater stress?

- 52 environmental variables
- Ordination to summarize

Just need 8

Stress scores of all wetlands

Kruskal-Wallis with non-parametric multiple comparisons test
REF < OS reference < OS process affected, at $\alpha = 0.05$
2) Biological response?

- Mining
- Salinity
- Nutrient limitation
- Turbidity
- Depth
- Slope
- Hydrocarbons
- Response?
Oil sands wetlands have different SAV

Categorical test of independence

<table>
<thead>
<tr>
<th></th>
<th>Chara</th>
<th>Myriophyllum</th>
<th>No spp.</th>
<th>R. cirrhosa</th>
<th>P. pusillus</th>
<th>C. demersum</th>
<th>U. macrorhiza</th>
<th>Total</th>
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<td>4</td>
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<td>3</td>
<td>5</td>
<td>5</td>
<td>24</td>
<td>4</td>
<td>63</td>
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</tbody>
</table>

$\chi^2 = 67.75$, d.f. = 12, $p < 0.00001$

74% of all Reference wetlands

Oil sands wetlands have different wet meadow plants

<table>
<thead>
<tr>
<th></th>
<th>Carex atherodes</th>
<th>Scutellaria galericulata</th>
<th>Carex aquatilis</th>
<th>Hordeum jubatum</th>
<th>Sonchus spp.</th>
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</tbody>
</table>

Dustin Raab (2010) MSc. thesis
Index of Biotic Integrity: submersed aquatic veg (SAV)

1. Select biotic metrics

<table>
<thead>
<tr>
<th>Measure Variables</th>
<th>Stress Gradient</th>
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<tr>
<td>% C. demersum</td>
<td>Low</td>
</tr>
<tr>
<td>Diversity</td>
<td>0</td>
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<tr>
<td>% Alkali tolerant</td>
<td>20</td>
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</table>

60 initial candidate metrics

11 significantly related to stress scores (\(\alpha < 0.05\))

Stress Gradient

Low

High
2. Minimize redundancy

5 non-redundant (Pearson $r \leq 0.6$)

- Relative abundance of *C. demersum*
- Richness of floating vegetation
- % of total richness constituted by *Potamogeton* spp.
- % cover of floating leafed spp.

Source: Don Cameron, MNAP-VLMF ©2007
3. Verify: SAV IBI scores by wetland type

ANOVA: $F_{2,59} = 34.7$, $p < 0.00001$

$R^2 = 0.51$, $P < 0.000001$

- Reference
- Physically disturbed
- Tailings contaminated
IBI: wet meadow vegetation

**Component metrics**
- Robel height (Biomass)
- Vegetation zone width
- Mean C value
- Relative diversity exotic spp.
- Relative diversity halophytes

Raab and Bayley (2012)
*Ecol. Indic.*, 15: 43-51

$R^2 = 0.50$
$P < 0.000001$
Higher stress, lower “health”
Summary

• Oil sands mining causes massive loss of peatland
  – ~30,000 ha peatland destruction already approved
  – Functions and values of peatland
Summary continued

• Reclamation not restoration
  – Replace peatlands with much less shallow open water marsh
  – Different functions and values

• Reclamation marshes are not “healthy”
  – Elevated environmental stress
  – Different plant communities
  – Lower biotic integrity
Conclusions

• Development charges ahead of reclamation creating 61,000 ha of reclamation debt
• 65% of land in the area was wetland
• Peatland is destroyed
• Replacement wetlands are different in type and of inferior quality
• Concern that reclamation plans may not be achievable
• Improved reclamation practices are needed
Acknowledgements

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