Wetland Loss and Degradation: The Hidden Costs of Ethical Oil

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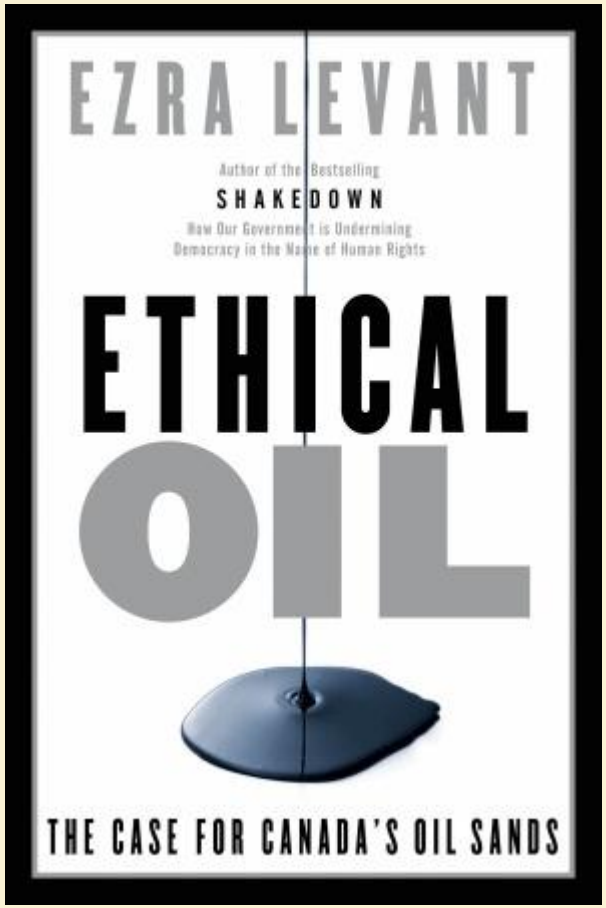
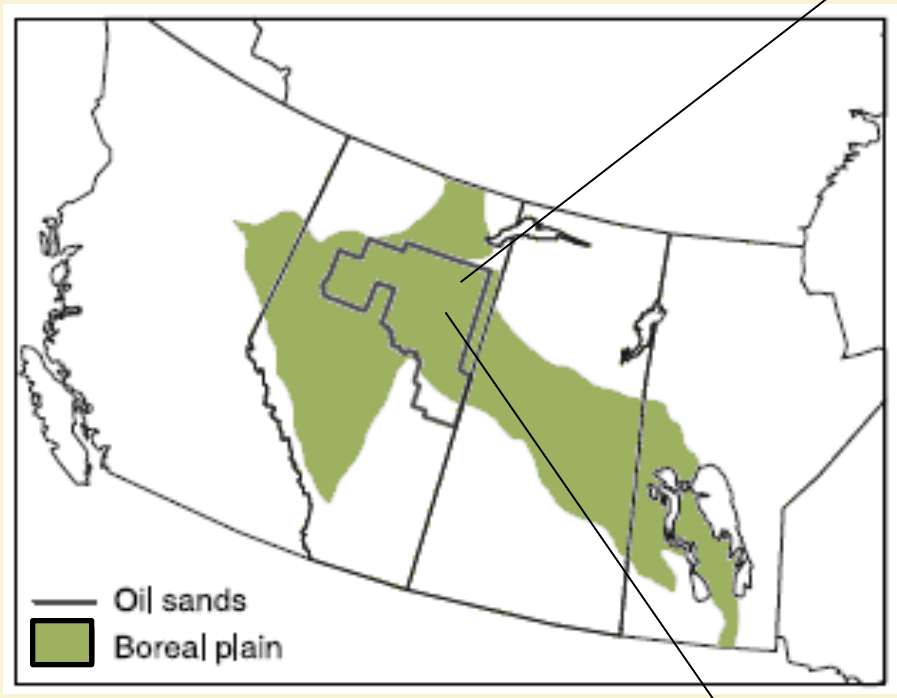
Ethical oil

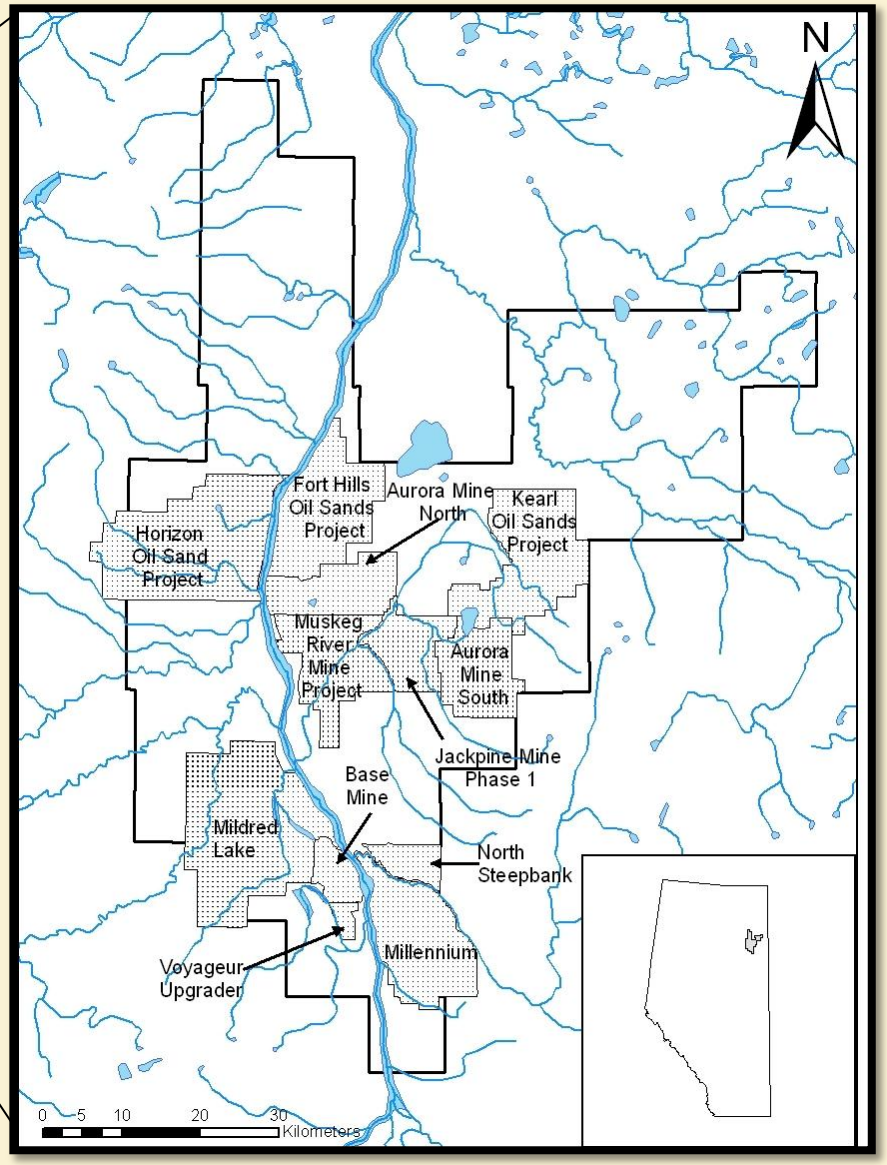
- Ezra Levant (2010) Ethical oil: the case for Canada's oil sands
  - Political oppression
  - Human rights
  - Canada vs. OPEC
- How to prioritize human and environmental ethical factors?
- Oil companies operating in Alberta are the same ones in China and the middle east.
- What are the costs?



Wetlands in the oil sands area

Rooney, Bayley, and Schindler (2012) *PNAS*, 109: 4933-4937.

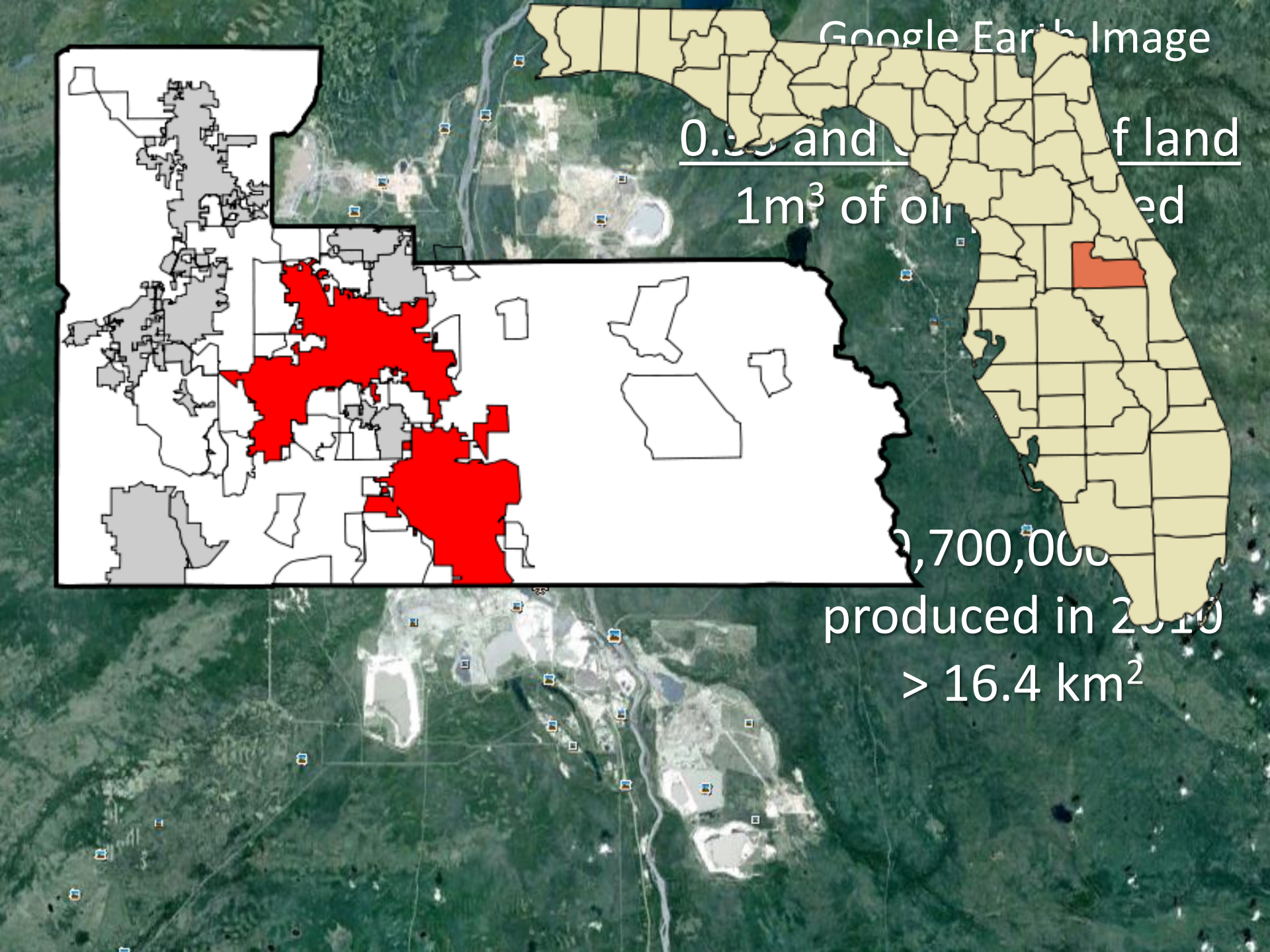


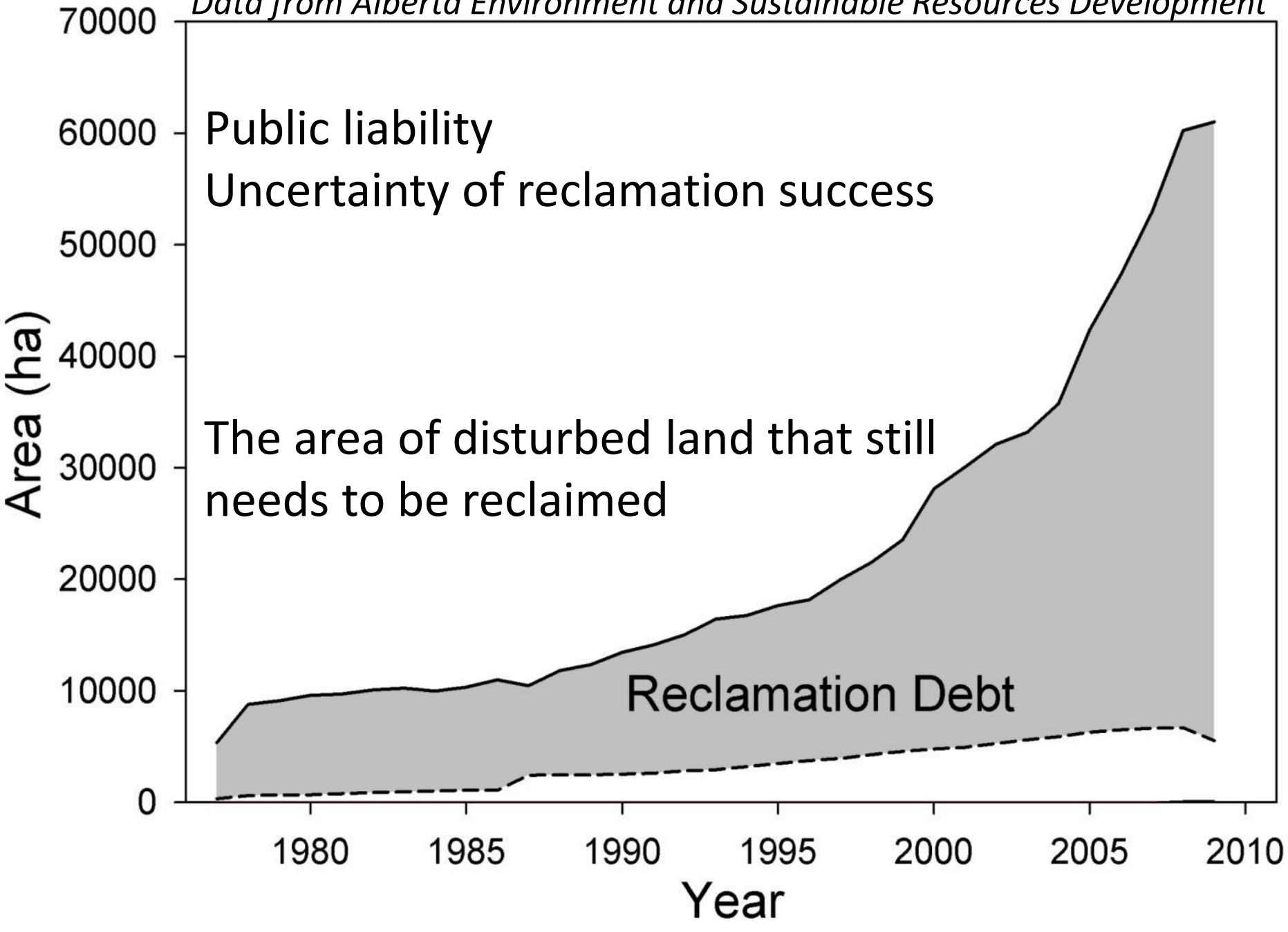


- Boreal Plain
- 475,000 ha is mineable
- 99% leased
- ~170,000 ha approved (10)

Oil sands accessed by strip mining

Edward Burtynsky

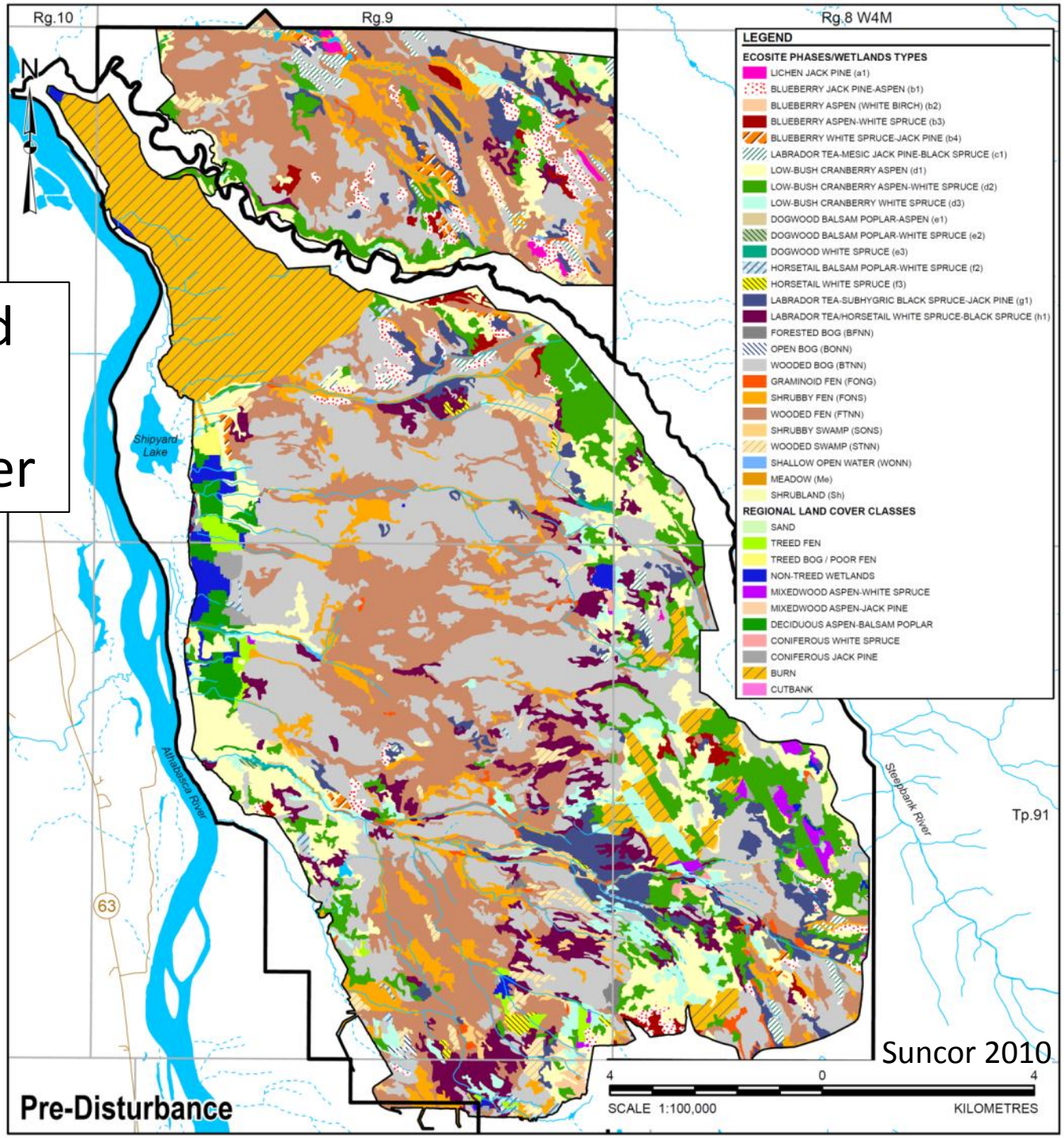

Google Earth Image
0.5 and
f land
1m³ of oil
ed
,700,000
produced in 2010
> 16.4 km²


Data from Alberta Environment and Sustainable Resources Development
Public liability
Uncertainty of reclamation success
The area of disturbed land that still needs to be reclaimed
Reclamation Debt
Area (ha)
70000
60000
50000
40000
30000
20000
10000
0
1980
1985
1990
1995
2000
2005
2010
Year

- Lots of peatland
- Little upland
- Little open water

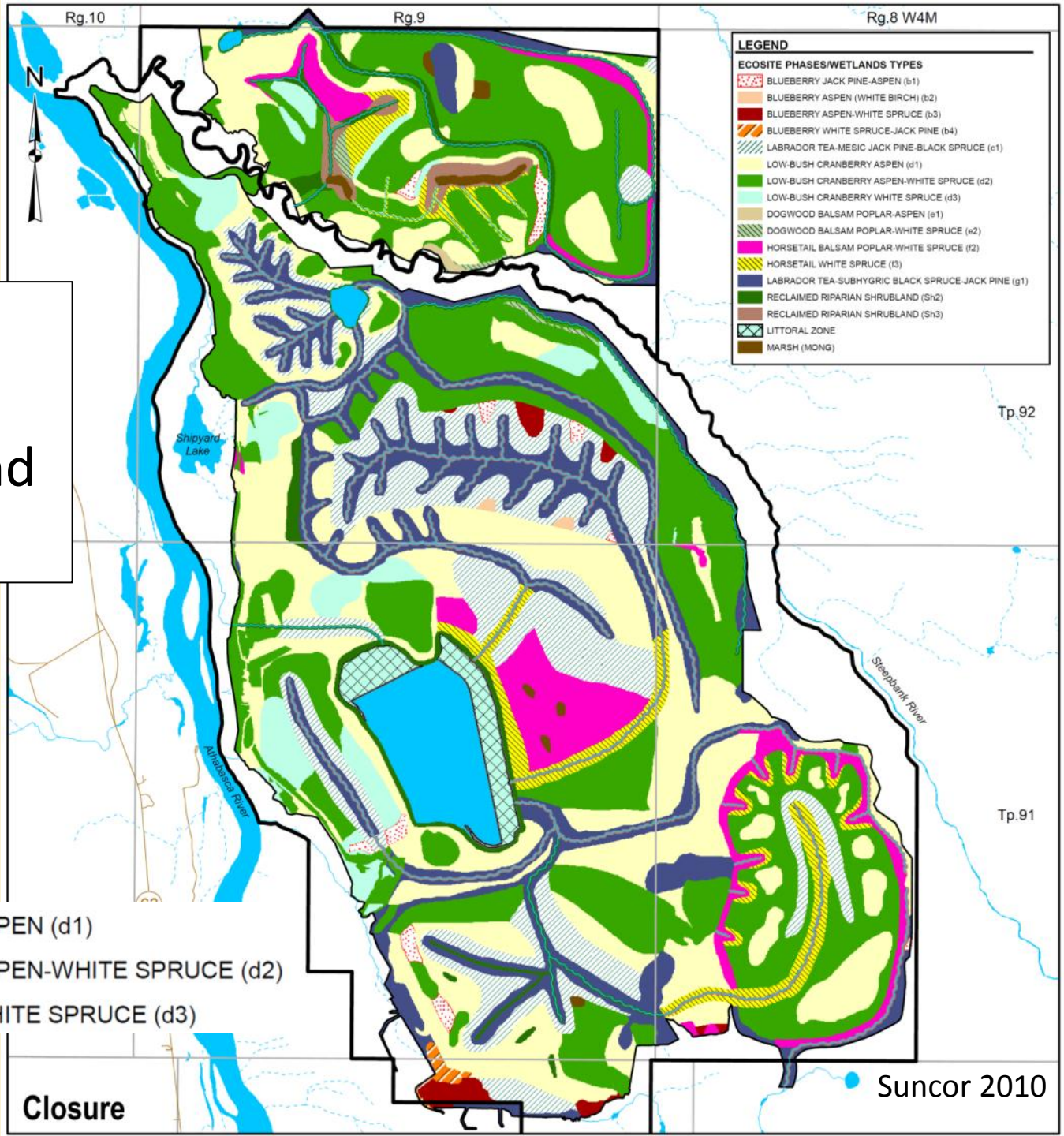
Pre-mining, the region is 62% peatland

WOODED BOG (BTNN)
SHRUBBY FEN (FONS)
WOODED FEN (FTNN)



Suncor 2010

- 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.

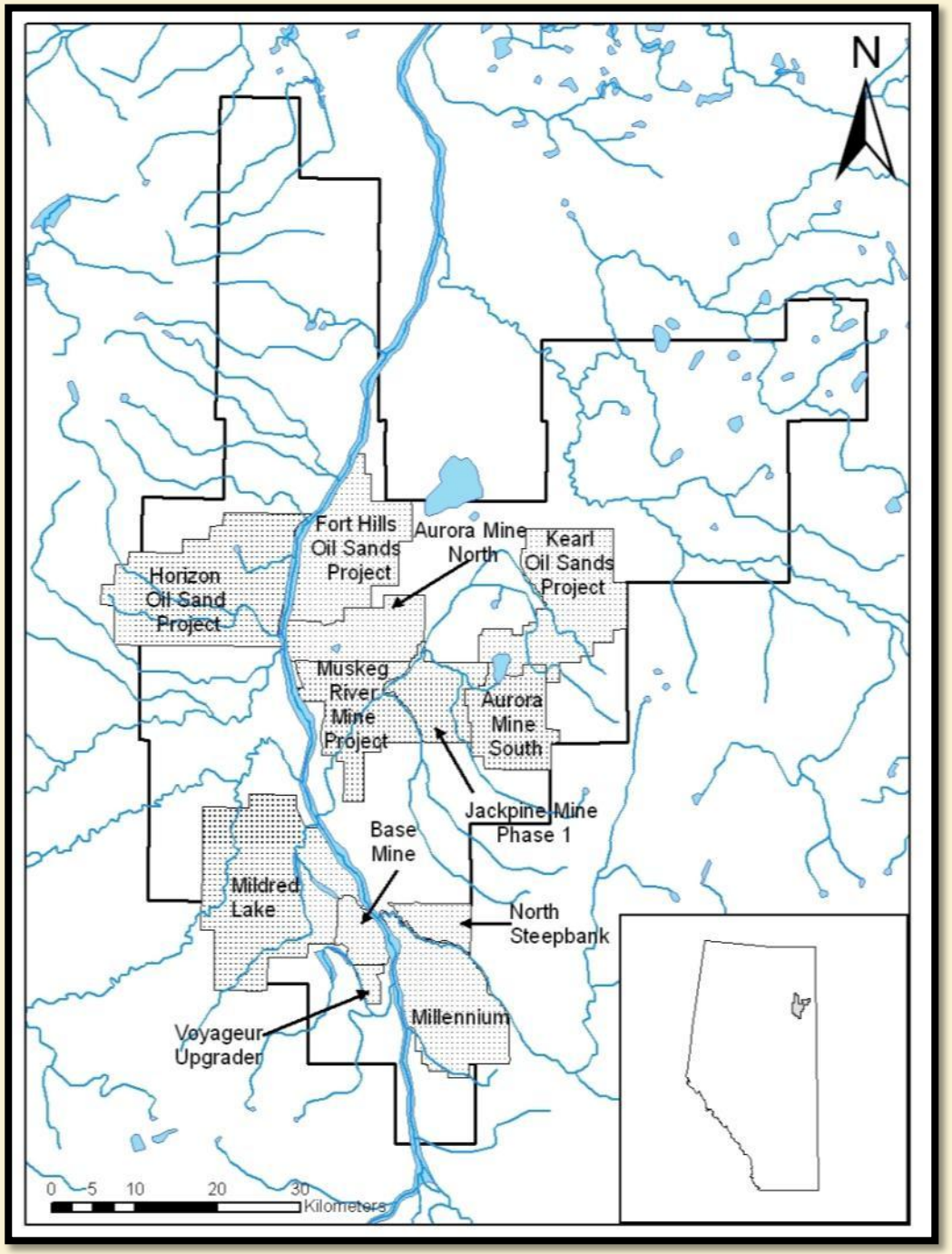
Photo: Suzanne Bayley 2004


Reclaimed forest
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

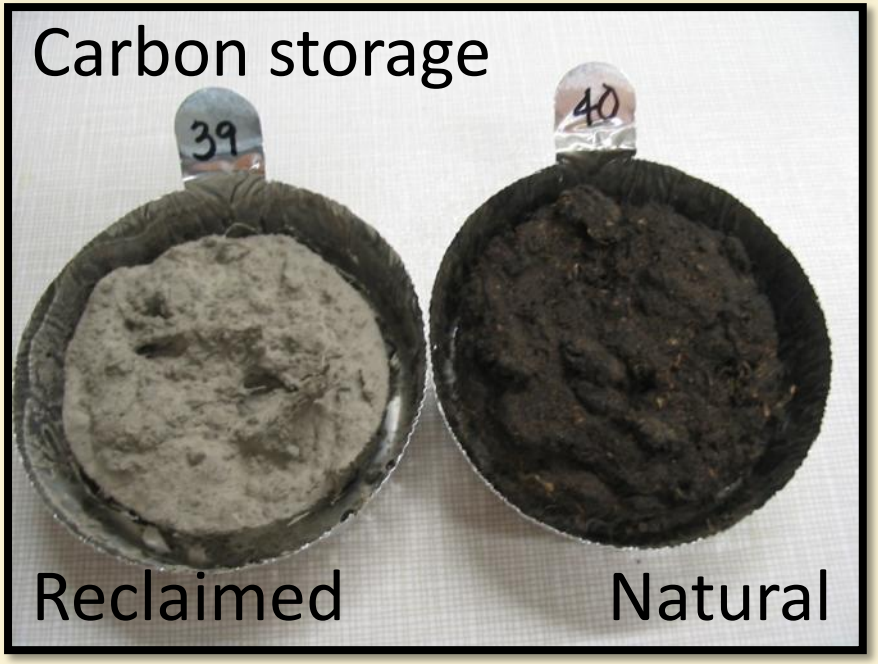
But, no operational scale evidence that reclamation efforts will succeed.

What is the cost?


Biodiversity: > 300 plant species
Photo: Dave Locky 2004

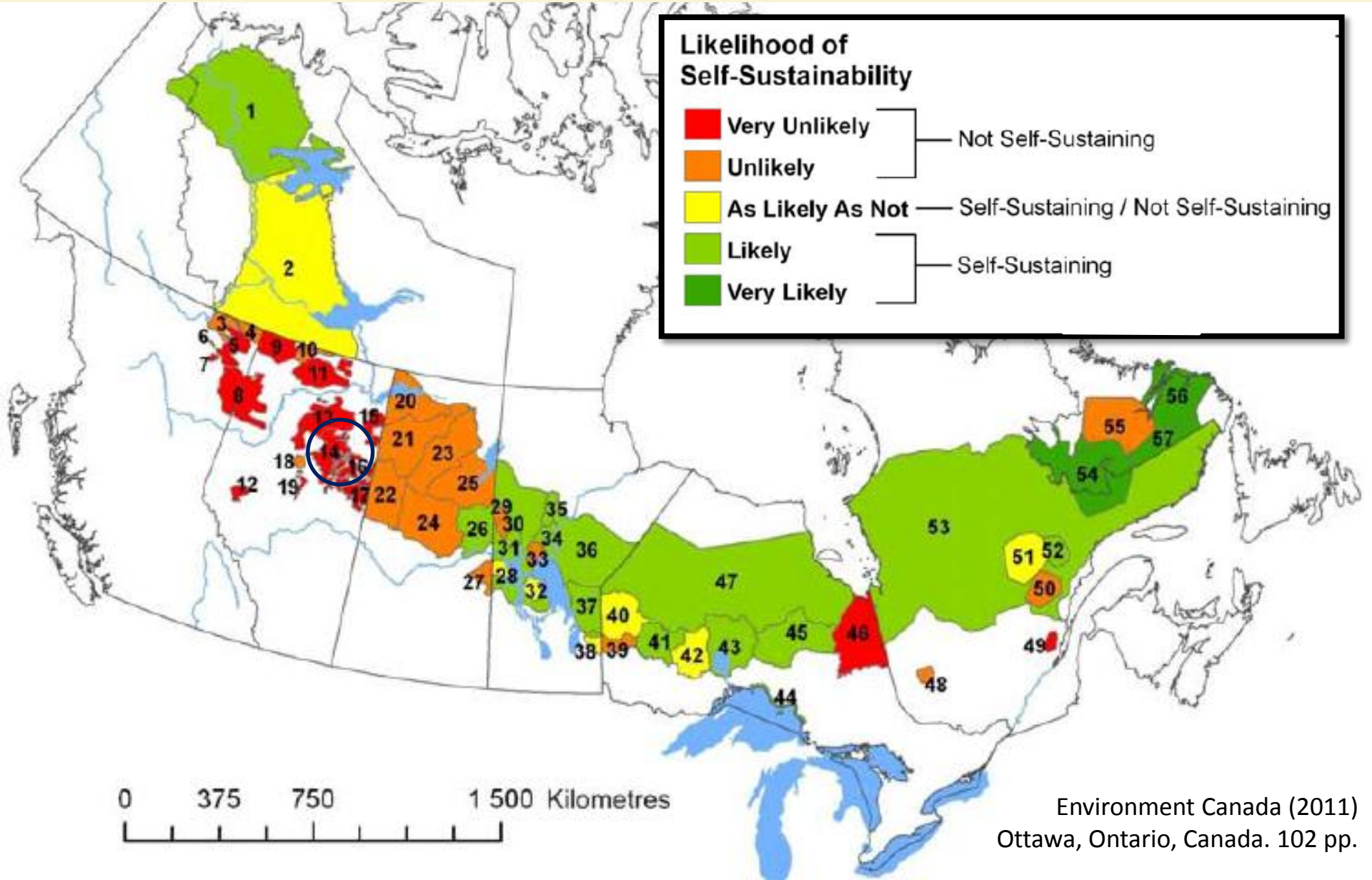

Habitat for species at risk


Water storage


Carbon storage
39
40
Reclaimed
Natural


Traditional use
Bog Cranberry

Integrated risk assessment for Boreal Caribou



Environment Canada (2011)
Ottawa, Ontario, Canada. 102 pp.

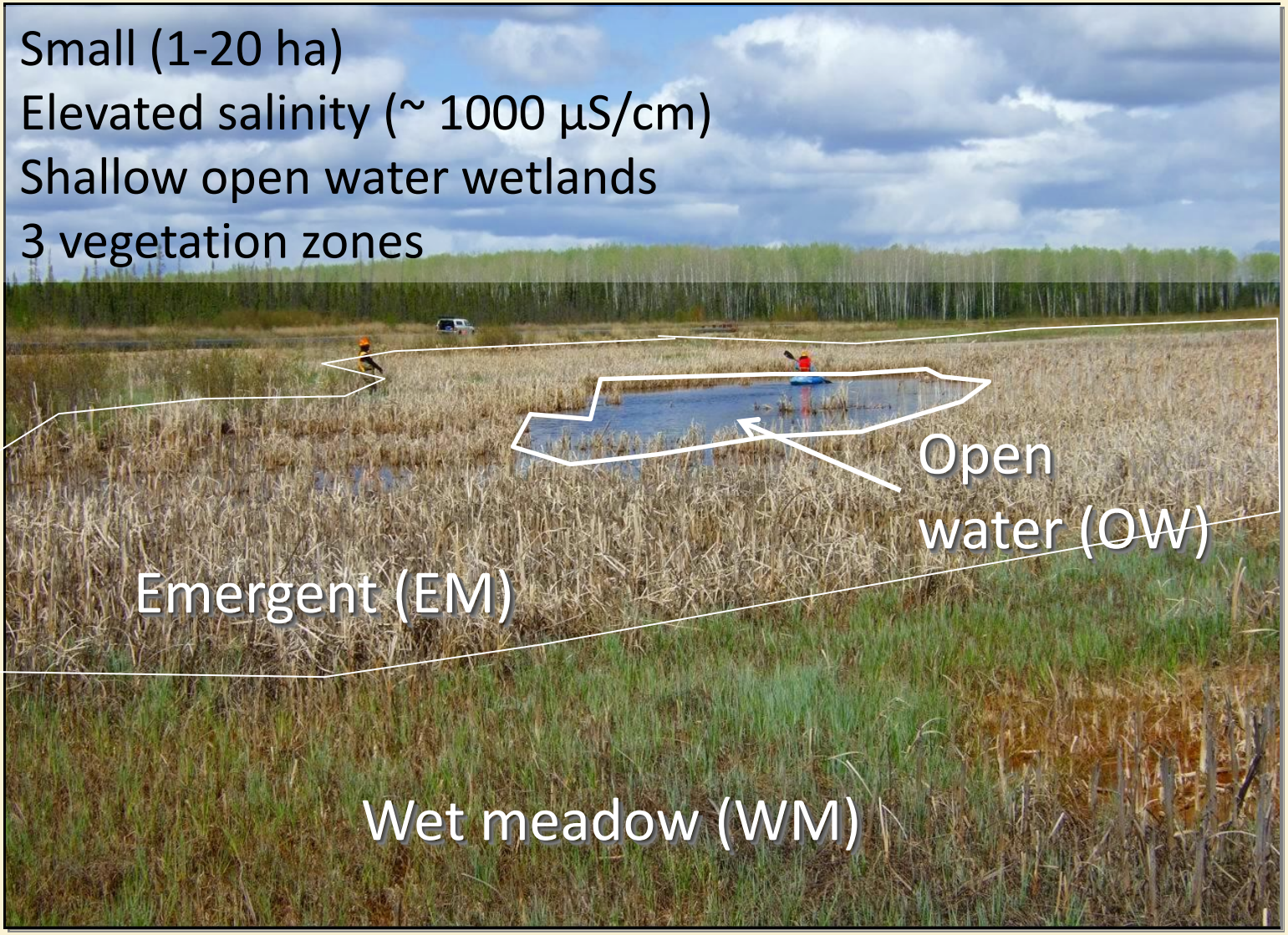
Reclamation and wetland degradation

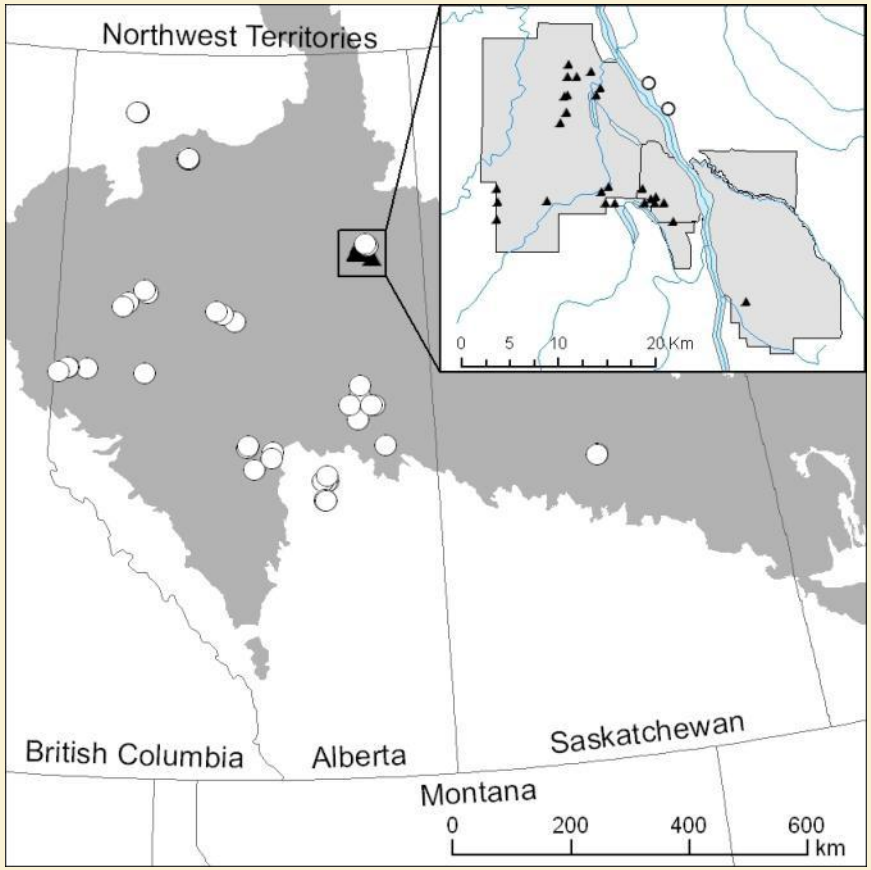
2) The shallow open water marshes built for reclamation do not resemble natural shallow open water marshes
   - Physical and chemical environment
   - Plant community

Difficulties in wetland construction

- Water quality
  - Salt
  - Metals
  - Hydrocarbons

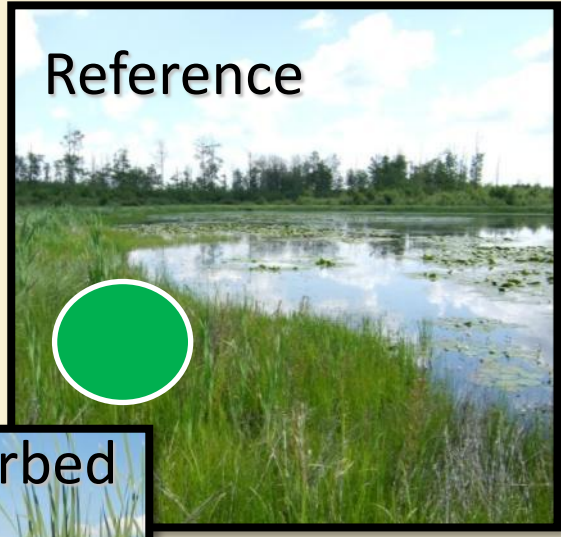
Reclamation wetlands

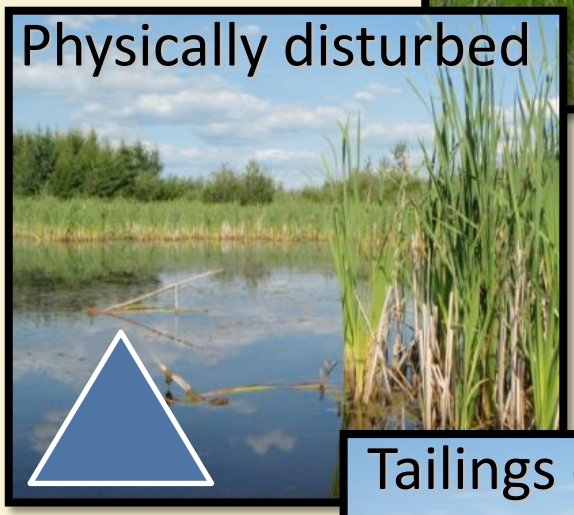




63 wetlands

- 38 REF
- 12 Phys.
- 13 Tailings

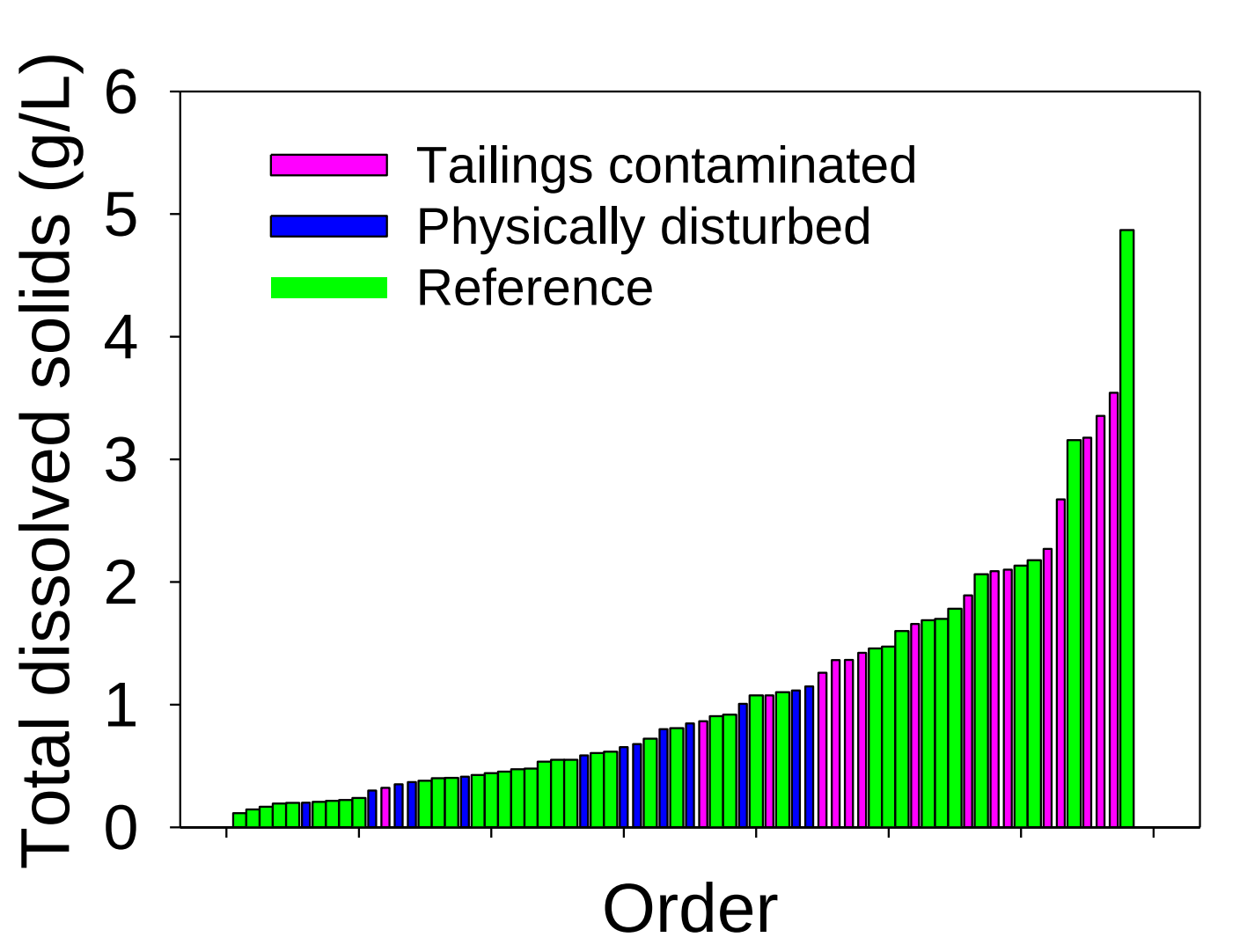




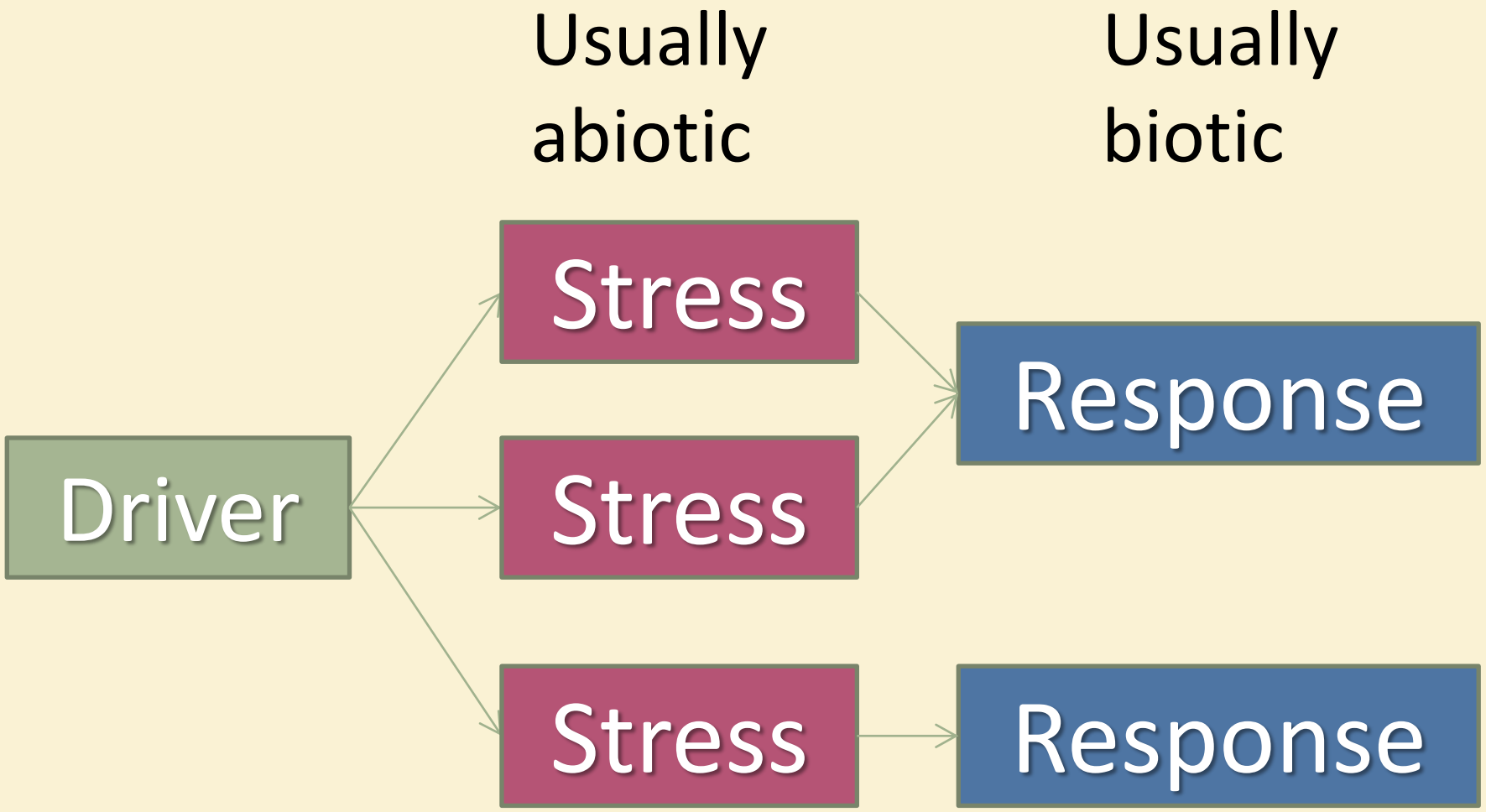
Similar range in salinity, surface area, depth, and turbidity.

Ref sites ranged north and south / east and west of the reclamation wetlands.

E.g., same range of salinity

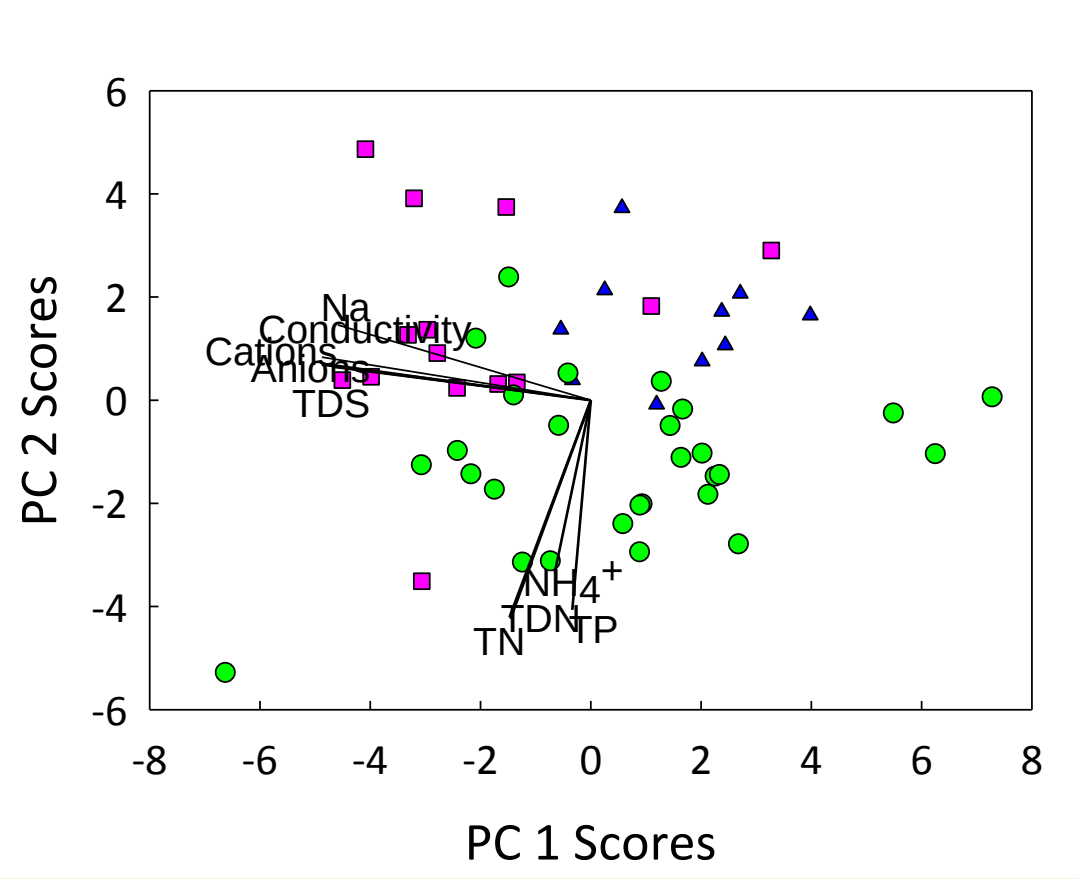


1) Environmental stress?



Are reclamation wetlands under greater stress?

- 52 environmental variables
- Ordination to summarize

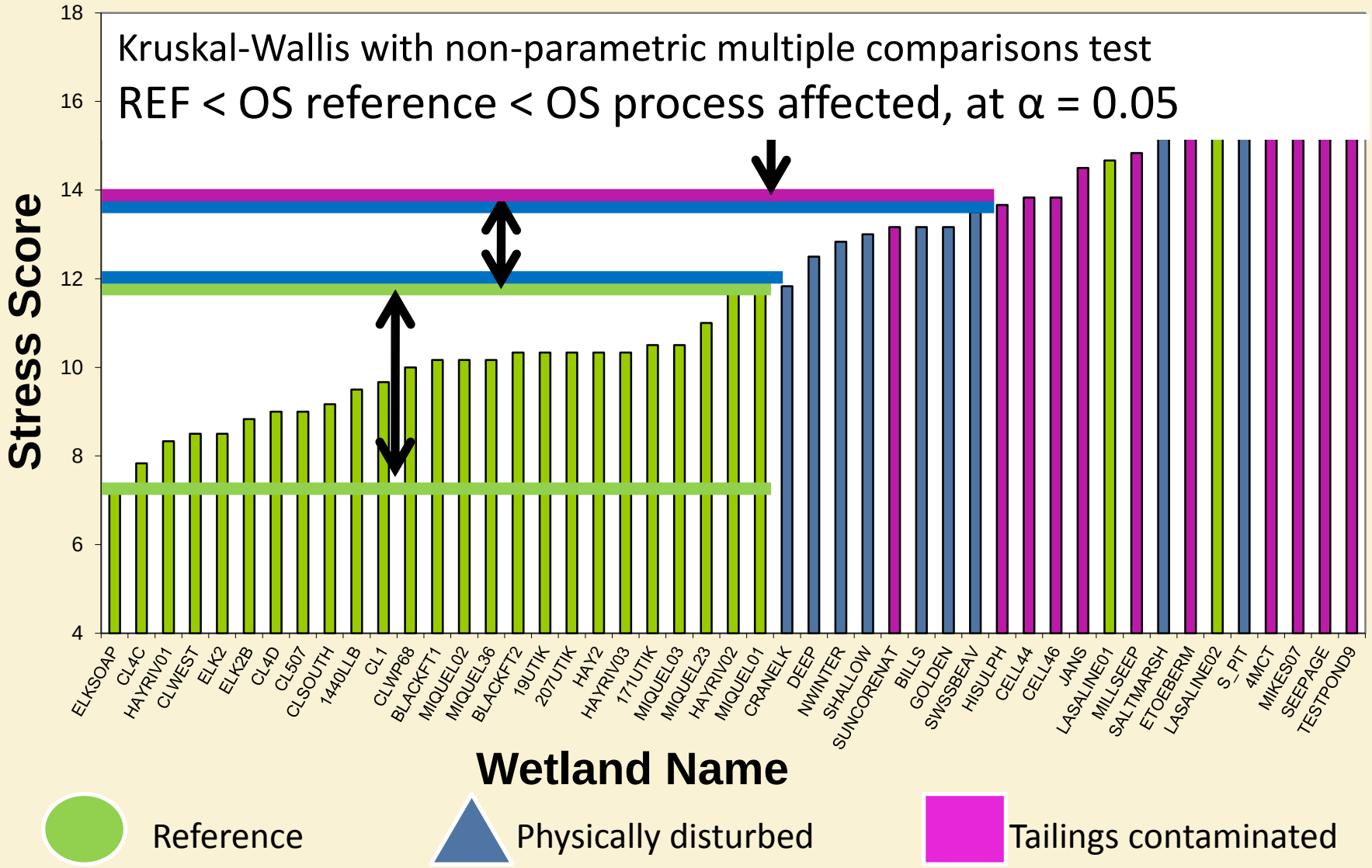


Rooney and Bayley (2010) *Ecol. Indic.,* 10: 1174-1183

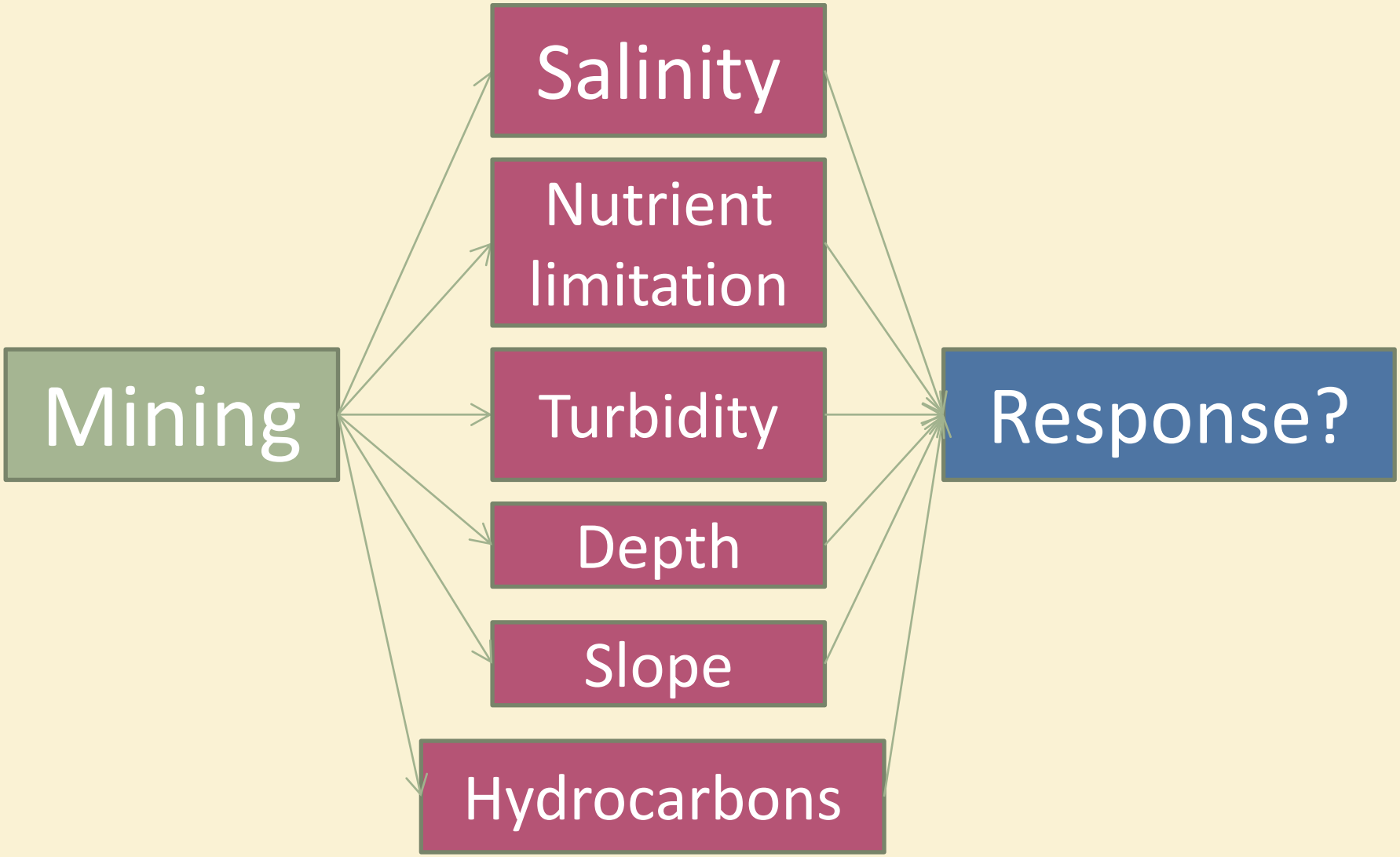
Just need 8

Water	Cations
	TN
Sediment	% water
Physical	Max depth
	Secchi/Total
	Amplitude
Cont.	% oil
	Cl^-

Stress scores of all wetlands



2) Biological response?



Oil sands wetlands have different SAV

Categorical test of independence

	Chara	*Myriophyllum*	No spp.	*R. cirrhosa*	*P. pusillus*	*C. demersum*	*U. macrorhiza*	Total
REF	2	2	2	1	3	24	4	38
OSREF	2	10	0	0	0	0	0	12
OSPA	5	1	1	4	2	0	0	13
Total	9	13	3	5	5	24	4	63

74% of all Reference wetlands

$\chi^2 = 67.75$,

d.f. = 12,

$p < 0.00001$

Rooney and Bayley (2011) *Ecol. Engineering*, 37: 569-579

Oil sands wetlands have different wet meadow plants

76% of REF	*Carex atherodes*, *Scutellaria galericulata*	*Carex aquatilis*	*Hordeum jubatum*, *Sonchus* spp.	Total
REF	19	3	3	25
OSREF	2	5	2	9
OSPA	0	5	6	11
Total	21	13	11	45

Dustin Raab (2010) MSc. thesis

Index of Biotic Integrity: submersed aquatic veg (SAV)

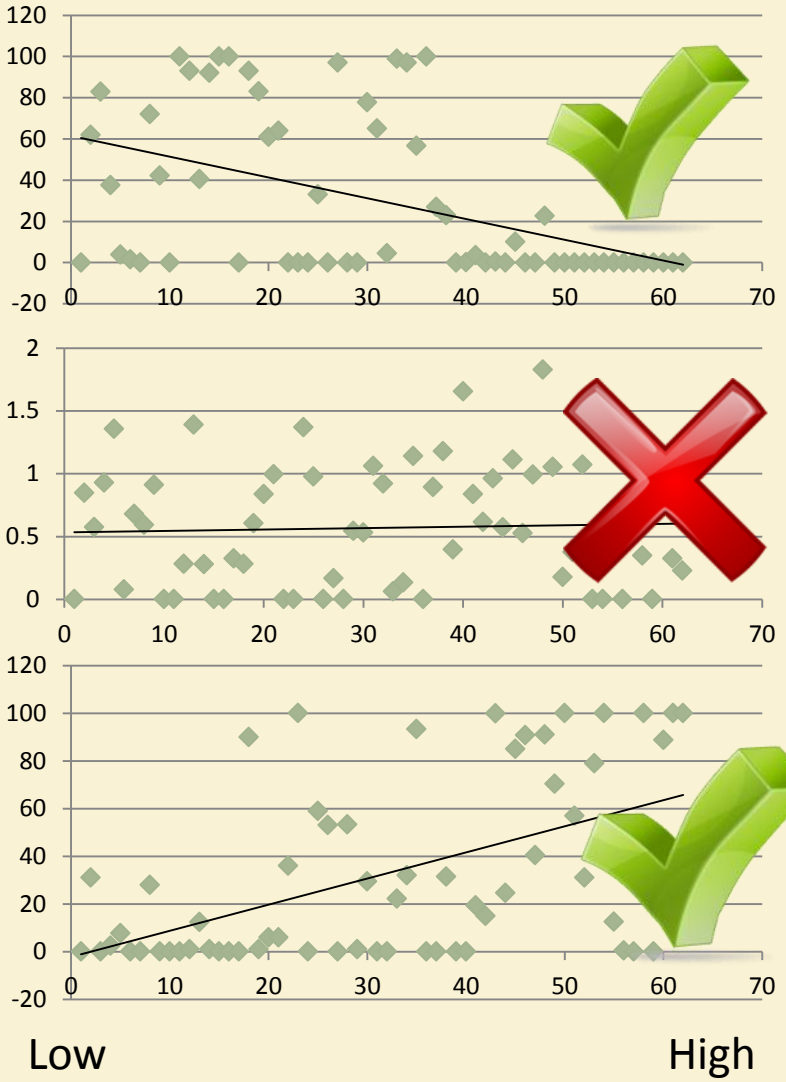
Rooney and Bayley (2012) *Env. Monit. Assess.*, 184: 749-761

1. Select biotic metrics

% *C. demersum*

Diversity

% Alkali tolerant



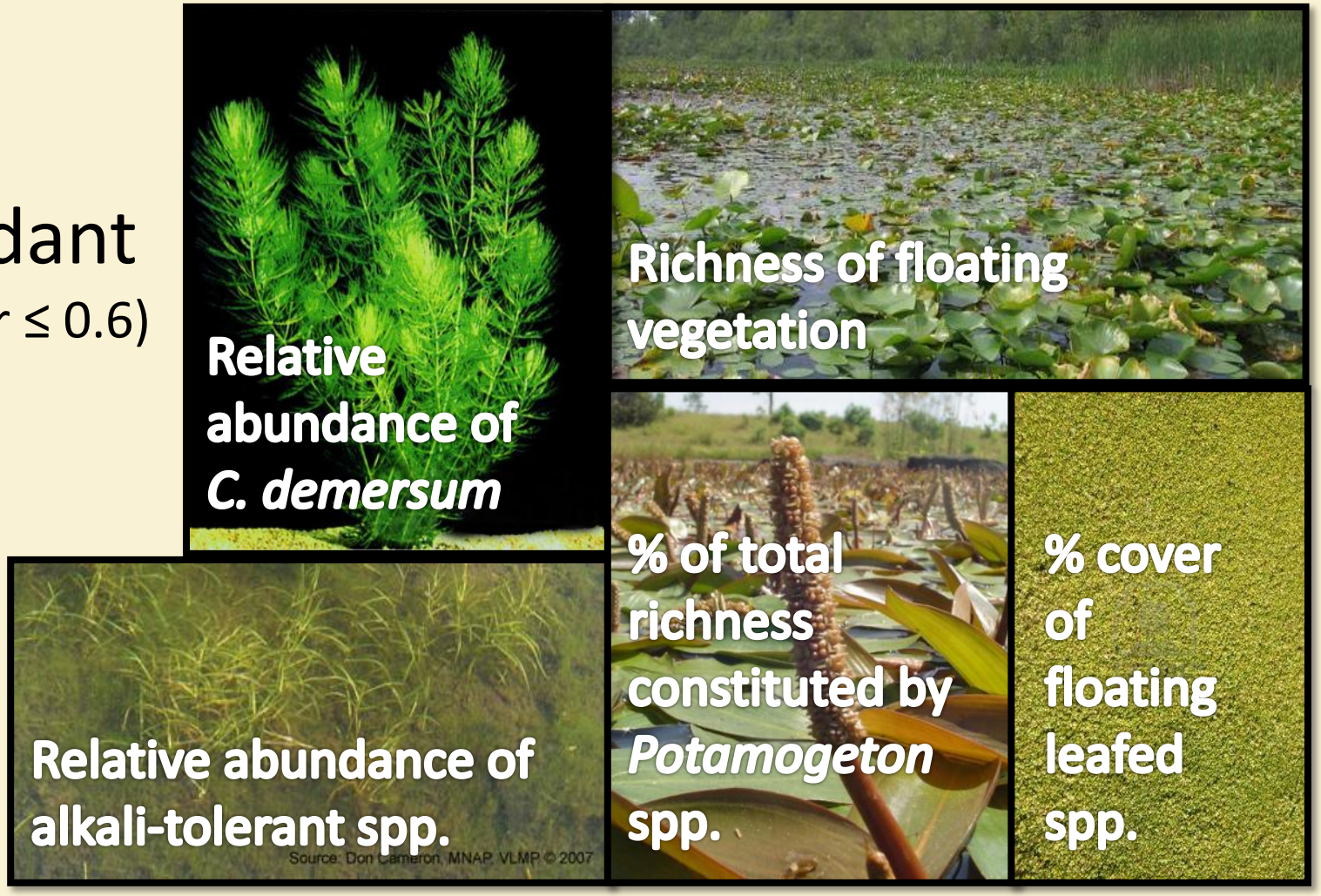
Stress Gradient

60 initial candidate metrics

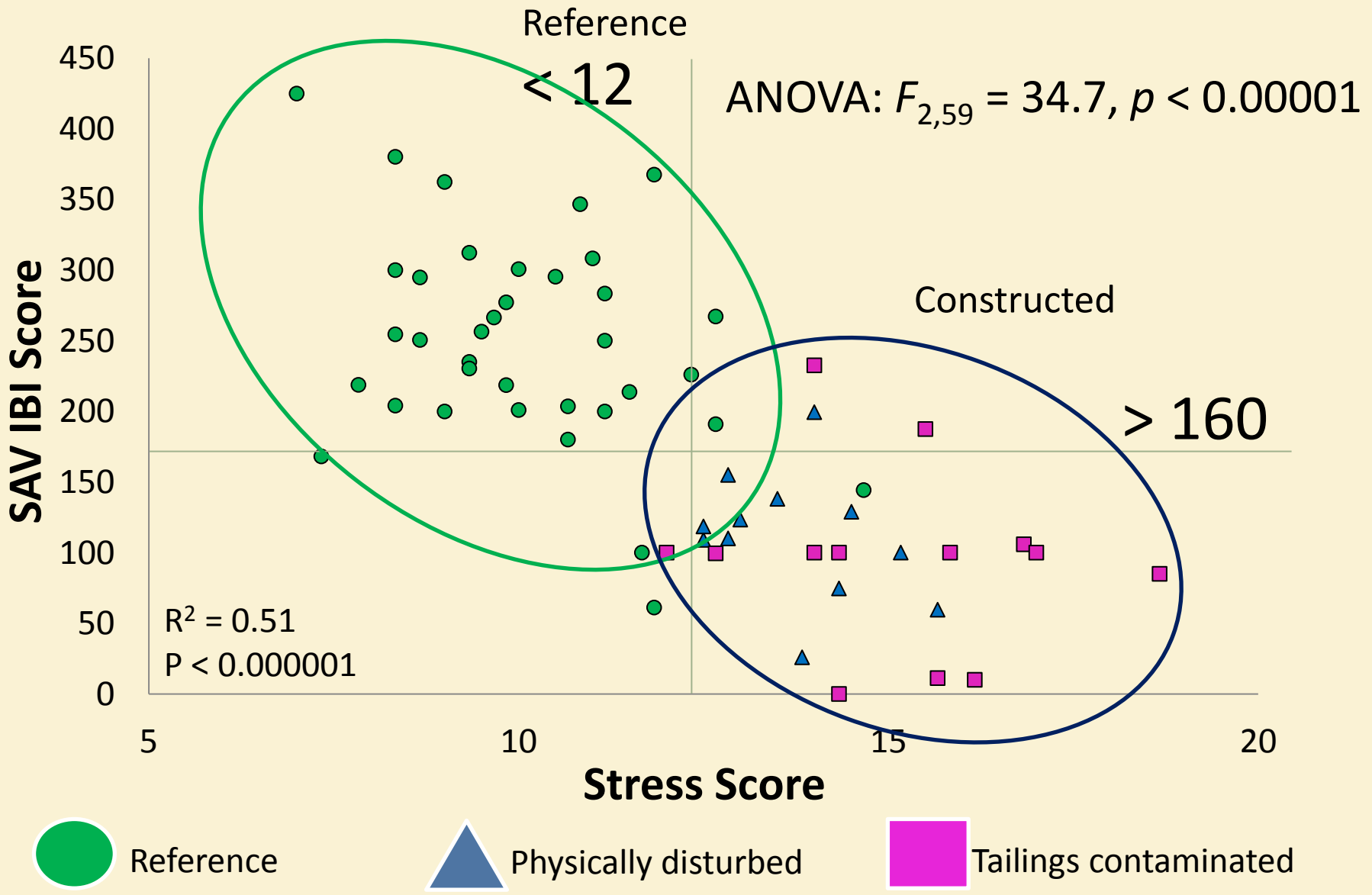
11 significantly related to stress scores ($\alpha < 0.05$)

2. Minimize redundancy

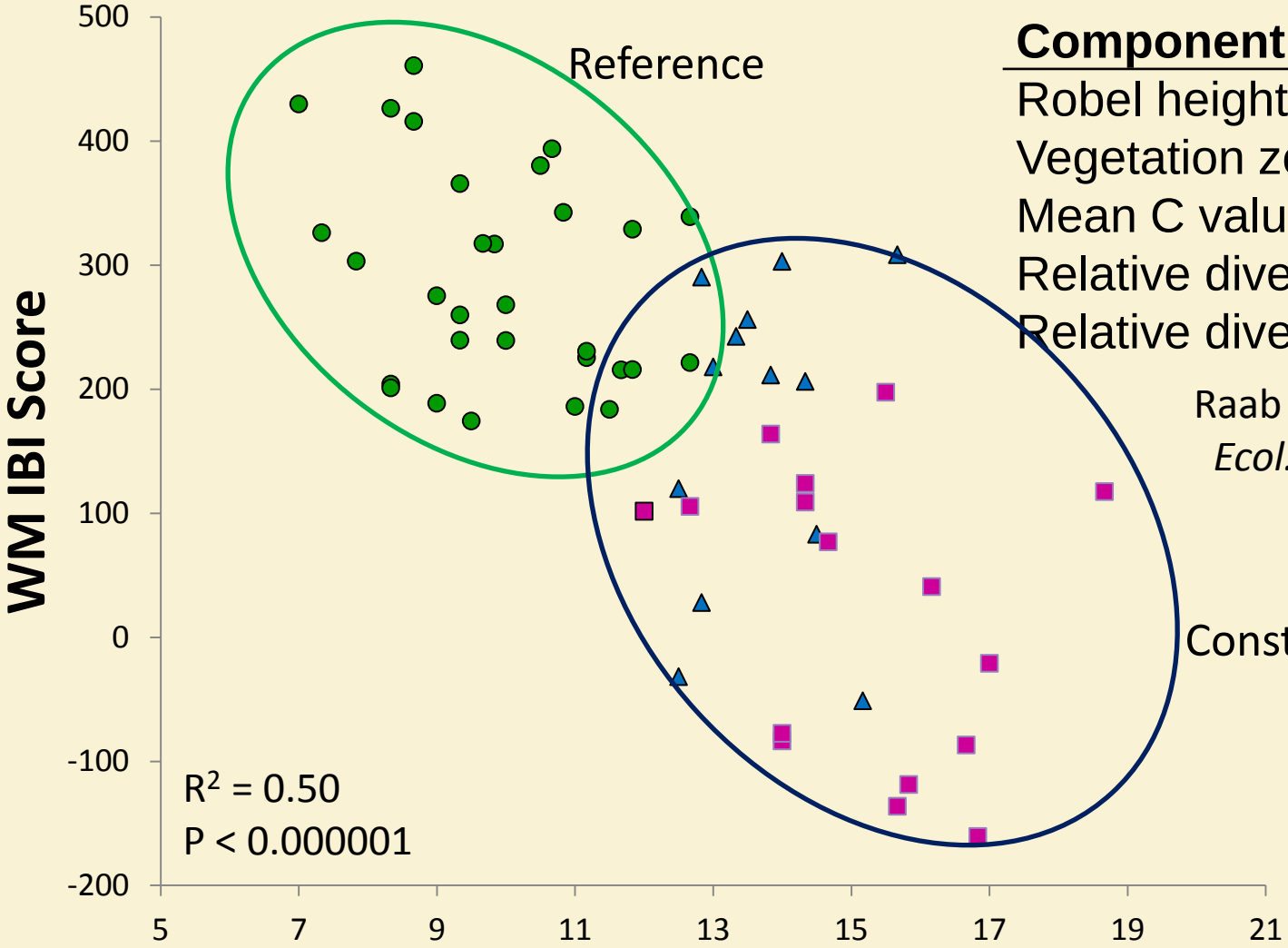
5 non-redundant
(Pearson r ≤ 0.6)



3. Verify: SAV IBI scores by wetland type



IBI: wet meadow vegetation



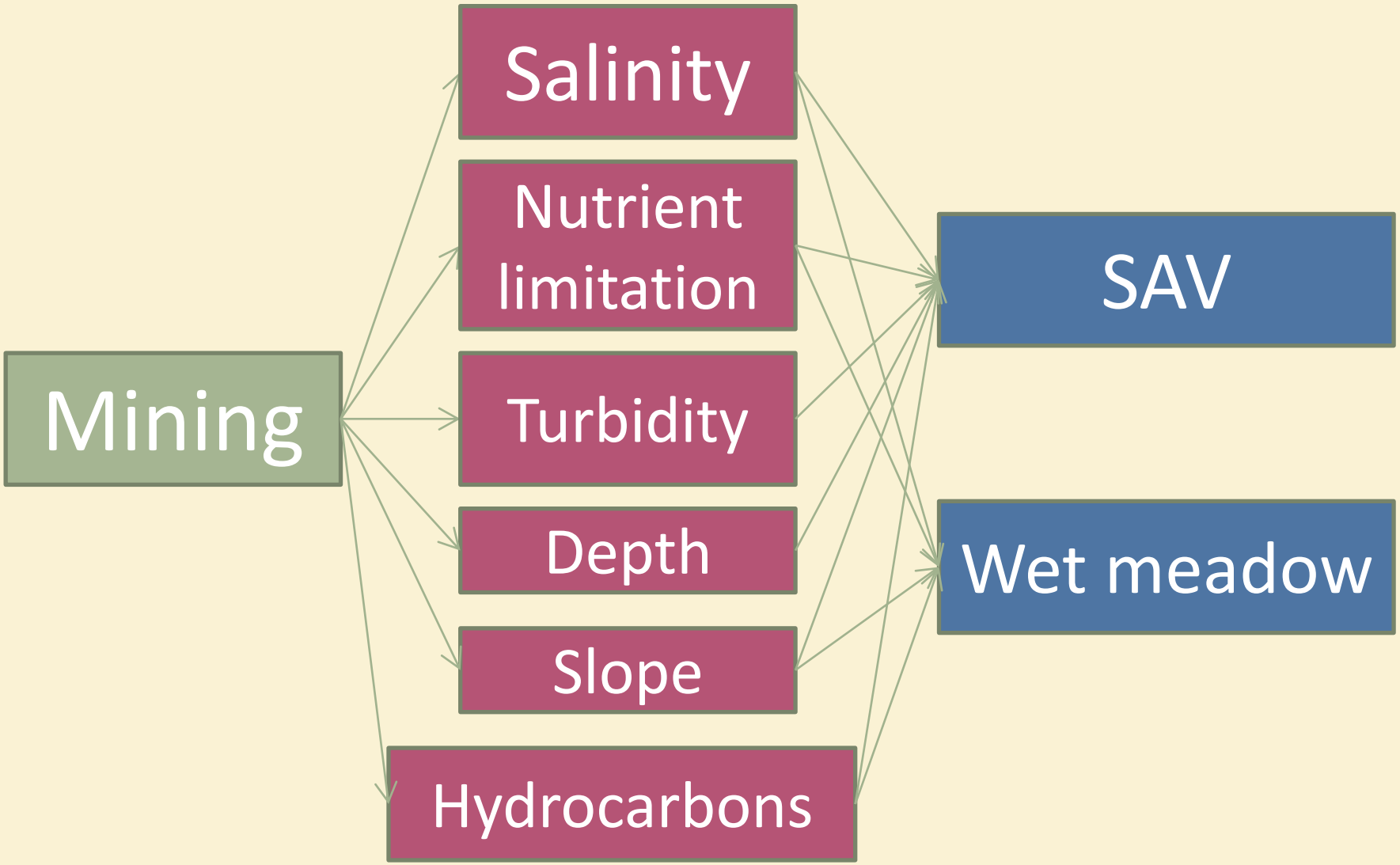
Component metrics

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

Reference
Physically disturbed
Tailings contaminated

Higher stress, lower “health”



Summary

- Oil sands mining causes massive loss of peatland
  - ~30,000 ha peatland destruction already approved
  - Functions and values of pealtand

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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Many field and lab assistants





CEMA Cumulative Environmental Management Association
Les Fiducies Killam Trusts
NSERC CRSNG
Alberta Innovates Technology Futures
Syncrude Securing Canada's Energy Future
SUNCOR ENERGY
NORTHERN SCIENTIFIC TRAINING PROGRAM
ACA grants in biodiversity
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