Water-level regime, redox conditions and decomposition in peatlands

Does hydrology control the carbon cycle?

Michel Vorenhout, Raija Laiho, Timo Penttilä, Petra Straková

MVH CONSULT

Luke
NATURAL RESOURCES INSTITUTE FINLAND

UNIVERSITY OF HELSINKI

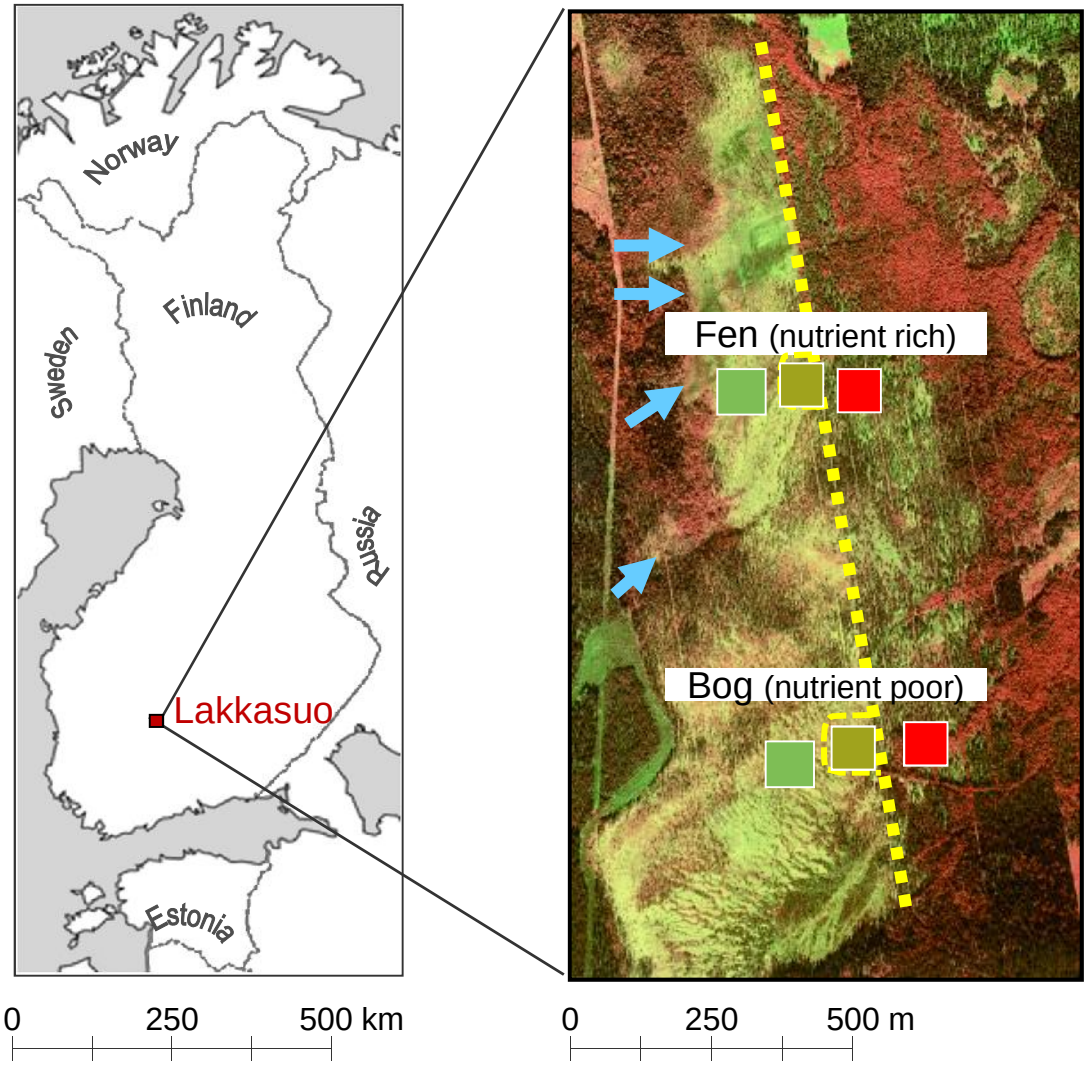
UNIVERSITY OF AMSTERDAM

Contents

1. NORTHERN PEATLANDS

With a focus on the Finnish Boreal peatlands

Study site: Lakkasuo South Finland (N. EU)

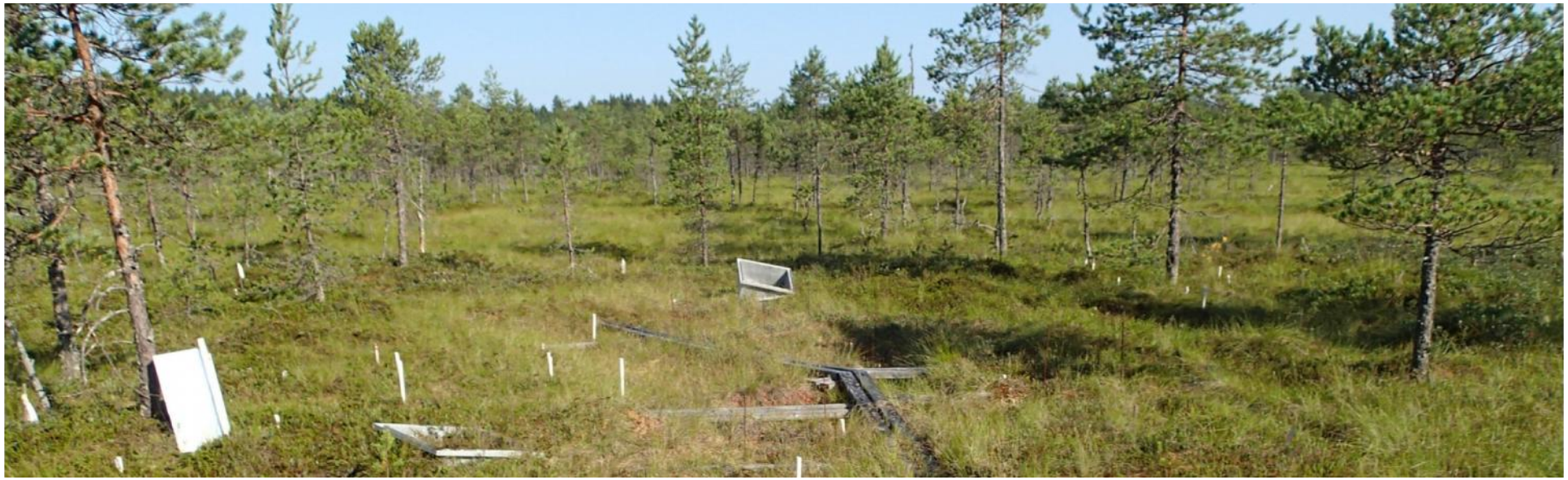


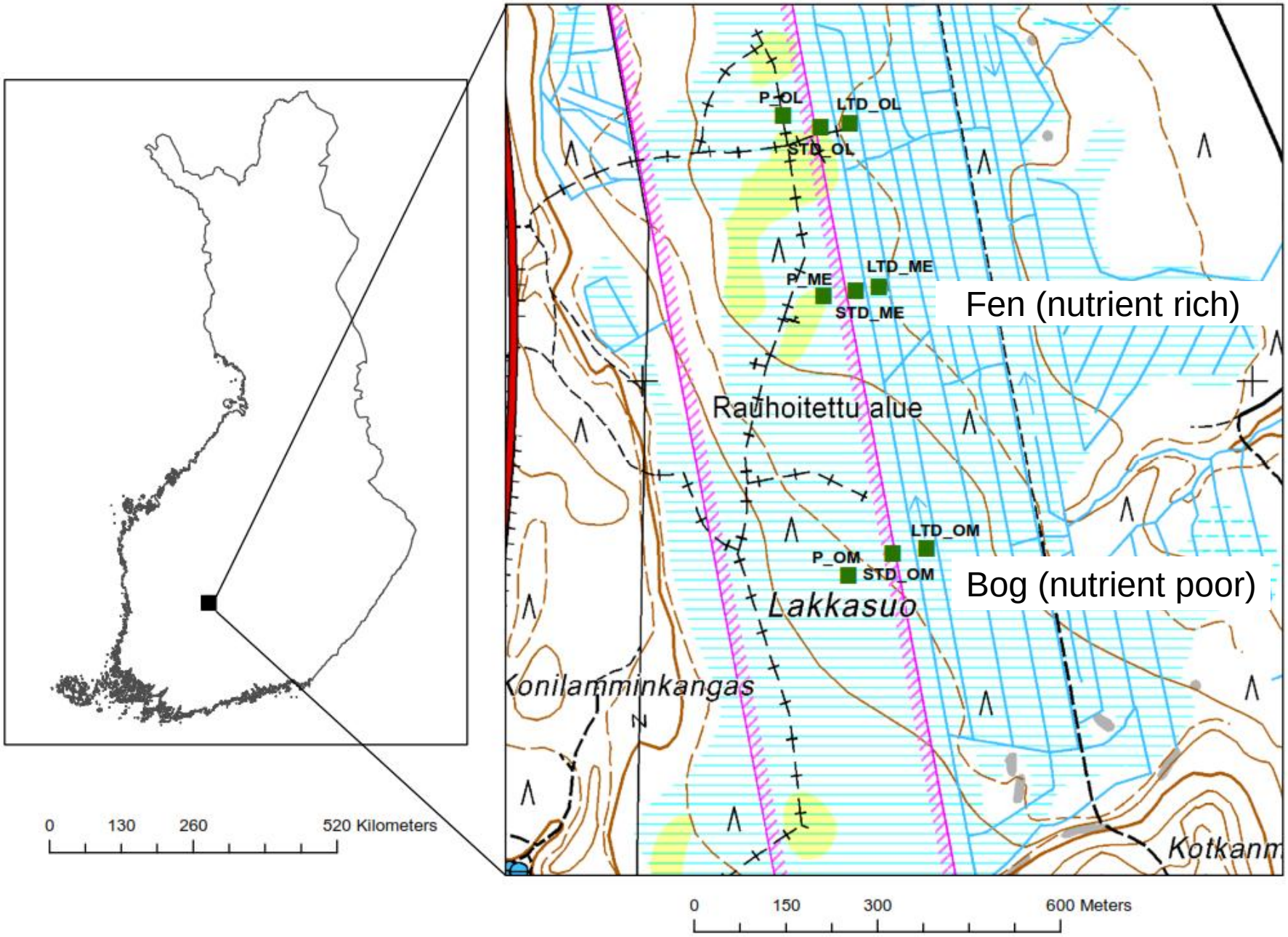
- Undrained (Pristine)
- Drained / STD (short term = years)
- Drained / LTD (Longterm = decades)

Straková 2010. Dissertationes Forestales 112

2. WATER LEVEL REGIME

And its effects on soil parameters




P_OL
LTD_OL
STD_OL
LTD_ME
P_ME
STD_ME
Fen (nutrient rich)
Rauhoitettu alue
LTD_OM
P_OM
STD_OM
Bog (nutrient poor)
Lakkasuo
Konilamminkangas
Kotkanm
0 130 260 520 Kilometers
0 150 300 600 Meters

What happens when a peatland is drained?

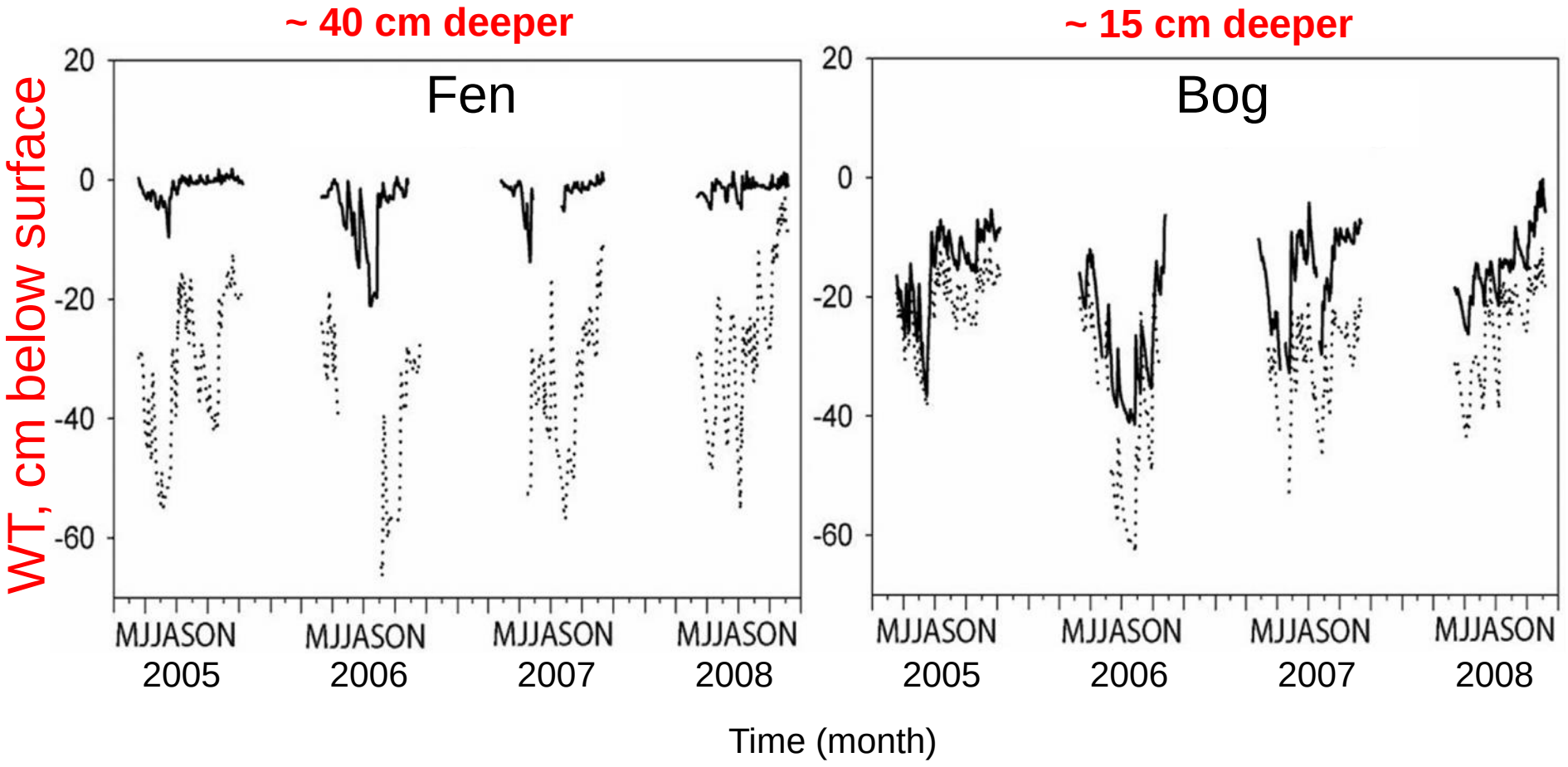
1. Less water leads to aeration
2. More oxygen in peat profile
3. Higher redox potential (Eh, mV)
4. Faster decomposition

Is this truly the case?

Wang, H., Richardson, C. J., & Ho, M. (2015). Dual controls on carbon loss during drought in peatlands. Nature Climate Change. doi:10.1038/nclimate2643

5. Long term effect of drainage needs to be taken into account

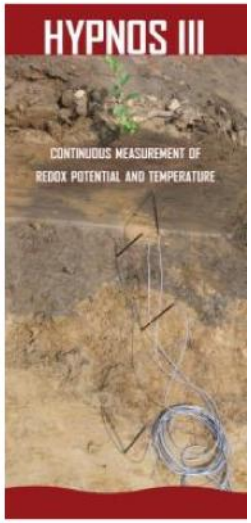
Water tables after drainage



Straková et al. 2012. Global Change Biology

Redox potential measurements

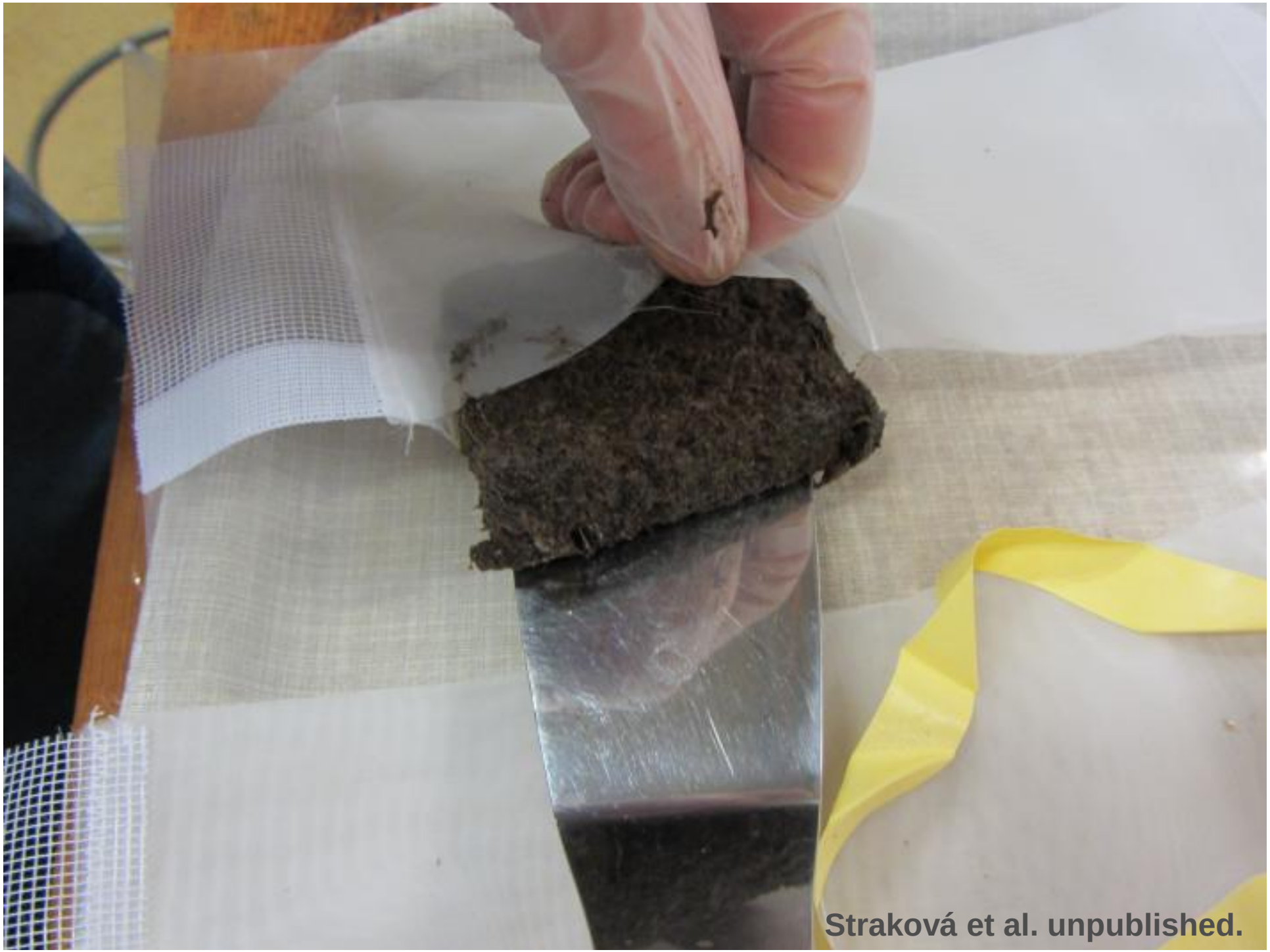
- Measurements Eh down to -50cm
- Hypnos redox/temp datalogger
- Measurement interval: 15 minutes

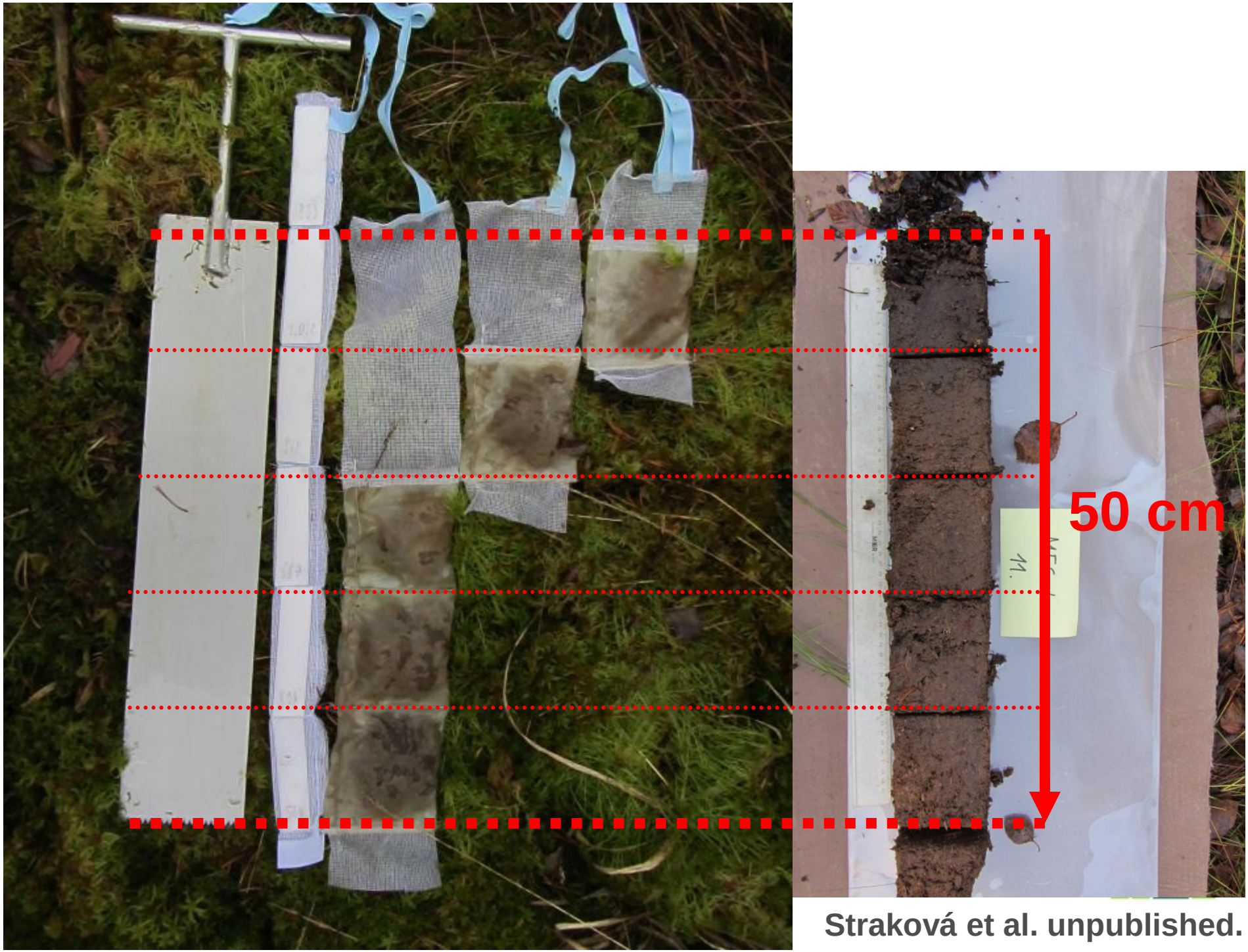


Raija installing Eh probes

Long Term Drained Site

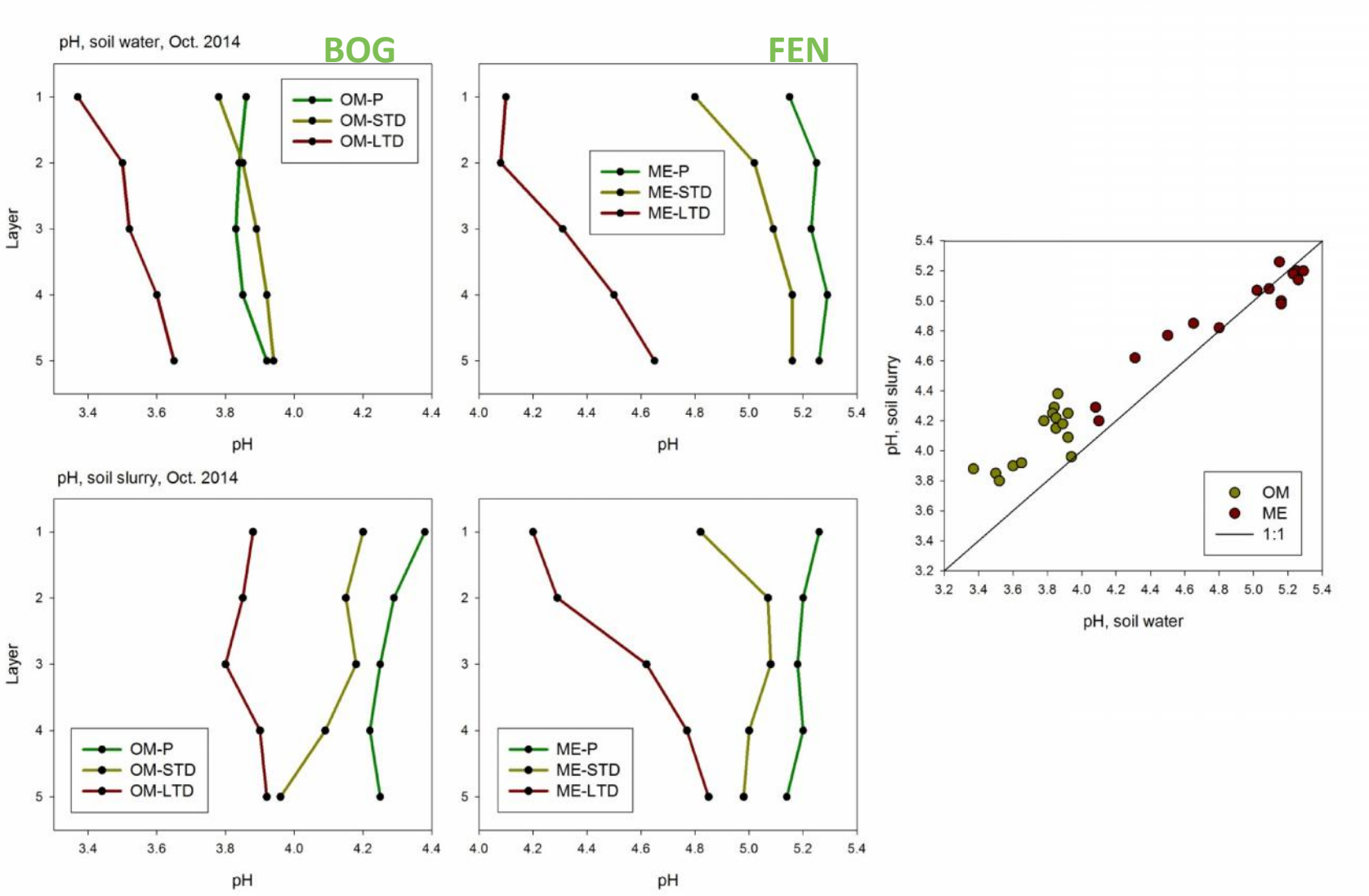

Straková et al. unpublished.


Straková et al. unpublished.

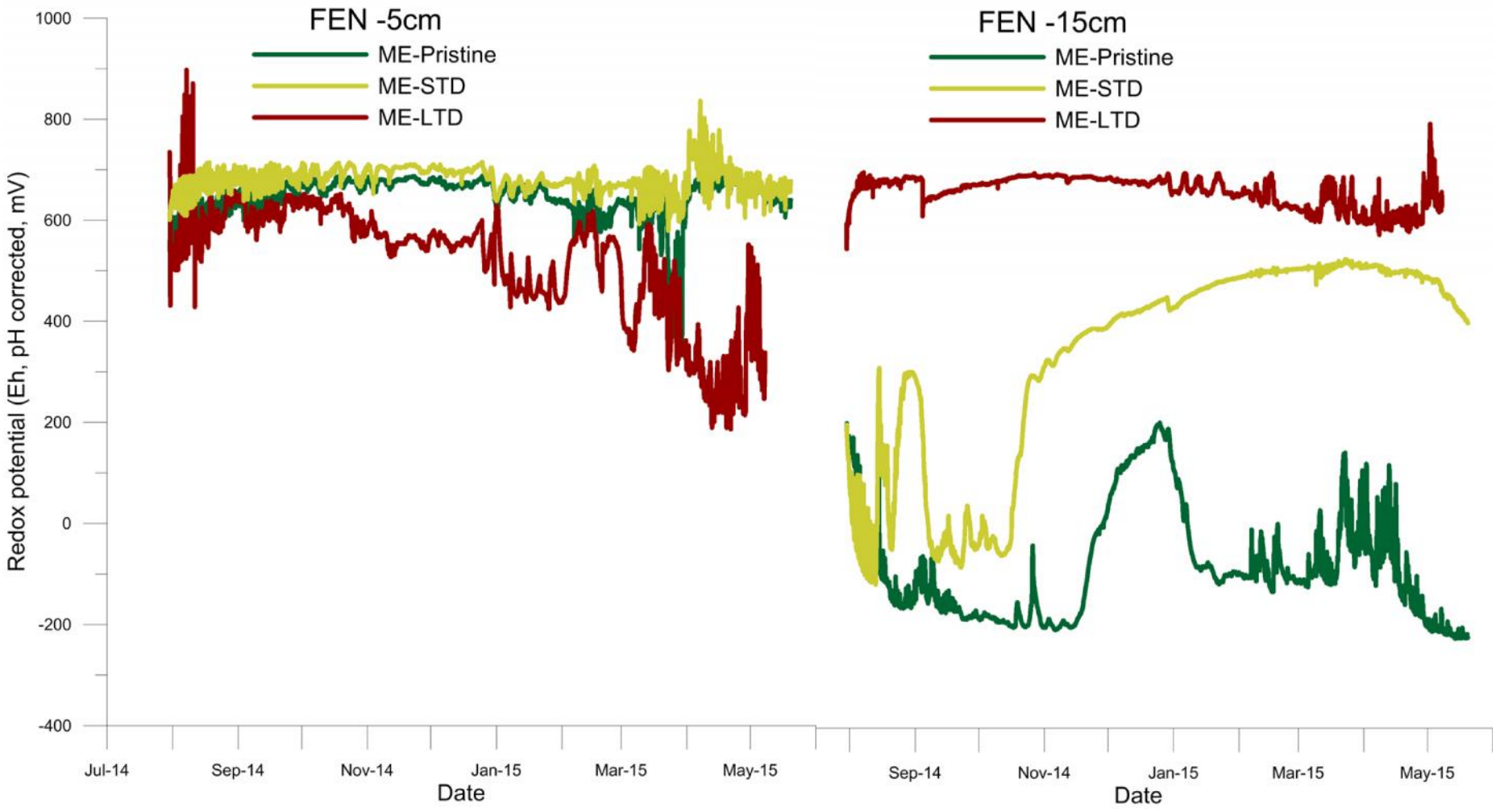


Straková et al. unpublished.

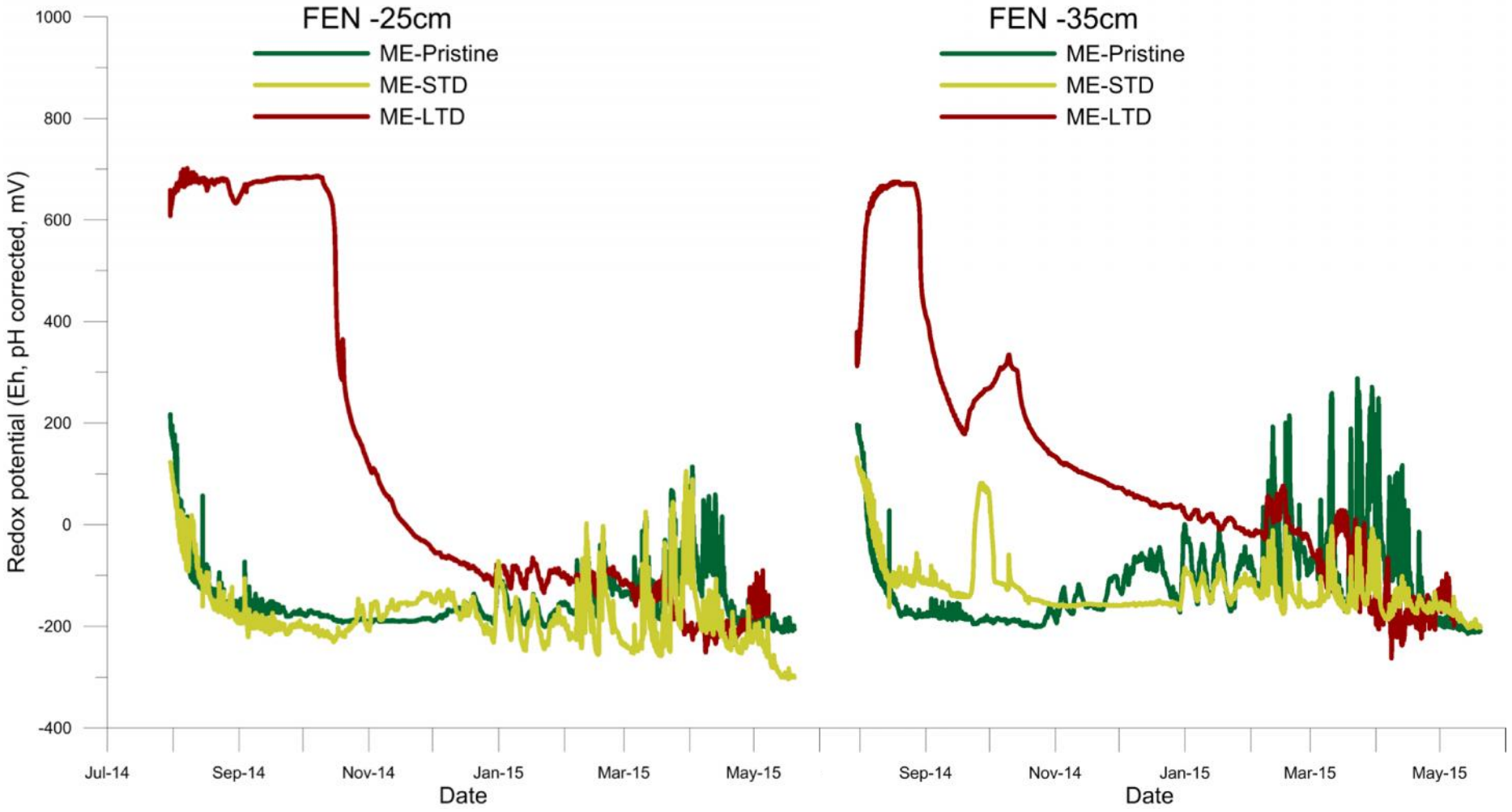
pH drops after drainage (Oct 2014)



Redox potentials in Fen (pH corrected, 1 yr)

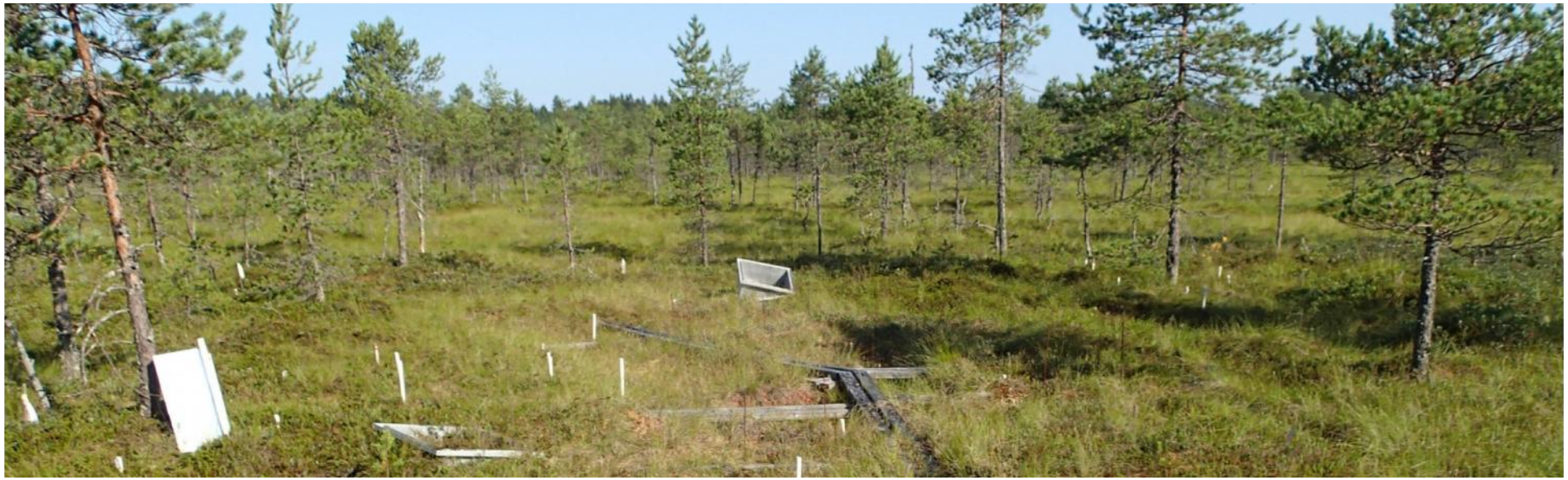


Redox potentials in Fen (pH corrected, 1 yr)

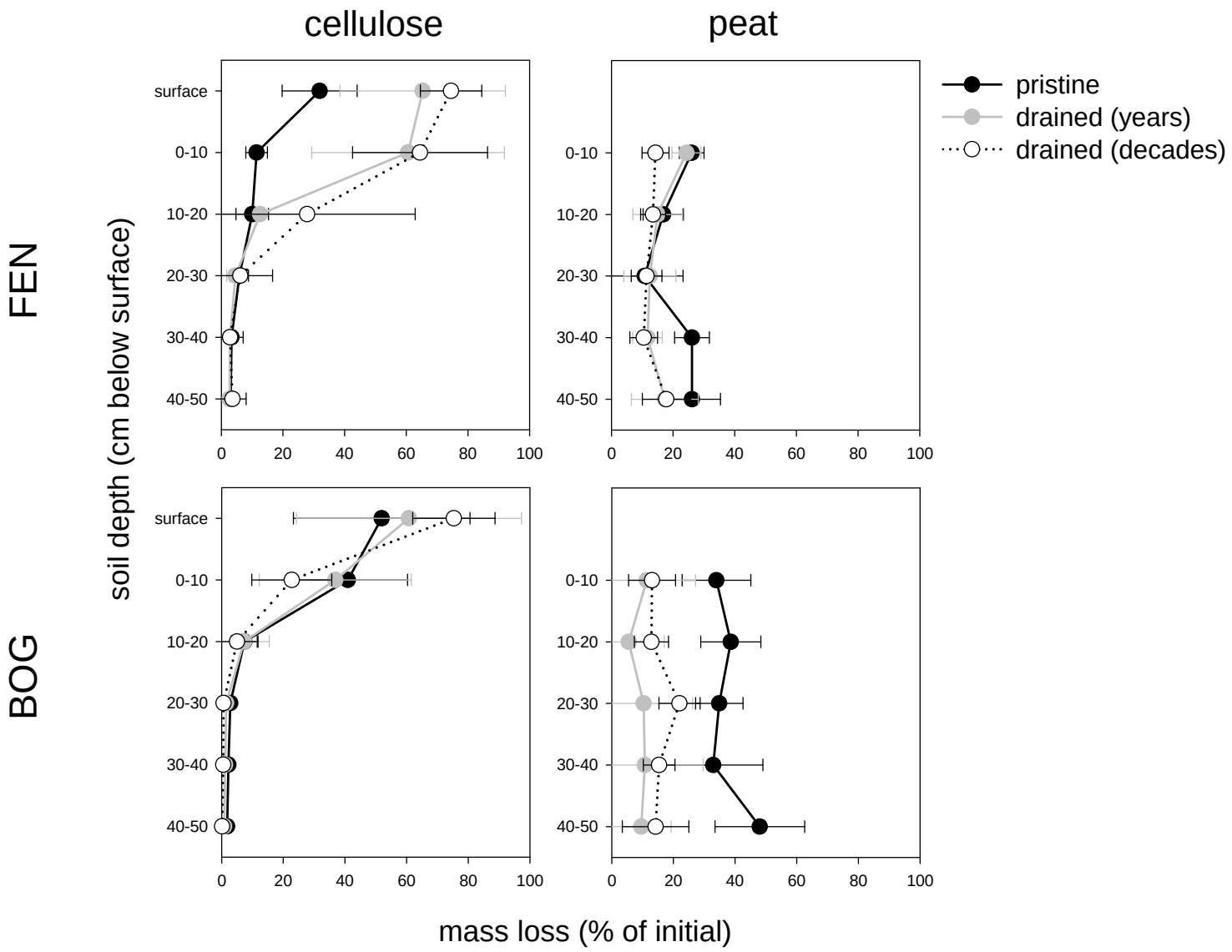


3. EFFECT ON DECOMPOSITION

And thus govern the carbon cycle ...



Decomposition rates (1 year)



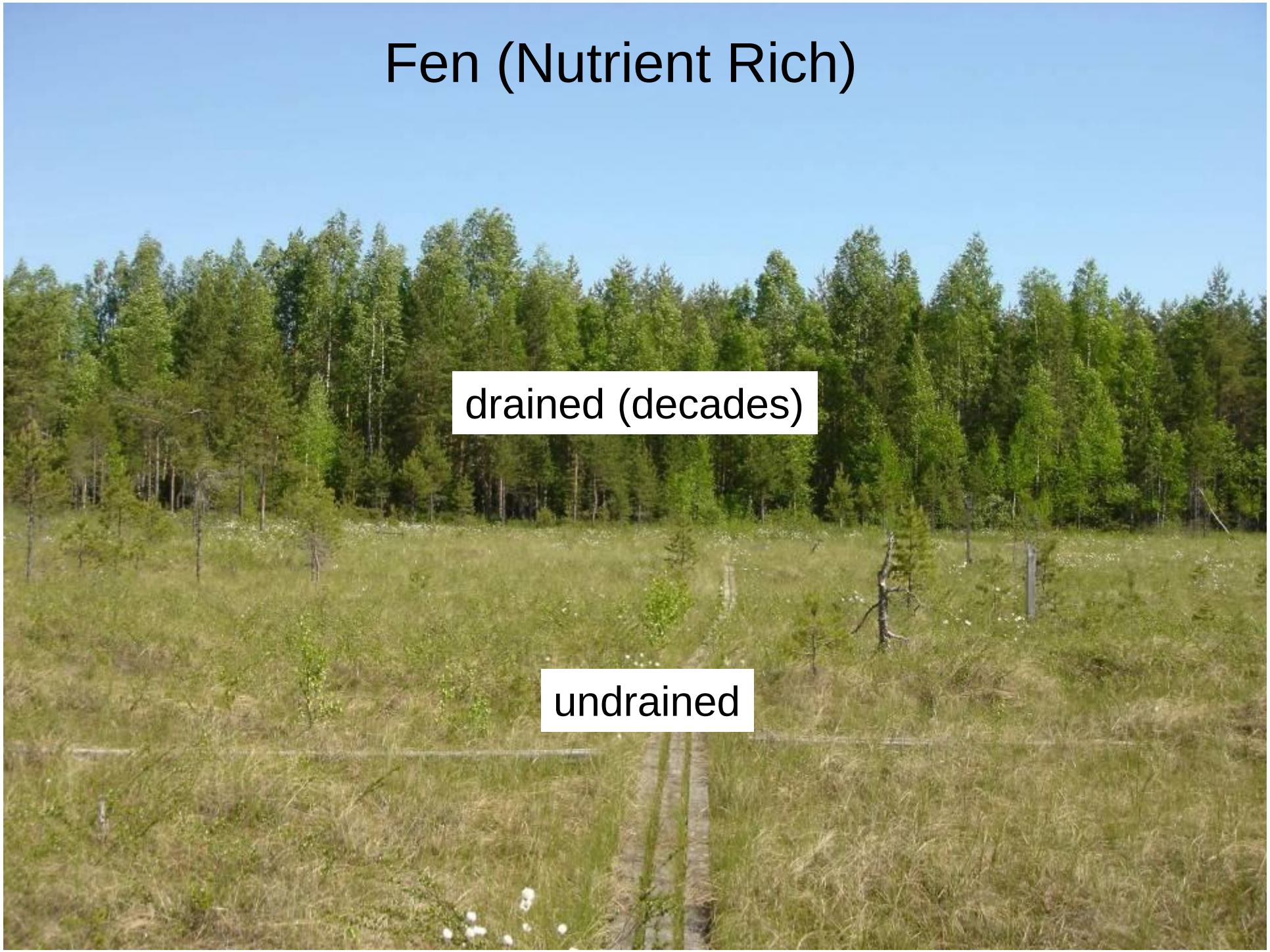
Decomposition: cellulose and local peat

- Mesh bags
- Uniform Pine cellulose used
  - Depth profile exists, Pristine Fen lower decomp.
- First year data being analyzed further
  - Peat shows similar mass loss in all sites through depth
    - » Effect of sampling and disturbance is larger than site effects for peat decomposition?
  - First year, out of three …
  - Extracellular enzymes for the microbial activity
    - » Both Protease and Urease activity higher in FEN top layers
    - » Activity in Bog layers shows less differences

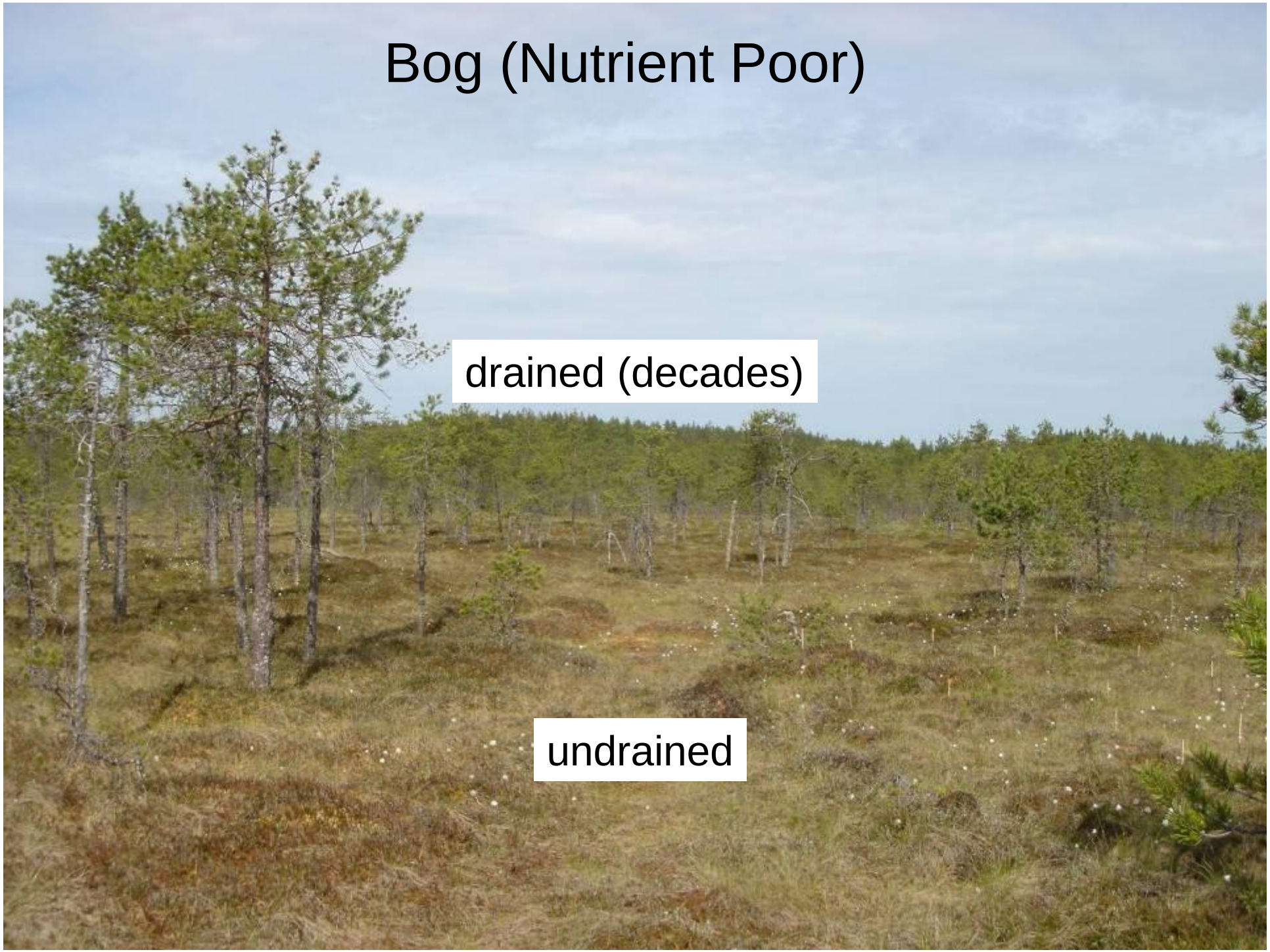
Why the slightly confusing patterns?

- Lower decomposition at higher redox potential for peat (but peat alone)
- The redox potential is a result of activity and it its turn influences activities as well.
  - Low redox: slower processes, or caused by activity?
  - Slowly dropping redox: electron acceptors are present (O_2, Fe, Mn, NO_3, CH_4)
- Other major cause?
  - Look for the obvious first

Fen (Nutrient Rich)



Bog (Nutrient Poor)

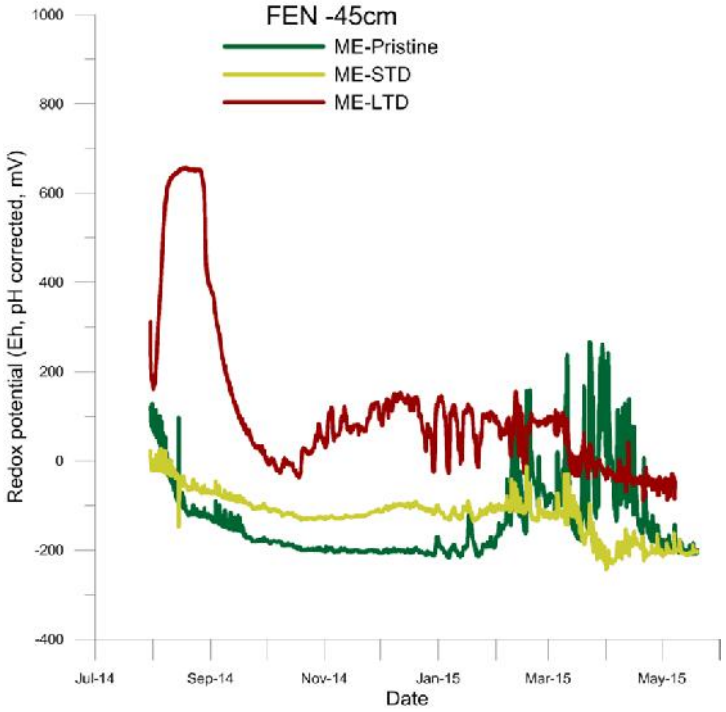


Drainage of fens and bogs

- Effects differ per site
  - Long and short term drainage effects the vegetation structure and quality
  - Fen or bog: nutrient status might influence decomposition
  - Take the history of site into account!
- The redox potential shows aeration at different layers per site
  - Pristine Fen shows variation, with +400 mV at some moments in top 10cm
  - Long Term Drained site shows +400mV values or above throughout the profile for part of the year
- Seasonal variation and interannual variation?
- First year out of three: be sure to check back!

Credits

- Valerie Vranová
- Ladislav Holik



Luke
NATURAL RESOURCES INSTITUTE FINLAND

UNIVERSITY OF HELSINKI

UNIVERSITY OF AMSTERDAM

References

Straková, P., Anttila, J., Spetz, P., Kitunen, V., Tapanila, T., & Laiho, R. (2010). Litter quality and its response to water level drawdown in boreal peatlands at plant species and community level. Plant and Soil, 335, 501–520. doi:10.1007/s11104-010-0447-6

Straková, P., Penttilä, T., Laine, J., & Laiho, R. (2012). Disentangling direct and indirect effects of water table drawdown on above- and belowground plant litter decomposition: Consequences for accumulation of organic matter in boreal peatlands. Global Change Biology, 18, 322–335. doi:10.1111/j.1365-2486.2011.02503.x

Vorenhout, M., van der Geest, H.G. & Hunting, E.R., 2011. An improved datalogger and novel probes for continuous redox measurements in wetlands. International Journal of Environmental Analytical Chemistry, 91(7-8), pp.801–810. doi: 10.1080/03067319.2010.535123