Assessing the efficiency in detecting long-term soil change

with the Quebec Forest Ecosystem Study and Monitoring Network (RESEF)

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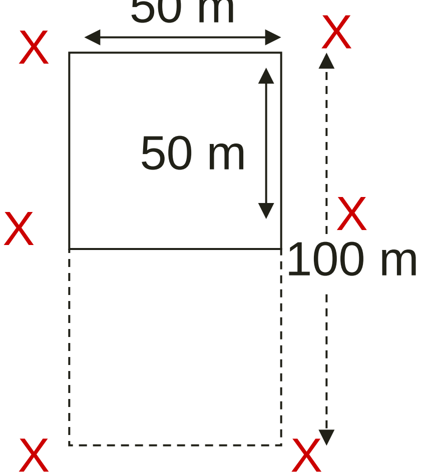
Ressources naturelles Québec

NESMC, USGS Troy NY, March 21 2013

Forest Ecosystem Study and Monitoring Network (RESEF)

- Started in 1986
- 42 plots
- 4 to 6 soil profiles / 10 yrs
- Enlargement to the north 2008-2013



Conifers: 0.25 ha
Deciduous: 0.5 ha

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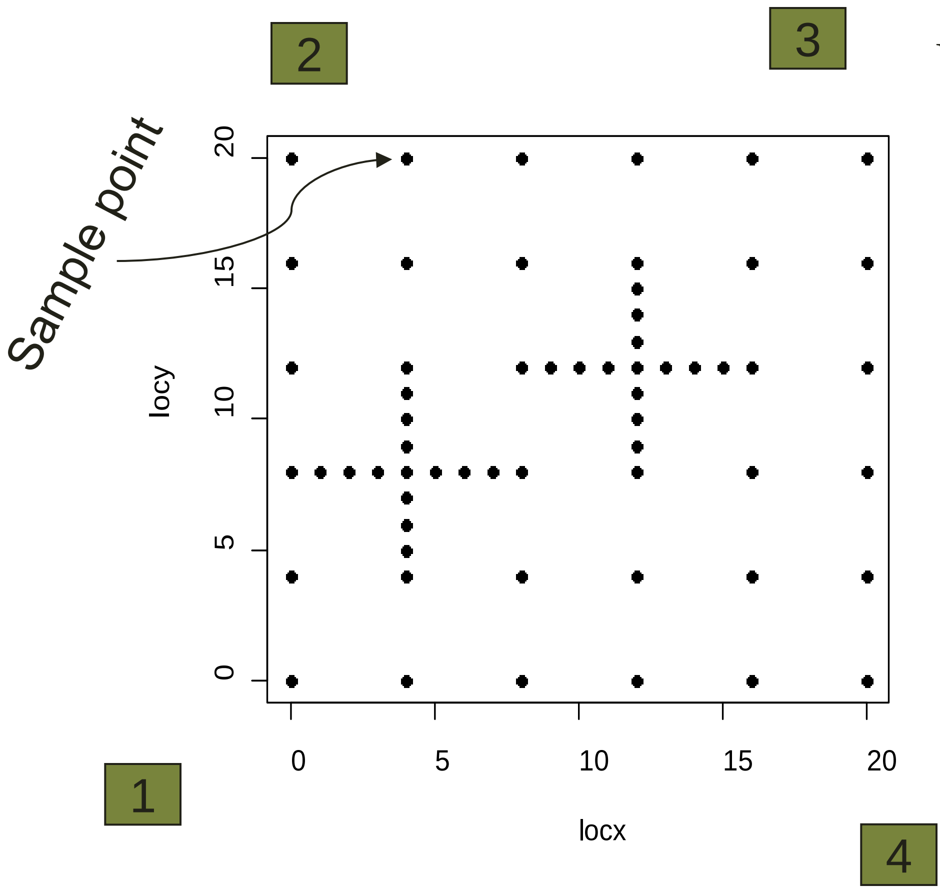
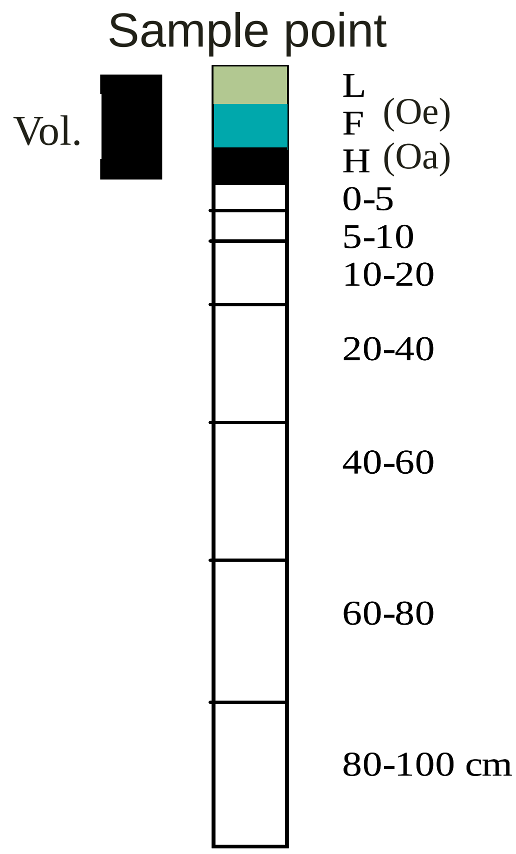
Forest Ecosystem Study and Monitoring Network (RESEF)

- 2002: new soil monitoring design





<u>First sampling</u>

- 60 sample points
- Forest floor stock with a core sampler
- Spade & auger
- 4 suppl. profiles

<u>Next samplings</u>

- interval: 10 yrs
- 10 new sample points distanced by at least 1 m

<u>Lifespan</u>

- 380 yrs

2002:

Plot

301


2002: Plot 301

Plot 301,profile 1

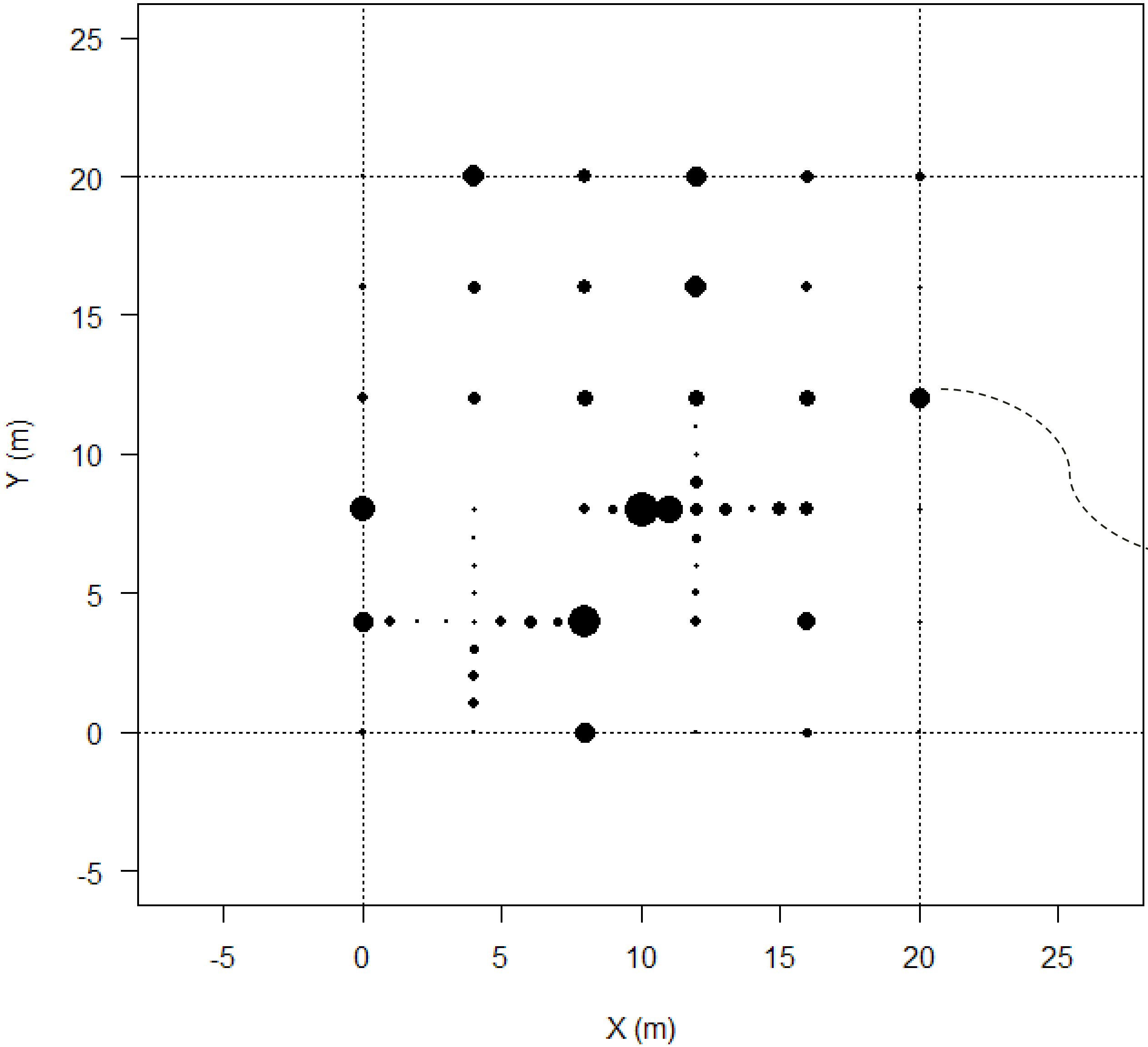
Volumetric FF sampling


2002: Plot 301
The first 20 cm


2002: Plot 301
20-40 cm


2002: Plot 301
Tree position

RESEF soil monitoring plot



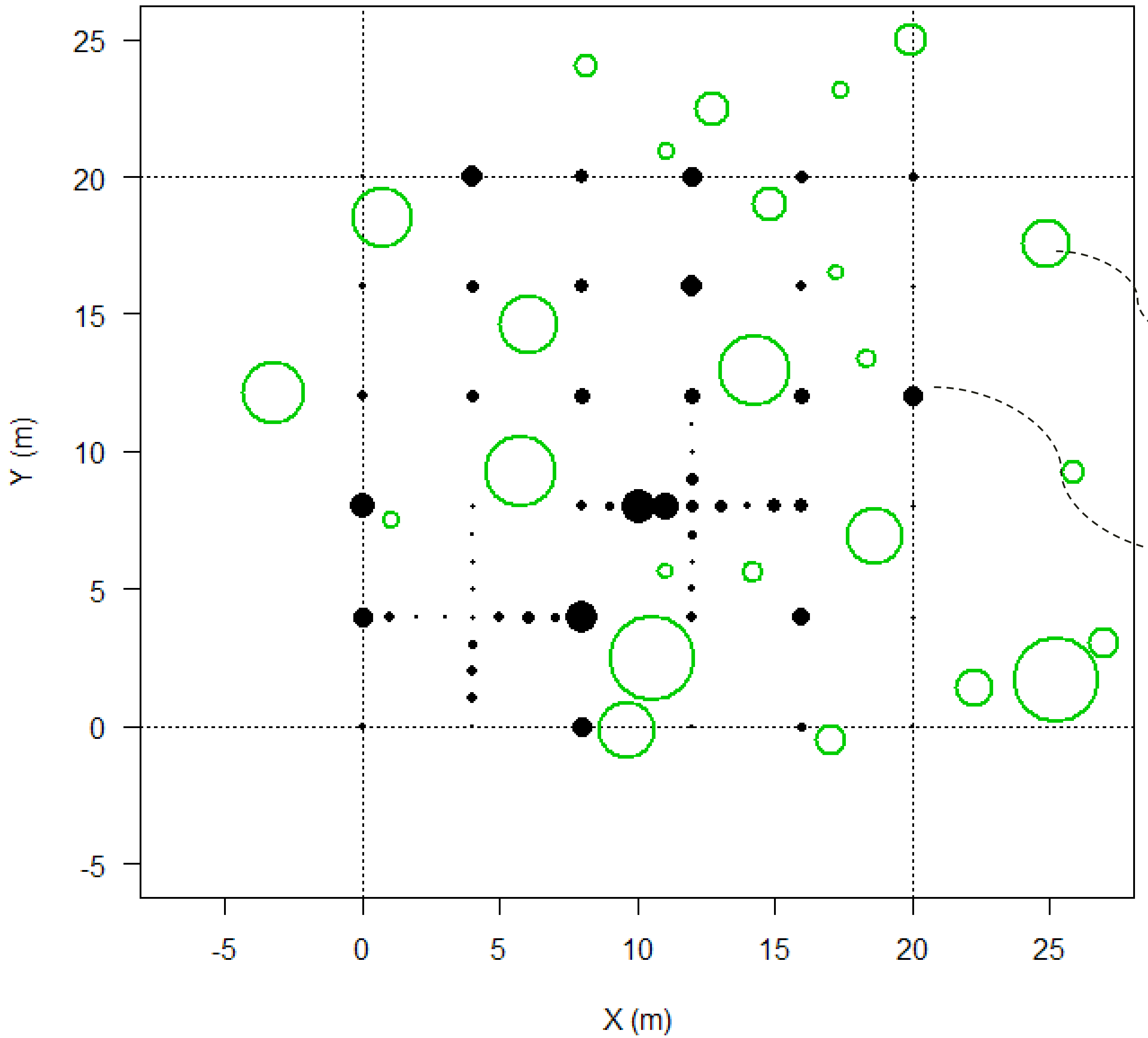
2002

Plot 301

Trees > 1 cm at DBH

[Ca] 0-5 cm depth
(range: 21 - 264 mg/kg)

RESEF soil monitoring plot



2002

Plot 301

Trees > 1 cm at DBH

Sugar maple

[Ca] 0-5 cm depth
(range: 21 - 264 mg/kg)

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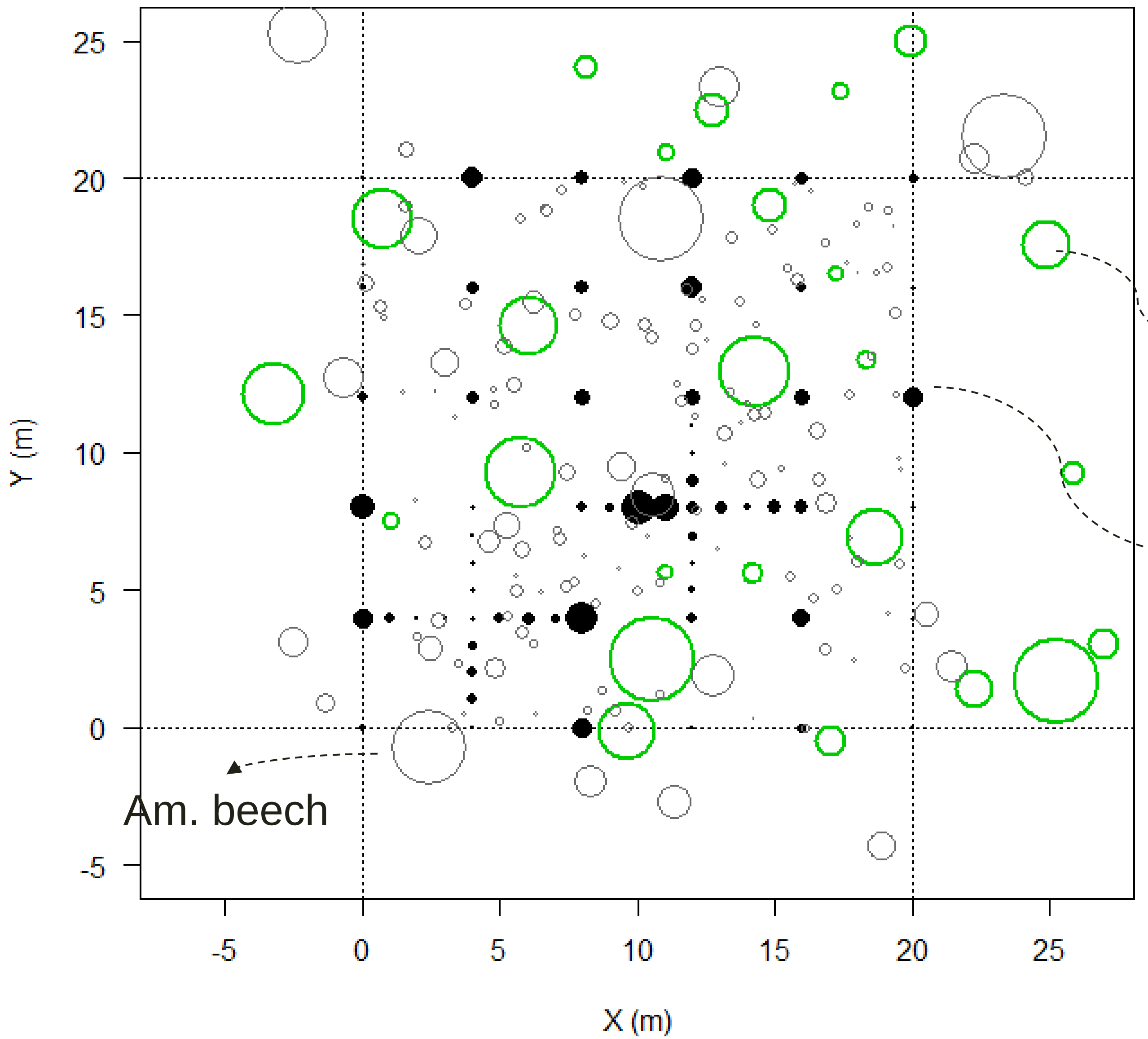
RESEF soil monitoring plot



2002

Plot 301

Trees > 1 cm at DBH

Sugar maple

[Ca] 0-5 cm depth
(range: 21 - 264 mg/kg)

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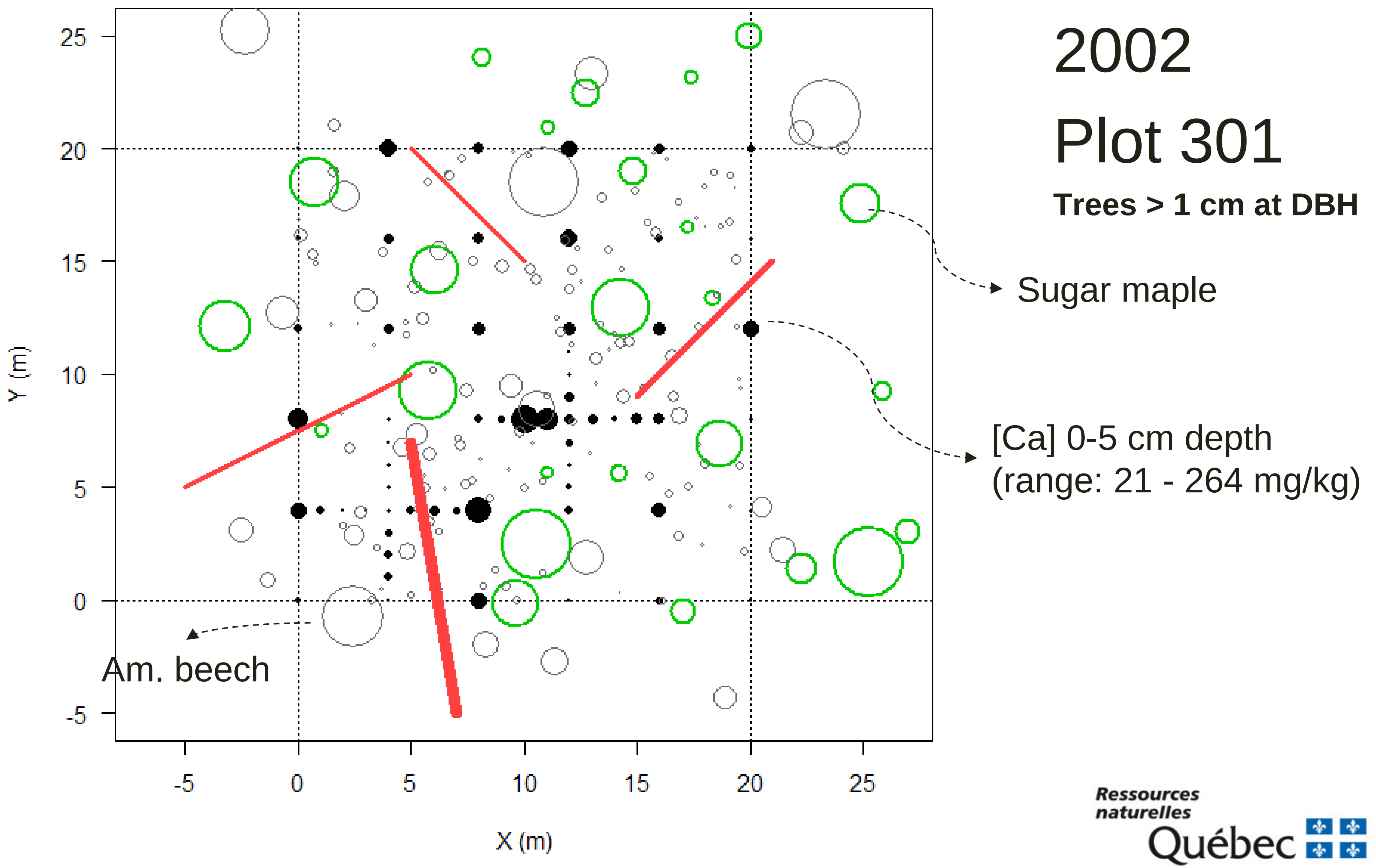
RESEF soil monitoring plot



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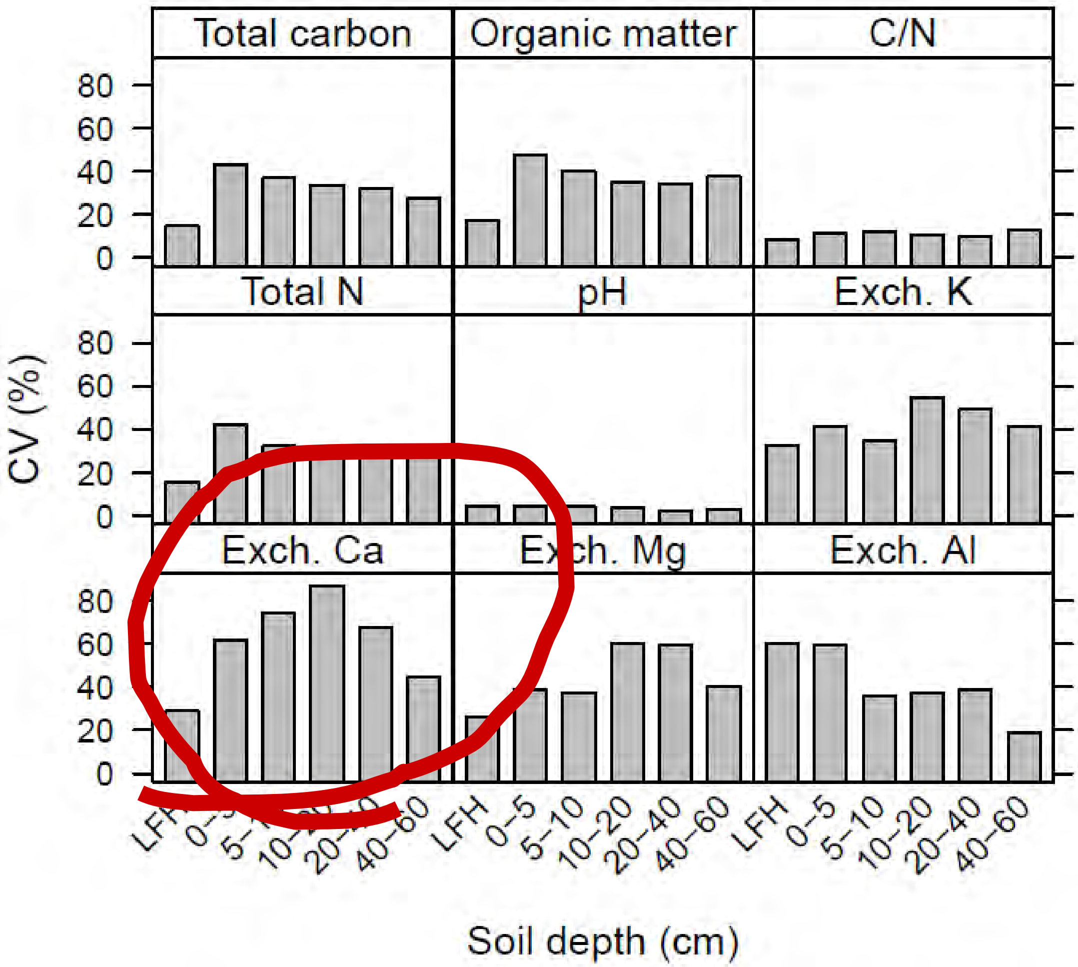
RESEF soil monitoring design

How good is it?

Plot 301

N=60



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Statistical analysis

- By generalized least squares (GLS)

  Possibility to include

  - appropriate variance component structures in the analyses (control for heterogeneity),
  - covariance component structures such as as spatial (control for dependencies),
  - and effects of environmental variables such as microtopography, distance from trees, and space can thus be isolated from the time effect.

Statistical analysis

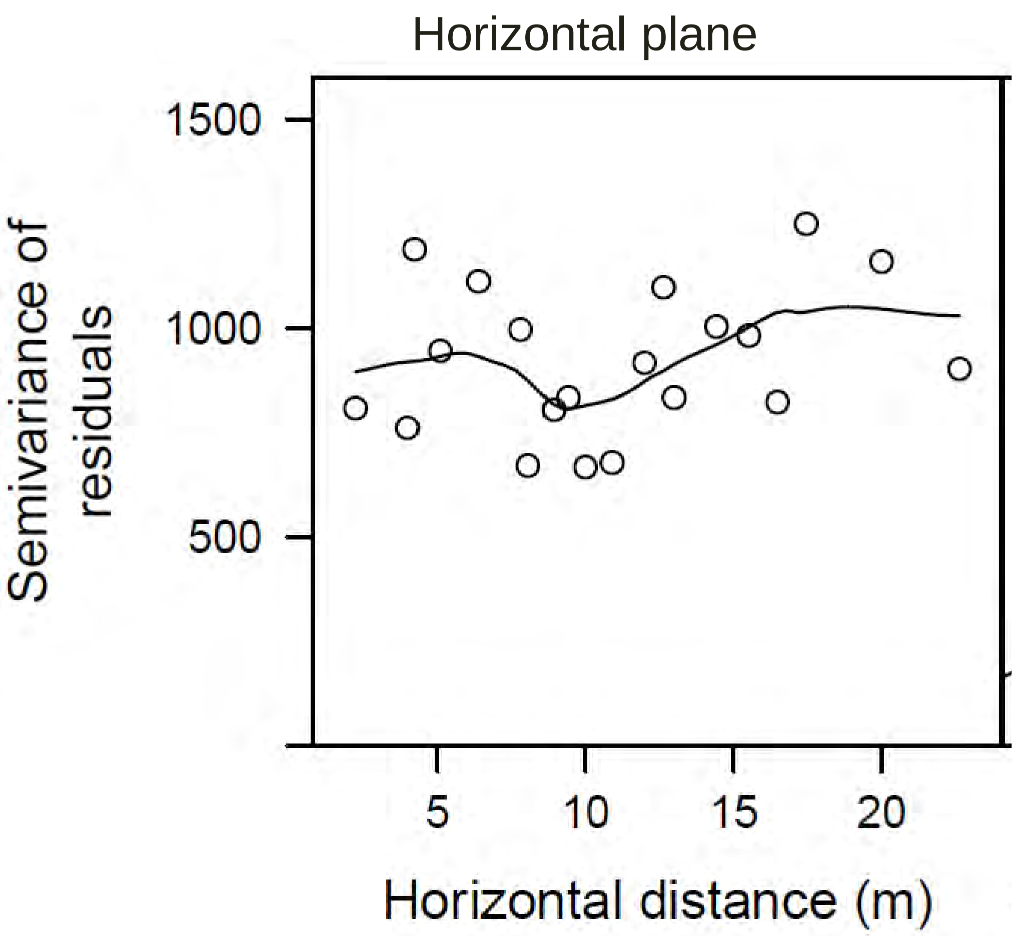
- Simple linear model (LM): Ca = a + b ln(depth) + e

- GLS model: Ca = a + b ln(depth) + e,

    + Spatial correlation structure (e) = Gaussian(~ln(depth) / point)

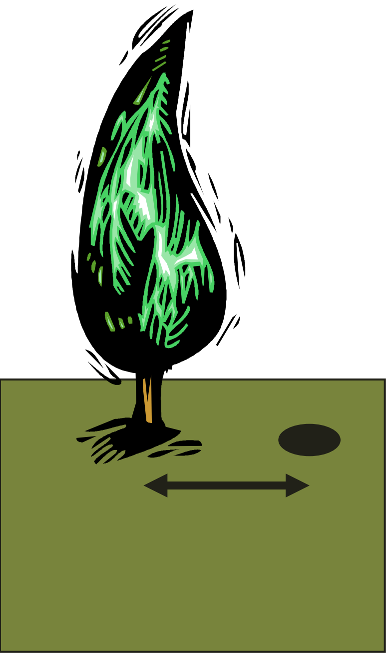
    + Variance component structure (e) = Exp(~ln(depth) / closest merchant tree species)

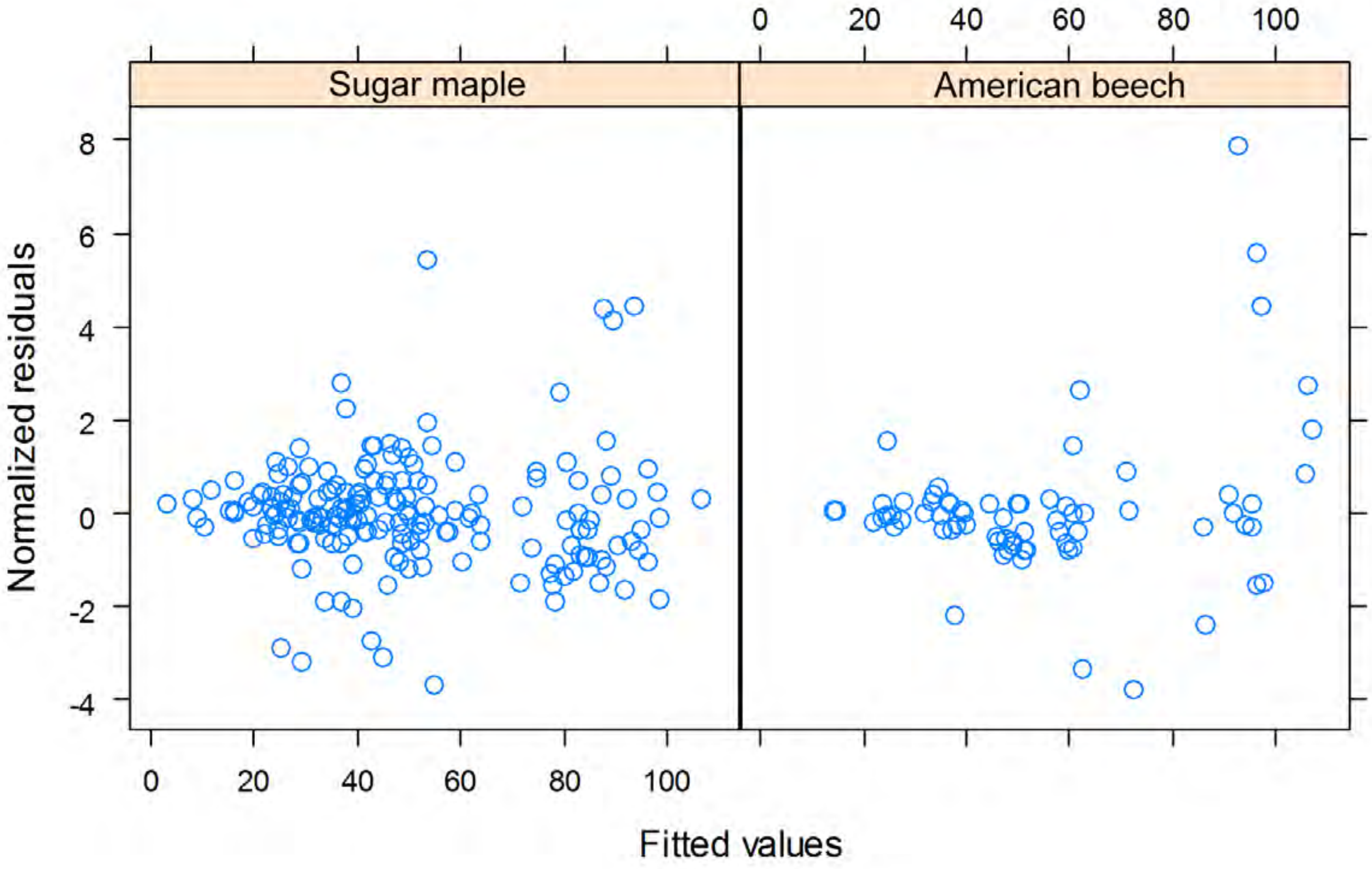
Spatial correlation structure of [Ca] (e)



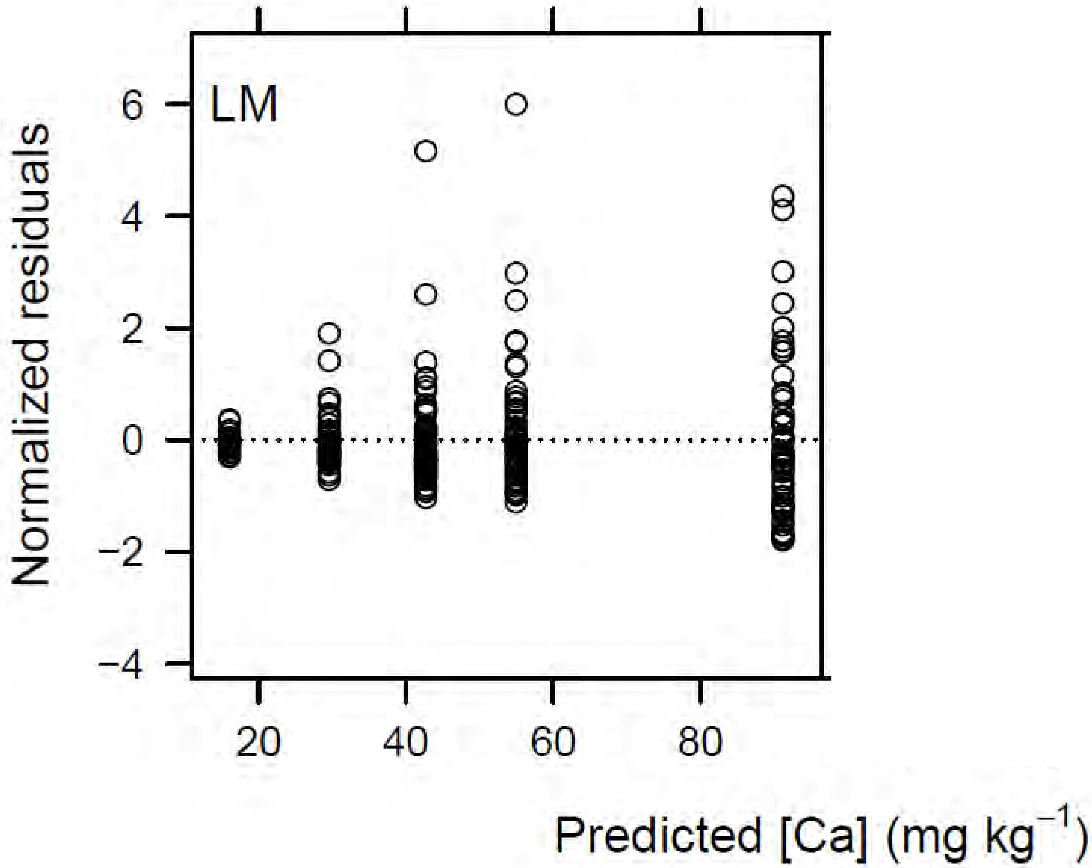
Variance component structure of [Ca] (e)

Closest merchant tree species (DBH > 9 cm)

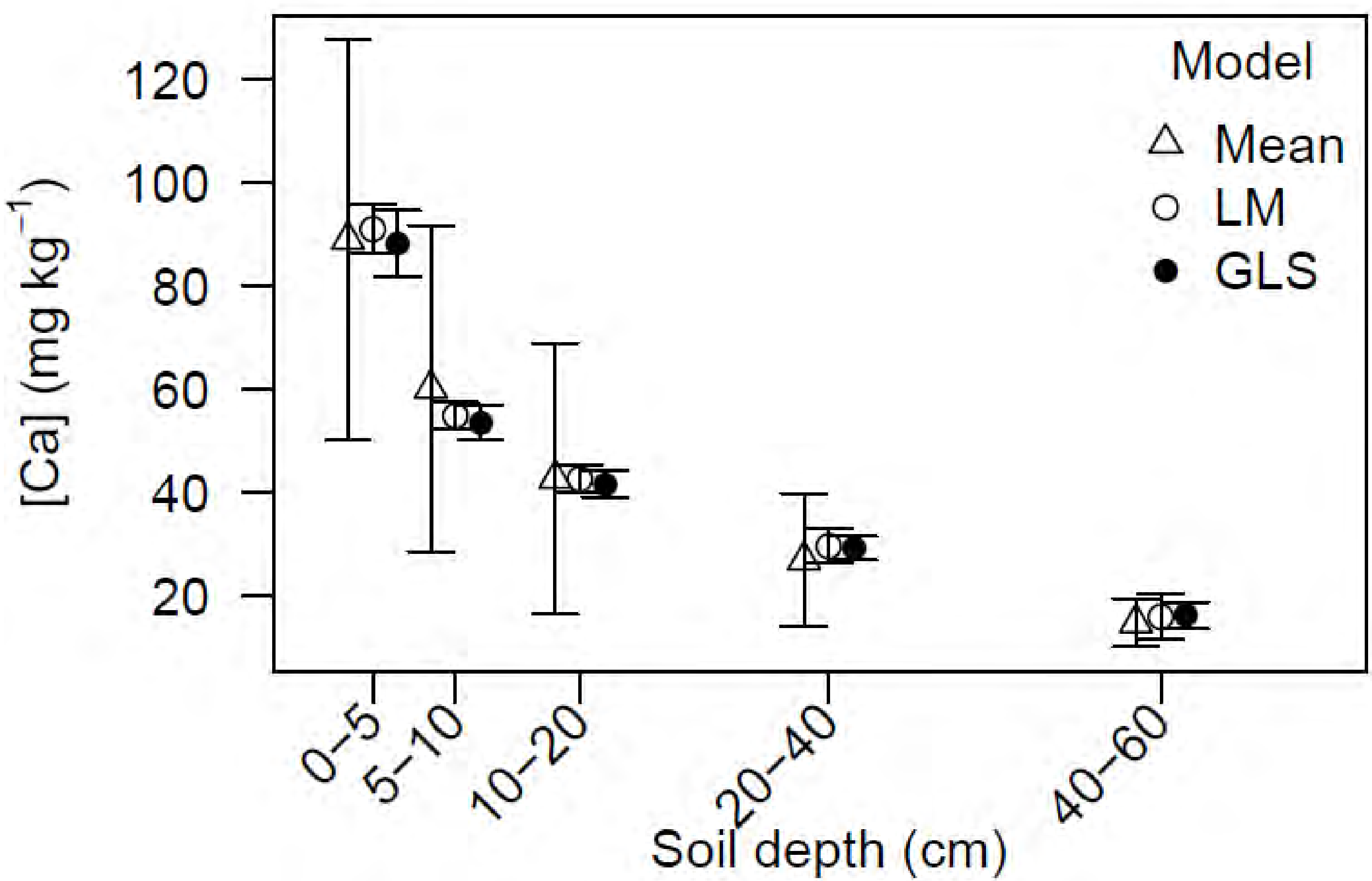




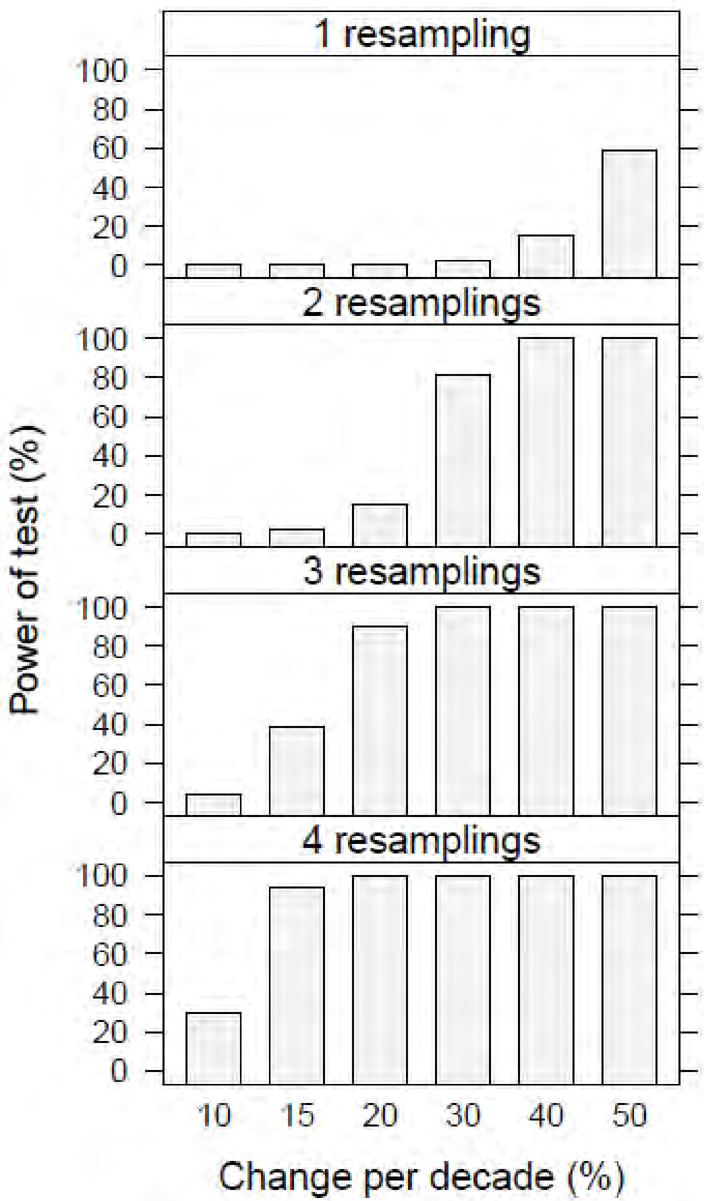
Analysis of residuals (final model)



Soil [Ca] with depth



Power of GLS model of [Ca] over time



- Monte Carlo simulations (1000 GLS runs/resampling)
- 10 new sampling points per decade
- The setup can detect ecologically meaningful [Ca] changes of 20 % or 15 % per decade in the mineral soil after at most three to four resamplings respectively.
- These changes are smaller than those observed by Bailey et al. (2005) in the surface Oa/A layer over 30 years in northern hardwood and mixed oak forests in Pennsylvania, USA (38% decrease in [Ca] per decade).

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21-77
C-3143
C-3143
21-66
C-3137
C3137
21-74
C-3139

Conclusion

- At least three resamplings will be necessary to detect ecologicaly meaningful changes in [Ca] in plot 301.
- The efficiency of the current monitoring design is acceptable.
- The monitoring of covariables, such as the position of trees, their growth and species, is important in order to explain the possible changes in soils that may happen in the future.


RESEF Plot 1002
Rupert River
Thank you
for your attention!