Where does added N go in a N-rich forest?

Lars Högbom[1], Olle Rosenberg[1], Ulf Sikström[1], Tryggve Persson[2], Hagos Lundström[1] & Sten Nordlund[1]

[1]The Forestry Research Institute of Sweden
[2]Swedish University of Agricultural Science

Background

- There are a general lack of field experiments using low additions of N.
- Lack of experiments with both low and ”normal” N fertilisation.
- Important knowledge are lacking on how the size of the N addition affect soil processes.

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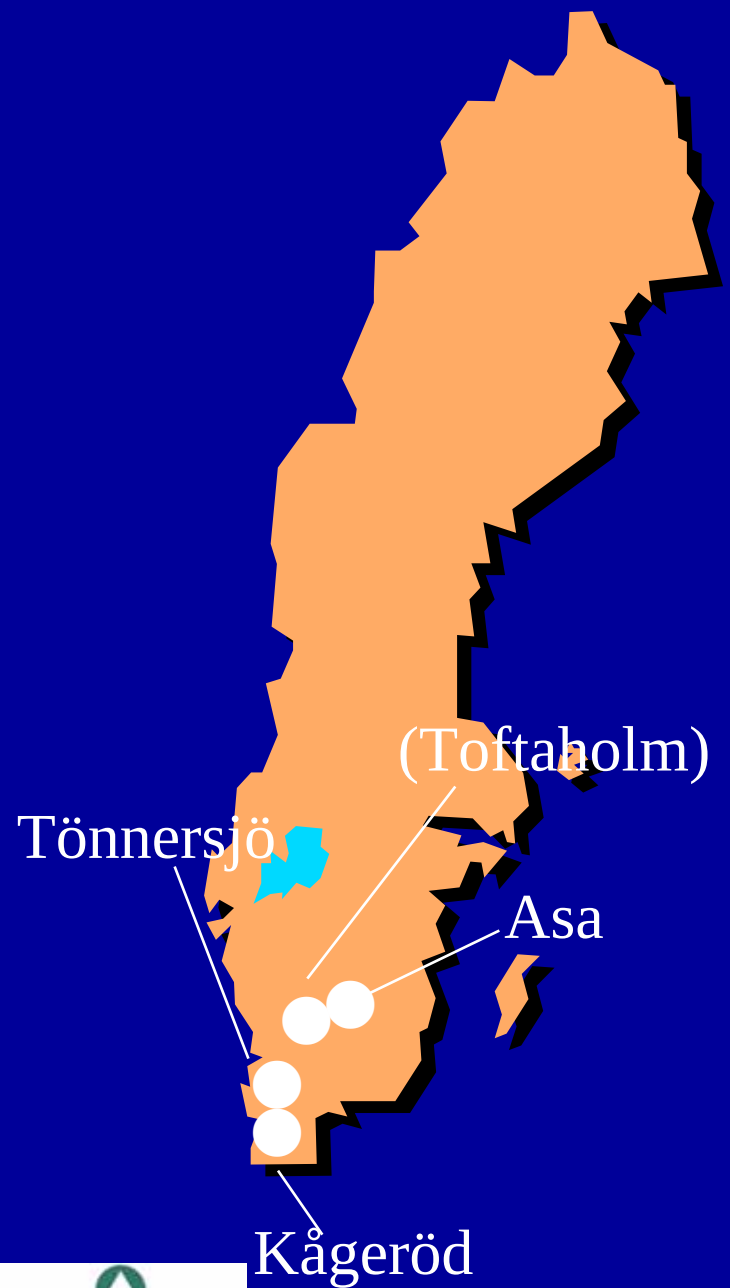

N-saturation experiments

- ✓ Two deposition levels: high and moderate N deposition.
- ✓ One productive and one very productive site at each of the deposition levels.
- ✓ The experiments started in 2001.
- ✓ Unfortunately of the sites was ruined by a storm in 2005.

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Questions

- How far from so called N-saturation are the forests in south west Sweden?
- The effect of the application rate?
- How is forest production affected by N deposition?
- Effects on field- and bottom layer plants?
- Effects on soil and soil solution chemistry by low dose additions?

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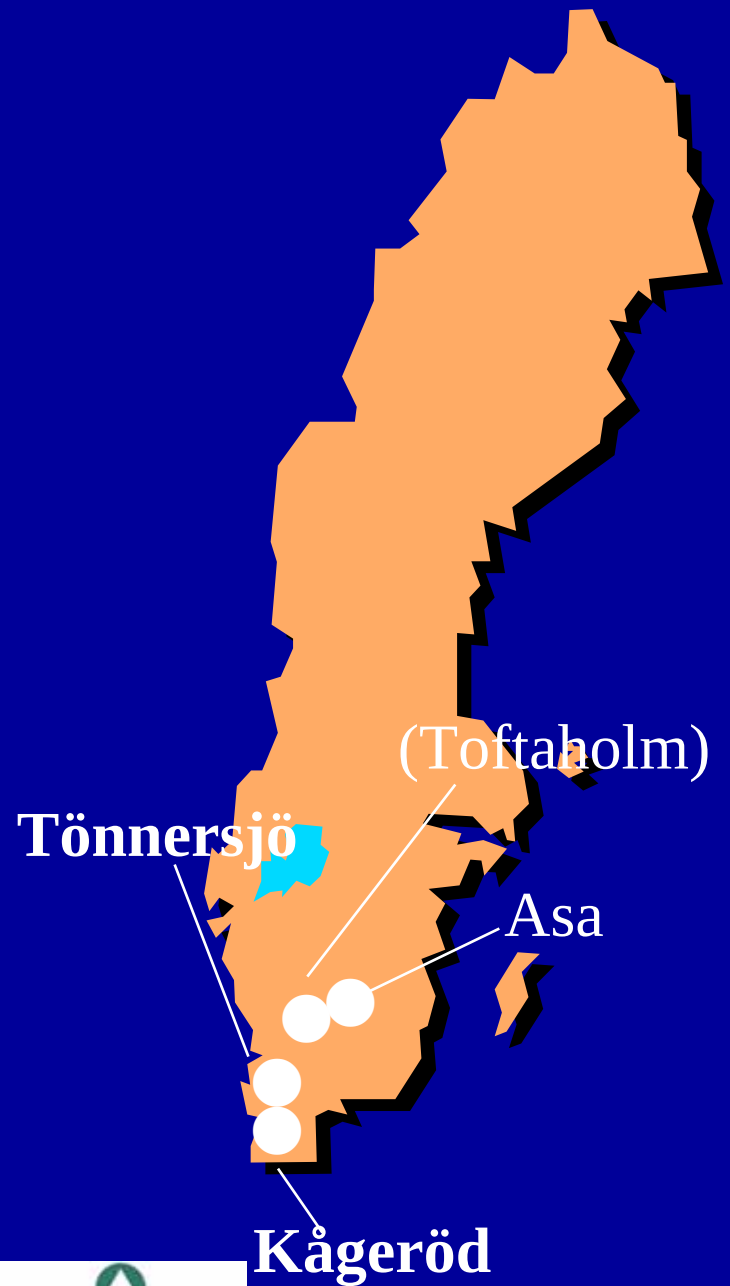

Experimental set-up

Control

20 kg N ha^{-1} annually

60 kg N ha^{-1} every 3:rd year

120 kg N ha^{-1} every 6:th year

Three blocks at each site

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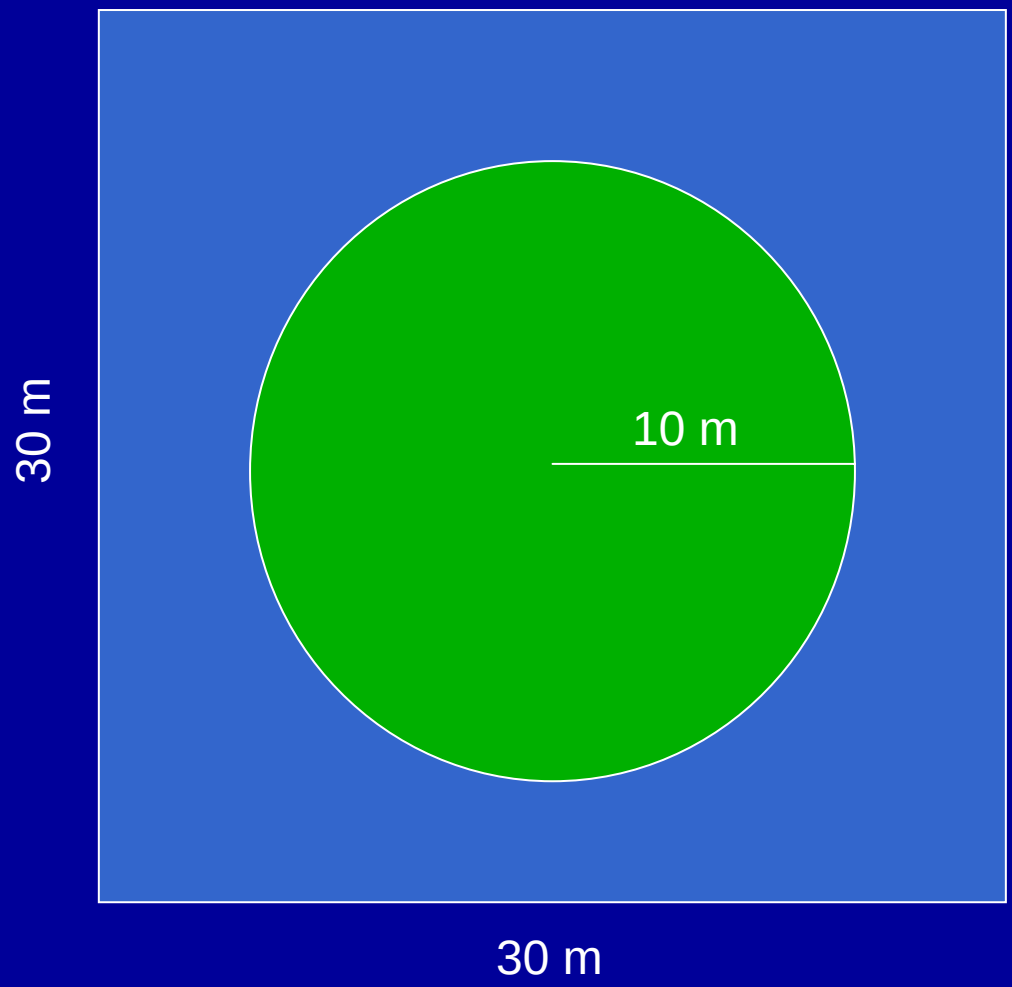
Plot setup



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Deposition

N-deposition (kg N ha^{-1})	Productivity: High	Productivity: Medium
"High"	**266-Kågeröd** OF 11.4 kg N ha^{-1} TF 9.2 kg N ha^{-1} % NH_4 = 50%	**267-Tönnersjö** OF 12.7 kg N ha^{-1} TF 7.7 kg N ha^{-1} % NH_4 = 50%
Medium	**268-Toftaholm** OF 9.3 kg N ha^{-1} TF 2.0 kg N ha^{-1}	**265-Asa** OF 7.8 kg N ha^{-1} TF 2.1 kg N ha^{-1}

Stand descriptions

Site	Age	Standing volume (m^3)	Basal area increment
Kågeröd	33	260	8.06
Tönnersjö	39	160/250	4.63
Asa	39	180	4.36
Toftaholm	40	240	5.27

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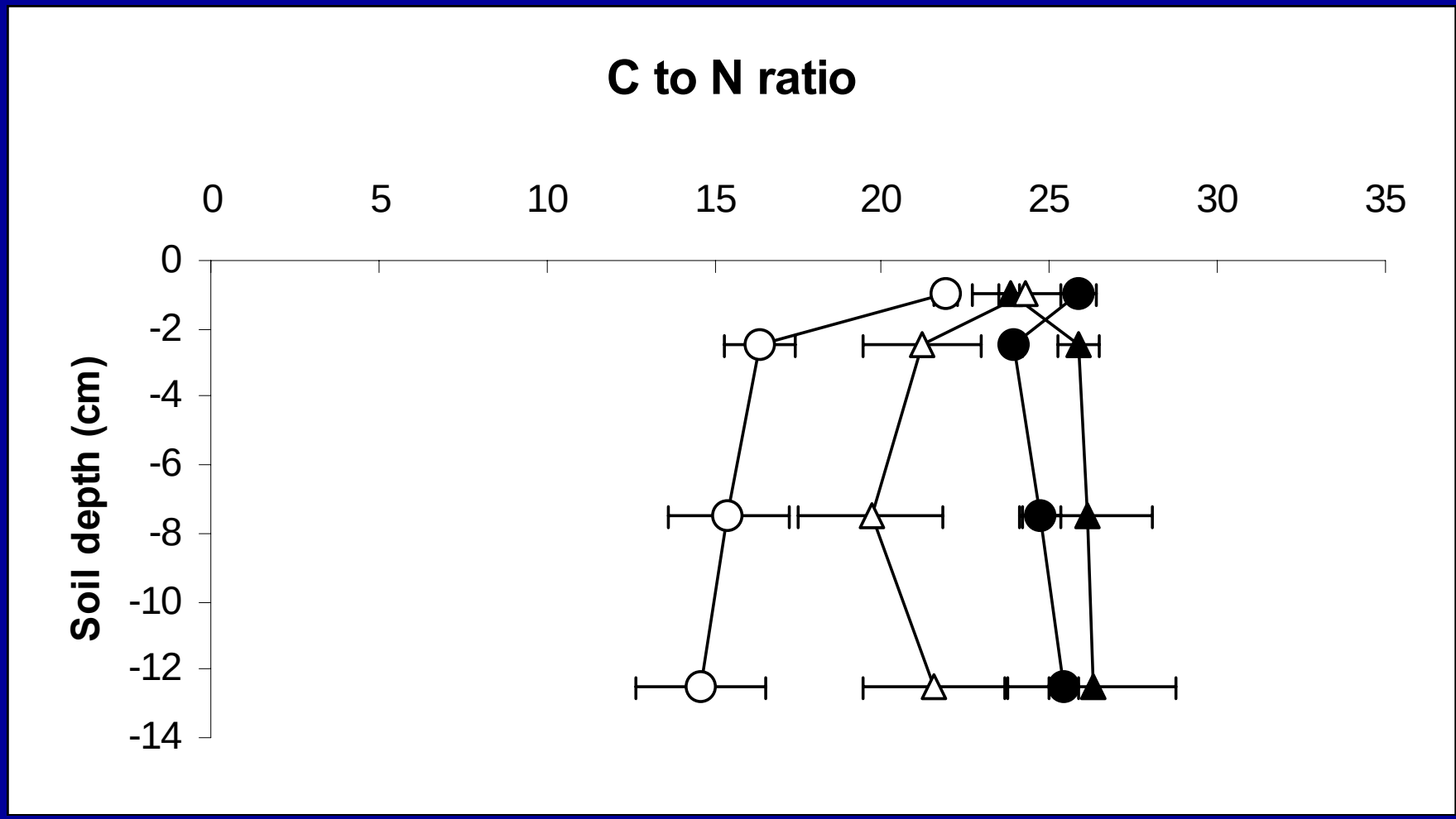
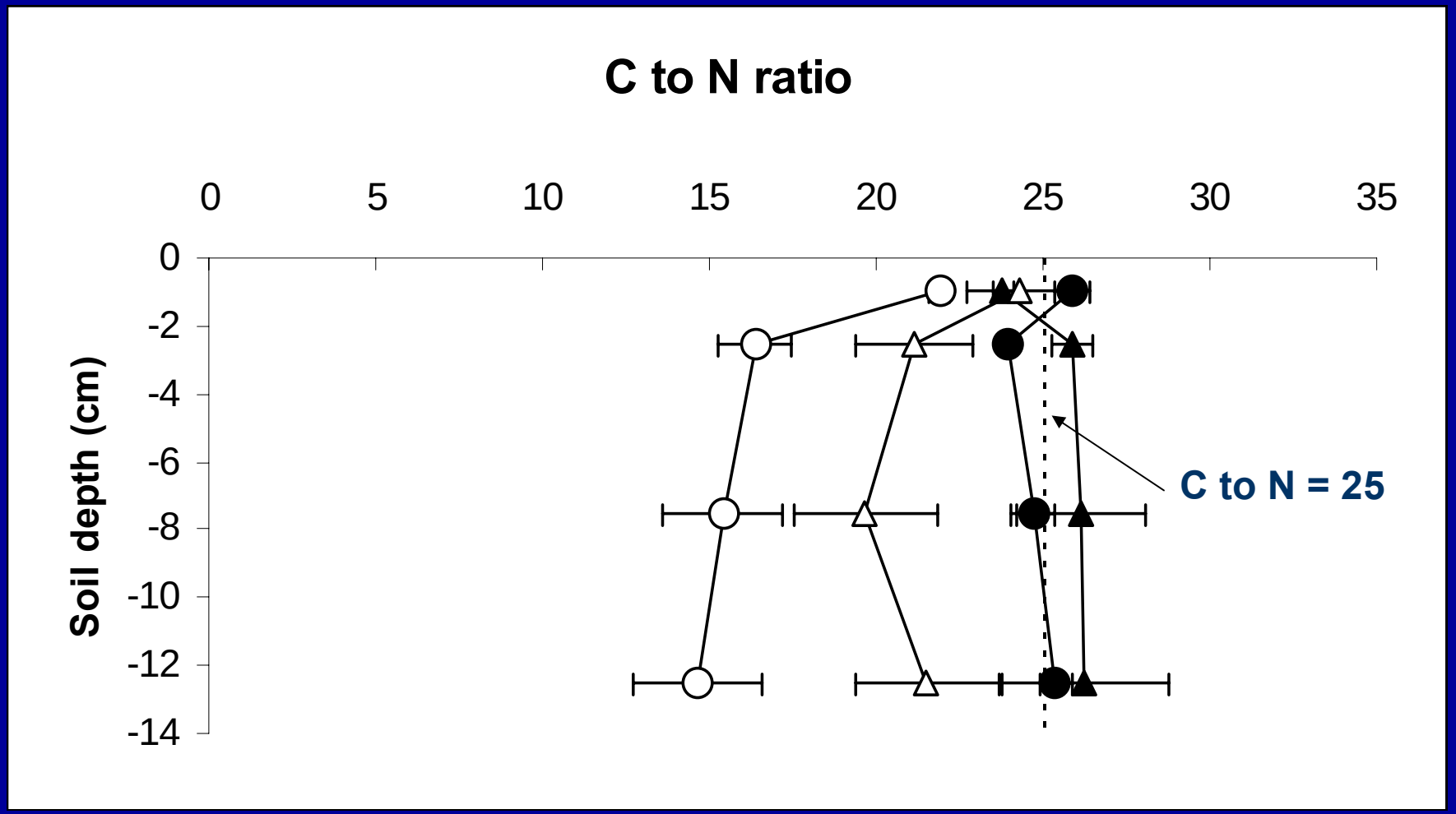


○ = Kågeröd, △ = Toftaholm, ▲ = Tönnersjö, ● = Asa



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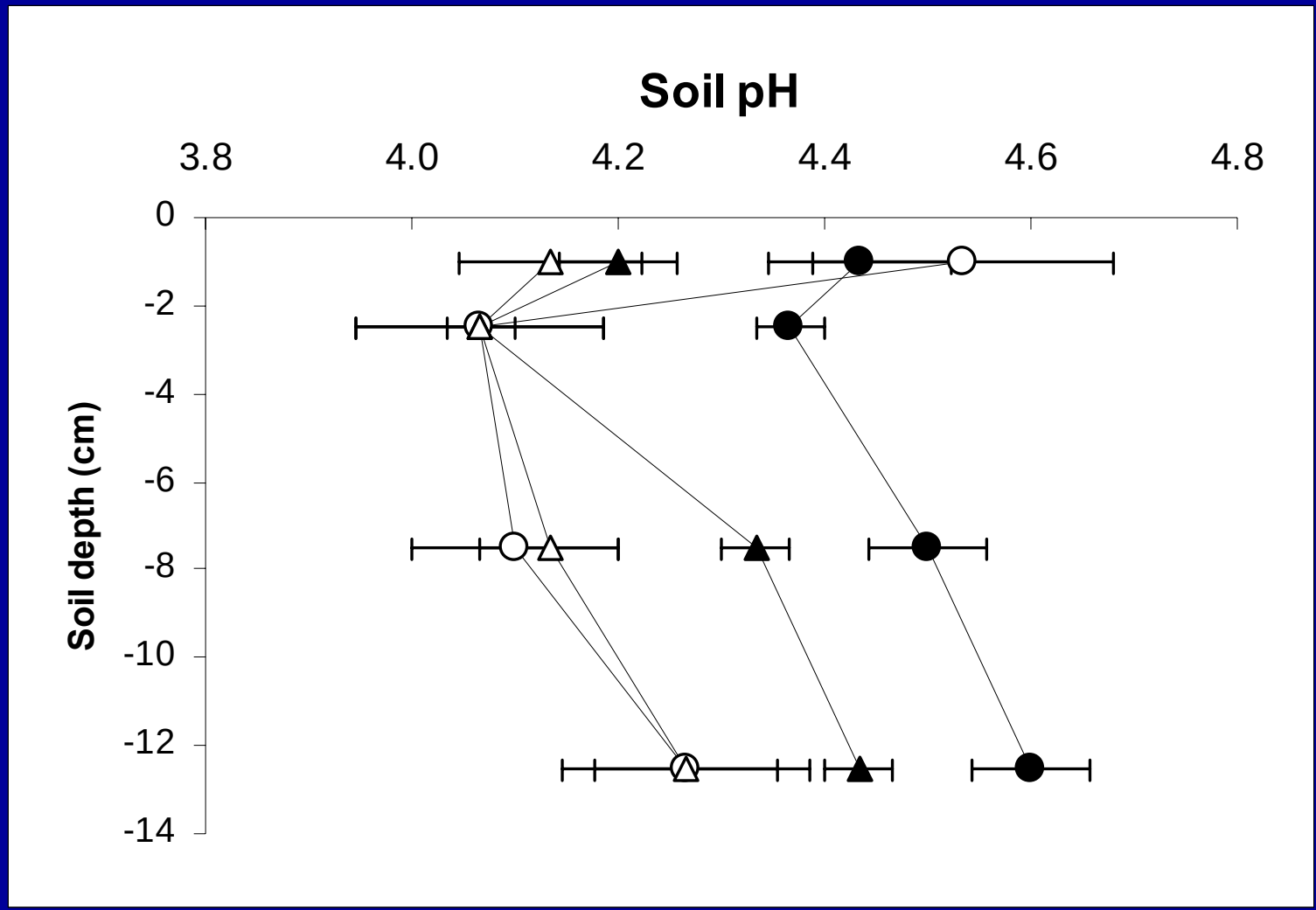

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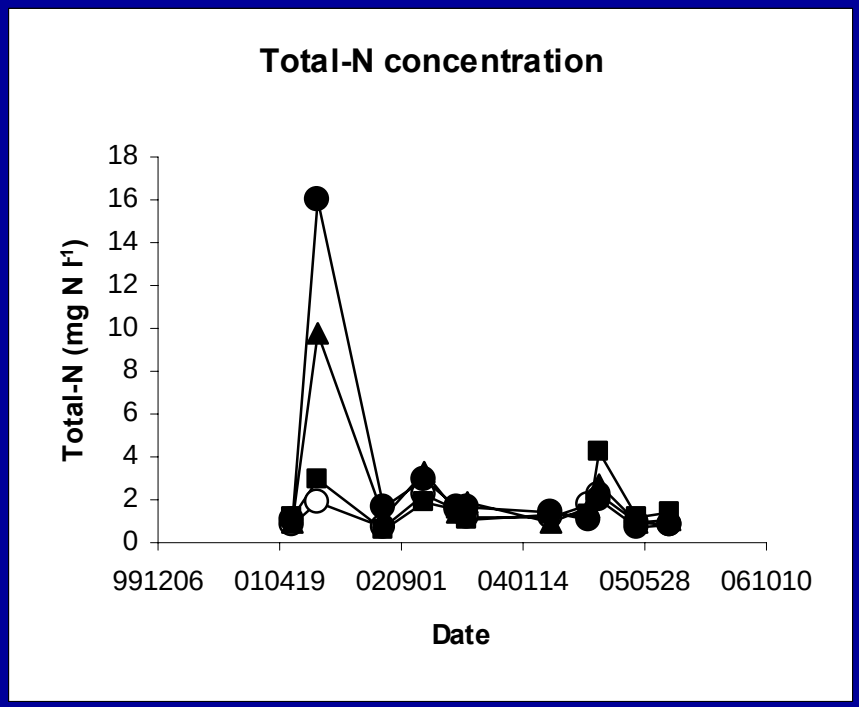
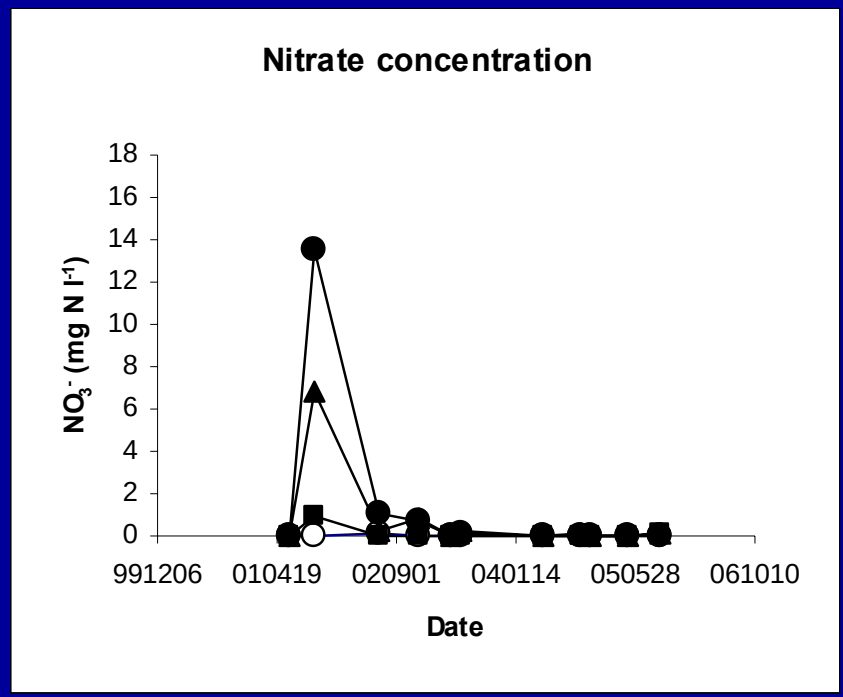
Tönnersjö soil solution concentration (mg N l^{-1}) at 50 cm below soil surface





○ = control, ■ = 20 kg N annually, ▲= 60 kg N every 3:rd year,

● = 120 every 6:th year

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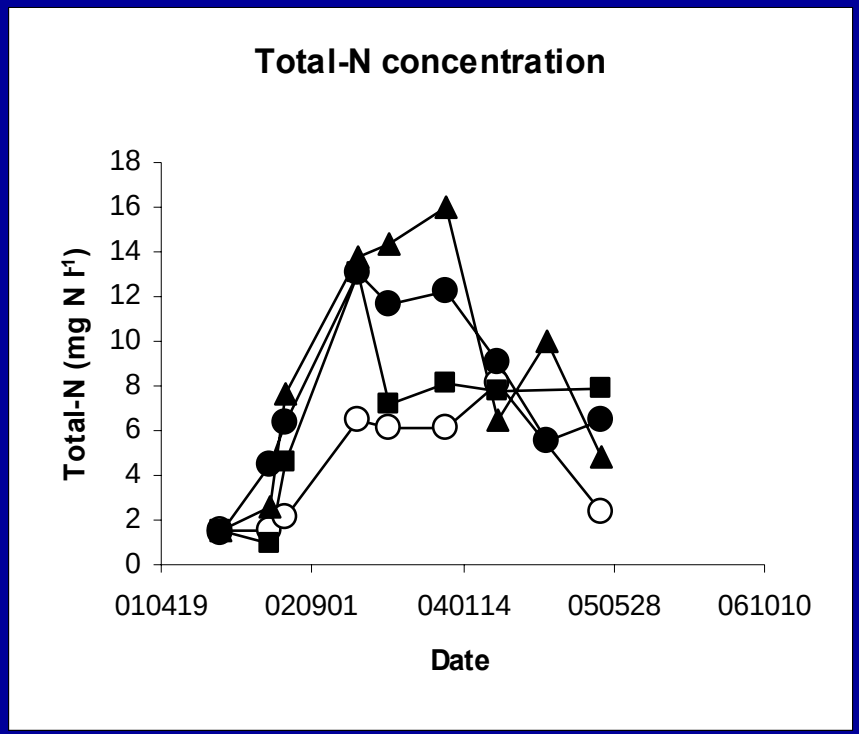
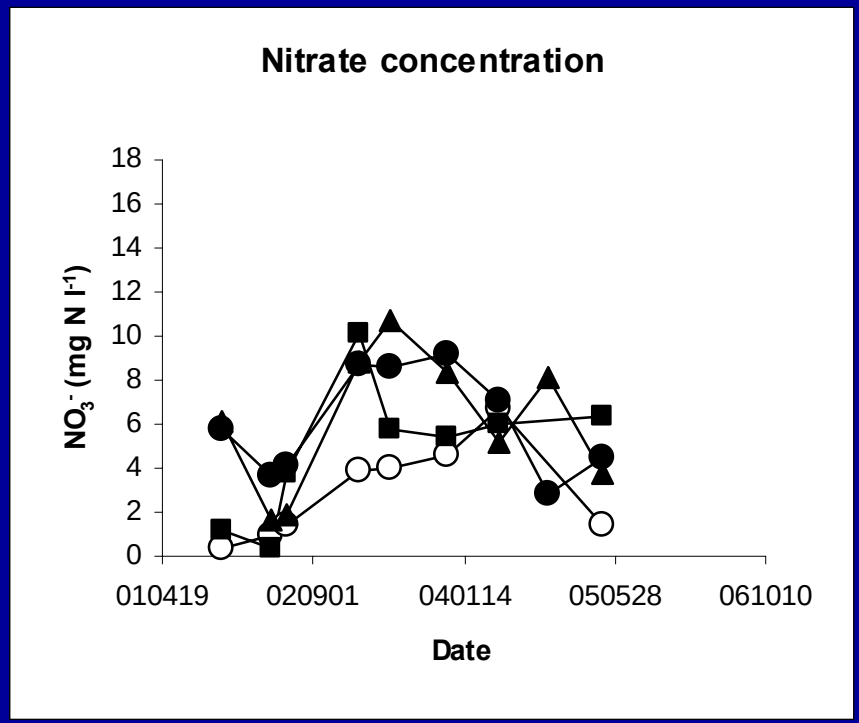
NH_4^+ between 0.001 – 0.03mg N l^{-1}

Kågeröd soil solution concentration (mg N l^{-1}) at 50 cm below soil surface





○ = control, ■ = 20 kg N annually, ▲= 60 kg N every 3:rd year,

● = 120 every 6:th year

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NH_4^+ between 0.015 – 1 mg N l^{-1}

"Quick and dirty" calculations of annual NH_4^+ loss (kg N ha^{-1} ± 1 s.e)

	Treatment			
	0	6*20	2*60	1*120
Tönnersjö	0.2 ± 0.2	0.7 ± 0.6	0.9 ± 0.5	0.2 ± 0.2
Kågeröd	0.3 ± 0.2	0.4 ± 0.2	2 ± 1	0.2 ± 0.2

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"Quick and dirty" calculations of annual NO_3^- loss (kg N ha^{-1} ± 1 s.e)

	Treatment			
	0	6*20	2*60	1*120
Tönnersjö	0.06±0.05	0.06±0.05	1 ± 0.6	1 ± 0.7
Kågeröd	12 ± 4	18 ± 5	27 ± 3	28 ± 5

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"Quick and dirty" calculations of annual total-N loss (kg N ha^{-1} ± 1 s.e)

	Treatment			
	0	6*20	2*60	1*120
Tönnersjö	**8 ± 0.8**	**10 ± 2**	**9 ± 1**	**9 ± 1**
Kågeröd	**22 ± 5**	**27 ± 5**	**44 ± 5**	**44 ± 5**

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“Quick and dirty” calculations of portion organic N

	Treatment			
	0	6*20	2*60	1*120
Tönnersjö	96%	86%	79%	85%
Kågeröd	43%	30%	34%	26%

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“budget” control plots at Tönnersjö

		Total
Open field (kg N ha^{-1} a^{-1})	NH_4^+ 4.8 NO_3^- 5.9	10.7
Through fall (kg N ha^{-1} a^{-1})	NH_4^+ 2.9 NO_3^- 4.6	7.5
Soil (humus + 0-15 cm) kg N ha^{-1}	NH_4^+ 16 – 9 NO_3^- 0.5 – 0.5	10 - 17
Leaching (kg N ha^{-1} a^{-1})	NH_4^+ 0.2 ± 0.2 NO_3^- 0.06 ± 0.05	**Tot-N 8 ± 0.8**

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“budget” control plots at Kågeröd

		Total
Open field (kg N ha^{-1} a^{-1})	NH_4^+ 5.7 NO_3^- 6.0	13.7
Through fall (kg N ha^{-1} a^{-1})	NH_4^+ 4.2 NO_3^- 5.2	9.4
Soil (humus + 0-15 cm) kg N ha^{-1}	NH_4^+ 13 – 19 NO_3^- 10 – 22	23 – 41
Leaching (kg N ha^{-1} a^{-1})	NH_4^+ 0.3 ± 0.2 NO_3^- 12 ± 4	**Tot-N 22 ± 5**

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Next year

- ^{15}N (double labelled) addition on main plots (inner 10 m radius), about 1 at-%.
  - Where does the added N go?

- Outside the inner circle 2 micro-plots with $^{15}NH_4{}^{14}NO_3$ or $^{14}NH_4{}^{15}NO_3$.
  - To look at differences in fate of added NH_4^+ and NO_3^-

- More on the poster

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“Take home”

- Some NH_4^+ is taken up by the trees
- Site/soil properties are important for
  - For example our data support that C to N ratio in the soil could be used as an indicator to identify “leaky” sites.
- Don’t forget organic-N

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Publications

Sikström, U., Högbom, L., Rosenberg, O., Persson, T., Nordlund, S., Lundström, H. (2004) – Site description and base-line data for an experimental series in southern Sweden. Skogforsk report #588.

Högbom L, Rosenberg O, Lundström H, Nordlund S (200x) – Effects on soil and soil-solution chemistry. Manuscript.

Persson, T. (200x) – ^{15}N retention. Manuscript.

Rosenberg, O., Högbom, L. (200x) – Vegetation changes. Manuscript.

Rosenberg, O., Högbom, L. (200x) – Deposition data. Manuscript.

Sikström, U. (200x) – Tree growth and needle element concentrations. Manuscript.

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