

RIS

Swedish National Forest Inventory

RIS MI

Swedish Forest Soil Inventory

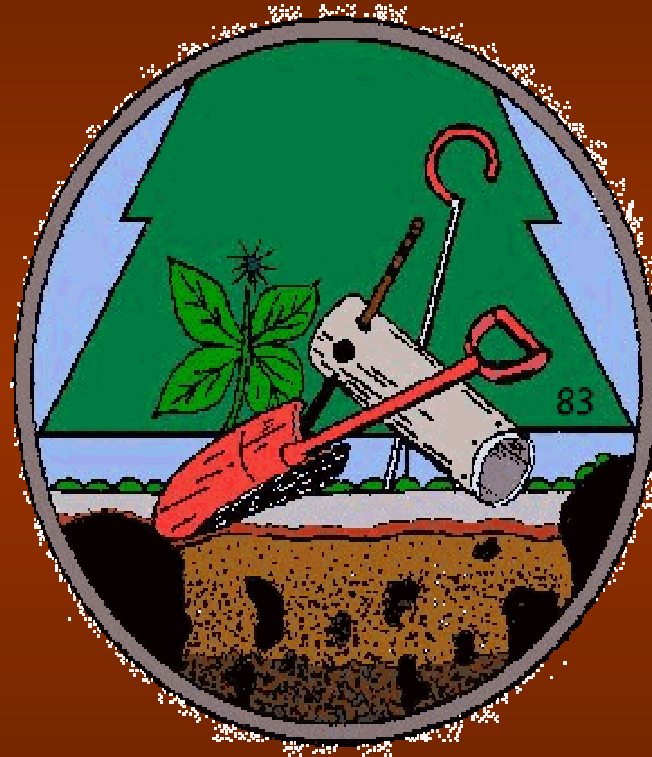
Integrated Monitoring - IM



Ecosystem monitoring – Forest Environment
Integrated Monitoring –IM & RIS MI

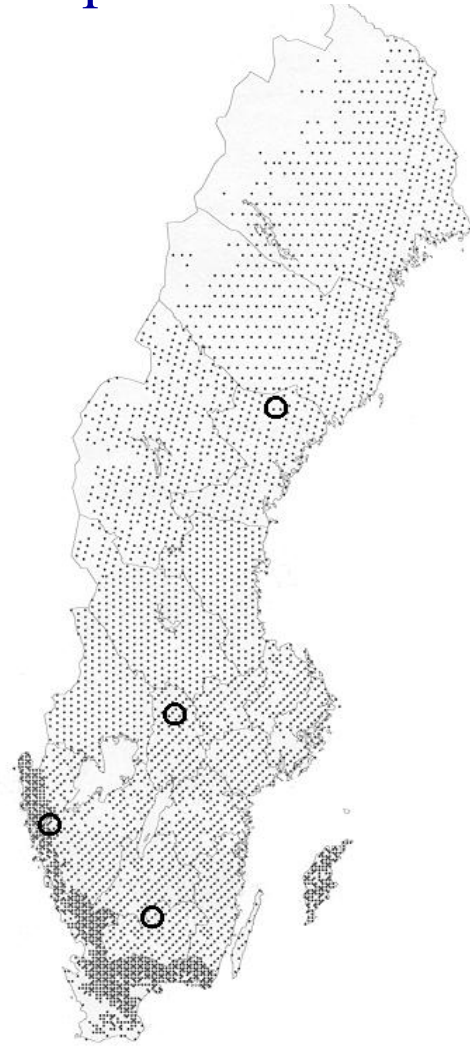
Swedish Soil Survey

- * Land use
- * Humus
- * Hydrology
- * Land type
- * Texture
- * Soils
- * Soil chemistry
- * Vegetation
- * Biodiversity
- * Soil change



Department of Forest Soils, SLU

SK plots 1983-1987

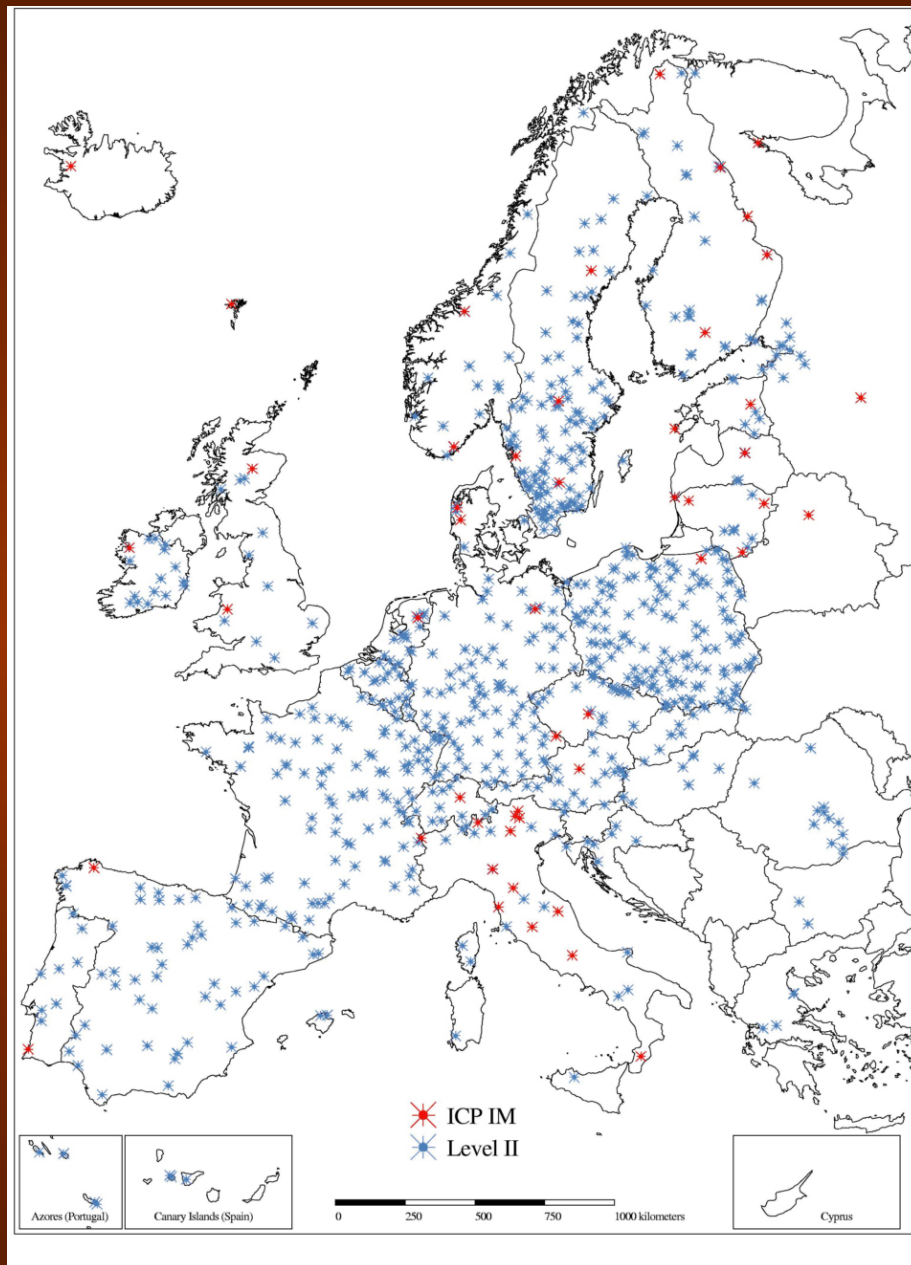


RIS MI

23000 plots

IM

**4
catchments**



ICP Forest level II
ICP IM sites

Soil inventories on NFI plots

NFI started 1923

- 1961-1975 occasional inventories on temporal plots - 45 000 plots
- 1983-1987 1st inventory on permanent plots - 17 000 plots
- 1993-2002 2nd inventory on permanent plots - 20 000 plots
- 2003-2012 3rd - c. 20 000 plots

Swedish NFI tract, several sizes,
but c. 800 m common



Swedish NFI content - start 1923

Land use

Growing stock and growth

Forest age and structure

Forest site conditions and vegetation

Harvesting and other forestry measures

Prerequisites for biodiversity

RIS MI content

Hydrology

Parent material

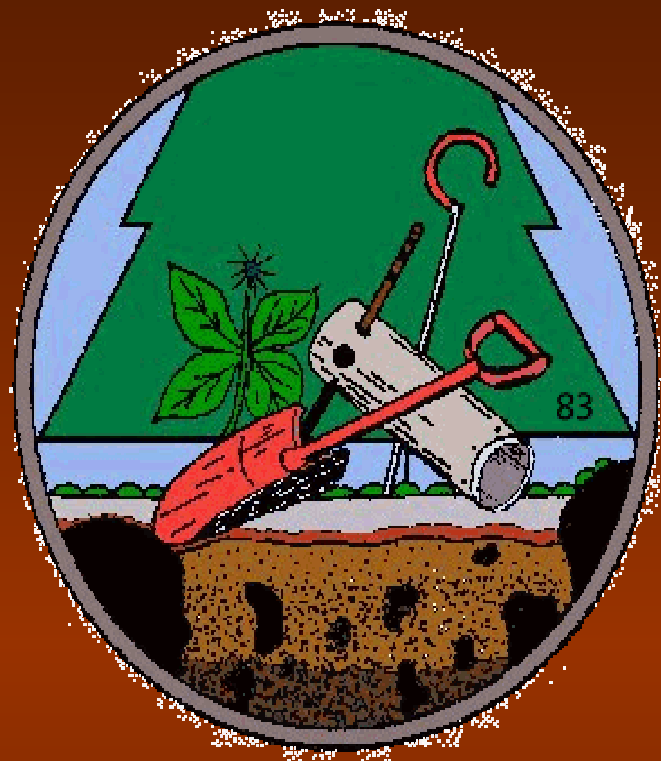
Texture

Organic soil layer

Soil type

Sampling for soil chemistry

Vegetation



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Hydrology

Dry

Fresh

Fresh-moist

Moist

Wet

Subsurface water flows

Missing

Short periods

Long periods

RIS MI

Soil parent material - Texture

Soil parent material

Texture

Sorted

Poorly sorted

Till

Bedrock

Peat

Gravel

Sand / Sandy

Fine sand

Silt / Silty

Clay

Gyttja

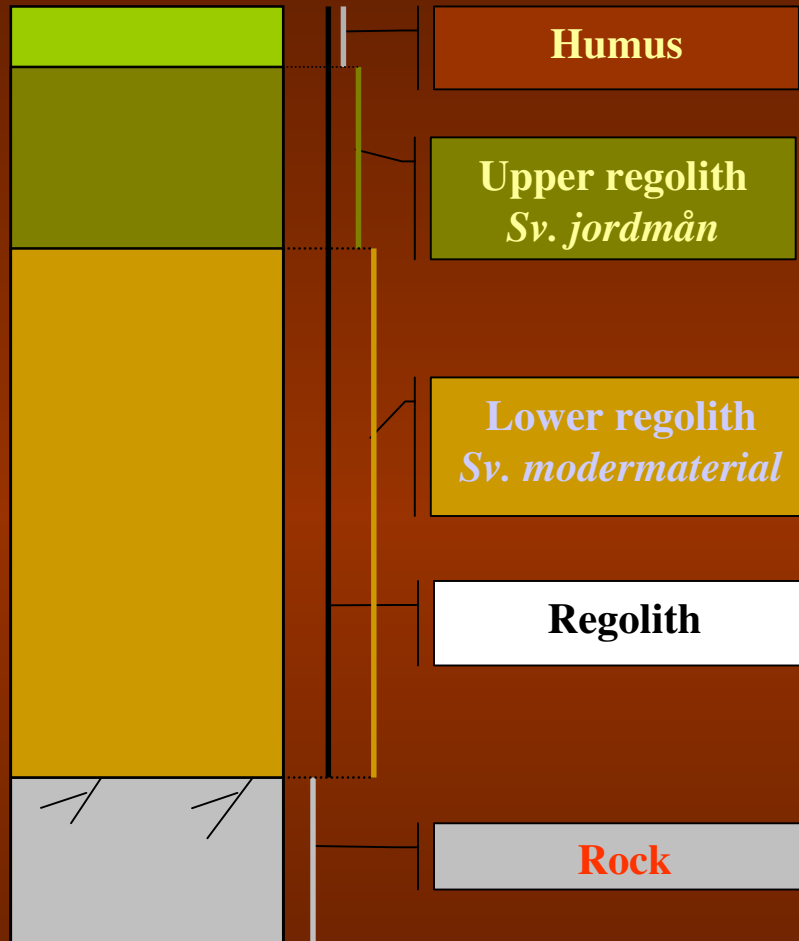
*Organic soil layer
Humus form*

Mor I and II
Moder
Mullike moder
Mull
Peaty mor
Peat

Soil

Histosol
Leptosol
Gleysol
Podzol
Umbrisol
Cambisol
Arenosol
Regosol

Soil and bedrock



Samples

Humus layer

Mineral soil 0-10 cm

Mineral soil 10-20 cm

Mineral soil 55-65 cm

Soil sampling - Soil chemistry

Horizons: O, E, B & C

pH

N

C

CEC

Na, K, Ca, Mg, Mn, Al, Ac

Vegetation

Mineral soils

Lichens, Mosses
6 classes

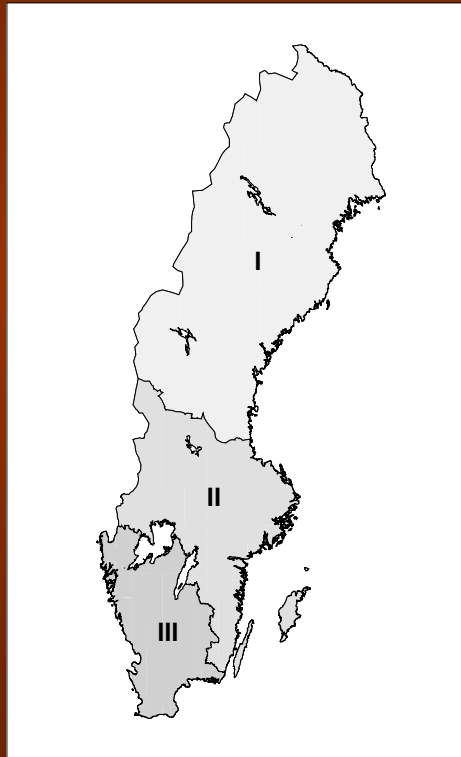
Herbs, Gras, Shrub
16 classes

Forest wetlands

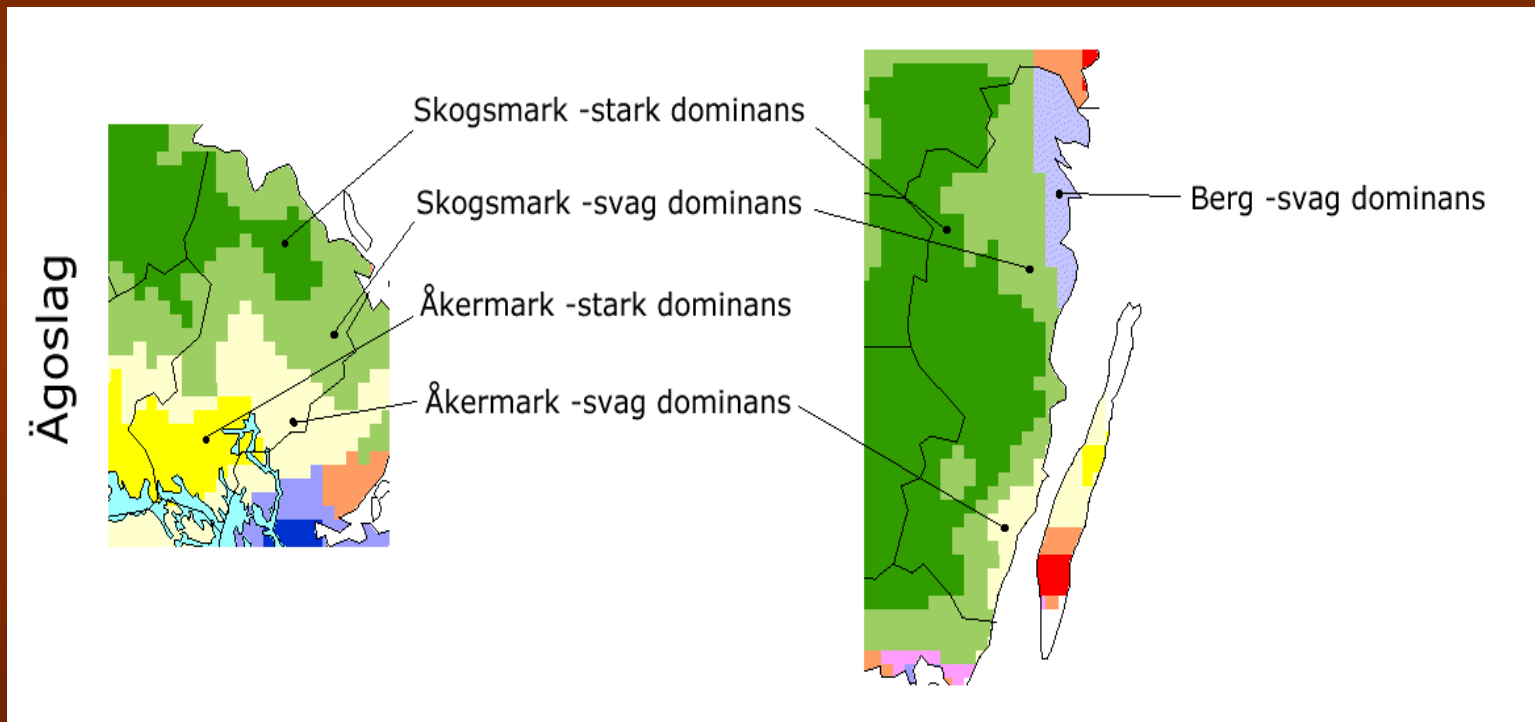
Tall and low herbs
Tall and low sedges
Blueberry, Vitis Idea

Rosemary – Cranberry
9 classes

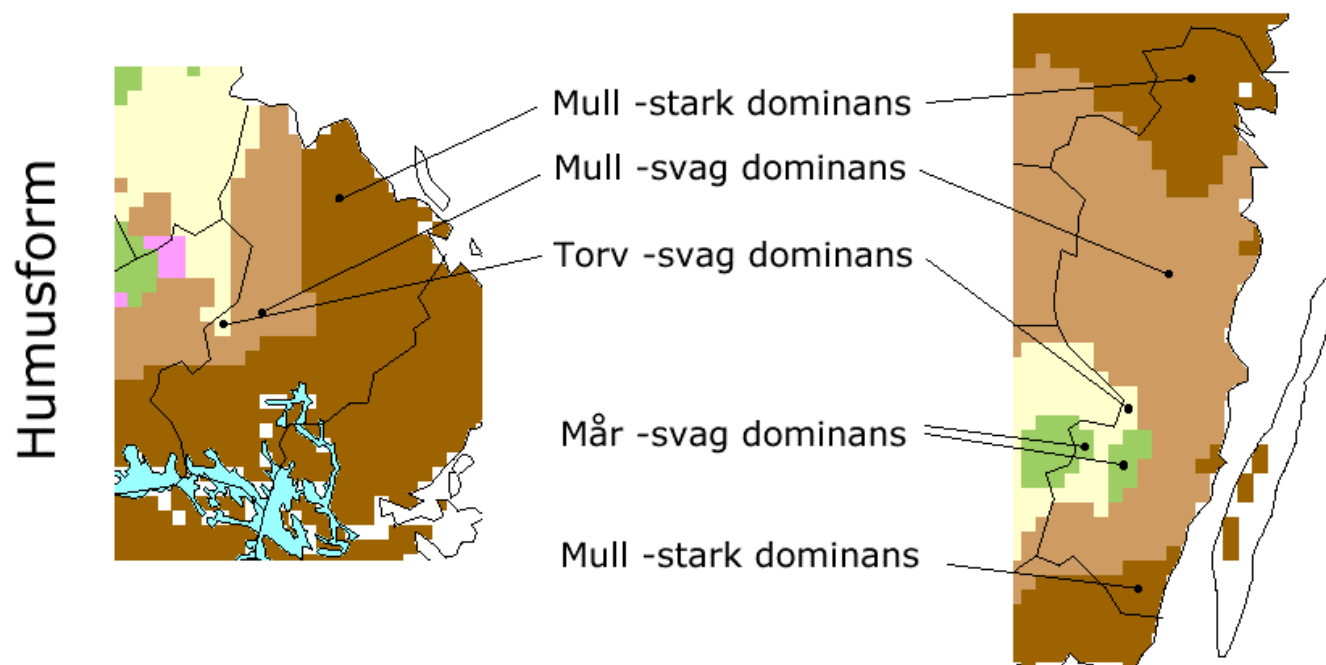
Common regions for evaluation and results presentation



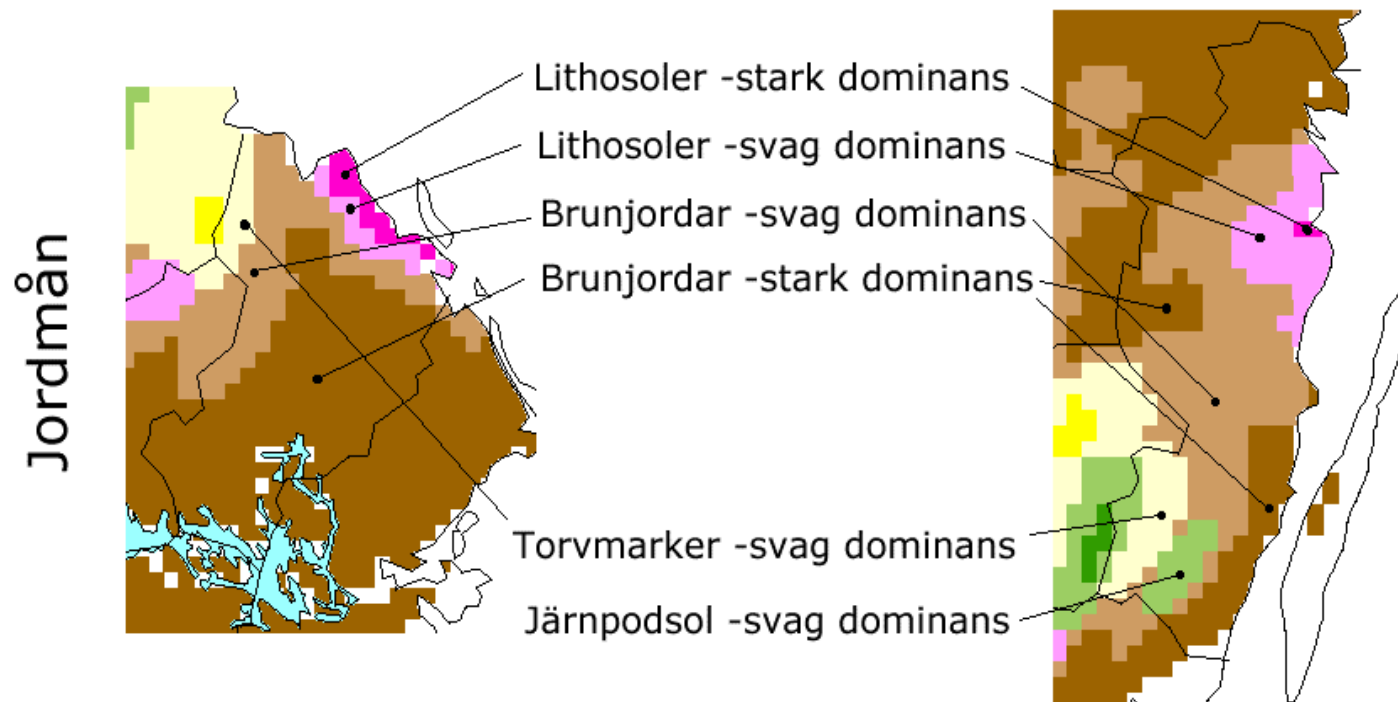
Land cover



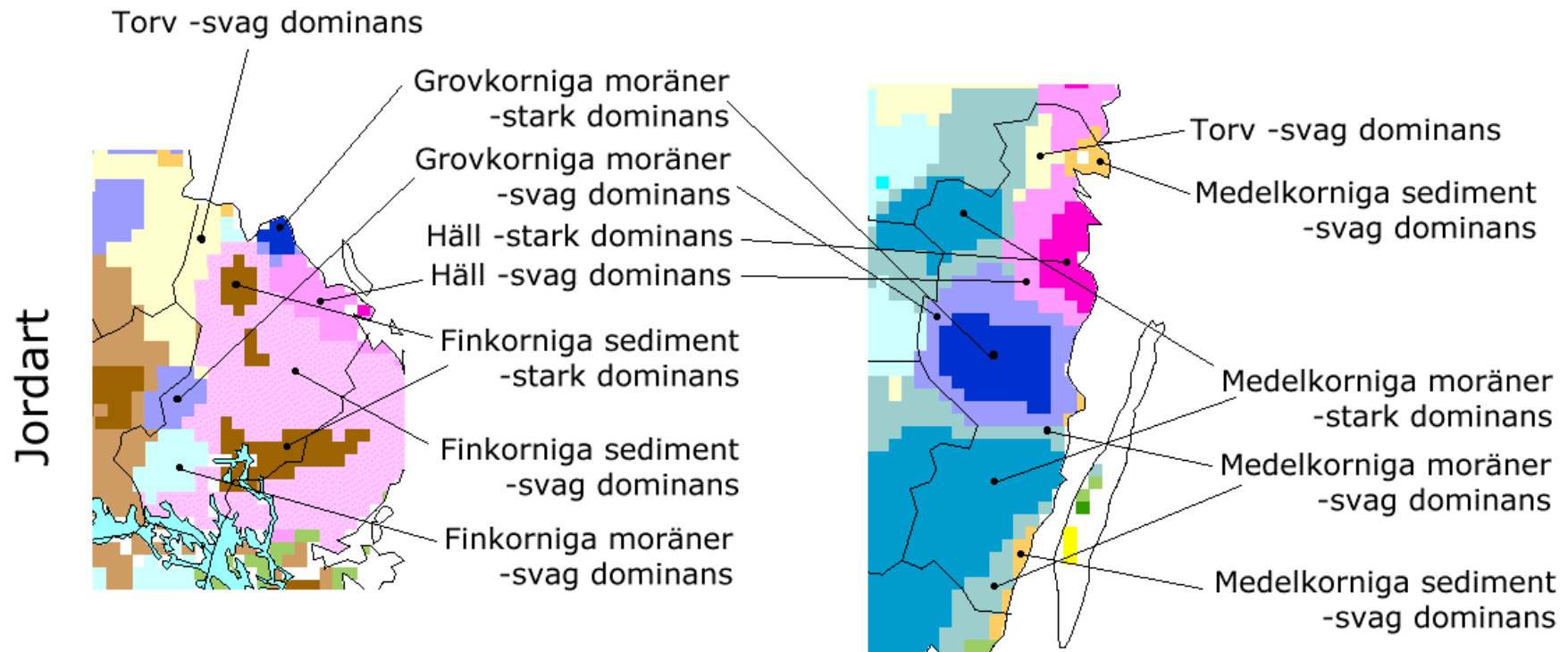
Humus form



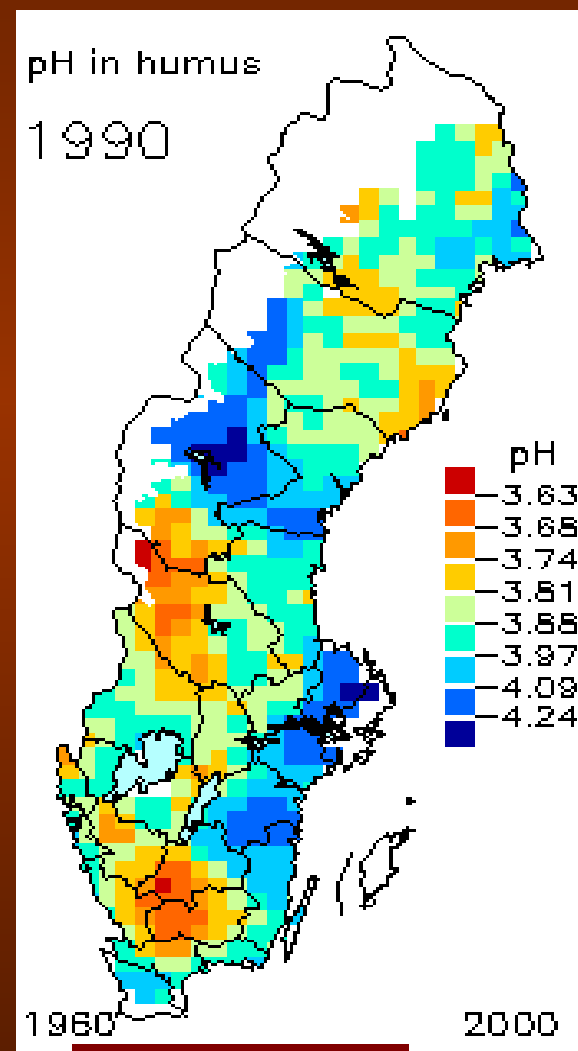
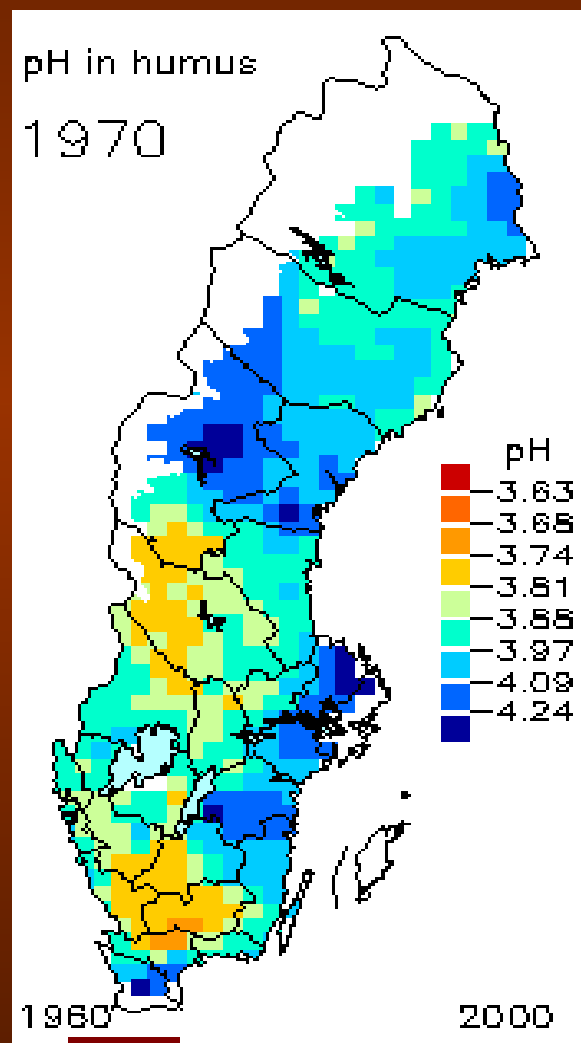
Soil type



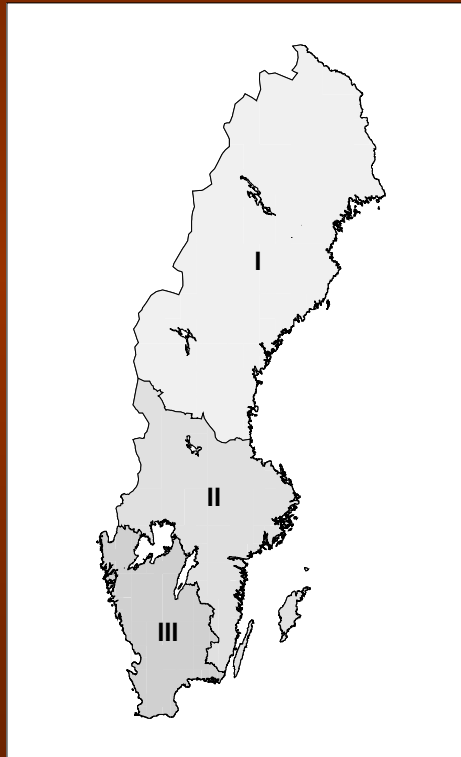
Soil parent material



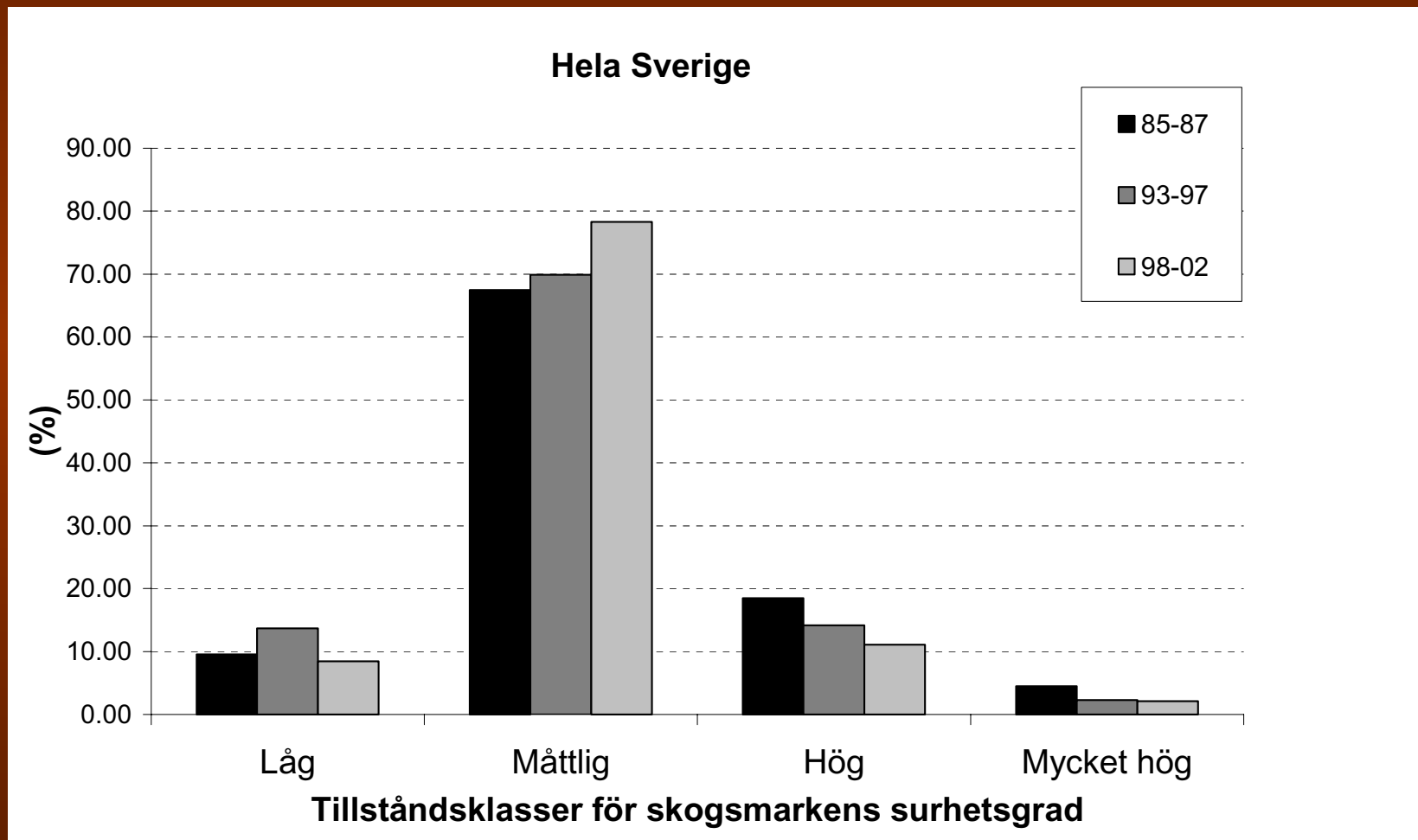
Soil acidification during 20 år



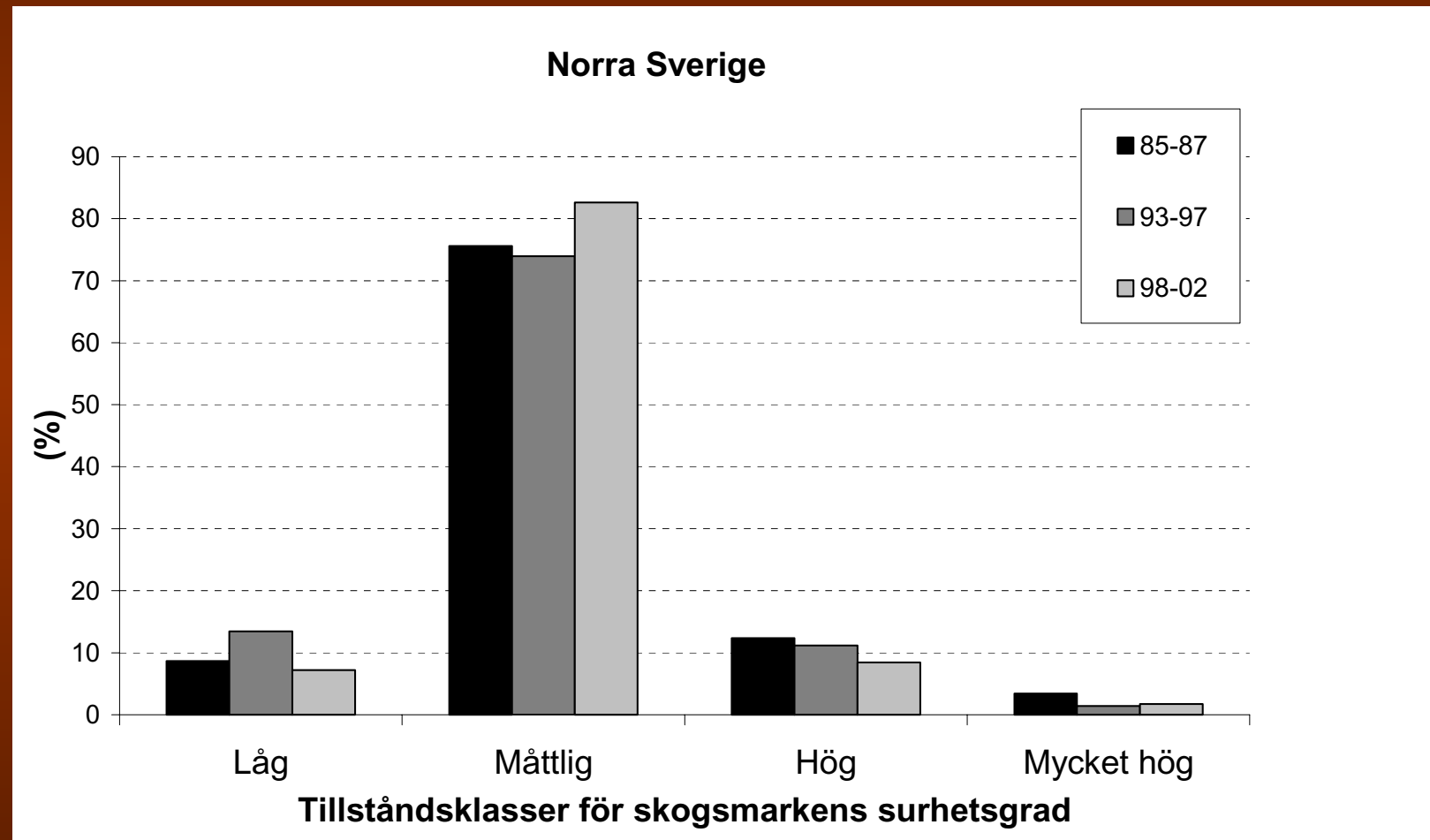
Common regions for evaluation and results presentation



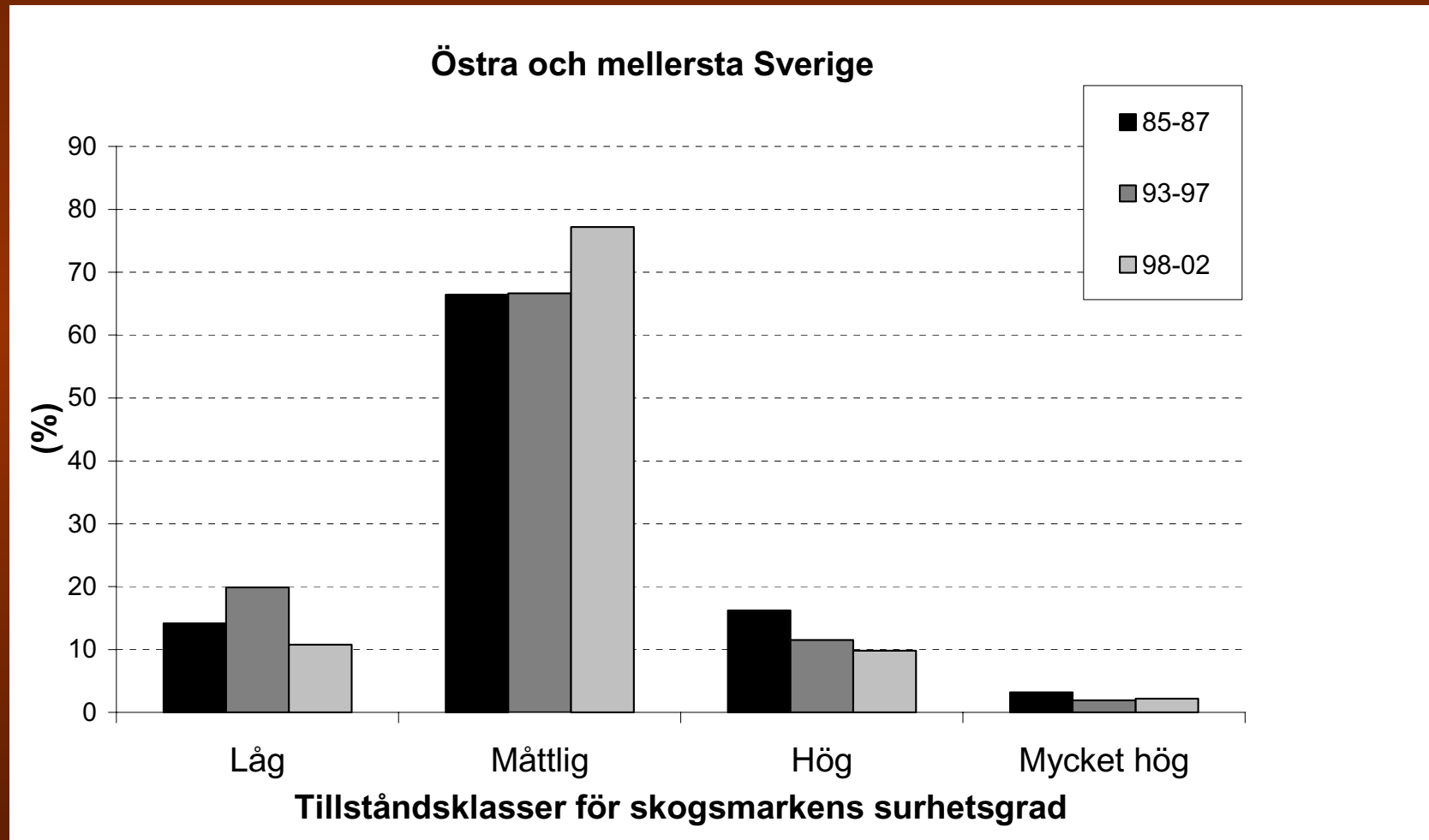
Acidity class for Sweden



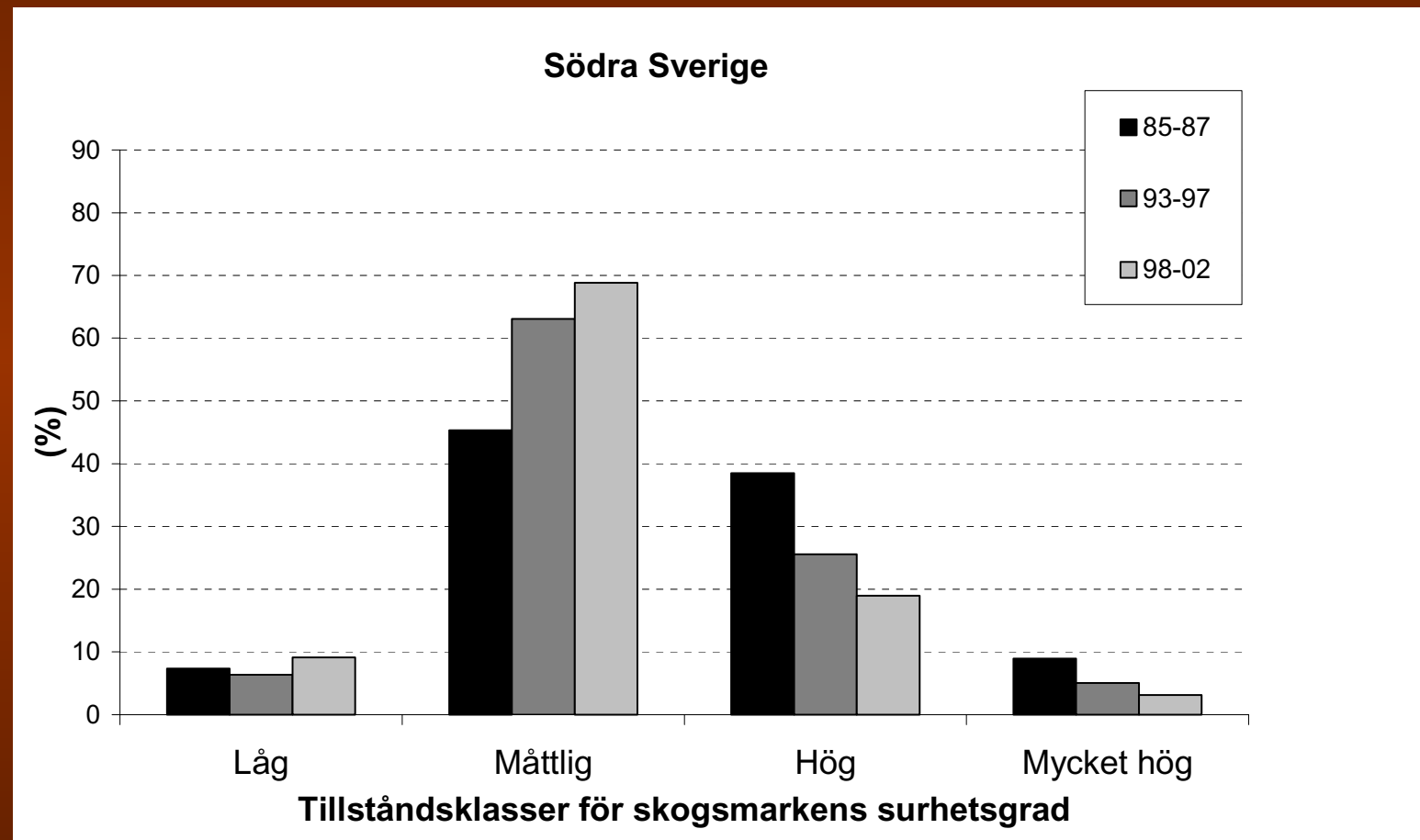
North Sweden



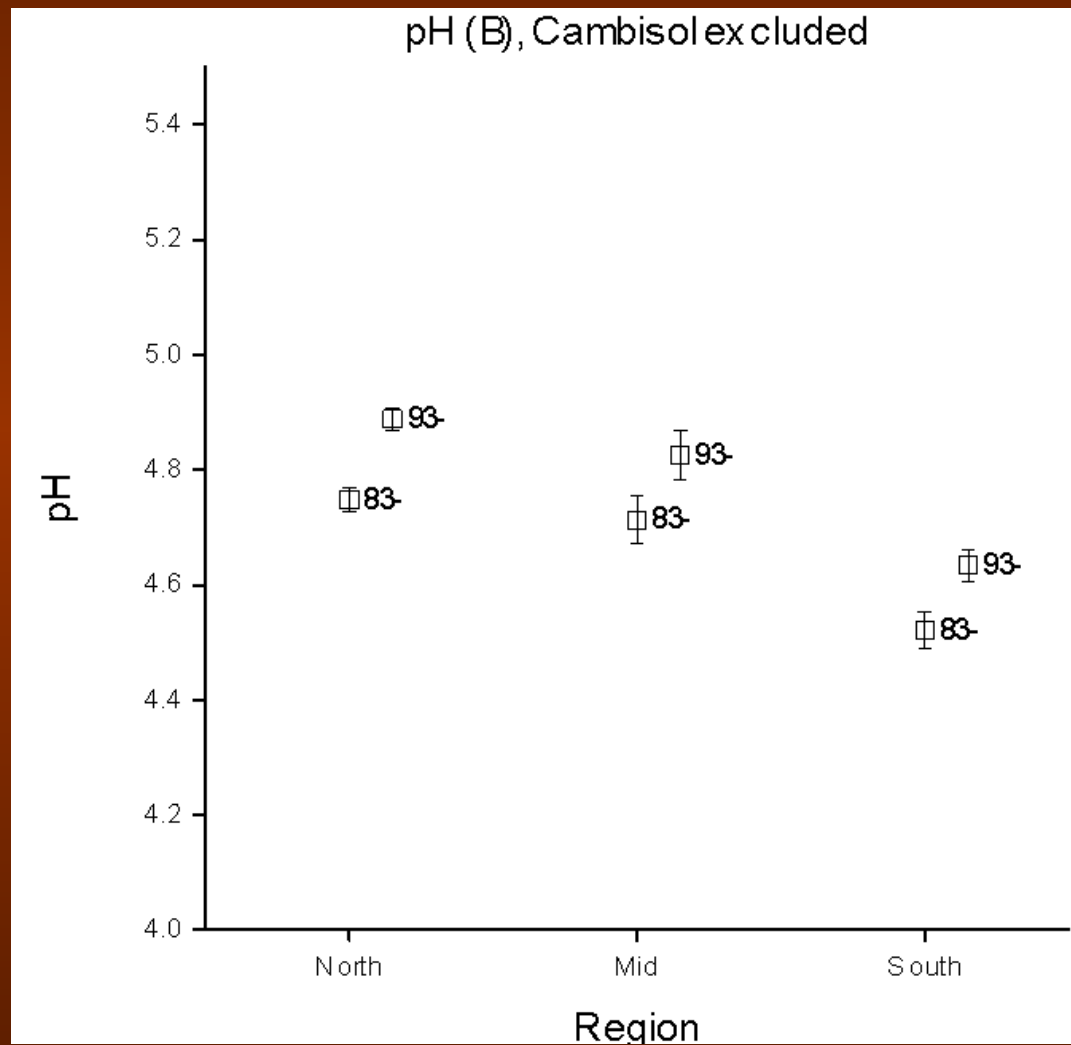
East and central Sweden



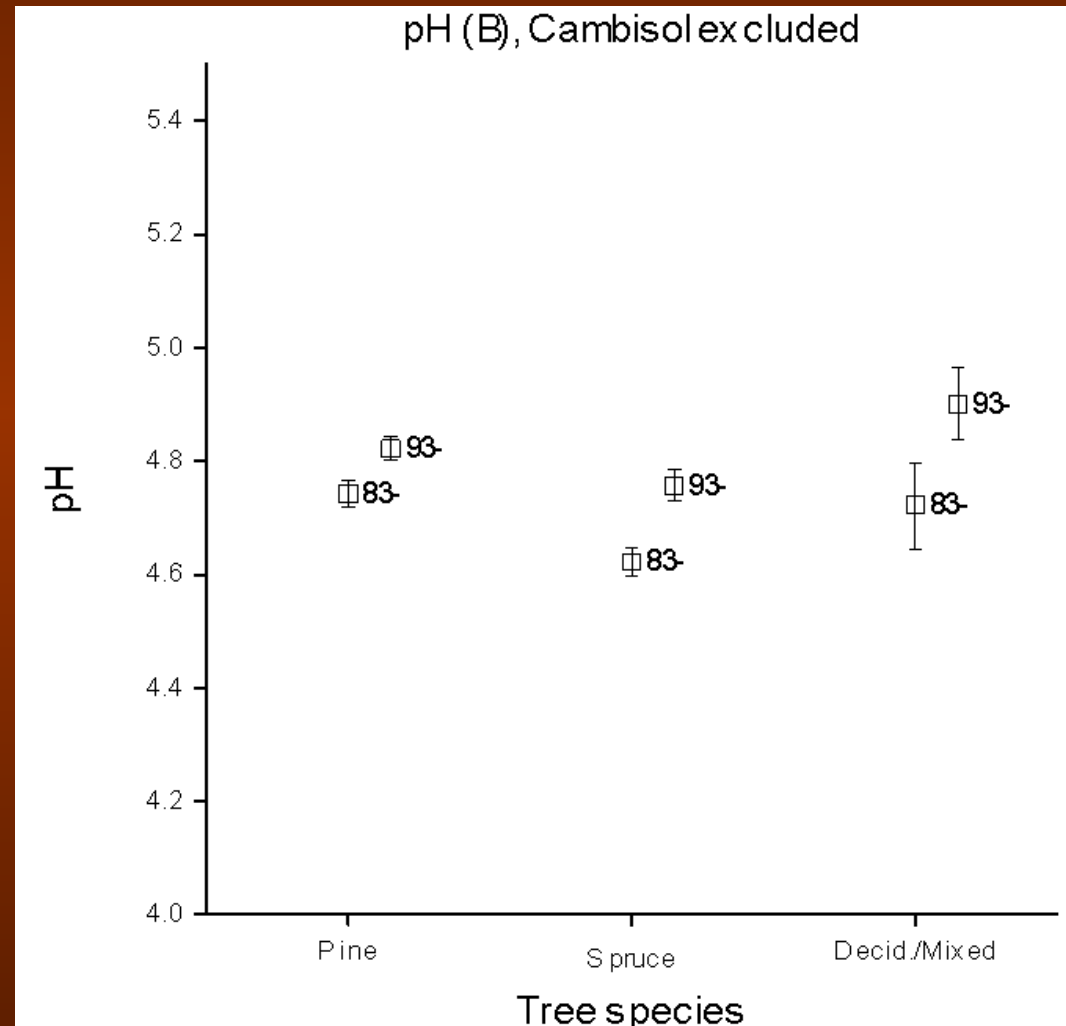
Southwest Sweden



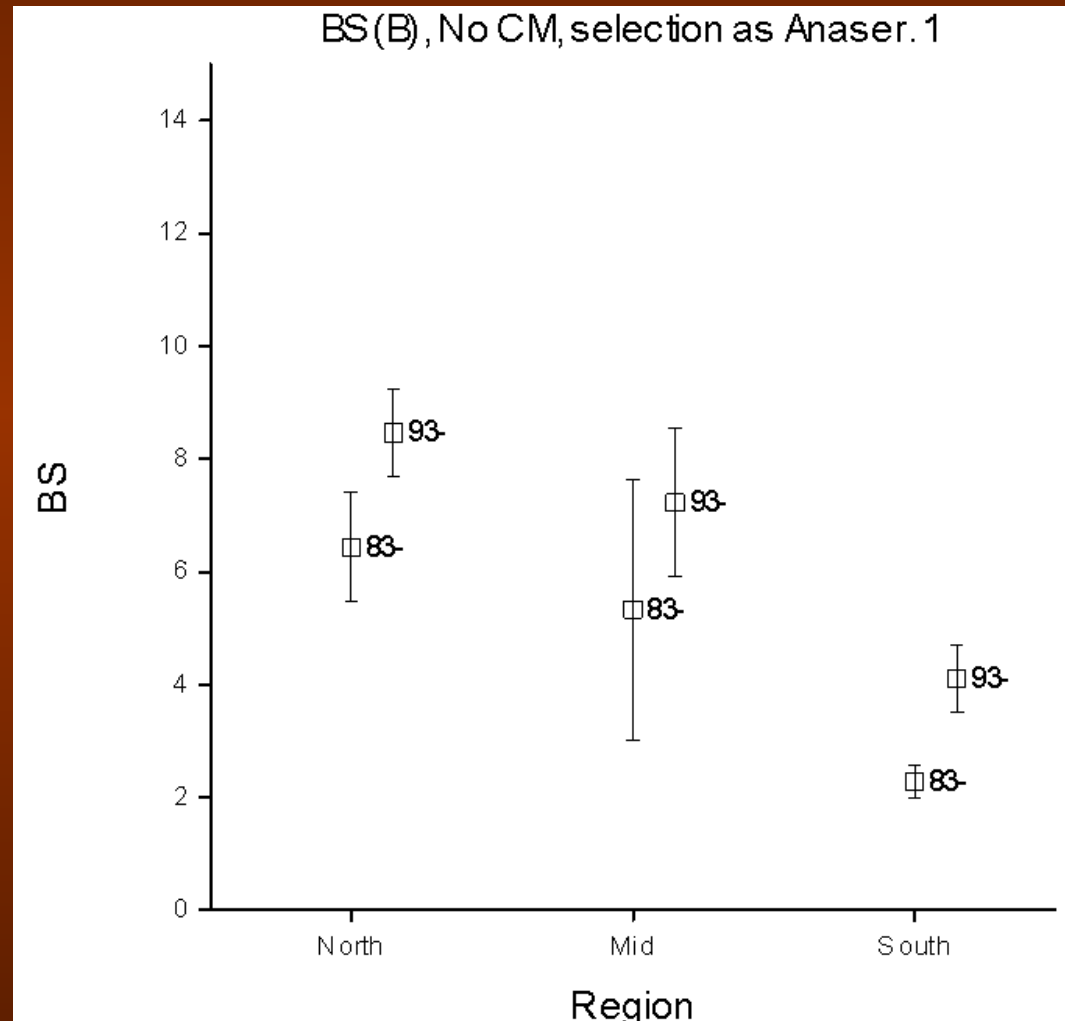
Change in regional pH



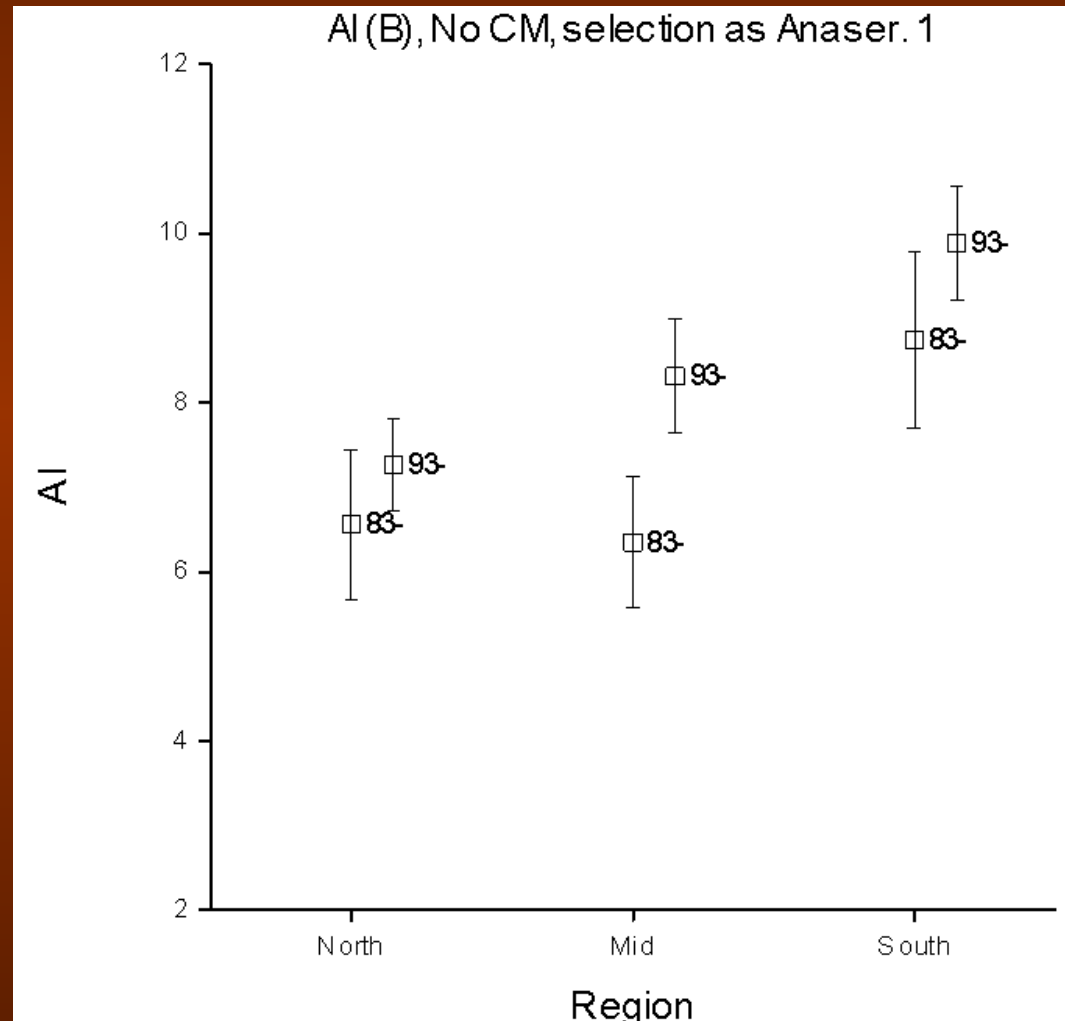
Change in pH in relation to tree species



Base saturation in regions



Exchangable Al in regions



Carbon sequestration

Photosynthesis 11.000

kg/ha, y

Respiration 9600

Stem wood 1200

Living Biomass 100



Leaching 50

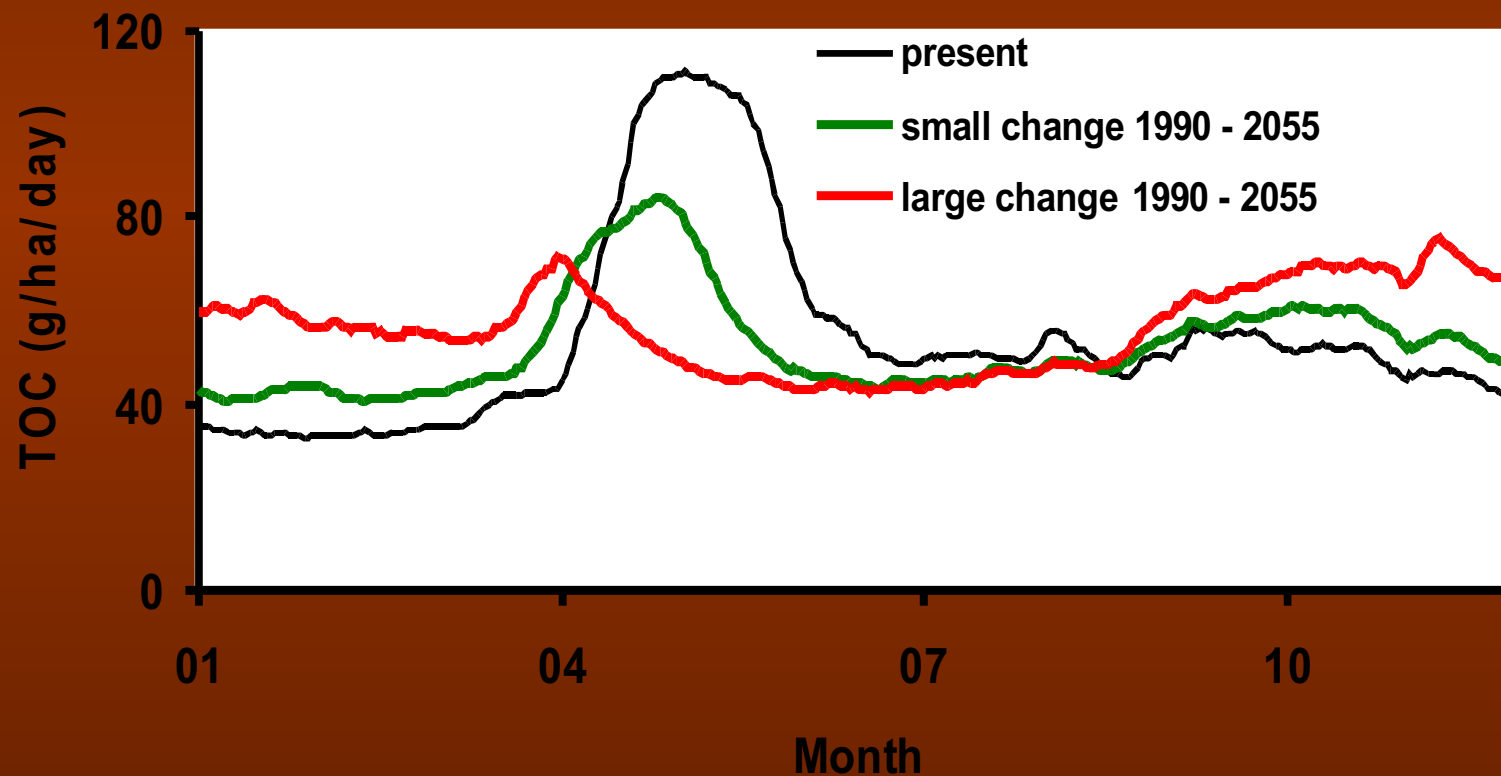


*Accumulation
in soil 100*

Balance: 11000 - 11050

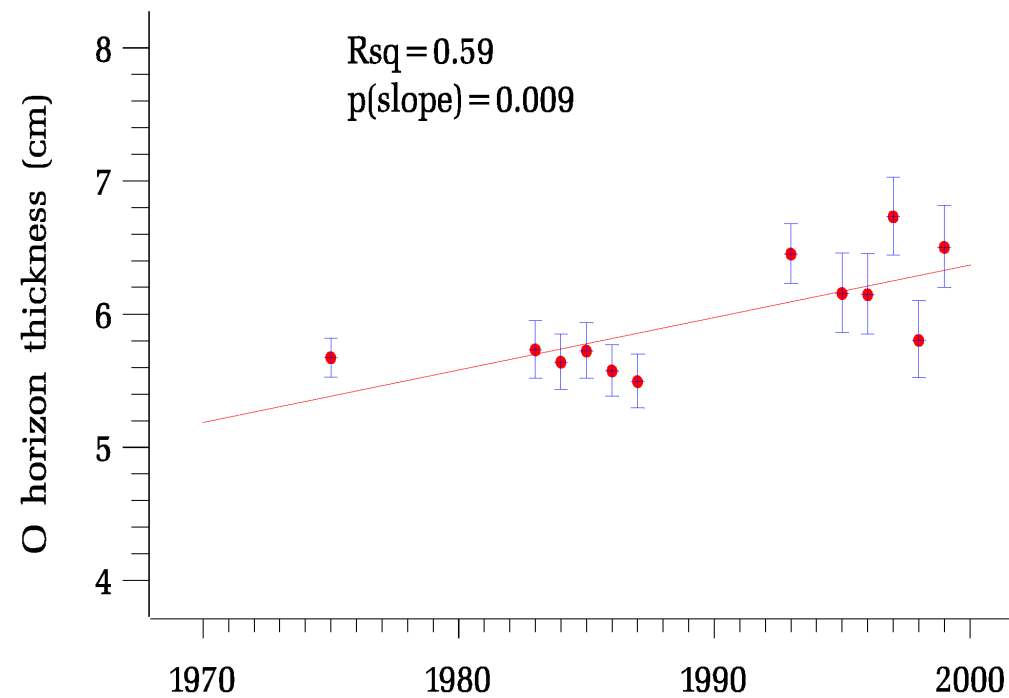
TOC leaching från IM site Hietajärvi, ANN modelling

(Holmberg et al., 2003)



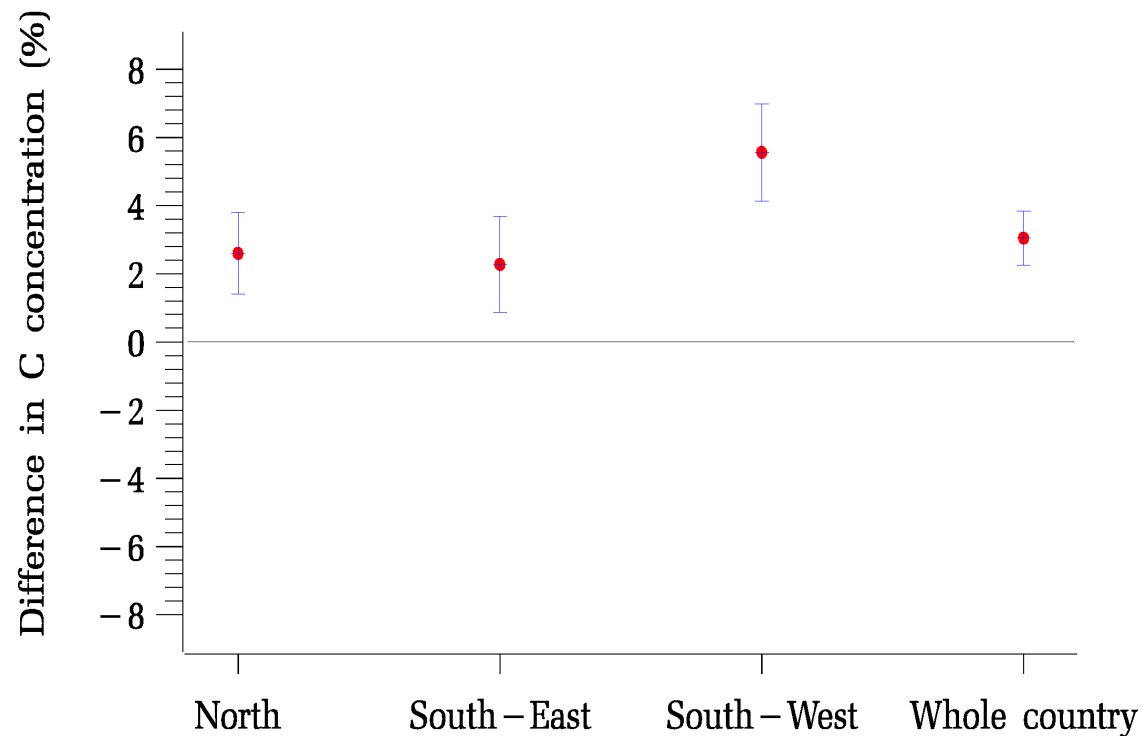
Carbon in the soil

O horizon thickness – whole country (95% confidence intervals)



Carbon concentration in the humus layer

Change in C concentration (%) between inventories
(95% confidence intervals)



**Amount of Carbon in O-horizon, kg/m²
Change during 10 years, "1985 - 1995"**

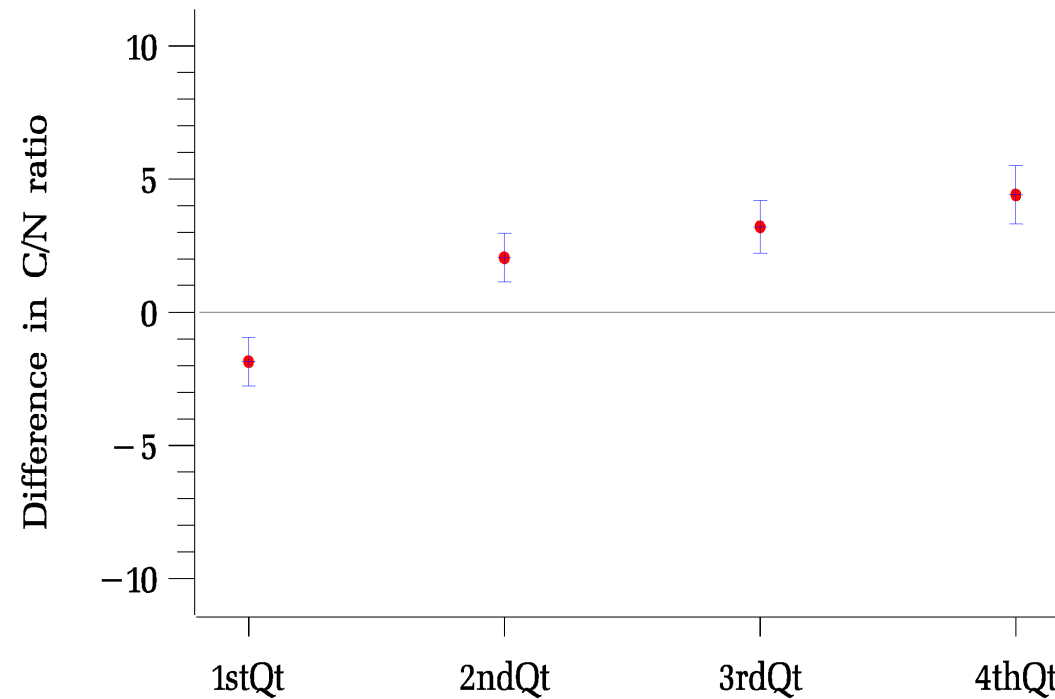
Region	1983-1987	1993-1996	Δ
1 "Norrrland"	1.6	1.7	+ 0.1
2 "Svealand"	2.2	2.5	+ 0.3
3 "Götaland"	2.7	3.3	+ 0.6*

NFI regions: Δ : +1.0 - 7.6 kg/m²
Counties: Δ : - 10 - +18 kg/m²

C/N ratio and carbon sequestration

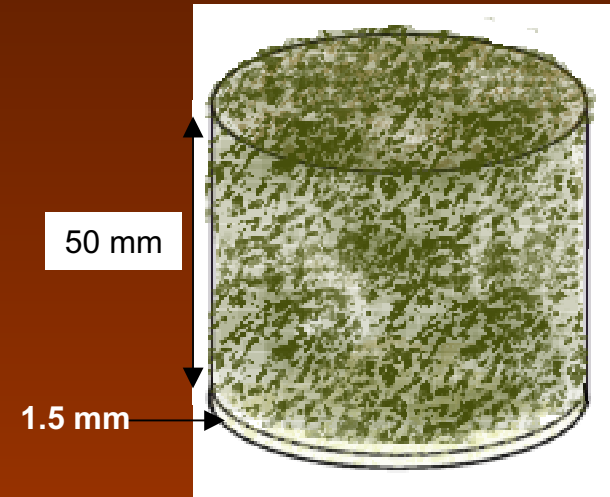
CN ratio change in the O horizon

Change in C/N ratio between inventories
(in carbon amount change quartiles)



The sampling error

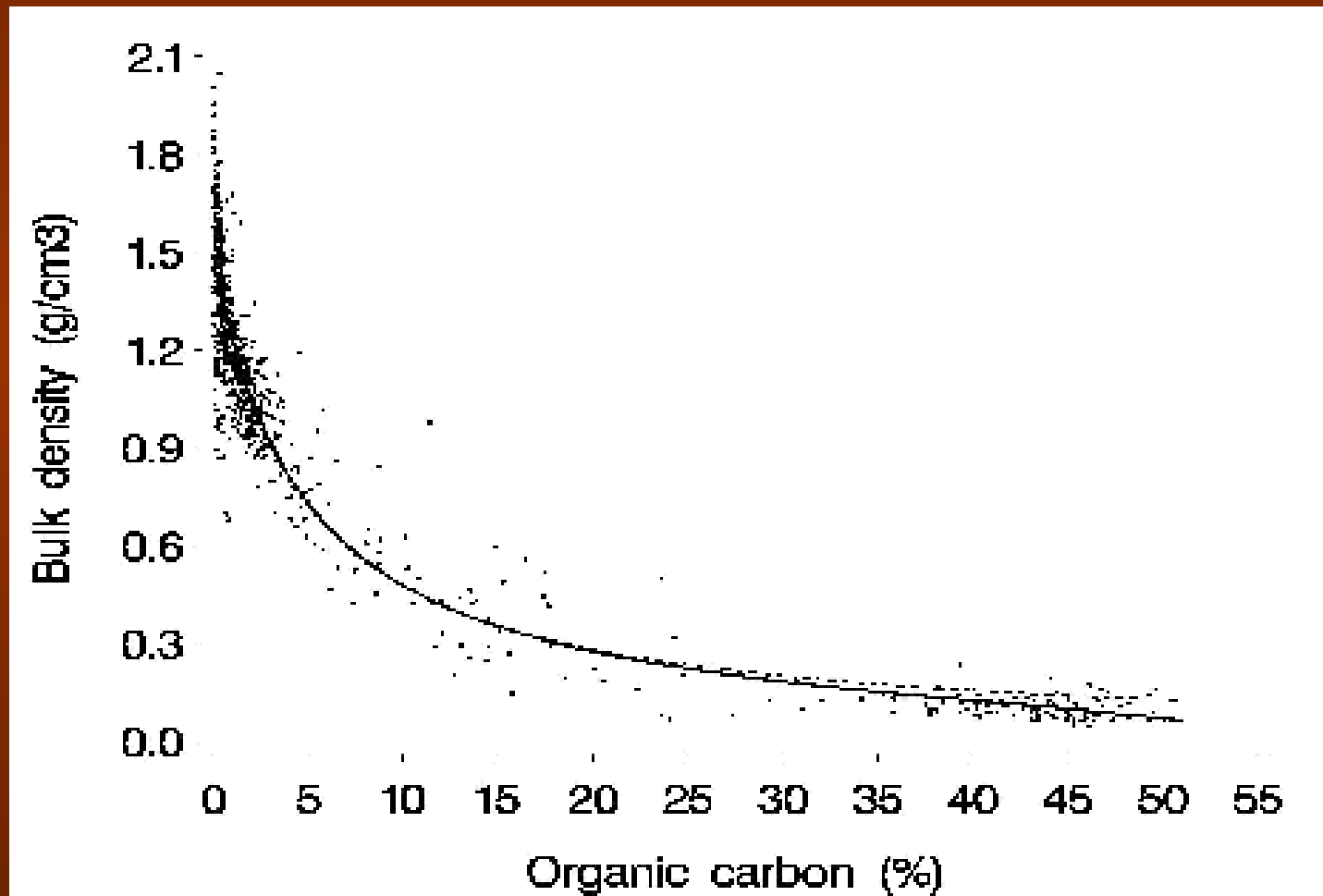
How much mineral soil
do we need in a sample
to decrease C concentration
with 3 %?



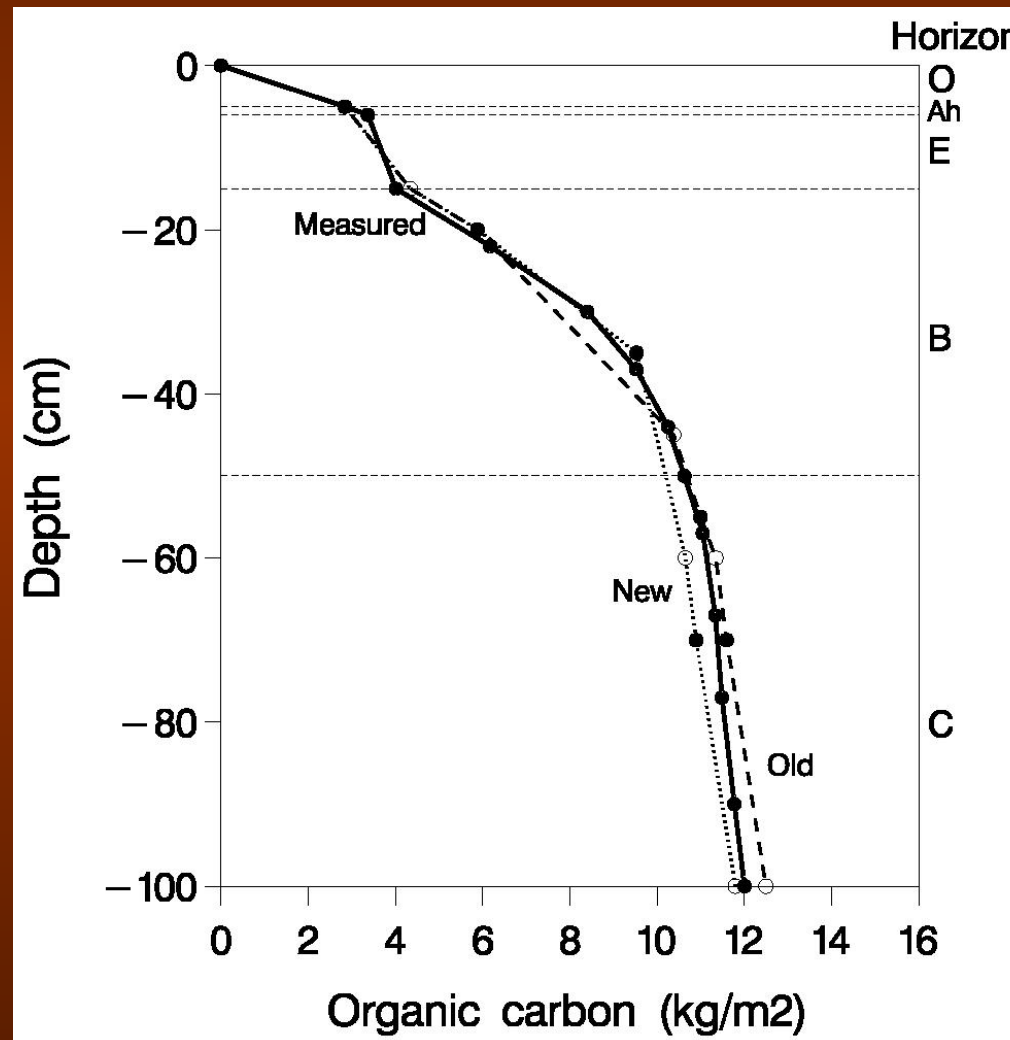
Carbon amount will be 1.5 % lower

	O horizon	Mineral soil
Bulk density:	0.3 g cm ⁻³	0.8 g cm ⁻³
C concentration:	50 %	10 %

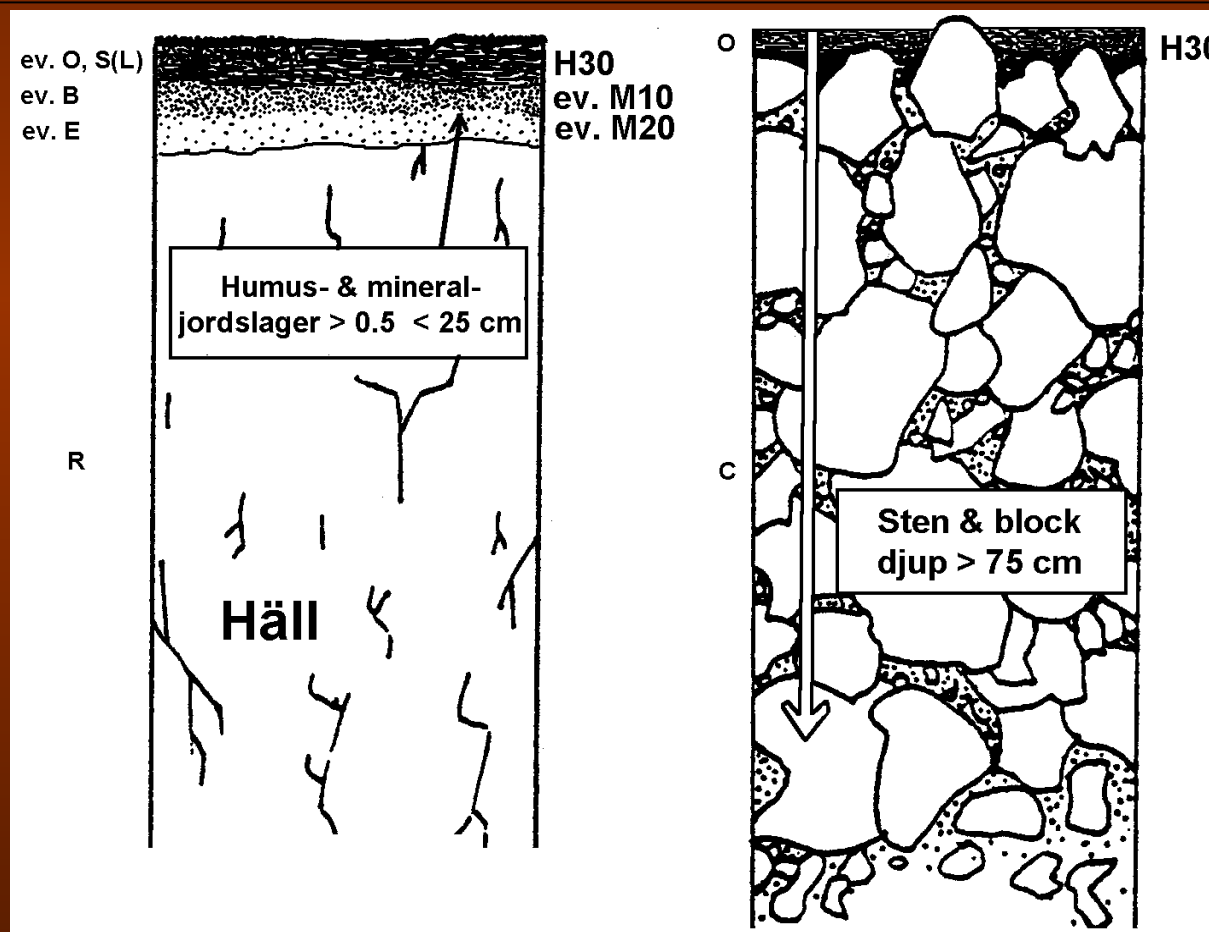
Determination of bulk density



Carbon content in a Podzol profile

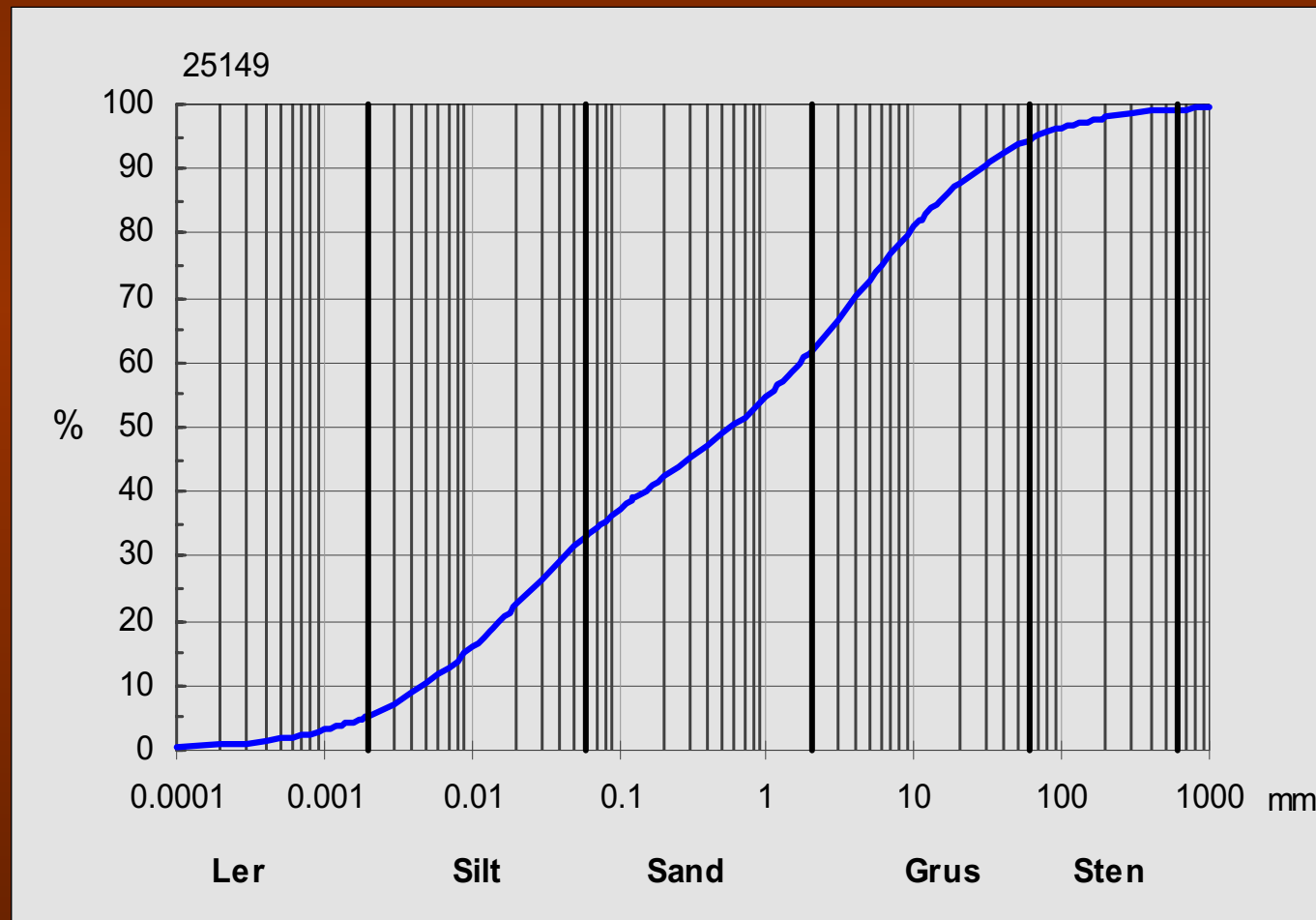


Leptosol, stones and boulders



Stoniness VIRO: $Y = 100 - 3,33 * X$

Tangenshyperbolicus



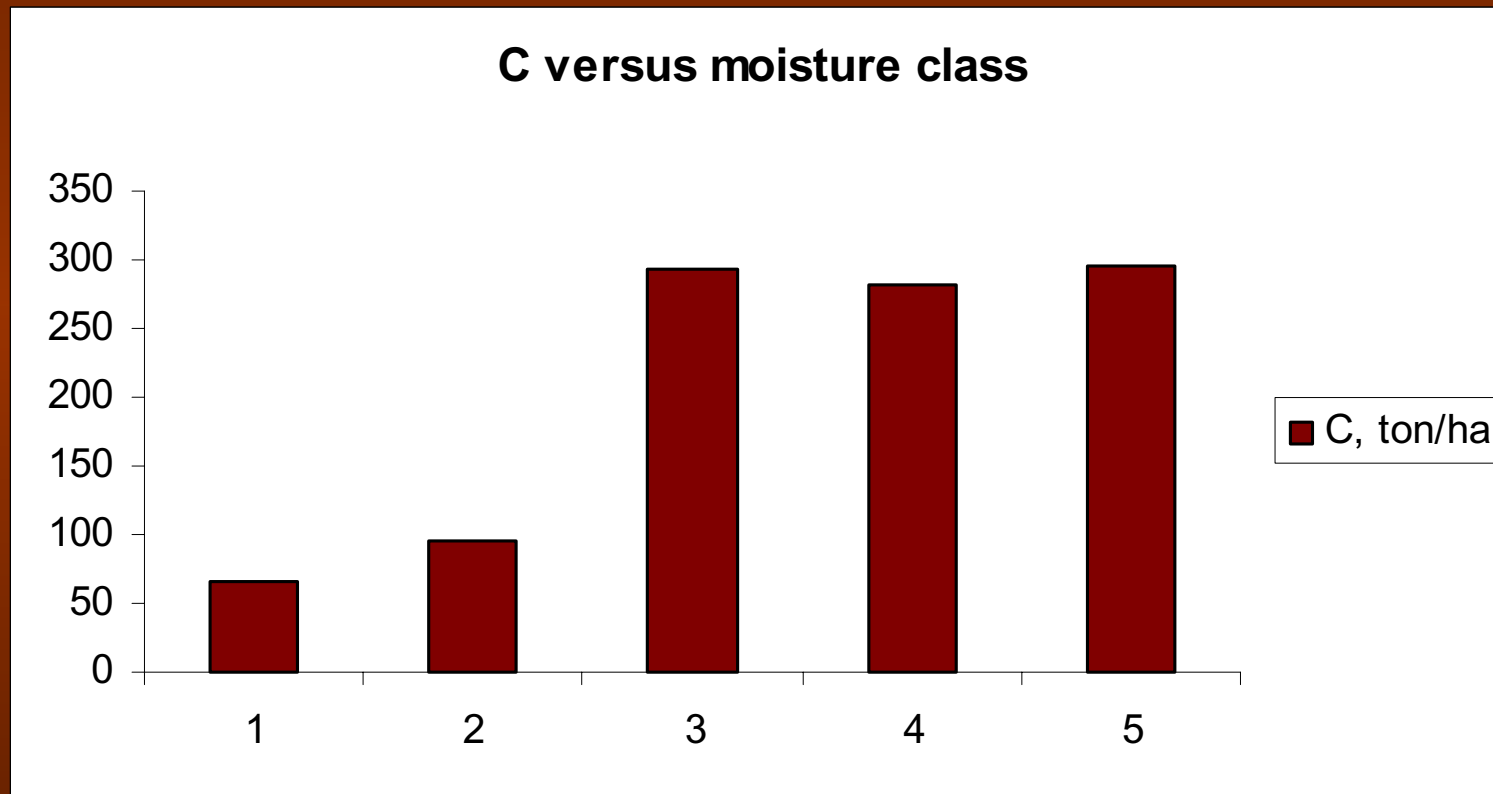
HI-f (forested) Spruce on peatland



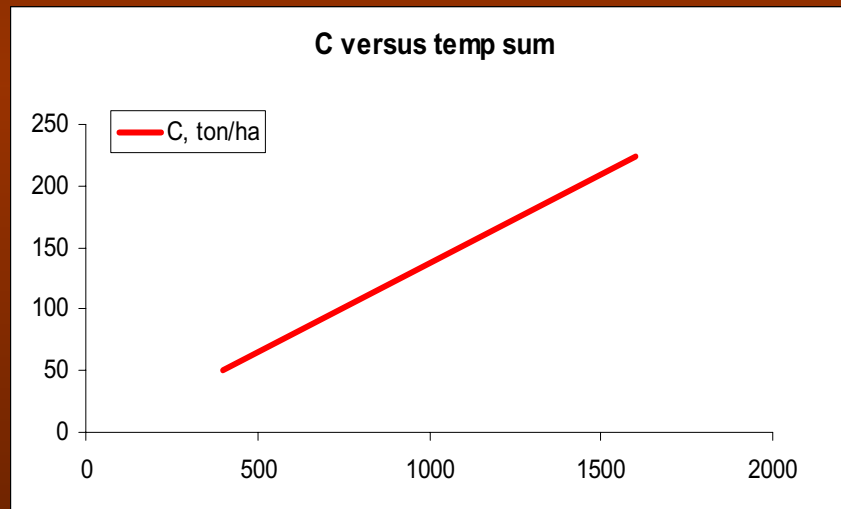
	Area [M Ha]	SOC stock [Mton]	Min RMSE	Max RMSE
Cambisol	1.8	250	237	264
Podzol	14.1	1067	1006	1130
Histosol	3.5	1154	1103	1205
Total	19.4	2471	2346	2599

The upscaling results give a total SOC stock on Swedish forest soils of 2471 Mton. Around 45% of the SOC, 1154 Mton, is stored in Histosols which cover 20% of the forested area. Podzols cover 70% of the forested area and store another 45% of the SOC (1154 Mton). Histosols contain a large amount of SOC which make them hotspots in case of climate change. This kind of soils need to be closely monitored. The uncertainty analysis show that the total SOC stock lies between 2346 and 2599 Mton.

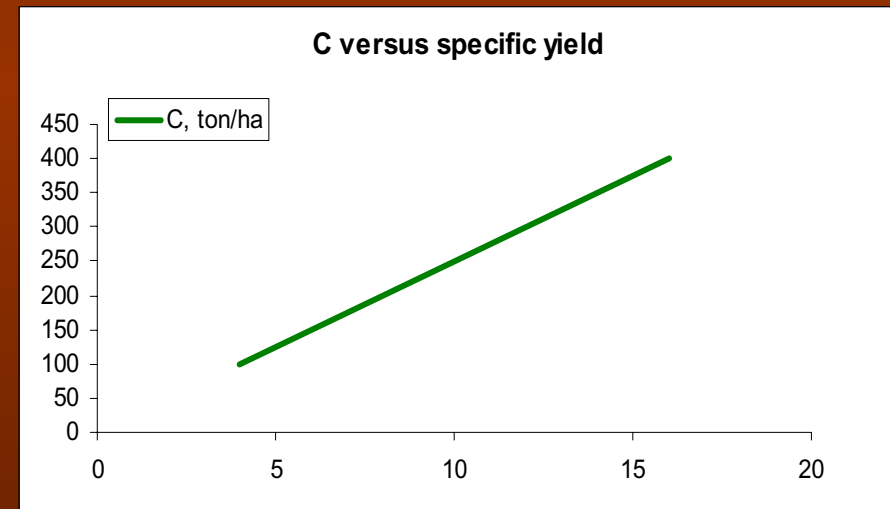
Carbon storage in the soil top 50 cm



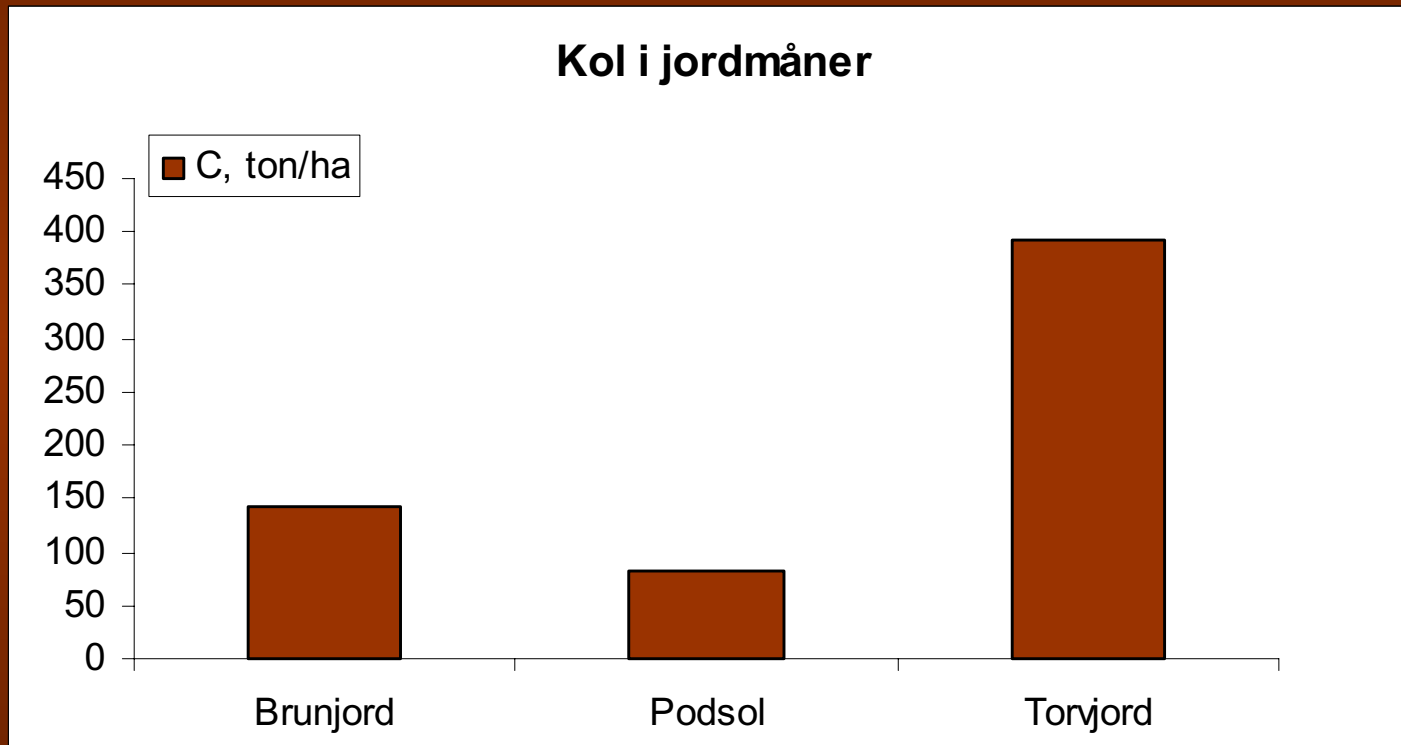
Temperature sum Soil carbon 0-50 cm



Productivity Soil carbon 0-50 cm

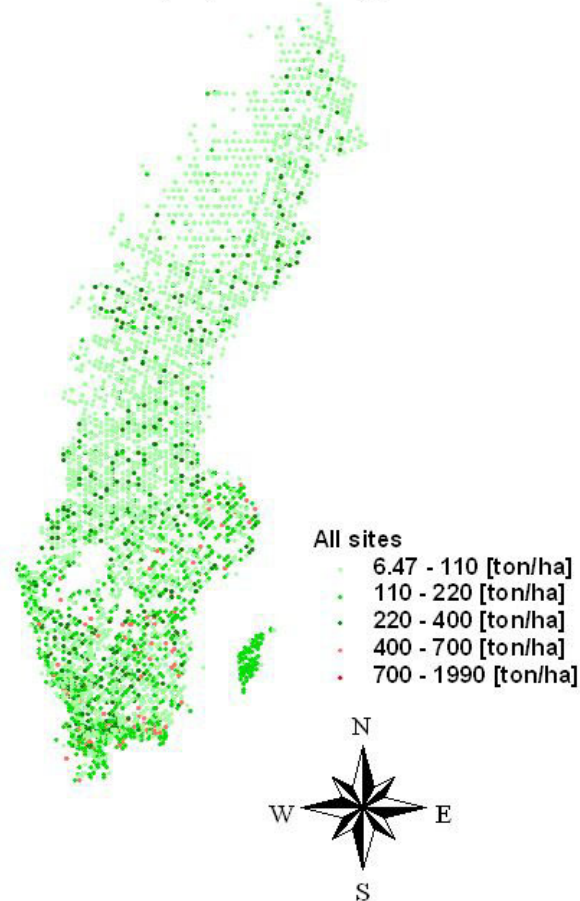


Carbon storage in three soil types, 0-50 cm



A map is created using the 7.000 plots, 2.500 of which having measured C content and 4.500 of which having estimated SOC stock using the regression model (one model per soil type).

C map (ton/ha), All sites





Swedish Forest Soil Inventory

BioSoil



Thank You for Your attention

