Potential Management of Forested Headwaters in Sweden

- Monitoring in Northern Sweden
- Potential production of Norway spruce in Sweden
- Soil respiration
- Regional Climate Change Scenarios
- Soil heating in boreal forest

Monitoring in Northern Sweden

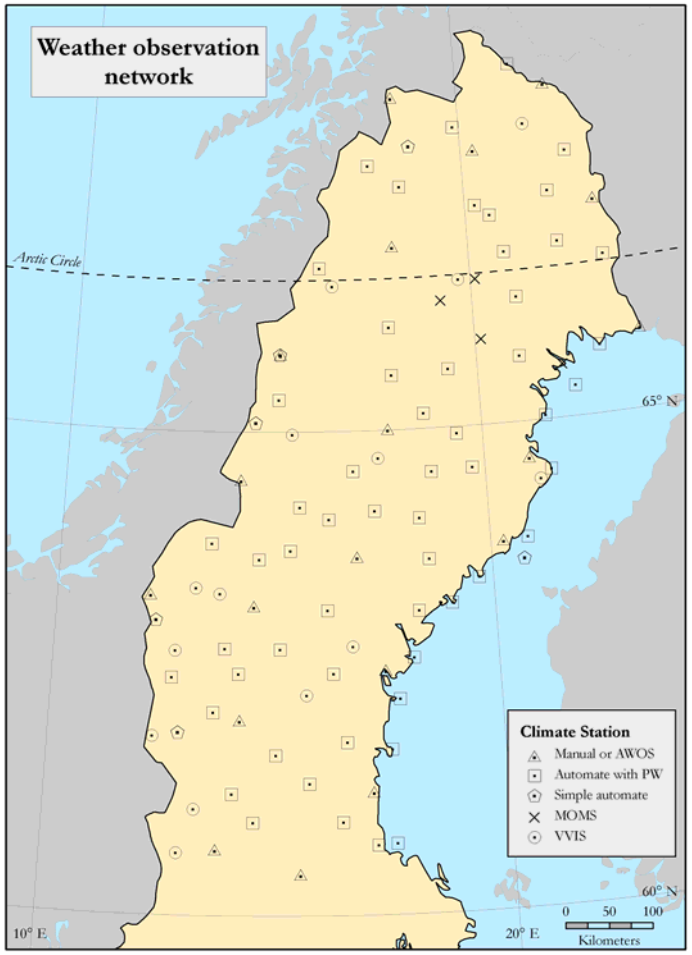
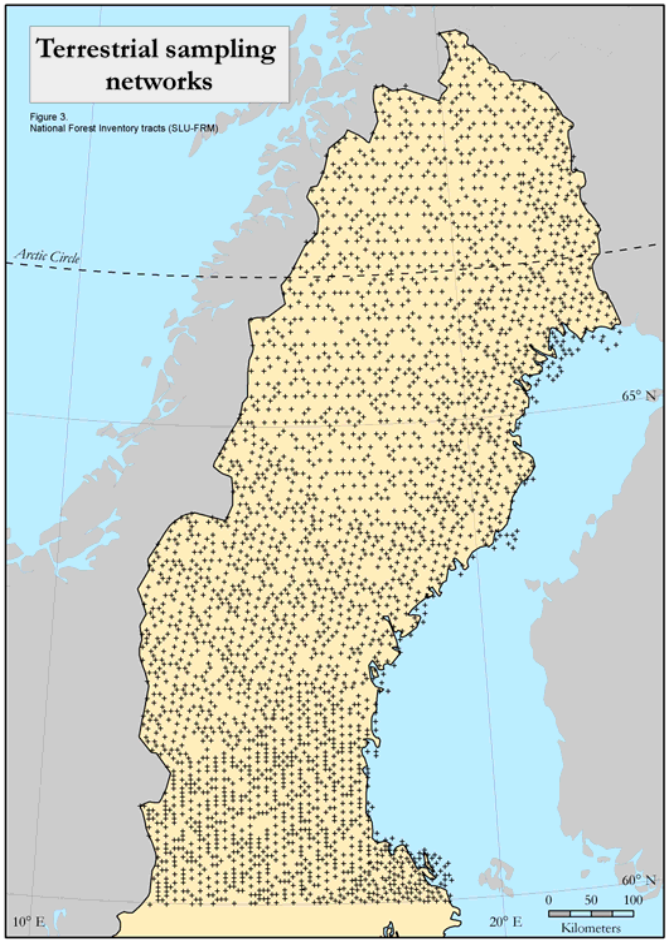


Figure 1.
Weather observation network operated by SMHI. At the VVIS-stations air temperature, air humidity, wind direction and wind speed are observed. The observations at MOMS-stations are as at VVIS, but air pressure and visibility are added. At the simple automate stations the observations are as at the VVIS- stations, but precipitation and maximum wind are added. For variables observed at the automate-with-PW stations visibility is added to the variables observed at the simple automate stations. Finally, the manual and AWOS stations observe the same variables as the automate-with-PW stations less maximum wind, but added air pressure, cloud amount and cloud base.



H.Grip & H.Olsson, Report in press

Approximate status for monitoring of key variables from the AON list in Sweden of potential relevance for arctic monitoring (H. Grip & H. Olsson, in press)

Key variable or Indicator variable		**Agency making the measurements and / or Comments**
Physical variables		
Albedo	😐	Measured at one site by Lund University
Elevation, at glaciers	😐	Bi-annual terminus mapping of 18 glaciers by Stockholm University. Nation-wide laser-scanning is planned.
Ice characteristics	☺	SMHI, from sea and land combined with satellite data
Precipitation	☺	SMHI climate network
Air pressure	☺	SMHI climate network
Solar radiation	😐	SMHI, at 5 locations + integration with satellite data
Snow depth	☺	SMHI climate network
Soil moisture	😐	On project basis by Lund and Gothenburg Universities and SLU at three sites each. SLU regular monitoring at one site.
Temperature, air, sea, soil	😐	SMHI climate network, sea surface temp at 4 places, soil temperature only at a few places by university groups, upper air temperature by balloon sounding at 2 locations
Wind speed	☺	SMHI climate network
Water vapor	☺	SMHI climate network, balloon sounding at 2 locations
Lake level	😐	Only few found, but many exists probably
Sea level	☺	SMHI, at 6 locations
Land cover	😐	NFI and satellite data analysis, no detailed vegetation maps

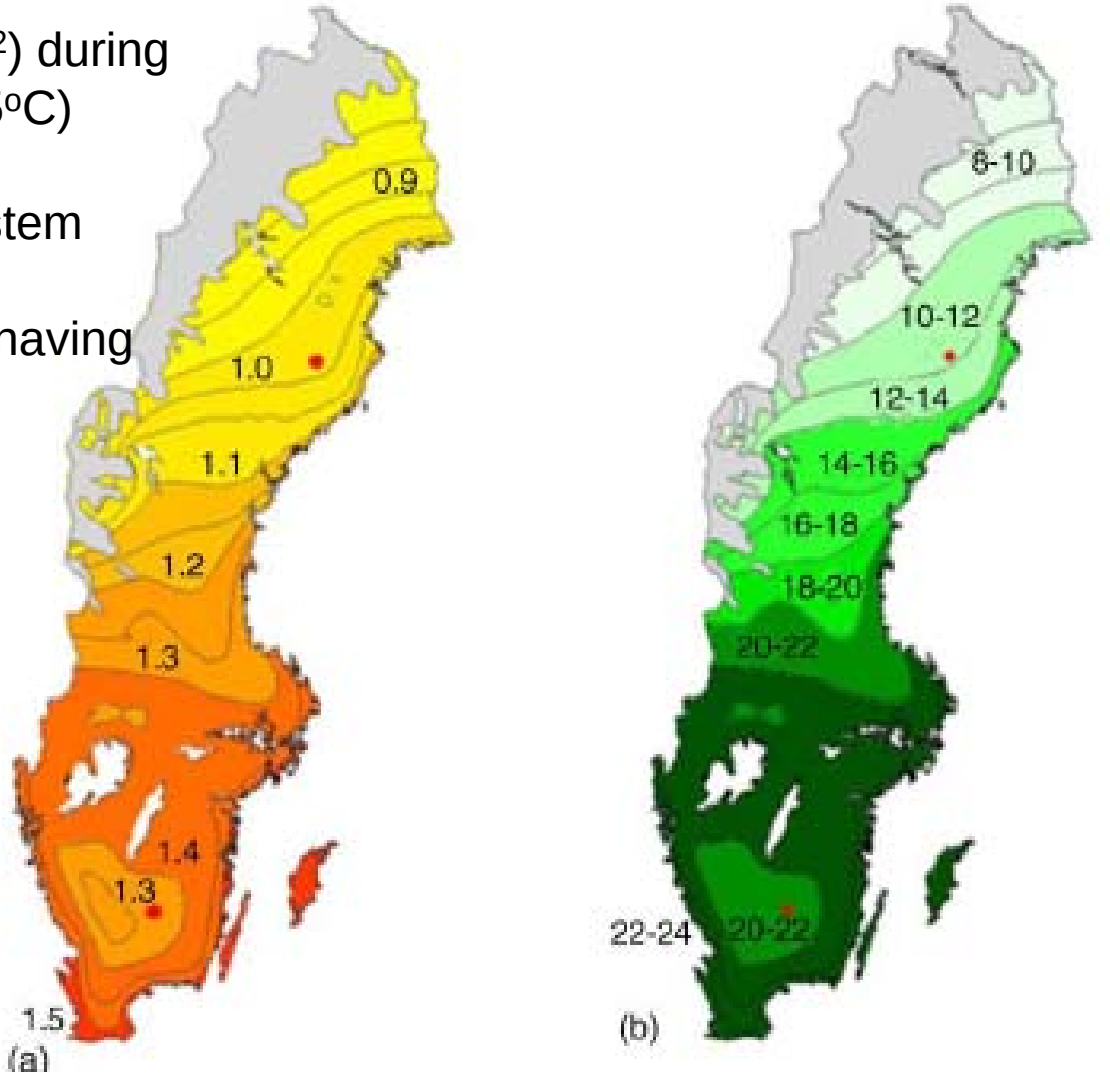
Approximate status for monitoring of key variables from the AON list in Sweden of potential relevance for arctic monitoring (cont.) (H. Grip & H. Olsson, in press)

Key variable or Indicator variable		Agency making the measurements and / or Comments
Biogeochemical variables		
Aerosol concentration	☺	IVL, monthly at 10 locations
Atmospheric chemistry	☺	IVL, monthly at 15 locations
Biodiversity	☺	NILS, Landscape inventory 1/5 years at 631 locations
Biomass	☺	Sampling based national forest inventory, and satellite data products for forest covered areas
Carbon concentration	😐	CO_2 flux by universities, terrestrial carbon by NFI
Nutrient concentration	☺	Soil surveys by SLU
Contaminant conc.	☺	IVL, at 6 locations
Dissolved oxygen conc.	☺	Made by marine research stations at 33 locations
Phenology and behavior of animals	😐	Sparse phenology network started 2007. Bird migration monitored at a few places. Extensive reporting from the general public (www.artportalen.se).
Tracer chemistry	😐	Stockholm University at 4 locations
Human-dimension variables		
Human demographics	☺	Statistics Sweden
Human health	☺	National board of health and welfare
Cultural diversity	☹	No regular statistics related to the indigenous Sámi population
Education	☺	Statistics Sweden
Economic indicators	☺	Statistics Sweden

Potential production of Norway spruce in Sweden

a) Amount of PAR (GJ m^{-2}) during the growing season (>5°C)

b) Potential production of stem volume (m^3 ha^{-1} a^{-1}) in Norway spruce stands having optimal nutrition and water supply

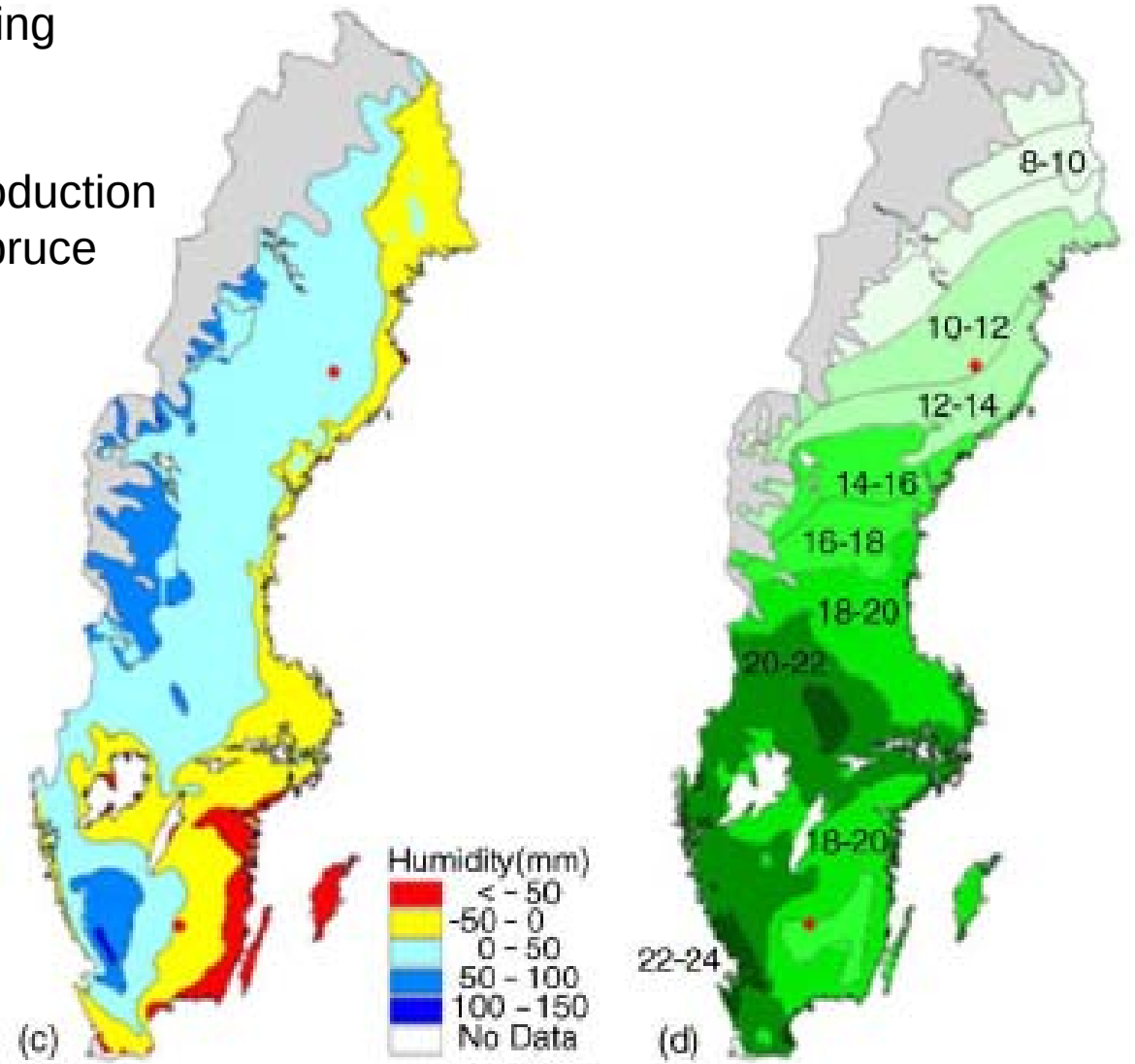


J. Bergh et al. For. Ecol. Manage. 204 (2005) 1-10.

Potential production of Norway spruce in Sweden

c) Humidity during the growing season (P-E, mm)

d) Attainable stem wood production ($m^3\ ha^{-1}\ a^{-1}$) in Norway spruce stands with solid fertilizer (MAI for rotation period)

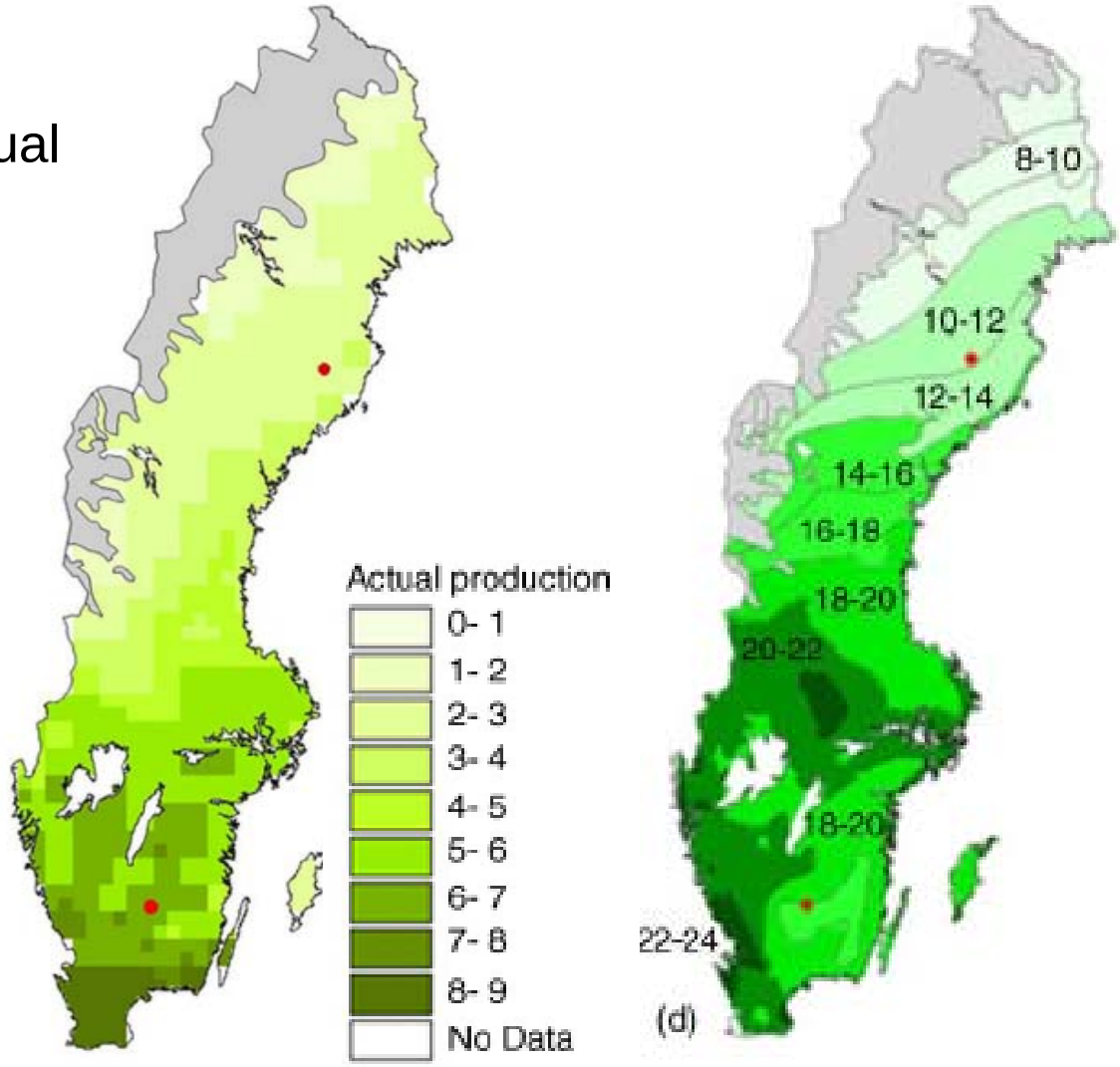


J. Bergh et al. For. Ecol. Manage. 204 (2005) 1-10.

Potential production of Norway spruce in Sweden

Stem volume production (m^3 ha^{-1} a^{-1}) as mean annual increment (MAI) during a rotation period

Left: Actual production
Right: Potential production

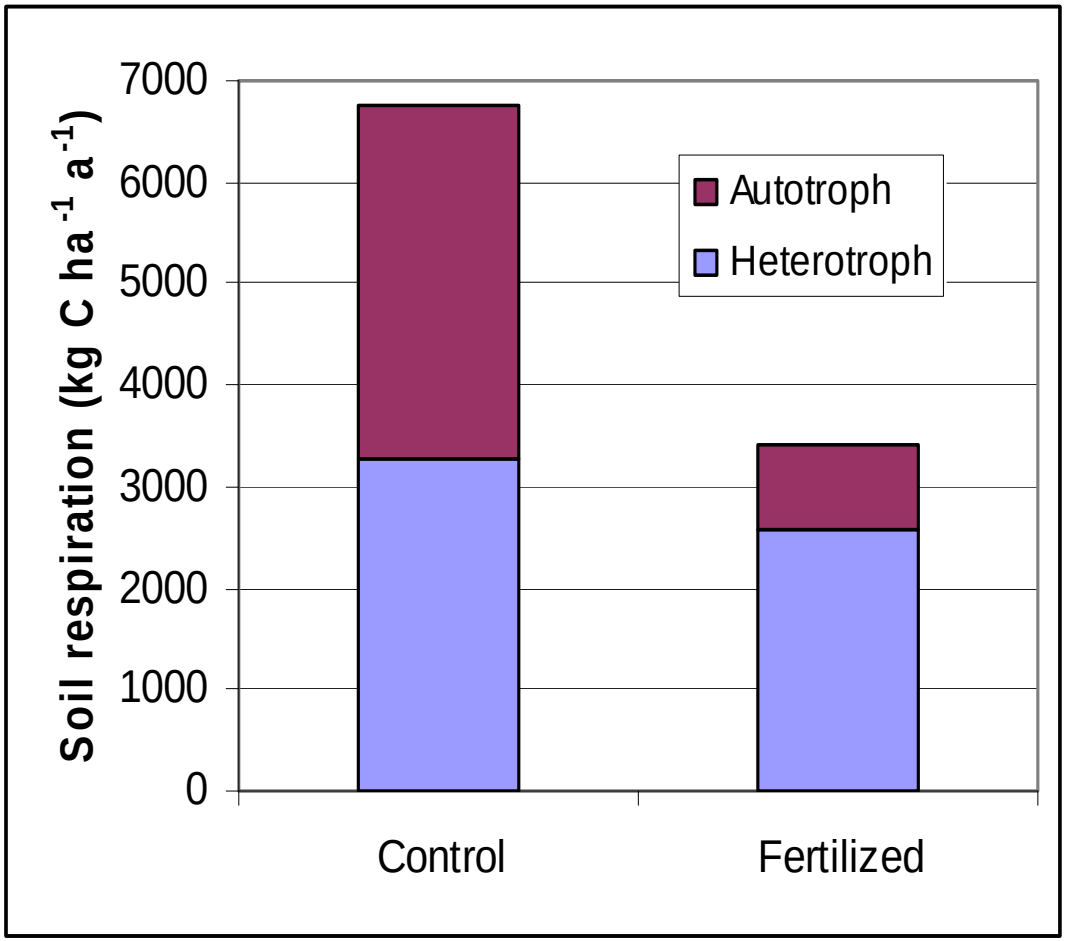


J. Bergh et al. For. Ecol. Manage. 204 (2005) 1-10.

Soil respiration

A large girdling experiment was conducted at the nutrient optimization trial at Flakaliden.

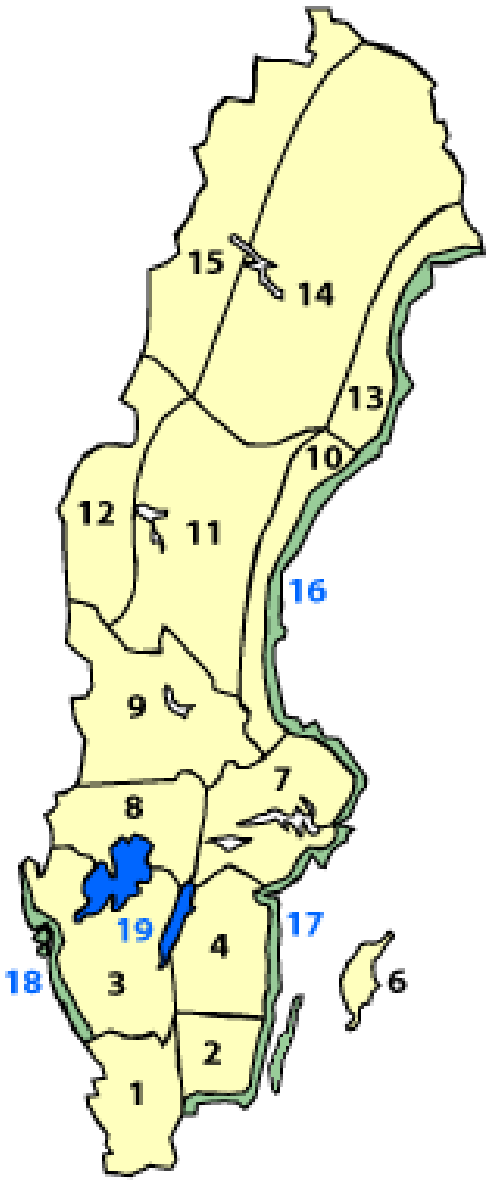
By girdling 0.1 ha plots of fertilized and non-fertilized 40-year-old Norway spruce stands and measuring soil respiration the autotrophic and heterotrophic components could be identified.



P. Olsson et al., Global Change Biol. (2005)

Regional Climate Change Scenarios

(Rossby Center, SMHI)



Scenario 2100	Area	TA, oC	Prec, %	Snow, d	Veg.per, d
SPRES A2	15	5	35	-70	47
	14	5	20	-80	46
	13	5	20	-100	54
	16	5,5	15	-100	74
	12	5	25	-100	61
	11	5	20	-100	64
	10	5	15	-100	81
	9	5	15	-80	89
SPRES B2	15	5	30	-60	34
	14	4,5	30	-60	34
	13	4,5	30	-80	38
	16	5	30	-100	47
	12	4	30	-80	42
	11	4	30	-80	41
	10	4	30	-80	51
	9	4	15	-40	55

Soil heating in boreal forest

To simulate a warmer climate in a young Norway spruce stand a soil heating experiment was started at Flakaliden 1995 by S.Linder in an optimum fertilization experiment that started 1986.

The experiment comprises four treatments:

Irrigation, Irrigation + soil heating, Liquid fertilization and Liquid fertilization + soil heating

Heating cables were inserted each 20 cm and below the humus layer and increased temperature by 5 ^{o}C above ambient

Soil heating in boreal forest

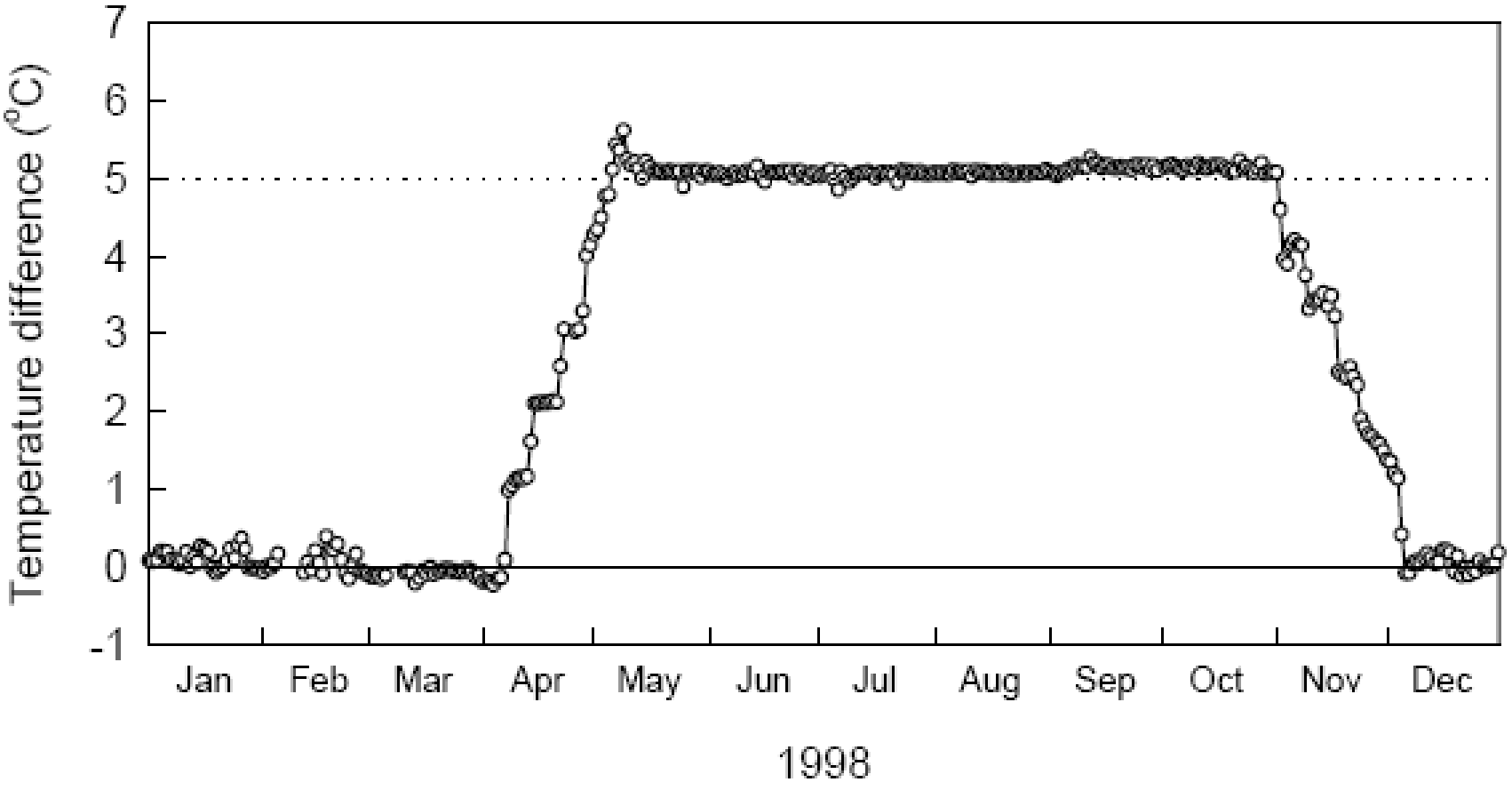


Figure 5. Difference in soil temperature, measured in the first centimetre of the mineral soil, between irrigated heated (Ih) and unheated (Ic) plots in 1998. Each data point is a mean of two plots.

M. Strömgren, PhD Thesis SLU, 2001

Soil heating in boreal forest

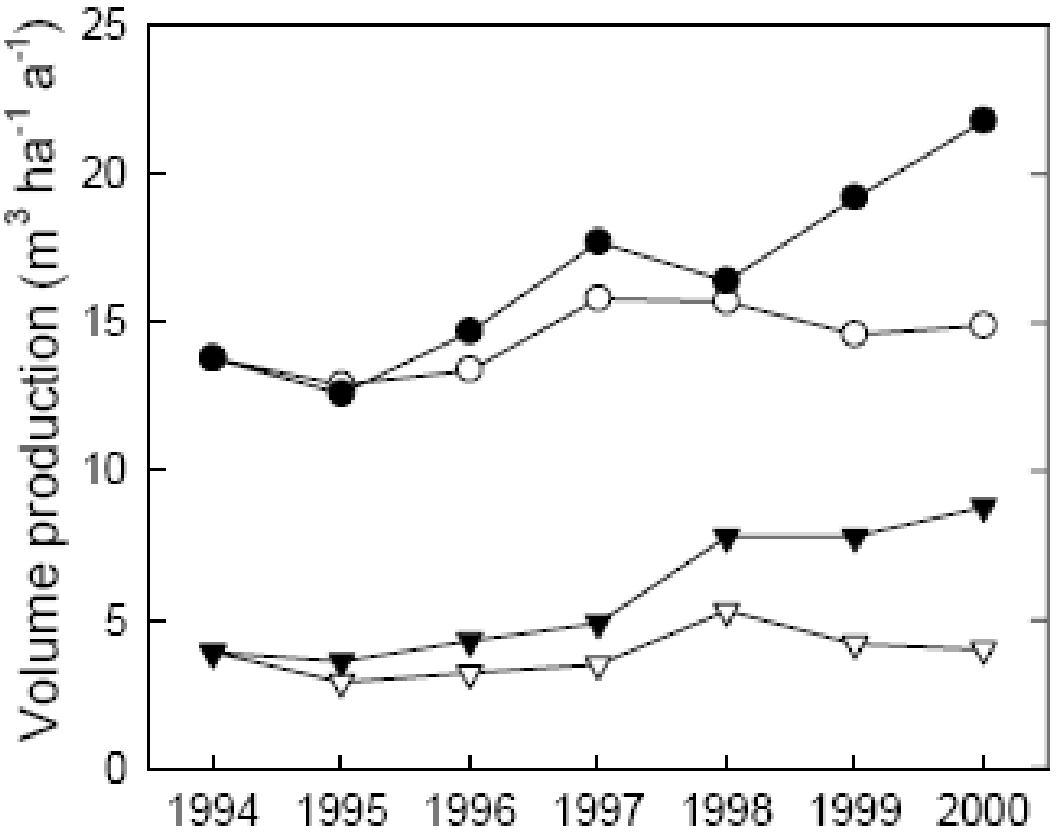
Annual stem increment

▽ Irrigation

▼ + soil heating

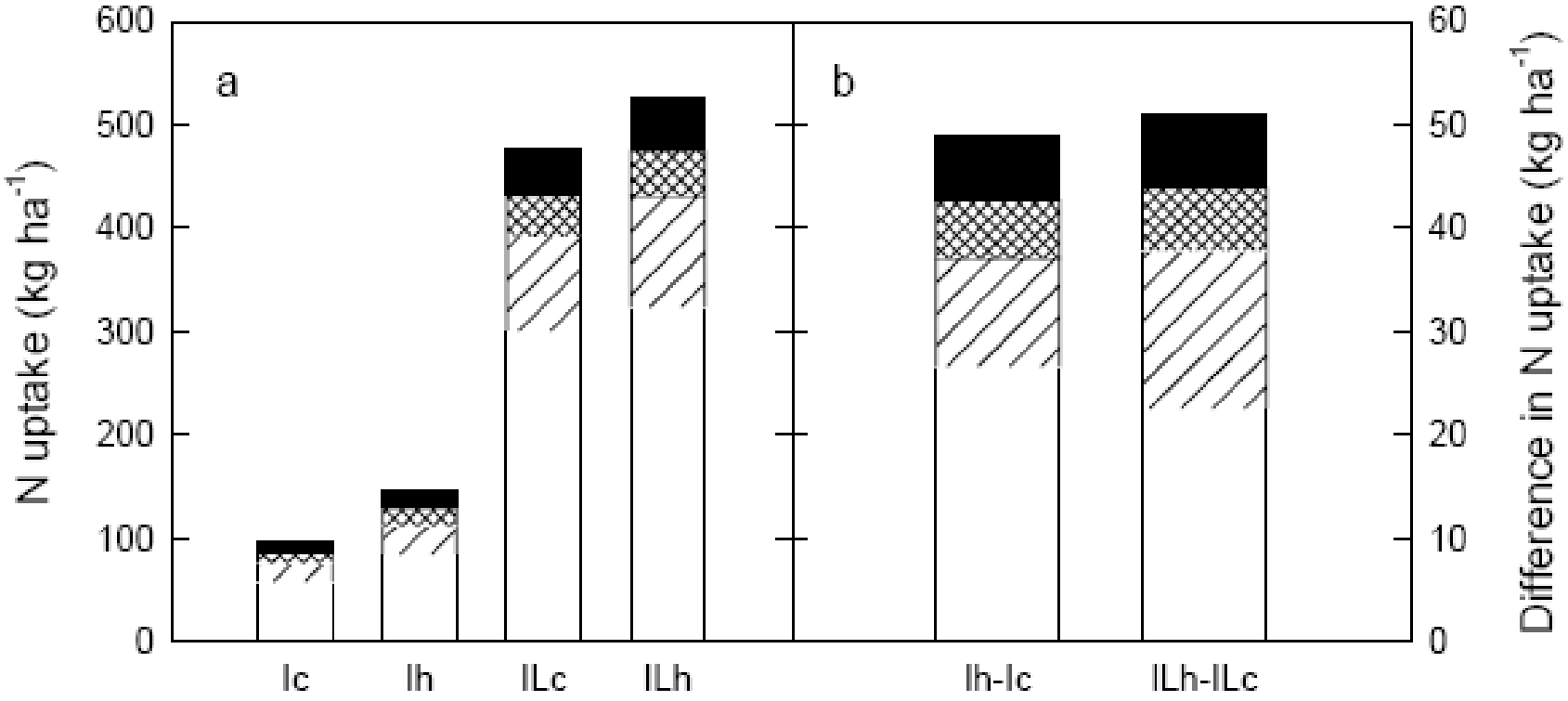
○ Liquid fertilization

● + soil heating



M. Strömgren, PhD Thesis SLU, 2001

Soil heating in boreal forest



Total above ground nitrogen uptake in 35-year old Norway spruce during the first six years of soil heating

Stemwood
Bark
Branches
Needles

M. Strömgren, PhD Thesis SLU, 2001

Soil heating in boreal forest

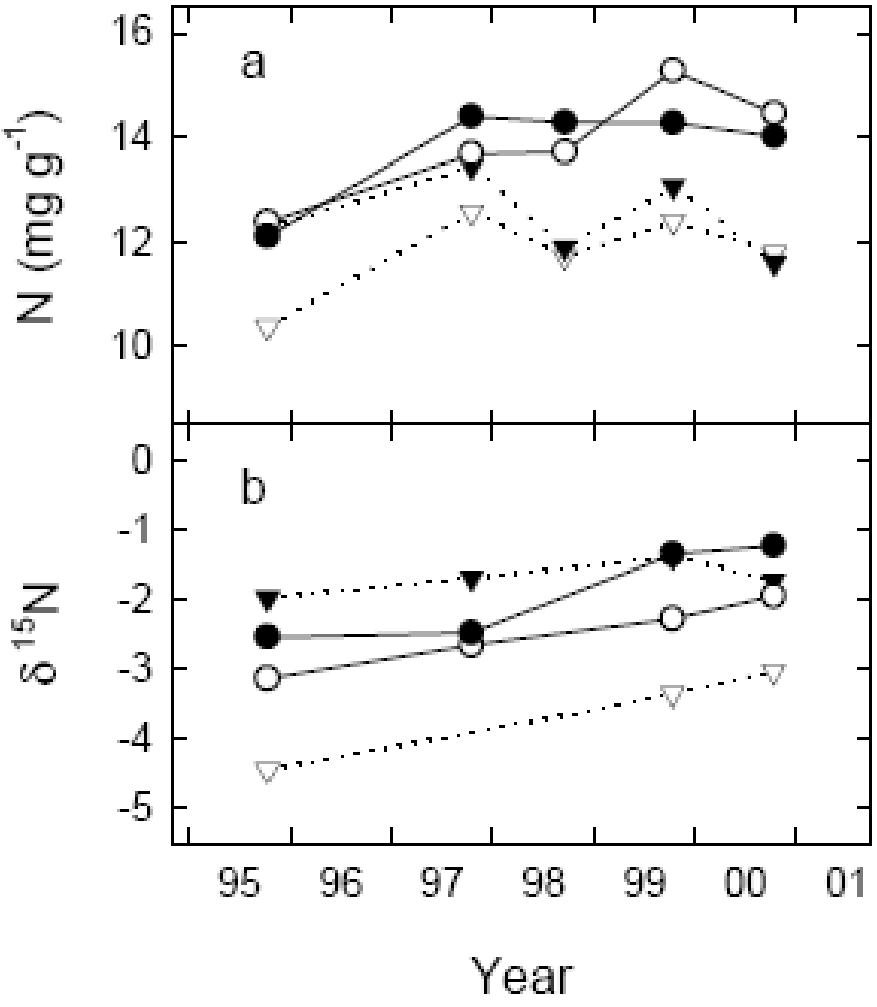
Nitrogen content and natural abundance of ^{15}N in one-year-old Norway spruce needles

△ Irrigated

▲ + heated

○ Liquid fertilized

● + heated



M. Strömgren, PhD Thesis SLU, 2001

Conclusions

- Monitoring in Northern Sweden
  - Mostly adequate, but sometimes unsecured
- Potential production of Norway spruce in Sweden
  - Optimal nutrition could increase production three times in northern Sweden
- Soil respiration
  - About half of photosynthates to below ground
  - Reduced to half under optimal nutrition
- Regional Climate Change Scenarios (to 2100)
  - Air temp. 4 - 5 ^{o}C increase
  - Precip. 20 – 30 % increase
  - Snow cover 60 – 100 days decrease
  - Vegetation period 40 – 80 days increase
- Soil heating in boreal forest
  - Increases stem volume production by mobilizing deeper soil nitrogen