# Air-surface gas exchange of semivolatile organic compounds in boreal forests


Henrik Kylin

NILU, Tromsø, Norway

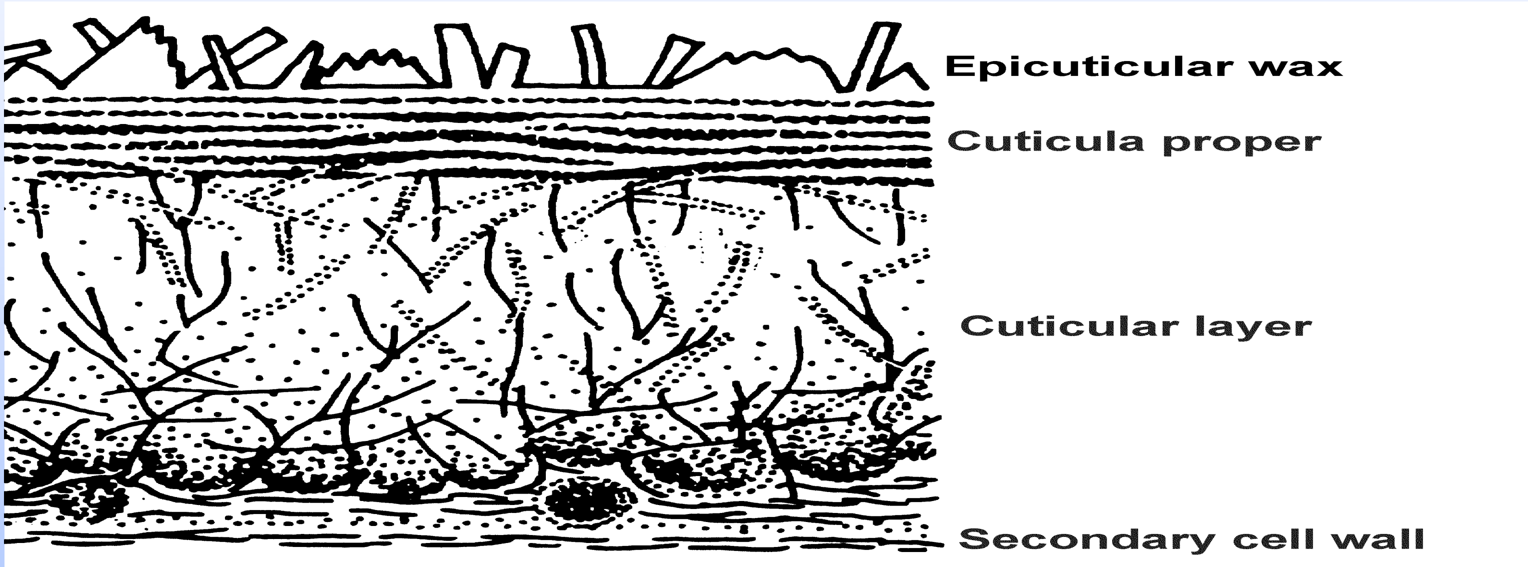
Dept Aquatic Sciences and Assessment
Swed Univ Agric Sci, Uppsala
Sweden

- Conclusions drawn from two studies
  - Emphasis on 30-month study on the uptake of airborne POPs in pine needles
  - POPs & PAHs in surface sediment of 100 lakes in Sweden

# Vascular plants

- have a hydrophobic surface that will sorb hydrophobic compounds from the surrounding air
- cover a large area of the northern hemisphere
- are potentially important for the surface air gas exchange of semivolatile organic compounds.

# The cuticle


Epicuticular wax
Cuticula proper
Cuticular layer
Secondary cell wall

# Long time-series pine needle study

- All year-classes of pine needles were collected every 2-4 weeks, > 5 replicates per sampling
- Duplicate air samples with same periodicity
- HCHs, HCB, DDTs, 7 PCBs quantified

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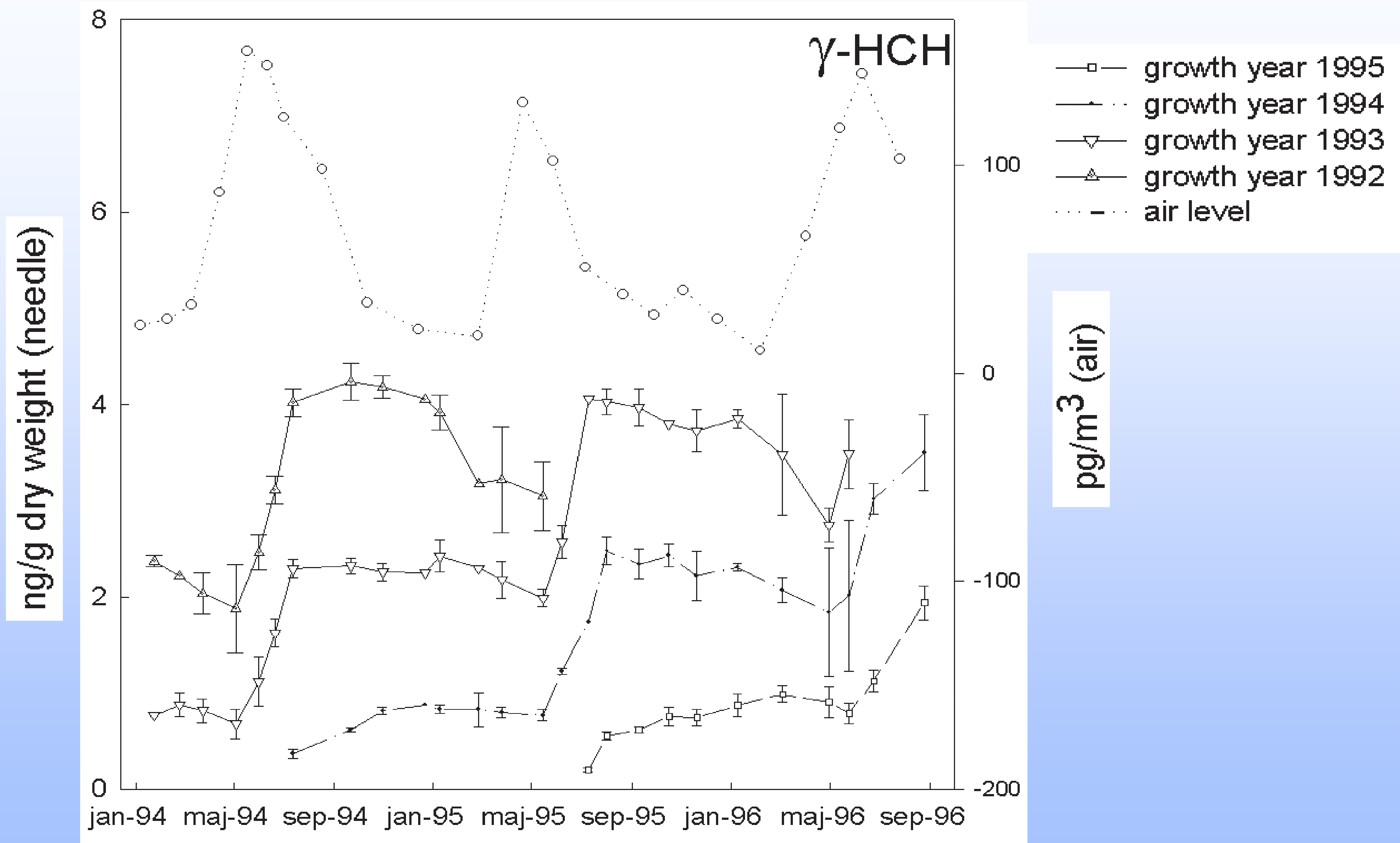
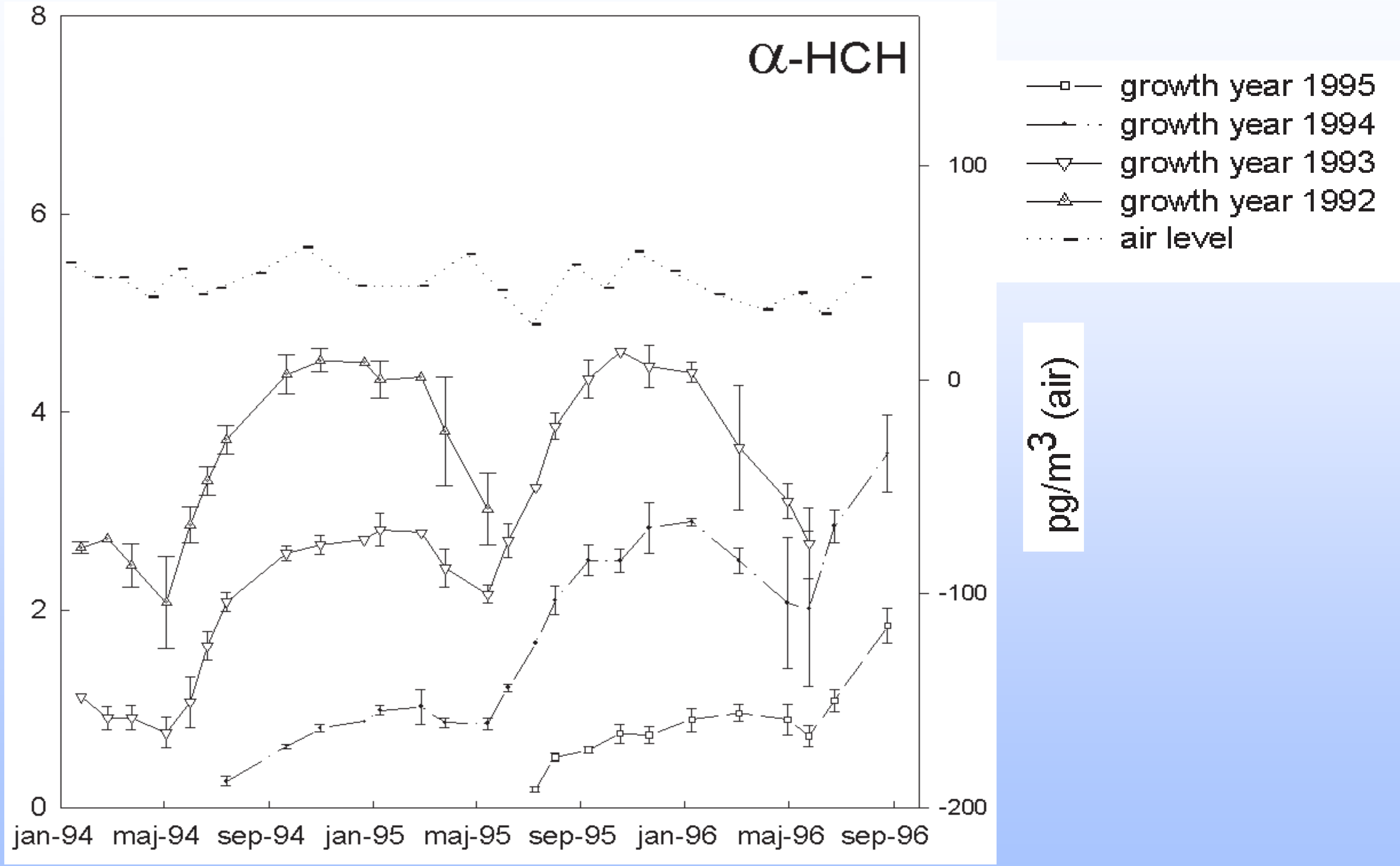
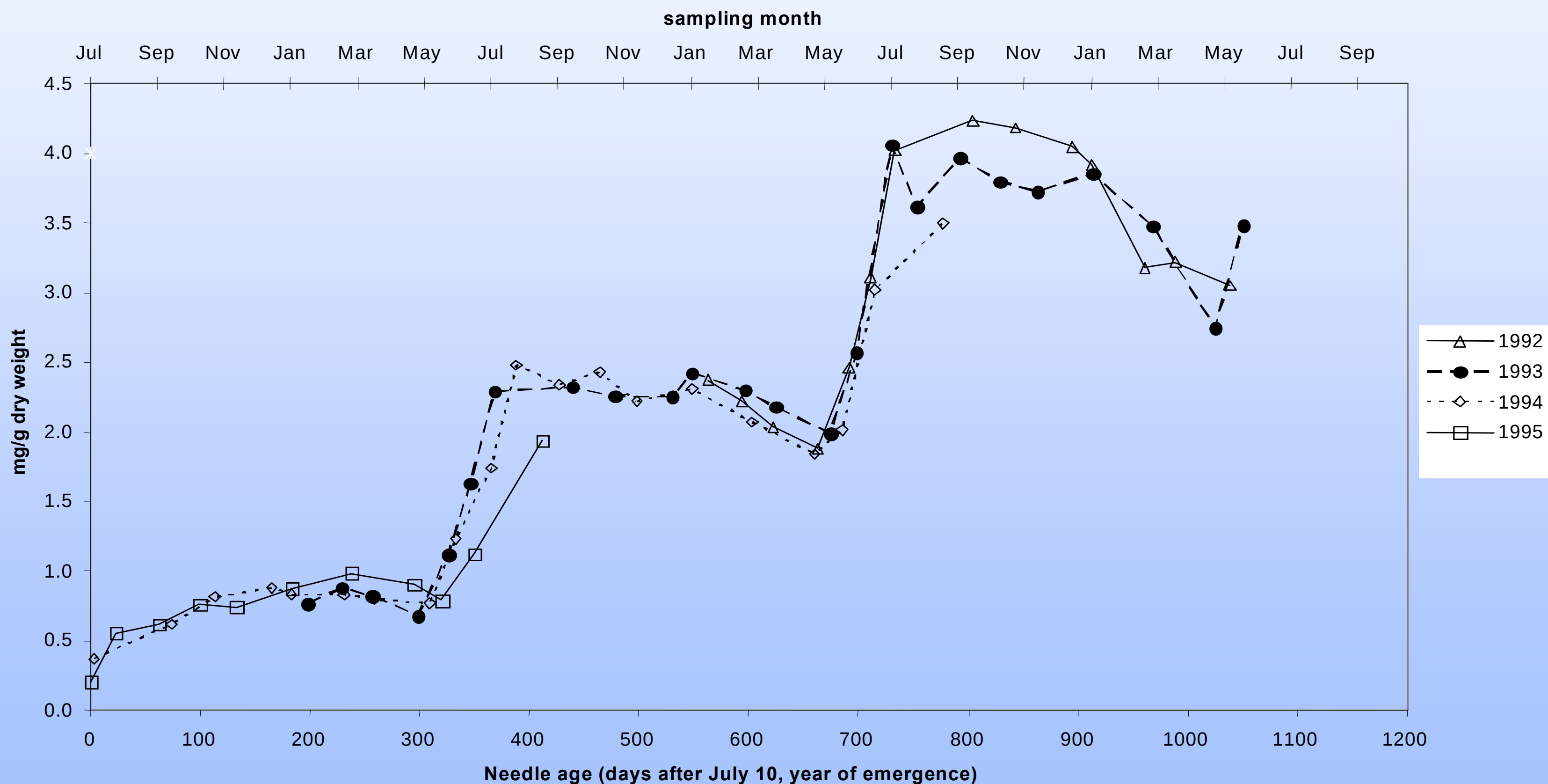
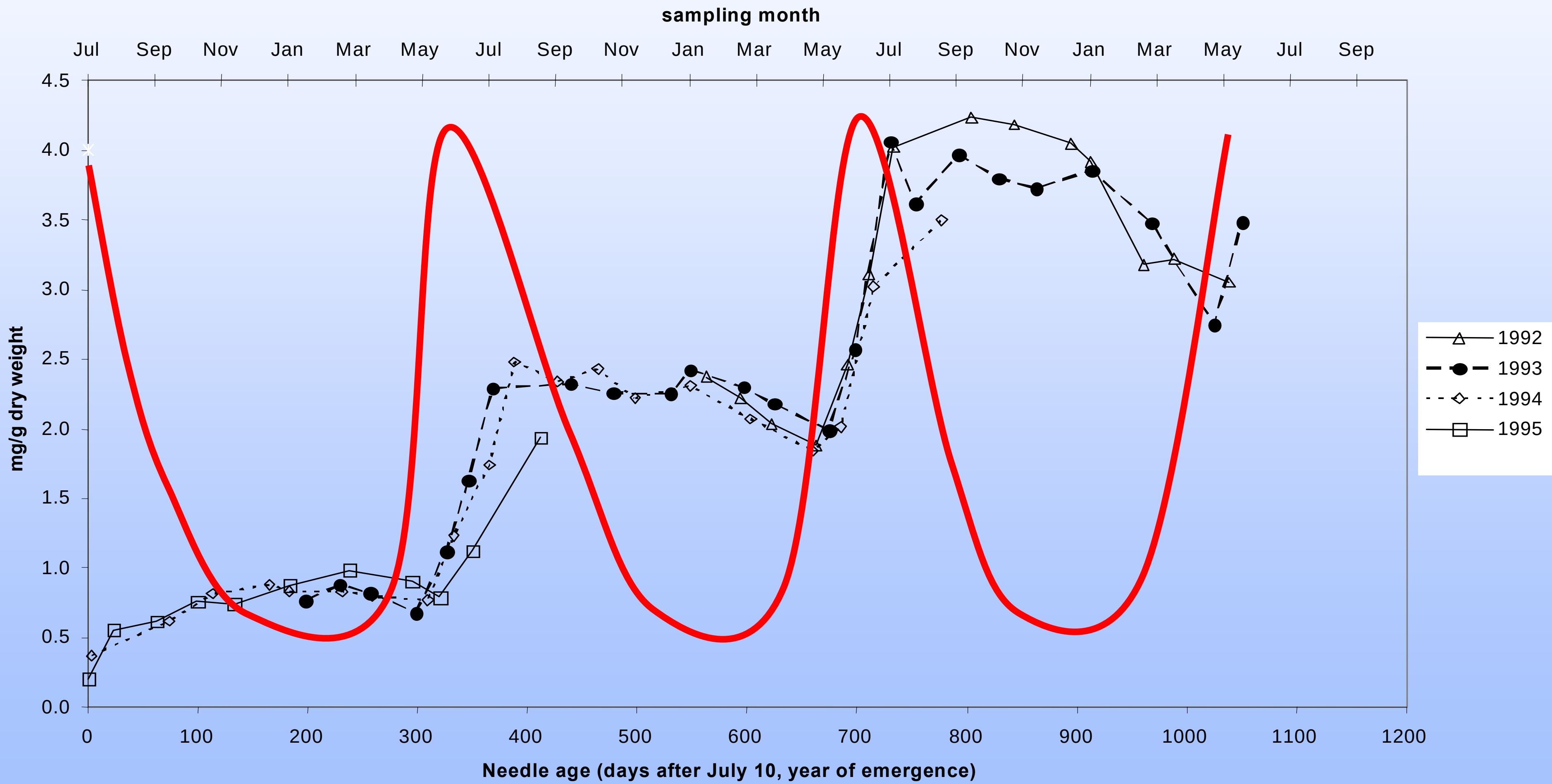



α-HCH
ng/g dry weight (needle)
pg/m3 (air)
8
6
4
2
0
100
0
-100
-200
jan-94
maj-94
sep-94
jan-95
maj-95
sep-95
jan-96
maj-96
sep-96
growth year 1995
growth year 1994
growth year 1993
growth year 1992
air level

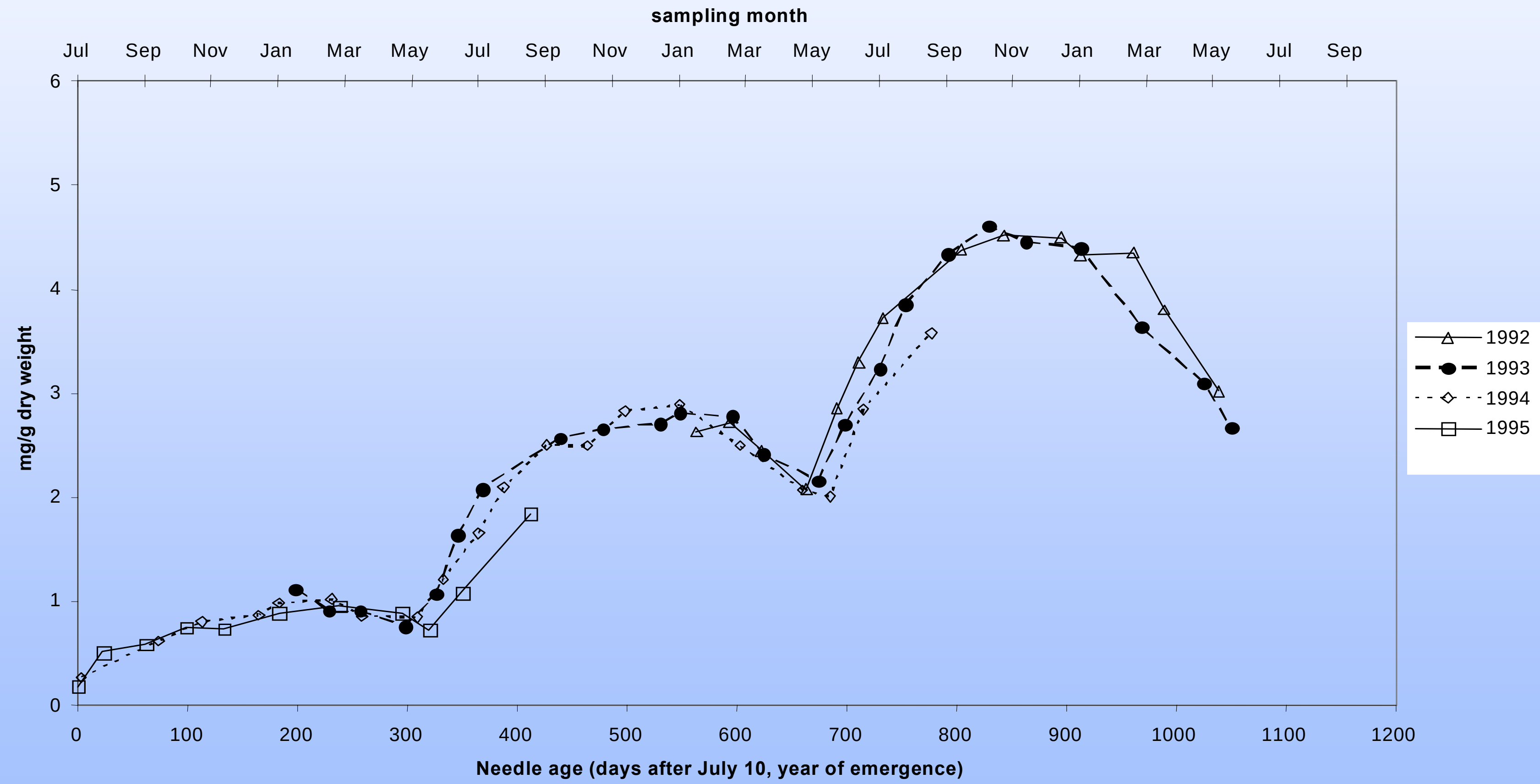
# γ-HCH concentration in in Scots pine needles during a lifetime cycle



# Comparison of γ-HCH in air and Scots pine needles



# α-HCH concentration in Scots pine needles during a lifetime cycle

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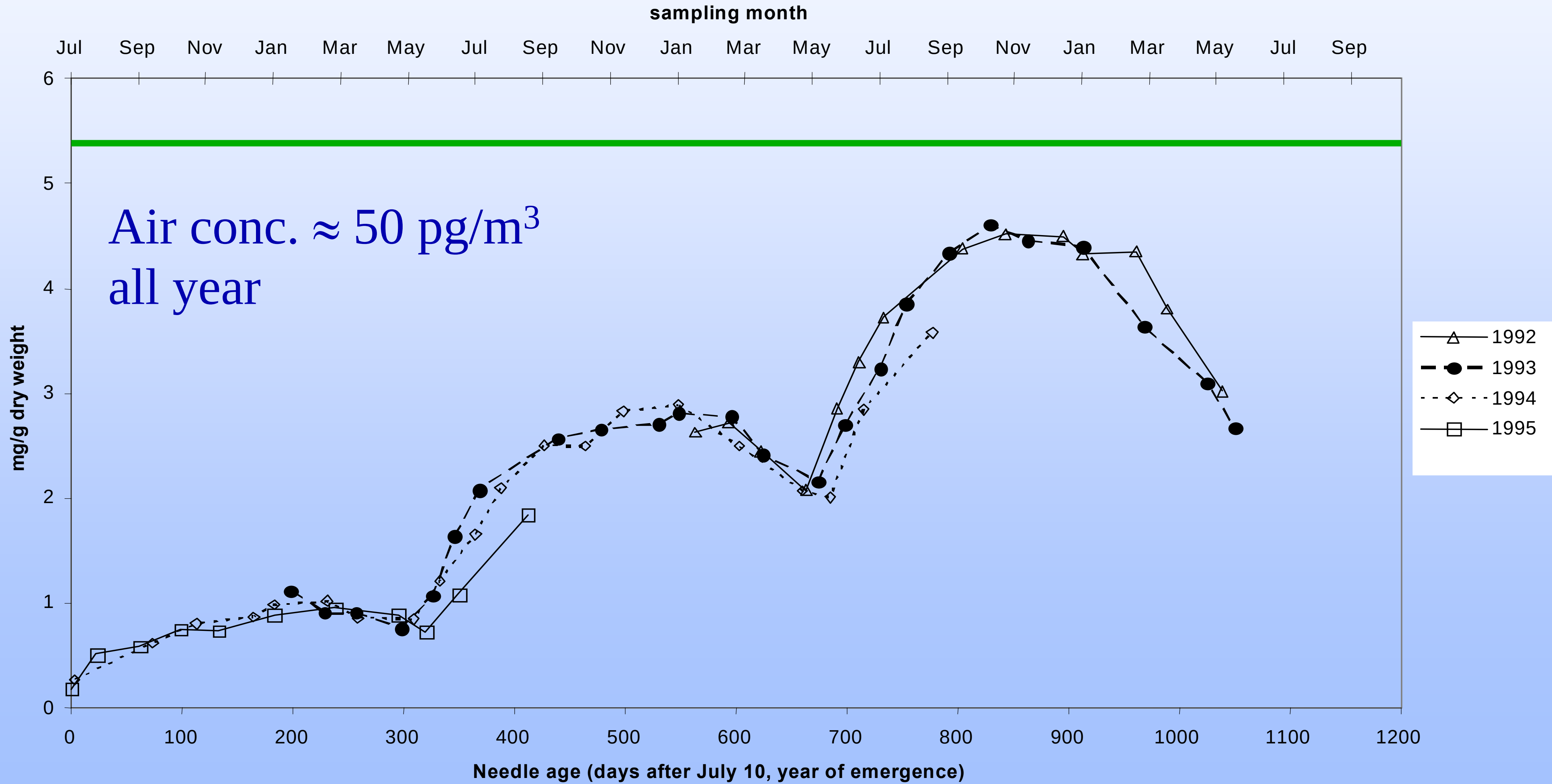


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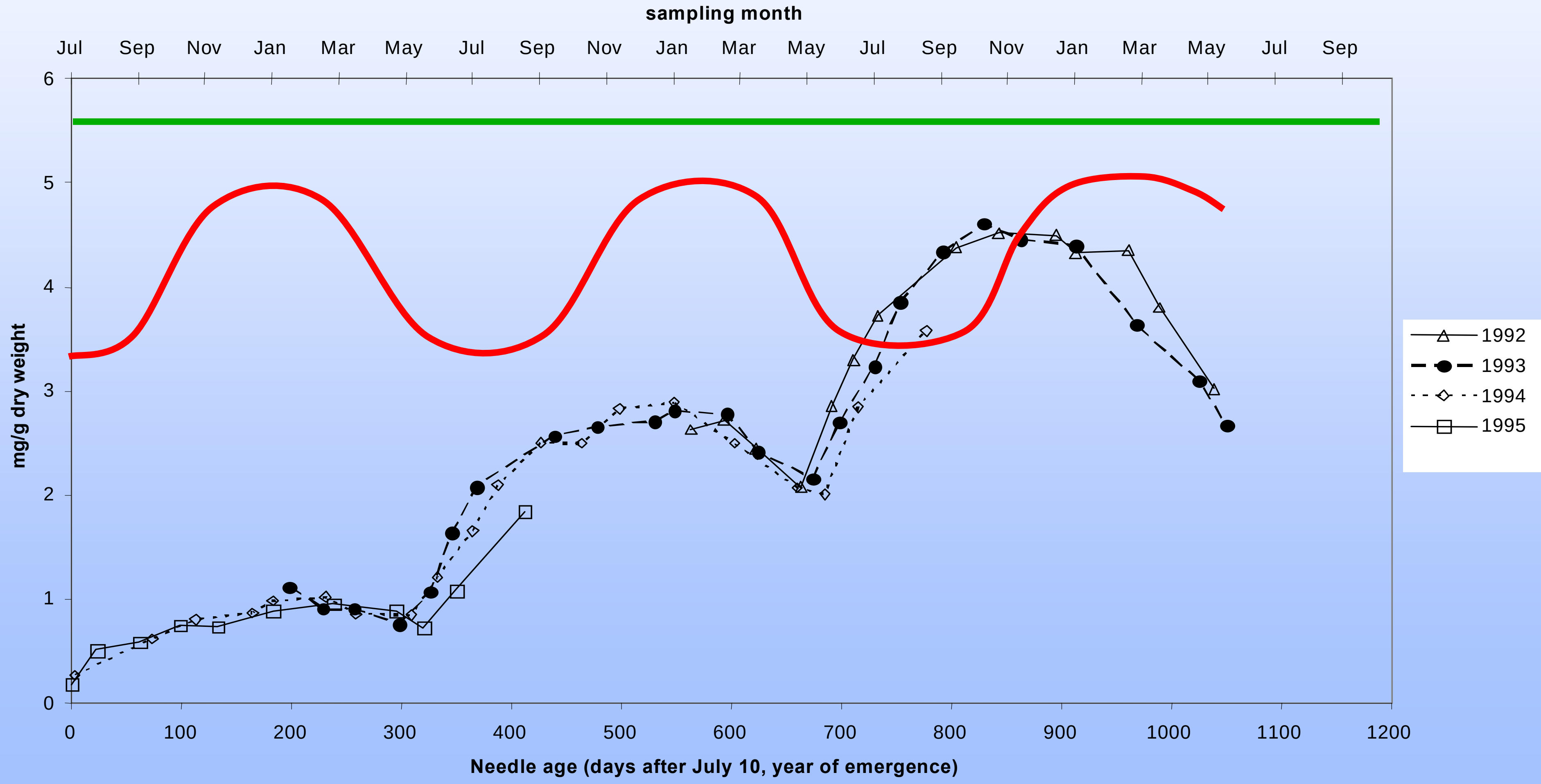
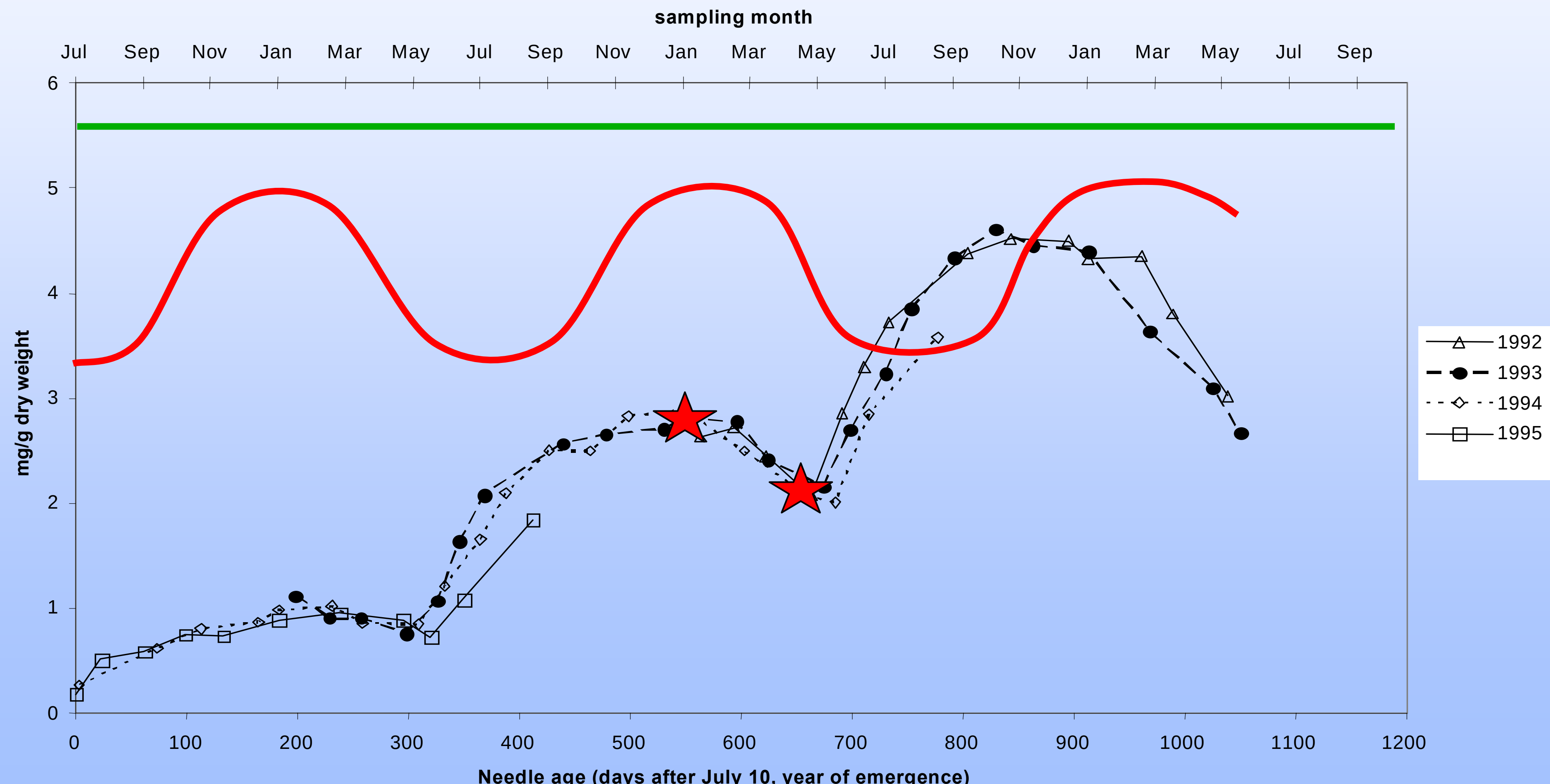
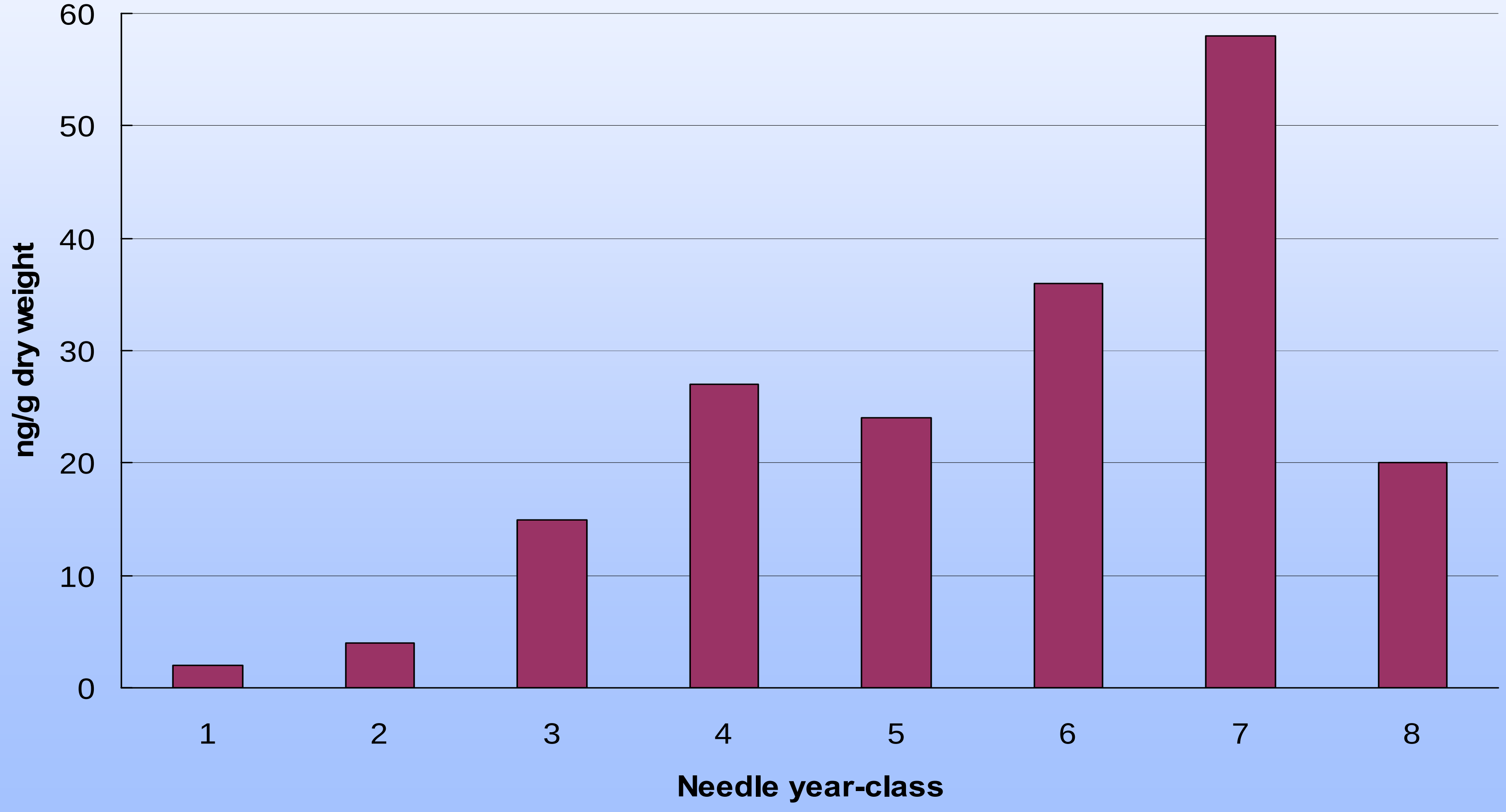
# Comparison of models and reality



# Consequences of too little data



# Accumulation of α-HCH in pine needles with more year-classes



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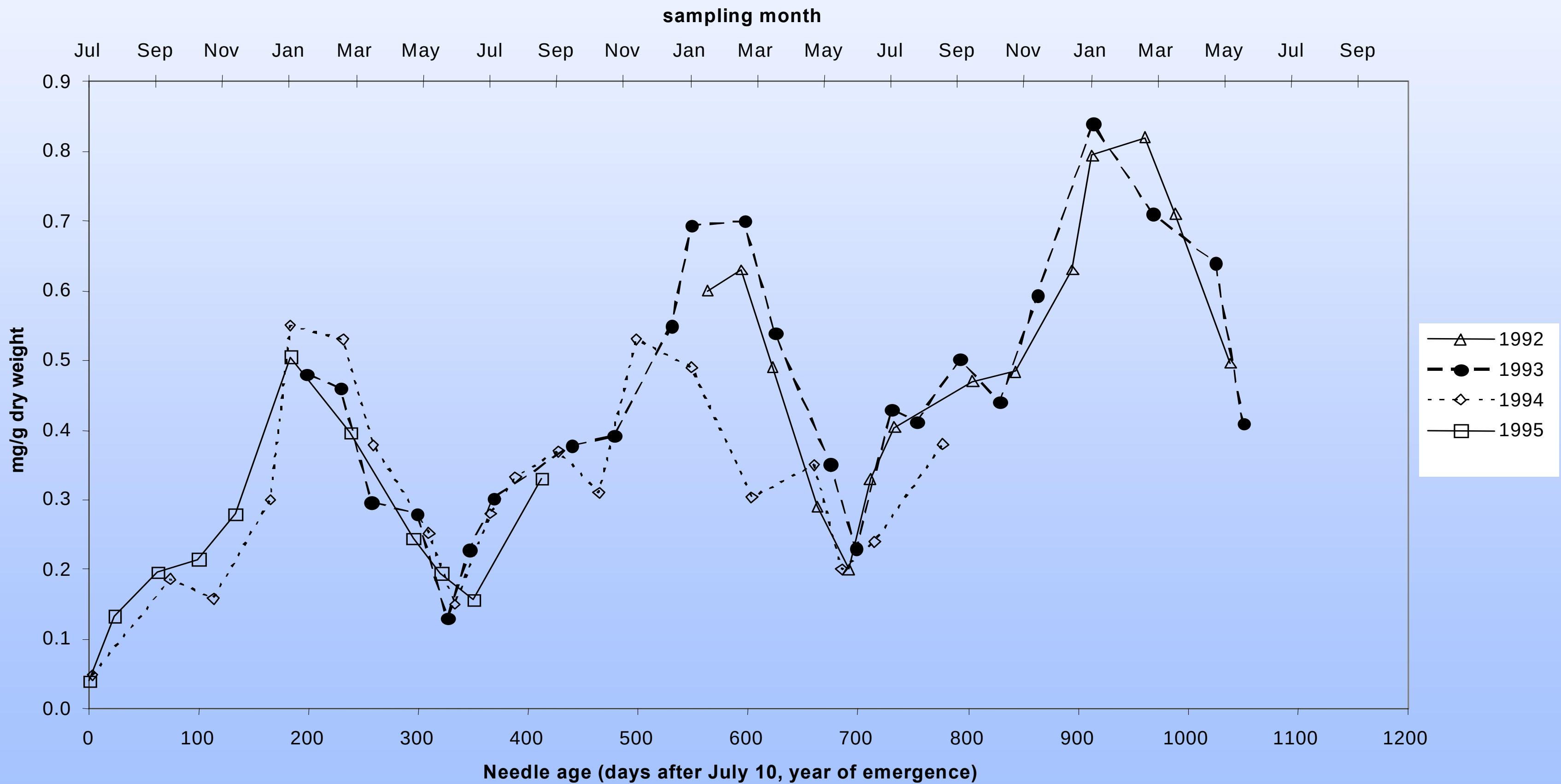
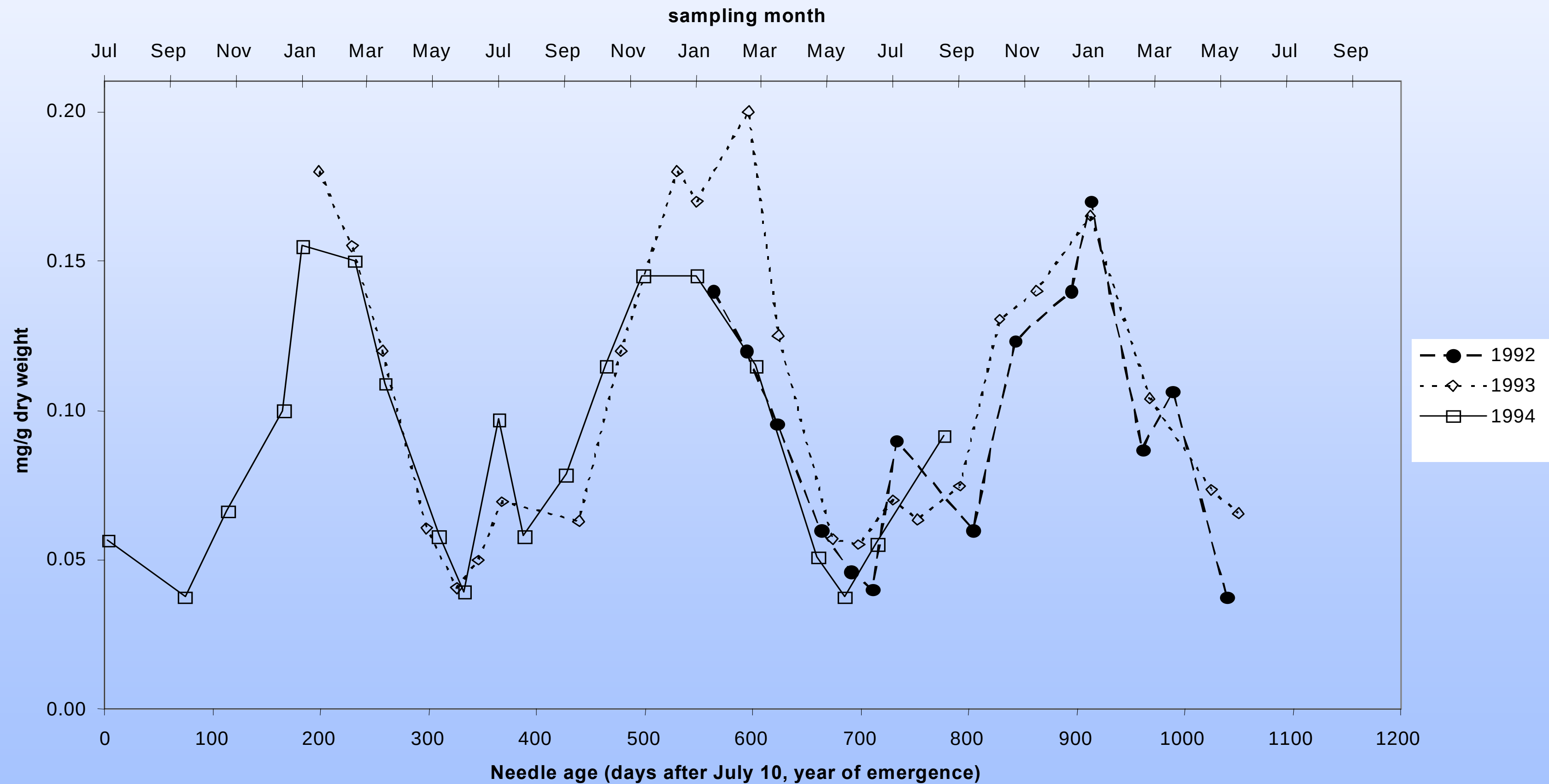
# DDT concentration in Scots pine needles during a lifetime cycle



# CB-170 concentration in Scots pine needles during a lifetime cycle

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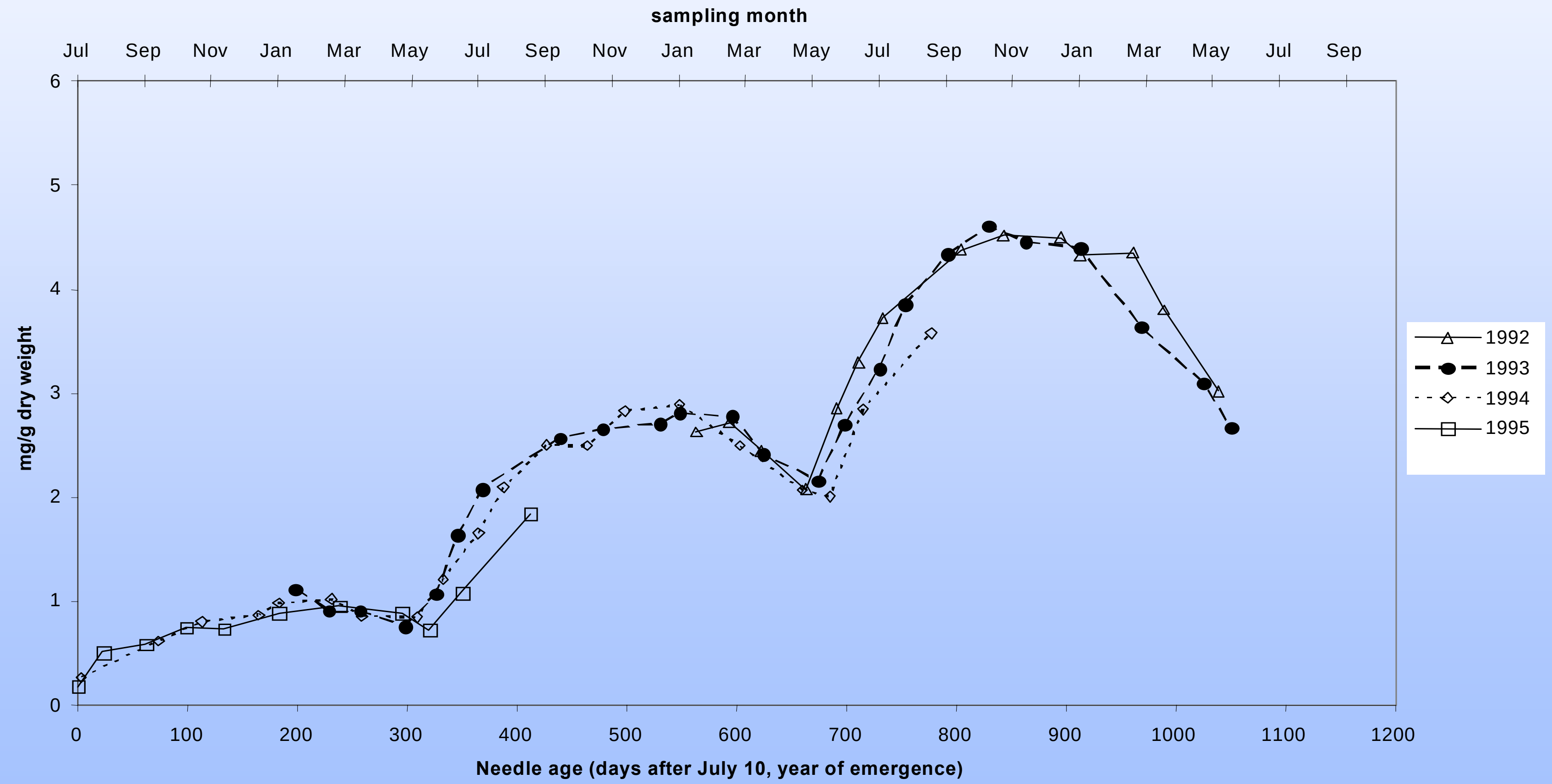
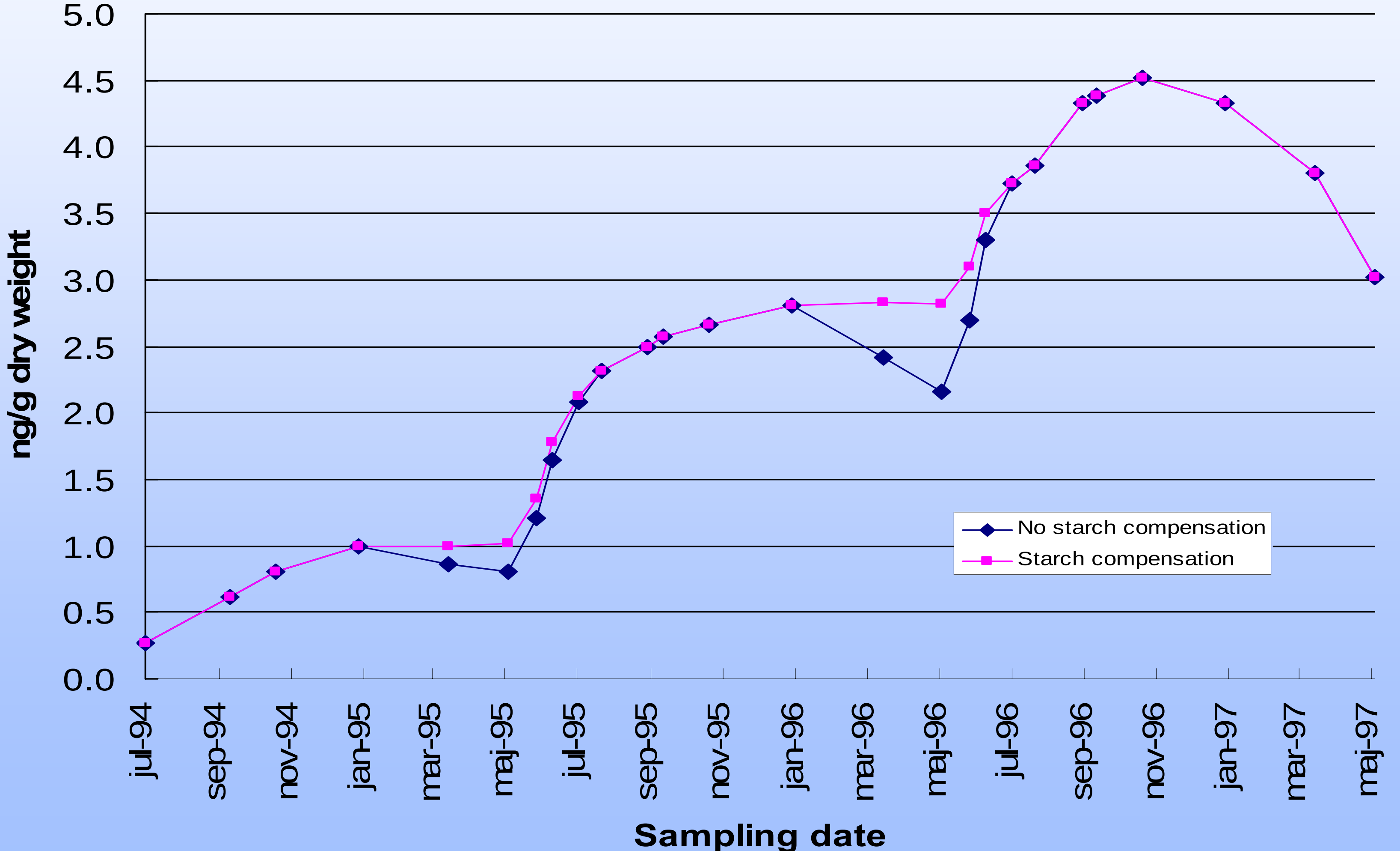
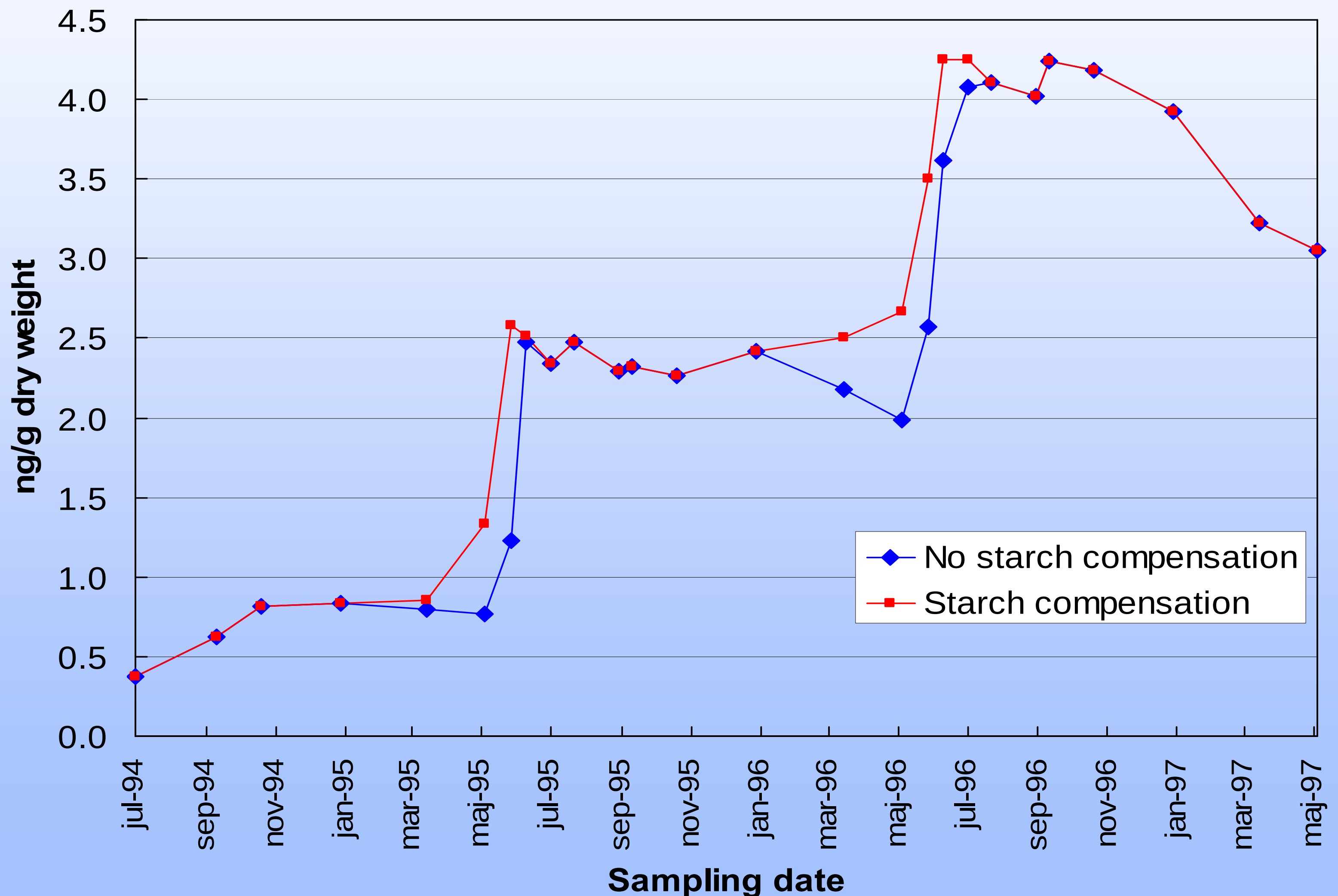
# Is there a logical explanation to the spring dip?



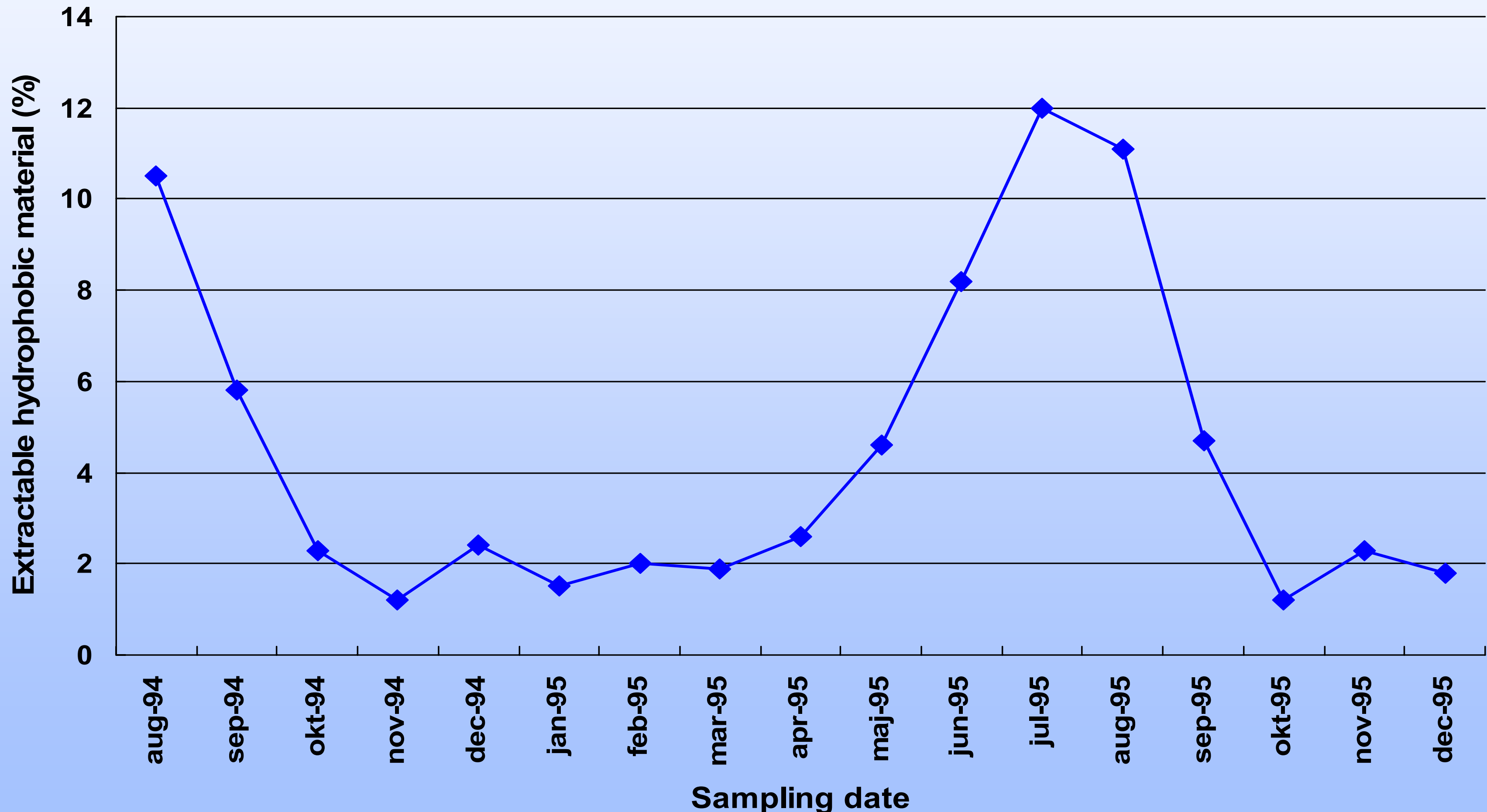
# α-HCH in pine needles with compensation for the starch content



# γ-HCH in pine needles with compensation for the starch content



# Seasonal variation of terpenoids and other tall oil compounds in Scots pine needles



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# Functions of terpenoids in plants

- Heat tolerance
- Water stress tolerance
- Pathogen defence
- The amount of terpenoids will therefore be elevated at high temperature, drought, and by insect and fungal attack

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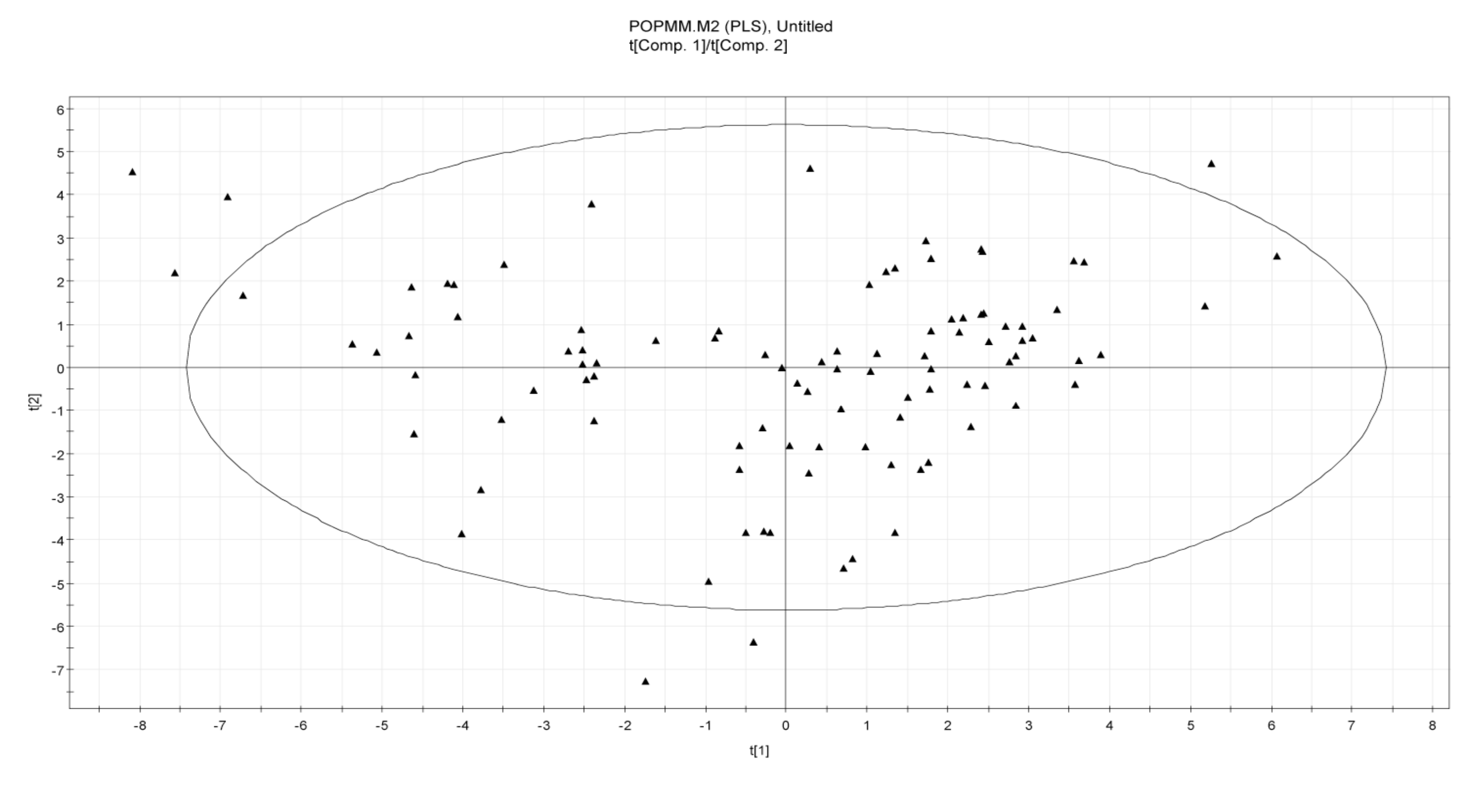
- Plasticizer for the cuticle?
- Swelling of cuticle and wax?

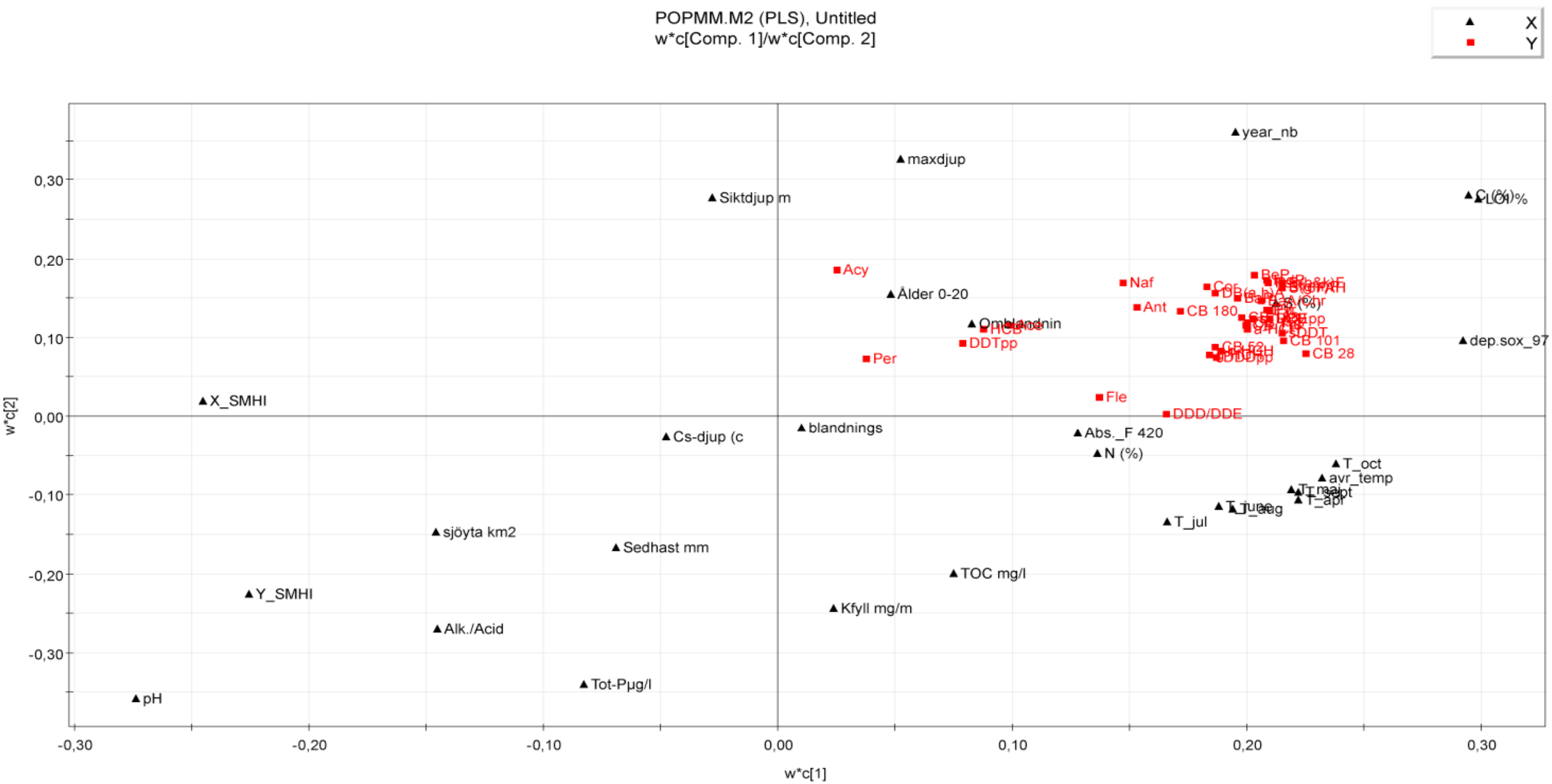
# 100-lake study

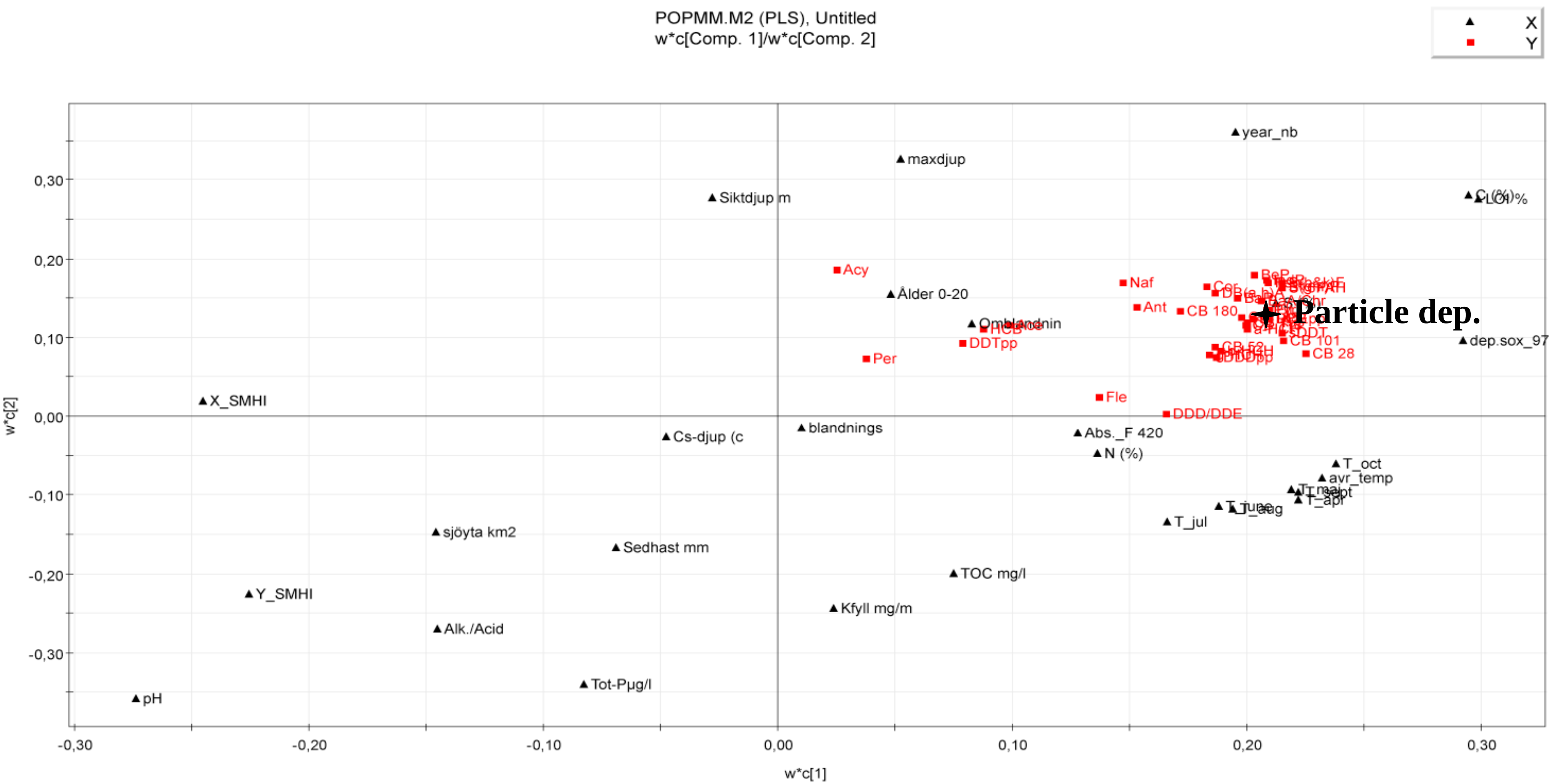
- 100 lakes from the Swedish environmental monitoring program, i.e., extensive auxiliary data
- HCHs, HCB, DDTs, 7 PCBs, 16 PAHs determined in top 1 cm
- Climatic gradient covering > 20 degrees




**Lakes in agricultural and mountainous areas "outliers"**

**Further statistical analysis of lakes with >50% forest in watershed**


POPMM.M2 (PLS), Untitled
w*c[Comp. 1]/w*c[Comp. 2]
X
Y
w*c[2]
w*c[1]
0,30
0,20
0,10
0,00
-0,10
-0,20
-0,30
-0,30
-0,20
-0,10
0,00
0,10
0,20
0,30
year_nb
maxdjup
Siktdjup m
Acy
Ålder 0-20
Naf
Ant
CB 180
BeP
CB 101
CB 28
dep.sox_97
DDTpp
Per
Fle
DDD/DDE
X_SMHI
blandnings
Cs-djup (c
Abs._F 420
N (%)
T_oct
avr_temp
T_jul
sjöyta km2
Sedhast mm
TOC mg/l
Y_SMHI
Kfyll mg/m
Alk./Acid
Tot-Pµg/l
pH



POPMM.M2 (PLS), Untitled
w*c[Comp. 1]/w*c[Comp. 2]
X
Y
Particle dep.
year_nb
maxdjup
Siktdjup m
Acy
Ålder 0-20
Naf
Ant
CB 180
DDTpp
Per
CB 101
CB 28
dep.sox_97
X_SMHI
Fle
DDD/DDE
blandnings
Cs-djup (c
Abs._F 420
N (%)
T_oct
avr_temp
T_jul
sjöyta km2
Sedhast mm
TOC mg/l
Y_SMHI
Kfyll mg/m
Alk./Acid
Tot-Pµg/l
pH
w*c[1]
w*c[2]

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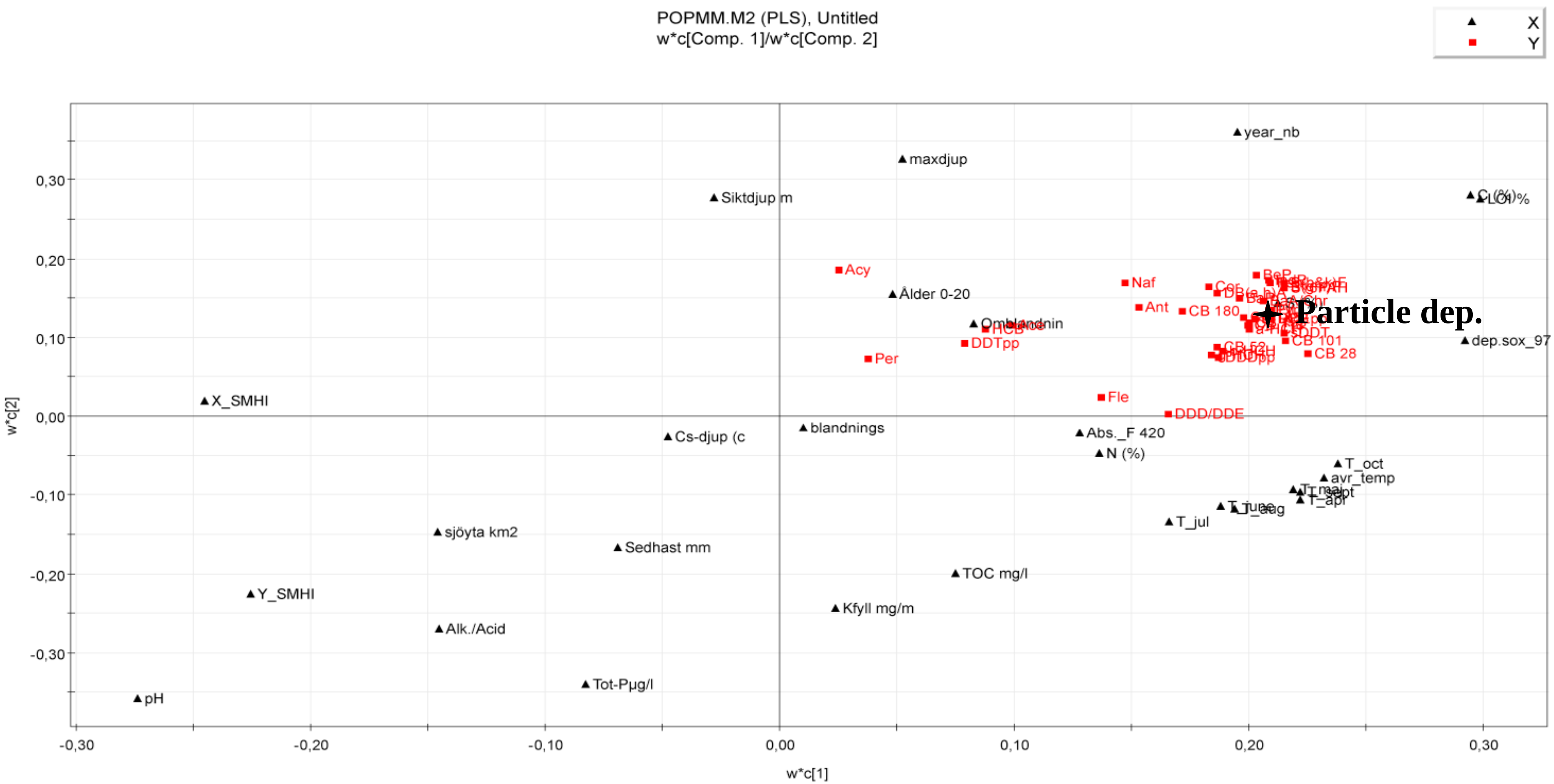


# Does particle deposition govern deposition of all compounds to lake sediments?

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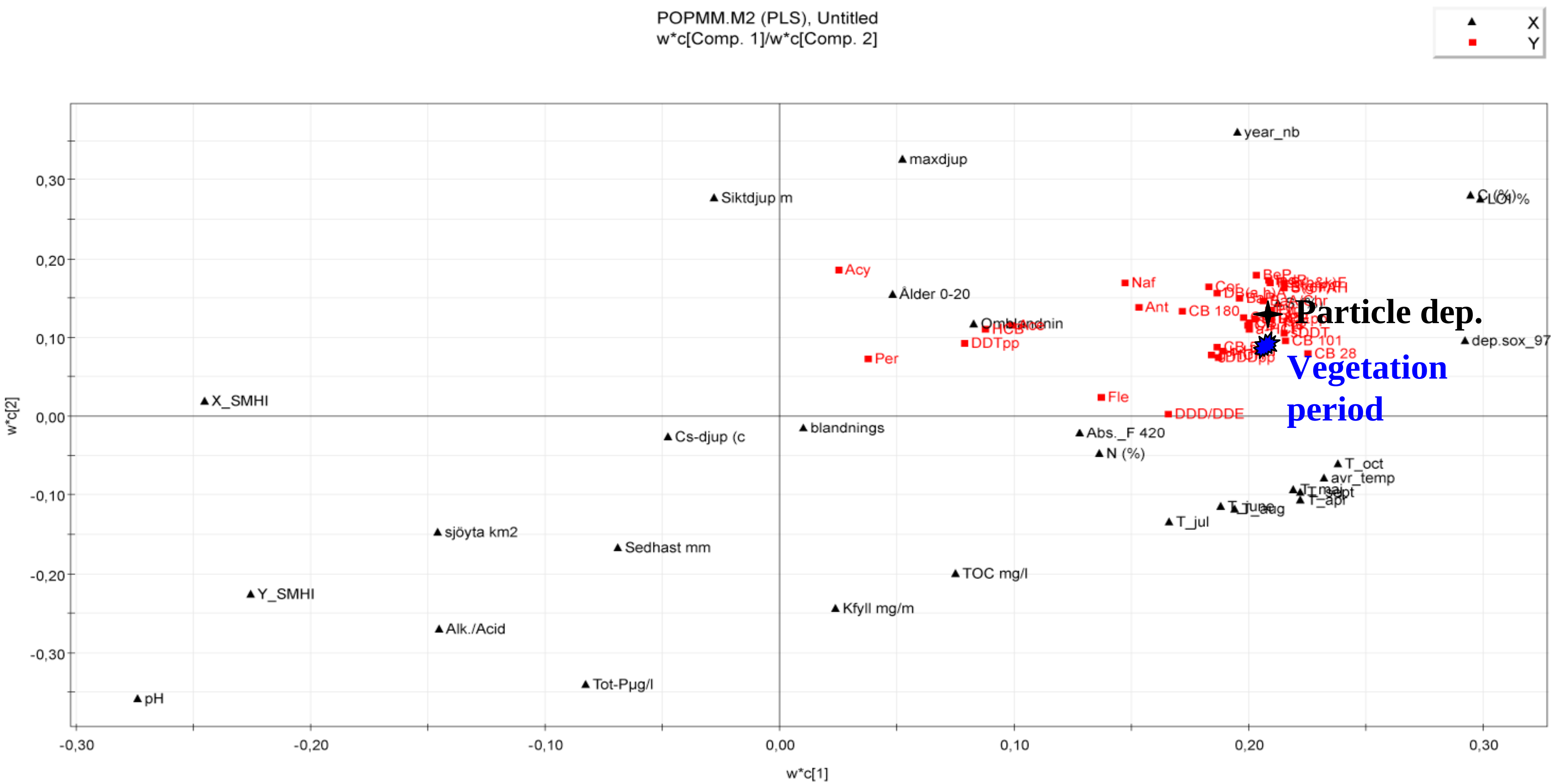


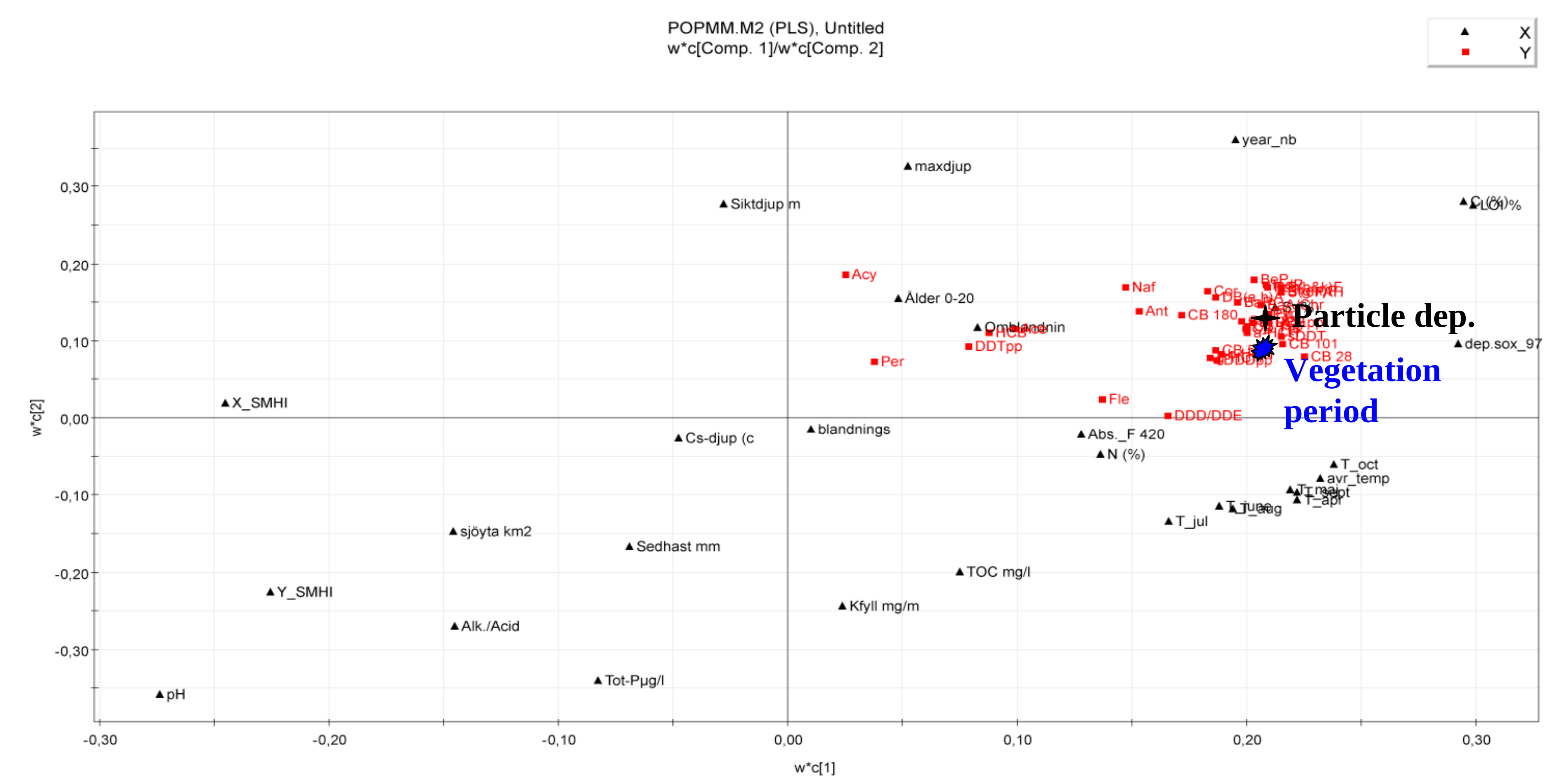


# The key is the vegetation period!

- People tend to live where the vegetation period is long
  - Sources of particle bound and gas phase compound need not be the same
- As there is no correlation with latitude and deposition of ”gas phase compounds” something else must govern the deposition of these compounds
- We propose that the levels of ”gas phase compounds” in the sediment is due to uptake in the vegetation and subsequent wash out into the lakes

# Conclusions

- Current models of plant uptake of SOCs from the gas phase do not sufficiently take into account the biology of plants
- With a warmer climate the vegetation period of the northern forests will become longer, and more of the gas phase SOCs will be sequestered by the forests
- Current knowledge is not sufficient to say if this will affect the transport of these compounds to the Arctic

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