

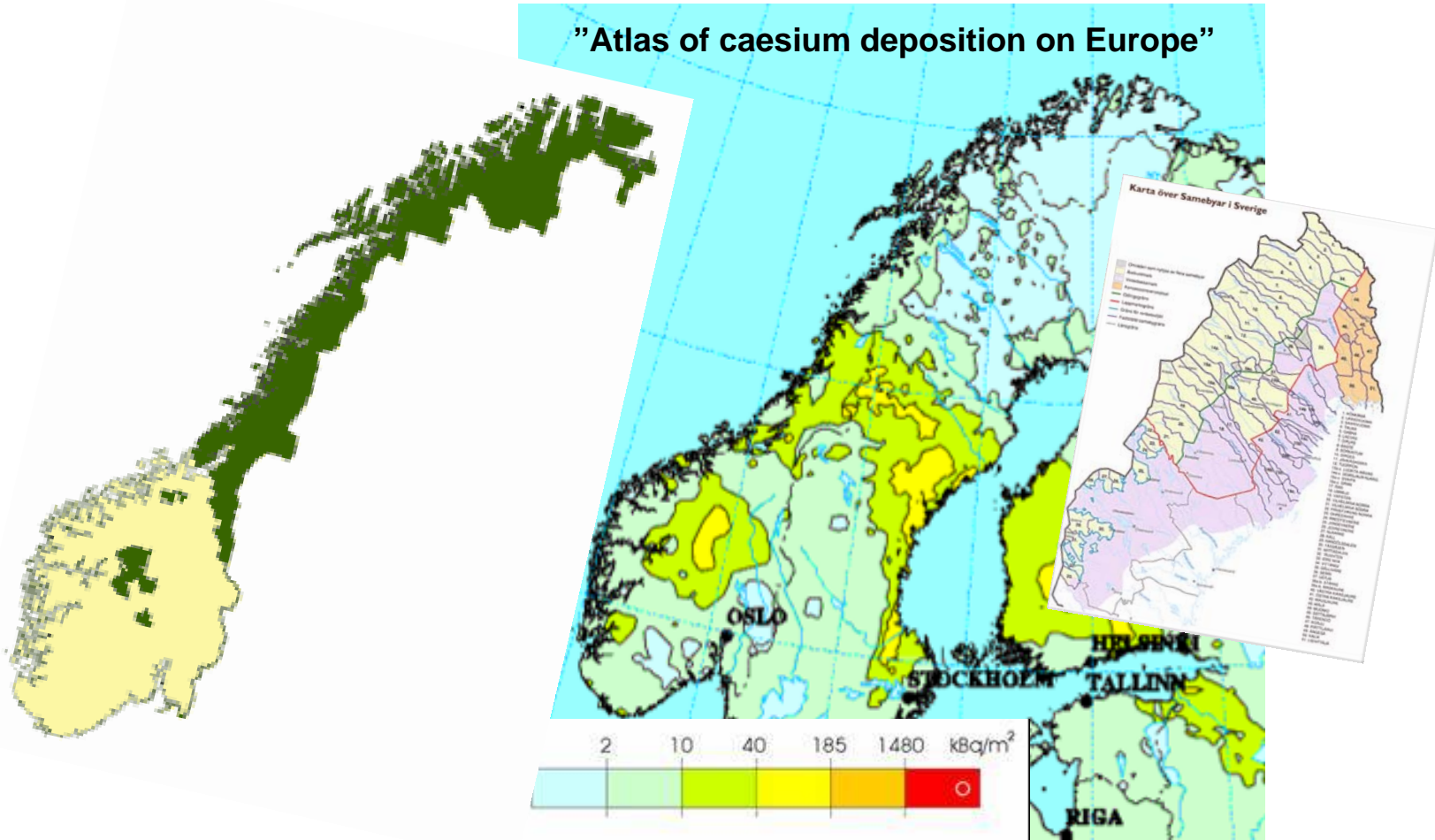
NKS-B REIN

Regional differences in reindeer radiocaesium contamination

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Chernobyl fallout and reindeer herding in Sweden and Norway

"Atlas of caesium deposition on Europe"



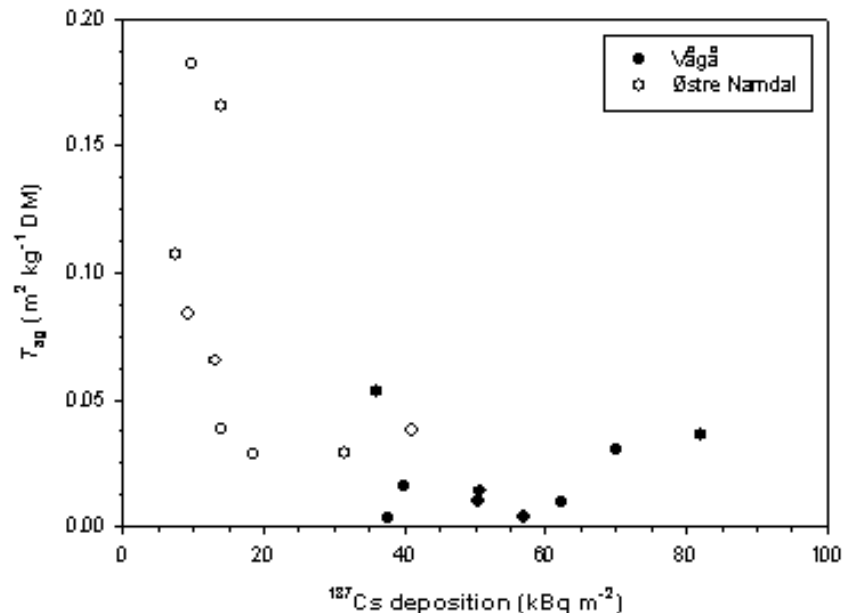
High transfer of radionuclides to reindeer

- Known from the NWT fallout in the 1950s and 1960s
- Reasons:
 - Reindeer eats lichens, particularly during winter
 - Lichens have no roots. They absorb nutrients and contaminants from air and precipitation, and they grow slowly
 - Reindeer have slower metabolism during winter and low mineral element intake on the lichen diet. Therefore they have low excretion of mineral elements during winter

REIN - Regional differences in reindeer radiocaesium contamination

Rationale for focus on regional differences:

- A study in Norway identified significant differences in uptake in 7 of 12 plant species from two different reindeer herding districts, potentially related to climatic differences. Example:



Deschampsia flexuosa sampled at 18 locations in Vågå and Østre Namdal.

Transfer:

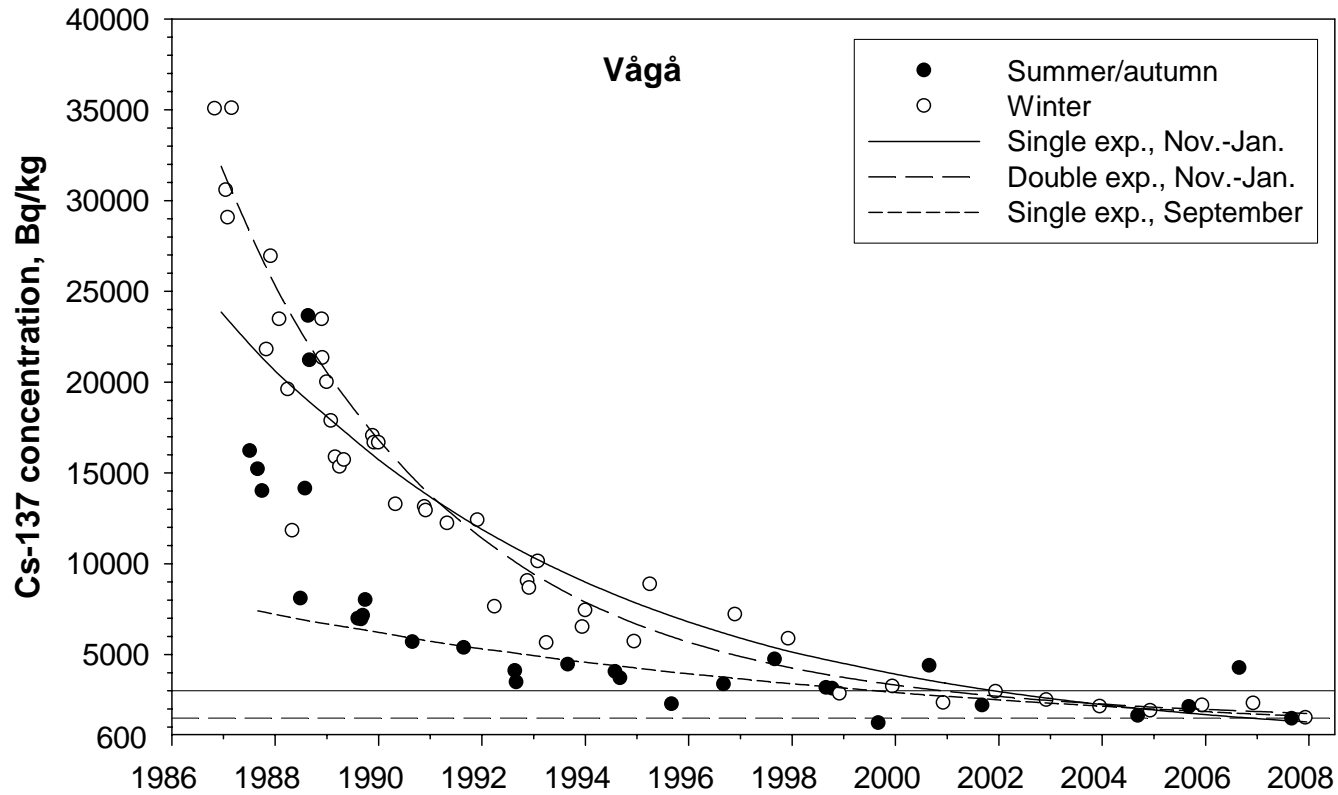
T_{ag} = Bq/kg DM in plants per Bq/ m^2 deposited.

- The study also identified changes in long-term trends in concentrations in reindeer

REIN – specific aims:

1. Synthesize the available information on contamination levels and ecological half-times for ^{137}Cs in reindeer.
2. Use the available data, especially the vegetation data, to improve the estimates of uptake in vegetation and intake in an draft reindeer radiocaesium model developed by SLU and FOI (Sweden)
3. Validate the model against updated long-term data series on ^{137}Cs concentrations in reindeer in Finland, Sweden and Norway.

Long-term trends in ^{137}Cs in reindeer

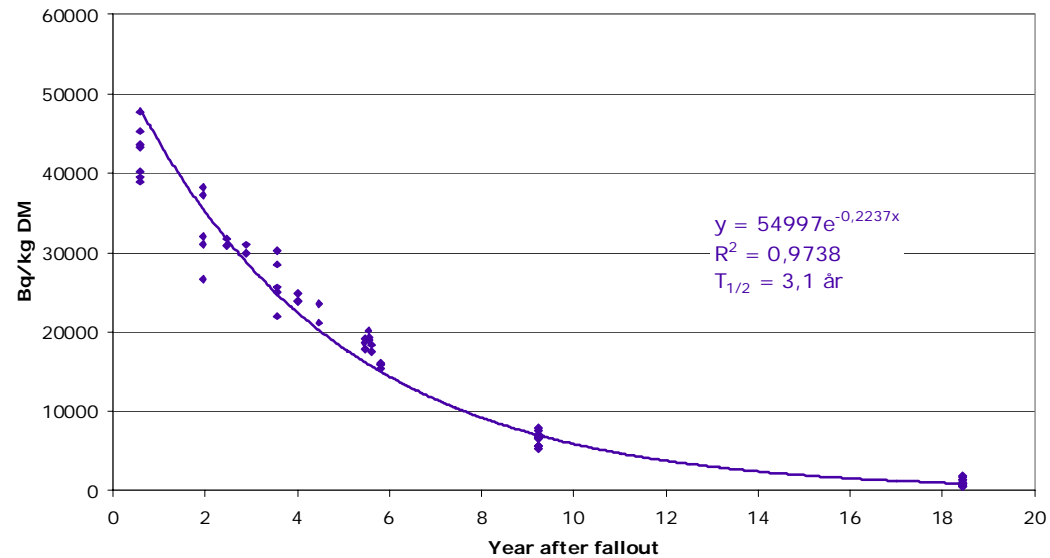


Intervention levels in Norway and Sweden: 3000 and 1500 Bq/kg (EU: 600 Bq/kg for non-members)

- Seasonal differences are reduced or absent
- Slower decline; approaches double exp. behaviour:
 $T_1 = 3.0 \pm 0.9$ and $T_2 = 27 \pm 84$ years

Long-term trends in ^{137}Cs in lichens

- Continuous decline (dilution by growth, decontaminated by weathering)
- Rate/half-time similar to that in reindeer the first years
- (Similar rates in recent Finnish study of lichens (Lehto et al. 2008))



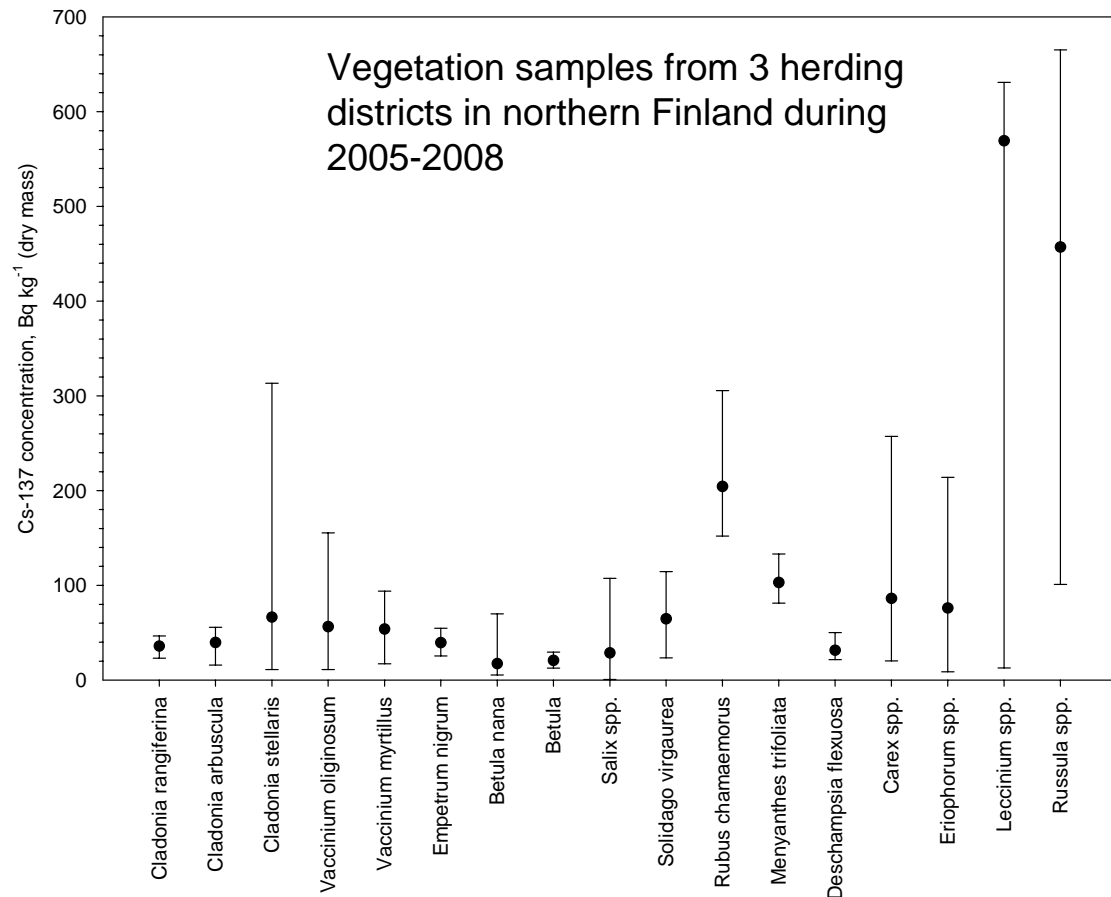
Mixed *Cladina* spp. from a pine heath 60 km north-west of Uppsala (Åhman 2005)

Lichens are no longer more contaminated than green plants

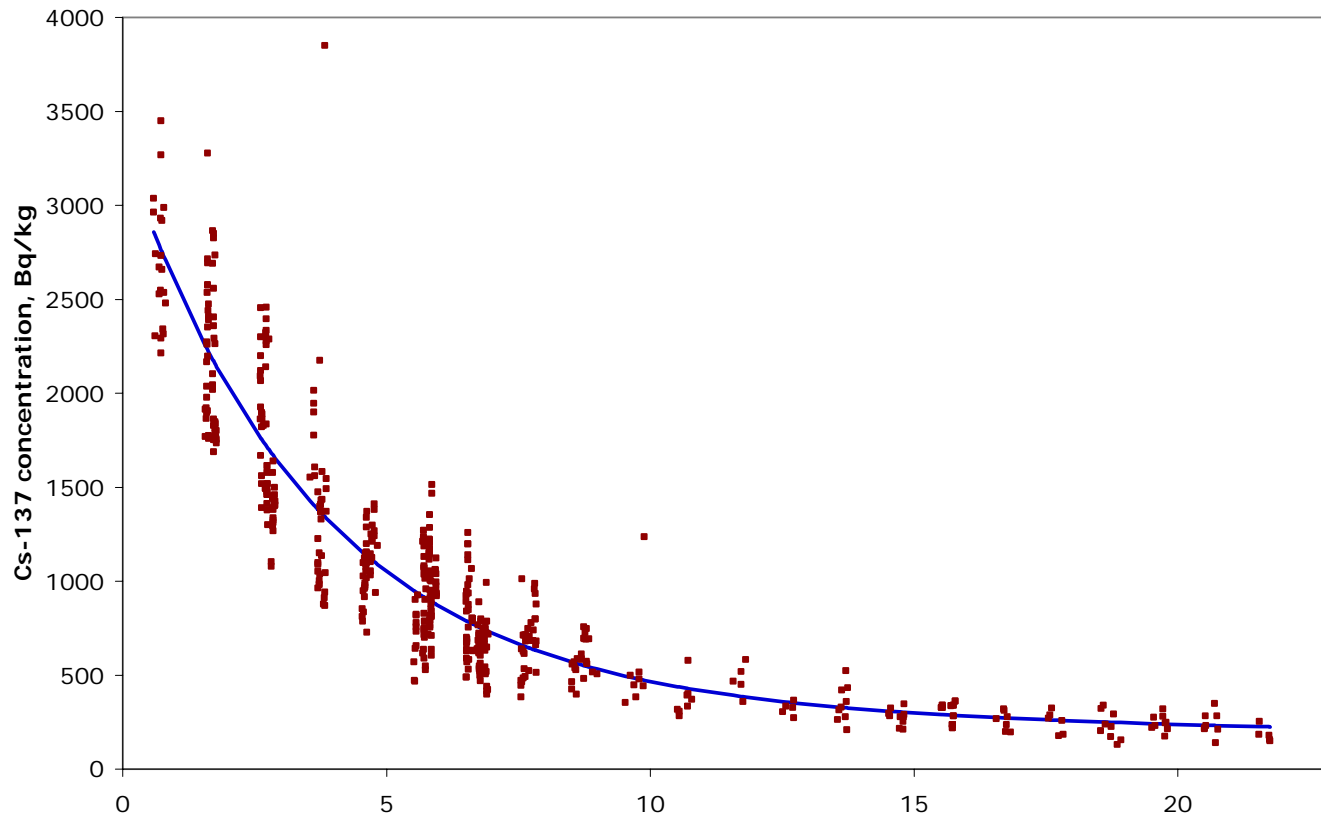
- Green plants have continuous uptake of ^{137}Cs from soil
- Variable but often slower long-term decline than in lichen

Therefore:

- Green plants will become more important sources of ^{137}Cs to reindeer.
- Important plants with slow decline will govern long-term decline in reindeer

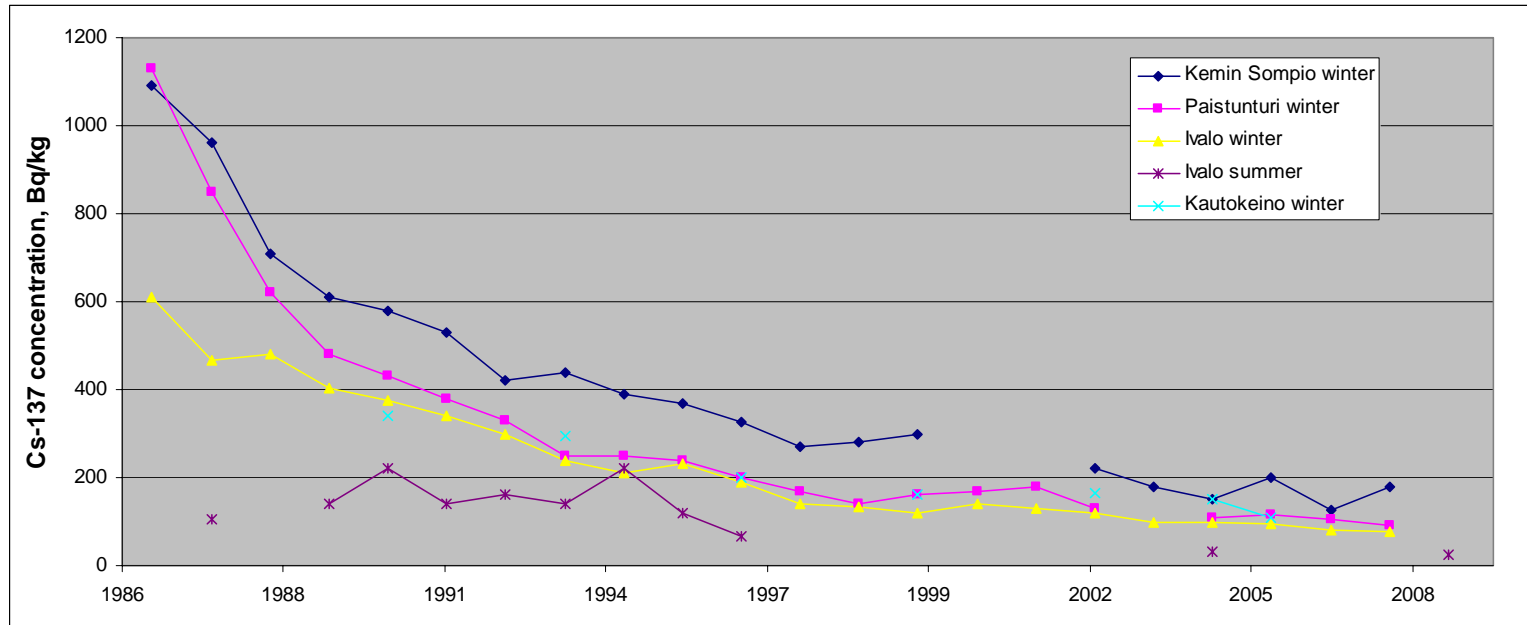


Trends in ^{137}Cs in Swedish reindeer



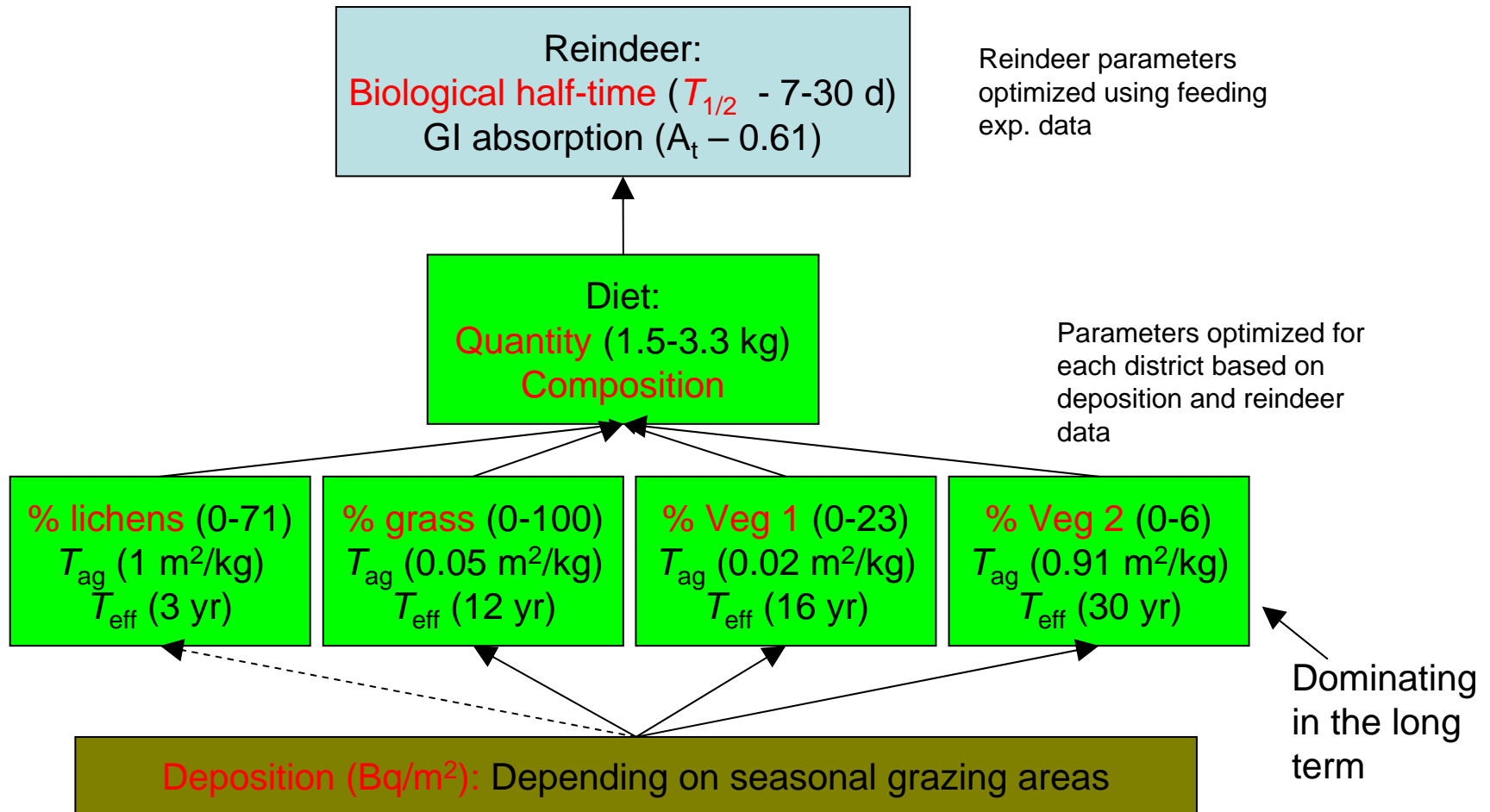
- Compiled data from 5 southernmost districts
- Half-times: $T_1 = 2.5$ and $T_2 = 31$ years (SE intervals: 2.2-2.9 and -33-11)

Cs-137 in northern Fennoscandia

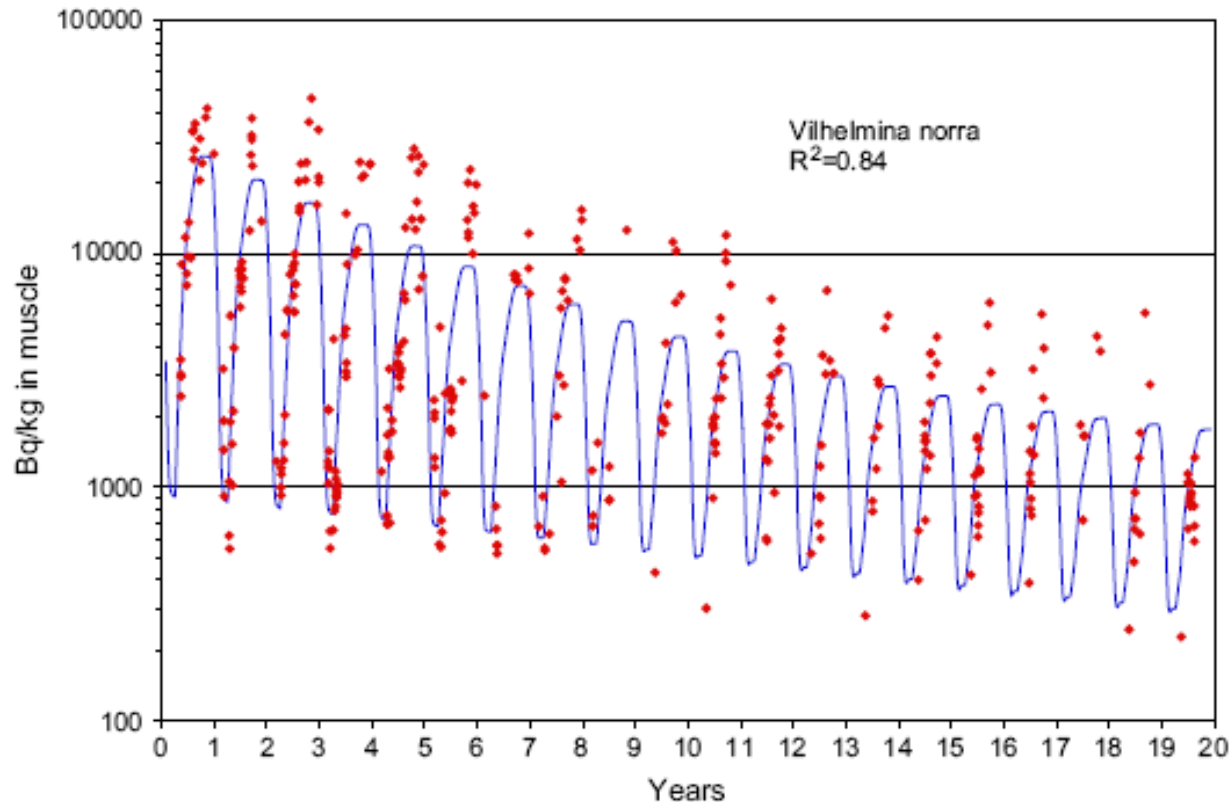


- Half-times: 7-10 years (similar to pre-Chernobyl estimates)
- Appears slower than in southern areas
- Potential reasons:
 - Larger fraction of NWT fallout: More bioavailable (i.e., incorporated in the lichen), and less weathering of ^{137}Cs in lichens?
 - Slower lichen growth in the north? (shorter growing season, dry climate)

The reindeer model



Modelling results



Comparison of simulated and observed activity concentrations of ^{137}Cs in reindeer from Vilhelmina norra reindeer herding district, Sweden. Dots are observed values (each representing 10 or more, mostly ≥ 30 , individual reindeer) and the line is the modelled curve (from Åhman (2007)).

Conclusions - Importance of REIN to NKS

1. Documenting and explaining trends is important for the continuous and ongoing practical management of the Chernobyl consequences; scientific basis
2. Norwegian authorities considers lowering the intervention limit. The existing countermeasure regime is design for a situation with seasonal differences in concentrations, and the results of REIN will be important when revising the regime
3. The persisting and high ^{137}Cs concentrations in reindeer in many areas warrant stronger focus on long-term trends in vegetation than has been the case for the last 10-15 years. This is crucial for assessments of future trends
4. The high transfer of nuclides in the reindeer-people food-chain, the geographical extension of reindeer herding and the special position of the Sami population in Finland, Sweden and Norway, demonstrates the need for maintaining competence and improving emergency preparedness related to this food-chain
5. The remaining Chernobyl problems in central Sweden and Norway makes these areas particularly vulnerable if new radiocaesium releases occur within the coming decades
6. Still no decision support system includes a reasonable reindeer model