

# Woodland monitoring in the UK

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The past - the impetus for forest health monitoring

# Overview

- FR woodland monitoring schemes
  - National Inventory (NIWT)
  - condition survey of non-woodland amenity trees
  - Forest Condition Survey (FCS and Level I)
  - Environmental Change Network (ECN)
  - Intensive Forest Health monitoring Network (Level II)
- Results from the FCS
  - observed trends
  - derived observations
  - European comparison
- Intensive forest monitoring
  - a national data resource
  - model verification
  - individual plot trend analysis
  - ozone pollution



# National inventory of woodland and trees (NIWT)

Ground truthing of 1% of forest area (1 ha plots): >40 000 plots; planned 5 year cycle



Stratum	Category	Options/comments
Meta-data	Owner status	Private, charity, FC
	Woodland context	Forestry, farm, mixed
	Management	Timber, game, conservation
Structure	% cover	Upper & lower canopy, shrub
	Standing deadwood	
	Number of trees	
	Abandoned timber	
Element	Fallen trees	7-20 cm, 20-50 cm, >50 cm
	Woodland classification	Broadleaf, conifer, mixed
	Thinning frequency	Once, twice
	Access	(For extraction)
	Dominant understorey (>2m)	Species
Crop	Regeneration	Vegetative, seedling, both
	Species	
	Species make-up	Pure, mixed, intruded
	Area	
	Stocking	
	Health	Crown dieback, windblow
	Timber potential	Normal, remedial, unproductive
	Planting year	
	Top height	
	Mammal damage	Bark stripping, browsing

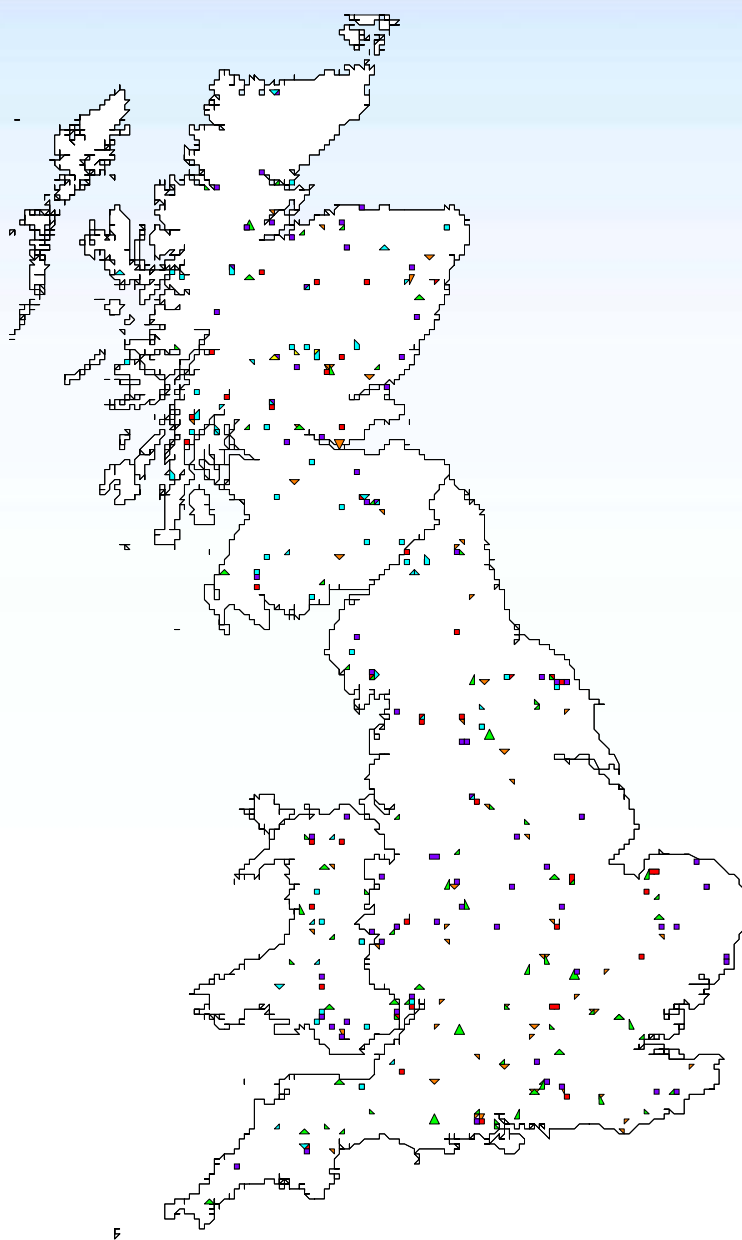
# Condition survey of non-woodland trees

- Established in 1993 (non-woodland amenity tree health monitoring scheme) and re-designed in 1999
- Funded by ODPM
- 106 plots (54 urban, 52 rural) each assessing a minimum of 30 trees and 6 genera; ~60% return rate for data
- primarily for reporting disease, climate and insect pest damage; some more detailed studies on crown density to provide a comparison with FCS
- unlikely to provide information on air pollution, but.....

# Forest Condition Survey (FCS)

- ▼ Beech (59)
- ▲ Oak (86)
- Norway spruce (55)
- ◆ Sitka spruce (66+3)
- Scots pine (81)
- ◇ Mixed species (3)

- 24 trees - 'external plots'
- Height measured on establishment
- Soil type identified on establishment
- DBH measured annually
- Crown condition measured annually





# Forest condition: EU/ICP-Forests Level I



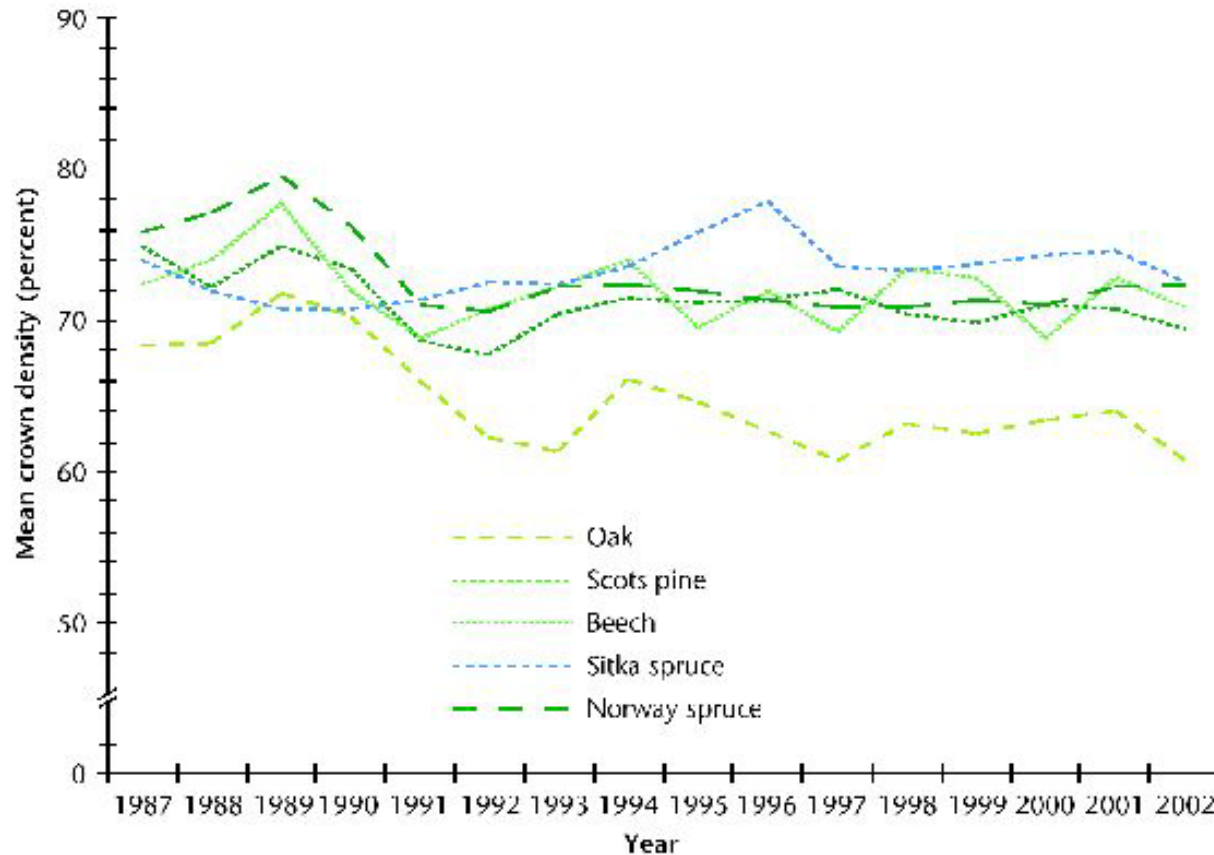
- ~90 plots
- >6000 plots across Europe, mostly 16 x 16 km grid
- 5 species (SS, NS, SP, Be, Ok)
- 24 'internal' trees, 0.25 ha minimum area
- Measurements: as for FCS plus
  - Soil chemistry and description: (1994)
  - Foliar chemistry: (1995)

# Forest condition survey (FCS): tree crown transparency



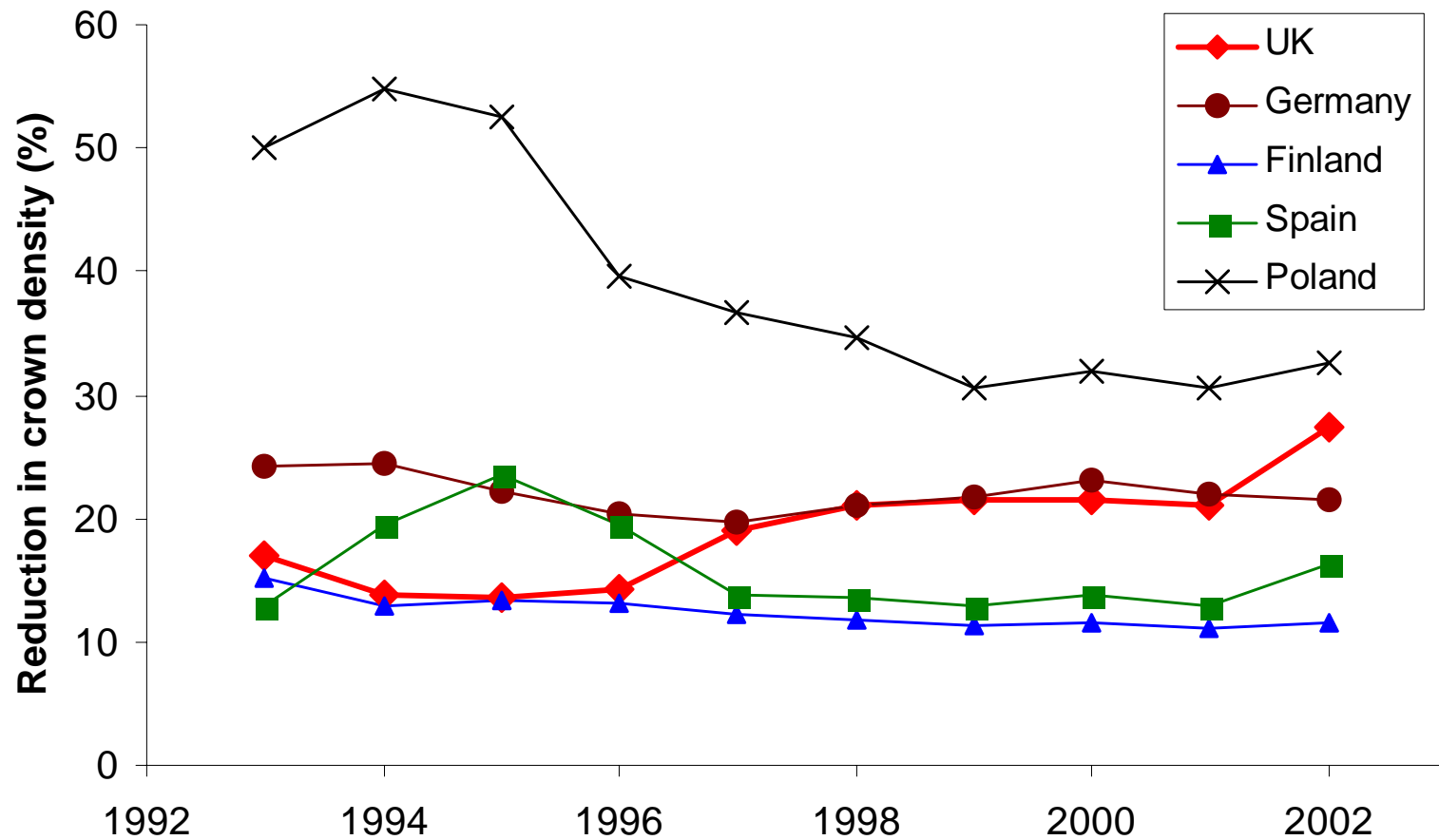


# FCS crown condition

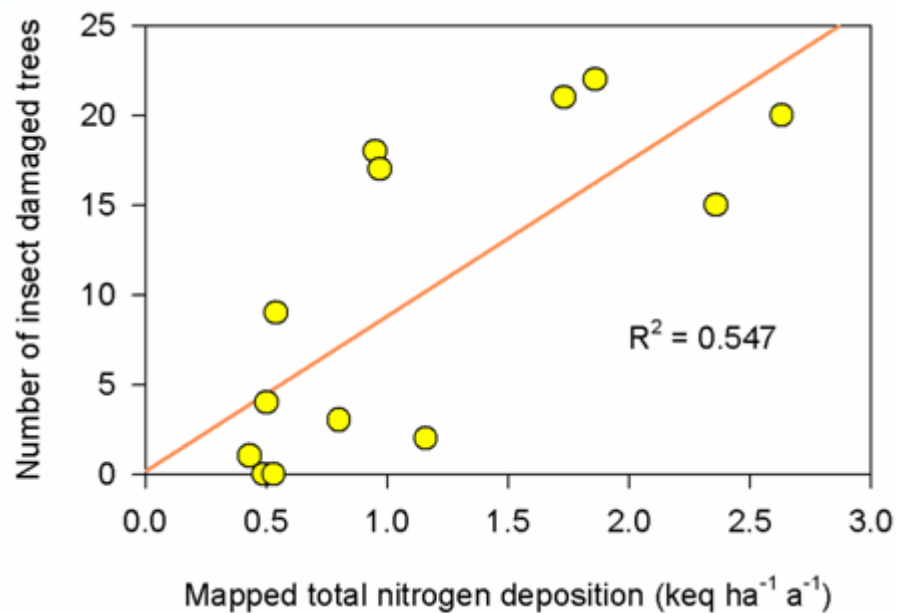
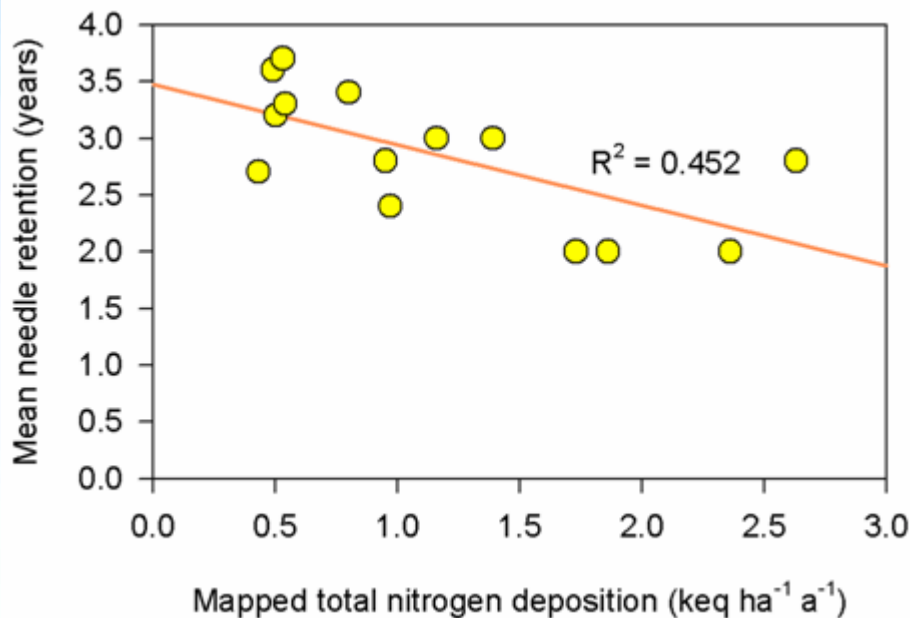


- SS - green spruce aphid
- Be - masting, climate
- Ok - winter moth, tortrix, climate, survey design
- SP - fungi, insects

# European comparison 'best local tree' index

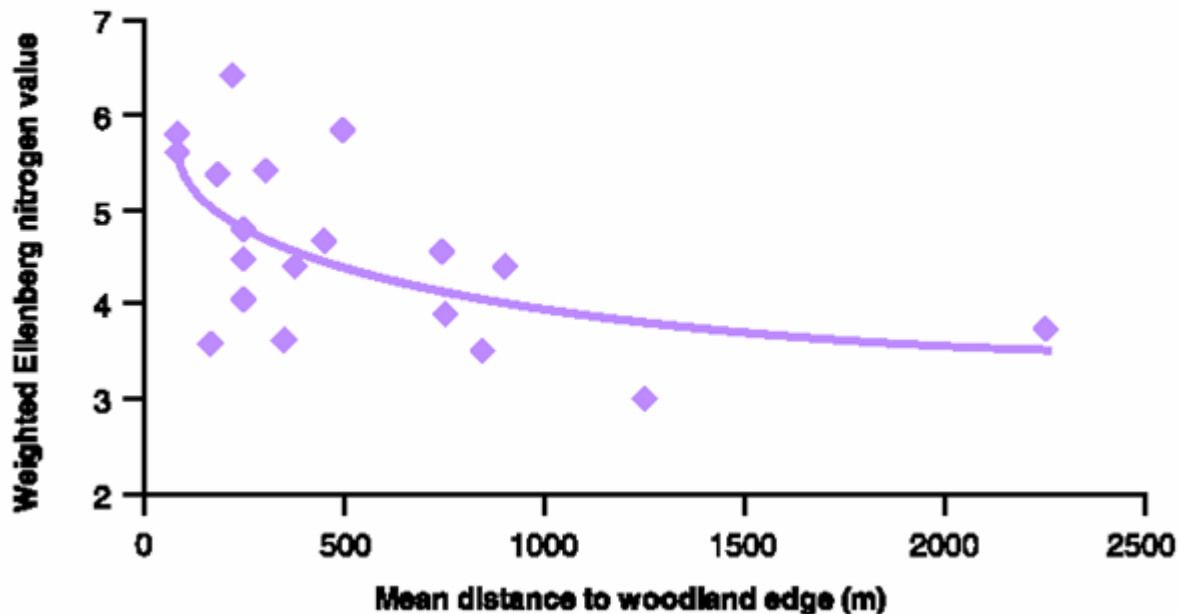


# Observed relationships between forest condition and nitrogen deposition (Level I)



# Nitrogen deposition and ground flora

Changes in the nitrogen demand of beech woodland ground flora with proximity to the woodland edge;  
 $R^2 = 0.35$ ,  $p = 0.025$ .





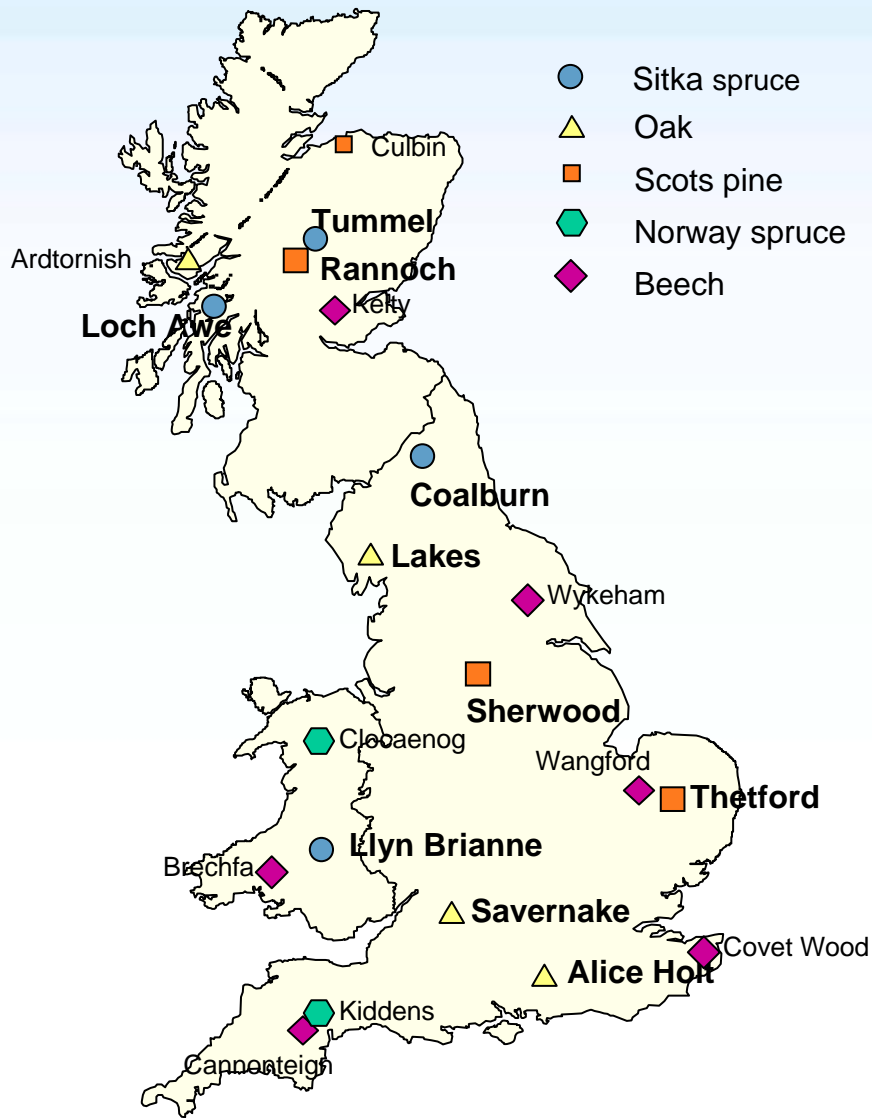
# Environmental Change Network (ECN)



## Terrestrial site protocols

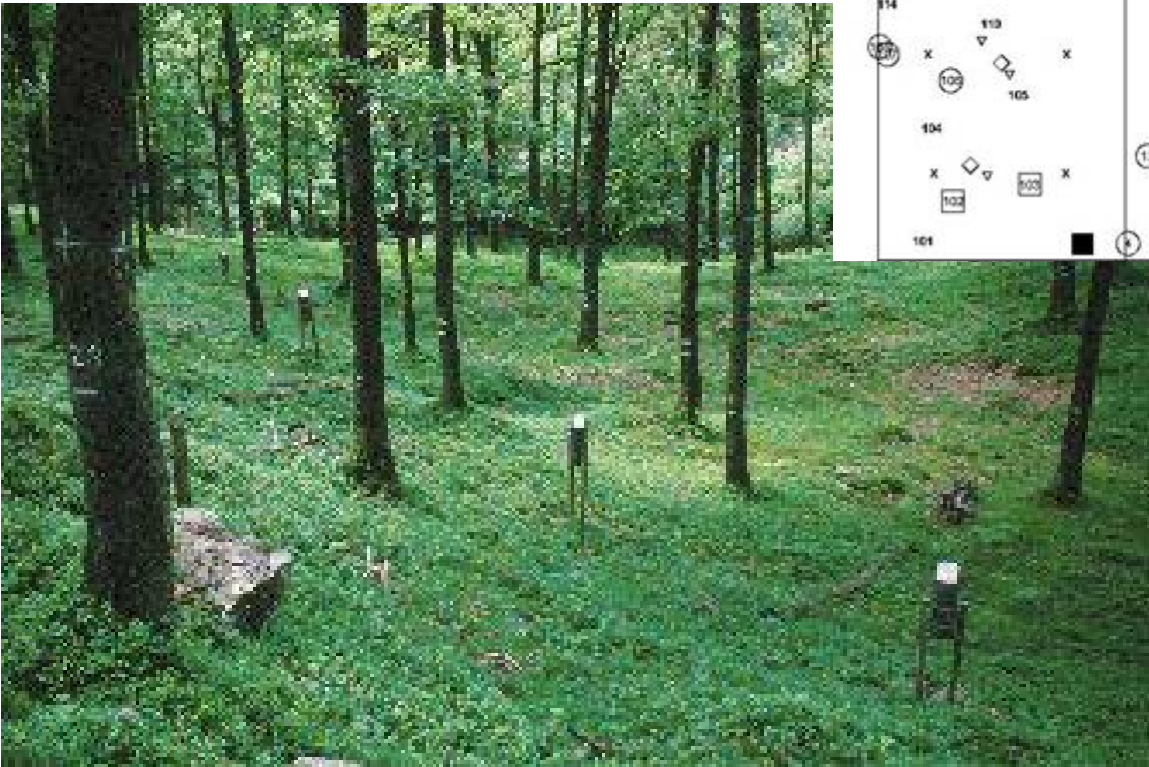
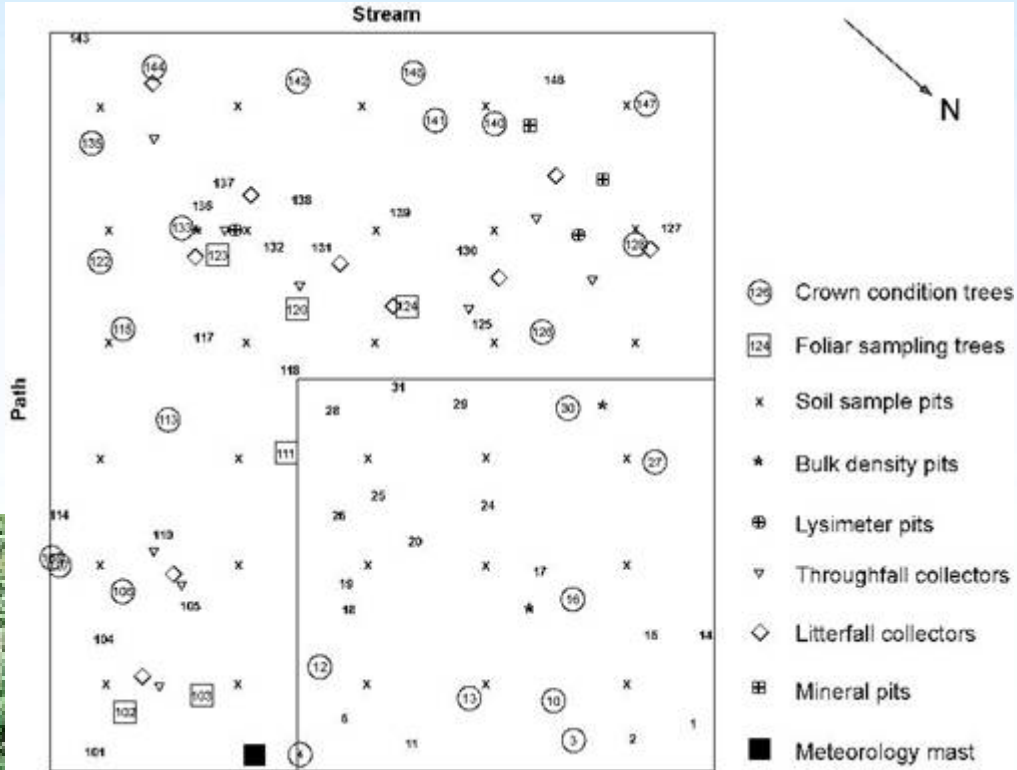
- land management and use
- soil survey
- soil solution chemistry
- meteorology
- rainfall chemistry
- atmospheric chemistry
- vertebrates
  - bats
  - birds
  - rabbits and deer
  - frog spawn
- invertebrate monitoring
  - moth
  - tipulids
  - butterflies
  - spittlebugs
  - ground predators
- vegetation assessment

# Intensive forest health monitoring network (Level II)



Measurement	No of plots	Frequency
Increment	20	5 yr
Crown condition	20	1 yr
Foliar chemistry	20	1 yr
Soil (chemistry & description)	20	10 yr
Litterfall	13	2-8 wk
Deposition	10	2 wk
Air quality	17 (2)	4 wk (1 hr)
Soil solution	10	2 wk
Meteorology	6 (5)	1 day (1 hr)
Phenology	20	2-4 wk
Ground vegetation	20	3 yr

# Intensive monitoring network



# A national data resource

- Plot level data used as the basis for setting woodland critical loads
- management accounted for
- plot level data related to national forest estate

<b>Savernake 105</b>			<b>Coalburn 46</b>			<b>Loch Awe 26</b>			<b>Tummel 9</b>			<b>Rannoch 25</b>		
horizon	depth	CEC	horizon	depth	CEC	horizon	depth	CEC	horizon	depth	CEC	horizon	depth	CEC
O	3		O	6		O	2		O	4		O	8	
A	3	18.52	H	17		H	1.5		Ah1	30	6.29	H	25	
E	19	15.73	Ah(g)	10	17.46	Ah	8	12.64	Ah2	6		E	7	10.03
2Btg	22	26.96	Eg	13	6.25	Eg	26	8.18	E	23	1.51	Bh	7	11.93
2BCtg	16	23.15	Bg	20	12.41	Bs	31	4.16	Bs	41	0.91	Bs	18	2.35
2Cgk	40	20.74	2BCg	57	9.61	BCg	15	1.17				Bhs2	28	0.42
												Bg	40	0.45

<b>Thetford 15</b>			<b>Llynbrienne 38</b>			<b>Grizedale 21</b>			<b>Sherwood 21</b>			<b>Alice Holt 111</b>		
horizon	depth	CEC	horizon	depth	CEC	horizon	depth	CEC	horizon	depth	CEC	horizon	depth	CEC
O	2		O	6		O	4		O	3		O	3	
Ah	13	4.93	H	13		H	2		H	2.5		Ah	7	23.10
Ah&Bw	11	3.94	A	15	16.36	Ah	6	12.92	AE&Ah	15.5	6.51	Eg	8	17.75
Bw	26	3.23	Bg	32	13.18	Bs	49	6.71	Bs	20	4.14	Btg	22	18.11
2BC	50	3.05	BC	53	8.16	Bc	5	1.48	BC	21.5	2.58	BCg	37	25.83
									2C	43	7.63	C(g)	26	26.29

Cation Exchange Capacity - BaCl<sub>2</sub> extract (cmol+ kg<sup>-1</sup> oven dried soil)



# Critical loads exceedance

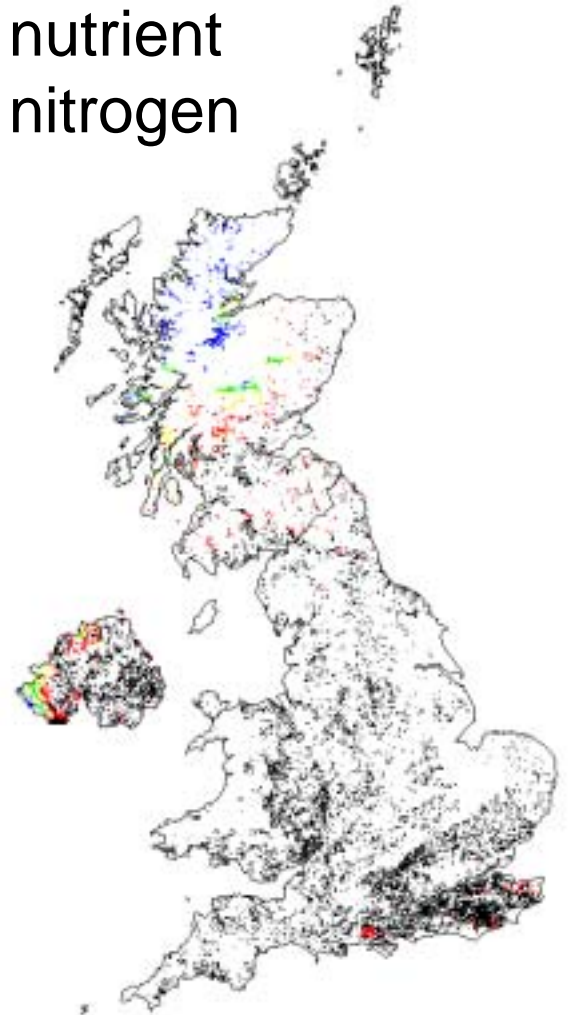
acidity



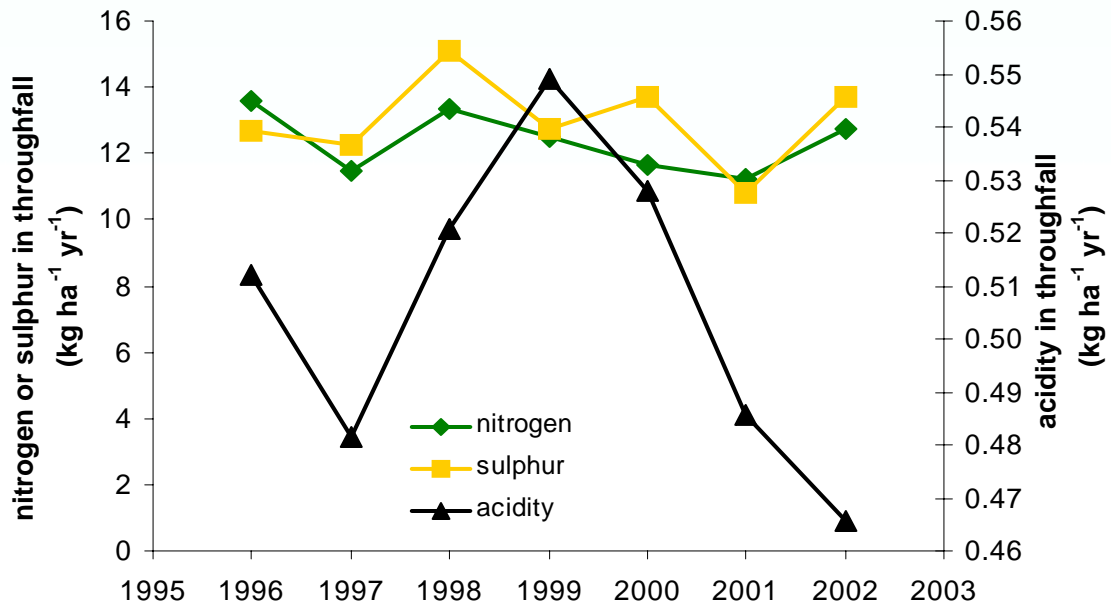
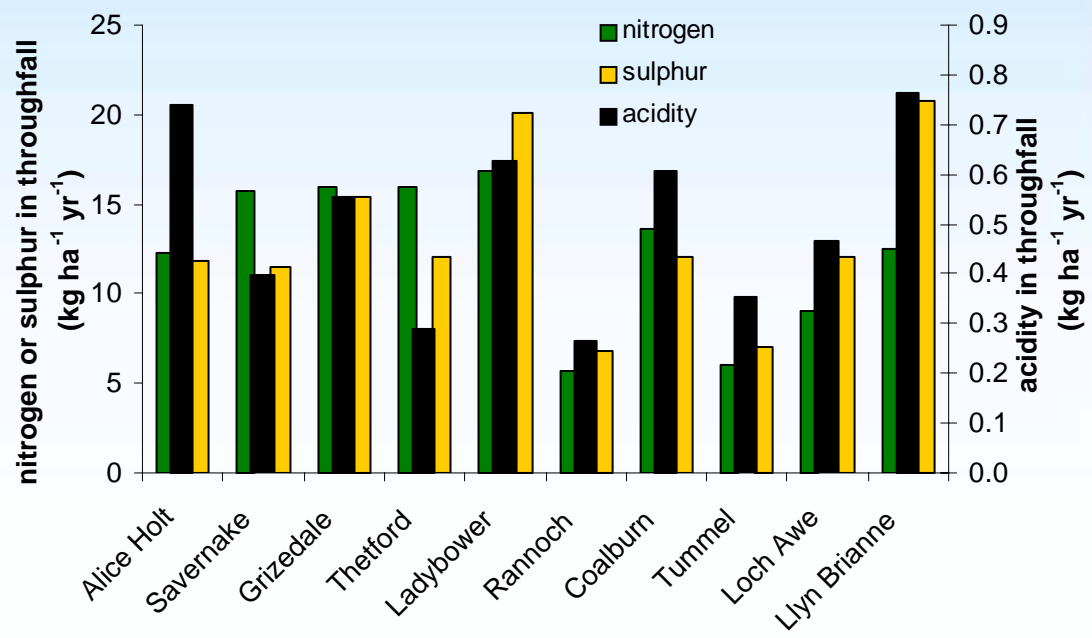
keq ha<sup>-1</sup> year<sup>-1</sup>

- Not exceeded
- 0.0 – 0.2
- 0.2 – 0.5
- 0.5 – 1.0
- > 1.0

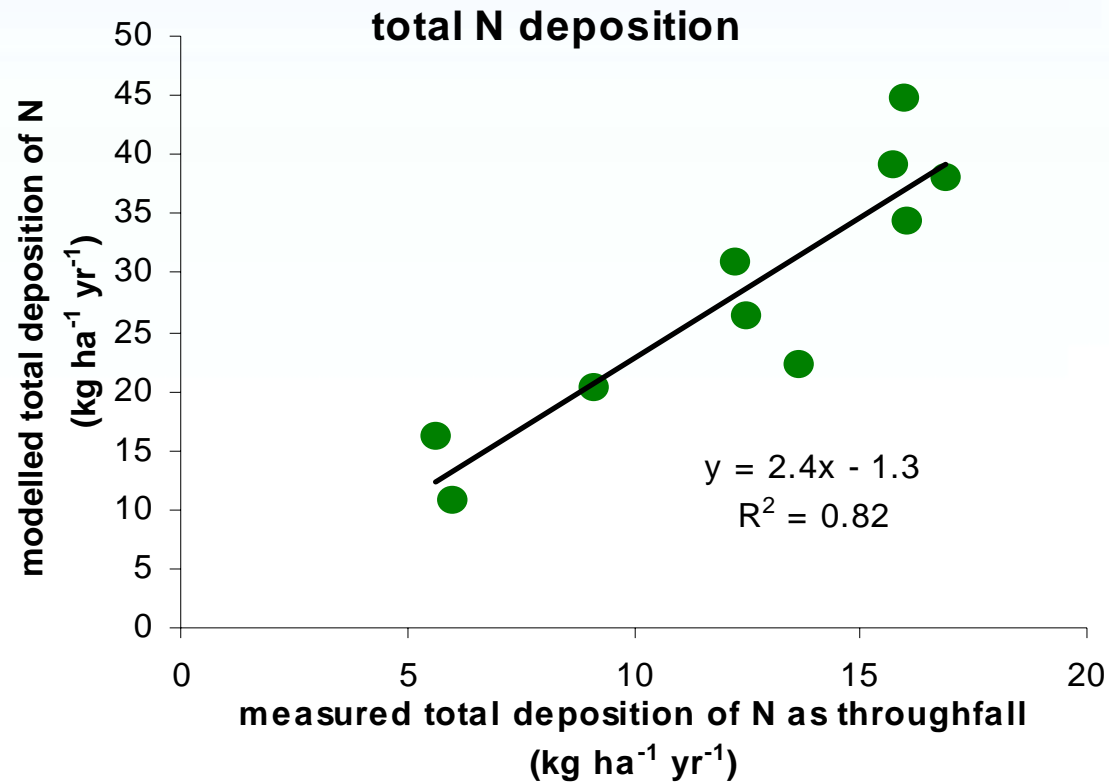
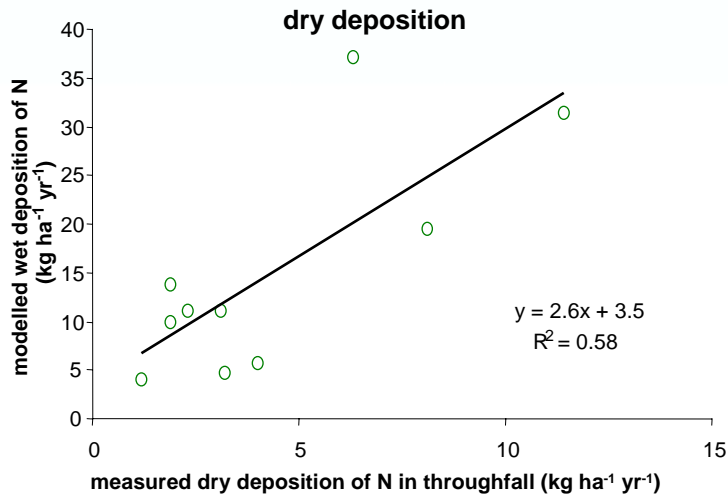
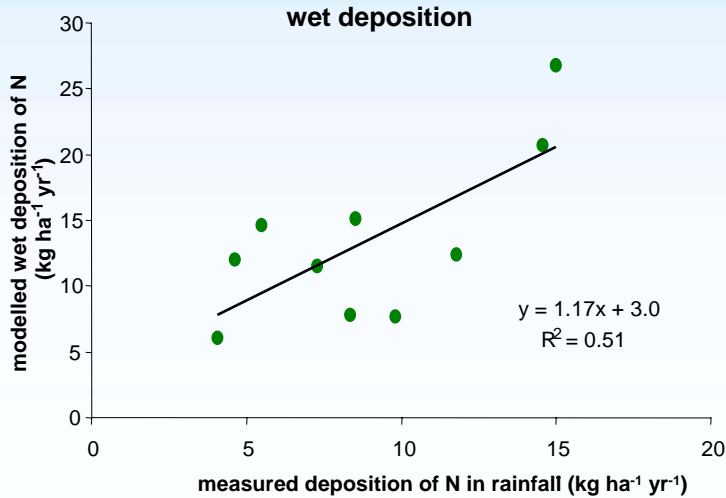
nutrient  
nitrogen



# Deposition summary - trend analysis and model verification

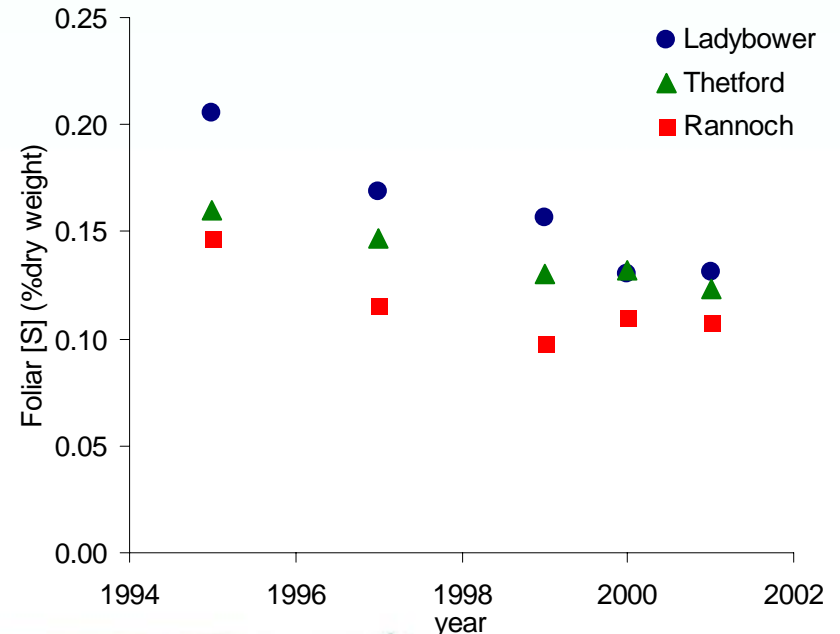
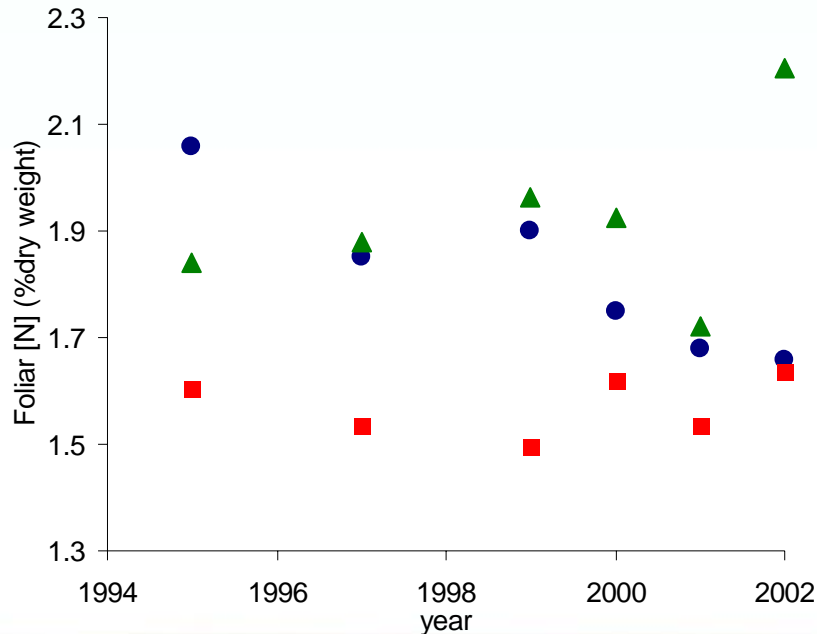
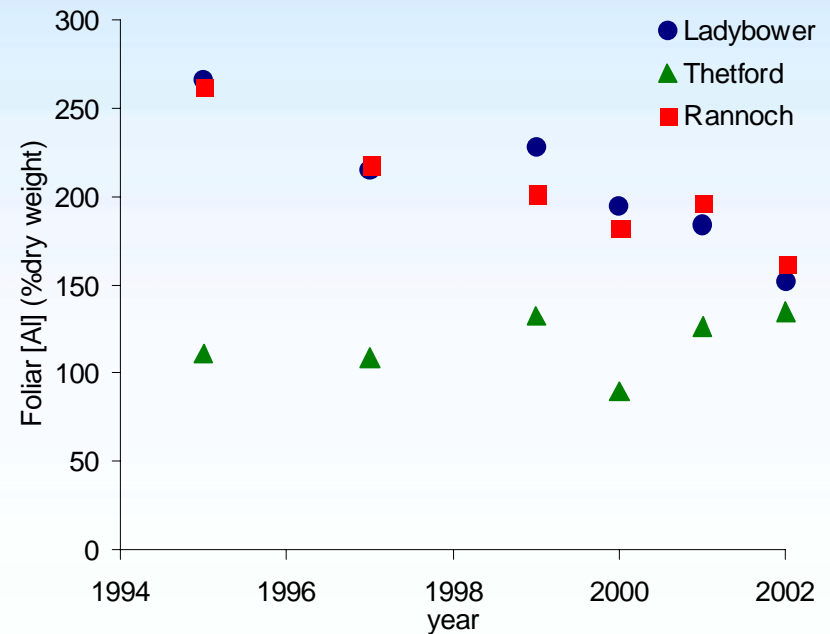


# Comparison of modelled and measured deposition



# Identification of long-term trends at individual plots

## - foliar chemistry



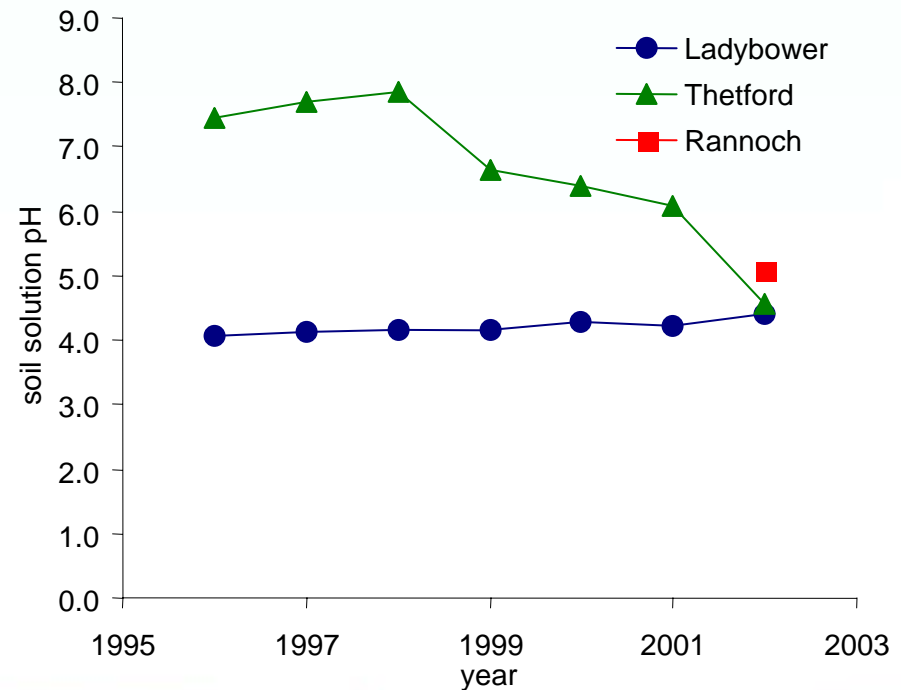
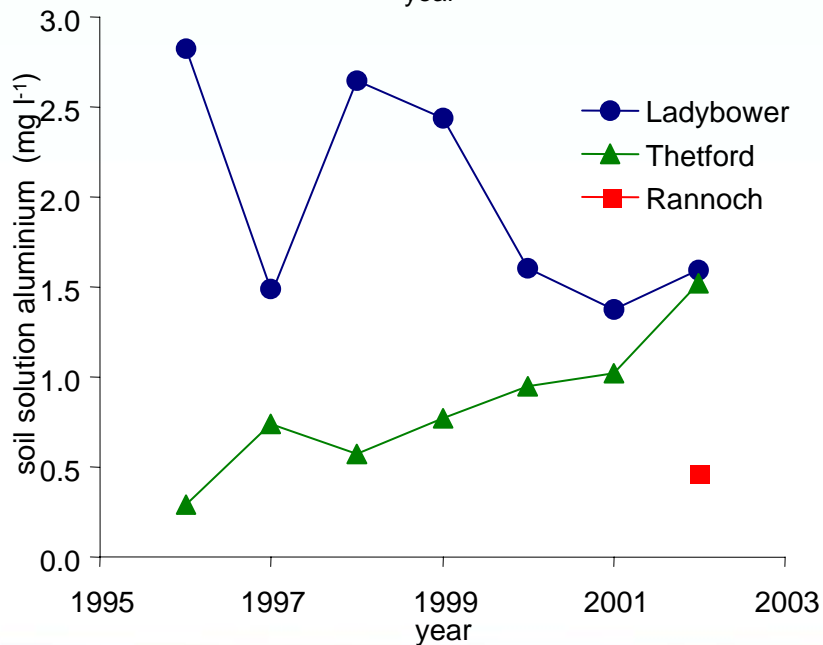
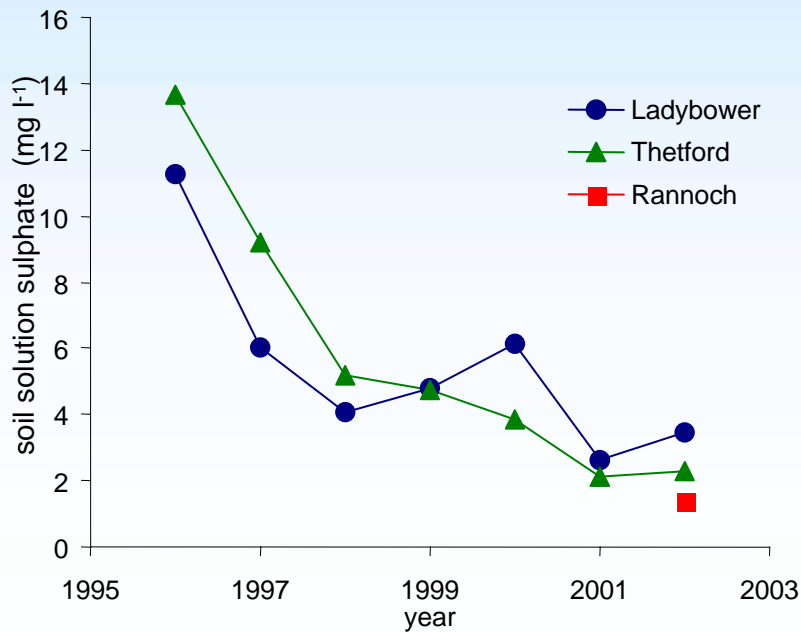


# Thetford plot ~200 m

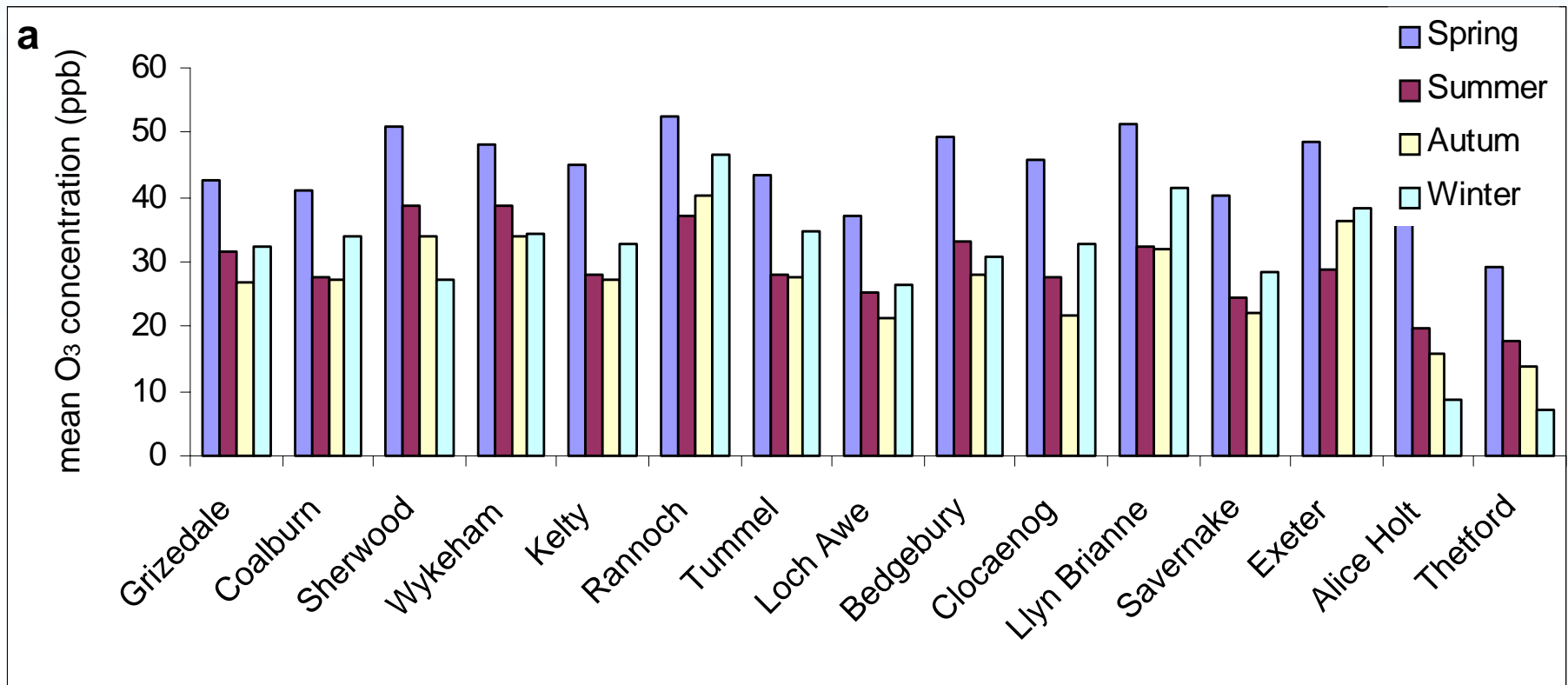


# Identification of long-term trends at individual plots

## - soil solution



# Ozone monitoring



# Ozone induced visible injury

*Liriodenron, Alice Holt 2003*



*Viburnum, kent, 2003*



*Weymouth pine, Thetford 2003*



*Ash, Andover 2003*

# Summary (1)

- Large-scale monitoring schemes indicate no systematic change in the condition of UK forests over time
- events and weather conditions in individual years have significant effects on crown density
- Intensive monitoring indicates some recovery from acid deposition at previously polluted sites
- foliar concentrations of sulphur appear to be falling
- high nitrogen inputs associated with intensive animal husbandry appear to be leading to ecosystem damage at individual plots





# Summary (2)

- Nitrogen deposition may be leading to a change in the groundflora associated with beech woodland; this phenomenon is particularly associated with forest edges and the proximity of intensive agriculture
- although the effects of ozone are largely unseen, visible injury is evident in some plots; reduced growth and needle retention in conifer species are also likely
- ***There is no convincing evidence that there is widespread chronic damage to UK forests as a result of acid deposition or air pollution...***
- .....but, environmental/climate change is likely to present a greater threat to woodland ecosystems and ongoing monitoring is essential.