

Woodland monitoring in the UK

Mark Broadmeadow

Steven Hendry, Dave Durrant, Elena Vanguelova,
Sue Benham, Andy Moffat, Matthew Wilkinson

Environmental Research Branch

Forest Research





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

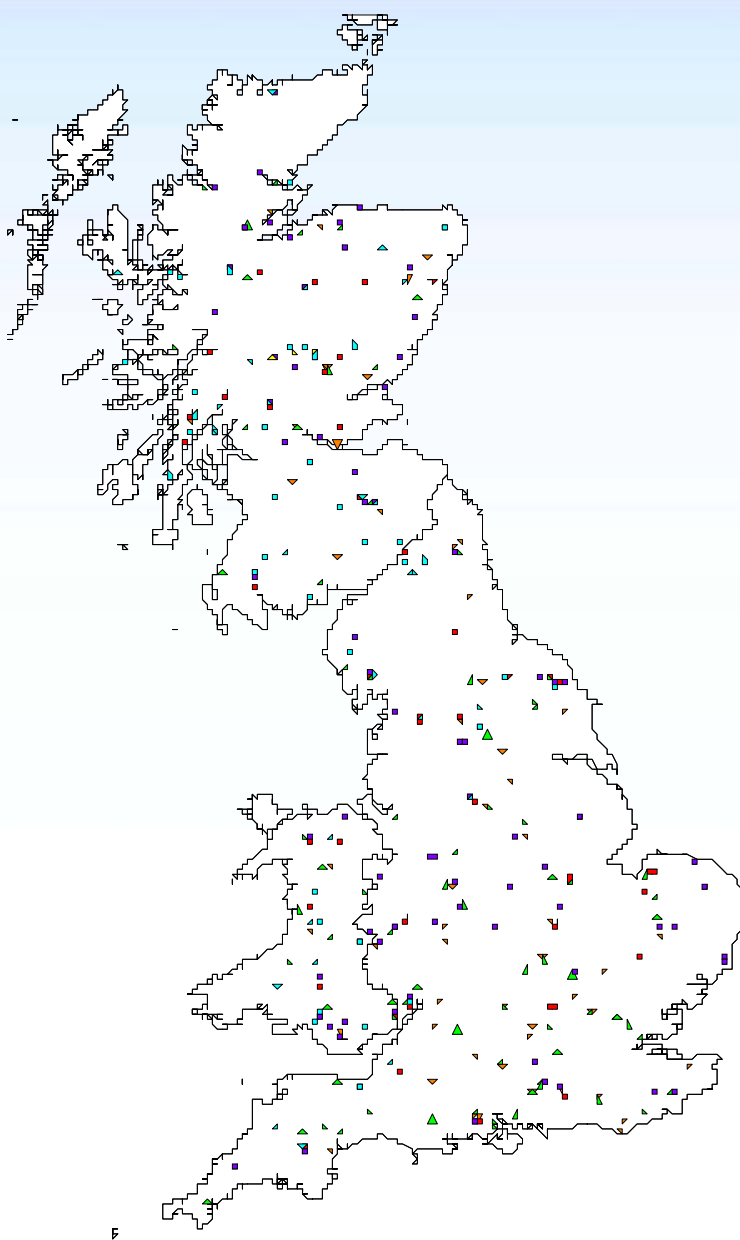
Condition survey of non-woodland trees

- 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

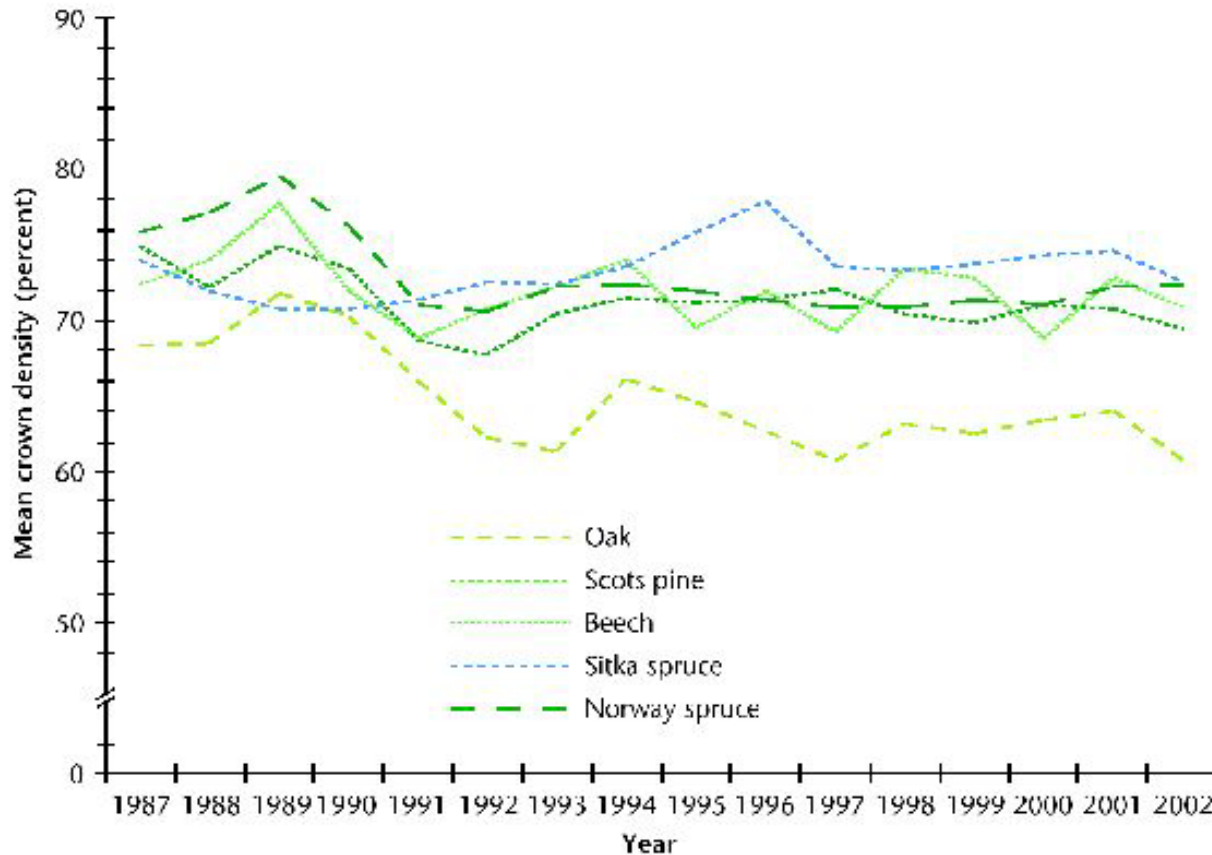


- ~90 plots
- >6000 plots across Europe, mostly 16 x 16 km grid
- 5 species (SS, NS, SP, Be, Ok)
- 24 'internal' trees, 0.25 ha minimum area
- Measurements: as for FCS plus
 - Soil chemistry and description: (1994)
 - Foliar chemistry: (1995)

Forest condition survey (FCS): tree crown transparency

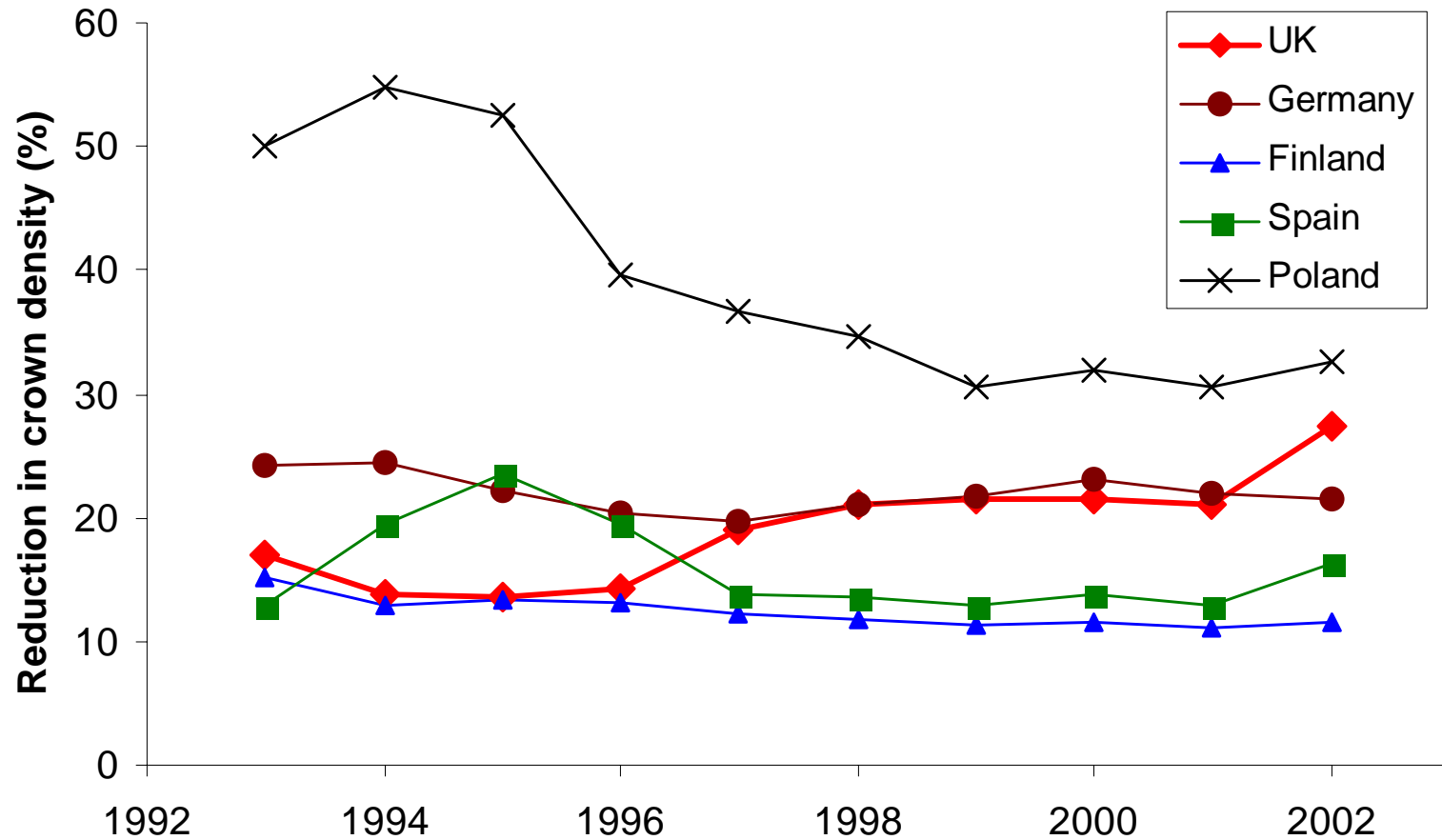


FCS crown condition

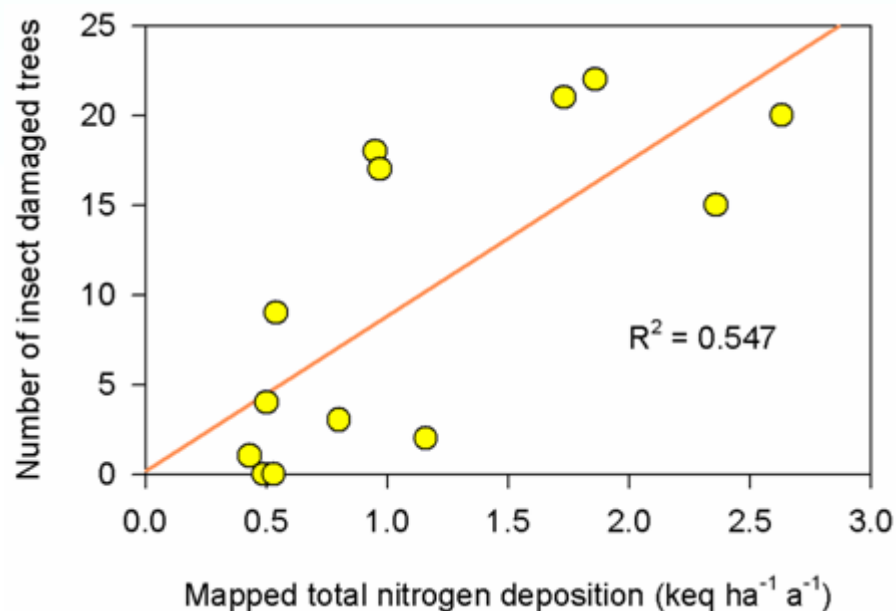
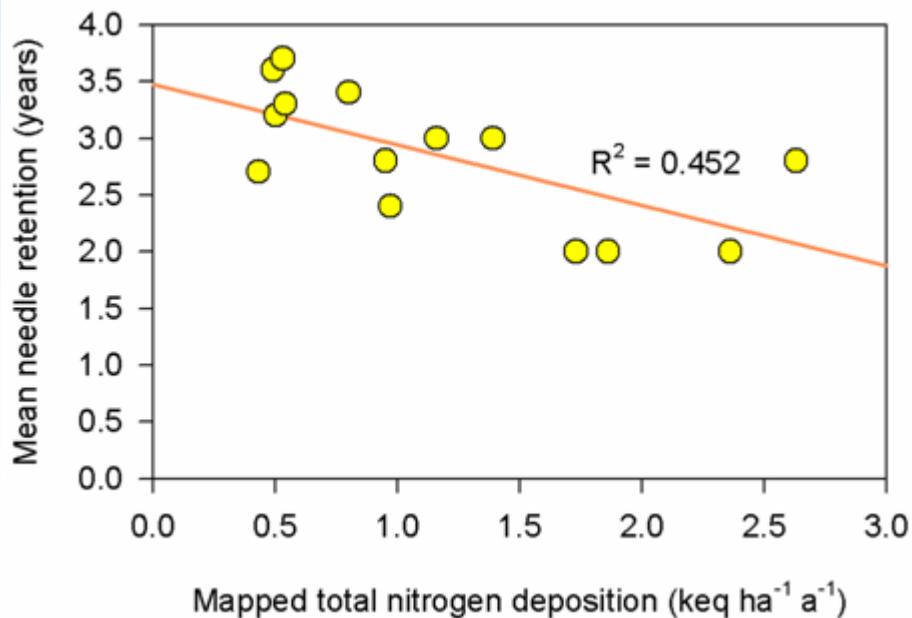


- SS - green spruce aphid
- Be - masting, climate
- Ok - winter moth, tortrix, climate, survey design
- SP - fungi, insects

European comparison 'best local tree' index

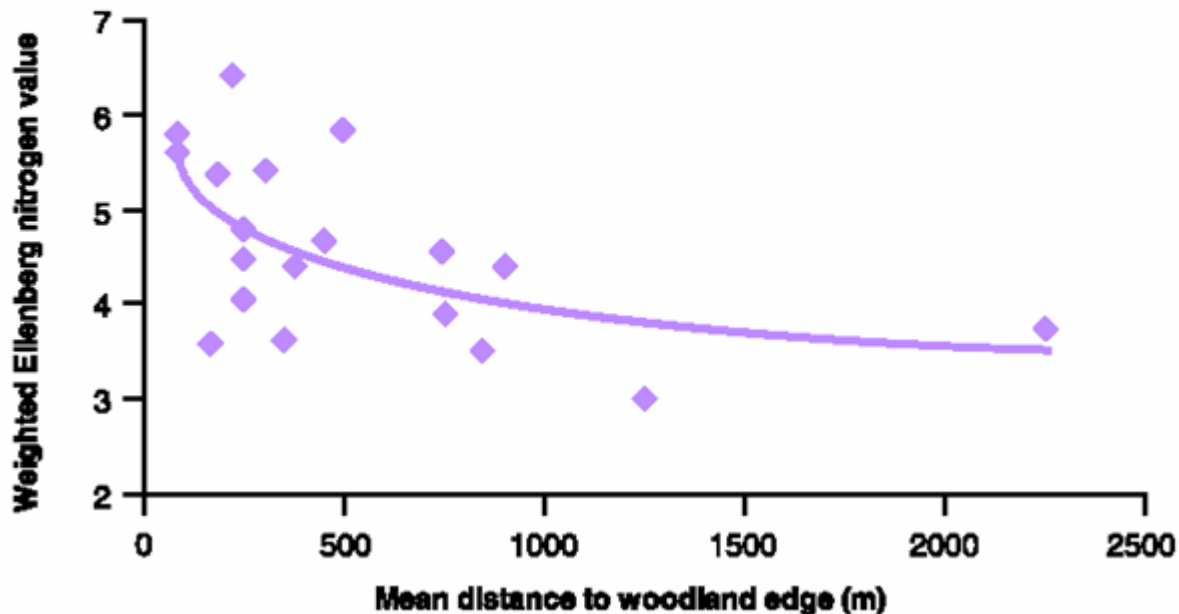


Observed relationships between forest condition and nitrogen deposition (Level I)



Nitrogen deposition and ground flora

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



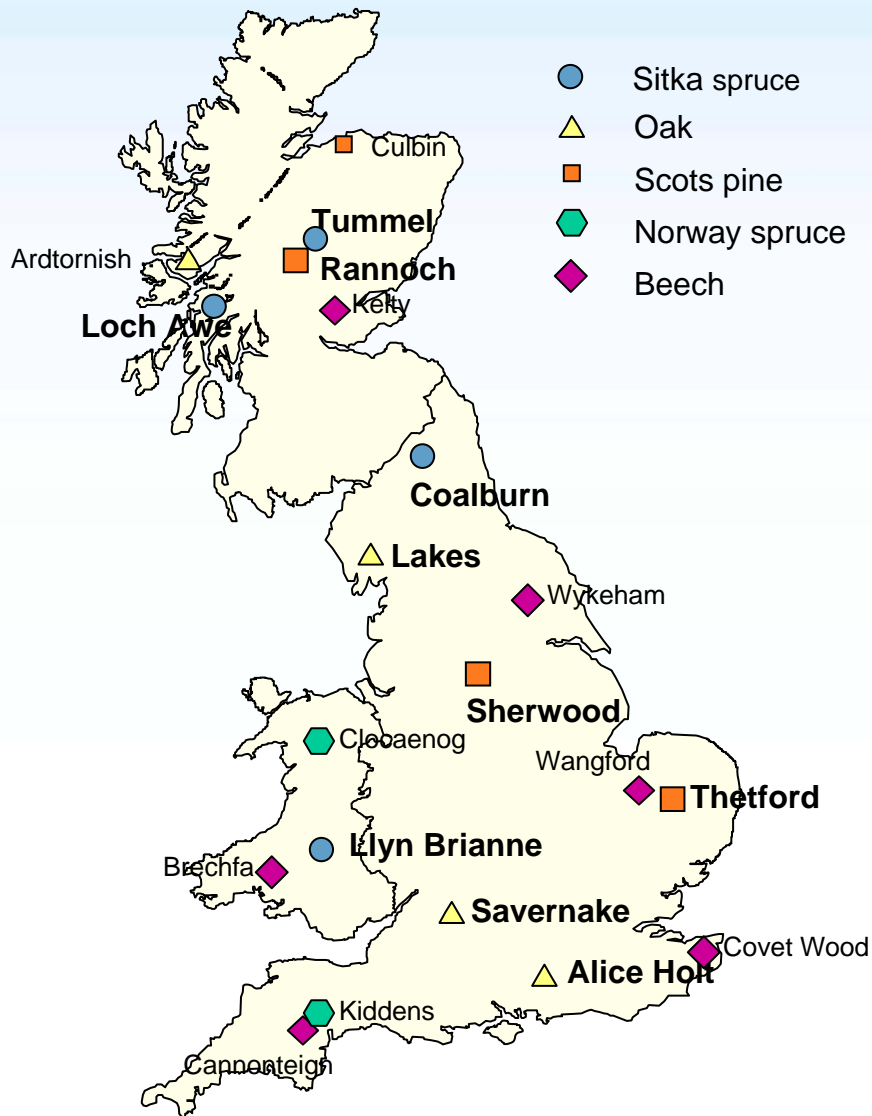
Environmental Change Network (ECN)



Terrestrial site protocols

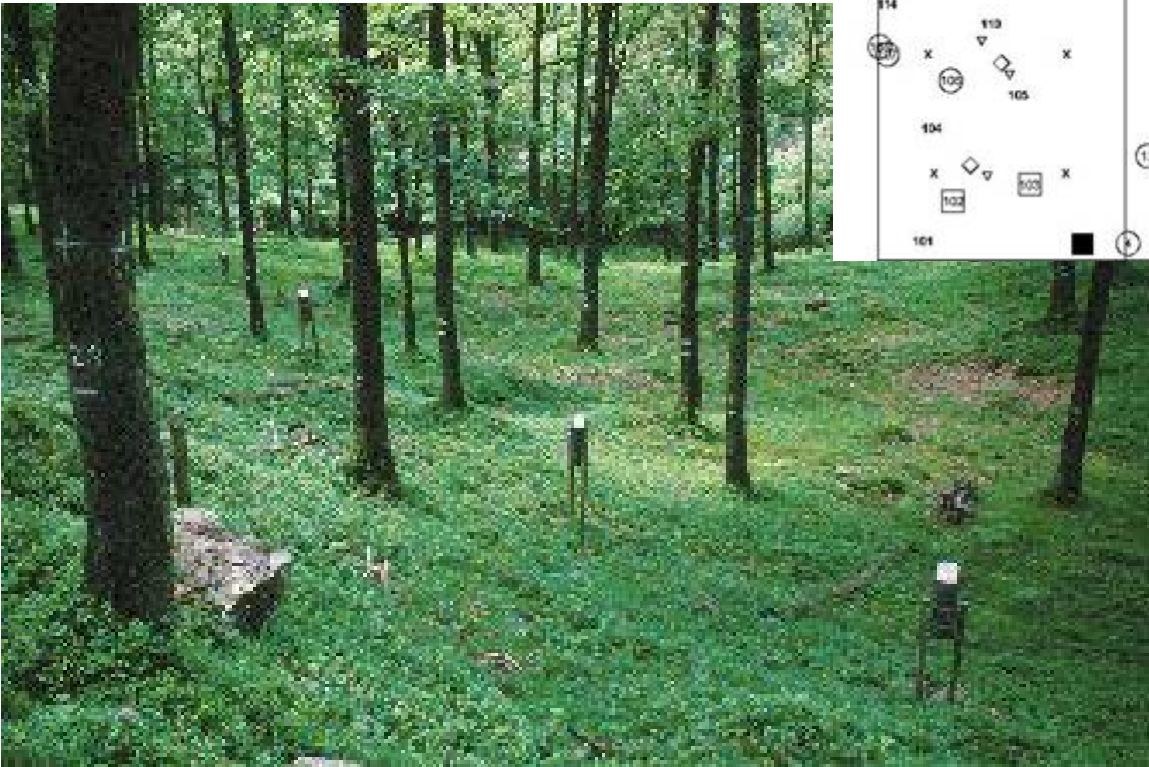
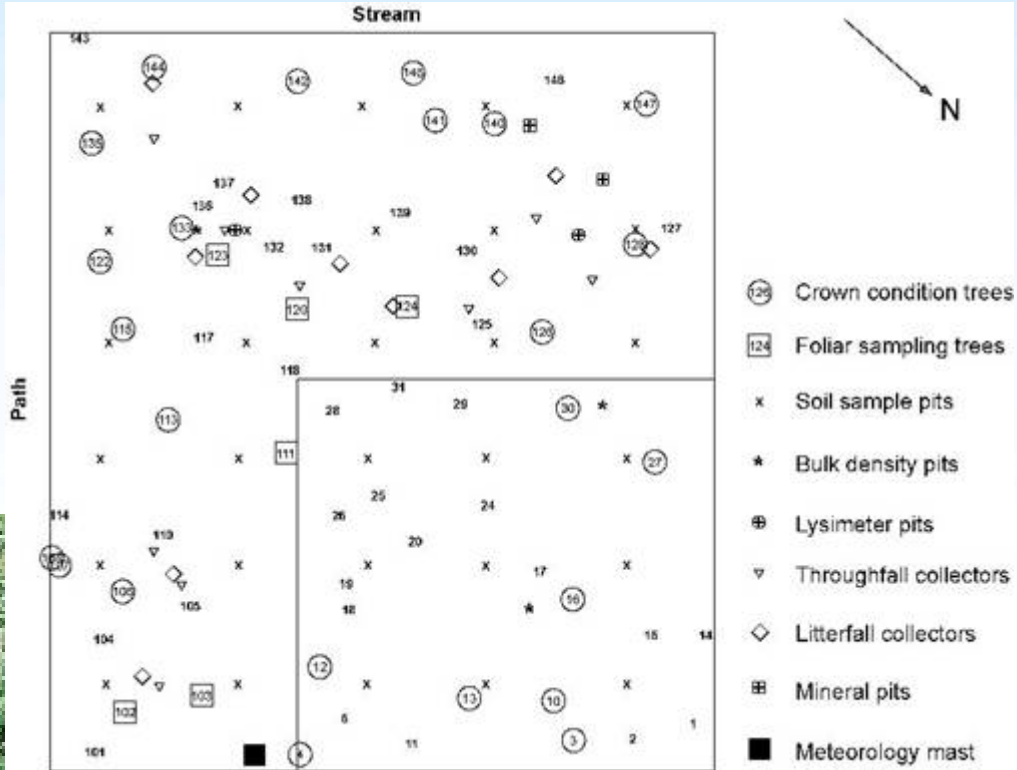
- land management and use
- soil survey
- soil solution chemistry
- meteorology
- rainfall chemistry
- atmospheric chemistry
- vertebrates
 - bats
 - birds
 - rabbits and deer
 - frog spawn
- invertebrate monitoring
 - moth
 - tipulids
 - butterflies
 - spittlebugs
 - ground predators
- vegetation assessment

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

Savernake 105			Coalburn 46			Loch Awe 26			Tummel 9			Rannoch 25		
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

Thetford 15			Llynbrienne 38			Grizedale 21			Sherwood 21			Alice Holt 111		
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 - BaCl₂ extract (cmol+ kg⁻¹ oven dried soil)

Critical loads exceedance

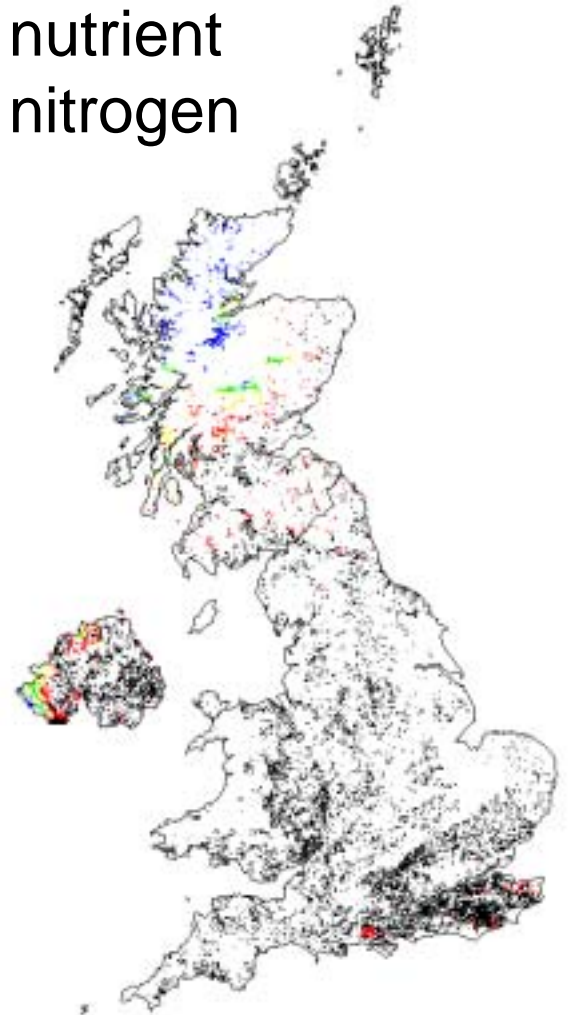
acidity



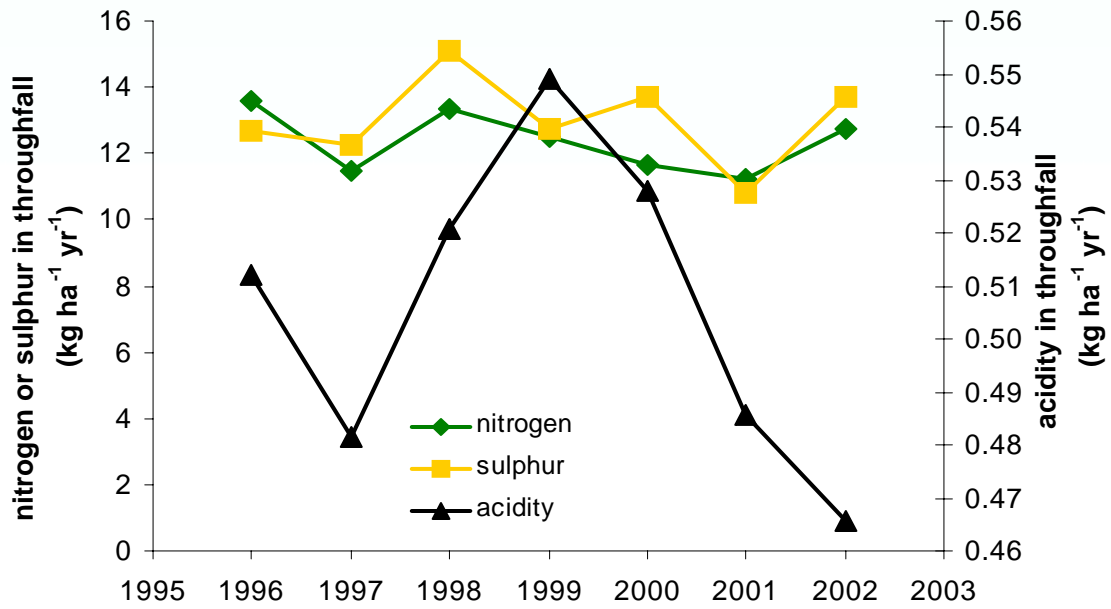
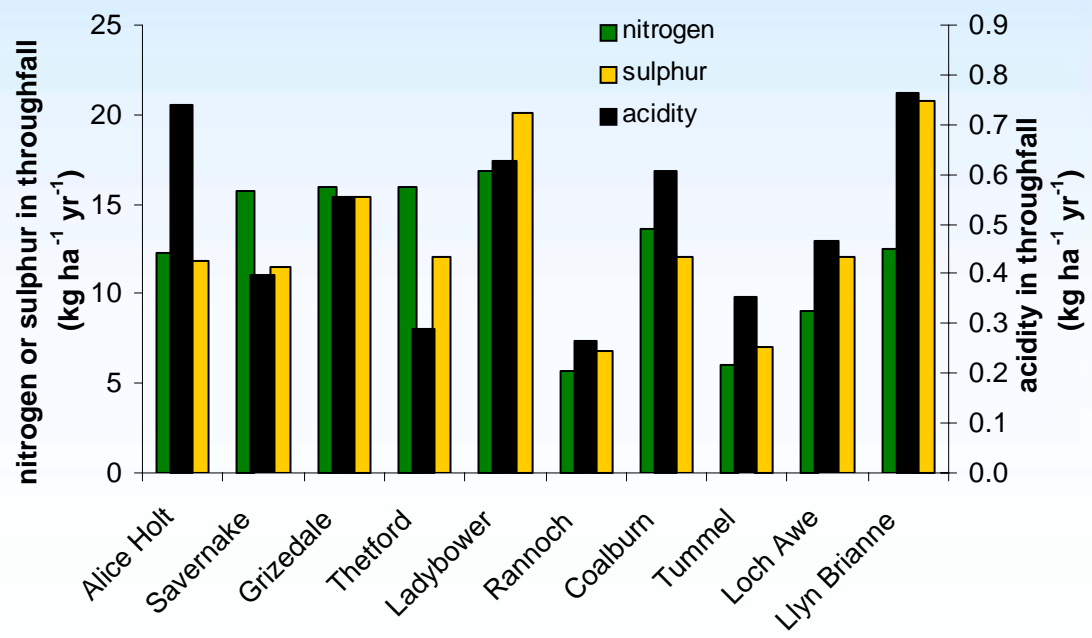
keq ha⁻¹ year⁻¹

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

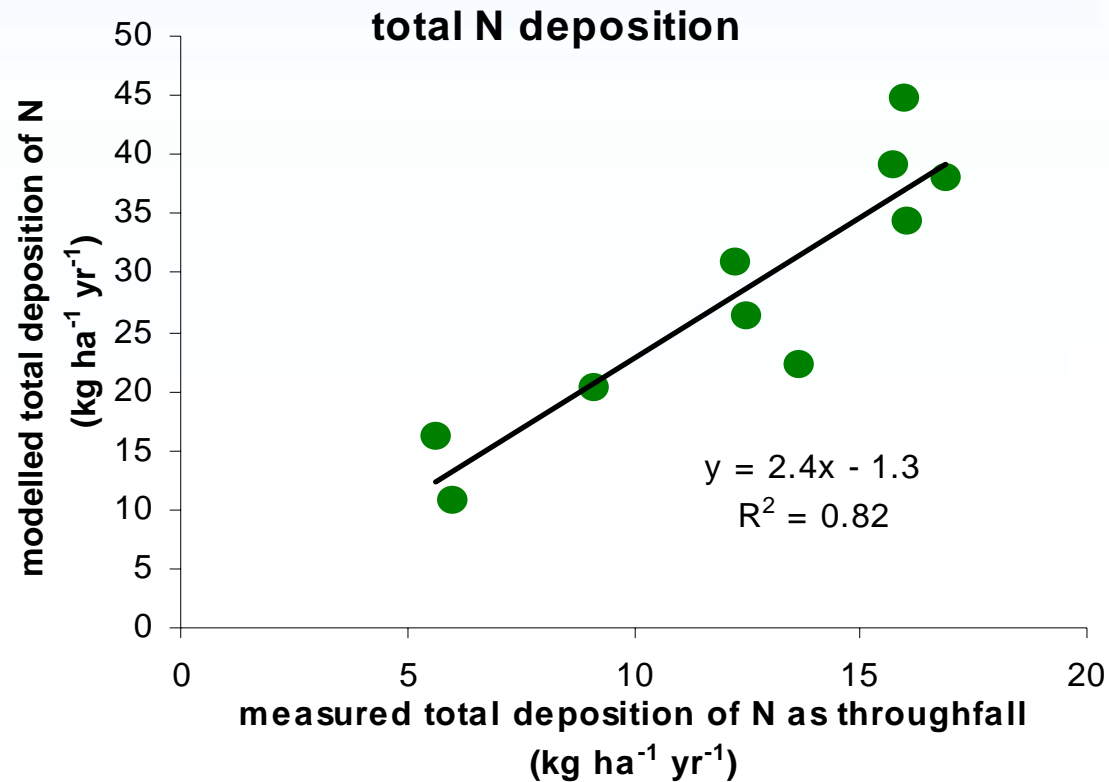
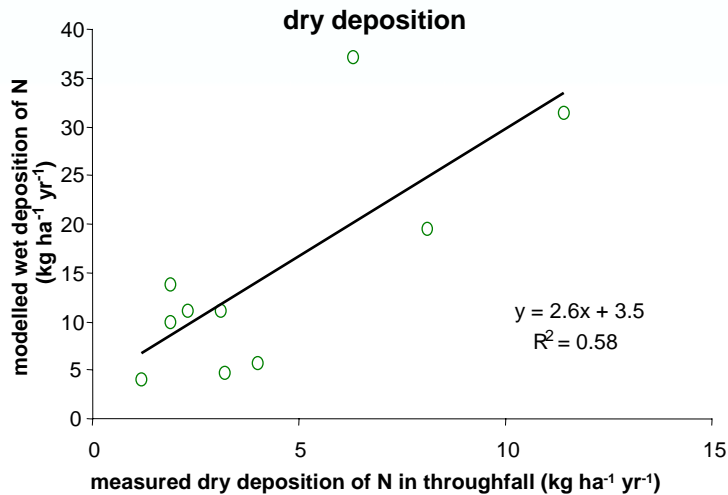
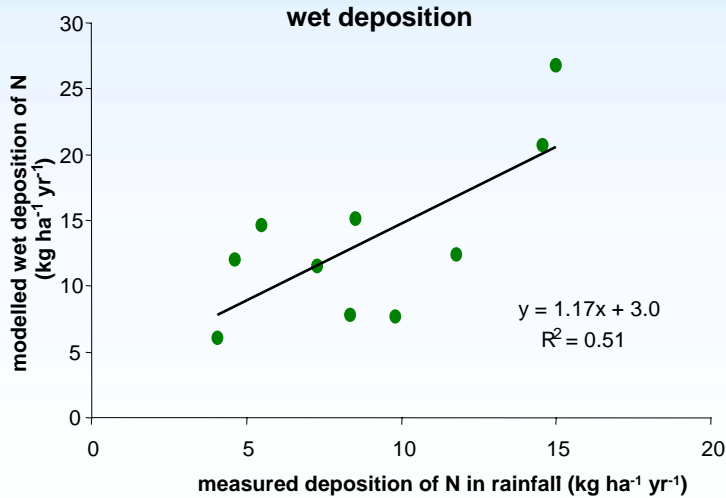
nutrient
nitrogen



Deposition summary - trend analysis and model verification

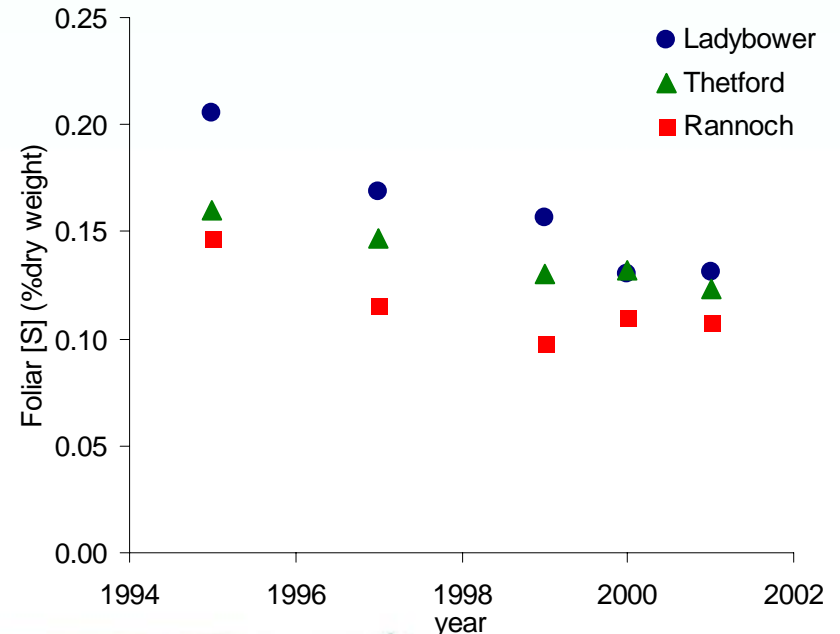
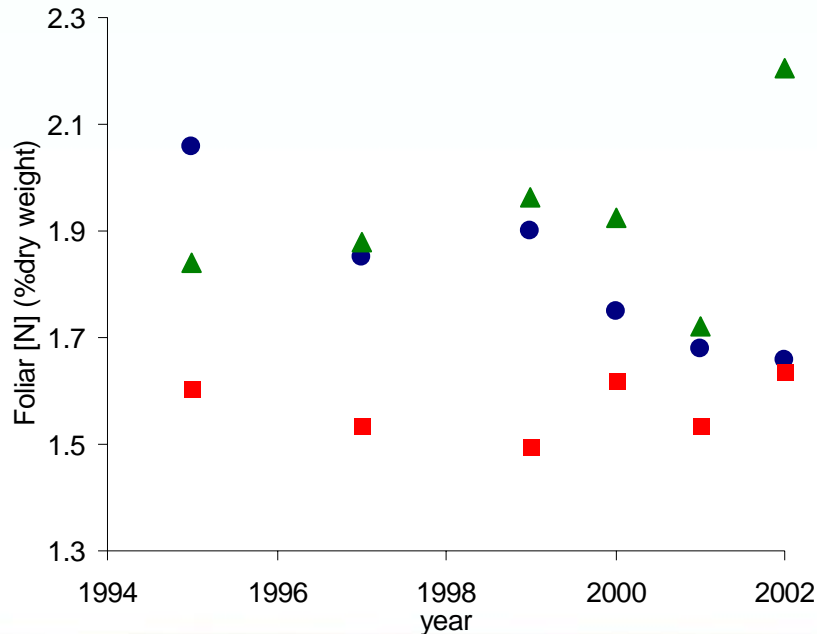
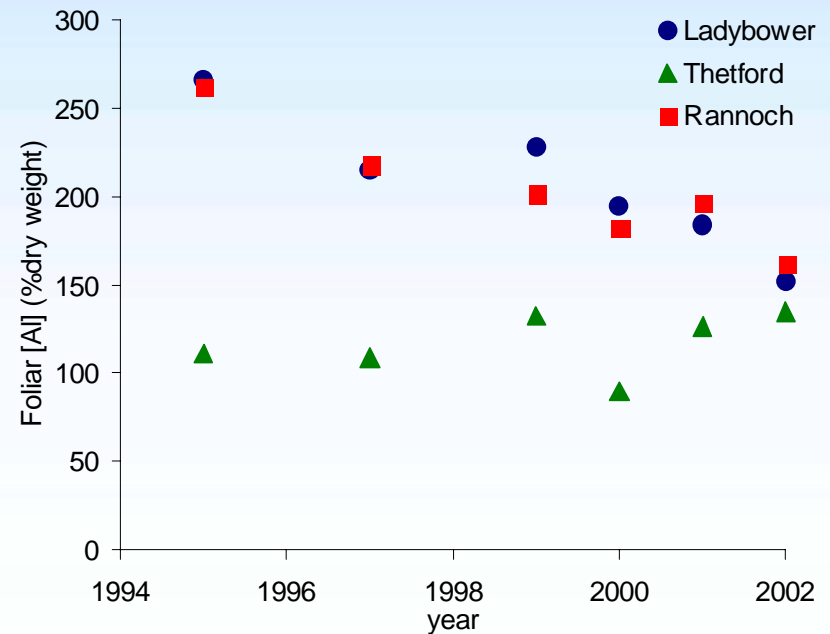


Comparison of modelled and measured deposition



Identification of long-term trends at individual plots

- foliar chemistry

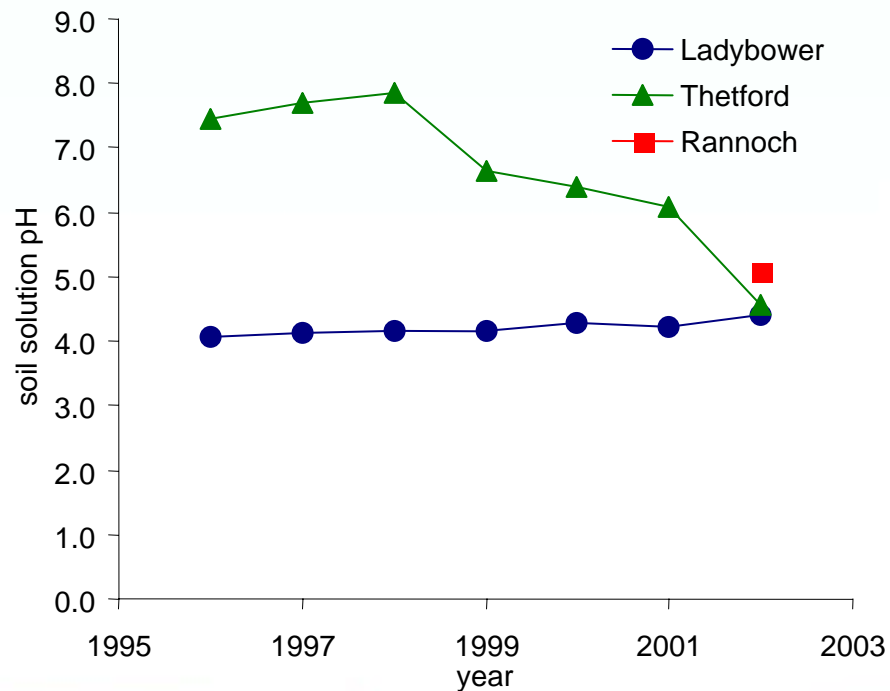
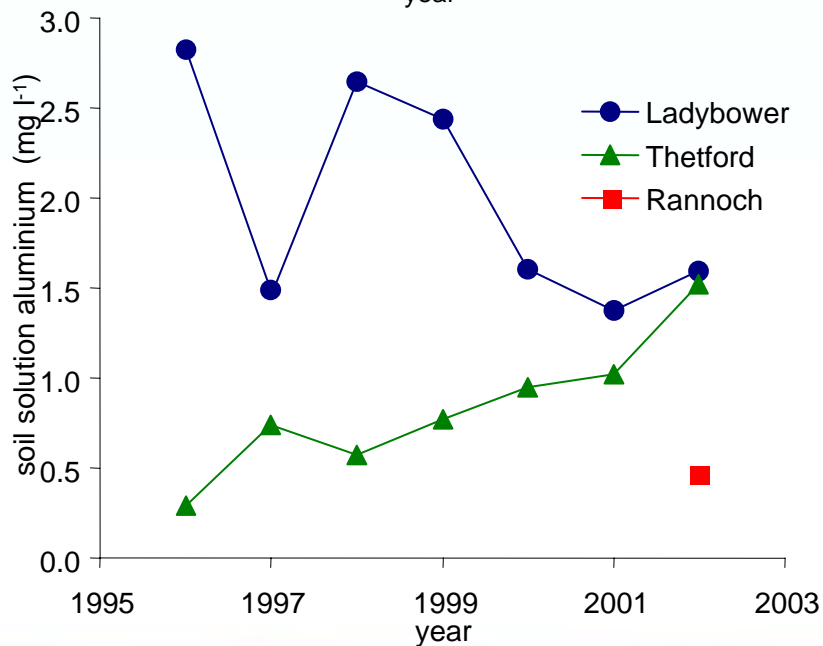
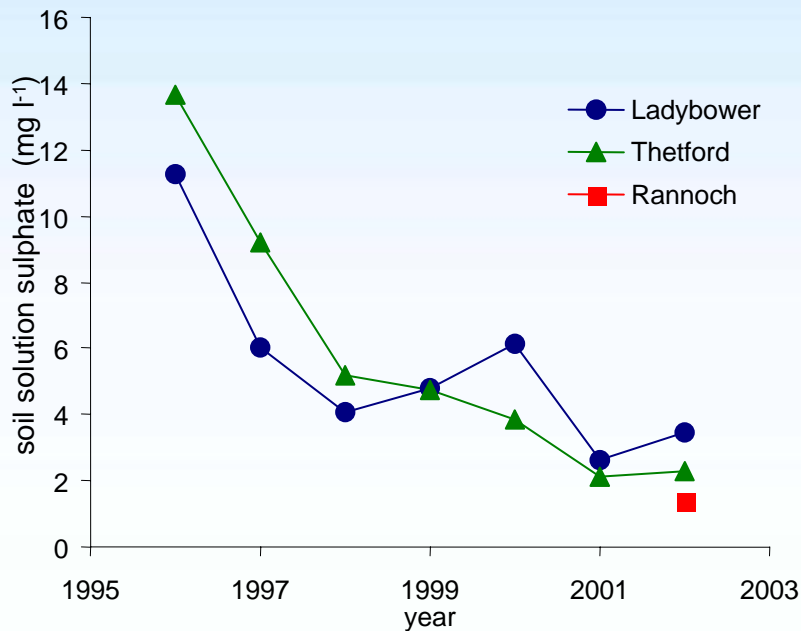


Thetford plot ~200 m

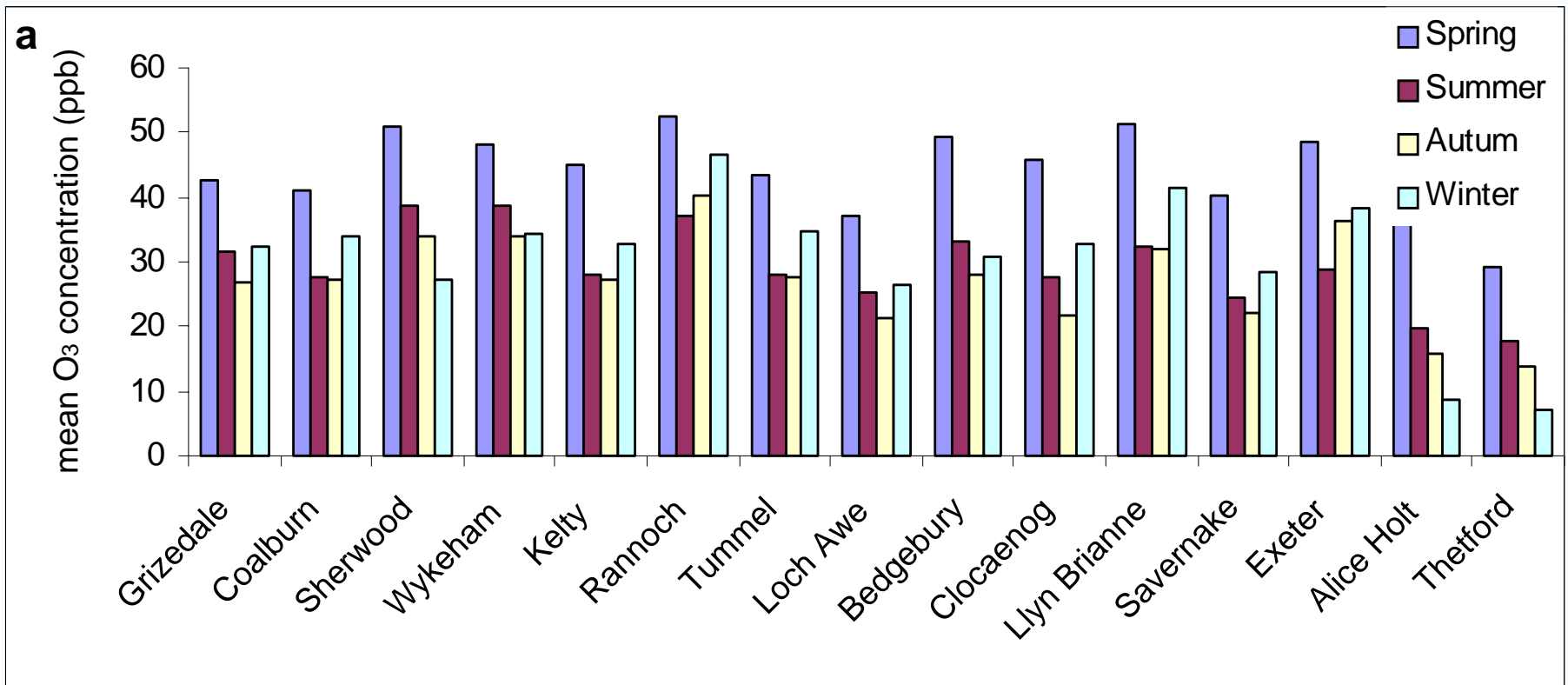


Identification of long-term trends at individual plots

- 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.