Forest Research

# Drought crack & drought damage in conifers

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# DROUGHT CRACK OF CONIFERS

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CONTENTS



## Drought damage to pole-stage Sitka in NE Scotland

### Drought damage to pole-stage Sitka spruce and other conifers in north-east Scotland

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### Summary

In May 2004, extensive damage was reported on pole stage and older Sitka spruce along the Dee valley in north-east Scotland. Three affected sites were assessed in detail between 2004 and 2006 to determine the cause of damage and monitor its development. Dead trees tended to be grouped, and by 2006 mortality averaged 22 % across the three sites.

Symptoms on surviving trees included varying degrees of top dieback, resinosis, and the formation of elongated lesions on stems and branches. An unidentified species of *Phomopsis*

### Introduction

Sitka spruce (*Picea sitchensis* [Bong.] carr.) is the most widely grown tree species in Scotland, occupying 520,000 ha in 1995, equal to 47 % of the total woodland area of Scotland (Forestry Commission 2002). Native to the Pacific north-west of North America, the natural range of Sitka spruce is restricted to a narrow, coastal belt with a humid, oceanic climate and 1,000 to 3,000 mm annual rainfall (Lines 1987). Approximately 380,000 ha have been planted in the wetter, western part of Scotland (Forestry Commission 1999a, b, c), but it is also grown in the central and eastern regions of Scotland, covering approximately 113,000 ha (Forestry Commission 1997 1999d, 2000). The planting rates of Sitka spruce in Scotland were particularly high between 1961 and 1990, with 425,000 ha planted during this period (Forestry Commission 2002). As a result, a large proportion of the current Sitka spruce crop in Scotland comprises trees at the pole stage or older.

Sitka spruce grows on a wide range of soils and has generally grown well in Britain, but it is better suited to moist, well drained soils than to drier sites where it does not thrive (Lines 1987). In the UK, Sitka spruce is subject to root attack by the fungus, *Heterobasidion annosum* (Fr.) Bref. and to foliar damage caused by the green spruce aphid (*Elatobium abietinum* [Walker]). Otherwise, Sitka spruce has relatively few health problems caused by other living agents (Gregory and Redfern 1987). Historically the bulk of reported injuries to Sitka spruce in the UK have been due to frost killing buds and young shoots, which has occurred quite frequently on this species in northern Britain (Gregory and Redfern 1987).

In May 2004, a report was received of needle yellowing and reddening on pole stage Sitka spruce in the Deeside area of the Grampian region in north-east Scotland. Damage was observed at scattered sites, mostly between Aboyne and Peterculter, but extending northwards towards Kemnay (Figure 1). It was reported to be quite severe, with entire crowns affected on individual trees. Similar damage was observed on pole stage Norway spruce (*Picea abies* L.) in this same area. The severity and extent of damage was quite unprecedented for Sitka spruce in Britain. The previous year, 2003, had been exceptionally dry and warm across much of western and central Europe (Rebetez *et al.* 2006), with drought conditions prevailing in many parts of the UK over a period of several months. Drought during 2003 was therefore suspected to be a possible cause.

This paper describes investigations undertaken during 2004

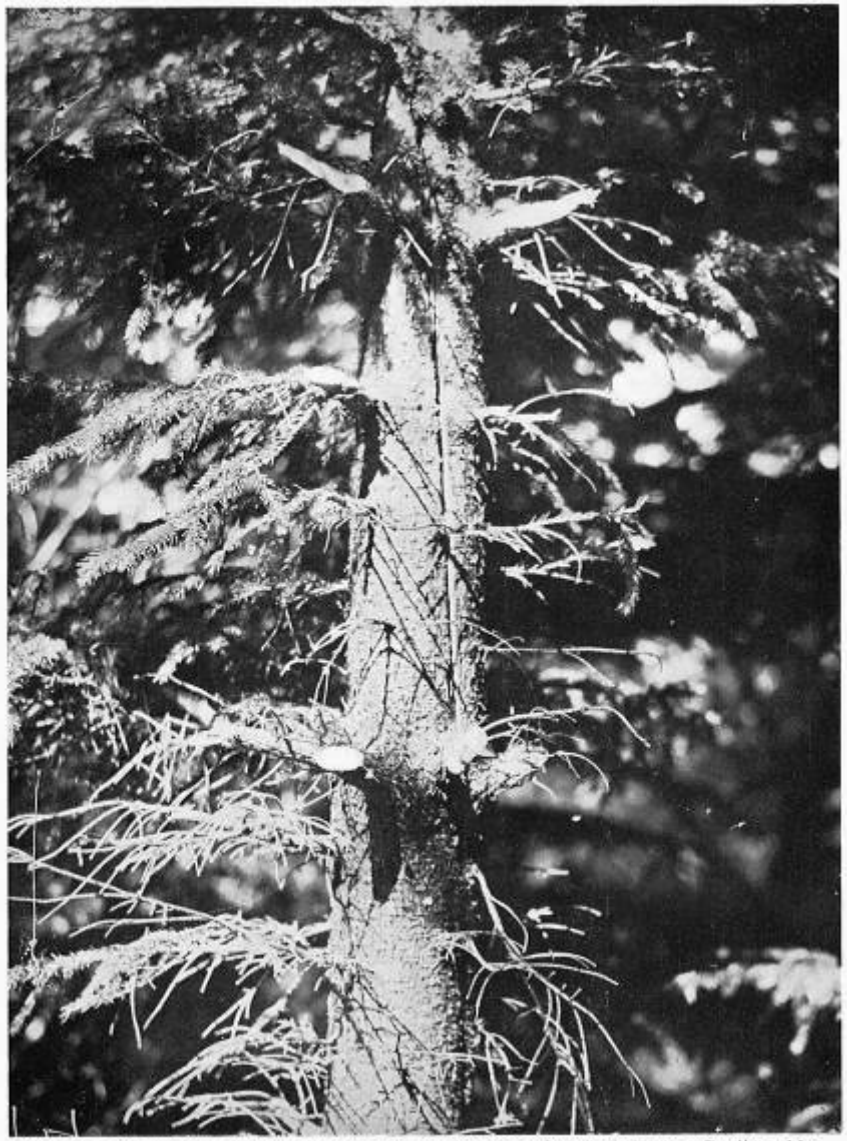


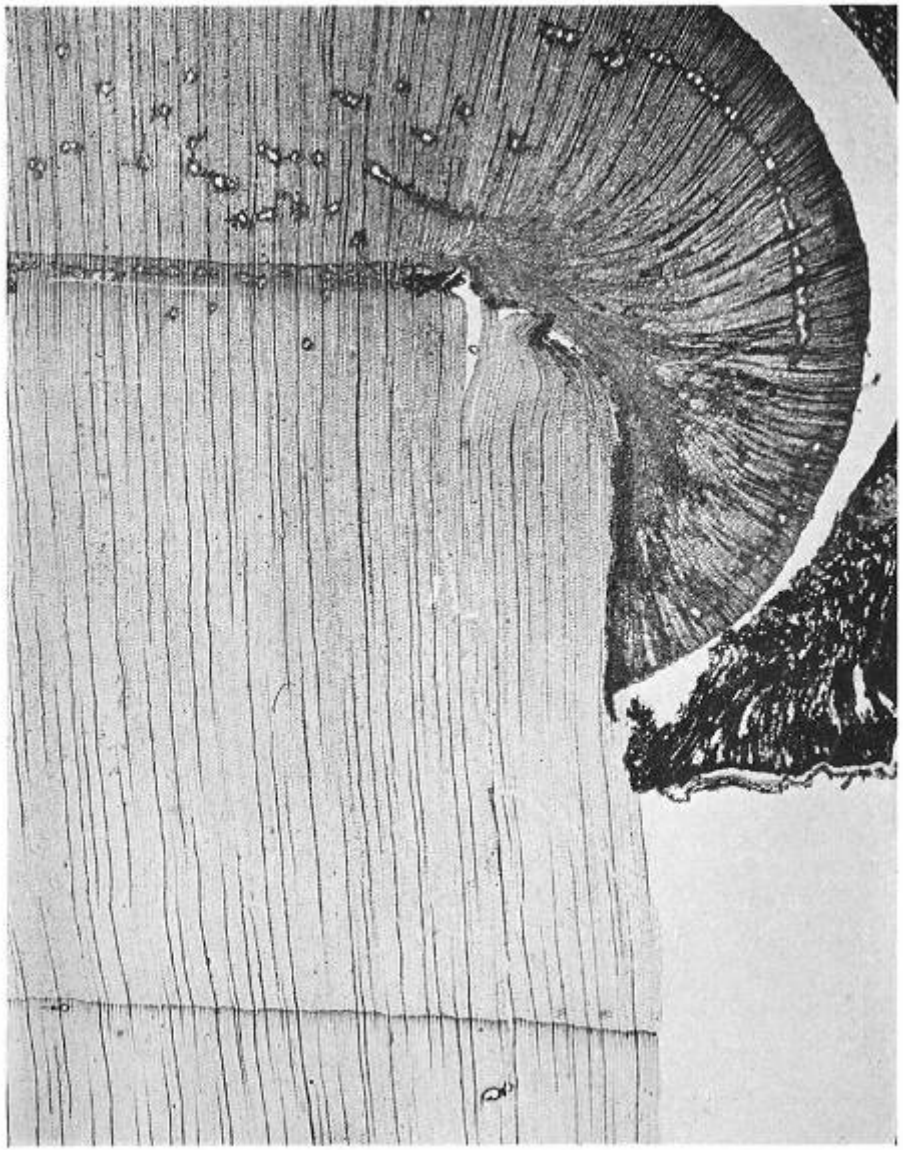
PHOTO 1. Sitka spruce, growing in the Crosswood Section of Myherin Forest, Cardiganshire, showing a drought crack.

# Recorded instances in UK

- Majority of records relate to *Picea* spp. & *Abies* spp. - Sitka spruce, Norway spruce, Grand fir, Noble fir.
- (Western hemlock, Douglas fir, Japanese larch and European larch have occasionally been affected)
- Associated with past major droughts in 1947, 1976, 1983, 2003.
- Evidence from *A. procera* for stem cracking in drought years as far back as 1899.

Clear dating evidence arises when cracks extend through the sapwood and break the cambium & bark.

The year and even the season at which damage occurred can then be determined by examination of growth rings.

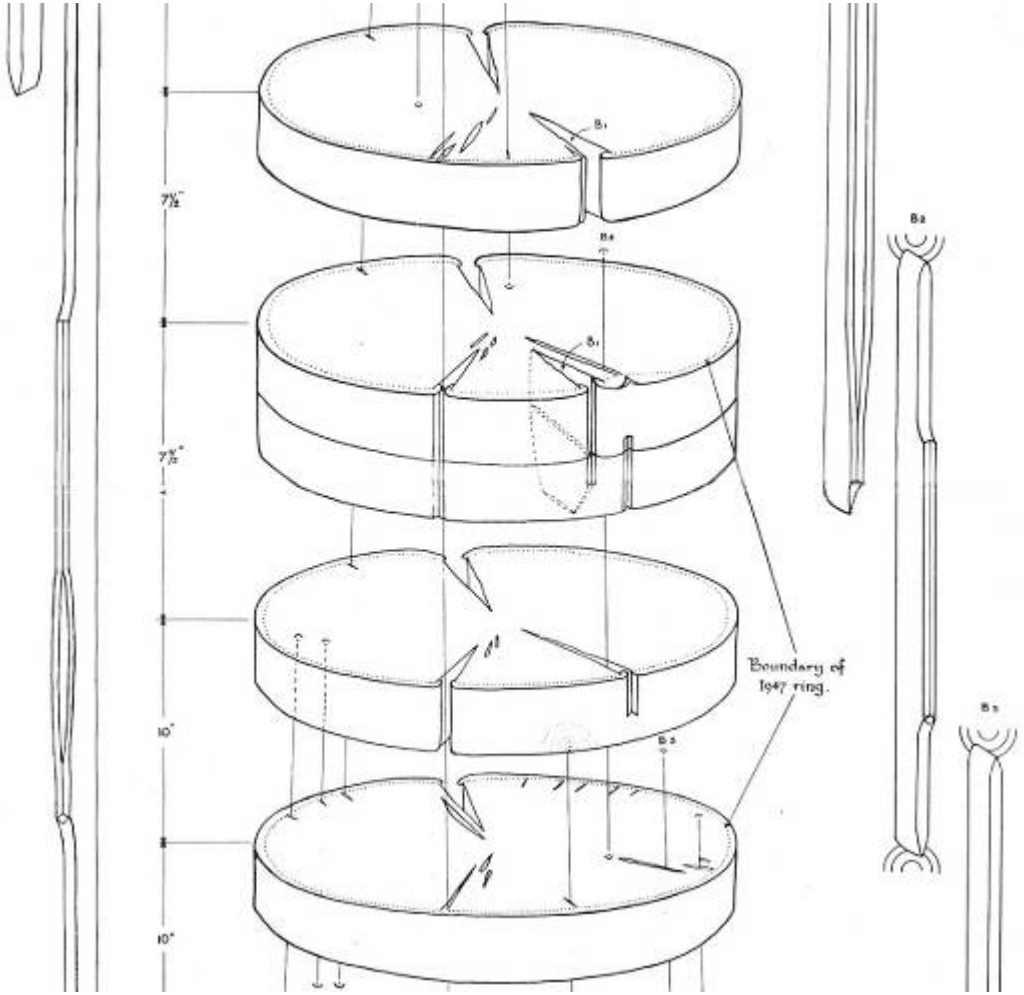


# Nature of drought cracks

- Cracks can be visible externally or confined within the stem - often within particular annual rings.

# Nature of drought cracks

- Cracks can be visible externally or confined within the stem - often within particular annual rings.
- The wood which is affected usually has a poor structure, with large annual increments of low density and with poorly developed latewood.
- Hypothesised that withdrawal of water from the stem and associated tissue shrinkage cannot be accommodated by wood of this type, which splits due to tension within the stem.




The length of cracks varies from about a foot to several feet and they often terminate at branch insertions. The wood anatomy at these points probably prevents the cracks from propagating further.

# Site conditions associated with cracking

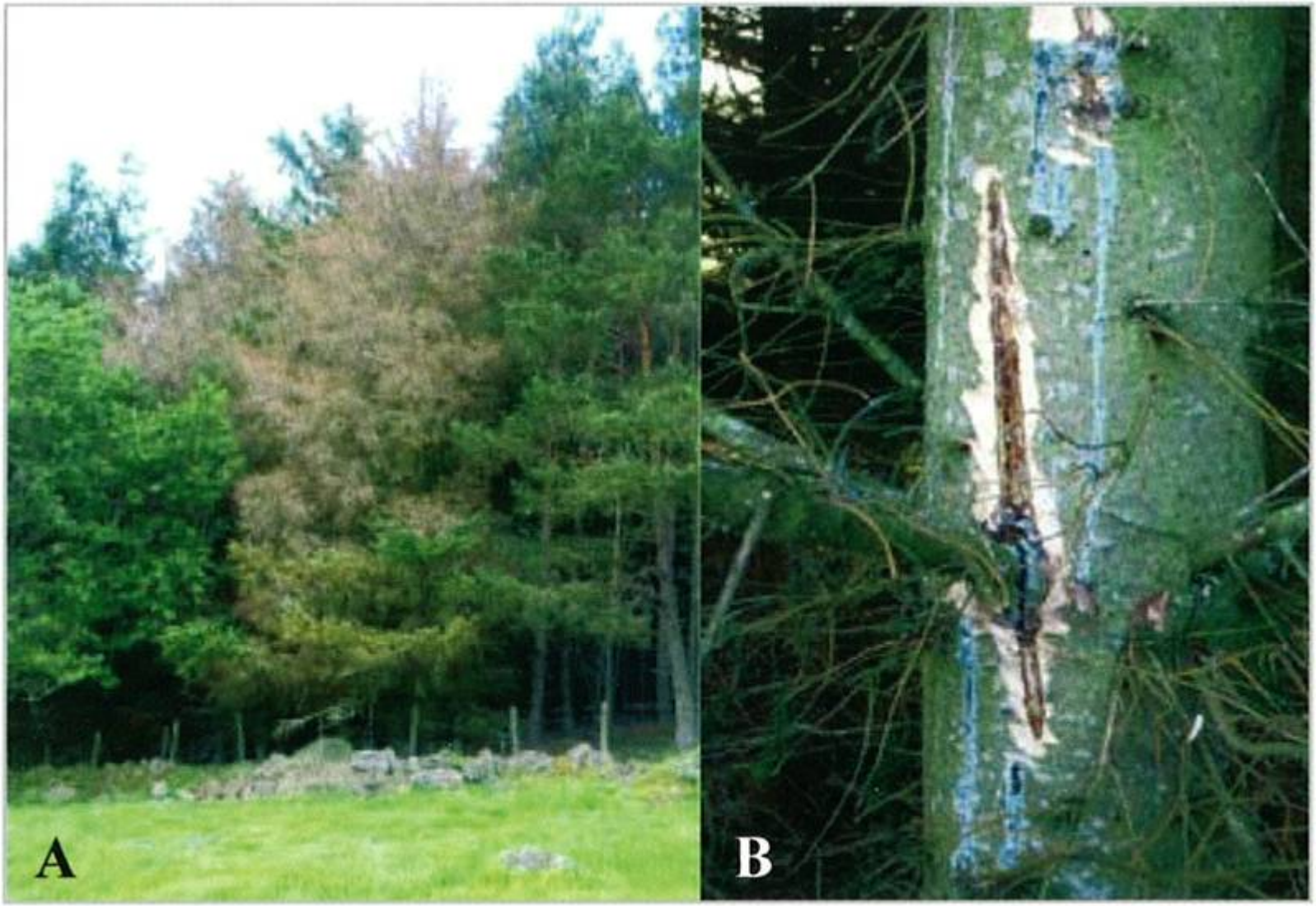
- Cracking is clearly associated with a restricted water supply to the trees but what conditions allow a crop to grow well for the majority of the time and suffer a damaging water deficit in times of drought?
- In western areas, cracking generally occurs on sites with freely draining subsoils where prolonged dry periods result in drying of the entire soil profile.

# Site conditions associated with cracking

- In eastern areas, cracking usually occurs on sites with impeded drainage where surface water is available in the upper soil horizons under normal weather conditions. Rooting depth is restricted on such sites and trees are therefore extremely vulnerable to variations in water availability.

# Cracking & mortality of spruce on Deeside following drought in 2003

- Reports of browning and mortality of pole-stage & older spruce were received by DDAS in May 2004.
- Most severe damage occurred in the area between Aboyne and Peterculter, and as far north as Kemnay.
- General observations made at 11 sites in July 2004 and detailed studies carried out at 3 of these in late 2004, 2005 and 2006.



# Lesions centred on branch insertion points

# Cracking & mortality of spruce on Deeside following drought in 2003

- Average mortality of ~20% across 3 sites.
- Areas within sites where 60-70% of trees recently dead.

**Percentage of trees with each damage variable**

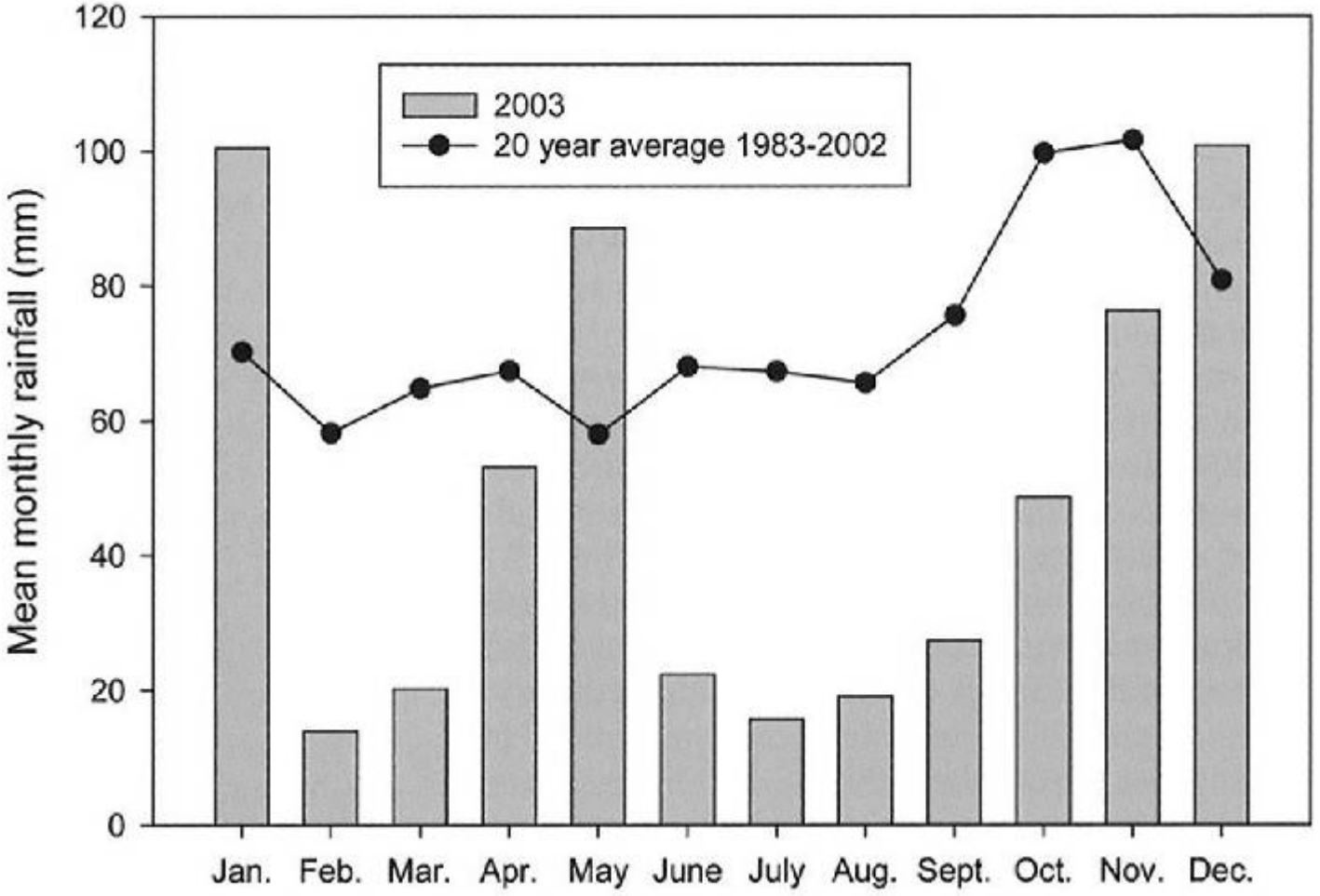
Percentage of Sitka spruce trees with mortality, resinosis, open stem cracks and lesions at the three sites surveyed in June 2006 (*n* = sample size)

| | Site 1 (*n*=100) | Site 2 (*n*=100) | Site 3 (*n*=220) |
|---|---|---|---|
| Mortality | 14 | 18 | 27 |
| Resinosis | 44 | 25 | 23 |
| Open stem cracks | 14 | 4 | 11 |
| Lesions | 1 | 0 | 23 |

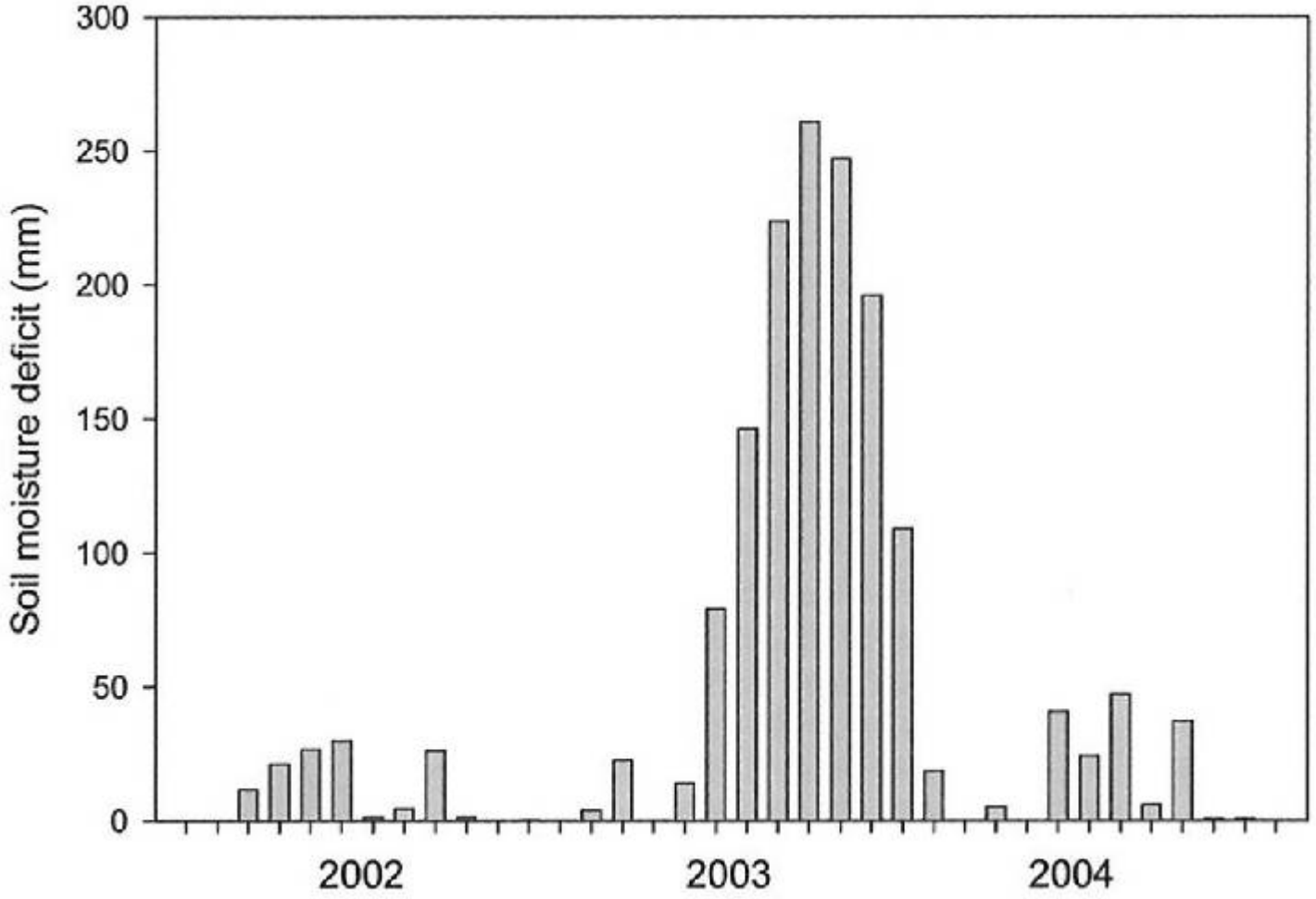
# Cracking & mortality of spruce on Deeside following drought in 2003

- Few pests or pathogens cause damage to Sitka spruce in the UK - occasional mortality due to attack by *Armillaria ostoyae* occurs in young crops but not in older stands.
- Here, only older (30-40 yo) trees were affected and detailed examination did not reveal any evidence of attack by pests or pathogens with the exception of occasional infection by *Heterobasidion.*
- Site characteristics were those identified above as being conducive to drought crack.

# Rainfall in Aberdeenshire in 2003 compared with long-term average



# Soil moisture deficits in the affected area for the period 2002-2004



# Implications for use of Sitka spruce

- Average annual rainfall in the areas affected was less than threshold for SS of 1000mm per annum recommended by Macdonald (1979).
- Although reasonable growth of SS may be obtained in areas receiving as little as 700-800mm rainfall per annum (Jarvis & Mullins, 1987), this would require consistent availability of moisture.
- Patterns of precipitation as well as annual totals need to be considered - sites where SS is grown on soils with impeded drainage are likely to be more vulnerable to damage under the “wet winter” / “dry summer” regimes predicted by climate models.

- Macdonald, JAB (1979). Norway or Sitka spruce? *Forestry* **40**, 129-138.
- Jarvis, NJ & Mullins, CE (1987). Modelling the effects of drought on the growth of Sitka spruce in Britain. *Forestry* **60**, 13-30.