

RAPID CHANGES IN THE VEGETATION OF A SHALLOW POND IN EPPING FOREST, RELATED TO RECENT DROUGHTS

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Introduction

Epping Forest is on the northern outskirts of London, south-east England, and lies to the west of the M11 motorway. The Forest is a remnant of the ancient wildwood that once covered the whole of Britain in post-glacial times (Baker et al. 1978), and is now the remains of a well preserved wood-pasture created in the 12th century. The Forest was managed under this regime until the beginning of the 19th century when a decline in the management system occurred (Rackham 1980). The continuity of the Forest for a period of ca. 4,000 years, and its associated pollarded trees, have become nationally and internationally important, and it constitutes a proposed Special Area of Conservation.

Today, Epping Forest contains a variety of habitats, including woodlands, grasslands, heathlands and numerous ponds. Many of the ponds originated from gravel extraction; some were constructed for ornamental purposes or as stock-ponds for grazing animals (Hanson 1992). Approximately 80 ponds occur in the Forest, ranging in size, depth and shape. Since the Epping Forest Act in 1878 there has been a gradual decline in the number of grazing animals, such as deer, cattle and horses, within the Forest (Layton 1985). As a result many ponds have become invaded and choked by vegetation, through natural processes, only to be influenced by present management policies and practices (Webster 1988).

Over much of Britain, 1995 and 1996 have been perceived as drought years (Everard 1996). To evaluate the impact that local climatic conditions are having upon successional changes in higher vegetation (macrophytes), Speakmans Pond in Epping Forest was surveyed and mapped in 1996. The results are related to previous vegetation surveys carried out in 1989 and 1991 and considered in relation to local rainfall, level of the water table, and air temperature. Detailed meteorological observations are made in the grounds of the Epping Forest Field Centre, ca. 300 metres from Speakmans Pond.

Speakmans Pond

At an altitude of 110 metres above sea-level, Speakmans Pond is situated in the High Beach area of Epping Forest (Grid Ref. TQ 410 979). The pond was

created through gravel-workings in about 1894, forming a large shallow depression which quickly filled with water (Dormor 1991). In 1962, a Mr Speakman wrote to the Epping Forest Committee requesting that a trench be dug to drain the gravel pit adjacent to his property (Dormor 1991). Previously the area was wet and boggy. It is thought likely that the name Speakmans Pond dates from this time.

In 1989 the Corporation of London carried out some management work on the site, removing much of the vegetation and reshaping and increasing the pond to a depth of ca. 30 to 60 cm. In addition, three trenches ca. 250 cm deep were dug to provide some standing water during the summer (see Fig. 5); these provide a retreat for aquatic invertebrates during the summer months.

Vegetation maps showing the distribution of species and plant communities were produced for Speakmans Pond by the Epping Forest Conservation Centre (now Epping Forest Field Centre) in June 1989, and by R. Dormor in 1991. Up to 1995, when the pond dried out, it was used as a teaching site during the summer, and has been under regular or casual observation for a number of years.

Rainfall

Annual rainfall has decreased steadily since 1993, when it peaked at 741.3 mm. The lowest rainfall occurred in 1995 and 1996, with annual amounts of 599.9 mm and 470.3 mm respectively (Fig. 1). January 1995 showed the highest recorded rainfall (200.8 mm) throughout the period analysed. Replenishment of water levels in Epping Forest are at their greatest during the winter months when the majority of precipitation occurs. However, rainfall in the period November 1995 to March 1996 was consistently lower when compared with the same periods in 1994/5 and 1993/4 (Fig. 1). This reduced precipitation did not significantly raise the water table and allow the recharging of surface water levels. Water in the pond scarcely filled the trenches or covered the bottom area of the rest of the pond.

The summer months reflect similar periods of reduced rainfall (Fig. 1). Isolated months, such as September 1995 and August 1996, had relatively high precipitation, with 100 mm and 71 mm, respectively. However, the relatively high air temperatures recorded at the time suggest that surface water would be evaporating quickly (Wotton 1995) and therefore little of the rainwater would percolate into the soil, making no difference to the reduced levels in the water table.

Water table

At the Field Centre, the water table is measured daily to a depth of 2 m by inserting a measuring rod into a 10-cm diameter plastic pipe mounted in a bore-hole 2 m deep. The number of months when a level of 0 mm was

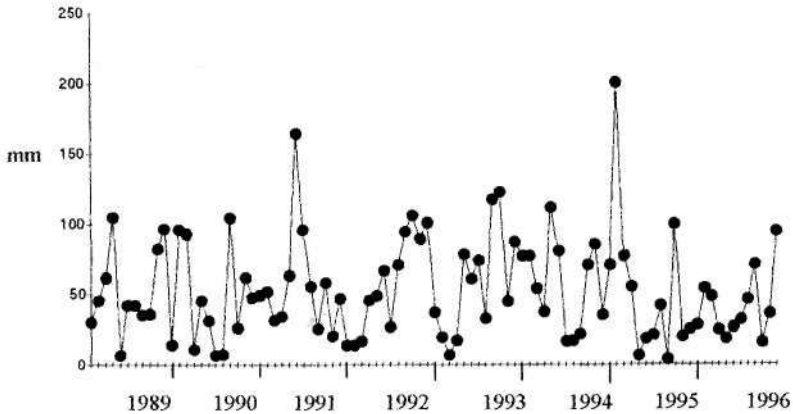


FIG. 1. Monthly total rainfall (mm) from January 1989 to November 1996.

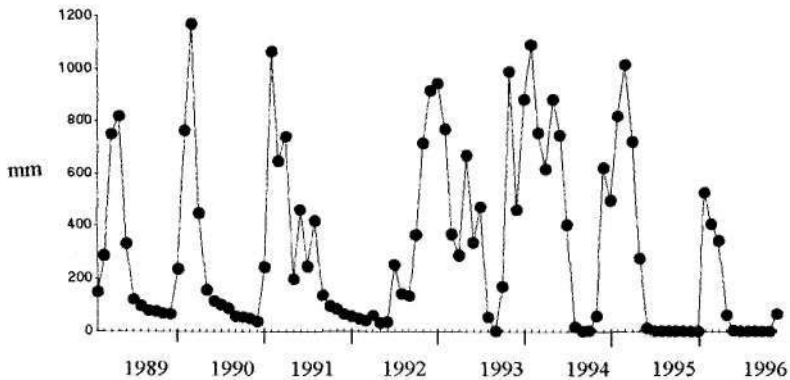


FIG. 2. Monthly mean water table (mm) at Epping Forest Field Centre, from January 1989 to November 1996. Water table was recorded to a depth of 2 metres (see the text).

recorded have increased over the last five years (Fig. 2). In 1992 the lowest recorded level was 41 mm in February; by 1993 it was down to 2 mm in August. In 1994, the level was at zero in August and 4 mm in September. In 1995, water levels were at zero for five months and less than 2 mm for two months. In 1996, water levels were again at zero for five months and less than

7 mm for two months (Fig. 2).

Wetland vegetation is highly dependent upon soil hydrology (Everard 1996). The geology found at High Beach consists of pebble gravels, producing a free-draining soil. As a result, the groundwater in this part of the Forest fluctuates highly throughout the seasons, giving rise to a perched water table. The dry summers, high temperatures and low rainfall further exacerbated these factors in 1995 and 1996.

The water levels recorded in 1996 show an average drop of ca. 75% compared with levels in 1993 and 1994, and were about 50% in 1995 (Fig. 2). In general there are high fluctuations in the level of the water table, with major recharges during the autumn and winter months. This has not happened substantially during 1995 and 1996. The number of months with very low or zero levels in the water table has reduced the pond's potential to store water (Fig. 2), and this has increased dramatically over the last two years. The pond has held little if no water, especially during the summer period when rainfall also has been reduced.

At Speakmans Pond there is not a direct correlation between rainfall and water table. However, movement of water through the soil horizons to the water table is influenced by geology and evapotranspiration, producing a delayed correlation, and the movement of water may have been affected by the particular hot and dry conditions experienced during 1995 and 1996. In fact most of the removal of water from the soil occurs in the surrounding woodland, by evapotranspiration. If movement of water from the ground through this process is greater than precipitation, drought conditions may occur (Woodard 1990).

Vegetation of the pond in 1989 and 1991

In 1989 the dominant marginal vegetation was floating sweet-grass *Glyceria fluitans*, which also covered a major part of the main body of the pond (Fig. 3). Other abundant species included soft rush *Juncus effusus*, reed mace *Typha latifolia* and yellow flag *Iris pseudocorus*. A small (central) area of open water contained bladderwort *Utricularia vulgaris* and white water-lily *Nymphaea alba*.

A similar plant coverage was found in 1991, with a dominance of floating sweet-grass along the shallow eastern edge (Fig. 4). Fully aquatic species were not present, apart from the small area of water lilies also present in 1989, whilst floating sweet-grass covered the previously open area of water (personal communication by R. May).

Vegetation of the pond in 1996

A marked change in the pond was found during the 1996 survey of vegetation in July, when the pool was dry (Fig. 5). The major plant cover now consisted

of creeping bent *Agrostis stolonifera*, with isolated clumps of Yorkshire fog *Holcus lanatus* around the edges; both are terrestrial grasses found on land surrounding the pond. Rushes (*Juncus*) had increased their distribution round the margins of the pond, and the patch of yellow flag noted in 1989 and 1991 was not found in 1996. The deeper trenches were also dry, but a small patch of white water-lily remained adjacent to one of the trenches (Fig. 5), surviving in moist soil but severely stressed by the lack of water in mid-summer.

Comments on changes and succession of plants in recent years

The changes in plant communities observed in Speakmans Pond are not characteristic of classical development phases in pond succession. There has been no build-up of organic matter, allowing progressive development from aquatic through marginal and finally to terrestrial seres, and the rapid change of plant communities found in Speakmans Pond is not that of the usual succession found in fresh waters (Jefferies & Mills 1990). Abnormal conditions resulting from the extensive droughts of 1995 and 1996 are almost certainly responsible for the extreme changes that have occurred in the pond's vegetation.

The dry conditions in the pond have prevented encroachment by the more invasive marginal semi-aquatic species. Reedmace, which is prominent in the development of succession in many Epping Forest ponds (Selby 1955), has been adversely affected by the lack of favourable conditions during the growing season. The amount of floating sweet-grass recorded in Speakmans Pond has declined greatly since 1989 (Figs 3 to 5). This species is considered to be good at exploiting sites with fluctuating water tables (Grime et al. 1990), but the extreme changes in water levels that have occurred recently in Speakmans Pond seem to have provided unfavourable conditions for it to compete successfully.

The main plant communities have changed dramatically over the last five years, with a loss of most of the aquatic vegetation. Much of the shallow portion of the pond is now covered by a community of bent grasses, especially creeping bent *Agrostis stolonifera*. This grass has exploited the wet littoral areas, due to lack of competition from structurally higher plants such as floating sweet-grass and reedmace. Also, the edges of the pond are now dominated by other grasses such as common bent *Agrostis capillaris*, velvet bent *A. canina*, and Yorkshire fog *Holcus lanatus*. These species are normally associated with the grassland sites found in Epping Forest, and colonisation of the pond by this terrestrial vegetation is more in line with the plant succession found on bare ground than the succession expected in a typical hydrosere.

The rapid and dramatic change in vegetation in Speakmans Pond is at present comparatively unique within Epping Forest (other ponds, including some on similar soils, did not completely dry out in 1995 and 1996) and raises

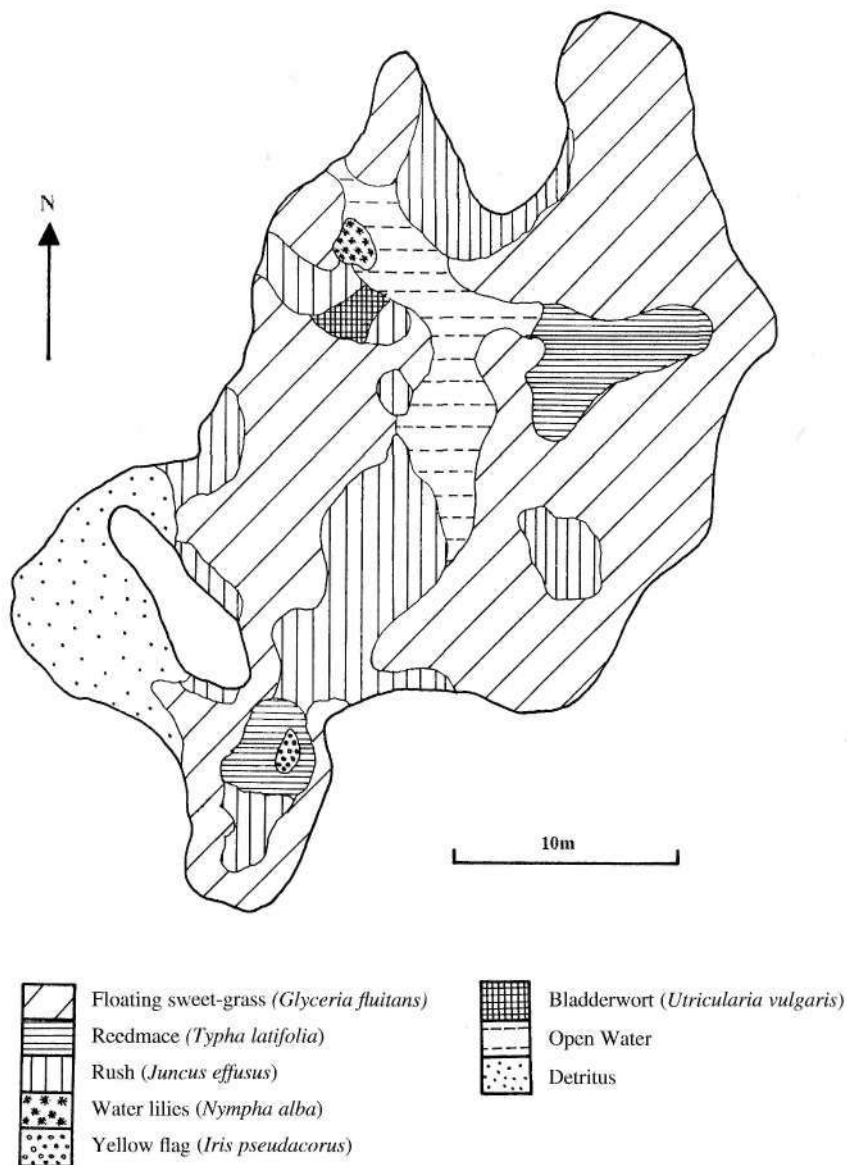


FIG. 3 Major vegetation of Speakmans Pond in 1989.

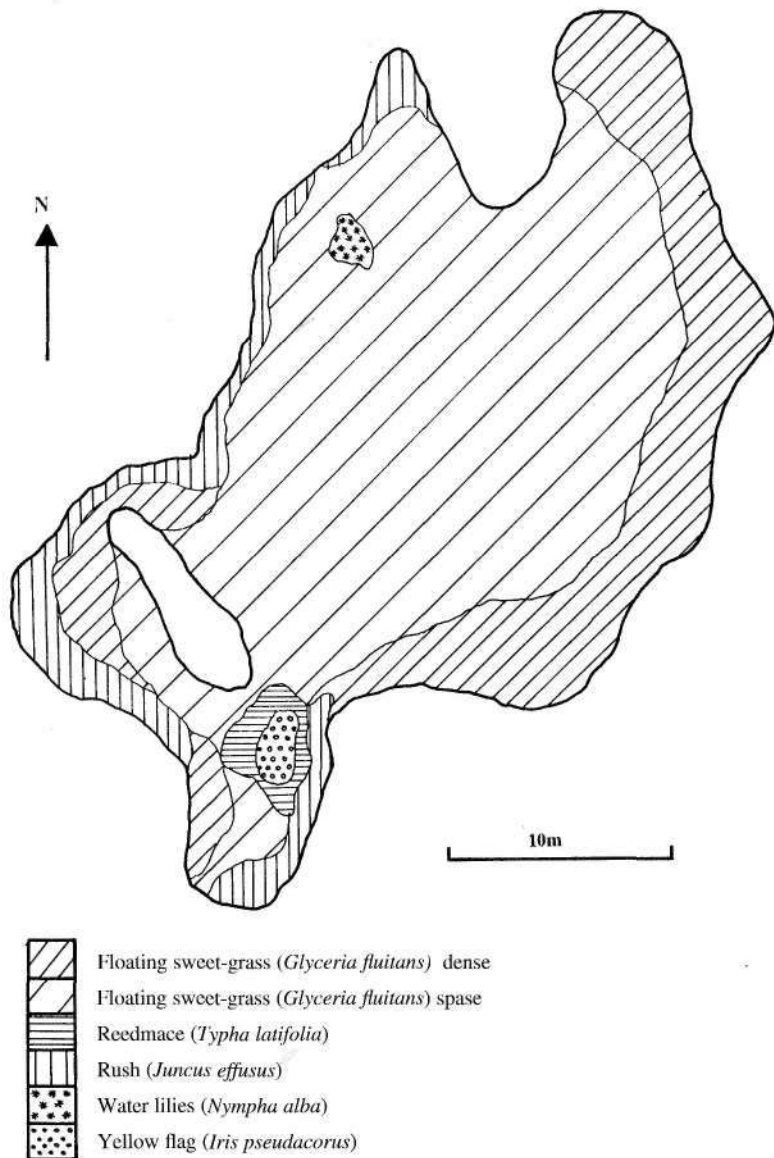


FIG. 4. Major vegetation of Speakmans Pond in 1991.

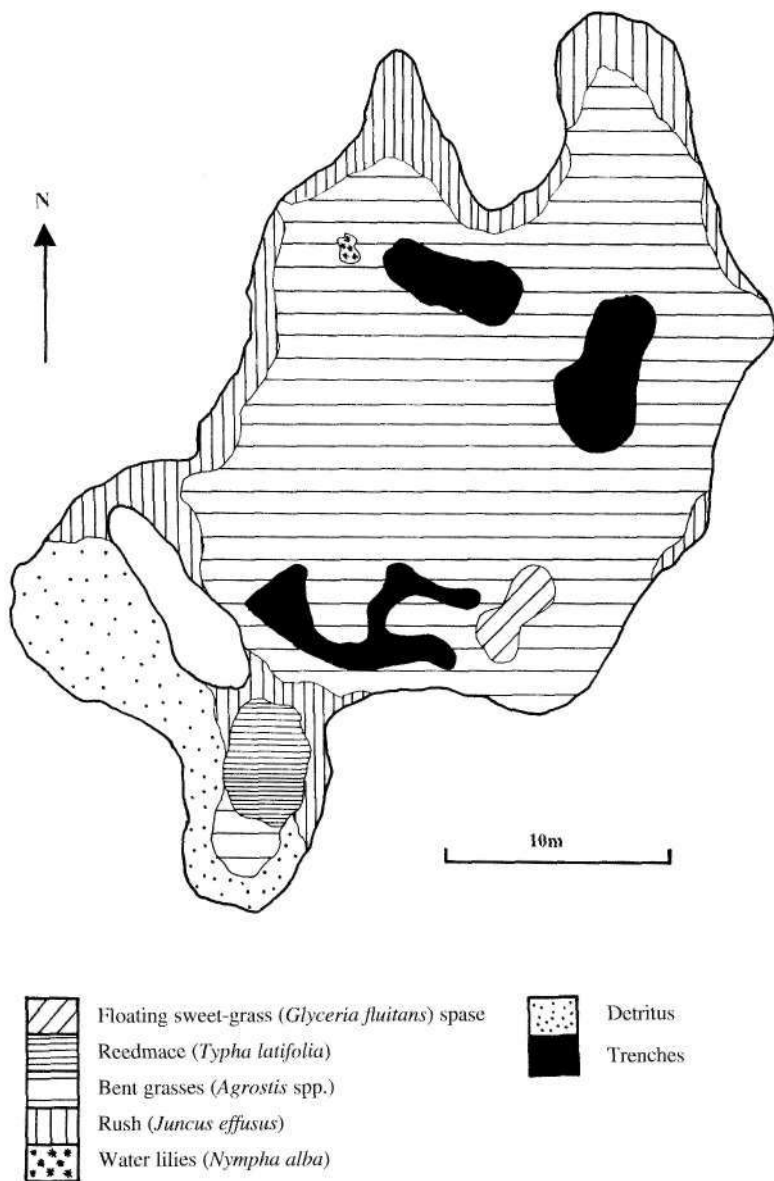


FIG. 5. Major vegetation of Speakmans Pond in 1996.

some interesting questions. Will the pond naturally recover some or all of its former plant communities if the water table rises again to former levels when (if) rainfall is higher in forthcoming summers? A decline in the dominance of creeping bent might be expected to occur if the summer of 1997 is wetter than 1995 and 1996, leading to a higher water table and prolonged immersion of the grass during the summer months. At what stage should management intervene and halt or even reverse the change in vegetation of the pond?

Prior to 1995, creeping bent was locally abundant on and around the edges of Speakmans Pond, but then the grass began to encroach into the pond. Most of the colonisation by creeping bent occurred during spring and early summer in 1995 and 1996, when the bottom of the pond was still wet; in summer, during the hottest months, even this species became stressed. Creeping bent is a fast-growing grass, capable of exploiting many habitats including aquatic systems (Grime et al. 1990); it regenerates by stoloniferous growth and seed dispersal. These factors have allowed the grass to colonise the pond and survive immersion for several months each winter.

The vegetation community now existing in Speakmans Pond is clearly not static. If the general trend in climatic conditions persists, the pond will continue to develop a terrestrial succession of plants. However, if there is a return to the traditional wetter English summer in the near future, it is unlikely that a creeping bent community would withstand total immersion throughout the year. Possibly it would then be replaced by surviving remnants of semi-aquatic plants in the pond, without any management intervention, and the pond could revert towards the type of community found in the early 1990s.

Acknowledgements

We are grateful to Rebekah May (formerly R. Dormor) for contributing information concerning Speakmans Pond, and to Epping Forest Field Centre for providing meteorological records. Our thanks also to John Skinner for commenting on a previous draft.

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