Conservation of Britain's biodiversity: *Salvia pratensis* L. (Lamiaceae), Meadow Clary

T. C. G. RICH*

Plantlife, 21 Elizabeth Street, London, SW1W 9RP

C. R. LAMBRICK

Picketts Heath, Ridgeway, Boars Hill, Oxford, OX1 5EZ

and

C. McNAB

40 Nine Acre Close, Charlbury, Chipping Norton, Oxon., OX7 3RB

ABSTRACT

A summary of conservation work carried out on the statutorily protected plant species *Salvia pratensis* L. (Lamiaceae) in Britain between 1994–1996 is given. It has been recorded in 138 hectads and 32 vice-counties, mainly in southern Britain. It is accepted as native or probably native in 32 hectads and nine vice-counties, and introduced elsewhere. It has been recorded in 17 native or probably native hectads since 1990, and in another 15 prior to 1990, most of the loss of native sites occurring before 1950. It is a robust, polycarpic, perennial which sets abundant viable seed. It occurs in neutral or calcicolous grassland and scrub on calcareous soils. Sites may be unmanaged, mown regularly or irregularly, or may be grazed by stock or rabbits. It grows and reproduces best in sites which are winter-grazed with plants protected during flowering. Conservation work carried out includes population monitoring, introduction of suitable grazing regimes, soil scarification, scrub clearance, cross pollination and seed bank collections.

KEYWORDS: population sizes, habitat management, distribution, ecology.

INTRODUCTION

Salvia pratensis L. (Lamiaceae), Meadow Clary, is a handsome, blue-flowered, perennial herb which is typically found in unimproved, calcareous or neutral pastures. It was first reported from Kent in 1696 (Druce 1932), and is now known from sites scattered across southern Britain with the majority of the populations in Oxfordshire. It has also been recorded elsewhere as an introduction.

S. pratensis has probably always been rare in Britain. Following concern that it was declining, surveys were carried out by the then Nature Conservancy Council during 1986–1988 (e.g. Everett 1987). It was added to Schedule 8 of the *Wildlife and Countryside Act 1981*, as amended, in 1992, and is statutorily protected. In 1994, Plantlife and the Ashmolean Natural History Society of Oxfordshire began a Species Recovery Programme with partial funding from English Nature to draw up a conservation plan for the species based on the excellent, detailed review of its ecology and conservation by Scott (1989).

The aim of this paper is to summarise the conservation work carried out on the species in Britain between 1994 and 1996. Full details (which have been up-dated here) are given in confidential Plantlife reports (Rich 1995, Rich & McNab 1996, Rich *et al.* 1997). A full Species Action Plan is being implemented in England by Plantlife with funding from English Nature (Rich *et al.* 1997), and in Wales by the Countryside Council for Wales (L. K. Wilkinson, pers. comm., 1996). Various

*Address for correspondence: Department of Biodiversity and Systematic Biology, National Museum and Gallery of Wales, Cardiff, CF1 3NP

studies are also being carried out in Holland where the plant is also locally endangered (Ouborg, Van Treuren & Van Damme 1991; Van Treuren *et al.* 1991, 1993; Ouborg & Van Treuren 1995).

DISTRIBUTION

About 450 records of *S. pratensis* were traced in the literature, major herbaria (**BM**, **BRISTM**, **CGE**, **K**, **LIV**, **MNE**, **NMW** and **OXF**), Biological Records Centre and correspondence with various botanists, statutory agencies and Wildlife Trusts. Only a few records have been rejected as the plant is easily identified and many records are supported by herbarium specimens.

The distribution of all records is summarised by 10-km squares in Fig. 1. *S. pratensis* has been recorded in 138 hectads (10-km ×10-km squares) and 32 vice-counties. The records pick out the main areas of chalk on the North and South Downs, the Chilterns, the Hampshire-Wiltshire plains and the limestone of Oxfordshire and Gloucestershire, reflecting its general requirement for calcareous substrates.

Whilst there is little doubt that *S. pratensis* is native in some localities in Britain and introduced to others, its status at some sites will probably never be resolved. The records have been revised as far as possible, noting the opinions of authors of the local Floras and other information. In general, *S. pratensis* is accepted as native in long-recorded sites or areas on chalk or limestone, and as introduced elsewhere. The presence of a single plant at a site may indicate that it is introduced, especially off calcareous soils, but the characteristic way in which single plants appear on suitable soils close to other records could also indicate a long persistent, native seed bank. Squares where *S. pratensis* is accepted as native are also shown in Fig. 1; it is native in 21 hectads and possibly native in another eleven hectads. In terms of vice-counties, it is native in vcc. 8, 15, 16, 17, 23, 24 and 34, and probably native in vcc. 13 and 35. This interpretation of the native distribution differs significantly from that presented in the *Atlas of the British flora* (Perring & Walters 1990).

There has been some debate about the status of the Monmouthshire population (e.g. Riddelsdell 1916). Kay & John (1995) investigated the population genetics and demographic ecology of 32 species of lowland grassland and related habitats in Wales including *S. pratensis*. Nine loci in six enzyme systems were analysed in *S. pratensis*, of which five were variable. The pattern of heterozygosity was variable and unexpected, suggesting that recombination might be restricted by a degree of structural heterozygosity. An unrooted phylogenetic tree indicated that there was a high degree of correlation between geographic and genetic inter-relationships, with very little differentiation within the sub-divided population but relatively large distances between populations (N.B. one locality in Kent is erroneously treated as two localities). There was some evidence of a cline of decreasing genetic variability from the more variable populations in south-east England to the least variable population in Monmouthshire. This pattern indicated that the surviving genotypic composition of the Monmouthshire population could be regarded as a typical edge-of-range population, perhaps derived from the Cotswold plants. This suggests that it could indeed be native or introduced from the Cotswold populations; based on the information available to date it is accepted as native. Further work on the genetics in relation to European material may provide more information on the status at this and other sites.

There appear to be several modes of introduction. *S. pratensis* has been specifically noted as introduced with foreign grain to many sites in Britain, especially during the period 1880–1930. It is locally common in Europe and was a regular seed contaminant of imported grass/clover permanent pasture seed mixtures but was rare in grain from annually-cultivated arable fields.

Salvia spp. have also been widely grown as herbs or salves (though *S. pratensis* is not especially noted for its medicinal uses). The name "Clary" appears to be derived from "clear-eye" – a practice by which mucilage from wetted seeds was put into eyes to "cleanse them" (this is not recommended practice). It was also used as a gargle for sore throats and as a cleanser of the teeth. The plant is now also fairly widely available in garden centres and its seed is present in so-called "wild-flower" seed mixtures. Some introduced records may therefore be a result of escapes from cultivation.

Sturt (1995) has recently drawn attention to the association of *Salvia verbenaca* L., Wild Clary, with churchyards where it was sown on graves in the belief that it conferred immortality. At least eight records of *S. pratensis* are associated with churches, and this association may also account for some introduced records.

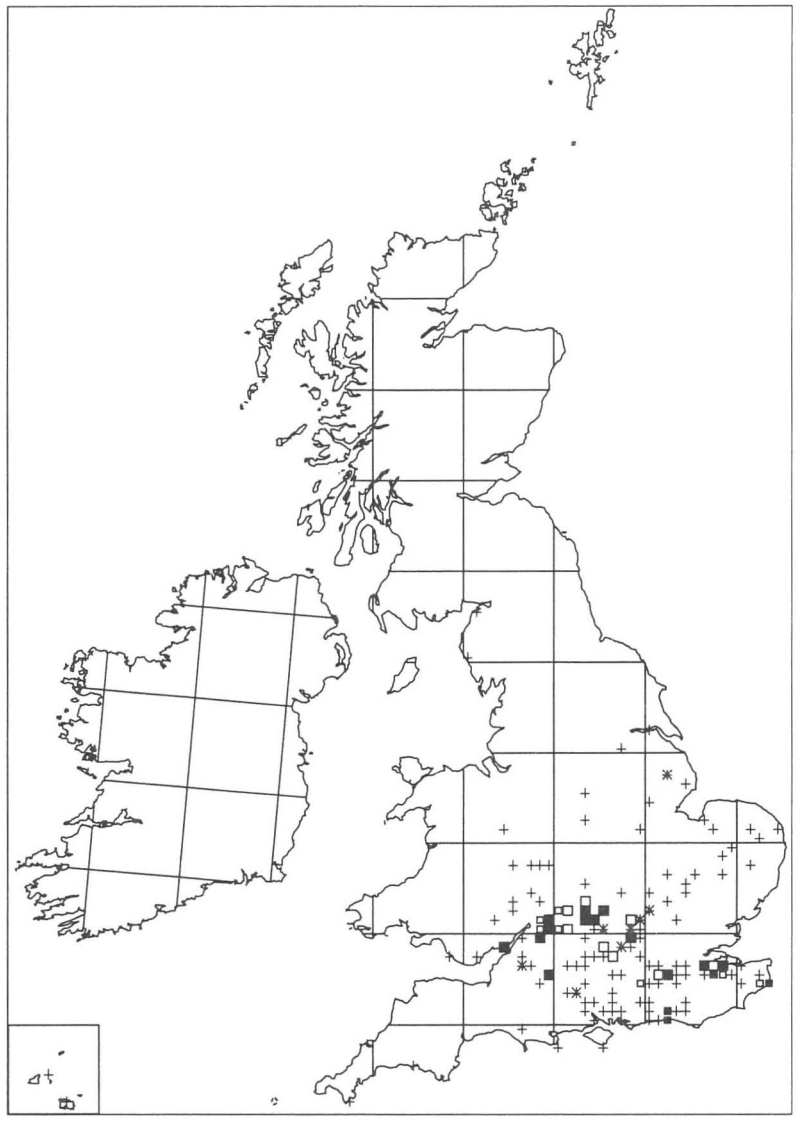

FIGURE 1. Distribution of *Salvia pratensis* L. in Britain. ■ Native 1990 onwards; □ native, pre-1990; ▪ possibly native, 1990 onwards; ▫ possibly native, pre-1990; ✳ introduced, 1990 onwards; + introduced, pre-1990.

POPULATION SIZES

At a national scale *S. pratensis* has been recorded as native or probably native in 17 hectads since 1990, and in another 15 prior to 1990. It has been recorded as an introduction in nine hectads since 1990. The plant should now thus be regarded as a Nationally Scarce species (cf. Stewart *et al.* 1994). Most of the loss of native sites appears to have taken place prior to 1950, and there is little evidence of significant decline in recent years; it is hoped that its statutory protection coupled with conservation work summarised below will prevent further losses.

Populations were counted at each site at least once between 1994 and 1996; the maximum counts are shown in Table 1. Populations were usually counted by walking around sites, but at one large

TABLE 1. MAXIMUM POPULATION COUNTS FOR NATIVE *SALVIA PRATENSIS* L. SITES RECORDED AT LEAST ONCE BETWEEN 1994 AND 1996. SITES ARE ONLY LOCALISED TO COUNTIES

Site	Year	Population
Buckinghamshire 1	1996	1
Gloucestershire 1	1994	200
Gloucestershire 2	1994	3
Gloucestershire 3	1996	1
Kent 1	1994	20
Kent 2	1996	c. 13
Monmouthshire 1	1994	3
Oxfordshire 1	1994	4000–5000
Oxfordshire 2	1994	408
Oxfordshire 3	1995	43
Oxfordshire 4	1994	8
Oxfordshire 5	1995	1270
Oxfordshire 6	1996	20
Oxfordshire 7	1995	19
Oxfordshire 8	1995	4
Oxfordshire 9	1995	358
Oxfordshire 10	1996	6
Oxfordshire 11	1996	211
Oxfordshire 12	1996	8
Oxfordshire 13	1996	20
Surrey 1	1996	11
Sussex 1	1994	200
Sussex 2	1995	1
Wiltshire 1	1994	1

site a more detailed systematic grid was used. In general each discrete clump was assumed to be one plant, but some clumps may have consisted of more than one individual. Counts included seedlings, vegetative and flowering plants.

The population sizes vary enormously from single plants to a few thousands. An unusual feature of *S. pratensis* is the survival of a single plant in one remote locality for long periods, perhaps for 30 years or more. There are about 7000 plants in 23 native sites (Table 1), and about 2000 introduced plants in Britain (Rich 1995).

An analysis of change in Oxfordshire indicates that 1994 populations are markedly below those of 1986–1988 censused by the Nature Conservancy Council (Everett 1987), though no sites have been lost (C. R. Lambrick in Rich 1995). The same appears to be true for some of the other populations elsewhere, indicating longer term climatic conditions may be important in regulating population sizes. It is likely that the management of sites is also critical.

Ouborg & Van Treuren (1995) examined the relationship between population size and fitness in *S. pratensis* in the Netherlands. In theory small populations would be expected to have lower fitness than large populations as higher levels of genetic drift and inbreeding would occur leading to a reduced viability and fecundity of the population. To test the theory, they cultivated plants from two large and two small Netherlands populations under similar conditions, and measured various components of seed size, germination, growth and reproduction. Contrary to the predictions, they found no evidence for reduced fitness in small populations, nor was there any evidence in the small populations for genetic erosion of fitness. It is possible that the small populations were at an early stage of genetic erosion where the allozyme diversity was low but the quantitative genetic variation underlying the fitness traits had not (yet) been affected. Applying these results to British populations, it may mean that even the small ones are viable in genetic terms. The evidence at the moment suggests that environmental or stochastic processes have more significant effects on populations than genetic processes.

ECOLOGY

The population biology and ecology of *S. pratensis* in Oxfordshire, and at a few sites in Gloucestershire and Hampshire was described in detail by Scott (1989), from which the account below has largely been taken, with additional data from other sites (Rich 1995; Rich & McNab 1996).

S. pratensis is a long-lived, polycarpic, perennial. Plants are relatively compact in growth form even when growing at high density (up to 50 plants per m^2) and may be distinguished from one another by distinctive morphological characteristics which include the sex, length and colour of flowers.

The peak flowering period is from late May to early July; Scott (1989) found 32–94% of the plants flowered on unmanaged sites. It is gynodioecious and self-compatible, though insects are required for within-flower selfing. Populations contain 1–9% of male-sterile plants and their frequency increases under intense shade or after damage from herbicides. Male-sterile plants have aborted stamens and smaller flowers than hermaphrodites. Flowers were visited by five species of pollinating bumblebees, and by pollen beetles, robber bumblebees and two species of butterflies.

Scott (1989) found that seed-set exceeded 90% on most sites, but was slightly reduced where all plants were robbed (84%) or when fewer pollinators were available in mid-August (83%). Late flowering male-sterile plants set 67–74% of seed suggesting that even hermaphrodites are substantially out-crossed. Seed took one month to ripen and was released from mid-July onwards. Laboratory experiments showed that 72% germinate immediately after wetting in daylight or darkness, though after-ripened seed is less viable. Seed can germinate after at least one year of dormancy in the soil seed bank.

Seedlings successfully establish where disturbance and stress generate gaps in the sward, exposing bare, uncompacted mineral soil. Short swards maintained by rabbit grazing provide very favourable conditions for seedling establishment and it is in these areas that the density of seedlings and mature plants is highest. Suitable niches for seedling establishment include worm casts, old ant hills, small mammal runs and rabbit scrapes. Establishment is generally unsuccessful in tall undisturbed grassland where more than 1 cm of moss or leaf litter accumulates under vigorous species such as *Brachypodium pinnatum* and scrub. Reproduction is also unsuccessful where plants are mown or intensively grazed by stock while flowering, as their inflorescences are destroyed (Scott 1989).

Many populations occur on flat to steeply sloping sites facing south or west, which provide a warm, sunny microclimate. They generally grow on shallow, calcareous soils overlying oolitic limestone or chalk, but may also occur (and persist) on mesotrophic, freely-drained soils. Plants have deep roots which extend into the C horizon of the soil.

S. pratensis occurs in hay meadows, grazed pastures, scrub and open woodland, and on banks, verges and tracks. It has been recorded in a range of communities of the National Vegetation Classification (Rodwell *et al.* 1991 *et seq.*). It mainly occurs in unimproved species-rich calcicolous grasslands (CG2 *Festuca ovina – Avenula pratensis* grassland, CG3 *Bromus erectus* grasslands, CG4 *Brachypodium pinnatum* grassland, CG5 *Bromus erectus – Brachypodium pinnatum* grassland) but surprisingly also occurs and persists in mesotrophic grasslands (MG1 *Arrhenatherum elatius* coarse grassland, MG7 *Lolium perenne* leys). Scrub or woodland edge communities in which it occurs are usually W21 *Crataegus monogyna – Hedera helix* scrub.

Sheep and cattle at a high stocking density graze off all inflorescences and defoliate plants. In Oxfordshire, plants grazed in late June fail to flower later in the year, but 13% of flowering plants cut during hay making in mid-June flowered again in mid-August (Scott 1989). It appears that roe and muntjac deer browse inflorescences while rabbits ignore *S. pratensis* entirely. On some sites significant damage was caused by sawfly larvae and small mammals to flowers and unripe seed respectively. The plant is also grazed by slugs and snails, which may cause significant mortality in damp situations. Dormant basal buds on the rootstock develop rapidly if the main axis is damaged by grazing or cutting, and as part of the seasonal growth-cycle from July onwards.

CONSERVATION MANAGEMENT

S. pratensis survives for long periods under various management regimes. Sites may be neglected or unmanaged, mown irregularly (e.g. road verges) or annually (e.g. hayfields), or grazed by rabbits or stock. In general, the plants seem to grow best and increase where the sites are winter-grazed with plants protected during flowering. Unfortunately this regime is not practicable for many sites such as road verges.

Scott (1989) has drawn up a series of recommendations to maintain and encourage the expansion of populations in existing sites; disturbance is required to maintain an open grassland sward, prevent plant litter and moss accumulating, and control the spread of invasive species. For site-specific conditions, the following management regimes were recommended:

1. Unmanaged sites should have a grazing or cutting regime introduced.

2. Mown sites should be cut in late July (early August) and the cuttings raked off. Soil scarification may also be required.

3. Sheep grazed sites should be grazed until early May, and then again from late July (early August) onwards. Grazing with cattle may be possible all year provided the stocking density is not too high. Plants can be protected by small enclosures during the summer if necessary. Every 4–5 years, the sites can be summer grazed.

These recommendations are being applied in various sites under the Species Action Plan and the results will be documented in due course. In addition, scrub clearance has been carried out at four shaded sites which has resulted in improved flowering performance. Soil disturbance has also been carried out at three sites but as yet has failed to produce more plants from the seed bank. At one site a single female plant has been cross-pollinated with another plant of known origin from another site.

Reinforcement of populations is being carried out at two sites with stochastically-threatened populations to increase the populations to this size.

Seed has been collected under licence from English Nature from six sites and deposited at the Seed Bank at the Royal Botanic Gardens, Wakehurst Place; further collections are planned.

ACKNOWLEDGMENTS

The work has been funded by English Nature's Species Recovery Programme, the Sir James Colyer-Fergusson Charitable Trust and Plantlife.

We would like to thank the Rare Plants Group of the Ashmolean Natural History Society of Oxfordshire, the National Trust, John Alder, Penny Angold, Bob Brocklehirst, Jack Chapman, Helen Coyte, Reg Crossley, Jo Dunn, Sue Erskine, Trevor Evans, Lynne Farrell, Richard Fitter, Ro Fitzgerald, Pel Fursdon, Gerald Gardiner, Joan Garlick, Beatrice Gillham, Paul Harmes, Graham Hart, Katherine Hearn, Derek Hill, Nick Hinson, Carol Hora, George Hutchinson, Ann Hutchison, Quentin Kay, Mark and Clare Kitchen, John Knight, Mark Knight, Brian Laney, David Lankester, Colin Lee, Andy McVeigh, Roger Mitchell, Elizabeth Norman, Tom Olliver, Richard Palmer, Alison Paul, Roy Perry, Eric Philp, Jack Pile, Joyce Pitt, Ron Porley, Andrew Proudfoot, Graham Roberts, Andy Scott, Alan Showler, Brian Starkey, Roddy Stevens, Peter Sturgess, Joe Trinder, Cathy Warden, Lindi Wilkinson, Phil Williams and Derek Wise for their help.

We also thank the keepers of the Natural History Museum (**BM**), Bristol City Museum (**BRISTM**), Cambridge (**CGE**), Kew (**K**), Liverpool Museum (**LIV**), Maidstone Museum (**MNE**), National Museum and Gallery of Wales (**NMW**) and Oxford (**OXF**) for access to herbaria and libraries. The map was plotted using DMAP.

REFERENCES

DRUCE, G. C. (1932). *The comital flora of the British Isles.* T. Buncle & Co., Arbroath.

EVERETT, S. (1987). *Rare plant survey of South Region.* Confidential report to N.C.C., Peterborough.

KAY, Q. O. N. & JOHN, R. F. (1995). *The conservation of scarce and declining plant species in lowland Wales: population genetics, demographic ecology and recommendations for future conservation in 32 species of grassland and related habitats.* Countryside Council for Wales Science report no. 110. March 1995. Countryside Council for Wales, Bangor.

OUBORG, N. J. & VAN TREUREN, R. (1995). Variation in fitness-related characters among small and large populations of *Salvia pratensis*. *Journal of ecology* **83**: 369–380.

OUBORG, N. J., VAN TREUREN, R. & VAN DAMME, J. M. M. (1991). The significance of genetic erosion in the process of extinction. 2. Morphological variation and fitness components in populations of varying size of *Salvia pratensis* L. and *Scabiosa columbaria* L. *Oecologia* **86**: 359–367.

PERRING, F. H. & WALTERS, S. M., eds. (1990). *Atlas of the British flora*, 3rd ed. B.S.B.I., London.

RICH, T. C. G. (1995). *The status of meadow clary (*Salvia pratensis *L.) in Britain in 1994.* Back from the brink project report no. 44. Unpublished confidential report to Plantlife, London.

RICH, T. C. G., *et al.* (1997). *Meadow clary (*Salvia pratensis*) in 1996.* Back from the brink project report no. 76. Unpublished confidential report to Plantlife, London.

RICH, T. C. G. & MCNAB, C. (1996). *Meadow clary (*Salvia pratensis*) in 1995.* Back from the brink project report no. 72. Unpublished confidential report to Plantlife, London.

RIDDELSDELL, H. J. (1916). *Salvia pratensis* L. *Report of the Botanical & Exchange Club of the British Isles* **4**: 426–427.

RODWELL, J. S. *et al.*, eds. (1991 *et seq.*). *British plant communities.* Cambridge University Press, Cambridge.

SCOTT, A. (1989). *The ecology and conservation of meadow clary (*Salvia pratensis *L.).* M.Sc. thesis, University College, London.

STEWART, A., PEARMAN, D. A. & PRESTON, C. D. (1994). *Scarce plants in Britain.* J.N.C.C., Peterborough.

STURT, N. (1995). Wild clary (*Salvia verbenaca*) in churchyards. *B.S.B.I. news* **68**: 28–29.

VAN TREUREN, R., BIJLSMA, R., OUBORG, N. J. & VAN DELDEN, W. (1993). The effects of population size and plant density on outcrossing rates in locally endangered *Salvia pratensis*. *Evolution* **47**: 1094–1104.

VAN TREUREN, R., BIJLSMA, R. VAN DELDEN, W. & OUBORG, N. J. (1991). The significance of genetic erosion in the process of extinction. 1. Genetic differentiation in *Salvia pratensis* L. and *Scabiosa columbaria* L. in relation to population size. *Heredity* **66**: 181–189.

(*Accepted June 1998*)