JNCC Report
No. 308

The nature conservation value of scrub in Britain

SR Mortimer[*], AJ Turner[*], VK Brown[*], RJ Fuller[†], JEG Good[‡]
SA Bell[‡], PA Stevens[‡], D Norris[‡], N Bayfield[β], & LK Ward[+]

August 2000

This report should be cited as:
Mortimer, SR, Turner, AJ, Brown, VK, Fuller, RJ, Good, JEG, Bell, SA, Stevens, PA, Norris, D, Bayfield, N & Ward, LK 2000. The nature conservation value of scrub in Britain. *JNCC Report* No. 308.

For further information please contact:
Habitats Advice
Joint Nature Conservation Committee
Monkstone House, City Road, Peterborough
PE1 1JY, UK

ISSN 0963-8091

This report was produced as a result of a commission research contract for English Nature with contributions from Scottish Nature Heritage and the Countryside Council for Wales

* CABI Bioscience, Silwood Park, Ascot, Berks, SL5 7TA
† British Trust for Ornithology, The Nunnery, Thetford, Norfolk, IP24 2PU
‡ Centre for Ecology and Hydrology, Deinol Road, Bangor, Gwynedd, LL57 2UP
β Centre for Ecology and Hydrology, Hill of Brathens, Glassel, Banchory, Kincardineshire AB31 4BY
+ 53 Miles Avenue, Sandford, Wareham, Dorset, BH20 7AS

Contents

Executive summary

Rationale and approach

1. Scrub has received little attention from nature conservationists, resulting in insufficient knowledge of the distribution, ecology, management and conservation status of scrub in Britain. This information is needed to identify, conserve and enhance valuable scrub.
2. This report represents a synthesis of the existing knowledge of scrub ecology and conservation, and identifies priorities for future conservation and research. This information has been accessed through published and unpublished literature, questionnaires, an expert workshop, and through consultation with national and international experts.

Definition and classification

3. For the purposes of this report, scrub includes all stages from scattered bushes to closed canopy vegetation, dominated by locally native or non-native shrubs and tree saplings, usually less than 5m tall, occasionally with a few scattered trees. This includes carr, scrub in the uplands and lowlands (including wood edge habitats), montane scrub and coastal scrub. The definition excludes dwarf shrub heaths, planted stands of young trees and coppice stump regrowth less than 5m high.
4. Most scrub in Britain is seral, forming a stage in the transition from open herbaceous vegetation to woodland. In certain situations, scrub can be considered a climax vegetation type, for example where altitude, exposure or edaphic factors limit tree growth. Such communities can be found in the alpine and sub-alpine zones, on exposed coasts and on skeletal soils.
5. For seral scrub, problems of definition occur when separating scrub from herbaceous and woodland vegetation. For species which have ranges above the scale of an individual scrub stand, the intimate mix of scrub with woodland or herbaceous communities is an important habitat requirement.
6. Widely used classifications of scrub types depend on floristics, the identity of dominant woody species and soil characteristics. However, for describing the conservation value of scrub types for associated organisms, especially birds and invertebrates, classifications which take account of both horizontal and vertical structural complexity are needed.
7. The National Vegetation Classification describes five scrub types, although scrubby vegetation forms an important component of many other grassland, heath, mire woodland and coastal NVC communities.
8. In Britain, scrub vegetation comprises a significant component of six priority habitats types in the EU Habitats Directive, namely dune juniper thickets (*Juniperus* spp.), semi-natural dry grasslands and scrubland facies on calcareous substrates (Festuco-Brometalia) (important orchid sites), limestone pavements, Caledonian forest, bog woodland and residual alluvial forests (Alnion glutinosae-incanae).
9. Scrub vegetation comprises an important component of 11 Priority Habitats in the UK Biodiversity Action Plan, and a minor component of several others.

Distribution and conservation value

10. The available information on the distribution and abundance of scrub communities in Britain is inadequate.

11. Best estimates (from the ITE [CEH] Countryside Survey 1990) are that there is 900 ±200 km^2 (90,000 ±20,000 ha) of scrub in Britain. On a country basis this breaks down into: England 600 ±100 km^2; Scotland 200 ±50 km^2; Wales 100 ±50 km^2.

12. Scrub occurs widely within SSSIs but has rarely been taken into account when designating them. Hence it is not known to what extent the distribution and abundance of particular scrub types within SSSIs is representative.

13. Scrub is generally valued by managers of designated sites for its contribution to biodiversity.

14. In England and Wales scrub is generally (with the exception of juniper) valued primarily for the species it supports rather than in its own right. In Scotland scrub (mainly upland and montane) is more often valued for its own intrinsic value.

15. Scrub is known to be an important habitat for a wide range of higher plants, herbivorous insects and birds, including Red Data Book and BAP1 species.

16. Little is known about the value of scrub for lower plants, non-herbivorous invertebrates, reptiles and amphibians, and mammals although scrub is likely to be equally important for these groups.

17. Most British scrub communities are well represented elsewhere in Europe. However, hawthorn scrub is particularly characteristic of the English lowlands and of marginal uplands in England and Wales, while Scottish montane dwarf willow communities differ in detail from their Scandinavian counterparts, perhaps reflecting climatic differences.

Ecology

18. Scrub in Britain is almost entirely a product of man's activities. In primeval landscapes, scrub would have occurred in at least five situations and local examples can still be found. These situations are: in primary successions such as dunes, on exposed coasts, as high altitude montane scrub, as ecotones between woodland and open habitats, as natural regeneration within treefall gaps.

19. The majority of scrub results from secondary successions. In the lowlands, the breakdown of traditional grazing and cutting regimes on marginal land has been a major stimulant for scrub development. Large-scale expansion of scrub may occur in the uplands as a result of abandonment of hill farms and reduction of deer numbers.

20. The mechanisms driving the successional development of scrub are poorly understood. A range of mechanisms may operate simultaneously. Seed dispersal may be a critical factor in the rate of scrub development and in the structural mosaics that develop. Most scrub species are dispersed by birds and factors such as proximity to seed sources, availability of perches and quality of the receptor site for dispersers may be important.

21. Successional development of scrub involves increases in soil nutrients, organic matter, shifts in the composition of the ground flora and ultimately reduction in the seed bank. These changes are accompanied by continuous development in the structure of the scrub as a result of canopy-closure and increasing height of the woody vegetation. Structural

development of much upland birch and pine scrub appears to be less complex than in much lowland scrub.

22. For many taxa, shrub species composition is less important than microclimate, microhabitat structure or macrohabitat structure. However, examples of apparent dependencies on particular species are to be found among the lower plants and among phytophagous insects. The majority of phytophagous insects are specific to plant family and a substantial number are specific to plant genus.

23. Many invertebrates and birds are associated with specific vegetation structures. This results in large ongoing changes in insect and bird communities as a result of the massive structural changes that accompany scrub development in succession.

24. Scrub often exists as a mosaic with grassland and other open vegetation. Spatial patchiness is an extremely important habitat feature for many plants and animals. In the case of invertebrates, fine-scale mosaics of structure and plant composition provide a diversity of niches and a variety of food and shelter. Edges are particularly important and intimate mixtures of grass, scrub and woodland may be advantageous to many insects. Similar structural patchiness can result in very rich bird communities. The maintenance of such mosaics is a difficult management challenge.

Management

25. There is often insufficient clarity in setting objectives for scrub management due to imprecise definitions of its role.

26. Scrub is often felt to be both beneficial and a nuisance on the same site, especially in the English lowlands where invasion of species-rich grassland is a very common problem. However, the proportion of scrub which is considered to be a nuisance is generally small (<25%). Juniper and hazel scrub are always welcome.

27. Much management of scrub in lowland England aims to develop and maintain mosaics of scrub and grassland, which are believed to favour the widest range of flora and fauna. Scrub is generally less welcome on wet habitats in the lowlands where it may adversely affect site hydrology. It is also often unwelcome in coastal areas where it invades maritime grasslands and dwarf shrub heath of international importance. Sea buckthorn, although having appreciable conservation value in its own right, is generally regarded as a pest species in sand dune systems.

28. Scrub is generally reviled by archaeologists and geologists who consider it a nuisance where it damages or obscures features of interest.

29. Scrub is rarely considered to be a nuisance in the uplands and in Scotland there is a major programme for the protection and enhancement of montane scrub communities.

30. A very wide range of techniques is used for scrub management and control, with very varying success. These techniques are mostly based on cutting with or without stump treatment followed by grazing or mowing. Practitioners urgently seek improved information on which techniques are appropriate where and when and how they should be carried out.

31. *Rhododendron ponticum* is by far the most serious invading exotic scrub species throughout Britain accounting for 44% of all cases mentioned by survey correspondents. Very large amounts of money are spent annually on Rhododendron control and eradication programmes.

The nature conservation value of scrub in Britain

32. Clearance of scrub is widely funded in lowland England, where scrub is widespread and frequently encroaches onto habitats perceived to be more valuable. In upland England and Wales, scrub is less common, and grants are available for both conservation management and clearance. Scotland contains a low proportion of the British scrub resource, but many of the uncommon habitat types of high conservation value. As a consequence, only management to conserve and enhance scrub is funded.

33. None of the schemes reviewed differentiate between scrub of high conservation value and other types of less valuable scrub when funding clearance.

34. Neither Countryside Stewardship nor Environmentally Sensitive Area schemes in England fund annual management to conserve or enhance scrub.

35. Land management grants to promote conservation and enhancement of wet scrub (willow and alder carr) are available in only a few regions of Britain.

Recommendations

Classification

36. The nature conservation value of scrub is generally related to its structure, including elements of both vertical canopy structure and horizontal spatial structure in relation to other habitats. The National Vegetation Classification, being based on floristic inventory of homogenous stands, is therefore inadequate for ascribing conservation value to scrub stands.

37. There is a need for a structural classification of scrub that is ecologically meaningful in terms of the requirements of scrub-associated organisms, especially invertebrates and birds. This classification must take account of spatial structure (mosaics / patchiness), scrub height and foliage profiles.

Distribution

38. In order to assess the absolute and relative importance of scrub to nature conservation, whether regionally, nationally or within Europe, there is a need for better information on the distribution and extent of the major scrub types.

39. Treatment of scrub within land cover surveys adopted by various agencies varies considerably. Much information on national distributions is potentially available within the ITE Countryside Survey 1990 and Countryside Survey 2000 datasets but it is currently in aggregated form under the main category 'Shrub'. Dis-aggregation of these data would provide information at the required level of detail.

Conservation status

40. Certain rare scrub types (e.g. juniper scrub) or scrub composed of rare shrub species (e.g. *Salix lanata*) have Habitat or Species Action Plans within the UK Biodiversity Action Plan. No changes to the definitions of broad or priority habitats are considered necessary. However, the conservation value of scrub as a structural component of many priority habitats needs to be fully acknowledged in relevant Habitat Action Plans.

41. An assessment is needed of the extent to which scrub within SACs and SSSIs is representative of the wider resource and to decide whether further designations are required to cover under-represented scrub communities.

42. Better information is needed on the status and management of scrub within existing SSSIs, including occurrence of scrub types, structural characteristics, associated species, conservation importance within the SSSI and management objectives.

43. An assessment is needed of the ecological contexts in which scrub should form a criterion for SSSI designation. In addition, citations for existing SSSIs and definitions of 'favourable condition' may need to be changed to take account of the nature conservation value of scrub.

44. Research is needed to determine for which species and under what circumstances scrub is a primary (or sole) habitat and when and where it is of secondary importance.

45. Characterisation of the unique attributes of British scrub types in relation to those of mainland Europe is essential in order to set conservation priorities within the UK. A meeting of key European specialists could provide a starting point for a European network on managing scrub vegetation for nature conservation.

Ecology

46. This review has identified the importance of mosaics of vegetation, of which scrub is an integral part, for several taxa. There is a need for research that identifies the optimum mosaic structures for ground flora, invertebrates and birds. This work needs to take account of the different scale requirements of these taxa and should take account of the importance of edges and glades within scrub.

47. The processes of scrub establishment and the development of patchiness within scrub are poorly understood. In particular, there is a need to examine more closely the role of birds in seed dispersal and how their behaviour influences the distribution and spatial structure of scrub.

48. A landscape approach to the importance of scrub for conservation needs to be developed. This could have two main components. First, an assessment of how the proximity of other habitats, especially woodland and grassland, affects the plant and animal communities found within scrub. Second, there is a need to determine the contribution that scrub makes to biodiversity within different landscape types relative to other habitats. The latter work would help to identify the extent to which species are dependent on scrub compared with other habitats and, therefore, clarify the complementarity of scrub and other habitats.

49. Research is needed on the successional dynamics of animal communities (especially invertebrates, birds and small mammals) within developing scrub. Such research should seek to identify which are the richest stages of successional development, both in terms of species richness and the presence of species of particular conservation interest. These data would be valuable in helping to underpin management policies that sought to maintain rich communities of animals within scrub habitats.

50. Carr has been remarkably little researched, especially concerning its animal communities and how these are influenced by factors such as successional stage and wetness. Further research in this area seems highly desirable in view of the current conservation interest in riparian woodland.

51. Very little is known about the mycorrhizal associations of scrub species and indeed, how these might benefit the rare communities. Manipulation may enhance the success of establishment or restoration of these communities, especially when soil conditions are not optimal.

Management

52. Carefully controlled experimental research is needed to determine the effectiveness of differing procedures for scrub management, including procedures for maintaining scrub as well as controlling it. This should take account of existing guidelines and the considerable amount of information contained within the responses to the questionnaire carried out as part of the current study.

53. In the context of scrub control, there is a need to identify whether critical thresholds of scrub development exist, beyond which scrub clearance is ineffective as a means of restoring habitats such as lowland calcareous grassland or fen.

54. Research is especially needed on appropriate management techniques for maintaining patchiness and mosaics. Rotational large-scale cutting of scrub is unlikely to be adequate for maintaining complex vegetation mosaics and approaches that adopt grazing or combinations of grazing and selective cutting are likely to be more successful.

55. A scrub management handbook should be developed outlining best practice for managing scrub, especially means of encouraging sustainable mosaics of scrub and other habitats.

Dissemination and Education

56. A major constraint on the conservation of scrub and its associated species is the widely-held opinion that scrub is of low conservation value and primarily a threat to other more valuable habitats. Methods of addressing this problem of perception need to be developed.

57. In particular, there is currently insufficient guidance concerning situations where scrub is valuable and in which contexts other conservation priorities take precedence. This problem is exacerbated by the linkages between the conservation value of scrub and its intimate association with other communities in habitat mosaics.

58. It would be highly desirable to establish a network of scrub demonstration sites where different approaches to difficult scrub management issues can be viewed and discussed with site managers.

Agri-Environmental Policy

59. In most situations, scrub is primarily considered as a threat to other habitats, and capital payments allocated for clearance. Funding for agri-environment schemes needs to take account of both the efficacy of scrub clearance for restoring species-rich herbaceous communities such as chalk grassland, and the intrinsic nature conservation value of scrub or habitat mosaics including scrub.

60. The introduction of annual management payments to conserve and enhance scrub of high conservation value in England (as opposed to one-off capital payments for clearance) would benefit scrub conservation, and bring the English agri-environment schemes into line with those in Wales and Scotland.

61. Little attention is paid to the roles of landscape processes when funding scrub management, despite the likely impact of the surrounding landscape on the value of individual habitat patches. A consideration of the large-scale spatial processes should be taken into account when allocating funding for scrub management. This approach relies

on scrub of high conservation value being identified in funding applications, something that is currently not addressed.

Landscape Policy

62. Conservation of seral scrub can only be achieved on a large spatial scale, allowing management producing mosaics of scrub at different successional stages.

63. Wherever appropriate, scrub should be encouraged as part of natural vegetation dynamics. For example, in the Scottish Highlands there may be increasing opportunities to regenerate natural woodland cover in which scrub is present not just in the initial establishment phase but also in the longer term as a natural component of the forest dynamics following disturbance by windblow or fire.

64. A more positive approach to scrub habitats is required in the uplands of England and Wales to match that adopted in Scotland. For example, it might be interesting to consider how treeline scrub communities might be enhanced in Snowdonia and the Lake District; how scrub communities might play an important role in 'wild-wood' developed on former conifer forest sites; how upland hawthorn scrub might be regenerated and extended under agri-environment schemes; how willow scrub might be used to enhance and link wet woodland habitats.

65. Landscape policies that promote the large-scale expansion of scrub on lowland flood plains would contribute significantly to the conservation of residual alluvial forest (a priority habitat in the Habitats Directive) and delivery of the Habitat Action Plan for wet woodland.

66. Scrub and associated wet woodland communities frequently develop on abandoned mineral extraction sites. Promoting the nature conservation value of such sites amongst mineral planning officers would provide opportunities for expansion of these habitats and their appropriate management.

67. Within the context of agricultural land, abandonment may provide opportunities for the creation of scrub habitats. Issues of negative perceptions of the value of scrub amongst landowners need to be addressed.

68. The use of scrub buffer strips adjacent to new farm woodlands would contribute significantly to the nature conservation value of such plantations.

69. The nature conservation value of scrub, and of mosaics of scrub, woodland and herbaceous communities, needs to be recognised in the planning of new lowland woods and national forests.

1 Approach

1.1 Rationale and scope

1.1.1 Rationale

Scrub as a habitat has received little attention from British nature conservationists. The Nature Conservation Review (Ratcliffe 1977) contains a section on calcareous scrub and refers, in passing, to scrub on heathland, and to upland and montane scrub. The guidelines for selection of biological SSSIs briefly mention scrub in the sections on woodland, grassland, heathland, fen, uplands, birds and butterflies, but scrub is not dealt with as a habitat in its own right. Few SSSIs have been designated for their scrub interest. The UK Biodiversity Action Plan neglects scrub almost completely as a habitat (only woolly willow *Salix lanata* and juniper *Juniperus communis* have Species Action Plans). It is more normal in conservation circles for scrub, especially on calcareous grassland and lowland heathland, to be seen as a problem that must be managed, typically by clearance.

The situation is different on the continent, where scrub and its related ecotones are more valued. Several habitats occurring in Britain are listed in Annex I of the EU Habitats and Species Directive. Scrub is recognised to have considerable nature conservation value, both in its own right and as a habitat for flora and fauna. This is as true of the edge habitats as of sites with habitat mosaics of woodland and heathland or grassland.

Many priority species in the UK Biodiversity Action Plan depend on scrub. In a recent analysis, around 10% of the 460 terrestrial BAP Priority Species were considered to be associated with scrub habitats. It is likely that the actual figure is higher than this, as the needs of many of the species are not known in detail.

Several Species Action Plans refer to species' needs for scrub, including the bullfinch, linnet, turtle dove and red-backed shrike. Other Priority Species, for which SAPs have yet to be published, which require scrub include black grouse, *Cryptocephalus coryli* (a leaf beetle), the banded mining bee *Andiron gravida*, lunar yellow underwing *Noctua orbona* and white-lined snout *Schrankia taenialis*.

Scrub is an integral part of grassland and heathland Priority Habitats. The lowland calcareous grassland Habitat Action Plan notes the contribution to local biodiversity of the grassland-scrub interface by providing shelter for invertebrates and edge conditions suitable for species such as bloody cranesbill *Geranium sanguinium*. As a part of a mosaic, scrub contributes to the nature conservation importance of several sites notified for their woodland interest, e.g. several SSSIs in the Peak District notified for their woodland or grassland interest.

In this review we show that scrub is an under-researched and undervalued resource that requires immediate action to identify and enhance its conservation value.

1.1.2 Objectives

The objectives of the work were as follows:

- to produce a report assessing current knowledge of scrub classification, distribution, ecology, management and conservation status in Britain,
- to determine priorities for scrub conservation and recommendations for future research.

1.1.3 Scope

The following areas were identified for inclusion in the review:

Definition:

- Definition of scrub.
- Overview and description of different types of scrub found in Britain.
- Floristics, structure, classification of scrub for conservation purposes.
- Current classifications and their limitations.

Context:

- Distribution and abundance of scrub types in Britain.
- Current protection, and coverage of scrub and scrub species by national and international conventions and directives.
- The value of scrub for species of importance to nature conservation.
- Consideration of the characteristics of the British resource in relation to European habitats.

Ecology:

- Scrub dynamics.
- Successional relationships, seral and climax scrub.
- Identification of valuable scrub.
- Mycorrhizal associations with scrub species.
- Ecological linkages between habitats and species of conservation interest.

Management:

- Review of current scrub management guidelines including practical techniques, and identification methods for improving the scrub habitat for BAP species and others of importance for nature conservation.
- Stock management.
- Review of agri-environment scheme prescriptions.

Recommendations:

- What basic research/survey is needed.
- What changes in policy are needed.
- What additions to nature conservation schedules, directives etc might be needed.

The report generally follows the structure defined by the five broad areas given above.

1.2 Sources of information

Information from a range of sources was used during the compilation of this review. Some of the most useful information was gathered from unpublished sources, via questionnaires and discussions at an expert workshop.

1.2.1 Literature and data

Published literature on scrub was identified using electronic databases (e.g. CAB Abstracts, BIDS) and existing reviews. Information was sourced to international journals, specialist publications and published reports. Specialist libraries (e.g. English Nature regional office libraries) were used to identify and access unpublished reports held by English Nature (EN), Scottish Natural Heritage (SNH) and Countryside Council for Wales (CCW).

Data on the distribution of scrub on all Sites of Special Scientific Interest in England, Scotland and Wales where scrub is a feature were extracted from databases held by EN, SNH and CCW respectively. These data were used to produce scrub distribution maps (Chapter 3). The maps for Scotland and Wales have a quantitative element, showing the area of scrub on each SSSI, in addition to information on distribution.

The Countryside Information System, which predicts the occurrence of scrub in 1km squares based on its occurrence in similar squares, was accessed to produce maps of the general pattern of distribution of scrub in Britain as a whole (Chapter 3).

Information on grant aid for scrub conservation was accessed through agri-environment scheme literature available from the Ministry of Agriculture, Fisheries and Food, the Forestry Commission, and through discussions with EN, CCW and SNH.

1.2.2 Consultation

Many British and European specialists were consulted both formally and informally during this project. A draft version of the review was widely circulated to staff working on scrub-related issues for EN, SNH and CCW. The comments received were invaluable in shaping this final report.

1.2.3 Surveys of land managers, specialists and advisors

Two questionnaires were used to survey the opinions of professionals involved in scrub conservation and management in Britain. The first questionnaire was targeted at land managers and other conservation practitioners, and aimed to assess attitudes towards scrub and the management techniques employed to maintain, control or remove scrub (Chapter 5). The questionnaire was distributed throughout England, Scotland and Wales to people with responsibility for land management. Analysis of responses gives a clear picture of the guidance needed by land managers to maximise the conservation benefits of work carried out on scrub. There is an inevitable bias in responses towards factors relevant to management of lowland, seral scrub, because this widespread habitat is the type of scrub that conservation land managers most frequently encounter.

The second questionnaire was used to identify strengths and weaknesses in agri-environmental policies relevant to scrub conservation in Britain, and was targeted at individuals involved in providing advice or awarding grants at a county or regional level (Chapter 6). Sixty seven individuals responded (more than half of the recipients), providing valuable insights into the uses and drawbacks of schemes funding scrub management. Although questionnaires were sent to many individuals throughout Britain, the majority of respondents were based in England, and had most experience of lowland, seral scrub. This reflects the greater density of conservation professionals working in England, and to some extent the recent changes in agri-environment regulations in Wales.

1.2.4 Survey of GIS professionals

The lack of availability and accessibility of data on the distribution and extent of different scrub types was raised several times at the expert workshop and on questionnaire returns. The use of Geographical Information Systems (GIS) for scrub conservation was investigated in a study area where information on scrub distribution was known to be available on GIS.

All organisations within the Chilterns Area of Outstanding Natural Beauty (AONB) using a GIS were contacted, and completed a telephone questionnaire (Chapter 3). Individuals were asked about their current and anticipated use of GIS to store, manipulate and analyse information on scrub.

1.2.5 Expert workshop

An expert workshop was held in Peterborough on 5th November 1999 to survey the opinion of 'key players' involved in scrub conservation in Britain (Appendix 1.1). Discussions focussed on scrub classification, management and research, and on the implications of existing policy for scrub conservation. The ideas discussed have been integrated throughout the text of this review, and form the core of the recommendations proposed in Chapter 6.

1.2.6 Synthesis

All information gathered during the writing of this report was assessed and emerging patterns identified during the final stages of this contract. Many key points relevant to scrub conservation were repeatedly raised through different channels. For example, the need for a single handbook guiding managers on best practice for scrub management was identified by responses to both the land management and the policy questionnaires, and highlighted during several sessions of the expert workshop. Research needs and constraints to successful management were derived from a combination of the above sources (literature, questionnaires, workshop) and prioritised in Chapter 6 (Recommendations).

2 Definition and classification

2.1 Definition of scrub

The nature of scrub communities in the Britain has led to difficulties in defining the limits of what is meant by 'scrub'. Many scrub communities in the Britain can be considered as seral stages in the succession from herbaceous communities to woodland. Scrub may occur as part of primary successions on screes, cliffs and quarries, but is more widely encountered as part of secondary succession after the abandonment of arable land or the relaxation or cessation of grazing on grassland or heathland. In places, succession of scrub to woodland may be arrested, for example as a result of exposure or altitude, or in places where seeds of tree species are absent or scarce.

A robust definition of scrub therefore has to include not only characteristics of the scrub vegetation itself, but also thresholds that separate it from preceding herbaceous communities and the woodland that may develop from it.

2.1.1 Scrub characteristics

Most definitions of scrub describe it as vegetation dominated by shrubs or bushes (e.g. Tansley 1939). However, the distinction between shrubs and trees is somewhat arbitrary. The height and growth form of woody species is commonly used to separate shrubs from trees. The definition of scrub given by Barkmann (1990) is therefore typical:

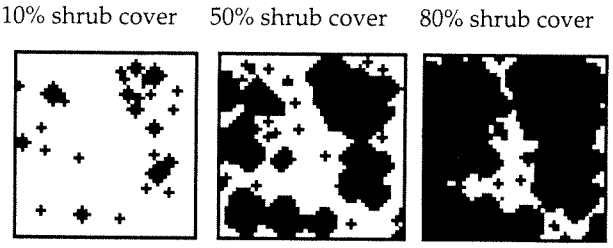
'vegetation 0.5 – 5 (-10) m high,
consisting of woody plants with many stems.'

However, such a definition would include the early stages of regrowth after coppicing in established woodland, a vegetation type probably better considered with other woodland vegetation. The low, dense, stiff branching growth form of living shrubs is noted in some definitions, although height is more widely used to separate shrubs from trees. Separation of woody species (phanerophytes) using Raunkiaer's life form classification has been suggested (Tansley 1939). Such an approach also has its limitations. Some species, best considered as small trees, are classified with many shrubs as microphanerophytes (buds held at 2-8m above the ground), whilst several species of dwarf shrub are classified as nanophanerophytes (buds at 0.25-2m), but would not be considered as scrub species (e.g. petty whin *Genista anglica*, western gorse *Ulex gallii*).

2.1.2 Distinction from herbaceous communities

Most definitions of scrub limit it to stands 'dominated' by shrub species. Accordingly, Ward (1974) defines scrub as 'extending from the stage at which the area covered by woody plants exceeds that covered by grassland'. Similarly, many land cover classifications use a threshold of 50% canopy cover by shrub species (e.g. ITE Countryside Survey, National Countryside Monitoring Scheme, Northern Ireland Countryside Survey), although some schemes use lower thresholds. An example is the monitoring scheme used for Environmentally Sensitive Areas (ESAs) which uses three categories of scrub, scattered scrub with grassland dominant (shrub cover 10-50%), scattered scrub with scrub dominant (shrub cover 50-80%) and dense scrub (shrub cover 80-100%) (Wyatt *et al.* 1994).

Figure 2.1 Illustrative 0.25 ha stands showing threshold levels of shrub cover used in the ESA Monitoring Scheme definition of scrub types.



2.1.3 Distinction from woodland

The distinction between scrub and woodland vegetation is less clear. Most schemes use the criteria of canopy height and/or the canopy cover of tree species. Thus, Ward (1974) defined the upper limit of scrub as the point 'when woody plants exceed 7 m in height and are composed mainly of tree species'. Current land cover classifications used in the UK differ in their means of distinguishing between scrub and woodland. These differences relate to survey methods adopted.

- ITE Countryside Survey (field survey)
  Stands greater than 5 m high are classified as woodland if >25% cover by tree species.
- National Countryside Monitoring Scheme (air photo)
  Stands greater than 5 m tall are classified as woodland if >50% cover by tree species.
- National Parks Monitoring Scheme (air photo)
  Scrub has <20% tree cover, tree species less than 3.5 m high, scrub species may be higher.

2.1.4 Definition adopted in this report

For the purposes of this report, scrub includes all stages from scattered bushes to closed canopy vegetation, dominated by locally native or non-native shrubs and tree saplings, usually less than 5 m tall, occasionally with a few scattered trees. This includes carr, scrub in the uplands and lowlands (including wood edge habitats), montane scrub and coastal scrub.

The definition excludes dwarf shrub heaths (dominated by ericaceous shrubs, crowberry *Empetrum nigrum*, dwarf gorse *Ulex minor*, etc.), planted stands of young trees and coppice stump regrowth less than 5m high.

2.2 Classification of scrub

2.2.1 Criteria for classifying scrub

2.2.1.1 Floristics

The most widely used schemes for the description of European vegetation use floristics as a means of classifying stands. Procedures for classifying vegetation developed by Braun-Blanquet and Tuxen, known as the Zurich-Montpellier School, have been widely used in continental Europe and Ireland since the 1920s. These methods place vegetation units in a hierarchical system of associations, alliances, orders and classes. Character species are identified for each level, based on their ecological amplitude and fidelity to particular units. The large amount of data collected from across Europe using such methods is currently being standardised into a single scheme, the European Vegetation Survey (Mucina 1997).

Such phytosociological techniques were not widely adopted in the UK, ecologists tending to focus on the mechanisms determining vegetation composition rather than extensive description and inventory. The value of setting ecological studies into their appropriate context was recognised in the surveys of Scottish mountain vegetation in the 1950s. This factor, combined with the need for a standard system of classification of the British vegetation in order to select sites for nature conservation, led to the National Vegetation Classification (NVC), commissioned by the Nature Conservancy Council in the 1970s.

2.2.1.2 Dominant canopy species

Prior to publication of the NVC, and in the absence of a systematic classification of vegetation within the UK based on floristics, scrub types were defined on the basis of the dominant canopy shrub species (e.g. Ward 1974, Ratcliffe 1977). This means of distinguishing scrub types is still widely used by site managers for management plans. The CORINE Biotopes Project Habitat Classification (Anon 1991) also describes several scrub types according to dominant shrub species.

2.2.1.3 Physiognomy

Classifications of scrub type that rely on differences in canopy structure and texture (e.g. Barkmann 1990) have several advantages over schemes using floristics. Scrub stands can be classified without the need for extensive inventory of plant species. In addition, the use of hierarchical schemes based on floristics for the classification of species-poor scrub, such as thickets dominated by one shrub species, is impossible because of the absence of potential character species. Perhaps more importantly, structural schemes may be more appropriate for describing the value of different scrub types for animals, as they better describe the micro-environmental conditions within the scrub stand for example, microclimate or the presence of particular plant structures. Such factors, rather than the presence of particular plant species, are likely to be more important determinants of the distribution of bird and invertebrate communities in scrub.

2.2.1.4 Successional status and age structure

Scrub occurs as a climax community in Britain above the altitudinal limit of woodland vegetation or in other situations where exposure or edaphic conditions limit tree growth. In the subalpine zone, shrubs and stunted trees occur together forming a scrub woodland at the tree line. At higher altitudes, in the alpine zone, low scrub vegetation composed of dwarf and prostrate shrubs occurs (MacKenzie 1997). In exposed situations, such as on cliff tops, trees may never grow beyond the scrub canopy and persist as stunted individuals because of the exposed conditions. Similarly, scrub communities may be maintained by edaphic conditions, for example on shallow soils associated with inland rock exposures.

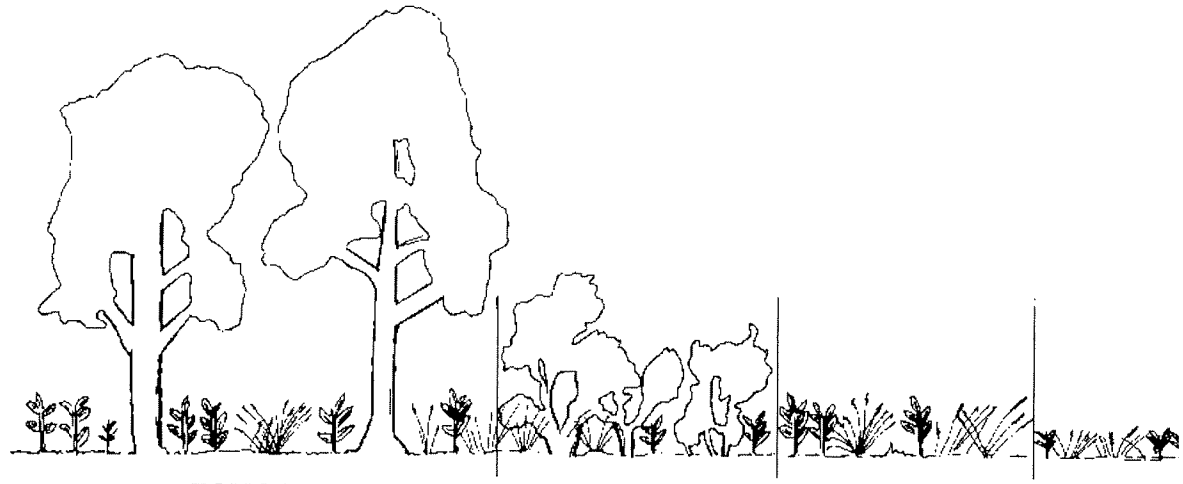
In spite of the occurrence of climax scrub in certain situations, most scrub in Britain is seral. Tansley (1939) used the term 'woodland scrub' to describe dynamic seral stages in the succession of herbaceous communities to woodland. Several factors may limit the development of 'seral' scrub towards woodland, for example, heavy grazing or a paucity of sources of seed of tree species in the vicinity. Such scrub stands are described as 'thicket scrub' by Tansley (1939), and are often found on abandoned arable land In places, grazing may even reverse the course of succession and promote the development of scrub and eventually grassland communities. Moss (1913) describes such 'retrogressive scrub' stands in the Peak District.

2.2.1.5 Vertical canopy structure

Related to the age structure of scrub is its vertical canopy structure. This characteristic is of particular importance at the edge of scrub stands. For example, nightingales *Luscinia megarhynchos* benefit from the low sucker growth found at the edge of blackthorn *Prunus spinosa* scrub (Fuller *et al.* 1999). Much of the botanical value of seral scrub habitats is associated with the tall herb vegetation occurring along the edges, the so-called 'saum' vegetation (see Figure 2.2 for definition). Management regimes often result in sharp boundaries between scrub and herbaceous vegetation, either as a result of stock fencing or where stands of scrub have been cleared. The shrub-dominated 'mantel' vegetation (Figure 2.2) may be absent from woodland edges for similar reasons. Where such sharp boundaries occur, the characteristic 'saum' and 'mantel' communities, which have high conservation value, are missing.

2.2.1.6 Horizontal spatial structure

The nature conservation value of many scrub types is derived from their occurrence in a mosaic of other vegetation types. Therefore, stands may be classified according to their spatial arrangement in relation to other habitats. This may consist of two elements, quantification of scrub cover, and description of spatial arrangement. Several land cover classifications define categories of scrub cover in relation to a backgound mosaic of herbaceous vegetation. For example, the ESA monitoring scheme defines categories of scattered scrub according to the percentage cover of grassland (see Figure 2.1). Scrub patches may be distributed randomly within herbaceous vegetation, or exhibit clumping as a result of vegetative spread (e.g. dogwood *Cornus sanguinea*) or local deposition of seeds in bird droppings below roost trees. Linear bands of scrub occur along ecotone boundaries, for example between grassland and woodland, or along the drier margins of swamps.



ZONE A
Woodland lacking grassland plant species.

ZONE B
'Mantel' zone of shrubs, many of the Rose (Rosaceae) family. Ground flora consists of woodland and 'Saum' plant species unless grazed where grassland species would predominate.

ZONE C
'Saum' zone dominated by tall herbs and grasses including rare species. Many typical grassland plants occur as unusual large forms.

ZONE D
'True' grassland in which low-growing species are more abundant.

Figure 2.2 The woodland-grassland ecotone, showing characteristics of the 'saum' and 'mantel' zones (reproduced from Crofts & Jefferson 1999 with permission of English Nature & The Wildlife Trusts).

2.2.2 Current classifications and their limitations

2.2.2.1 *Floristic and related classifications*

Until the publication of the National Vegetation Classification, there had been no systematic description of the variation in scrub vegetation present in Britain. Classifications based on botanical composition had been developed for Scottish mountain vegetation (Poore & McVean 1957, McVean & Ratcliffe 1962). In the lowlands, scrub types had been defined according to soil type and the dominant species of tree and shrub (Ward 1974, Ratcliffe 1977). Peterken (1981), in his classification of British woodland types, described several types of seral scrub. The emphasis in Peterken's classification was on scrub as a precursor to different types of woodland. The resulting scrub types are similar to those of Ward (1974).

National Vegetation Classification

The method adopted by the NVC involved computational analysis of floristic data from around 31,000 stands of homogenous vegetation. The floristic data consisted of the abundance of species of vascular plant, bryophyte and macrolichen in samples varying in size according to vegetation type. The communities described in the NVC correspond to vegetation units of similar level to the associations defined in European phytosociology.

In the UK, statutory nature conservation agencies, conservation NGOs and local authorities have almost universally adopted the NVC as a means of describing vegetation. A review of the coverage of the NVC within the UK has recently been completed (Rodwell *et al.* 1998), and the need for description of further communities identified. Allocation of NVC communities within the hierarchical scheme of the European Vegetation Survey has been carried out (Rodwell 1997).

The NVC describes 5 scrub and two 'underscrub' communities, although no definition of scrub is given (Rodwell 1991a). Table 2.1 shows scrub and some associated vegetation types described in the NVC, and their corresponding positions in the European Vegetation Survey classification.

One of the key limitations of the NVC for nature conservation purposes, is that it is a classification of data from plots of homogenous vegetation. The value of scrub habitats is often dependent on their position in a mosaic of other vegetation types. Scrubby vegetation and scattered shrubs occur in many grassland, heath, mire and other NVC vegetation types. Similarly, several woodland NVC types have scrubby variants in situations where altitude or exposure limit tree growth. A classification of scrub types which takes account of horizontal spatial structure and canopy architecture is needed for conservation purposes.

Habitats Directive and Natura 2000

With the increase in EU legislation on nature conservation, the need for a standard scheme for describing European habitats has become clear. The Habitats Directive identified habitats of conservation importance within the European Union. Special Areas of Conservation (SACs), forming the so-called Natura 2000 network, are being designated to conserve these priority habitats. Annex I of the Habitats Directive used the hierarchical classification of European habitats developed by the CORINE Biotopes project. This has been modified and expanded in recent years to reflect conservation priorities and take account of the accession of Austria, Finland and Sweden to the EU (Anon 1996).

The relationship between NVC communities and habitats listed in the EU Habitats Directive is shown in Table 2.2.

UK Biodiversity Action Plan

The UK Biodiversity Action Plan process involves the preparation of action plans for threatened species and habitats. Twenty seven 'Broad Habitats' have been defined (17 terrestrial and freshwater, 10 coastal and marine), into which all habitats found in the UK can be placed (Anon 1995, Anon 1998-9). The Broad Habitats form a comprehensive framework for monitoring of changes in the UK environment and, as far as possible, are compatible with other widely-used habitat and land cover classifications. Within each Broad Habitat, a number of 'Priority Habitats' have been identified, using the following criteria:

- Habitats for which the UK has international obligations
- Habitats which are threatened or at risk
- Habitats which may be functionally critical
- Habitats which are important for priority species

Priority Habitats represent distinct management units within the landscape. As such, they are defined at a larger spatial scale than NVC communities, and can consequently take account of vegetation mosaics including scrub

Scrub vegetation occurs in a number of Broad and Priority Habitats and there is not always a simple relationship between NVC communities and BAP habitats. The general relationship is illustrated in Table 2.2.

2.2.2.2 *Structural classifications*

A classification of European scrub and woodland communities based on vegetation structure and texture has been proposed by Barkmann (1990). This classification uses a hierarchical approach, the main criteria separating scrub types being:

- photoperiodicity of the dominant shrub species
- leaf size and leaf form of the dominant shrub species
- presence/absence of thorns or spines
- presence and nature of understorey vegetation

Such structural classifications have not been widely used, but might provide a useful ecological framework for describing the faunal interest of scrub vegetation. The classification is illustrated in Table 2.3 with reference to scrub types found in the UK. At present, there is little information on the fauna of different scrub types in the UK, so it is difficult to determine the value of such classifications. Classification involving architectural complexity of the shrub species, especially under different management regimes, may prove particularly useful for invertebrate and bird communities.

2.2.2.3 *Land cover classifications*

Various land cover classifications are currently in use in the UK. These include international, national and regional schemes, together with schemes covering designated areas, such as those used in National Parks and ESAs. The classifications differ in their treatment of scrub vegetation, depending on the methods and aims of the scheme in question (Wyatt *et al.* 1994). A comparison of treatment of scrub within these schemes is given in Table 2.4. The schemes also differ in their precision with regard to identifying scrub vegetation, depending on whether data are collected through satellite, aerial photo or field survey.

Table 2.1 Scrub and associated herbaceous woodland fringe vegetation, showing position of NVC vegetation types in the hierarchical European Vegetation Survey scheme (after Rodwell *et al.* 1998). Names of provisional new NVC communities given in footnotes.

Class	*Order*	*Alliance*	*NVC communities*	*Notes*
Juncetea maritimi				
	Glauco-Puccinellietalia			
		Armerion maritimae	SM14, SM21, SM25	Scrubby vegetation on upper fringes of salt marshes
Galio-Urticetea				
	Lamio albi-Chenopodietalia boni-henrici			
		Aegopodion podagrariae	new [1,2]	Sunny or semi-shaded woodland margins and clearings
		Galio-Alliarion	OV24, OV25, new [3]	Thermophilous communities on fertile woodland margins
Epilobietea angustifolii				
	Atropetalia			
		Carici pil.-Epilobion ang.	OV27	Woodland margins and clearings on base-poor soils
		Atropion bellae-donnae	new [4]	Woodland margins and clearings on base-rich soils
Scheuchzerio-Caricetea fuscae				
	Caricetalia davallianae			
		Caricion davallianae	SD13, SD14, SD15	Dune slack scrub with *Salix repens* and/or *Juniperus communis*
Oxycocco-Sphagnetea				
	Sphagnetalia magellanici			
		Erico-Sphagnion papillosi	M17, M19	Bogs, including those with *Betula nana* scrub
	Erico-Sphagnetalia papillosi			
		Ericion tetralicis	M15	Wet heaths, including those with *Myrica gale* scrub
Molinio-Arrhenatheretea				
	Molinietalia caeruleae			
		Junco conglomerati-Molinion	M25	Mires, including those with *Myrica gale* scrub
Mulgedio-Aconitetea				
	Adenostyletalia alliariae			
		Salicion arbusculae	W20	Sub-alpine willow scrub
Trifolio-Geranietea sanguinei				
	Origanetalia vulgaris			
		Geranion sanguinei	new [5,6]	Sunny scrub and woodland edges on calcareous soils ('saum')
	Melampyro-Holcetalia mollis			
		Melampyrion pratensis	new [7]	Woodland margins and rides on dry, impoverished acid soils
		Potentillo erec-Holcion moll	new [8]	Woodland margins and rides on damper acid soils
Rhamno-Prunetea				
	Prunetalia spinosae			
		Prunion fruticosae	W22	Scrub communities on moist, more fertile soils
		Berberidion vulgaris	W21	Scrub communities on dry, warm stony slopes
		Salicion repentis arenariae	SD16, SD18	Willow and buckthorn scrub on sand dunes
		Ulici-Sarothamnion	W23	Broom and gorse scrub
		Rubion subatlanticum	W24, W25	Bramble communities of woodland margins and hedgerows
	Sambucetalia racemosae			
		Sambuco-Salicion capreae	new [9]	Elder and willow scrub on nutrient rich mull soils
Querco-Fagetea				
	Quercetalia robori-petraeae			
		Quercion robori-petraeae	U20, new [10]	Includes upland thorn and *Rhododendron* scrub
	Fagetalia sylvaticae			
		Alnion incanae	W7	Includes some scrub dominated by *Salix aurita* in Scotland
Salicetea purpureae				
	Salicetalia purpurea			
		Salicion albae	W6	Includes willow scrub of sub-montane and lowland areas
Alnetea glutinosae				
	Alnetalia glutinosae			
		Alnion glutinosae	W1, W5	Alder woodlands of swamps, fens and wet pastures
	Salicetalia auritae			
		Salicion cinereae	W2, W3	Willow scrub and woodland of mires
Vaccinio-Piceetalia				
	Piceetalia excelsae			
		Dicrano-Pinion	W18, W19, new[11]	Upland and montane pine and juniper scrub
		Vaccinio-Piceion	W4	Includes some scrub dominated by *Salix aurita* in Scotland

Provisional new NVC communities (from Rodwell *et al.* 1998)

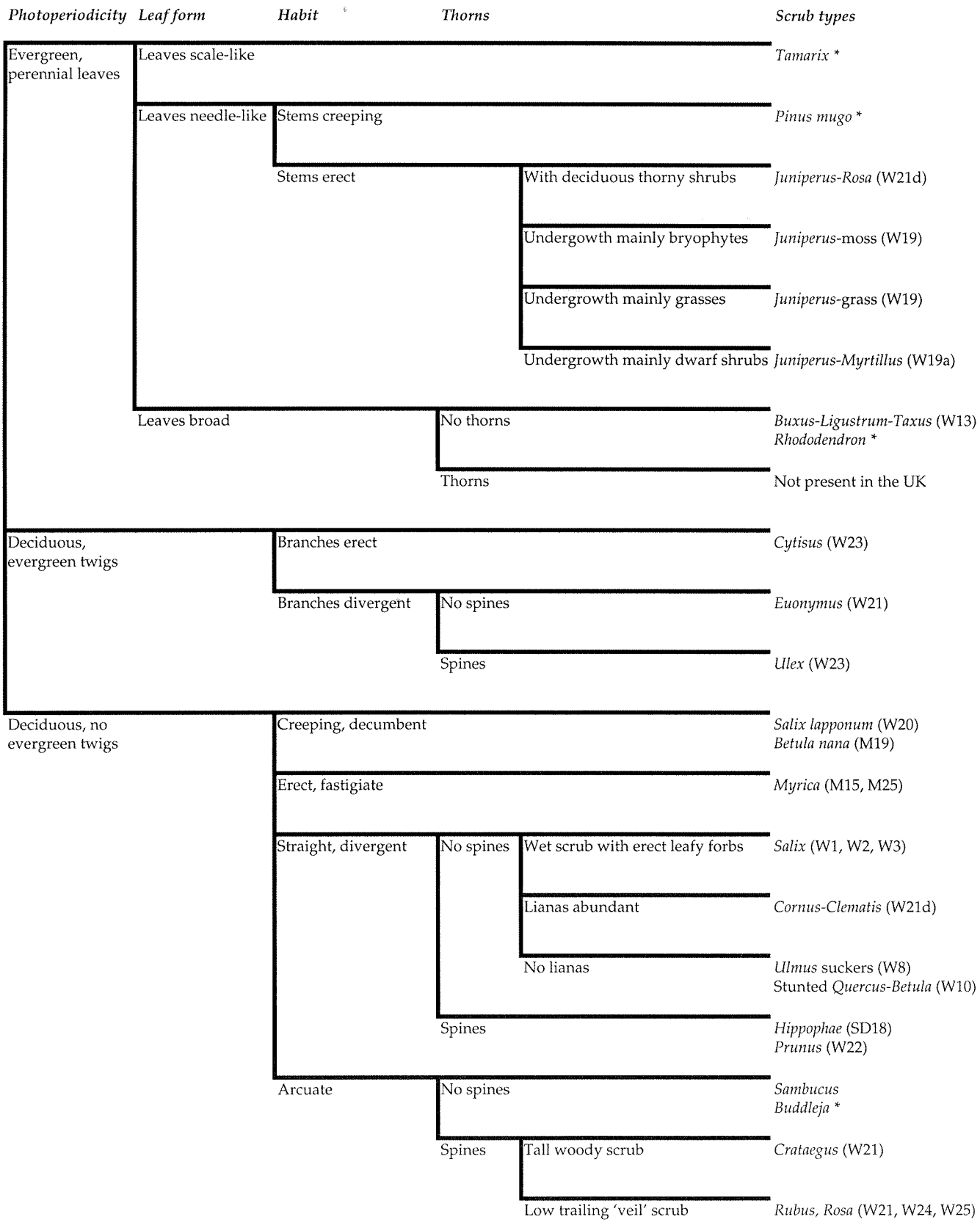
1 *Aegopodium podagraria-Urtica dioica* community
2 *Petasites hybridus-Aegopodium podagraria* community
3 *Alliaria petiolata-Chaerophyllum temulentum* community
4 *Atropa belladonna-Hypericum hirsutum* community
5 *Agrimonia eupatorium-Origanum vulgare* community
6 *Corylus avellana-Geranium sanguineum* community
7 *Holcus mollis-Melampyrum pratensis* community
8 *Potentilla erecta-Holcus mollis* community
9 *Sambucus nigra-Urtica dioica* scrub
10 *Rhododendron ponticum* community
11 *Pinus sylvestris-Cladonia* woodland

Table 2.2 Scrub types in the NVC and their relationships with CORINE biotopes, Habitats Directive categories and Broad and Priority Habitats in the UK Biodiversity Action Plan.

CORINE code	*NATURA 2000 code*	*Habitats Directive Annex 1*	*BAP Broad Habitats*	*BAP Priority Habitats*	*NVC types*	*Notes*
17.3	1220	Perennial vegetation of stony banks	Supralittoral sediment	Coastal vegetated shingle	W22 W23 W24	
18.21	1230	Vegetated sea cliffs of the Atlantic and Baltic coasts	Supralittoral rock	Maritime cliff and slope	W21 to W25	
15.16	1420	Mediterranean and thermo-Atlantic halophilous scrubs (Arthrocnemetalia fructicosae)	Littoral sediment	Coastal saltmarsh	SM21 SM25	
16.25	2160	Dunes with *Hippophae rhamnoides*	Supralittoral sediment	Coastal sand dunes	SD18	Invasive species actively controlled in the UK
16.26	2170	Dunes with *Salix arenaria*	Supralittoral sediment	Coastal sand dunes	SD16	
16.29	2180	Wooded dunes of the Atlantic coast	Supralittoral sediment	Coastal sand dunes		Poor example by European standards
16.27	2250	* Dune juniper thickets (*Juniperus* spp.)	Supralittoral sediment	Coastal sand dunes		
31.4	4060	Alpine and subalpine heaths	Montane habitats		M19	*Betula nana* stands
31.622	4080	Sub-Arctic willow scrub	Montane habitats		W20	
31.82	5110	Stable *Buxus sempervirens* formations on calcareous rock slopes (Berberidion p.)	Broadleaved, mixed and yew woodland		W13	UK examples are rare and restricted outliers
31.88	5130	*Juniperus communis* formations on heaths or calcareous grasslands	Calcareous grassland	Lowland calcareous grassland	W19 W21	
31.88	5130	*Juniperus communis* formations on heaths or calcareous grasslands	Calcareous grassland	Upland calcareous grassland	W19	
31.88	5130	*Juniperus communis* formations on heaths or calcareous grasslands	Dwarf shrub heath	Upland heathland	W19	
34.31-34	6210	Semi-natural dry grasslands and scrubland facies on calcareous substrates (Festuco-Brometalia) (* important orchid sites)	Calcareous grassland	Lowland calcareous grassland	CG1 to CG9	
52.1	7130	Blanket bog (*active only)	Bogs		M19	*Betula nana* stands
62.4	8240	* Limestone pavements	Inland rock	Limestone pavements	W21 W22	
42.51	91C0	* Caledonian forest	Coniferous woodland	Native pine woodland	W18 W19	
44A1-4 44.3	91D0 91E0	* Bog woodland * Residual alluvial forests (Alnion glutinosae-incanae)	Broadleaved, mixed and yew woodland	Wet woodland	W1 W2 W3	

* indicates priority habitat types in the Habitats Directive

Table 2.3 Classification of scrub types found in the UK based on vegetation structure and texture (after Barkmann 1990).



* indicates introduced shrubs

Table 2.4 Treatment of scrub vegetation in various land cover classifications in use in the UK. Differences in precision are illustrated with reference to NVC communities. These land cover surveys use mapping units much larger than the stands used to define NVC communities. Consequently, no direct correlation between land cover classes and NVC communities is implied.

NVC types: / *Classification:*	*W1* *W2* *W3*	*W18* *W19*	*W20*	*W21* *W22*	*W23*	*W25* *U20*	*others*
Countryside Survey *(satellite)*	Deciduous/ Mixed Wood	Coniferous/ Evergreen Woodland; Deciduous/ Mixed Wood	Shrub Heath	Deciduous/ Mixed Wood	Shrub Heath	Bracken	
Monitoring Landscape Change *(air photo)*	Scrub; Peat Bog	Scrub	Scrub	Scrub	Gorse	Bracken	
National Countryside Monitoring Scheme *(air photo)*	Scrub (tall 3-5 m, low < 3 m)	Scrub (tall 3-5 m, low < 3 m)	Scrub (low < 3 m)	Scrub (tall 3-5 m, low < 3 m)	Scrub (tall 3-5 m, low < 3 m)	Bracken	
Land Cover Scotland *(air photo)*	Broadleaved Wood (>50% tree cover); Wet lands	Undifferentiated Low Scrub; Coniferous Woods (>50% tree cover)	Montane Vegetation	Undifferentiated Low Scrub; Smooth grasslands with low scrub	Undifferentiated Low Scrub; Smooth grasslands with low scrub	Bracken	Rhododendron Scrub
Northern Ireland Countryside Survey *(field survey)*	Fen Carr	Coniferous Woodland, semi-natural; Scrub (dense, scattered)		Scrub (dense, scattered)	Gorse Heath (continuous, scattered); Gorse Heath/ Bracken Mosaic	Gorse Heath/ Bracken Mosaic	Dune Scrub
National Parks Monitoring Scheme *(air photo)*	Scrub	Scrub	Scrub	Scrub	Scrub	Bracken	
Environmentally Sensitive Areas Monitoring *(air photo)*	Fen Carr	Scrub (dense, scattered)	Scrub (dense, scattered)	Scrub (dense, scattered)	Scrub (dense, scattered)	Bracken (continuous, scattered)	

Source: Wyatt *et al.* (1994)

2.2.3 Classification for conservation purposes

Classification schemes are tools for describing variation. The criteria used in the scheme depend on the use to which the classification will be put. Classifications of scrub stands for nature conservation purposes need to take account of two factors, the nature conservation value of the scrub concerned and the likely vegetation development of the stand through time, i.e. its successional status.

2.2.3.1 *Classification of conservation value*

Scrub vegetation may have high nature conservation value for one or more of the following reasons:

- *The conservation value of the shrub species present*
  Some scrub types are dominated by shrub species that are of conservation importance because of their rarity, for example juniper *Juniper communis*, box *Buxus sempervirens*, or downy willow *Salix lanata*.

- *The conservation value of other species associated with the scrub type*
  Scrub composed of woody species of low botanical interest may be of considerable value to particular rare species or groups of associated species, belonging to a range of taxa. For example, blackthorn scrub for nightingale or coastal hazel *Corylus avellana* scrub for lichen assemblages.

- *The conservation value of scrub as a landscape element in a mosaic including other habitats*
  Scrub may form an important component of habitat mosaics in certain systems. Examples include the thermophilic saum vegetation of chalk grassland/scrub interface or scrubby birch *Betula* spp. and willow *Salix* spp. vegetation at the edge of wet heathland and mires. In upland areas, climax scrub represents an important component of the ecotone from woodland to montane heath with increasing altitude. The same is true for other situations where scrub forms part of a natural ecotone, for example the scrub and elfin woodland communities of exposed coastal areas.

2.2.3.2 *Classification for management*

In addition to identifying the intrinsic conservation value of biological components of scrub, management plans need to take account of two sets of factors, structural and temporal.

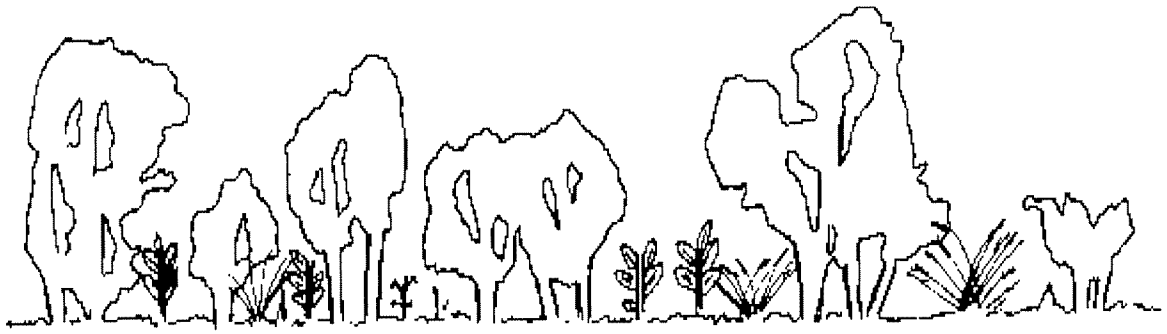
The vertical and horizontal structure of the scrub stand will determine whether the correct habitat components necessary for rare species or groups of associated organisms are present. The characteristics of scrub of high conservation value have been described for lowland grassland systems (see Figure 2.3, Crofts & Jefferson 1999) as:

- Mixed age structure
- Complex three dimensional structure
- Many clearings and glades
- High boundary/area ratio
- Well developed marginal vegetation ('saum').

The second consideration is the likely development of the scrub stand through time. The age structure of the woody species in a scrub stand provide an indication of its successional status and likely development through time. Characterisation of the age structure is, therefore, necessary in order to make informed management decisions. This is especially true for lowland seral and sub-seral scrub types. The presence of shrub seedlings, suckers or tree saplings will provide an indication of whether the stand will develop into woodland, remain as scrub, or degenerate to a herbaceous community.

In areas with climax scrub, such as in the alpine and sub-alpine zones of Scotland, other management considerations are important. Here problems of population survival in small isolated patches mean that factors such as patch size and position in relation to other semi-natural woodland are of paramount importance (D. Gilbert pers. comm.). For dioecious species such as juniper and willows, the presence of male and female plants is important for population persistence (Marriott 1997).

Closed scrub. Canopy closure results in the shading out of nearly all ground flora and conditions for plant growth are made even more difficult due to the build up of a deep litter layer. Even woodland plants find such conditions difficult.



Scrub of high nature conservation value is characterised by a diverse range of scrub species and a complex canopy structure. There are many gaps allowing the survival of grassland and 'saum' species.

Scrub of low nature conservation value consists of one or two scrub species and has a uniform canopy. Bushes are often evenly spaced and can close rapidly to shade out grassland species in the gaps. 'Saum' species are likely to be absent.

Figure 2.3 The conservation value of seral scrub in lowland grasslands in relation to canopy structure (reproduced from Crofts & Jefferson 1999 with permission of English Nature & The Wildlife Trusts).

2.3 Coastal scrub types

2.3.1 Scrub on shingle

2.3.1.1 *Scrub communities*

Scrub may develop on stable areas of large shingle structures, where stones are thrown beyond the reach of wave disturbance and fine material builds up between the pebbles. The exposed conditions of most extensive shingle areas in the UK result in a short scrub vegetation. Dwarf forms of broom *Cytisus scoparius* ssp. *scoparius* and blackthorn are found on the most exposed areas, with bramble *Rubus fruticosus*, elder *Sambucus nigra* and gorse *Ulex europaeus* in more sheltered areas. Juniper occurs on some vegetated shingle bars in north-eastern Scotland.

2.3.1.2 *Zonation and succession*

Scrub on shingle occurs in mosaics with open herbaceous shingle vegetation and, where fine material has built up, with maritime grassland or heathland vegetation. At some sites, where shingle adjoins areas of saltmarsh, zonations with halophytic drift line communities or shrubby sea-blite *Suaeda vera* stands are found.

The development of scrub on shingle occurs as a result of succession from open herbaceous communities. The succession of shingle scrub to woodland is not well documented, and exposure or disturbance may limit such a progression.

2.3.1.3 *Conservation value*

The UK has a significant component of European resources of large shingle areas (Sneddon & Randall 1993). Scrub forms an important part of the mosaic of habitats on larger sites. Several SACs containing extensive areas of shingle have been designated (see Appendix 3.2).

Perennial vegetation of stony banks
CORINE: 17.3 NATURA 2000: 1220

2.3.2 Scrub on sea cliffs

2.3.2.1 *Scrub communities*

In areas with soft cliffs, extensive stands of scrub may occur, especially on slumping undercliffs such as those at Lyme Regis, Dorset or St Catherine's Point, Isle of Wight. Scrub may also occur on harder cliffs, such as the Elgol Cliffs on Skye. On cliff tops, scrub stands occur which are similar to other lowland types on similar soils, but are usually much reduced in height as a result of the exposed conditions. Hazel, blackthorn, bramble, gorse and privet *Ligustrum vulgare* are particularly characteristic of such conditions. On limestone soils juniper and burnet rose *Rosa pimpinellifolia* occur. The limestone cliffs at Great Orme's Head are the only site for the endemic shrub wild cotoneaster *Cotoneaster cambricus*. Stands of stunted trees, or 'elfin woodland', also occur on cliff tops and slopes, having the structure and appearance of scrub. These form important sites for lichens on the west cost of Britain.

2.3.2.2 *Zonation and succession*

Scrub on cliff tops and associated slopes occurs in mosaics with open herbaceous sea cliff vegetation, grassland, heathland and, in less exposed conditions, woodland. On soft cliffs subject to slippage, dynamic mosaics of pioneer vegetation, grassland, heathland and woodland are maintained through periodic disturbance.

Scrub develops on cliffs and undercliffs as a part of primary succession from pioneer and other herbaceous communities. On cliff tops, scrub may develop in maritime grasslands or heathlands after the relaxation or cessation of grazing. Succession of scrub to woodland occurs only in the most sheltered conditions, for example in small valleys and ravines. Generally, the exposed conditions or disturbance of the substrate limit progression to woodland.

2.3.2.3 *Conservation value*

Scrub has conservation value on cliff tops and slumping soft cliffs as part of vegetation mosaics including grassland, heathland and open pioneer vegetation. Scrub stands are especially valuable in areas with extensive undercliffs. Bryophytes and lichens can be important on western and northern cliffs. Scrub on sea cliffs can provide significant food resources and cover for migrating and breeding birds.

Vegetated sea cliffs of the Atlantic and Baltic coasts
CORINE: 18.21 NATURA 2000: 1230

2.3.3 Scrub on salt marshes

2.3.3.1 *Scrub communities*

Scrub vegetation composed of halophilous species typical of the Mediterranean region occurs in a few localities on the south and east coasts of England. Communities dominated by the shrubs shrubby sea-blite and sea-purslane *Atriplex portulacoides* are found on the upper fringes of saltmarshes. Such stands are found in the *Halimione portulacoides* and *Suaeda vera* salt-marsh communities of the NVC (SM14 and SM25 respectively, Rodwell 1999).

2.3.3.2 *Zonation and succession*

Low scrub vegetation with shrubby sea-blite and sea-purslane occurs along the upper fringes of extensive areas of salt marsh. The vegetation usually marks the upper limit of tidal inundation and lies between the saltmarsh and vegetation developing on sand dunes or shingle bars.

The community is maintained by the extreme edaphic conditions. Disturbance caused by wave action during storms leads to replacement by annual drift line vegetation, with species such as sea beet *Beta vulgaris* ssp. *maritima*. In the absence of inundation and disturbance, scrub replaces these annual communities.

2.3.3.3 *Conservation value*

In the UK, such scrubby vegetation is only found on sites with extensive areas of saltmarsh, sand dune or shingle on the south and east coasts (Burd 1989). Three SACs contain significant stands of halophilous scrub (see Appendix 3.2).

Mediterranean and thermo-Atlantic halophilous scrubs (Arthrocnemetalia fruticosae)
CORINE: 15.16 NATURA 2000: 1420

2.3.4 Scrub on coastal dunes

2.3.4.1 Scrub communities

Scrub communities occur in more stable areas of dune systems, typically in dune slacks or on higher ground amongst areas of dune grassland or heathland. However, in dune hollows and on sheltered sides of dune ridges, sea-buckthorn *Hippophae rhamnoides* can form a characteristic dune scrub community (SD18 *Hippophae rhamnoides* scrub in the NVC). The shrub develops a dense cover, displacing herbaceous species, although mature stands are characterised by the presence of common nettle *Urtica dioica*. Sea-buckthorn is native in the UK only on the east coast from Dunbar to Dungeness (Stewart *et al.* 1994). The species has invaded many dunes outside of its native range, either through planting to stabilise sand dune movement or bird dispersal from gardens. Sea-buckthorn is considered a serious problem in some dune systems on the western coast.

In dune slacks, scattered individuals of creeping willow *Salix repens* (referred to in the Habitats Directive by its synonym, *Salix arenaria* L.) occur within herbaceous communities of species typical of moist soil conditions (SD13 *Salix repens-Bryum pseudotriquetrum*, SD14 *Salix repens-Campylium stellatum* and SD15 *Salix repens-Calliergon cuspidatum* dune slacks in the NVC). Erosion of areas with creeping willow leads to the characteristic 'hedgehog dunes' found at a number of sites in the UK. In some older, more stable, dune slacks, stands dominated by creeping willow occur (SD16 *Salix repens-Holcus lanatus* dune-slack, Rodwell 1999), comprising a low scrubby vegetation. In wetter areas, these stands may include alder *Alnus glutinosa*, bog-myrtle *Myrica gale* and grey willow *Salix cinerea*, whilst in dry areas creeping willow may be accompanied by other shrubs, such as privet.

On older dunes on the landward side of extensive dune systems, the balance of erosion and accumulation results in stable vegetation and allows the development of scrub. The scrub types found here are generally similar to other lowland types, depending on the base status of the substrate. On base-rich soils, blackthorn, elder, privet and hawthorn *Crataegus monogyna* are found, whilst bramble, gorse and broom *Cytisus scoparius* are found on more acidic dunes. Important stands of juniper scrub occur in mosaics with wet slack, dune grassland and heath on the coast of north-east Scotland.

2.3.4.2 Zonation and succession

Dune scrub occurs in the more stable areas of sand dune systems, on the landward side of ridges, in hollows, slacks and amongst dune grassland and heathland. The pattern of occurrence within associated vegetation types of different successional stage depends on the pattern of disturbance at the site. In mobile systems, cyclic alternation of sand dune and dune slack occurs. In more stable areas, the type of scrub vegetation is controlled by rates of sand erosion and accumulation, and the level of the water table. For example, grey willow scrub (W1 in the NVC) may be found as a bordering fringe between wet dune slacks with creeping willow and dry dune grassland with scattered dry scrub. The role of grazing animals in maintaining dune grassland and heathland became obvious after the decrease in rabbit populations following the myxomatosis outbreak in the 1950s.

A number of other NVC woodland and scrub communities occur in sand dunes in Britain (Dargie 1993, 1995), these are covered in Sections 2.4 and 2.5. The succession of dune grassland and heathland, through scrub, to woodland is poorly understood, because in most extensive dune systems, the more stable areas on the landward edge are grazed or planted for forestry.

2.3.4.3 Conservation value

The most important areas of dune scrub for conservation in the UK are the dune juniper thickets of north-east Scotland, a priority habitat type in the Habitats Directive (Anon 1996). Dunes with *Hippophae rhamnoides* are included in the Habitats Directive and, whilst sea-buckthorn is native on the east coast, it is of widespread occurrence as an invasive Pearson & Rogers 1962, Stewart *et al.* 1994). Sea-buckthorn dune scrub has therefore not been considered a priority habitat type in the UK for the purposes of SAC designation. This situation may change as part of the SAC moderation process (S. Rees, pers. comm.).

Dune scrub forms an important component of many SACs with extensive sand dunes which have been designated because of the importance of their fixed dune habitats (CORINE habitat types 16.22, 16.23, 16.24). In areas of calcareous dune with extensive mosaics of dune grassland and scrub, important communities of thermophilic saum vegetation occur, often accompanied by an abundance of bloody crane's-bill *Geranium sanguineum* (J. Hopkins, pers. comm.). Scrub on sand dunes often provides very important food resources and cover for migrating birds. Populations of invertebrates and breeding birds can also be of considerable interest.

Dunes with *Hippophae rhamnoides*
CORINE: 16.25 NATURA 2000: 2160

Dunes with *Salix arenaria*
CORINE: 16.26 NATURA 2000: 2170

*** Dune juniper thickets (*Juniperus* spp.)**
CORINE: 16.27 NATURA 2000: 2250

2.4 Lowland scrub types on wet soils

2.4.1 Scrub on wet mineral soils

2.4.1.1 *Scrub communities*

Scrub occurring on wet mineral soils in lowland areas is usually dominated by grey willow. Downy birch *Betula pubescens* occurs occasionally in these stands. Other woody species occurring at lower frequency are alder, hawthorn and pedunculate oak *Quercus robur*. Scrub of this type is described as *Salix cinerea–Galium palustre* woodland (W1) in the NVC (Rodwell 1991a). Such willow carr occurs alongside ponds, lakes, rivers, canals, ditches and streams, and in damp hollows in places such as dune slacks. The prolific fruit production and widespread dispersal make grey willow a frequent colonist of damp ground in abandoned gravel and sand pits, and along roadsides. The understorey vegetation is patchy, reflecting differences in canopy closure and soil moisture, and lacks the swamp and fen dominants typical of fen carrs on more organic soils.

2.4.2.2 *Zonation and succession*

Grey willow scrub on wet mineral soils occurs as a component of several habitat complexes. Along the margins of ponds and lakes, this scrub type may be separated from open water by swamp vegetation dominated by species such as common reed *Phragmites australis*, branched bur-reed *Sparganium erectum* or bulrush *Typha latifolia*. In extensive wetland areas, tall-herb fen (e.g. S25 *Phragmites australis-Eupatorium cannabinum* or S26 *Phragmites australis-Urtica dioica*) may occur between the swamp and carr. On drier ground, the scrub community grades into *Alnus glutinosa–Urtica dioica* woodland (W6). Often, however, agricultural practices limit the development of woody vegetation and the willow carr gives way to wet grasslands (MG6 *Lolium perenne-Cynosurus cristatus* or MG10 *Holcus lanatus-Juncus effusus*) or has abrupt boundaries with arable land (Rodwell 1991a). Along roadside and other linear features, willow carr occurs as thin strips adjacent to mown grassland, usually *Arrhenatherum elatius* grassland (MG1).

Little published information exists on the successional development of grey willow stands on wet mineral soils. In sheltered situations, it is likely to develop into alder woodland (W6) with increases in cover of birch and alder above the willow canopy and expansion of bramble and common nettle in the understorey. On exposed western coasts of Britain, this scrub type may represent climax woody vegetation (Rodwell 1991a).

2.4.2.2 *Conservation value*

Whilst the botanical diversity of such scrub is low, this vegetation can form an important component of the landscape in areas with mosaics of open water, swamp and fen. It forms a component of wet woodland, a priority habitat in the UK Biodiversity Action Plan.

Residual alluvial forests (Alnion glutinosae-incanae)
CORINE: 44.3 NATURA 2000: 91E0

2.4.2 Scrub on wet organic soils

2.4.2.2 *Scrub communities*

Grey willow and downy birch also form the woody dominants in scrub on wet, organic soils such as those associated with fens and mires. In places, alder or alder buckthorn *Frangula alnus* can form a significant component of the shrub canopy. There is usually a distinct undershrub layer with species such as bramble and dog-rose *Rosa canina*. The understorey is usually dominated by graminoids typical of the preceeding fen vegetation, of which common reed is the most frequent. Patches of tall forbs are also found, for example, hemp-agrimony *Eupatorium cannabinum* and meadowsweet *Filipendula ulmaria*. Scrub of this type is described as *Salix cinerea–Betula pubescens–Phragmites australis* woodland (W2) in the NVC (Rodwell 1991a).

2.4.2.2 *Zonation and succession*

Willow carr occurs on topogenous fen peats, on flood plain mires, valley mires and basin mires. It develops either as a result of direct invasion of fen, or by secondary succession following the abandonment of mowing marsh. Extensive open water transitions including this scrub type are most commonly found in East Anglia and in the meres of the Cheshire and Shropshire basin. In such areas, sequences from open water, through swamp and fen vegetation (e.g. S24 *Phragmites australis-Peucedanum palustre* or S25 *Phragmites australis-Eupatorium cannabinum*) to willow carr can be found (Rodwell 1995). Towards higher, drier areas, willow carr may be bordered by woodland with alder, birch or oak, or abut agriculturally managed areas.

Succession of this scrub community to woodland occurs with increased terrestrialisation. On base-rich substrates, willow carr is likely to develop to alder woodland (W6), with increases in the cover of alder and elder in the canopy and bramble and common nettle in the understorey. On more acid substrates, developing canopy cover of birch and increased dominance of purple moor-grass *Molinia caerulea* in the understorey mark the development of carr into *Betula pubescens–Molinia caerulea* woodland (W4). In places, degeneration of the birch canopy and increased cover of purple moor-grass suggest eventual development of an ombrogenous mire community.

2.4.2.3 *Conservation value*

This scrub type forms an important component of the landscape in areas with mosaics of open water, swamp, fen, mire and woodland. It forms a component of wet woodland, a priority habitat in the UK Biodiversity Action Plan.

*** Bog woodland**
CORINE: 44A1-44A4 NATURA 2000: 91D0

2.4.3 Bog myrtle scrub

2.4.3.1 Scrub communities

The nitrogen-fixing shrub bog myrtle *Myrica gale* is found in a wide range of wet heaths and mires in lowland areas and upland fringes of Britain. The shrub usually occurs as scattered bushes, but in places, forms a closed-canopy vegetation up to 2 m tall. Purple moor-grass is usually the dominant understorey species in bog myrtle stands. In the densest stands, the shade produced by the scrub canopy, combined with nutrient enrichment from the nitrogen-fixing shrub, result in an understorey of low botanical diversity. In the NVC, bog myrtle stands are included in *Scirpus cespitosus–Erica tetralix* wet heaths (M15) and *Molinia caerulea–Potentilla erecta* mires (M25) (Rodwell 1991b).

2.4.3.2 Zonation and succession

Bog myrtle scrub stands are found on wet acid-neutral peats and peaty mineral soils mainly in the cooler, wetter areas of western and northern Britain. Such vegetation usually marks areas of water movement on gentle slopes, soakaways and along the courses of streams. Stands of bog myrtle occur in mosaics with other mire and heath communities.

2.4.3.3 Conservation value

Bog myrtle forms a valuable component of the structural complexity of wet heath, mire, blanket bog and moorland habitats in the lowlands and upland fringes, especially in the southern and eastern parts of Britain. Along with patches scrubby birch and willow, it is an important component of the habitat requirements of several rare invertebrate species associated with these habitats.

2.5 Lowland scrub types on dry soils

2.5.1 Scrub on dry calcareous substrates

2.5.1.1 *Scrub communities*

Many shrub species are restricted to dry calcareous soils in the warmer, drier lowland areas of the UK. As a consequence, the botanical diversity of woody species in scrub types on such soils is high. However, the NVC includes such types within a single community, the *Crateagus monogyna–Hedera helix* scrub (W21). This community is found on a wide range of base-rich to circumneutral soils in lowland Britain, there being little variation in the dominant woody species over this range. Hawthorn, blackthorn, bramble and dog-rose form the core shrub species, and maintain dominance on all but the most shallow and dry soils. *Crataegus–Hedera* scrub is found on many types of unmanaged land: land slips, abandoned land, spoil tips, railway embankments, roadsides, and on grasslands after the relaxation of grazing or mowing.

Two sub-communities of *Crataegus–Hedera* scrub are associated with calcareous soils. The *Brachypodium sylvaticum* sub-community (W21c) is found on deeper soils and the shrub canopy is largely composed of hawthorn, blackthorn and bramble (Rodwell 1991a). In the understorey, false brome *Brachypodium sylvaticum*, wild strawberry *Fragaria vesca* and ivy *Hedera helix* are of frequent occurrence.

The *Viburnum lantana* sub-community (W21d) is found on shallow, infertile rendzinas and lithomorphic soils on harder limestones (Rodwell 1991a). Here, the abundance of hawthorn and blackthorn is diminished and a range of calcicolous shrubs add to the diversity of the canopy. This sub-community includes the so-called southern mixed shrub communities of Ward (1974) and Ratcliffe (1977). Shrub species such as dogwood, privet and wayfaring-tree *Viburnum lantana* are strong preferentials for this scrub type. Several rose species *Rosa* spp. are found in this scrub type, and the climbers traveller's-joy *Clematis vitalba* and black bryony *Tamus communis* are frequent. Lowland populations of juniper on the chalk are associated with this scrub type, occurring either as pure stands or mixed with southern shrubs. The trees whitebeam *Sorbus aria* and yew *Taxus baccata* supplement the diversity of woody species. In the north of Britain, similar scrub types occur, although the diversity of the shrub species declines as species reach their northern limits, with few examples north of Morecambe Bay and the River Tyne.

Box scrub occurs very locally at three sites in southern England on steep chalk or limestone slopes. Box is usually accompanied by yew, and the deep shade and dry soil conditions result in a very sparse ground flora. In the NVC, box scrub is placed in the *Taxus baccata* woodland (W13) or the *Taxus* sub-community of the *Fagus sylvatica–Mercurialis perennis* woodland (W12).

On limestone outcrops in western and northern Britain, several rare species of whitebeam *Sorbus* spp. occur, some of which are endemic (e.g. *S. eminens, S. wilmottiana*). These are found with calcicolous shrubs and trees growing on cliffs and steep rocky slopes, such as those of the Wye Valley, Avon Gorge and the Isle of Arran. Such scrubby vegetation is probably the climax vegetation in such conditions.

Hazel scrub also occurs on shallow calcareous soils on harder limestones in the west and north of Britain. Hazel usually prefers deeper, moister soils, but can persist in pockets of soil on limestone pavements, screes and cliffs. In Derbyshire, a distinctive type of hazel scrub is found in intimate mosaics with calcareous grassland. Associated with this scrub-grassland complex is a distinctive 'saum' community, with a characteristic mixture of herbaceous species. Such scrub is also considered part of the *Viburnum* sub-community of the *Crataegus–Hedera* scrub in the NVC. Hazel scrub also occurs on base-rich soils in coastal areas of north and west Scotland. Important lichen assemblages are found on the stunted hazel trees in these situations.

2.5.1.2 *Zonation and succession*

Except on the most shallow soils or in extremely exposed conditions, scrub on dry calcareous soils in the lowlands of Britain is a sub-climax woody community. Zonation usually reflects a mosaic of different successional stages. Abrupt boundaries occur where fences limit grazing pressure. Such scrub also occurs as a linear feature along woodland edges, roadsides and railway embankments. Gradual transitions to herbaceous communities are found on abandoned or extensively managed land.

On disturbed sites, quarry floors and around rabbit warrens on the softer limestones of the Oolite and Chalk, scrub can develop in the absence of grazing by primary succession from open weedy tall herb communities. On the harder limestones in the north of Britain, scrub replaces fern-dominated communities and *Arrhenatherum elatius* grassland in primary successional sequences, the scrub developing into *Fraxinus excelsior–Acer campestre–Mercurialis perennis* woodland (W8).

Scrub dominated by dogwood is associated with secondary succession on disturbed land, such as that on abandoned arable or cleared woodland, on shallow calcareous soils. Dogwood often forms pure stands through vegetative spread and this invasive shrub can be difficult to control.

Scrub develops after the cessation or relaxation of grazing on calcareous grasslands. In the south and east, this is from Mesobromion grasslands (CG2-7), and in the cooler, wetter northern and western areas, from *Sesleria* grasslands (CG8, CG9). In coastal areas, *Festuca ovina–Carlina vulgaris* grasslands (CG1) can develop to scrub after the relaxation of grazing pressure, but in places exposure limits the development of scrub. In these secondary successions, increased shrub cover is accompanied by the development of tall grassland, dominated by rank species such as false oat-grass *Arrhenatherum elatius,* tor-grass *Brachypodium pinnatum* or upright brome *Bromus erectus.* The spread of scrub may be associated with the development of *Rubus fruticosus–Holcus lanatus* underscrub (W24).

The development of tree cover in scrub on lowland calcareous soils in southern Britain usually leads to beech woodland (W12), often with an intermediate stage dominated by ash. On steep slopes on the chalk in the warmer south-east, yew woodland (W13) may develop from southern mixed shrub communities. In cooler northern and western areas, scrub on calcareous soils develops into *Fraxinus–Acer–Mercurialis* woodland (W8).

2.5.1.3 *Conservation value*

Many species of rare plant and invertebrate are found in lowland scrub on calcareous soils. In addition, it forms an important landscape component for birds and mammals. Rich communities of birds and invertebrates can be supported, especially where the structural diversity of the scrub is high. The *Crataegus-Hedera* scrub (W21) of the NVC covers a large range of scrub varying in composition and species richness. Different stands will have different degrees of conservation value depending on botanical composition and structural complexity.

Two scrub types are of importance because of the rarity of the shrub species, namely box and juniper, the latter having a Species Action Plan. The rare, endemic whitebeams found on limestone outcrops in the west of Britain add to the conservation importance of scrub in these situations. Scrub forms an important component of 'Semi natural grasslands and scrubland facies on calcareous substrates', and several rare orchid species are associated with the scrub-grassland interface. The thermophilic saum communities of the mosiacs of scrub and calcareous grasslands in the Derbyshire Dales are of particular importance.

In European terms W21 represents a subset of the Rhamno-Prunetea which is characteristically dominated by pruinose rosaceous shrubs. Similar broad community types have been described from Germany (Tüxen 1952, Ellenberg 1978) and The Netherlands (Westhoff & den Held 1969). There is no reason to believe that the British representatives of this compendious grouping are distinct from similar communities in nearby continental Europe.

Stable *Buxus sempervirens* formations on calcareous rock slopes (Berberidion p.)
CORINE: 31.82 NATURA 2000: 5110

***Juniperus communis* formations on heaths or calcareous grasslands**
CORINE: 31.88 NATURA 2000: 5130

Semi natural grasslands and scrubland facies on calcareous substrates (Festuco-Brometalia) (*important orchid sites)
CORINE: 34.31-34.34 NATURA 2000: 6210

2.5.2 Scrub on neutral substrates

2.5.2.1 *Scrub communities*

Scrub dominated by hawthorn is not restricted to calcareous soils. On fertile soils of moderate base status, such as clays and brown earths, hawthorn is accompanied by blackthorn, elder and elm *Ulmus* spp. These scrub types also lie within the *Crataegus monogyna–Hedera helix* scrub (W21). Common nettle and cleavers *Galium aparine* are usually the most frequent species in the understorey, accompanied by dog's mercury *Mercurialis perennis* on the more base-rich soils. Such communities occur on derelict land, abandoned arable land, neglected pastures, hedgerows and roadsides.

On deeper, moister, more fertile soils, blackthorn replaces hawthorn as the dominant shrub species. Communities dominated by blackthorn are included in the *Prunus spinosa–Rubus fruticosus* scrub (W22) of the NVC. Blackthorn is the dominant woody species in such vegetation, and is accompanied by gorse on more base-poor soils, and hazel and privet on soils with a higher base status. The understorey is impoverished, bramble and bracken *Pteridium aquilinum* occurring with some constancy. In the densest thickets there may be large areas of bare ground under the shrub canopy. Such scrub is found on a range of abandoned or extensively managed land. Blackthorn has a higher tolerance of salt than many shrub species, and it is frequently found on cliff tops, exposure limiting the scrub canopy to heights of less than 1 m in places.

On damp, disturbed, nutrient-rich soils on roadsides, railway embankments and wasteland, scrub dominated by elder is common. Elder may form pure stands, or be accompanied by other woody species, typically grey willow and sycamore *Acer pseudoplatanus*. These are usually fringed with bramble and herbaceous species such as common nettle and rosebay willowherb *Chamerion angustifolium*. A new NVC community, *Sambucus nigra-Urtica dioica* scrub, has been proposed by Rodwell *et al.* (1998) for such vegetation. Elder scrub is associated with rabbit warrens and badger setts on calcareous soils. The disturbed, fertile conditions favouring its spread. The low palatability of the shrub to rabbits also contributes to its success in these conditions.

The invasive shrub butterfly-bush *Buddleja davidii* is found in scrub communities in similar situations to elder. It can form pure stands on shallow, stony, fertile soils. Extensive areas can be found on abandoned railway sidings and cleared woodlands on chalk.

2.5.2.2 *Zonation and succession*

Scrub on neutral soils in the lowlands is a stage in succession from open ground or herbaceous communities to woodland. Only in the most exposed situations, such as on cliff tops, is scrub considered a climax vegetation. In successions on waste or derelict land, blackthorn, elder and hawthorn scrub occurs in mosiacs with more open herbaceous vegetation and woodland, the patterning reflecting the history of disturbance at the site. On abandoned arable land or grassland, blackthorn or hawthorn thickets often have abrupt boundaries along fence lines. In extensively managed landscapes, the boundaries with grassland may be less distinct. Blackthorn scrub also occurs in linear formations along wood margins and woodland rides.

On abandoned grasslands, succession from mesotrophic grasslands (e.g. MG1 *Arrhenatherum elatius* grassland, MG5 *Cynosurus cristatus-Centaurea nigra* grassland, MG6 *Lolium perenne-Cynosurus cristatus* grassland) to blackthorn or hawthorn scrub occurs, often with *Rubus–Holcus* underscrub (W24) as an intermediate stage. This underscrub community also represents an early stage in succession on abandoned arable land. The succession progresses from scrub to oak (*Quercus robur-Pteridium aquilinum-Rubus fruticosus* woodland W10) or beech (*Fagus sylvatica-Rubus fruticosus* woodland W14) woodland on soils of low base status, whilst on more base-rich, moist soils, *Fraxinus-Acer-Mercurialis* woodland (W8) may represent the end-point of succession.

2.5.2.3 *Conservation value*

This scrub type is common on disturbed fertile soils and abandoned land in the UK. However, mosaics of short turf, tall turf and scrub on neutral soils are extremely important for birds and invertebrates. In addition, patches of this scrub type may form important refugia for common species in intensively-farmed landscapes.

Prunus spinosa-Rubus fruticosus scrub characteristically contains fewer woody species than *Crataegus-Hedera* scrub but the three sub-communities encompass a similar range of species in the field layer. Similar scrub types have been described from northern France (Géhu 1964), from The Netherlands (Doing 1962, Westhoff & den Held 1969) and from Germany (Ellenberg 1978) and there is no evidence that the range of British stand types are distinct.

2.5.3 Scrub on acidic substrates

2.5.3.1 *Scrub communities*

Scrub stands dominated by gorse occur on dry, free-draining, base-poor, brown earths. Broom is often present, and can be the dominant shrub on drier, more acid soils. All such stands are placed in the *Ulex europaeus–Rubus fruticosus* scrub (W23) of the NVC. In dense stands, the understorey vegetation is poorly developed, but under more open canopies a grassy sward with species of acid grassland, such as common bent *Agrostis capillaris*, red fescue *Festuca rubra* and heath bedstraw *Galium saxatile*, is found. This scrub type is widespread on marginal land throughout the lowlands and upland fringes in the UK. Bryophtye cover may be high, *Rhytidiadelphus squarrosus* being the most frequent species.

On the driest and most acid heaths in the south-east of England, the introduced shrub shallon *Gaultheria shallon*, a garden escape, is becoming established.

The introduced shrub rhododendron *Rhododendron ponticum* is a vigourous invader of oak woods on acid soils at low altitudes in the west of Britain. This species also invades open vegetation in heathlands and bogs, forming dense scrub. The dense shade and thick leaf litter typical of such rhododendron thickets lead to severe impoverishment of the understorey. A rhododendron scrub community was proposed in the review of coverage of the NVC (Rodwell *et al.* 1998).

Juniper occurs as scattered bushes in heathlands at low altitude in northern England and Scotland but rarely forms true scrub vegetation. Juniper scrub on base-poor soils in the wetter areas of the UK is described in Section 2.6.4.

2.5.3.2 *Zonation and succession*

Gorse scrub occurs in mosiacs with acid grasslands, heaths, and underscrub communities on marginal agricultural land. It is also found as a linear feature on woodland fringes and along hedgerows. The grasslands are typically *Festuca ovina-Agrostis capillaris-Galium saxatile* grassland (U4), or more acidophilous forms of mesotrophic grasslands (e.g. MG5, MG6). Many heath communities, dominated by dwarf gorse and ericaceous shrubs occur in intimate mixture with gorse scrub, the identity of the communities depending on geographical location. On sea cliffs, the scrub occurs in areas of maritime fescue grassland (MC9 *Festuca rubra-Holcus lanatus* maritime grassland, MC10 *Festuca rubra-Plantago* spp. maritime grassland). In extensively grazed areas, there is usually an extensive fringe of *Pteridium aquilinum–Rubus fruticosus* underscrub (W25).

Gorse scrub occurs on patchy drift deposits in landscape characterised by neutral or calcareous soils. Here, this scrub type can show transitions to blackthorn or hawthorn scrub. It is in such localities that the so-called 'chalk heath' communities occur. Enrichment of the calcareous soils lying on the slopes beneath such deposits, combined with the ability of gorse to acidify its rhizosphere, allowing gorse and other calcifuges such as heather *Calluna vulgaris*, to coexist with calcicolous chalk grassland species.

Onward succession of gorse scrub to woodland is prevented by grazing or burning, resulting in a dynamic mosaic of this scrub type with acid grassland or heathland. Tall, eutrophic herb communities occur on fertile soils after burning or soil disturbance. The tree species which colonise gorse scrub are birch, oak and pine. Closure of the tree canopy results in oak woodland (W10 on fertile brown earths, W16 *Quercus* spp.-*Betula* spp.-*Deschampsia flexuosa* woodland on infertile, acid soils). In the upland fringes, such scrub is succeeded by mixed birch and oak woodland (W11 *Quercus petraea-Betula pubescens-Oxalis acetosella* woodland or W17 *Quercus petraea-Betula pubescens-Dicranum majus* woodland). On cliff tops, exposure may prevent further development of this scrub community.

2.5.3.3 *Conservation value*

This scrub type is widespread on suitable soils throughout lowland Britain. Although its botanical diversity is low, it is of considerable conservation value in the south because of the importance of its associated organisms or as part of habitat mosaic. For example, this scrub type is important for populations of stonechat *Saxicola torquata* and Dartford warbler *Sylvia undata*.

2.6 Upland scrub types

The definition of the upland zone used here follows that of Ratcliffe and Thompson (1988), that is, those areas lying typically above the limits of enclosed farmland. This section therefore includes scrub types found in areas at low altitudes where climatic conditions are particularly unfavourable, for example the exposed coasts of north-western Scotland.

2.6.1 Scrub on wet soils in the forest zone

2.6.1.1 Scrub communities

Willow carr is associated with open water transitions and mires in the wetter northern parts of Britain. Whilst not exclusively an upland scrub type, occurring as it does around lakes at low altitude, it is best considered a scrub type of the upland zone. In contrast to its southern counterpart, the *Salix–Betula–Phragmites* woodland (W2), alder and downy birch occur with lower frequency. In these conditions grey willow is joined by other Salices which have a northern montane distribution in Britain, most notably bay willow *Salix pentandra*. Many of the associated shrub species found in lowland willow carr are absent from these northern carrs. The understorey is heterogenous, with tall forbs such as meadowsweet, shorter forbs such as marsh-marigold *Caltha palustris* and sedges, the most frequent of which is bottle sedge *Carex rostrata*. Bryophytes may contribute significantly to the ground cover. In the NVC, such vegetation is described as *Salix pentandra–Carex rostrata* woodland (W3).

Three willow species are best considered with scrub types of the forest zone, although their distributions extend into the sub-alpine zone. Eared willow *Salix aurita* occurs widely in the Western Highlands, often with grey willow at lower altitudes. The ground flora of these stands resembles those of the *Betula pubescens-Molinia caerulea* (W4) or *Alnus glutinosa-Fraxinus excelsior-Lysimachia nemorum* (W7) woodlands of the NVC.

Upland scrub of tea-leaved willow *Salix phyllicifolia* occurs in northern England and Scotland, usually on river banks. Stands can be found in Upper Teesdale, along the River Tyne and River Dee in Aberdeenshire. Such scrub stands form important refugia for a wide range of grazing intolerant plants such as wood crane's-bill *Geranium sylvaticum* and globeflower *Trollius europaeus* (Pigott 1956). The stands in northern England form the main location for shrubby cinquefoil *Potentilla fruticosa* in Britain (J. Hopkins, pers. comm.). Dark-leaved willow *Salix myrsinifolia* occurs in similar situations to tea-leaved willow, along river banks, lake shores and damp rock ledges.

Bog myrtle scrub also occurs in open mires in the upland fringes. This scrub type is similar to its lowland counterpart, described in section 2.4.3.

2.6.1.2 Zonation and succession

In open water transitions around lakes, willow carr is separated from open water by fen and swamp communities. On drier ground, the scrub can grade into woodland, often birch woodland (W4), or border wet pastures (Pearsall 1918, Tansley 1939, Pigott & Wilson 1978). In basin mires, willow carr occurs in complex mosaics with fen, mire and birch woodland communities, the vegetation patterns reflecting local variations in water levels and base status (Proctor 1974, Adam *et al.* 1975).

Succession of willow carr in these situations is likely to lead to birch (W4) or alder (W6) woodland. In some circumstances, woody vegetation may be a precursor to herbaceous bog, with Sphagnum increasing in abundance as terrestrialisation decreases the influence of the typically base-rich ground water on the vegetation of the mire surface (Rodwell 1991a).

2.6.1.3 Conservation value

Upland willow carr forms an important component of the landscape in areas with mosaics of open water, swamp, fen, mire and woodland. It forms a component of wet woodland, a priority habitat in the UK BAP.
Tea-leaved willow stands in northern England form important habitats for several rare plant species.

Residual alluvial forests (Alnion glutinosae-incanae)
CORINE: 44.3 NATURA 2000: 91E0

Bog woodland
CORINE: 44A1-44A4 NATURA 2000: 91D0

2.6.2 Scrub on dry soils in the forest zone

2.6.2.1 Scrub communities

Scrub dominated by hawthorn occurs widely in upland areas of western Britain (Tansley 1953). Other woody species present include blackthorn, grey willow, hazel, rowan and crab apple *Malus sylvestris* (Good *et al.* 1990). Such vegetation is not described in the NVC, but has similarities to the *Pteridium aquilinum-Rubus fruticosus* community (U20), and is best regarded as a treeless variant of the Quercion robori-petraeae.

2.6.2.2 Zonation and succession

Hawthorn scrub usually occurs as discrete patches on freely draining brown earth or brown podzolic soils on steeper slopes in upland pastures. These stands are surrounded by *Agrostis-Festuca* grassland or bracken (U20) communities. The patches may be formed by suckering or limited seed dispersal. The use of this scrub type by passerine birds for roosting may contribute to this patchiness.

Studies in Snowdonia have shown that individual hawthorn bushes in this vegetation type may be very long-lived. It is thought that colonisation of the grassland was the result of a past relaxation in grazing pressure, although some bushes may form a relict of previous woodland vegetation. Tree species are generally absent from the sward, so succession to woodland is unlikely to occur (Good *et al.* 1990).

2.6.2.3 Conservation value

Plant and animal communities associated with upland thorn scrub are generally of low diversity. This scrub type forms an important landscape element in upland areas, adding to their structural complexity. In these places, it provides important habitat for bird species such as stonechat *Saxicola torquata*, whinchat *Saxicola rubetra* and tree pipit *Anthus trivialis*.

This scrub type is rather uncommon on the continent of Europe and does not fall easily into European phytosociological systems. It may be regarded as a variant within the Querceta robori-petraeae lacking trees, for much of this bracken land can be shown to have been cleared of woodland in recent times.

2.6.3 Treeline scrub and scrub woodland

2.6.3.1 Scrub communities

Between the upper limit of the forest zone at the 'tree line', and the lower limit of the alpine zone, at the altitudinal limit of tree growth, lies the sub-alpine zone (MacKenzie 1997) or sub-montane zone (*sensu* Ratcliffe & Thompson 1988). Within this zone, tree and shrub species grow togther and in places form a scrub woodland. Tree species including birch, hazel, oak, aspen *Populus tremula,* rowan *Sorbus aucuparia* and Scots pine *Pinus sylvestris* occur in this zone in stunted and wind-pruned forms.

For example, Scots pine becomes increasingly stunted towards the upper limit of its altitudinal range, above 600 m, through exposure to wind and low temperatures. Here, low-growing 'Krumholz' trees in excess of 200 years of age may be found. The understorey is usually composed of bilberries *Vaccinium* spp. with some heather and extensive bryophyte cover.

2.6.3.2 Zonation and succession

Treeline scrub woodland occurs very rarely in Britain, although scattered trees occur often in the sub-alpine zone zone, they seldom form scrub vegetation. Scots pine can be found growing at its altitudinal limit at only a very few places in the Scottish highlands. The most notable of these is at Creag Fhiaclach in the Cairngorms. Here, Scots pine scrub gives way to montane juniper scrub with increasing altitude. Below this altitude, pine forest consisting of patches *of Pinus sylvestris–Hylocomium splendens* woodland (W18 in the NVC) interspersed with open areas of heath with bilberry, heather and bearberry *Arctostaphylos uva-ursi* (H12 *Calluna vulgaris-Vaccinium myrtillus* heath, H16 *Calluna vulgaris-Arctostaphylos uva-ursi* heath). Succession of Scots pine scrub is prevented by the exposed conditions.

1.6.4.1 Conservation value

Scots pine scrub occurs in a few places at high altitudes in the Scottish highlands. These sites represent some of the only places in the UK where trees persist up to their altitudinal limit. Such scrub is a component of native pine forest, a Priority Habitat, and occurs in association with more open juniper formations.

*** Caledonian forest**
CORINE: 16.27 NATURA 2000: 2250

2.6.4 Upland juniper scrub

2.6.4.1 Scrub communities

Juniper forms scrub vegetation in the uplands of northern Britain, up to altitudes in excess of 650 m (Rodwell 1991a). Two sub-species of juniper occur in these situations, forming components of two different vegetation types. *Juniper communis* ssp. *communis* forms scrub vegetation that is a component of the *Juniperus communis* ssp. *communis–Oxalis acetosella* woodland (W19) of the NVC. This scrub type usually has a patchy spatial structure, with open areas and thickets of dense juniper. There are few other woody species associated with this scrub type, although stunted individuals of birch *Betula pubescens* occur infrequently. The open areas are characterised by vegetation composed of dwarf shrubs (e.g. bilberry), ferns (e.g. hard-fern *Blechnum spicant*), herbs (e.g. heath bedstraw, wood-sorrel *Oxalis acetosella*) and bryophytes (e.g. *Hyloconium spendens*).

Juniper communis ssp. *nana* occurs as a low growing shrub in mixed dwarf shrub heath (H15 *Calluna vulgaris-Juniperus communis* ssp. *nana* heath), on gentle slopes at the upper limits of the sub-alpine zone and lower limits of the alpine zone (Horsfield & Thompson 1997). It also occurs as isolated individuals in other alpine heaths such as *Calluna vulgaris-Arctostaphylos alpinus* heath (H17, Rodwell 1991b).

2.6.4.2 Zonation and succession

Upland juniper scrub occurs in zonations with a range of upland grassland heath and mire communities, the spatial patterning reflecting both edaphic conditions and grazing pressure. In areas where calcareous rock outcrops lead to base-rich soils, juniper scrub occurs alongside calcareous grassland (e.g. CG9 *Sesleria albicans-Galium sterneri* grassland, CG10 *Festuca ovina-Agrostis capillaris-Thymus praecox* grassland). On more acidic soils, juniper occurs with upland dwarf shrub heaths (e.g. H18 *Vaccinium myrtillus-Deschampsia flexuosa* heath). In this situation, boundaries between herbaceous vegetation with scattered juniper bushes and true juniper scrub may be difficult to place. With increases in soil water logging, juniper scrub may give way to mire or wet heath communities (e.g. M10 *Carex dioica-Pinguicula vulgaris* mire, M15 *Scirpus cespitosus–Erica tetralix* wet heath)

Below the tree line, *Juniperus communis-Oxalis* scrub shows transition to woodland (usually W11, W17 or W18) with increasing cover of birch, oak or pine, scrub and woodland communities occurring in intimate mosaics. Above the tree line in the Scottish highlands, *Juniperus communis-Oxalis* scrub replaces pine scrub at the altitudinal limit of Scots pine.

At high altitudes, juniper scrub may represent a climax montane scrub community. However, at lower altitudes, it is likely that management factors, especially grazing pressure, limit colonisation by tree species. Here, juniper scrub is best considered a seral community (Rodwell 1991a).

2.6.4.3 Conservation value

The importance of juniper scrub for nature conservation is reflected in the fact that it is the most widely studied scrub type in the UK. Juniper has its own Species Action Plan in the UK BAP. Upland juniper scrub is one component of the juniper formations listed in the Habitats Directive. *Juniperus communis-Oxalis* scrub occurs in the forest zone in the Scottish Highlands and Southern Uplands. Stands occurring in the sub-alpine zone are rare and found mainly in the eastern Highlands. The total area of this montane scrub type is unlikely to exceed 100 ha in Britain (Horsfield & Thompson 1997). Scrub composed *of Juniperus communis* ssp. *nana* also has a restricted distribution, with an estimated area in Britain of 610 ha, occurring mainly in the northwest Highlands and Islands of Scotland (Horsfield & Thompson 1997).

The high altitude climatic climax stands of *Juniperus - Oxalis* scrub have close affinities with Scandinavian sub-alpine juniper scrubs such as the *Junipereto Betuletum nanae*

myrtilletosum (Nordhagen 1928, 1943). However, the juniper in Scandinavia is *Juniperus communis* ssp. *nana* and there is a good representation of dwarf birch *Betula nana*, while in Scotland there is no evidence of an association between juniper and dwarf birch. Whether these differences are sufficient to merit the Scottish communities being treated as distinct is a matter for debate.

Juniperus communis formations on heaths or calcareous grasslands
CORINE: 31.88 NATURA 2000: 5130

2.6.5 Dwarf birch scrub

2.6.5.1 Scrub communities

Dwarf birch occurs as a consituent of blanket bogs, and forms clumps of scrub at some sites in the north and central Highlands. These dwarf birch bogs were first described by Poore and McVean (1957) and fall within the *Betula nana* variant of *the Calluna-vulgaris-Eriophorum vaginatum* blanket mire, *Vaccinium vitis-idaea-Hylocomium splendens* sub community (M19ci, Rodwell 1991b).

2.6.5.2 Zonation and succession

Dwarf birch occurs as stands in blanket bogs and as isolated individuals and small patches in other upland heath communities (M15 *Scirpus cespitosus-Erica tetralix* wet heath, M17 *Scirpus cespitosus-Eriophorum vaginatum* blanket mire). Dwarf birch is suppressed by grazing and burning, and within Britain it occurs primarily in situations where soil conditions limit these factors (Hester 1995).

2.6.5.3 Conservation value

Dwarf birch is a nationally scarce plant species in Britain (Stewart *et al.* 1994). Dwarf birch scrub is known from a limited number of sites in the north and central Highlands, but the exact extent of this scrub type is unknown. Similar communities occur in Scandinavia, often with dwarf birch attaining a greater height. Dwarf birch scrub forms part of the blanket bog habitat in Annex I of the Habitats Directive (Anon 1996).

Blanket bogs (* active only)
CORINE: 52.1-52.2 NATURA 2000: 7130

2.6.6 Sub-arctic willow scrub

2.6.6.1 Scrub communities

On wet base-rich soils in montane areas with low grazing pressure, Arctic-Alpine or Arctic-Subarctic species of willow may form a low scrub vegetation up to 1 m high. Downy willow *Salix lapponum* is the most widespread species and usually dominates, it is accompanied, and occasionally replaced, by mountain willow *S. arbuscula*, woolly willow *S. lanata* or whortle-leaved willow *S. myrsinites*. The understory contains sub-shrubs, grasses and bryophytes, but perhaps most notable is the abundance taller herbs which are intolerant of grazing and low-growing Arctic-Alpine herbs. The NVC places such vegetation in a single community (W20 *Salix lapponum–Luzula sylvatica* scrub).

2.6.6.2 Zonation and succession

Sub-Arctic willow scrub usually occurs as isolated stands on rocky knolls or cliff ledges in a mosaic of *Festuca-Thymus-Agrostis* calcareous grassland (CG10) or *Festuca ovina-Agrostis capillaris-Alchemilla alpina* grass heath (CG11). At high altitudes it is associated *with Festuca-Alchemilla-Silene* dwarf heath (CG12) and *Dryas octapetala-Silene acaulis* ledge communities (CG14).

In places where calcareous rocks form local intrusions into less base-rich substrates, Sub-Arctic willow scrub may occur on rocky knolls or ledges surrounded by a landscape dominated by calcifuge grasslands or heaths. Here, Sub-Arctic willow scrub grades with *Luzula sylvatica-Geum rivale* (U17) or *Luzula sylvatica-Vaccinium myrtillus* (U16) cliff ledge communities, which may contain isolated individuals of montane willows.

Rodwell (1991a) considers *Salix-Luzula* scrub to be sub-alpine climax vegetation on wet base-rich soils, replacing scrubby *Fraxinus excelsior-Sorbus aucuparia-Mercurialis perennis* woodland (W9) with increasing altitude. Such transitions may once have been widespread in the Scottish Highlands, but have been lost through increased grazing pressure.

2.6.6.3 Conservation value

Sub-Arctic willow scrub is one of the UK's rarest habitats, occurring as small discrete stands, nowhere larger than 0.5ha and largely confined to the Scottish Highlands. Many of the dominant shrubs are either Nationally Scarce or Red Data Book species. A Species Action Plan has been drawn up for woolly willow, a Priority Species in the UK BAP.

Within Europe, similar vegetation occurs only in Sweden and Finland. Selection of SACs in the UK has taken account of the association of this habitat with others listed in Annex I, namely Eutrophic tall herb, Alpine calcareous grassland, Alpine and subalpine heaths and Species-rich *Nardus* grassland (a priority habitat).

Based on the current much more widespread distribution of similar vegetation in Scandinavia, it is likely that it was once much more widely distributed in Scotland and has been brought to the verge of elimination by man's activities (Mardon 1991). The nearest equivalents to the *Salix -Luzula* scrub community in Europe are the various kinds of aub-alpine willow scrub described from Scandinavia by Nordhagen (1928, 1943) and Dahl (1956), particularly the *Salicetum geraniosum alpicolum* from Sikilsdalen and the *Rumiceto - Salicetum lapponae* from the Rondane area. According to Rodwell (1991a) there are distinct differences between these communities and our own montane willow scrub which generally has fewer tall herbs and does not spread into mire vegetation like its Scandinavian counterparts. More generally, the *Salix-Luzula* scrub belongs among the sub-alpine and alpine tall-herb communities in which Ellenberg (1978) has distinguished a Salicion arbusculae with prominent dwarf willows. It may be considered, as argued by Gilbert *et al.* (1997) that the differences between the Scottish and Scandinavian communities are sufficient to justify a special conservation effort for W20. The requirements to ensure its survival and expansion have been discussed by Mardon (1991) and Gilbert *et al.* (1997).

Sub-Arctic Willow scrub
CORINE: 31.622 NATURA 2000: 4080

3 Distribution and conservation value

3.1 Distribution and extent of scrub types in Britain

3.1.1 Scrub distribution

There is no available map or dataset that accurately represents the distribution of scrub communities in the British Isles. This is partly because scrub is mostly impermanent and often has imprecise boundaries, but mainly because scrub is difficult to define or classify from remote sensed images. Thus the ITE Land Cover Map (LCM), which is based on remote sensing of land cover, cannot be used with adequate precision for identifying the occurrence of scrub. The best available indication of nation-wide scrub cover is probably provided by the ITE Countryside Information System (CIS), which predicts the occurrence of 'shrub' in each 1km square based on its occurrence in similar squares from among the 570 sampled in the 1990 Countryside Survey (CS90). This information is presented in map form in Figure 3.1. The definition of shrub used is: 'Woody vegetation predominantly of shrubby species (even if >5 m high) often with tree regeneration and brambles with a canopy cover of > 50%. Dry shrub contains species such as hawthorn *Crataegus monogyna*, blackthorn *Prunus spinosa*, grey willow *Salix cinerea*, dog rose *Rosa canina*, gorse *Ulex europaeus*, broom *Sarothamnus scoparius*, and includes dune scrub dominated by such species as sea-buckthorn *Hippophäe rhamnoides*. Swampy shrub and carr comprises semi-natural shrub growing on waterlogged substrate, particularly peat. Species include willows *Salix* spp. and alder buckthorn *Frangula alnus*. The map does not include carr woodland, dominated by such species as downy birch *Betula pubescens* and common alder *Alnus glutinosa*, which is included in the broadleaved woodland category.

The map (Figure 3.1) indicates that in 1987-8 (the date of the survey), scrub occurred most frequently on calcareous soils in the south of England, around the coasts of south-west England and Wales, and on marginal lands in the uplands throughout Great Britain. The general pattern of distribution is unlikely to have changed over the past 12 years, although there may have been some regional changes in scrub area due to changes in grazing pressures.

3.1.2 Occurrence of individual scrub types

Scrub is a major habitat type on the chalk and limestone in the south of England and to a lesser extent the calcareous soils in the Peak District. The most widely distributed NVC communities in these situations are the *Crataegus monogyna-Hedera helix* (W21) and *Prunus spinosa-Rubus fruticosus* (W22) scrub communities (Rodwell 1991a). These communities also occur on neutral soils including quite heavy clays in the south of England. In some places on the chalk, especially on steeply-sloping, south-facing ground NVC community W13 (*Taxus baccata* woodland) occurs. It frequently displaces juniper *Juniperus communis* scrub, the yew seedlings being protected by the mature juniper bushes. Although the stands of W13 may be very long-lived the individual yews rarely exceed 10 m in height and the vegetation has the appearance of scrub.

The equivalent hawthorn scrub to W21 in the uplands is not given an individual NVC community or sub-community type, although it may be considered to be a characteristic component of U20 (*Pteridium aquilinum-Galium saxatile*) community. This scrub type, in which hawthorn bushes, and to a lesser extent other shrubs (hazel *Corylus avellana*, crab apple *Malus sylvestris*, blackthorn and holly *Ilex aquifolium*), are scattered among bracken *Pteridium aquilinum*, generally occurs on steeply-sloping marginal land. It is very widespread throughout the uplands of England and Wales, but is much less common in Scotland. In many cases upland hawthorn scrub appears to be a plagio-climax community rather than a seral stage to woodland since research has shown that some stands are centuries old (Good *et al.* 1990). Ironically, because the hawthorn bushes often comprise <50% of land cover, the community which is dominated both visually and ecologically by their presence is described as grassland rather than scrub.

Scrub, mainly dominated by birch *Betula* spp. and gorse (W23 *Ulex europaeus-Rubus fruticosus* scrub) occurs widely on acid heathlands and lowland commons throughout the south and west of England and Wales. It often forms a mosaic with heathland and acid grassland, the extent and species composition of the scrub component varying depending on location with soil type, surrounding vegetation and exposure influencing it. Scrub on heathland adjacent to native broadleaved woodland may be rapidly colonised by oak *Quercus* spp., while on sites where seed is available from nearby plantations or adjacent more mature scrub, Scots pine *Pinus sylvestris* may invade and take over the site.

Gorse scrub may also be found around the coast where it may invade many communities on base-poor soils if the opportunity is afforded by decline of agricultural usage. The other common coastal scrub community on more base-rich soils is W22 which is common on cliffs and which often spreads inland where grazing is light or lacking. It often forms a mosaic with various heath communities, notably H7 *Calluna vulgaris-Scilla verna* (maritime heath) (which also occurs on the west coast of Scotland and the inner and outer isles), H8 *Calluna vulgaris-Ulex gallii* heath and, to a lesser extent H12 *Calluna vulgari -Vaccinium myrtillus* heath. On soft coasts scrub dominated by sea-buckthorn (SD18 *Hippophae rhamnoides* scrub) is widespread, often having been planted for stabilisation of dunes. It is often regarded as having a largely deleterious influence but a detailed study in the 1970's (Ranwell 1972) suggested that it has benefits as well, providing shelter for a wide range of plants and animals. Hawthorn scrub may also 'invade' dune systems, as happened on a wide scale following the decimation of rabbit populations by myxomatosis from the mid-1950's onwards. The progress of hawthorn scrub development at Newborough Warren on Anglesey and the resultant nitrogen and phosphorus enrichment of topsoil were recorded by Hodgkin (1984).

On wetter inland sites in the south of England willow carr (W1 *Salix cinerea-Galium palustre* and W2 *Salix cinerea-Betula pubescens-Phragmites australis* woodlands) are an important

and widely distributed scrub woodland types. In northern Briatin, scrubby woodland of W3 *Salix pentandra-Carex rostrata* woodland occupies similar sites. Alder and birch woodlands (W4 *Betula pubescens-Molinia caerulea*, W5 *Alnus glutinosa-Carex paniculata*, W6 *Alnus glutinosa-Urtica dioica* and W7 *Fraxinus excelsior-Lysimachia nemorum* woodlands), while not strictly scrub often have a scrubby appearance and structure. W4 and W7 are found mainly in the north and west of England and Wales, W5 and W6 predominantly in the south.

Some scrub types, notably W20 (*Salix lapponum-Luzula sylvatica* scrub),W19 (*Juniperus communis-Oxalis acetosella* woodland), and box *Buxus* scrub have conservation interests disproportionate to their very small ranges, in part because they probably represent remnants of communities which were once much more widespread.

In Scotland there is considerable interest in the conservation of scrub communities, several of which are rare and/or threatened, often as a result of overgrazing (Hester 1995). Data from the Scottish National Countryside Monitoring Scheme shows only 2% scrub cover in the 1970s, with Grampian Region containing the most extensive scrub communities. The total area of scrub in Scotland is unlikely to have changed substantially since then. However, more recent surveys provided detailed information on the distribution and extent of montane scrub in north-west Scotland (MacKenzie 1996) and in east, west and south Scotland and the Northern Isles (MacKenzie 1999). McKenzie is currently collating all known information on high altitude and coastal Scottish scrub (D. Gilbert *pers. comm.*). This work has highlighted the variability of information available, particularly the lack of information on the size and condition of sites. In some cases a four figure grid reference is the only available information. Several recent studies have provided additional, more detailed information on the distribution and abundance of juniper scrub in different parts of Scotland including the Borders (McBride 1997) and Fair Isle (Riddiford 1997).

The high altitude (350-500 m) area of birch and juniper at Morrone in NE Scotland is probably the nearest equivalent in Britain to the extensive Scandinavian sub-alpine birch/juniper scrub (Hester 1995). Many of the birch are contorted and <5 m tall (Ratcliffe 1977, Huntley & Birks 1979a, 1979b). French *et al.* (1997) report the recent development of high altitude Scots pine scrub in the northern Cairngorm mountains following reduction in grazing and browsing and suggest that a natural subalpine scrub zone appears to be developing. Most of the natural scrub remaining on the islands to the north and west of Scotland has sub-alpine affinities due to extreme exposure (McVean 1964).

3.1.3 Sources and reliability of information

There is little information held by the country agencies on distribution or abundance of scrub on a national or local basis due to imprecise definitions and boundaries, and compounded by the former lack of interest in scrub.

Where scrub occurs in SSSIs and other designated areas in England, it is usually mentioned but is not quantified (as it is in the SSSI databases for Scotland and Wales). Management prescriptions for sites rarely include scrub management, with the exception of recommendations for its control or removal.

According to the ITE Countryside Information System, in 1990 approximately 43,000 1 km squares (18% of the total rural squares) contained > 0.5 ha but <4.1 ha of scrub. The total area of scrub in Great Britain in 1990 was estimated to be 900 km^2 (±200 km^2) of which 600 km^2 (±100 km^2) was in England, 200 km^2 (±50 km^2) was in Scotland and 100 km^2 (±50 km^2) was in Wales. More detailed figures for particular scrub types reside within the CS1990 and CS2000 databases, but it is beyond the scope of this study to extract and present that data. A comprehensive review is due to be published soon of the distribution and extent of scrub communities in Scotland, building on earlier reviews (MacKenzie 1996, 1999, Gilbert pers. comm.).

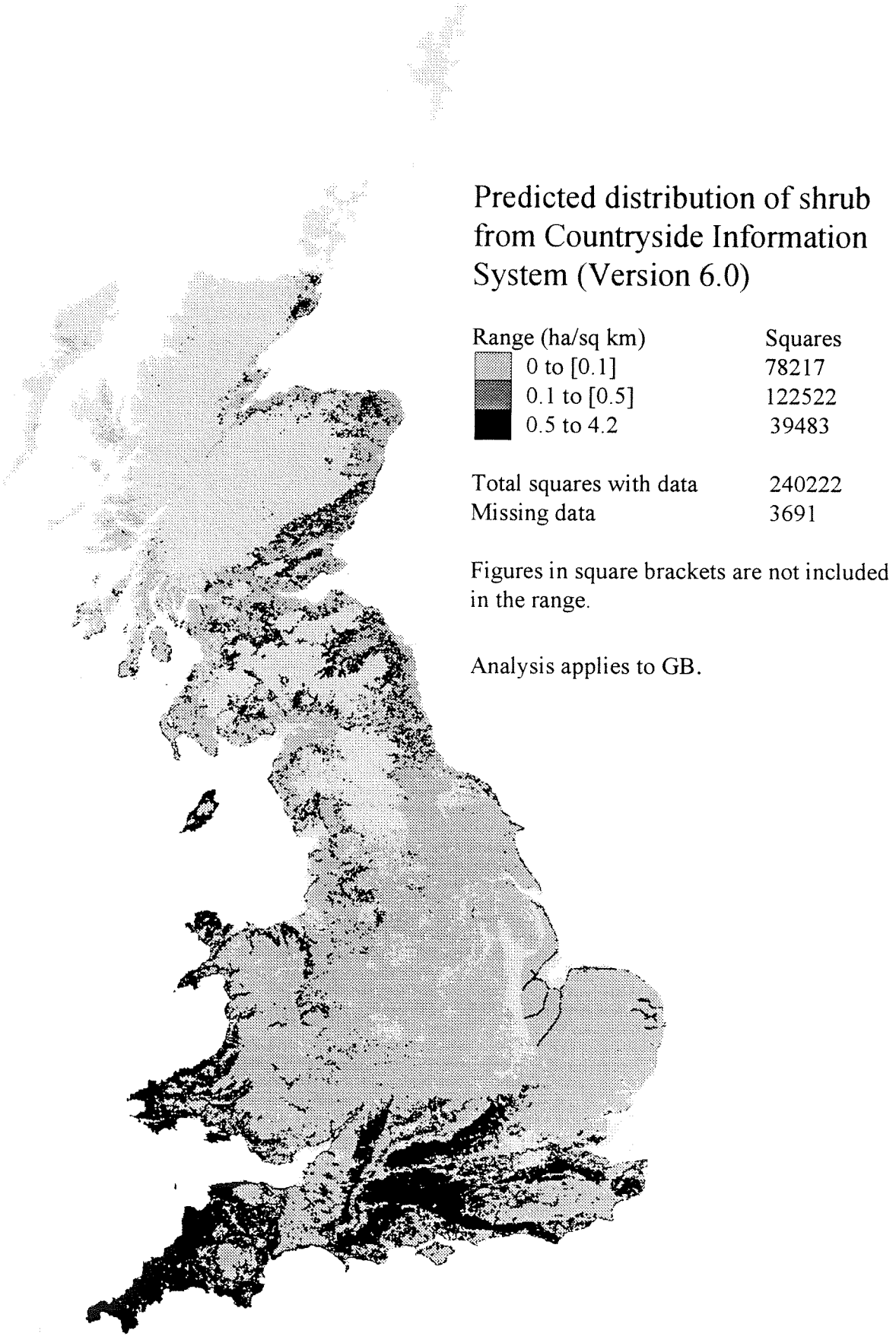


Figure 3.1 Predicted distribution of shrub from the Countryside Information System (Version 6.0).

3.1.4 Occurrence on protected sites

3.1.4.1 Nature Conservation Review (NCR) sites

The Nature Conservation Review (Ratcliffe 1977) provides some information on the distribution and nature conservation value of scrub habitats. Several scrub types are included in the woodland section of the review, however, information on the importance of scrub in these sites is difficult to gather from the published information. Tabular information is presented on the occurrence of scrub of nature conservation value in lowland grasslands, heathlands and coastal areas. This information is shown in Appendix 3.1. Scrub on many of these lowland sites is seral, and since the survey work for the NCR took place over 30 years ago, the continued conservation value of scrub communities on these sites cannot be assumed.

3.1.4.2 Sites of Special Scientific Interest (SSSIs)

Site descriptions held by the countryside agencies English Nature (EN), Scottish Natural Heritage (SNH) and Countryside Commission for Wales (CCW) for SSSIs provide a more useful indication of scrub distribution. These data indicate where scrub is a feature, and in some cases quantify scrub area. The data for England refers only to locations and is shown by major shrub types in Figures 3.2-3.7.

The distribution of SSSIs with calcareous scrub, mainly W21 *Crataegus monogyna-Hedera helix* scrub (Figure 3.2) seems to give a good representation of the major chalk and limestone areas in England, picking out the chalk of the North Downs, South Downs and Chilterns, the Oolitic limestone of the Cotswolds, Northamptonshire and Lincolnshire Wolds, and further north the Carboniferous limestone of Derbyshire, Yorkshire and the Lake District.

The distribution of lowland acid scrub dominated by gorse (W23 *Ulex europaeus-Rubus fruticosus* scrub) in SSSIs is shown in Figure 3.3. Its distribution, to a considerable extent, complements that of calcareous scrub (Figure 3.2) with concentrations in Cornwall, the Isle of Wight, and on freely drained non-calcareous soils in eastern England.

The distribution of lowland neutral scrub (predominantly W22 *Prunus spinosa-Rubus fruticosus* scrub) on SSSIs (Figure 3.4) picks out the deeper, moister and more fertile soils in Worcestershire, Warwickshire, Nottinghamshire and Lincolnshire, with scattered representation on the London Clay in the Home Counties. On some SSSIs, both calcareous scrub and neutral scrub occur on the same sites as there is often an imperceptible intergrading between hawthorn-dominated scrub (W21) and blackthorn-dominated communities (W22). Wetland scrub (W1 *Salix cinerea-Galium palustre*, W2 *Salix cinerea-Betula pubescens*, W3 *Salix pentandra-Carex rostrata*) on SSSIs is shown in Figure 3.5. These sites are concentrated in such areas as the Norfolk Broads, the Lake District and in Cornwall, with scattered sites in wetland areas elsewhere in England. The scrub is often a small component, for example where it forms fringing vegetation around lakes and fens.

It can be seen that most coastal SSSIs with scrub as a feature (Figure 3.6) are located in the south and west of England. Their distribution broadly follows that of hard rock coasts, where scrub is often found on sea cliffs, and soft coasts around tidal estuaries and on dune systems, for example along the coast of Lancashire.

Juniper *Juniperus communis* scrub is probably more fully represented within the SSSI network in England than any other type. Figure 3.7 clearly shows its distribution in the north of England and in the few areas where it occurs on calcareous soils in the south.

The distribution of scrub within SSSIs in Scotland and Wales is shown in Figures 3.8-3.11. For these countries, SSSI records do not generally indicate scrub type (NVC community). However, data on the area of scrub on each site have been extracted (Figures 3.8 and 3.10) and from these, the proportion of the area of each SSSI which is scrub has been calculated (Figures 3.9 and 3.11).

It can be seen that in Scotland most of the SSSIs with scrub mentioned as a component habitat are in the eastern central zone around the Firth of Forth and the southern highlands (Figure 3.8). Lesser concentrations are to be found in Berwickshire and Peebleshire and around the Cromarty Firth. Sites with large areas of scrub (>50 ha) are few in number and restricted to the west and north-east of Scotland. There are many sites where scrub exceeds 10% of the area, but only four where greater than 50% is scrub (Figure 3.9).

SSSIs with scrub in Wales show a more scattered distribution than in Scotland (Figure 3.10) although there are concentrations in Cardiganshire, Pembrokeshire and Anglesey. Most of the sites with appreciable areas of scrub are on or near the coast. Looking at the proportion of scrub in each SSSI we see (Figure 3.11) that, as in Scotland, there are many sites in Wales where scrub exceeds 10% of SSSI area but only a few where greater than 50% is scrub.

These maps show only the 'bare bones' of scrub distribution within SSSIs in the three countries. As we do not know the overall distribution and extent of different scrub communities, many of which are in any case constantly changing as a result of scrub clearance and successional processes, it is difficult to determine whether scrub is adequately represented within the individual country site networks. If it is, then except in the cases of such historically valued communities as juniper scrub, and montane willow scrub in Scotland, this is likely to be more by chance than design, since scrub is nearly always an incidental inclusion within SSSIs established primarily to protect other habitats.

3.1.4.3 Special Areas of Conservation (SACs)

Of the currently designated Special Areas of Conservation, about 25% contain scrub habitats of conservation importance. These sites are listed in Appendix 3.2, together with the scrub habitat types occurring on each sites according to classification used in Annex I of the Habitats Directive.

SSSIs with scrub identified in England

Calcareous (W21)

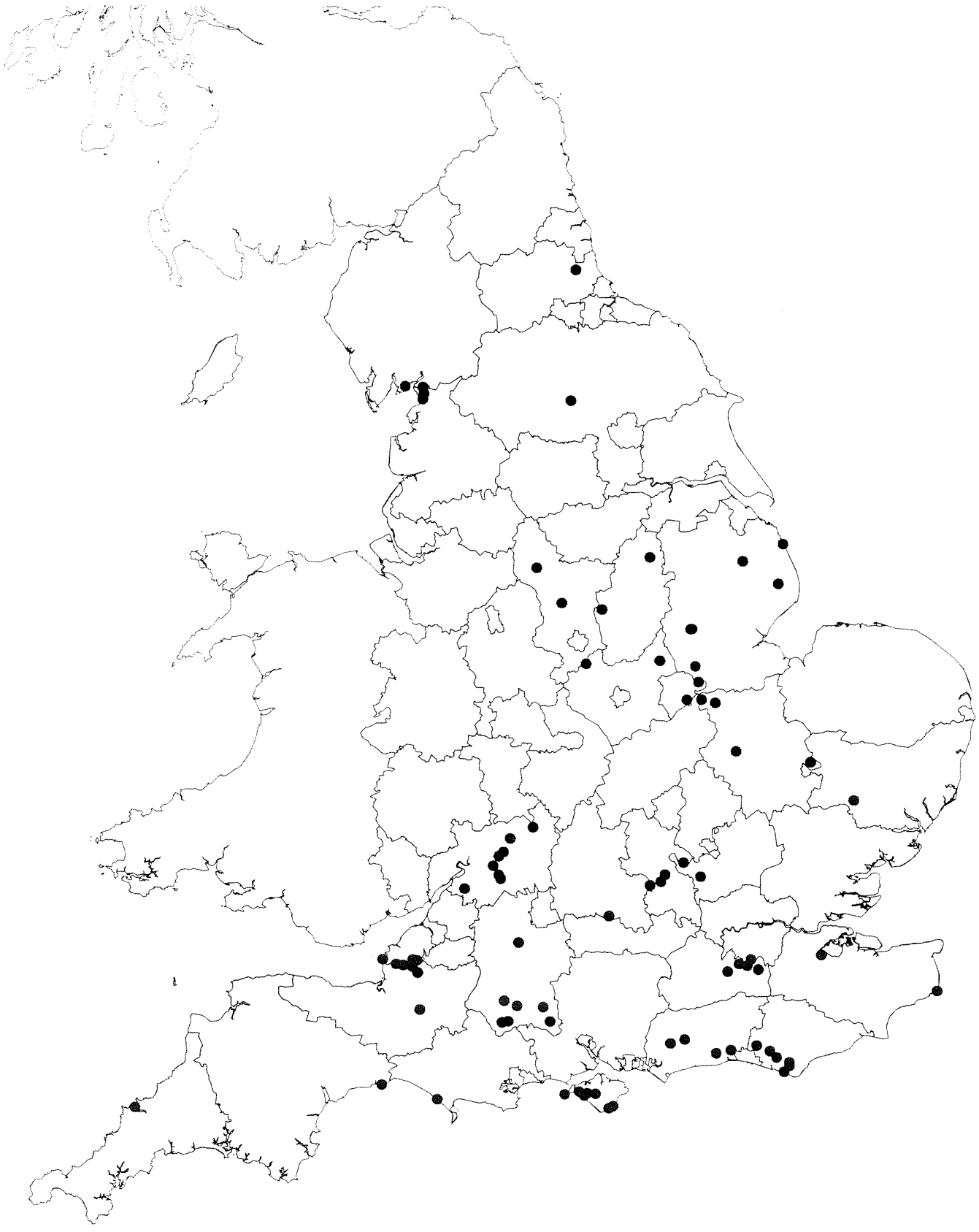


Figure 3.2 Distribution of scrub on dry lowland calcareous soils (NVC type W21) in Sites of Special Scientific Interest in England.

SSSIs with scrub identified in England

Lowland Acid (W23)

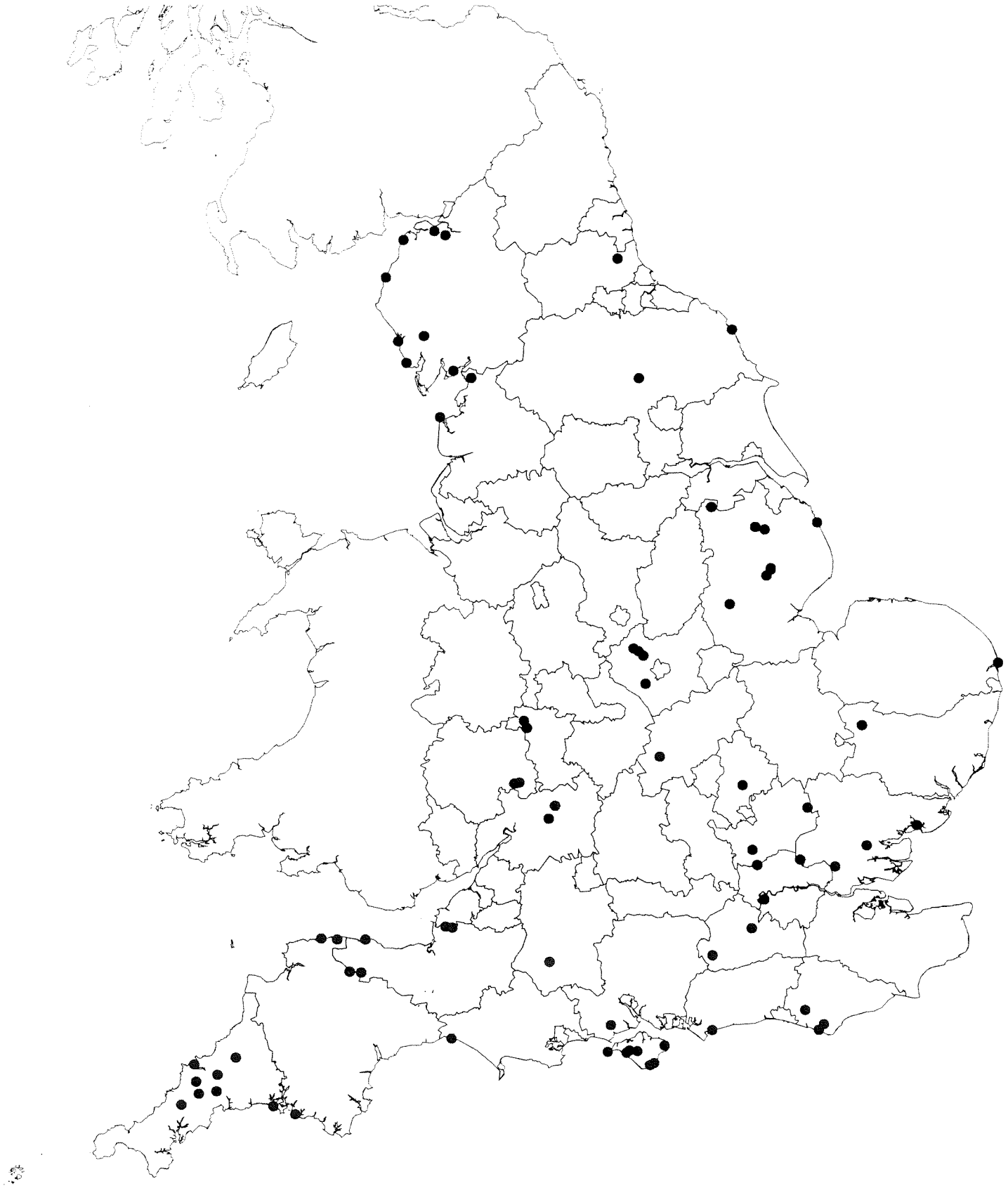


Figure 3.3 Distribution of scrub on dry lowland acidic soils (NVC type W23) in Sites of Special Scientific Interest in England.

SSSIs with scrub identified in England

Lowland Neutral (W22)

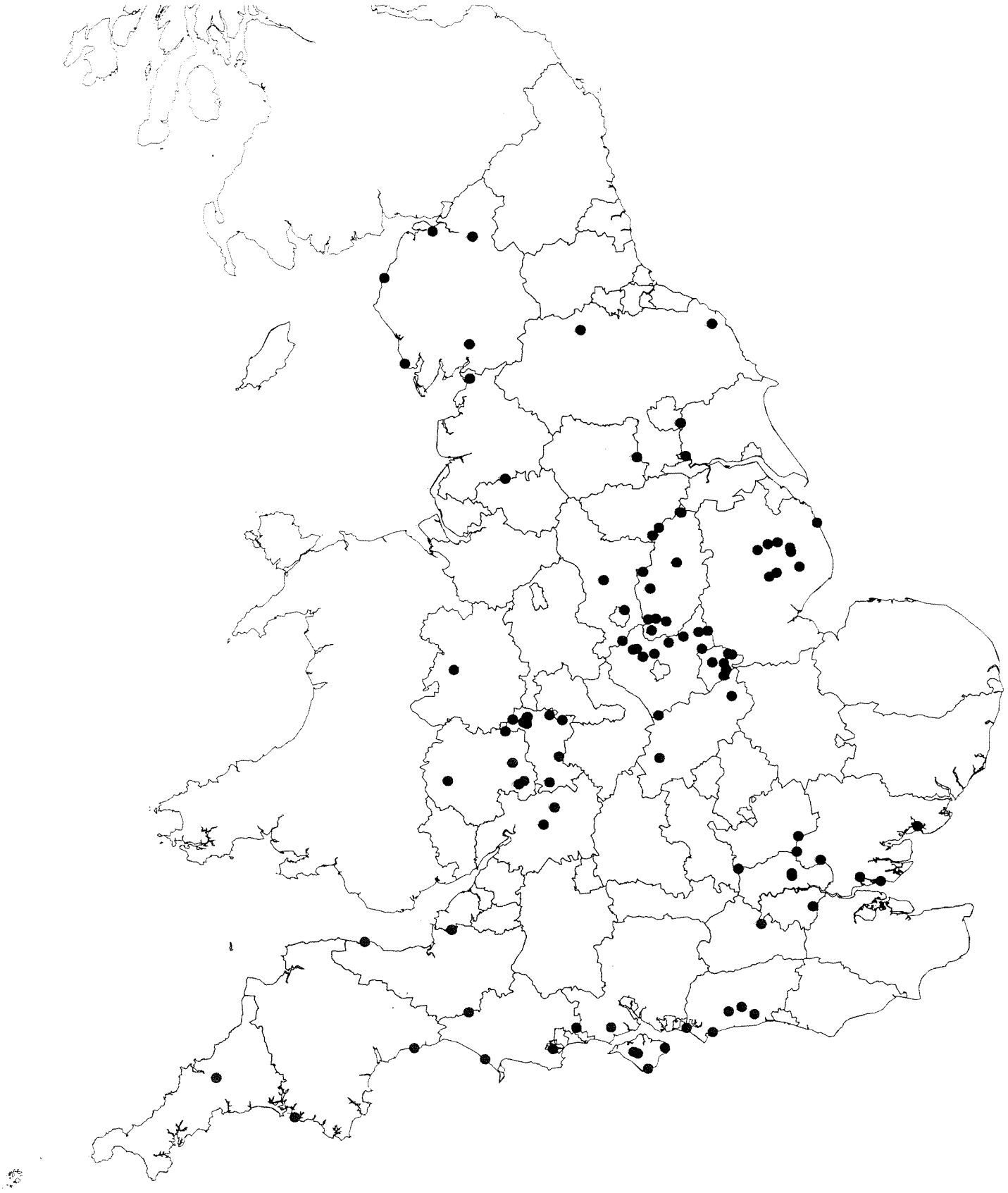


Figure 3.4 Distribution of scrub on dry lowland circumneutral soils (NVC type W22) in Sites of Special Scientific Interest in England.

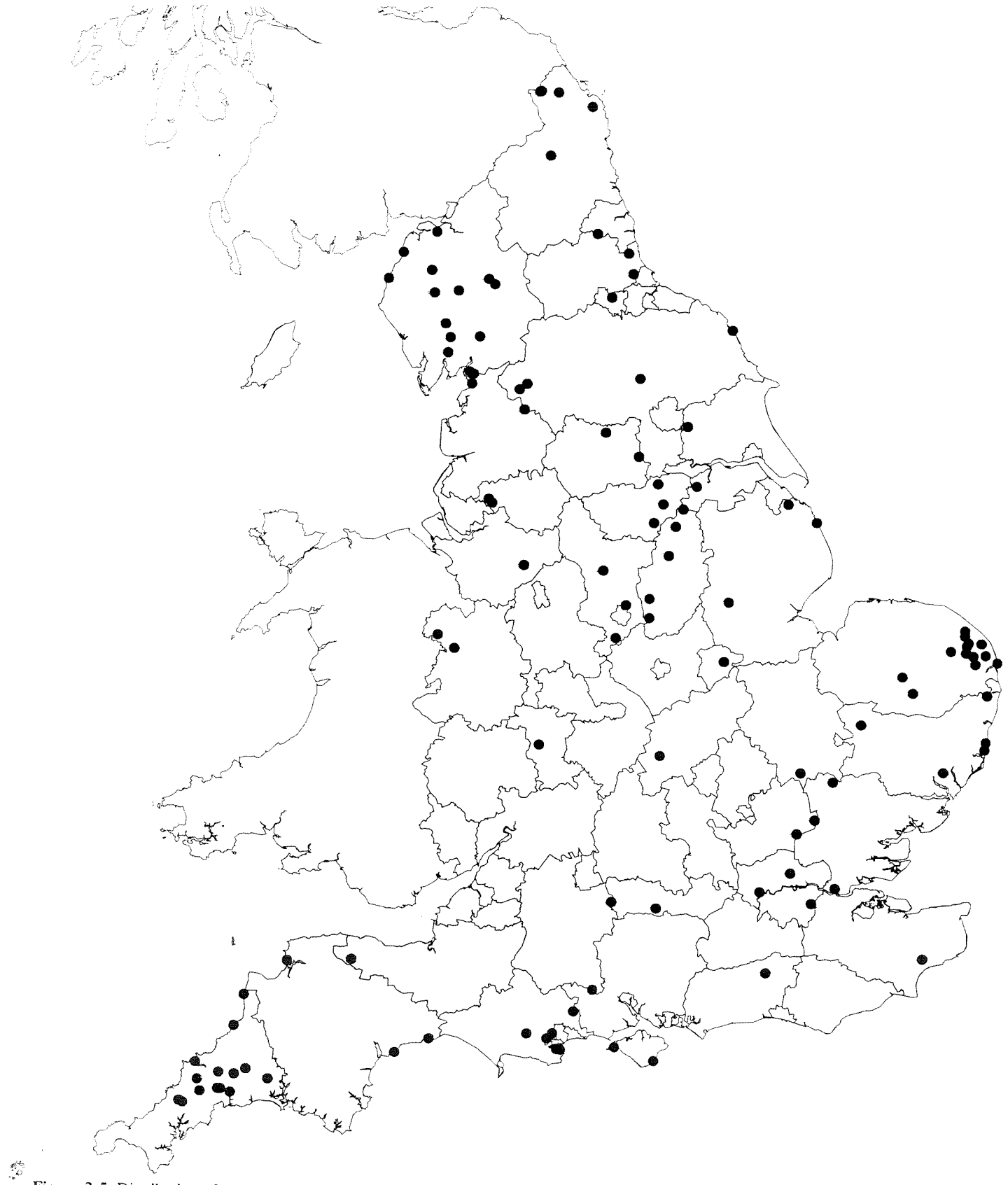


Figure 3.5 Distribution of scrub on wetland soils (NVC types W1, W2, W3) in Sites of Special Scientific Interest in England.

SSSIs with scrub identified in England

Coastal

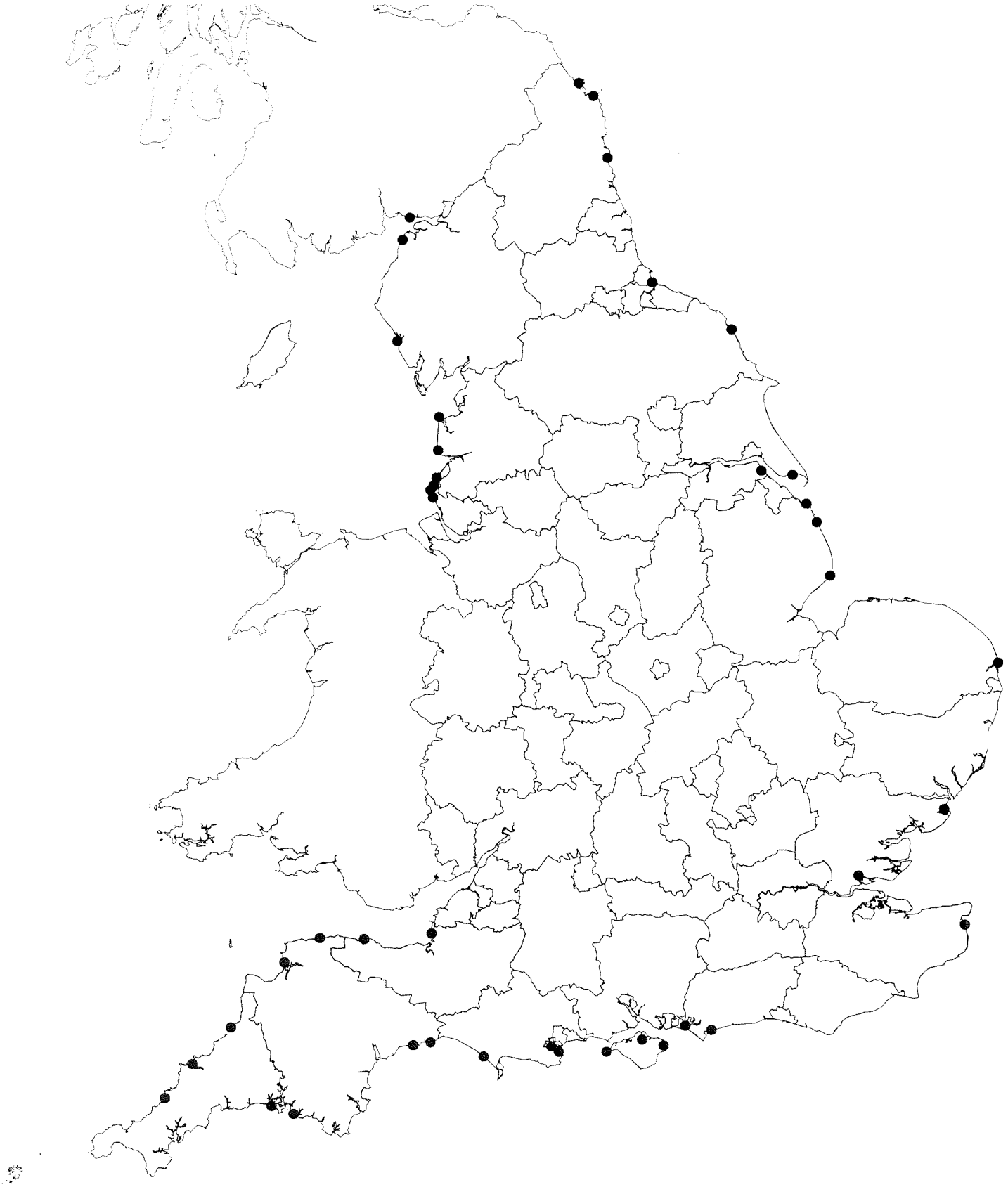


Figure 3.6 Distribution of scrub on coastal in Sites of Special Scientific Interest in England.

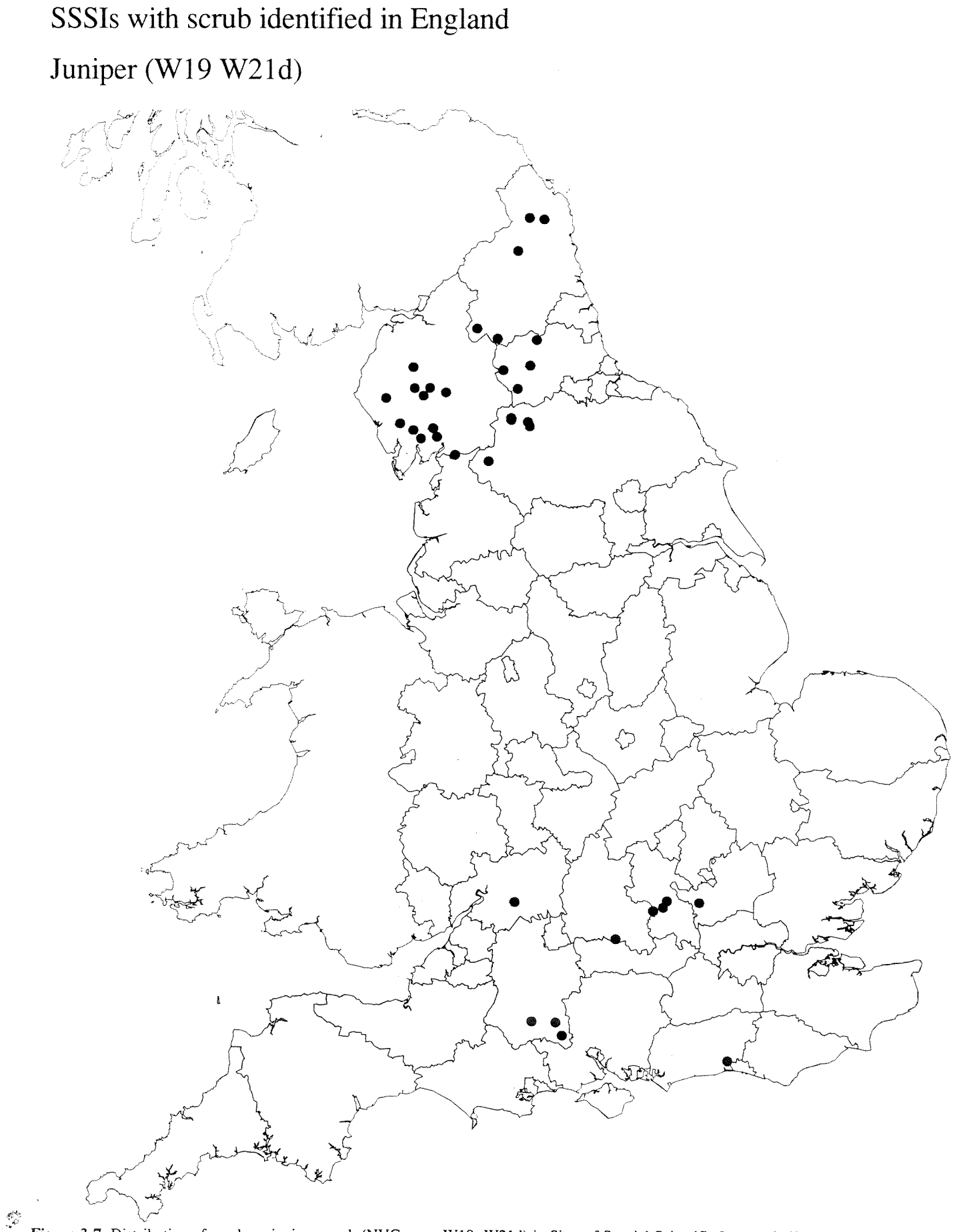


Figure 3.7 Distribution of scrub on juniper scrub (NVC types W19, W21d) in Sites of Special Scientific Interest in England.

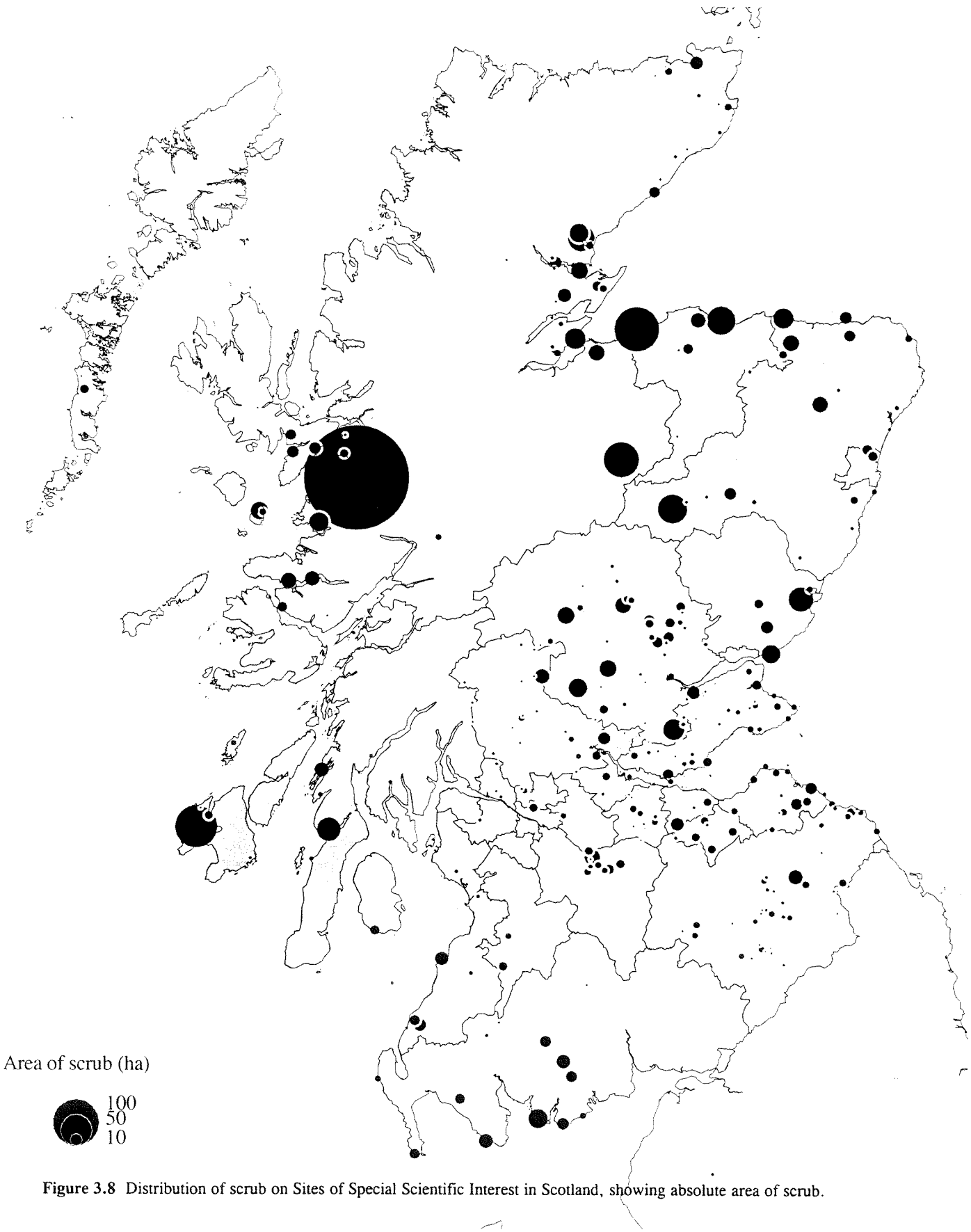


Figure 3.8 Distribution of scrub on Sites of Special Scientific Interest in Scotland, showing absolute area of scrub.

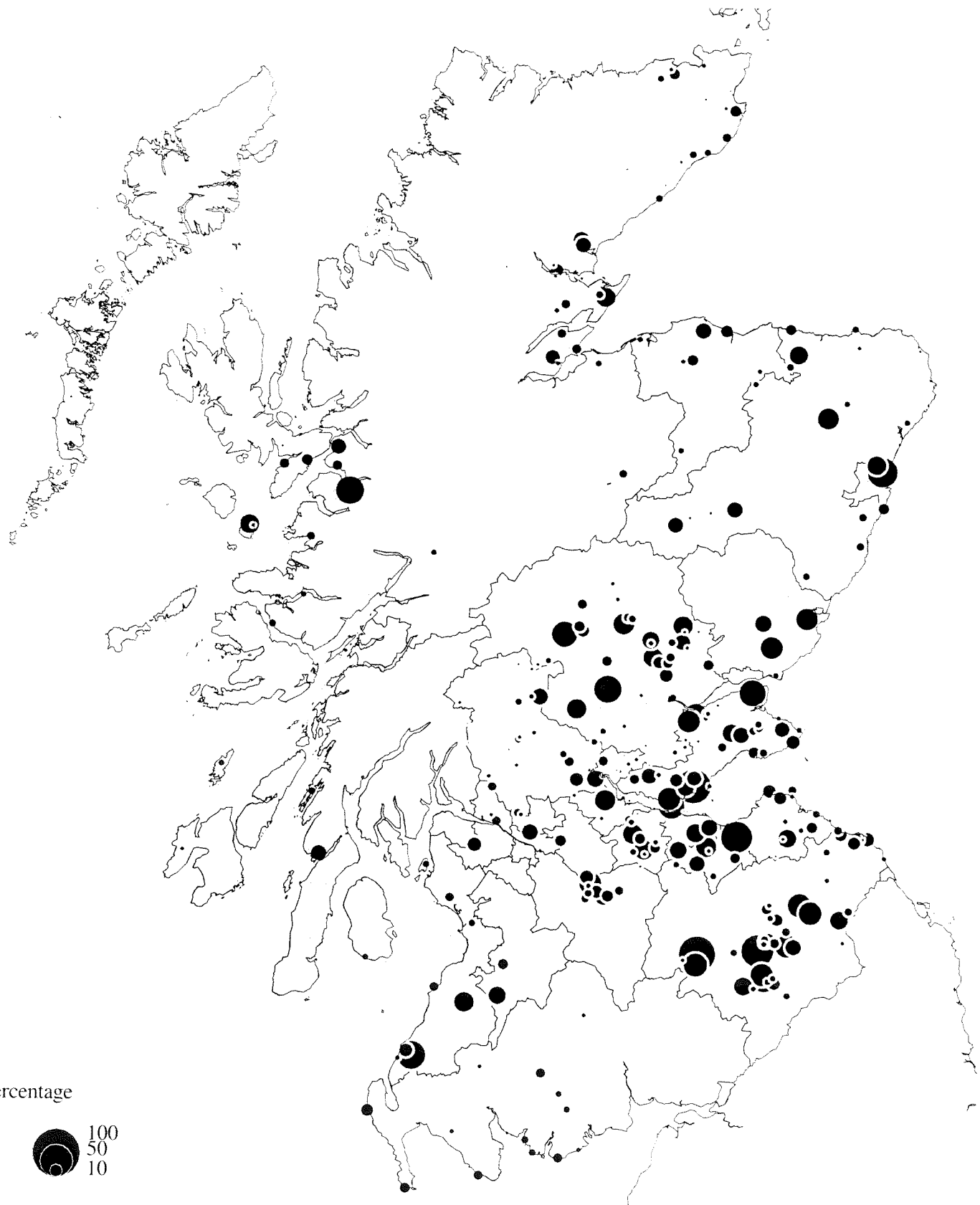


Figure 3.9 Distribution of scrub on Sites of Special Scientific Interest in Scotland, showing scrub as a proportion of total site area.

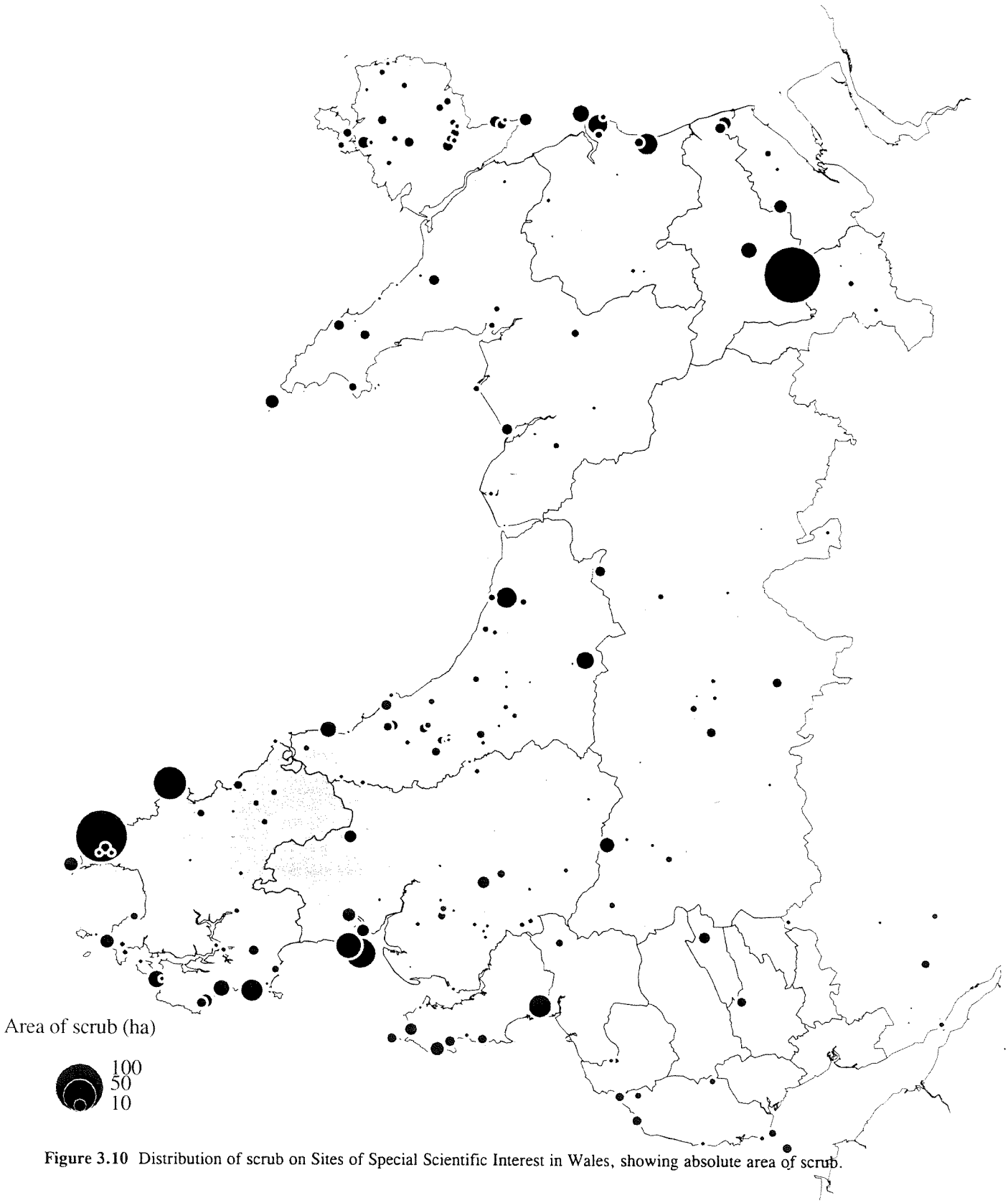


Figure 3.10 Distribution of scrub on Sites of Special Scientific Interest in Wales, showing absolute area of scrub.

SSSIs with scrub identified in Wales

Symbols indicate scrub as proportion of total SSSI area (%)

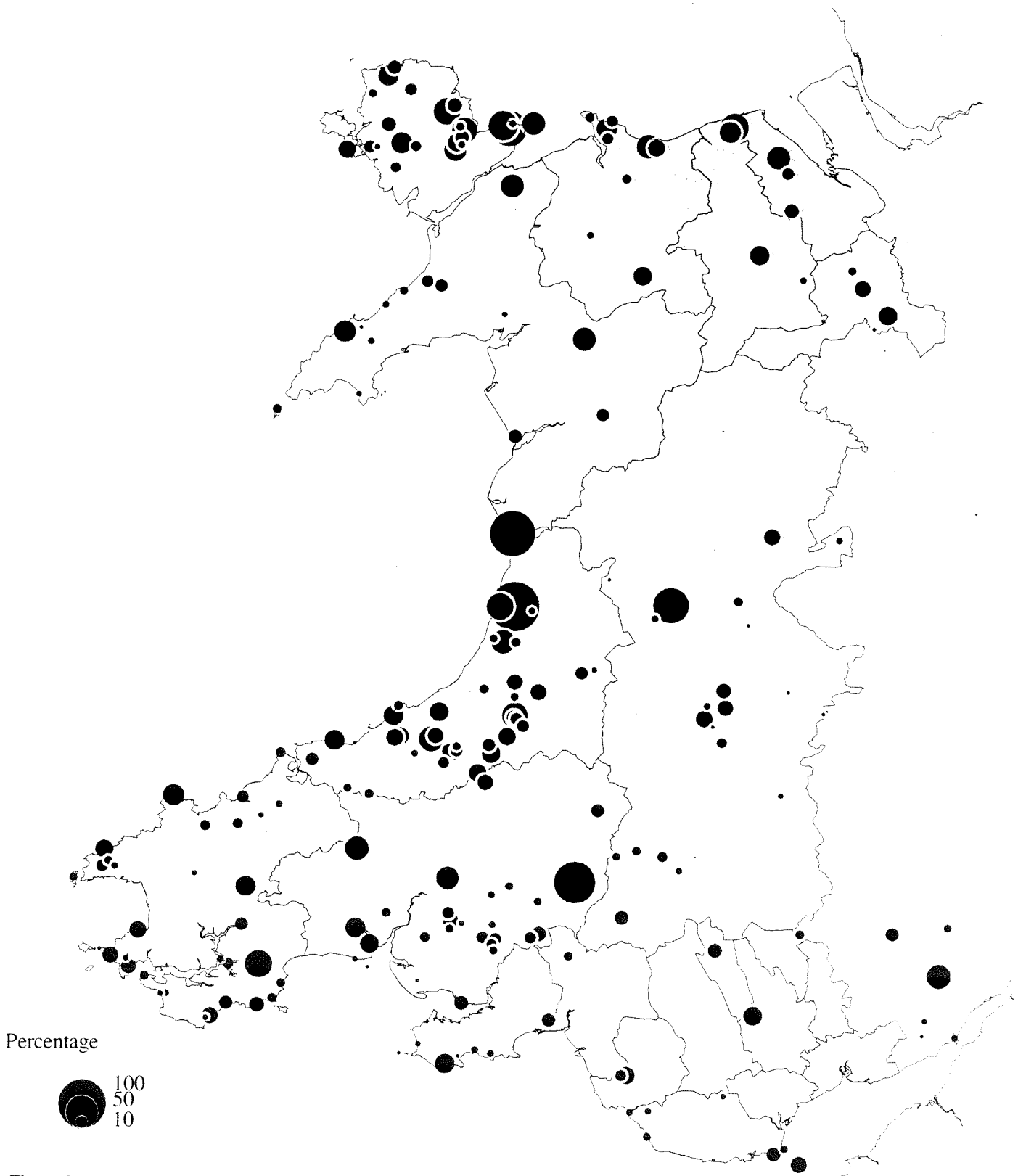


Figure 3.11 Distribution of scrub on Sites of Special Scientific Interest in Wales, showing scrub as a proportion of total site area.

3.1.5 Digitised data held on Geographical Information Systems

Geographical Information Systems (GIS) are now commonly used by local authorities and non-governmental organisations to store and analyse information on habitat distribution. Geographical coverage, level of detail of information and types of analysis performed vary greatly between organisations. The Chilterns Area of Outstanding Natural Beauty (AONB) has been used as a case study to examine the range of organisations holding digital data relevant to scrub conservation on a GIS, and the availability of these data.

3.1.5.1 Case Study: Chilterns AONB

The Chilterns AONB covers 833 km² of the Chiltern Hills, extending along a NE - SW axis between Hitchin and Reading, and includes parts of Bedfordshire, Buckinghamshire, Hertfordshire and Oxfordshire (Chilterns Conference 1994). The Chilterns are a nationally important landscape, defined by the underlying chalk geology, containing large areas of chalk grassland (Steven & Biron 1992). Chalk scrub in the Chilterns is frequently species rich (Smith 1980) and valued as a habitat for invertebrates such as the nationally scarce Duke of Burgundy *Hamearis lucina*. The role of chalk scrub as a valued resource is reflected in the number of scheduled sites of nature conservation importance in the Chilterns which include scrub as 'an attractive and important feature in its own right' (English Nature undated, Chilterns Conference 1994). Nevertheless, careful management is needed as scrub may rapidly encroach on to, and subsequently reduce the nature conservation value of, adjacent chalk grasslands.

There is considerable interest in scrub conservation in the Chilterns (English Nature 1999), which is reflected in the volume of data held on GIS (Table 3.1). Data are available from a range of sources, primarily aerial photographs (English Nature, Oxford Brookes University) and site surveys (Buckinghamshire County Council, Hertfordshire Biological Records Centre). The potential level of use of GIS varies greatly between organisations, for example the Hertfordshire

3. Distribution and conservation value

Biological Records Centre holds only site outlines within the GIS, referring the operator to more detailed data files held on their Site Database stored on Recorder. In contrast, the English Nature and Oxford Brookes University Geographical Information Systems hold site-specific data including type and percentage cover of scrub. Both operating systems are capable of displaying geographical distribution of records on base maps, but Arc/Info provides a more powerful tool for analysis of the landscape-scale processes which are likely to influence scrub conservation in the Chilterns.

The value of the Geographical Information Systems in use is limited by the amount of data held in digital format, and the availability of resources to transfer existing data from computer databases and paper files into suitable GIS format. These constraints operate on most of the organisations using GIS, and are not specific to the Chilterns. As with many conservation projects, lack of communication and exchange of information are also issues, and in the past have resulted in the duplication of digitising effort between organisations. This is currently being addressed by the Chilterns AONB Officer. Funding is being sought to co-ordinate GIS resources throughout the AONB, and create a centralised repository of habitat data for the Chilterns AONB held on GIS. Storage and manipulation on a GIS with a powerful operating system such as Arc/Info would enable maximum use of these data.

All of the operating systems used to store and manipulate scrub data relevant to the Chilterns AONB are sufficiently sophisticated to enable data exchange between systems, although transformation into compatible export files may be required. All organisations surveyed were willing to make data held on their GIS available to other user groups, particularly Wildlife Trusts, other conservation organisations and research organisations such as universities. A charge to cover staff time would be expected, although only the Hertfordshire Biological Records Centre has existing guidelines on charges. Most organisations currently deal with applications on an *ad hoc* basis, and address questions of charges, confidentiality and the implications of inputting costs on an individual basis.

Table 3.1 Information on scrub distribution and characteristics in the Chilterns held on Geographical Information System

Organisation	*Details*	*System*	*Access*
Buckinghamshire County Council	The Biological Notification Site Register for Buckinghamshire is digitised, and can be queried to identify sites with scrub in the Chilterns AONB. The GIS holds details on each site, including survey date, ownership and co-ordinates. Further information on scrub types, species composition is available by referring to the BNSR paper copy. All Sites of Importance for Nature Conservation in Buckinghamshire will be digitised by end March 2000.	Arc/Info, viewed in Arc/view	Access negotiable, some charge may be made.
English Nature Chilterns Team	Distribution of chalk scrub in the Chilterns Natural Area in 1973 and 1995. Digitised from aerial photographs at a scale of 1:50,000 (Redgrave 1996). Scrub categorised by percentage cover (4 categories) and scrub type (12 categories).	MapInfo	Some charge may be made for accessing this information.
FRCA	Small areas digitised for Countryside Stewardship Agreement map purposes only.	Arc/Info	No access.
GIS Habitat Research Group, Oxford Brookes University	Distribution of chalk scrub in the Chilterns Natural Area digitised from aerial photographs (Redgrave 1996) (as EN above). A separate study of all land use, including scrub, also digitised from aerial photographs at a scale of 1:10,000, covering 525 km^2 of the AONB (Oxfordshire 1992, Buckinghamshire 1995).	Arc/Info	No procedure for access in place. Queries regarding Redgrave's survey data would be referred to EN.
Hertfordshire Biological Record Centre	Site outlines digitised for all sites where field surveys have been carried out. Site outlines linked to Recorder site database, which holds site information including habitat characteristics and descriptions. Key words can be used to find distribution of habitats e.g. scrub (RSNC habitat classification system).	Arc/Info, viewed in Arc/view	Commercial and non-sponsoring organisations: £46 per hour. Members of the public, conservation organisations and other organisations with a service level agreement with HBRC: no charge.
Oxfordshire County Council	Some information on scrub held on GIS (further information currently unavailable)	Contact for details	Contact for details.
Wycombe District Council	No scrub data. Colour aerial photographs of relevant sections of AONB soon to be digitised onto GIS.	MapInfo	

3.2 Conservation value of scrub

The information in this section comprises a review of published literature, complemented by information obtained from unpublished sources and responses to the questionnaire. Information in single quotation marks refers to remarks made by questionnaire respondents (see Appendices 5.3-5.5). To avoid large numbers of references to individuals and unnecessary and inappropriate personalisation, these responses are presented anonymously. Where necessary for the sake of clarity, the geographical location to which comments refer is reported.

3.2.1 Vascular plants

Most scrub in Britain is sub-climax woody vegetation, although in places (sea cliffs, mountain tops, areas remote from seed of larger tree species) it may effectively be climax vegetation. Scrub is often valued as a diversifying element in predominantly grassland, or woodland, areas. For example:

> 'The Yorkshire Dales are generally heavily grazed by sheep and rabbits, so there is very little tall vegetation and/or scrub. As a result we see significant increases in scrub cover as important for structural diversity and for associated flora and fauna'.
>
> '(Scrub is an..) important component of semi-natural ecotones and habitat mosaics (contributes to habitat structure, microclimate diversity, food source etc)'.
>
> 'Scattered scrub is a distinctive component of the downland landscape in the Chilterns'.

It is important to realise that the scrub sites which are most 'valuable' for conservation (i.e. those with greatest biodiversity) are generally open, patchy scrub rather than closed scrub.

Some scrub types are important vegetation communities in their own right e.g. W8g hazel *Corylus avellana* scrub (W8g), western gorse *Ulex gallii* (H8) scrub and the wayfaring-tree *Viburnum lantana* sub-community of *Crataegus monogyna-Hedera helix* scrub (W21d). 'Southern mixed scrub' (*sensu* Ward 1974) may have many native shrub species, including spindle *Euonymus europaeus*, hawthorn, buckthorn *Rhamnus cathartica*, blackthorn, wayfaring-tree *Viburnum lantana*, wild privet *Ligustrum vulgare*, gorse, ash *Fraxinius excelsior*, yew *Taxus baccata* and common whitebeam *Sorbus aria*. Hopkins (1996) comments that, 'Such diverse scrub is often rich in rare plants and invertebrates and accounts for a significant part of the conservation value of areas such as the North Downs, Chilterns and Morecambe Bay'.

In Scotland alpine willow scrub communities (defined as occurring above the natural treeline), though widely scattered and often providing patchy cover, are considered important components of native vegetation which merit positive conservation action (Horsfield & Thompson 1997). These communities generally contain a mix of several high altitude dwarf willow species, often with *Salix lapponum* most abundant but also including some or all of woolly willow *S. lanata*, mountain willow *S. arbuscula*, dark-leaved willow *S. myrsinites* and net-leaved willow *S. reticulata* (Matthews 1955, Ratcliffe 1977). Although these willow species are generally limited to ungrazed areas, especially cliff ledges, there is evidence that they can spread into a range of other high altitude communities if grazing is excluded or controlled (Rae 1996). This is being done in a few trial areas in the Highlands as part of the Millenium Forest for Scotland Montane Shrub Project (Gilbert 1997). Woolly willow is a Red Data Book species, being the least widely distributed of these species in Scotland.

Dwarf birch *Betula nana* grows in quite different situations to the dwarf willows, generally being found on flat and gently sloping blanket peatland sites growing in blanket mire (M19 *Calluna-vulgaris-Eriophorum vaginatum*) or wet heath (M15 *Scirpus cespitosus-Erica tetralix*, M17 *Scirpus cespitosus-Eriophorum vaginatum*) communities. It is a nationally scarce species and one that is easily missed because in Britain grazing reduces its height growth to that of the dwarf shrubs amongst which it grows. In other parts of its circumpolar range where grazing is less severe dwarf birch attains heights of a metre or more (Scott 1997). There is currently no restoration project for dwarf birch scrub as it is not thought to be as severely threatened as willow scrub, since it is a component species in a wide range of plant communities. However, reduced grazing and burning would probably enhance its status within many areas of peatland (Horsfield & Thompson 1997).

Juniper occurs in two scrub communities in Scotland. *Juniperus communis-Oxalis* (W19) scrub is found mainly at high elevation (although generally at or below the treeline) in the eastern Highlands but also occurs at low elevations in the Southern Uplands. *Calluna-Juniperus communis* ssp. *nana* heath (H15) is confined to the northwest Highlands and Islands, where it is known from six SSSIs.

Several NVC scrub communities are considered important for ground flora as well as their woody component. Hopkins (1996) lists 34 rare and local plant species particularly associated with scrub and related habitats in Britain. Red Data Book and Nationally Scarce vascular plant species associated with scrub and woodland edge habitats are listed in Table 3.2. The distribution of these rare plant species of scrub habitats are shown in Figure 3.12 (pre 1970 records) and Figure 3.13 (post 1970 records). The maps highlight areas with important scrub communities. The importance of scrub on calcareous soils is clear from the maps. Many rare scrub plants being found on the chalk (North Downs, South Downs, Chilterns) and Carboniferous limestone (Avon Valley, Wye Valley, Peak District, Great Orme, Craven and Morecambe Bay) outcrops. The importance of coastal scrub on the south-west peninsula is also noteworthy. Finally, the alpine and sub-alpine scrub of the Scottish Highlands provides habitat for a number of rare scrub plants.

Responses to the questionnaire survey of land managers showed that some species were valued primarily as food plants for invertebrates. One questionnaire respondent mentioned coppicing birch to allow marsh violet *Viola palustris* to flourish for the benefit of the small pearl -bordered fritillary *Boloria selene*, several were managing blackthorn for black hairstreak *Strymonidia pruni* and brown hairstreak *Thecla betulae* butterflies. The Duke of Burgundy butterfly *Hamearis lucina* lays its eggs on cowslips *Primula veris* which grow in the sheltered herb-rich 'saum' vegetation found on scrub margins.

Table 3.2 Red data book and nationally scarce species of vascular plant associated with scrub or woodland edge habitats.

Scientific name	*English name*	*Occurence in NVC types (where mentioned in NVC)*	*Status*	*BAP*	*S8*
Aceras anthropophorum	Man Orchid	CG2, CG3, CG5	NS		
Actaea spicata	Baneberry		NS		
Althaea hirsuta	Rough Marsh-mallow		RDB en	SCC	S8
Arum italicum neglectum	Italian Lords-and-Ladies		NS		
Bromus benekenii	Lesser Hairy-brome		NS		
Buxus sempervirens	Box	W12,W13	NTS	SCC	
Calystegia sepium roseata	Hedge Bindweed		NS		
Campanula patula	Spreading Bellflower		NS		
Carex appropinquata	Fibrous Tussock-sedge	W3,W5, M9	NS		
Carex atrata	Black Alpine-sedge	W20, CG14, U17	NS		
Carex depauperata	Starved Wood-sedge		RDB cr	SCC	S8
Carex digitata	Fingered Sedge	W8	NS		
Carex elongata	Elongated Sedge	W2,W5	NS		
Cephalanthera rubra	Red Helleborine		RDB cr	SCC	S8
Clinopodium menthifolium	Wood Calamint		RDB en	SCC	S8
Corallorrhiza trifida	Coralroot Orchid	W3	NS		
Dryopteris cristata	Crested Buckler-fern	W2,W4,W5	NTS		
Epipactis atrorubens	Dark-red Helleborine	W8, CG8, CG9, CG12, CG13	NS		
Epipactis leptochila	Narrow-lipped Helleborine		NS		
Epipactis phyllanthes	Green-flowered Helleborine		NS		
Gentianella germanica	Chiltern Gentian	CG2	NS		
Gladiolus illyricus	Wild Gladiolus		NTS	SCC	S8
Helleborus foetidus	Stinking Hellebore		NS		
Himantoglossum hircinum	Lizard Orchid	W21, CG7	RDB vu	SCC	S8
Lathyrus palustris	Marsh Pea	W24	NS		
Leucojum aestivum	Summer Snowflake		NTS		
Leucojum vernum	Spring Snowflake		RDB		
Linnaea borealis	Twinflower	W18,W19	NS	PS	
Lithospermum purpureocaeruleum	Purple Gromwell		NTS		
Lobelia urens	Heath Lobelia	M25	RDB vu	SCC	
Lonicera xylosteum	Fly Honeysuckle		RDB en		
Lysimachia thyrsiflora	Tufted Loosestrife	W1,W3, M4	NS		
Melampyrum cristatum	Crested Cow-wheat		NS		
Melampyrum pratense commutatum	Common Cow-wheat		NS		
Melittis melissophylum	Bastard Balm		NS		
Meum athamanticum	Spignel		NS		
Orchis militaris	Military Orchid	W21	RDB vu	SCC	S8
Orchis purpurea	Lady Orchid	W21	NS		
Orchis simia	Monkey Orchid	W21, CG2	RDB vu	SCC	S8
Ornithogalum pyrenaicum	Spiked Star-of-Bethlehem		NS		

Scientific name	*English name*	*Occurence in NVC types (where mentioned in NVC)*	*Status*	*BAP*	*S8*
Orobanche hederae	Ivy Broomrape		NS		
Orobanche rapum-genistae	Greater Broomrape		NS	SCC	
Peucedanum palustre	Milk-parsley	W2,W5, M22, M24	NS		
Physospermum cornubiense	Bladderseed		RDB vu	SCC	
Phyteuma spicatum	Spiked Rampion		RDB vu	SCC	S8
Polemonium caeruleum	Jacob's-ladder	MG2	NTS	SCC	
Potentilla crantzii	Alpine Cinquefoil	W19, CG9-12, CG14, U15, U17	NS		
Potentilla fruticosa	Shrubby Cinquefoil	CG9	NTS	SCC	
Pulmonaria longifolia	Narrow-leaved Lungwort		NS		
Pulmonaria obscura	Suffolk Lungwort		RDB vu		
Pyrola media	Intermediate Wintergreen	W18,W19, H16	NS		
Pyrola rotundifolia rotundifolia	Round-leaved Wintergreen	W2,W3,W18, CG14, M9, U7	NS		
Rosa agrestis	Small-leaved Sweet-briar		NTS		
Rumex aquaticus	Scottish Dock		RDB vu		
Salix arbuscula	Mountain Willow	W20, CG14	NS		
Salix lanata	Wooly Willow	W20, U16, U17	RDB vu	PS	
Salix lapponum	Downy Willow	W20, CG14, H18, U15-17	NS		
Salix myrsinites	Whortle-leaved Willow	W20, CG14, U16, U17	NS		
Salix reticulata	Net-leaved Willow	W20, CG14, M11, U16, U17	NS		
Salvia pratensis	Meadow Clary	CG2	NS		S8
Scrophularia scorodonia	Balm-leaved Figwort		NS		
Seseli libanotis	Moon Carrot	W21, CG2	RDB vu		
Silene nutans	Nottingham Catchfly	W21, MG1, CG2	NS		
Sorbus bristoliensis	Broad-leaved Whitebeam		RDB en		
Sorbus hibernica	a Whitebeam		NS		
Sorbus lancastriensis	a Whitebeam		NTS		
Sorbus rupicola	a Whitebeam		NS		
Sorbus wilmottiana	a Whitebeam		RDB ce		
Stachys germanica	Downy Woundwort		RDB en		
Thelypteris palustris	Marsh Fern	W2,W5, M22, M24	NS		
Vicia bithynica	Bithynian Vetch		NS		
Vicia lutea	Yellow-vetch		NS		

Explanatory notes

NS Nationally Scarce species (occurring in 16 to 100 10 x 10 km squares in Great Britain, but not included in Red List)
NTS Near threatened species (occurring in 15 or fewer 10 x 10 km squares in Great Britain, but not included in Red List)
RDB cr Red List – critically endangered (IUCN 1994 criteria)
RDB en Red List – endangered (IUCN 1994 criteria)
RDB vu Red List – vulnerable (IUCN 1994 criteria)

PS BAP Priority Species in UK Biodiversity Action Plan
SCC BAP Species of Conservation Concern in UK Biodiversity Action Plan

S8 Plant species on Schedule 8 of the Wildlife and Countryside Act 1981

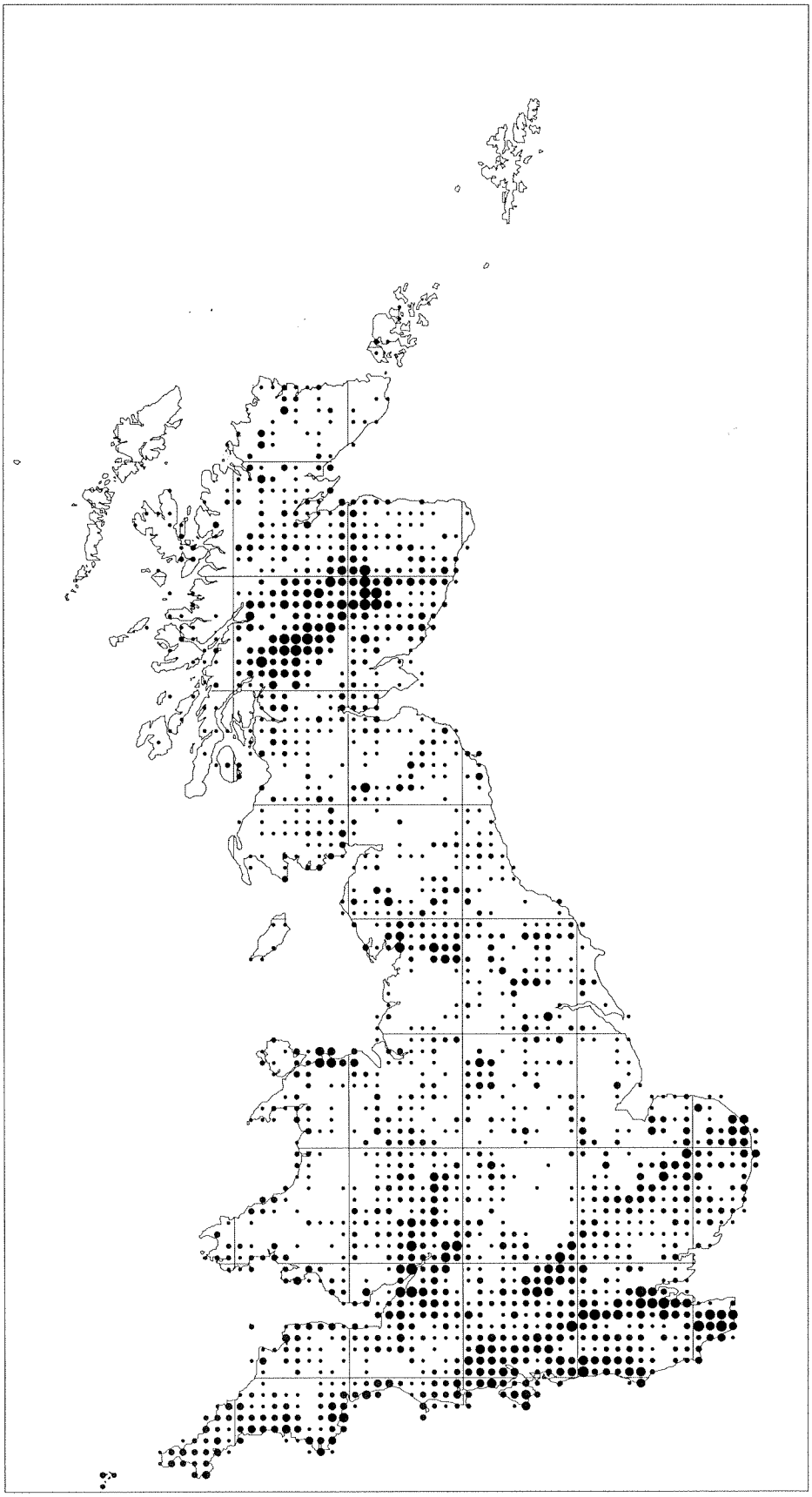


Figure 3.12 Species richness of Red Data Book and Nationally Scarce scrub plants. The smallest dots denote 10km squares in which 1 rare scrub species has been recorded; progressively larger symbols are used for additional species recorded, except that the largest symbol is used for squares with 9-12 species. Data are derived from the Biological Records Centre, all records are used.

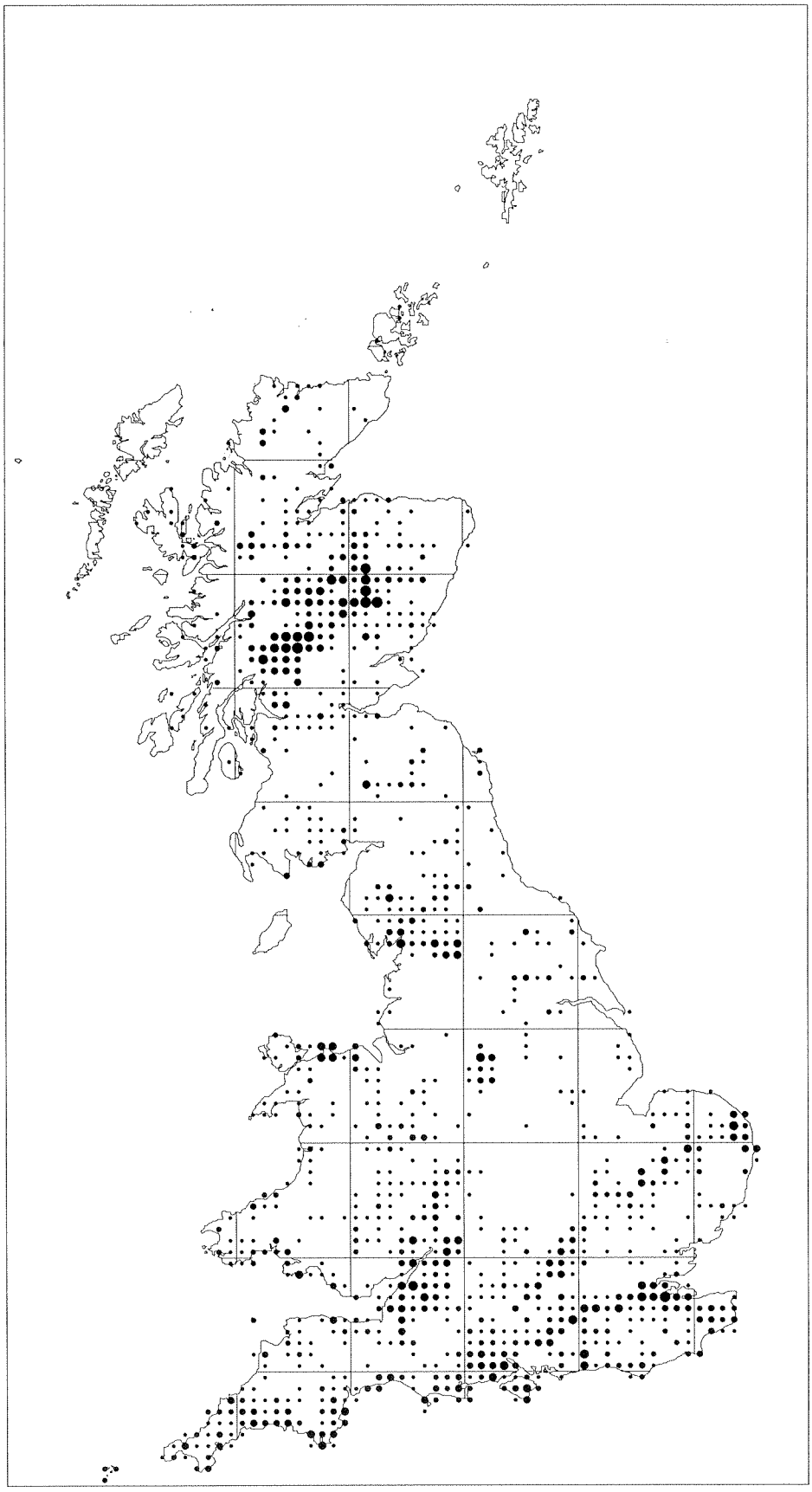


Figure 3.13 Species richness of Red Data Book and Nationally Scarce scrub plants. The smallest dots denote 10km squares in which 1 rare scrub species has been recorded; progressively larger symbols are used for additional species recorded, except that the largest symbol is used for squares with 9-10 species. Data are derived from the Biological Records Centre, only post 1970 records are used.

3.2.2 Lower plants

Some woody scrub species, such as elder *Sambucus nigra*, can be an important substrate for epiphytic lower plants. Coastal scrub can be particularly valuable for lichens, whilst in Scotland, hazel stands support important lichen communities including several species endemic to the British Isles. The larger, older stems in a hazel stool are most important, suggesting that apart from climate, ecological continuity is of key importance to the maintenance of these lichen communities. Currently, three lichen species associated with scrub have Species Action Plans in the UK Biodiversity Action Plan, namely *Graphina pauciloculata, Pseudocyphellaria norvegica* and *Teloschistes chrysopthalmus*. Scrub also forms a sheltered habitat favoured by bryophytes. In East Anglia wet scrub woodland communities were valued for their assemblages of *Sphagnum* spp..

A study of the development of mycoflora of three juniper scrubs in The Netherlands and Germany over the period from 1964-1991 (Vries & Arnold 1994) showed an increase with scrub age of nitrophytic litter decomposers and a corresponding decline of species associated with weakly acidic grasslands. Lignicolous and ectomycorrhizal fungi increased as the scrub became progressively invaded by other coniferous and broadleaved trees. Some rare fungi were found to be associated with the scrub and one species had not been reported previously from Germany.

3.2.3 Birds

3.2.3.1 *Breeding bird communities – an overview*

Scrub is used by an extremely wide range of bird species. Almost all repondents to the questionnaire thought scrub important for birds. Several distinctive assemblages of breeding birds in scrub habitats can be identified based on existing knowledge. These are summarised in Table 3.3. The diversity of bird life in scrub is partly accounted for by the fact that it embraces a wide range of vegetation structures. In the early stages of succession, lowland scrub can support several breeding birds such as skylark *Alauda arvensis*, meadow pipit *Anthus pratensis* and whinchat *Saxicola rubetra* that are essentially associated with open grassland or heathland. In its later stages of development, scrub supports many characteristic woodland birds such as blackbird *Turdus merula*, song thrush *Turdus philomelos*, robin *Erithacus rubecula* and chaffinch *Fringilla coelebs*. Between these two extremes, more specialised scrub bird communities are found in the lowlands, typified by high densities of breeding warblers, especially willow warbler *Phylloscopus trochilus*, whitethroat *Sylvia communis*, garden warbler *Sylvia borin*, lesser whitethroat *Sylvia curruca* and blackcap *Sylvia atricapilla* (Fuller 1995). Similar lowland bird communities, often with exceptionally high densities of breeding warblers, are only found in middle-aged coppice (e.g. Fuller & Henderson 1992).

Often scrub exists as a mosaic with other habitats, including grassland, heathland or woodland. In such places the diversity of breeding birds can be extremely high because a wide range of niches and habitat structures can be present. The effect of scrub structure on birds is considered in greater detail in sections 4.2.2 and 4.2.3.

The diversity of breeding bird life in scrub is illustrated by an analysis of breeding bird censuses undertaken on 39 scrub sites distributed throughout Britain but concentrated mainly in the south (R.J. Fuller, S. Gillings & S.J. Gough, unpublished data). These sites were all censused as part of the BTO's Common Birds Census and they consisted either of continuous scrub or mosaics of dense scrub intimately mixed with patches of grass, bracken or ericaceous shrubs. In all cases, scrub cover exceeded 50%. A total of 89 breeding bird species was recorded on these sites and the species were extremely diverse in body size, diet, nest site usage and habitat needs. The most abundant species of birds breeding at these sites are shown in Table 3.4.

Willow warbler, blackbird, dunnock *Prunella modularis*, wren *Troglodytes troglodytes*, yellowhammer *Emberiza citrinella* and linnet *Carduelis cannabina* are consistently among the most abundant species breeding in scrub habitats in Britain. Hole-nesting species are generally scarce breeding species in scrub, but Table 3.4 shows that blue tit *Parus caeruleus* is generally the most common hole-nester. There is, however, much variation in the composition of scrub bird communities depending on the mosaic of vegetation types that are present, the successional stage and geographical location. Some species that do not feature in Table 3.4 may, in fact, be highly characteristic of certain restricted forms of scrub. Examples include stonechat *Saxicola torquata* in western gorse scrub and sedge warbler *Acrocephalus schoenobaenus* in wet scrub (Table 4.2.2.1).

3.2.3.2 *Use of scrub by scarce and declining breeding birds*

Scrub is an important habitat for several breeding bird species that are rare, local or in serious decline in Britain. Cetti's warbler *Cettia cetti* is closely associated with marshy scrub or willow carr (Wotton *et al.* 1998). The extremely rare marsh warbler *Acrocephalus palustris* will also breed in wet bushy habitats. Dartford warbler *Sylvia undata* is a species of lowland heathland that is largely dependent on mixtures of heather and gorse. The most productive territories are ones that have much gorse, though the preferred nest site is in heather (Bibby 1979a). Much of the food is collected from gorse (Bibby 1979b).

Two other heathland birds – nightjar *Caprimulgus europaeus* and woodlark *Lullula arborea* – will also use areas of open or scattered scrub, though they do not depend on it as strongly as the Dartford warbler. Both species appear to require some bushes or trees as songposts and heathland-nesting nightjars may even show a preference for nesting in areas with scattered birch and pine scrub (Berry 1979). In both cases, however, encroachment of trees and bushes rapidly results in site abandonment, although nightjar will tolerate a greater level of scrub and tree cover than will woodlark. Hedgerows or scrub are essential components of the territory of the cirl bunting *Emberiza cirlus* (Sitters 1985).

Scrub habitats appear to be of increasing importance to the declining English population of nightingales *Luscinia megarhynchos* (Fuller *et al.* 1999). The 1999 BTO survey of the species shows that more territories are now associated with scrub habitats than with coppice (Wilson 2000). Nightingales require dense thickets which are also favoured by species such as garden warbler and blackcap. In southern England (as far north as Lincolnshire and Nottinghamshire) scrub was managed by a large number of questionnaire respondents for nightingales. Scrub is also important for another declining lowland bird species, the turtle dove *Streptopelia turtur*. In this case, closed-canopy scrub is among one of its main nesting habitats, though the birds obtain much of their food (seeds) from adjacent open habitats.

Table 3.3 Scrub habitats supporting particularly distinctive assemblages of breeding birds in Britain.

Northern upland scrub Principally birch *Betula* and juniper *Juniperus* scrub which is relatively poor in bird species and strongly dominated by willow warbler *Phylloscopus trochilus* (Gillings & Fuller 1998, Gillings *et al.* 1998).

Western upland scrub Upland slopes in Wales, the Shropshire Hills and south-west England often carry mixtures of hawthorn *Crataegus monogyna* scrub and bracken *Pteridium aquilinum* (termed *ffridd* in Wales) and sometimes gorse *Ulex* which can be exceptionally rich in chats including whinchat *Saxicola rubetra*, common stonechat *Saxicola torquata* and common redstart *Phoenicurus phoenicurus*.

Lowland heathland scrub Gorse *Ulex* mixed with rank heather *Calluna vulgaris* supports a species-poor assemblage including Dartford warbler *Sylvia undata* and common stonechat (*Saxicola torquata*) (Bibby 1978).

Lowland hawthorn Crataegus monogyna and mixed scrub The bird communities are typified by high densities of warblers in the canopy-closure phase and by yellowhammers *Emberiza citrinella*, linnets *Carduelis cannabina* and common whitethroats *Sylvia communis* in the earlier stages of scrub growth.

Lowland Blackthorn Prunus spinosa scrub Dense blackthorn *Prunus spinosa* appears to be a preferred habitat of nightingales (Rufous Nightingale *Luscinia megarhynchos)* in southern England, though it also uses other scrub types and coppiced woodland. In other respects the bird assemblage resembles that of hawthorn *Crataegus monogyna* scrub.

Wet scrub Sedge warbler (*Acrocephalus schoenobaenus*), reed bunting (*Emberiza schoeniclus*) and, far more rarely, Cetti's (*Cettia cetti*) and marsh warblers (*Acrocephalus palustris*) will use scrub often in conjunction with adjacent marsh or fen vegetation, including reedbeds.

Coastal dune scrub Sea-buckthorn *Hippophae rhamnoides* scrub, often mixed with hawthorn *Crataegus monogyna* and elder *Sambucus nigra*, can support high overall densities of birds including high densities of common whitethroats *Sylvia communis*, linnets *Carduelis cannabina* and common redpolls *Carduelis flammea* (Williamson 1967, Morgan 1978). Densities of common whitethroats *Sylvia communis* in particular can be exceptionally high (Boddy 1992).

Table 3.4 The 10 species with the highest mean territory densities (territory ha^{-1}) in an analysis of 39 BTO Common Birds Census scrub sites. Not all sites were censused in each time period.

	1966-68 (n=15)		1973-75 (n=15)		1980-82 (n=28)	
Rank	Species	Density	Species	Density	Species	Density
1	Willow warbler *Phylloscopus trochilus*	0.90	Wren *Troglodytes troglodytes*	1.03	Willow warbler *Phylloscopus trochilus*	0.87
2	Linnet *Carduelis cannabina*	0.88	Willow warbler *Phylloscopus trochilus*	1.02	Blackbird *Turdus merula*	0.59
3	Blackbird *Turdus merula*	0.79	Blackbird *Turdus merula*	0.92	Dunnock Hedge Accentor, *Prunella modularis*	0.56
4	Dunnock HedgeAccentor, *Prunella modularis*	0.75	Dunnock HedgeAccentor, *Prunella modularis*	0.83	Wren *Troglodytes troglodytes*	0.49
5	Common Whitethroat *Sylvia communis*	0.72	Linnet *Carduelis cannabina*	0.68	Robin *Erithacus rubecula*	0.46
6	Yellowhammer *Emberiza citrinella*	0.65	Robin *Erithacus rubecula*	0.55	Chaffinch *Fringilla coelebs*	0.40
7	Sky Lark *Alauda arvensis*	0.53	Yellowhammer *Emberiza citrinella*	0.45	Yellowhammer *Emberiza citrinella*	0.39
8	Meadow Pipit *Anthus pratensis*	0.44	Chaffinch *Fringilla coelebs*	0.40	Linnet *Carduelis cannabina*	0.31
9	Song thrush *Turdus philomelos*	0.38	Blue tit *Parus caeruleus*	0.34	Blue tit *Parus caeruleus*	0.24
10	Wren *Troglodytes troglodytes*	0.32	Song thrush *Turdus philomelos*	0.32	Sky lark *Alauda arvensis*	0.23

In the uplands, scrub is important to another declining species, the black grouse *Tetrao tetrix*. Birch, willow and juniper scrub can support this species which lives at the interface of open moorland and woodland (Parr & Watson 1988). In Scotland, respondents referred to the management of willow and juniper scrub for this species.

Capercaillie *Tetrao urogallus* may also occasionally use upland scrub but the species is principally associated with mature stands of Scots pine.

Finally, the red-backed shrike *Lanius collurio*, though virtually extinct as a breeding bird in Britain, was once strongly dependent on thorny scrub of various kinds. If the shrike were to make a recovery it would presumably reoccupy these habitats. In summary, scrub is an extremely important habitat for several species in Britain in the sense that a high proportion of individuals depend on it. These species include black grouse, turtle dove, nightingale, whinchat, stonechat, Cetti's warbler, Dartford warbler and cirl bunting. Several priority Biodiversity Action Plan bird species make use of scrub as major breeding habitat: marsh warbler, nightjar, turtle dove, linnet, cirl bunting, red-backed shrike, bullfinch *Pyrrhula pyrrhula*, black grouse and song thrush. A full list of Biodiversity Action Plan bird species for which scrub is a major habitat appears in Table 3.5

3.2.3.3 *Non-breeding uses of scrub by birds*

Most research on birds in scrub has been undertaken in the breeding season. Nonetheless, scrub is important as a roosting habitat and as a source of food for migrant and wintering birds and for birds breeding in adjacent habitats. Scrub also provides shelter for migrating and wintering birds.

Long-eared owls *Asio otus* depend heavily on scrub for winter roosting (R.Williams pers comm.). More commonly, however, large flocks of starlings *Sturnus vulgaris*, thrushes, finches and buntings roost in scrub of various kinds, though there has never been a detailed study of their roost requirements. The importance of scrub as a roost for birds was illustrated by a study at Castor Hanglands National Nature Reserve in which winter counts of birds were made in grassland, rank grass and low scrub, dense scrub and deciduous woodland (Gough 1999). During the day, similar numbers of birds were counted in dense scrub and woodland. In late afternoon, however, there were huge influxes of roosting birds into the dense scrub and counts at that time were approximately five times as great as in the woodland. The main species roosting in the scrub were fieldfare *Turdus pilaris*, redwing *Turdus iliacus*, blackbird, starling, greenfinch *Carduelis chloris* and yellowhammer.

Provision of food by berried shrubs is important to winter visitors and passage migrants; this was frequently mentioned by questionnaire respondents, the value of sea buckthorn being highlighted. For accounts of use of scrub by migrant birds see Boddy (1991) and Edgar (1986). In fact, a wide range of berry-bearing shrubs is exploited by birds in a mutualistic relationship between plant and bird. The use of shrubs as a source of food by berry-feeding birds is described in greater detail in chapter 4. Hawthorn is generally less abundant on mainland Europe than in Britain where its berries provide a staple food for flocks of migrant thrushes in autumn and winter (Snow & Snow 1988). British hedgerows and scrub dominated by hawthorn can therefore be regarded as a resource of international significance for species such as fieldfare and redwing.

A final important point about the use of scrub by birds is that it often forms a key resource in a landscape context. For many species, scrub may not provide all the resources required, either spatially or in terms of the annual life cycle. Nonetheless, scrub can provide essential resources at certain times which may influence productivity and survival. One example is the wintering thrushes, starlings, finches and buntings that feed on farmland but roost in scrub. These roosts themselves become valuable food resources for predatory birds such as sparrowhawk *Accipiter nisus* and tawny owl *Strix aluco*. Another example, is provided by upland scrub that can provide food resources in early spring for merlins *Falco columbarius* Bibby (1986). It has been suggested that the provision of more scrub in upland areas would benefit birds of prey such as merlin, hen harrier *Circus cyaneus* and short-eared owl *Asio flammeus* because there would be an increase in prey in the form of small birds and mammals (Usher & Thompson 1993).

Table 3.5 Biodiversity Action Plan bird species for which scrub can form a particularly important habitat. In each case some indication of the principal use of scrub is given. The order of species follows the British Ornithologists' Union British List.

Priority Biodiversity Action Plan species

Black grouse	*Tetrao tetrix*	year-round habitat (uplands)
Turtle dove	*Streptopelia turtur*	nesting habitat (dense scrub)
Nightjar	*Caprimulgus europaeus*	breeding habitat (open scrub)
Woodlark	*Lullula arborea*	breeding habitat (open scrub)
Song thrush	*Turdus philomelos*	year-round habitat
Marsh warbler	*Acrocephalus palustris*	breeding habitat (wet scrub)
Red-backed shrike	*Lanius collurio*	potential breeding habitat
Tree sparrow	*Passer montanus*	roost habitat
Linnet	*Carduelis cannabina*	nesting and roost habitat
Bullfinch	*Pyrrhula pyrrhula*	year-round habitat
Cirl bunting	*Emberiza cirlus*	nesting and roost habitat
Reed bunting	*Emberiza schoeniclus*	nesting (wet scrub) and roost habitat
Corn bunting	*Miliaria calandra*	roost habitat

Species of Conservation Concern

Merlin	*Falco columbarius*	feeding habitat in spring, possible roost habitat
Long-eared owl	*Asio otus*	nesting and roost habitat
Tree pipit	*Anthus trivialis*	breeding habitat (open scrub)
Dunnock	*Prunella modularis*	mainly breeding habitat
Nightingale	*Luscinia meharyhnchos*	breeding habitat
Whinchat	*Saxicola rubetra*	breeding habitat (mainly open upland scrub)
Stonechat	*Saxicola torquata*	breeding and wintering habitat (open scrub)
Fieldfare	*Turdus pilaris*	winter feeding and roosting habitat
Redwing	*Turdus iliacus*	winter feeding and roosting habitat
Cetti's warbler	*Cettia cetti*	year-round habitat (wet scrub)
Grasshopper warbler	*Locustella naevia*	breeding habitat (open scrub)
Sedge warbler	*Acrocephalus schoenobaenus*	breeding habitat (wet scrub)
Dartford warbler	*Sylvia undata*	year-round habitat (gorse)
Lesser Whitethroat	*Sylvia curruca*	breeding habitat
Garden warbler	*Sylvia borin*	breeding habitat
Blackcap	*Sylvia atricapilla*	breeding habitat
Chiffchaff	*Phylloscopus collybita*	winter habitat, especially wet scrub
Willow warbler	*Phylloscopus trochilus*	breeding habitat
Goldcrest	*Regulus regulus*	breeding and, especially, wintering habitat
Firecrest	*Regulus ignicapillus*	winter habitat, mainly in western Britain
Willow tit	*Parus montanus*	year-round habitat
Greenfinch	*Carduelis chloris*	roost habitat
Goldfinch	*Carduelis carduelis*	roost habitat
Redpoll	*Carduelis flammea*	nesting and roost habitat
Hawfinch	*Coccothraustes coccothraustes*	winter feeding habitat
Yellowhammer	*Emberiza citrinella*	breeding and roost habitat

3.2.4 Invertebrates

The dominating woody plants of scrub are the food-plants of very many species of phytophagous insects and mites (Table 3.6). There are also numerous other insect species feeding upon the lichens, algae and fungi associated with the bark and wood of shrubs and trees. Many of these insects are at the base of complex food webs, which include parasitic and hyperparastic insects, and predatory insects, mites and spiders (Duffey *et al.* 1974, Shaw 1984). All these invertebrates provide food for larger animals, particularly insectivorous birds.

Saproxylic species make a major contribution to the invertebrate component of scrub habitats. Most leave the decomposing wood habitat for some phase of their life history (Speight 1989), often when the adults are dispersing in the spring and early summer (Kirby 1992). Many Coleoptera and Diptera that breed in dead wood are thought to be dependent on other habitats as adults (Stubbs 1972). Nectar (easily assimilated energy) and pollen (protein for egg laying) from flowering plants are thought to be the key needs of saproxylic insects with requirements for other habitats (Warren & Key 1989). The proximity of dead wood to sources of nectar and pollen, particularly from Umbelliferae, Compositae and hawthorn (Warren & Key 1989) is likely to be best satisfied within a diverse mosaic of habitat types and structures at the grassland/scrub/woodland interfaces. For example, scrub species such as hawthorn and blackthorn in the vicinity of ancient trees may provide nectaring sources for tree-living saproxylic species (Sisitka 1996). Open space may also be important for flight lines to nectaring sites (Key & Ball 1993, Key 1996), suggesting dense scrub or woodland may disadvantage some species (Stubbs 1972). Hawthorn is thought to be the most important early nectar source (Stubbs 1972, Kirby 1992, Key 1996), and many species including saproxylic species appear to have life-cycles adapted so that the peak of adult emergence coincides with the peak of hawthorn blossom (Key 1996). Other scrub species used for nectaring by saproxylic species include holly, guelder-rose and bramble, in addition to broad-leaved herbs often found in an open scrub/grassland/woodland mosaic, such as hogweed, angelica, ragwort and thistle (Alexander *et al.* 1996, Alexander 1999). The deadwood of many scrub species is used, for example, hawthorn is used by wood-boring Anobiidae beetles, and Buprestidae beetles (jewel beetles) such as *Agrilus sinatus*. Larvae of the Red Data Book (Endangered) Buprestidae *Anthaxia nitidula* is found only beneath the bark of blackthorn and some other woody Rosaceae (Shirt 1987).

Some saproxylic species are dependent on flowers, not for the nectar or pollen resources, but as a site for predation of the insects feeding on these structures (Key 1996, Warren & Key 1989, Key & Ball 1993).

The total number of species of phytophagous insect/mites feeding on 31 scrub woody plant genera was 2219 (Table 3.6). This is nearly a third of the total phytophagous species in Britain. Total numbers of species on plants can be related to the size of the plants (trees>shrubs>perrenial herbs>annuals) and to their abundance, geographical spread and the length of time the plant species has been present since the last glaciation (Lawton & Schroder 1977, Strong *et al.*1984, Leather 1986).

Of the phytophagous orders Lepidoptera have the most species on scrub woody plants, followed by Coleoptera, Hemiptera, Hymenoptera, Diptera, Acari and Thysanoptera. Orthoptera are almost all polyphagous, and bush crickets are the most likely to be recorded. Phasmidae (stick insects) have been introduced and are recorded in a few places in the West Country.

Taxonomically isolated shrub genera having few or no other species or genera in their plant family often have low numbers of associated insects e.g. hollies *Ilex*, box and yew. These three species are also evergreen, with tough resistant leaves and have high levels of deterrent secondary biochemicals to which few insects have been able to adapt (Daniewski *et al.* 1998.)

Of the eight genera with <30 insect/species in Table 3.6, five are introduced plant genera (Yela & Lawton 1997). Oligophagous insects, found in the original geographical range of introduced plants have not colonised Britain for a variety of reasons, but when they do appear, they often spread rapidly e.g. on firethorns *Pyracantha* (Nash *et al.* 1995). British native insects will spread to introduced plants, if the plants have close taxonomic relatives, but some insect species may not adapt quickly. Therefore it is expected that the total numbers of insects/mites will rise slowly on introduced plants.

3.2.4.1 Specificity of insects to the shrub genus

The majority of insects are specific to plant family. In the ITE Phytophagous Insect Data Bank (PIDB) records 76% are family specific while a further 10% occur on two families only (Ward & Spalding 1993). Insects are less specific to genera and in this scrub data 34% fed only on the genus (760 species out of 2219 insects/mites). The numbers specific to plant species (i.e. monophagous) are not available, but are known to be lower than on genera, and with more uncertainties. Recorders do not include all hosts of polyphagous insects, while rare plants are less well studied entomologically than common plants (Ward 1988). Table 3.7 shows the total numbers specific to the genus for the 31 shrubs of Table 3.6. Most of the genera with many insects in total also have more specific species and vice versa (Figure 3.14). Some genera deviate more than others from this general pattern, and are considered briefly below.

Juniper has the highest proportion of generically specific species (41%) compared to the total number of species that have been found feeding upon it. Taxonomic isolation is one factor involved here, as plant species that are monotypic to a family and genus often have a higher proportion of specific invertebrate species. Juniper is our only native representative of the Cupressaceae. Additionally juniper has a wide range, with arctic-alpine phytophagous insects in Scotland and species with Mediterranean distribution in southern England.

There are higher percentages of specific species on maples *Acer* (31%) and willows *Salix* (29%) and roses *Rosa*. This is partly because of the strong representation of families of insects with many oligophagous insects. These are mainly insects which feed endophytically e.g. gall midges, gall mites, micro-moth leaf-miners, and also aphids which are often specific (Ward & Spalding 1993). Again, the wide geographical spread of the hosts, particularly of *Salix* (Willows) and *Rosa* (Roses) is important.

Introduced plant genera all appear in the second half of Table 3.7, and have few generically specific insects/mites. No specific species have been recorded so far on butterfly-bushes *Buddleja*, aromatic wintergreens *Gaultheria* and snowberries *Symphoricarpos*.

Table 3.6 Number of insect species feeding on woody scrub plant genera.

Scrub genera	Total	Lepidoptera	Hemiptera	Coleoptera	Hymenoptera	Diptera	Acari	Thysanoptera	Orthoptera	Phasmida	Dermaptera
Salix (Willows)	**752**	296	124	160	106	46	15	5			
Betula (Birches)	**521**	262	68	115	52	10	7	7			
*Prunus** (Cherries)	**384**	214	62	63	19	9	12	4	1		
*Crataegus** (Hawthorns)	**356**	198	55	68	17	7	9	2			
Alnus (Alders)	**283**	92	67	78	29	3	10	4			
Corylus (Hazels)	**253**	91	54	70	18	6	11	3			
*Rubus** (Brambles)	**237**	114	39	29	31	10	8	4	1	1	
*Rosa** (Roses)	**215**	81	45	29	38	12	4	4		2	
Acer (Maples)	**193**	71	50	42	5	5	18		1		
*Sorbus** (Whitebeams)	**160**	62	31	38	19	3	7				
Sarothamnus (Brooms)	**124**	53	29	24	2	12	3	1			
Ulex (Gorses)	**71**	31	11	17		4	3	5			
Ligustrum (Privets)	**66**	42	12	5	2	3	1	1			
Myrica (Bog-myrtles)	**66**	48	14	4							
Juniperus (Junipers)	**63**	23	20	5	3	5	5	2			
Cornus (Dogwoods)	**55**	25	17	7	1	2	2	1			
Rhamnus (Buckthorns)	**46**	21	15	4	1	3	2				
Buddleja# (Butterfly-bushes)	**44**	35	3	4		1	1				
Viburnum (Viburnums)	**44**	14	17	5	3	3	2				
Ilex (Hollies)	**36**	9	16	10		1					
Sambucus (Elders)	**36**	9	6	8	2	6	2	3			
Clematis (Traveller's-joys)	**35**	22	4	2		3	1	2			1
Euonymus (Spindles)	**33**	13	17	2			1				
Frangula (Alder Buckthorn)	**28**	20	6	1		1					
Hippophae# (Sea-buckthorn)	**28**	15	7	5			1				
Rhododendron# (Rhododendrons)	**27**	8	16	1		1	1				
Taxus (Yew)	**26**	10	8	3		1	4				
Symphoricarpos# (Snowberries)	**25**	12	2	2	4	5					
Buxus#? (Box)	**22**	1	18			1	2				
Tamarix# (Tamarisks)	**14**	5	7			1	1				
Gaultheria# (Aromatic Wintergreeens)	**3**		3								
TOTAL	**2219**	**864**	**455**	**356**	**247**	**154**	**109**	**29**	**2**	**2**	**1**

* Genera belonging to the Rosaceae # Genera of introduced plant species (*Buxus* [Box] probably native Staples 1970)

Table 3.7 Number of insect species *only* feeding on woody scrub plant genera (annotation see Table 3.6)

Scrub genera	Total	Lepidoptera	Hemiptera	Hymenoptera	Diptera	Acari	Coleoptera	Thysanoptera	Dermaptera	Orthoptera	Phasmida
Salix (Willows)	**217**	40	54	59	37	7	16	4			
Betula(Birches)	**112**	50	19	21	9	3	8	2			
Acer (Maples)	**60**	20	17	3	5	13	2				
*Rosa** (Roses)	**44**	15	6	18	4	1					
*Prunus** (Cherries)	**43**	21	5	6	4	6	1				
Alnus (Alders)	**40**	13	7	8	3	4	4	1			
*Rubus** (Brambles)	**32**	9	5	9	4	5					
*Crataegus** (Hawthorns)	**29**	8	7	5	4	2	3				
Juniperus (Junipers)	**26**	12	3	2	5	3		1			
Sarothamnus (Brooms)	**26**	5	7		10	2	1	1			
Corylus (Hazels)	**22**	4	6	1	4	5	2				
Ulex (Gorses)	**16**	5	1		3	2	3	2			
*Sorbus** (Whitebeams)	**14**	2	2	4	2	4					
Clematis (Traveller's-joys)	**10**	4	1		3	1	1				
Rhamnus (Buckthorns)	**10**	2	5		1	2					
Rhododendron# (Rhododendrons)	**8**	2	4		1	1					
Cornus (Dogwoods)	**7**	2	1	1	2	1					
Viburnum (Viburnums)	**7**	2	3		1	1					
Euonymus (Spindles)	**6**	6									
Hippophae# (Sea-buckthorn)	**5**	2	2			1					
Buxus#? (Box)	**5**		2		1	2					
Ligustrum (Privets)	**4**	1	1		2						
Myrica (Bog-myrtles)	**4**	2	2								
Sambucus (Elders)	**4**			1	1	1		1			
Tamarix# (Tamarisks)	**4**	1	1		1	1					
Frangula (Alder Buckthorn)	**2**	1	1								
Ilex (Hollies)	**2**		1		1						
Taxus (Yew)	**2**		1			1					
Buddleja# (Butterfly-bushes)	**0**										
Gaultheria# (Aromatic Wintergreens)	**0**										
Symphoricarpos# (Snowberries)	**0**										
Total	**760**	**229**	**164**	**138**	**108**	**68**	**41**	**12**	**0**	**0**	**0**

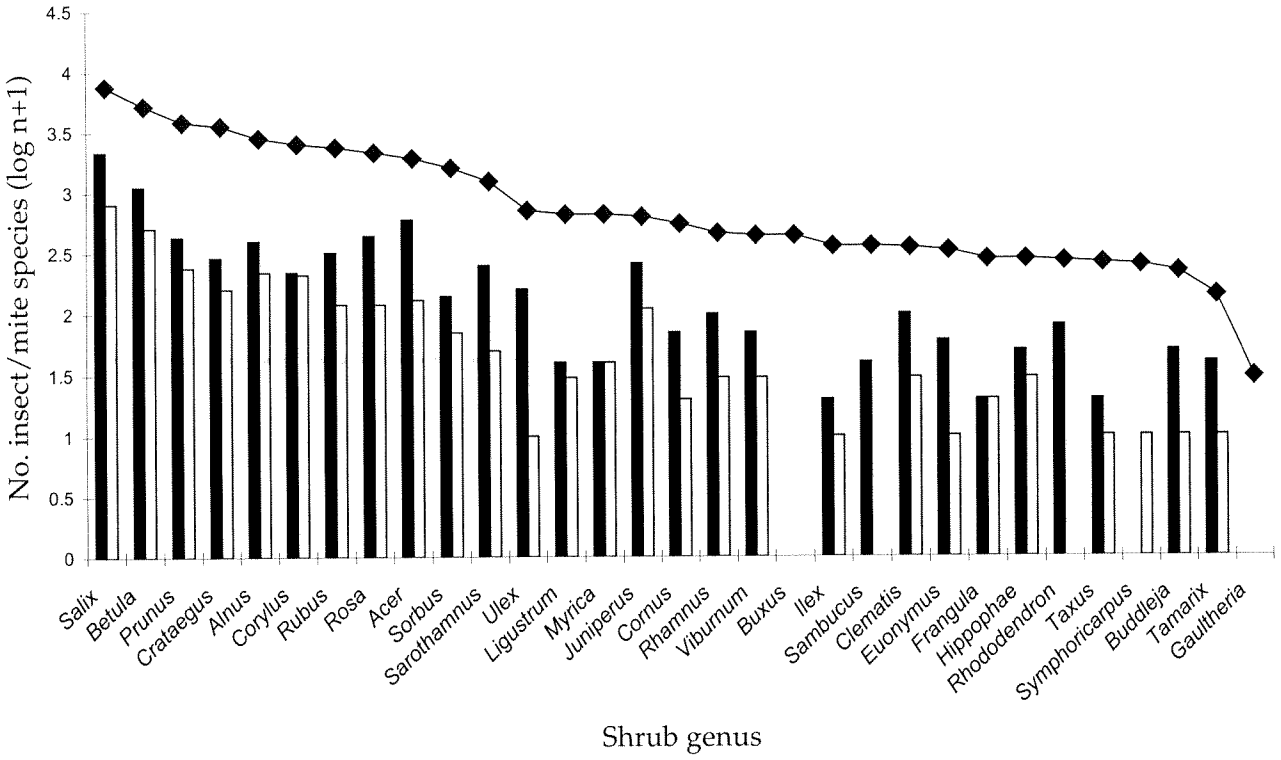


Fig. 3.14 Total numbers of insect and mite species (line), with numbers specific to genus (black bars) and Red Data Book species (white bars), arranged in order of total numbers on the shrub genera of Table 3.6 (Scale log +1).

Table 3.8 Number of Red Data Book (RDB) and Biodiversity Action Plant (BAP) insect species per woody scrub plant genera.

	RDB species:													BAP species:		
Scrub genera	**Total RDB**	**RDB Endangered** 1	**RDB Endangered (proposed)** 1p	**RDB Vulnerable** 2	**RDB Vulnerable (proposed)** 2p	**RDB Rare** 3	**RDB Rare (status uncertain)** 3*	**RDB Rare (proposed)** 3p	**RDB Out of danger** 4	**Extinct (no RDB status)** Ex	**Extinct probably (no RDB status)** Exp	**RDB Insufficiently known (proposed)** Kp	**Total BAP**	**BAP1** 1	**BAP2** 2
Salix (Willows)	81	15	11	7	1	20	2	23		1		1	20	19	1
Betula (Birches)	51	8	5	7	2	16		12	1				15	14	1
Prunus (Cherries)	24	4	7	2	1	5		3	1	1			3	3	
Alnus (Alders)	22	4	1	5	1	9		2					7	6	1
Corylus (Hazels)	21	5	3	5	1	5		2					6	6	
Crataegus (Hawthorns)	16	4	4	4		4							2	2	
Acer (Maples)	13	2	2	1	1	3		2		2			1	1	
Rosa (Roses)	12	1		2	1	2		5				1	1	1	
Rubus (Brambles)	12		1	2	1	3		3	1	1			0		
Juniperus (Junipers)	11	3	2		2		2	2					0		
Sorbus (Whitebeams)	7	1	1	3		1		1					0		
Sarothamnus (Brooms)	5		2			2		1					2	2	
Myrica (Bog-myrtles)	4	1	1			2							1	1	
Clematis (Traveller's-joys)	3			2		1							0		
Hippophae (Sea-buckthorn)	3		2		1								0		
Ligustrum (Privets)	3			1		1			1				1	1	
Rhamnus (Buckthorns)	3	1				2							0		
Viburnum (Viburnums)	3					1			1		1		0		
Cornus (Dogwoods)	2		2										0		
Frangula (Alder Buckthorn)	2					1			1				0		
Buxus (Box)	1	1											0		
Euonymus (Spindles)	1				1								0		
Ilex (Hollies)	1					1							0		
Symphoricarpos (Snowberries)	1		1										1	1	
Taxus (Yew)	1	1											0		
Tamarix (Tamarisks)	1			1									0		
Buddleja (Butterfly-bushes)	0												0		
Gaultheria (Aromatic Wintergreens)	0												0		
Rhododendron (Rhododendrons)	0												0		
Sambucus (Elders)	0												1	1	
Ulex (Gorses)	0												1	1	

3.2.4.2 *Red Data Book (RDB) and Biodiversity Action Plan (BAP) Insect species*

All the categories of RDB and BAP species among the 2219 phytophagous species recorded in the PIDB on 31 genera of scrub woody plants are listed in Table 3.8. In all there were 206 species, 9% of the total scrub insects/mites. 83 of these 206 insects (40%) are recorded only on one genus of plant. For the different orders, 92 species were Lepidoptera, many being macro-moths, while there were 55 Coleoptera, 45 Hymenoptera, 13 Hemiptera, only one Diptera and no Acarina or Thysanoptera.

Like the generically specific species, the numbers of RDB species are correlated with the overall total insects *Juniperus* has the highest percentage of RDB species compared to its total fauna (17%). It is therefore particularly important to conserve this plant with its fauna, especially as juniper is known to be declining in many lowland areas (Ward 1973, Borders Forest Trust 1997, Clifton *et al.* 1997). The lowlands of southern England have insects of Mediterranean distribution, but there are other RDB and restricted distribution species in montane areas of Scotland, where there may be climate change in the future. For example, the Kentish glory moth *Endromia versicolora* requires young birch saplings up to approximately 2 m high for egg laying (Barbour & Young 1993).

Willow, birch and sea-buckthorn also have high proportions of RDB species. The figures for willow, divided into those species occurring on lowland and montane willow species, are shown in Table 3.9.

Gorse is interesting in having no scheduled rare species at all, although there are 71 phytophagous species recorded. Butterfly-bush also has no RDB species, out of 44 insects recorded, and has no generically restricted species.

Table 3.9 Numbers of insects recorded on the genus *Salix* , and on lowland and montane species of *Salix*, with number of RDB species.

	All *Salix* species	Lowland species	Montane species
Total	**752**	**479**	**45**
Lepidoptera	296	214	4
Hemiptera	124	79	10
Coleoptera	160	59	6
Hymenoptera	106	73	15
Diptera	46	42	7
Acari	15	10	3
Thysanoptera	5	2	0
Total RDB	**81**	**43**	**8**

Table 3.10 Insect species associated with scrub habitats with Priority Species status in the UK Biodiversity Action Plan.

Scientific name	*English name*	*Scrub habitats*
Boloria euphrosyne	Pearl-bordered fritillary	woodland clearings, scattered scrub
Carterocephalus palaemon	Chequered skipper butterfly	woodland edges, scrub & grassland
Cicadetta montana	New Forest cicada	open scrub, woodland edges
Cryptocephalus coryli	a leaf beetle	hazel (woodland edges), birch (heathland)
Cryptocephalus decemmaculatus	a leaf beetle	willow & birch growing in bogs
Cryptocephalus nitidulus	a leaf beetle	birch & hazel, downland scrub
Cyclophora pendularia	Dingy mocha moth	willow, heaths, scrub
Doros profuges (=conopseus)	a hoverfly	scrub, wood edges, calcareous grasslands
Formica rufa	Southern wood ant	woodland clearings, heath & scrub
Formicoscenus nitidulus	Shining guest ant	bracken
Melanapion minimum	a weevil	wood margins, willow carr
Paradiarsia sobrina	Cousin German	young birch
Polia bombycina	Pale shining brown butterfly	scrubby grassland
Procas granulicollis	a weevil	woodland edges, bracken
Trichopteryx polycommata	Bare tooth-striped moth	woodland clearings, chalk downland
Xestia rhomboidea	Square-spotted clay moth	scrub patches

3.2.5 Reptiles and amphibians

Reptiles and amphibians use scrub for a variety of reasons, as foraging habitat, as resting areas, as an aid to thermoregulation and for hibernation. Reptiles utilise mosaics of scrub and more open areas of vegetation for thermoregulation. Scrub/grassland edges are particularly important for basking snakes and lizards (J. Foster, pers. comm.). Scrub encroachment is listed as a threat for two priority species in the UK BAP, namely the pool frog *Rana lessonae* and the sand lizard *Lacerta agilis*. Whilst scrub invasion, especially of heathlands, is a threat to several species of reptile and amphibian , inappropriate scrub clearance can be just as damaging. Attention needs to be given to both the spatial arrangement of clearance within a vegetation mosaic, and the seasonal timing of operations, in order to protect these species.

Only four correspondents to the questionnaire mentioned the value of scrub for amphibians and reptiles. Winter cover for amphibians was important in west Wales, nesting habitat for reptiles in Sussex, berries for sand lizards in Dorset, and as adder *Vipera berus* habitat in Wiltshire. There is little doubt that scrub has value for other herpetofauna, but good research information is lacking.

3.2.6 Mammals

Many mammal species use woodland, especially woodland edge, as a primary or secondary habitat, including badger *Meles meles*, red fox *Vulpes vulpes*, rabbit *Oryctolagus cuniculus* and various deer, use scrub as substitute for woodland. A range of small mammal species are likely to be favoured by the increase in shelter and structural diversity resulting from scrub development on grassland sites, but there does not appear to be any published information.

The value of scrub to small mammals in general was mentioned by only two survey correspondents. However, its importance for dormice *Muscardinus avellanarius* was noted by eight correspondents from southern England and Pembrokeshire. Recent research in Dorset has shown that dormice use ancient hedges and both inland scrub and coastal scrub as well as woodland, particularly if nest boxes are supplied (Eden & Eden 1999).

4 Ecology

4.1 Scrub dynamics

4.1.1 The origins and sources of scrub

With a few local exceptions, modern scrub is almost entirely a creation of man's activities, yet scrub vegetation would have occurred in several situations in primeval European landscapes largely unaffected by humans. In terms of contemporary conservation, this is an important point because many species of plants and animals will be adapted to the vegetation structures provided by scrub habitats. Moreover, shrub species were some of the first to colonise after the last ice age and scrub would certainly have been the first type of woody vegetation cover. Since then it has persisted, where climate and man have allowed, as a climax vegetation at the extremes of altitude and oceanity. The forest that followed the scrub would also have expanded to its furthest extent until climate halted its progress. Within these forested landscapes, scrub would have occurred in at least five situations. Examples of each of these **natural types of scrub** can be found in present day Britain but they are rare.

1. As a seral stage wherever primary successions were initiated. These situations would have occurred on stabilized coastal dunes, on eroding coastal cliffs and in river valleys with unstable sediments subject to scouring by floodwater.
2. Wherever extreme climatic conditions, especially windspeed and temperature, restricted the development of full woodland vegetation. In the lowlands these conditions probably pertained mainly to exposed western coasts.
3. In the uplands, montane and sub-montane scrub would have been far more widespread than today (Ratcliffe & Thompson 1988). For example, scrub was widespread in the Outer Hebrides, Shetland, Orkney and Caithness but was destroyed by burning, grazing and clearance about 5000-4000 BP (Birks 1988). Climate change was also a factor in the downward displacement and eastward retraction of scrub during this period.
4. As an ecotone between woodland and open habitats. It is arguable how much open unwooded land existed in primeval lowland Britain. If large herbivores did maintain patches of open grass and heath in some areas, especially those with nutrient-poor soils, it is likely that scrub would have been a constituent of the mosaic of habitats. Substantial areas of willow *Salix* spp. and alder *Alnus glutinosa* scrub would have been a typical component of the vegetation in the major floodplains, especially perhaps at the fringes of the permanent swamp and dry woodland.
5. Natural regeneration within treefall gaps in otherwise continuous forest would, where grazing pressure allowed, have temporarily created scrub-like vegetation structures.

Scrub frequently exists as ephemeral vegetation in the process of active succession from open grass or heath to woodland; Tansley (1939) termed this **seral scrub**. However, much scrub exists in situations where factors such as grazing, periodic fire or cutting prevent the establishment of trees but allow the persistence of scrub; this is effectively an arrested succession which Tansley (1939) termed **subseral scrub**. This type of scrub typically exists as a deflected successional stage or plagioclimax. Most dense thickets of mature scrub, such as blackthorn *Prunus spinosa* and hawthorn *Crataegus monogyna* with no obvious tree regeneration, should be regarded as subseral scrub for these will almost certainly develop into woodland eventually (see 4.1.3). A different situation arises where climate, salt deposition, substrate stability, soil depth or hydrology are not conducive to tree growth but do permit the development of scrub. Scrub that persists indefinitely as a result of such factors was termed **climax scrub** by Tansley (1939). Extant examples of climatically maintained scrub are found on coastal cliffs in southwest England, on small islands in freshwater lochs in north-west Scotland, in some coastal areas of western Scotland, especially the Inner Hebrides, and in the montane scrub of the Scottish Highlands.

Salt spray appears to be an important factor inhibiting the growth of scrub on upper seacliffs in southwest England and Wales (Hopkins 1996, Oates 1999). Scrub dominated by low banks of blackthorn or gorse *Ulex* spp. are particular features of upper cliff slopes in these regions. Substrate stability is an important factor resulting in the natural persistence of scrub and young woodland on a few cliffs, for example at Axmouth-Lyme Regis Undercliffs, Dorset. Coastal cliff sites with scrub can be considered as among the most natural areas present in Britain, although some will have received past management. Coastal protection schemes can damage these systems where they stabilize slopes. Some spate upland rivers also carry vestiges of scrub on unstable sediments on islands and banksides. There are no surviving lowland examples of natural floodplains in Britain. However, the carrs of the Bure Marshes, Norfolk, provide examples of near-natural wetland scrub structures, with various transitions and intermediate vegetation types between open swamp and closed canopy alder woodland. Perhaps the best example of scrub that is maintained by grazing or fire is gorse on southern heaths.

Scrub development within **primary successions** is a localized phenomenon. It occurs on dune systems in several forms in both wet slacks and old fixed dunes. Within non-calcareous wet dune slacks, low to medium scrub of creeping willow *Salix repens*, eared wilow *S. aurita* and bog myrtle *Myrica gale* is typical; calcareous slacks can have an abundance of creeping willow. The most distinctive scrub associated with fixed dunes is sea buckthorn *Hippophae rhamnoides* which can form extensive tracts, especially on the east coast. Old fixed dunes can, however, develop a wide range of scrub communities. Gorse *Ulex europaeus*, broom *Sarothamnus scoparius* and bramble *Rubus fruticosus* commonly develop on acidic dunes. On non-acidic soils, thickets of blackthorn hawthorn, elder *Sambucus nigra* and

privet *Ligustrum vulgare* may all be present. Other primary successions involving scrub may occur on unstable cliffs, scree and along some upland watercourses. However, the most widespread primary successions occurring in the lowlands are those associated with abandoned mineral workings. At dry sites, the scrub that develops depends on nutrient status: chalk and limestone quarries often contain diverse calcareous scrub whereas extraction at more acid sites can lead to gorse, broom and birch *Betula* spp. scrub. Flooded mineral workings often develop fringing thickets of willow scrub.

The majority of contemporary scrub in Britain has arisen through **secondary succession**. In the lowlands, the breakdown of traditional grazing systems on marginal land over the last 100 years has been a stimulant for scrub development. Grazing pressure by domestic animals on downland, heathland, coastal rough grassland and most lowland commons decreased to the point where much of this land was hardly grazed by livestock by the middle of the 20th century. Many of these formerly open sites have been strongly invaded by scrub and woodland but there is much local variation caused by the exact history of grazing by livestock and rabbits *Oryctolagus cuniculus* and by habitat restoration schemes involving scrub removal. Paradoxically, numbers of sheep escalated throughout most of Britain during the last quarter of the century (Fuller & Gough 1999) but this has taken place in the uplands and on lowland improved productive grasslands. More locally, the abandonment of vegetation cutting and turf cutting has triggered scrub expansion. This has occurred on many of the East Anglian valley mires (e.g. Redgrave Fen, Norfolk) but the best documented example is Wicken Fen where saw sedge *Cladium mariscus* was traditionally cut on a three to four year cycle and peat was also cut (Friday & Colston 1999). These practices declined at the end of the 19th century and in subsequent decades there was massive scrub expansion. The amount of scrub created on lowland marginal land during the 20th century has probably peaked and is now declining as a result of succession to woodland and habitat restoration, though no reliable statistics are available.

Scrub has sometimes been generated within the wider countryside as a consequence of the downturns in the agricultural economy. While this has not occurred in Europe on the scale evident in the eastern and Midwest USA, where large numbers of poor farms were completely abandoned at the end of the 19th century in favour of increased production on more productive land (Whitney 1994), there have been periods of temporarily reduced production here. This occurred most strikingly in the depression years of the 1920s and 30s when grain prices collapsed and arable farming contracted. The drive for self sufficiency in the Second World War and the subsequent intensification of agriculture has, however, removed all traces of pre-war scrub expansion. Abandonment of farmland as a process leading to scrub development in the 21st century cannot be ruled out, especially on poor quality grazing land. Perhaps the most likely large-scale expansion of scrub in the near future is in upland areas, where reductions in grazing pressure may result from abandonment of hill farms and the removal of deer. In the Scottish Highlands, reduction of red deer numbers and associated expansion of scrub is seen as a conservation opportunity by some ecologists and conservationists for ultimately this process will lead to more natural vegetation types (Usher & Thompson 1993, Scottish Natural Heritage 1994, Hester & Miller 1995, Staines *et al.* 1995). Large-scale scrub regeneration, mainly of birch and Scots pine *Pinus sylvestris*, is already taking place on several nature reserves in the central and eastern Highlands, for example at Creag Meaghaidh, Cairngorm NNR, Dinnet NNR and Abernethy RSPB reserve.

There is a final miscellaneous category of secondary successional scrub that develops on temporarily neglected land of various kinds. These include the fringes of industrial sites and land awaiting development where *Buddleja* often gains a strong hold as well as various forms of native scrub. Railway embankments can support a variety of scrub types, including naturalized and native species.

4.1.2 Mechanisms of scrub invasion

Classical models of successional mechanisms are of three broad kinds: facilitation, tolerance and inhibition (Connell & Slatyer 1977, Finegan 1984). Here we review the extent to which these and other models are likely to apply to the successional establishment of scrub.

The facilitation model applies when the invasion of one species is dependent on change in the environment brought about by another species. Facilitation is potentially most likely to occur in primary successions. Woody plants do not colonise until nitrogen levels have built up to 400 – 1200 kg ha $^{-1}$ (Crawley 1997). In primary succession the nitrogen is built up mainly through nitrogen fixing species and atmospheric deposition. Most scrub species also require a reasonable depth of soil and moderate levels of soil organic matter in order to maintain roothold and grow to reasonable stature. Although these processes are driven largely by early successional plant species, they are community processes rather than true interspecific facilitation (Crawley 1997). There is no evidence that facilitation involving interactions between individual species is a critical factor determining the successional invasion of shrubs, nevertheless scrub can usually only flourish in primary successions once the environment has been substantially modified by preceding vegetation. Though technically not facilitation, some bird dispersed shrubs can only gain a foothold once perches are present for birds, hence the invasion of bird-dispersed shrubs may be facilitated by wind-dispersed shrubs. Another example is the protection from browsing animals that some shrubs, such as juniper *Juniperus communis*, can sometimes afford to other plants.

Tolerance models are based on the assumption that later successional species are able to colonise through their ability to tolerate reduced resource levels (light and nutrients) imposed by the earlier, faster-growing colonists. Eventually the latter species are outcompeted by the former (this is also the outcome of facilitation). Inhibition models are fundamentally different to facilitation models in that they assume that early successional species make conditions less suitable for later arrivals and until they die, or are in some way suppressed, the later species are prevented from becoming established. The rate of succession under an inhibition model is linked directly to the longevity of species and to the rate at which local disturbances create opportunities for regeneration by late successional species.

Inhibition is a particularly relevant mechanism in the establishment of scrub in the sense that dense mats of grass, ericaceous shrubs and leaf litter may inhibit regeneration of woody shrubs. This can result in very slow progress of rank

grassland towards scrub (Hopkins 1996). The death of individual plants or local disturbances such as trampling and poaching by livestock or fire may be required to establish regeneration. Examples include persistent mats of mat-grass *Nardus stricta* and purple moor-grass *Molinia caerulea* on moorland that may inhibit germination of woody vegetation. A special case of inhibition occurs where grazing holds immature shrubs in check. This may happen if shrubs become established but then become subjected to intensified grazing that is insufficient to kill them but prevents their further growth. Under these circumstances, subsequent relaxation of grazing, may result in rapid release of scrub growth. Hawthorn scrub in grassland can be maintained indefinitely in a low stunted state by sheep grazing, though the sustained use of hill or mountain breeds of sheep that feed less selectively than their lowland counterparts would probably eventually result in the scrub disappearing.

The initial floristic composition model (Finegan 1984, Crawley 1997) is at the opposite extreme to facilitation in that it implies succession is merely driven by the differing life strategies and growth rates of the plant species that are present at the outset. Under this model fast-growing, short-lived species are gradually replaced by slower-growing, longer-lived species. Plant composition in secondary succession may often be driven by such life history differences where a substantial seed bank or parent seed source is present at the outset. However, initial floristics, tolerance and inhibition are not mutually exclusive; these mechanisms may act simultaneously.

Finally, one must consider factors influencing seed dispersal and predation as determinants of the rate and nature of succession. The majority of shrub species produce fleshy fruits and are, therefore, primarily adapted for dispersal by birds. A mutualistic relationship has evolved between berry-bearing shrubs and birds; in Britain the avian dispersers include especially the larger thrushes, the *Sylvia* warblers, robin *Erithacus rubecula* and starling *Sturnus vulgaris* (see 4.2.1.4). Mutualism is potentially far-reaching because there is evidence that birds feeding on juniper avoid selecting fruits that are damaged by insects that predate the pulp or seeds. This has the effect of increasing the proportion of healthy fruits in the seed rain (Garcia *et al.* 1999). We are unaware of any detailed studies of the dynamics of dispersal of any shrub species in Britain, though the work of Snow & Snow (1988) is valuable as a documentation of the usage made of different fruits by birds. The most detailed European studies of dispersal are of juniper in Spain which show that in addition to wintering thrushes, juniper is dispersed by carnivorous mammals, rabbits and livestock (Herrera 1989, Santos *et al.* 1999). However, the birds are the most effective dispersers (Santos *et al.* 1999). It is likely that mammals also have a dispersal role for some shrubs in Britain. For example, Tansley (1939) mentions that rabbits are important dispersers of hawthorn. Wind dispersed scrub species include alder, willow, birch and pine. It should be noted, however, that although birds do not act as dispersers for these species, they do consume their seeds. Small mammals can exert severe predation on seeds in old fields and this may influence the rate and spatial pattern of shrub and tree establishment (Manson & Stiles 1998).

For all shrub species, the proximity of seed sources is important. This is likely to be especially important in upland areas devoid of existing scrub and tree cover over large areas. Under such circumstances, even when conditions are otherwise favourable for regeneration, scrub development may be a slow process. Finegan (1984) has argued that the behaviour of dispersers, especially birds, is a critical factor in the rate and pattern of succession of woody plants. In the case of bird-dispersed species, invasion may also be slow if birds do not use the receptor site. Deposition of faeces, and hence of seed, can be a slow process if there are few perches (Finegan 1984, McClanahan & Wolfe 1993). Even within established scrub, the dispersal of seed from bushes in small isolated fragments may be less effective than that for bushes of the same species within larger patches of scrub, this being a function of the frequency with which berry-eating birds visit patches of different sizes (Santos *et al.* 1999).

This section has focused on seral scrub but rather different issues may be relevant concerning the potential expansion of montane willow and juniper scrub (D. Gilbert pers. comm.). These include the proximity of male and female plants and so the potential to produce seed. There also appears to be a relationship between population size, volume of viable seed and successful recruitment that requires investigation.

4.1.3 Structural dynamics of scrub development

As scrub colonises open ground and gradually progresses towards woodland there is a huge transformation of physical architecture. These structural changes are extremely important in driving many of the associated changes in animal communities yet they appear not have been documented in detail for any type of scrub in Britain. In the absence of any long-term quantitative studies on the dynamics of scrub vegetation we have based the following account on our own observations of scrub structures made in the course of studies of animal succession within scrub. Three basic situations are outlined below which relate mainly to the pattern of tree regeneration within the scrub.

1. **Lowland thicket scrub** (*sensu* Tansley 1939) occurs when few tree species regenerate within the developing scrub. The scrub itself grows into a dense thicket, which may persist for a considerable length of time though, in the absence of cutting, this will eventually give way to woodland as bushes die and generation opportunities arise for trees. Examples of thicket scrub can include stands dominated by hawthorn, blackthorn and gorse. In describing the typical sequence of structural changes, it is assumed that the scrub is developing on former grassland, that seed sources are readily available for the scrub, that regeneration sites are available for the shrubs and that subsequent grazing pressure by livestock, deer or rabbits does not arrest or disrupt the development of the scrub. Where the latter happens, low open scrub may be maintained for a considerable period. The structural development of scrub is a continuum. Nonetheless, it is useful to identify three broad main phases which can be defined in terms of the cover and height of the woody vegetation and in terms of the foliage profile i.e. the distribution of foliage across different heights.

   Phase I - establishment. Relaxation of grazing or mowing results in growth of the grass and the initial colonization of shrubs. During this phase there is an intimate vertical mixture of grass and woody vegetation,

and spatial heterogeneity is high with some patches dominated by grass, others becoming increasingly dominated by shrubs. Once the scrub grows above approximately 1 m and the scrub cover exceeds approximately 50%, the intimate vertical mixtures and horizontal mosaics of grass and woody vegetation start to break down.

Phase II - canopy-closure. Increased growth of the scrub results in conditions where open areas of grass are becoming increasingly scarce through shading and the density of the low woody vegetation, within 1.5 m of the ground, is extremely high, often forming impenetrable thickets. Even when the scrub canopy has fully closed, for a period of time the low woody vegetation will remain dense.

Phase III - post canopy-closure. This is the least structurally diverse stage. Following canopy closure, and with continued growth of individual bushes, the density of low vegetation declines rapidly, both in the field layer and the quantity of low woody vegetation. The biomass of vegetation becomes increasingly concentrated in the scrub canopy and a 'leggy' structure becomes evident to the scrub. Within mature blackthorn and mature hawthorn it becomes possible to walk beneath the canopy with ease.

2. **Lowland woodland scrub** (*sensu* Tansley 1939). The major difference between woodland and thicket scrub is that trees are growing within the former scrub more or less from the outset. Examples of woodland scrub include several formerly grazed commons in the Chilterns where oak *Quercus* spp. grows within hawthorn scrub and regenerating mixtures of ash *Fraxinus excelsior* and hawthorn on limestone. The same sequence of structural changes occurs as for thicket scrub but there is more structural heterogeneity within the establishment and canopy-closure phases. A greater range of shading conditions also exists under woodland scrub which may allow a greater variety of herbs to exist. Perhaps the main difference, however, is in the post canopy-closure phase where the presence of trees results in much greater diversity of structure and a more rapid progression to a woodland structure.

3. **Birch and pine scrub on upland and lowland heath.** This is distinguished as a third type of structural development because, on upland and lowland heathland and moorland, much scrub regeneration usually consists of the tree species that ultimately form the mature woodland. The structural phases of establishment, canopy-closure and post canopy-closure still apply, but the vegetation structures are relatively simple compared with those in much lowland thicket and woodland scrub. Tree and shrub species composition is relatively low so these types of developing scrub tend to have lower diversity of microhabitats and shading conditions.

4.1.4 Spatial patterning, mosaics and edges

Inevitably the above descriptions of structural changes are simplified. There is much variation with the botanical type of scrub and in the spatial uniformity of the process. Patchiness in developing scrub, in both the establishment and canopy-closure phases, is an important habitat feature for many associated plants and animals. The processes by which patchiness develops have not been examined in detail but several factors are likely to be relevant.

The spatial patchiness inherent in the development of much scrub vegetation may have its origins partly in the location of perches for birds. Isolated established bushes will tend to attract birds which deposit more seeds, thus forming a regeneration nucleus (Finegan 1984). The effect may be enhanced where suckering species, especially blackthorn, become established. The behaviour of birds is not, however, the sole factor driving patchiness. Receptive germination sites may not be evenly distributed over the site. Furthermore, seed predation by small mammals may be spatially uneven (Manson & Stiles 1998). Large trees growing within the scrub will also promote patchiness by casting shade and hence inhibiting the growth of shrubs nearby.

Grazing has an important effect on patchiness. An increase in grazing pressure after scrub establishment, or spatial unevenness in grazing, can intensify the patchiness within scrub. On calcareous grassland, rabbits can slow down, and possibly prevent, the expansion of scrub outside regeneration nuclei and thus enhance the mosaic effect.

Where mosaics of scrub and grassland develop, the vegetation structure at the edges of scrub patches is different to that within the patches. Foliage density at the edges of patches is usually denser at the edges and there is often vertical continuity of grass and shrubs forming a complex structure that is not evident within the scrub patch. These complex structures are probably important to a wide range of animals and plants. Hopkins (1996) points out that several plants that are sensitive to grazing may find refuges at the edge of scrub patches where grazing pressure is often less intense. Among the plants he listed are wild parsnip *Pastinaca sativa*, hogweed *Heracleum sphondylium* and false oat-grass *Arrhenatherum elatius*.

Hopkins (1996) has also drawn attention to the concepts of saum and mantel which are well established in a European context but less widely recognised in Britain. Saum and mantel are components of an ecotonal mosaic of vegetation consisting of species-rich grassland, scrub and woodland. Saum is vegetation characterised by tall herbs and sparse shrubs, while mantel is dominated by shrubs. The existence of these different vegetation types in close proximity to one another is usually a product of episodic, low intensity management involving grazing on unproductive land of low nutrient status. Such mosaics are extremely localised in Britain, but Hopkins (1996) gives some examples of locations where they may be found, for example the Derbyshire Dales. In biodiversity terms these mosaics can be extremely rich.

The maintenance of species-rich scrub mosaics represents a conservation challenge. The complex mosaics and edge structures that develop during the successional growth of scrub (and this certainly applies to saum and mantel structures) are rarely evident in scrub that is managed by rotational cutting (Gough & Fuller 1998). This form of management effectively coppices the vegetation,

resulting in much regeneration occurring from cut stumps which usually gives a far more uniform appearance to the developing scrub. The structural consequences of starting from open grassland or as regrowth from felled scrub are, therefore, very different. Maintaining biological richness within scrub mosaics is largely dependent on managing the scrub to ensure that it does not reach the closed-canopy stage where nutrient build up occurs (Hopkins 1996).

4.1.5 Environmental changes associated with scrub development

Vegetation succession leads to several alterations in environmental conditions in addition to ones of vegetation structure and floristics. Light regimes are substantially modified by the vegetation changes and the consequences are especially profound for plants growing in the field layer.

Scrub development generates major changes in soils. Nutrient conditions change with succession with build-up of nitrogen, which is enhanced where nitrogen-fixing species are dominant members of the scrub community, for example alder, sea buckthorn and gorse. Phosphorus mining can also occur in scrub, whereby there is enrichment of the soil close to the surface. This can result in dominance by competitive ruderals when scrub is cleared (Grubb & Key 1975). Organic soil content also increases under a scrub canopy with the build up of leaf litter. These processes are particularly important on nutrient poor sites where subsequent attempts to restore a species-rich grassland flora may be hindered by rapid growth of nutrient-demanding rank vegetation (Hopkins 1996).

4.1.6 Mycorrhizal interactions

The occurrence and role of mycorrhizal fungi in scrub communities in Britain and Europe are virtually unknown. The symbiosis between mycorrhiza and host plant relies on the provision of carbon by the host plant to sustain the fungus in return for nutrient (particularly phosphate) acquisition by the fungus (Smith & Read 1997). The mycorrhizal fungus, whether arbuscular or ectomycorrhizal, maybe specific to the plant species. However, the association is variable both within and between species and tends to be more prevalent in nutrient limited soils, often utilised by scrub communities. Mycorrhizal fungi are known to be particularly important in the establishment phase of plants (Gange *et al.*1990) and thus their role in the spread of scrub communities may be considerable. The concept of artificially manipulating mycorrhizal fungal communities is new and yet to be fully researched. However, innoculation of soils with appropriate mycorrhiza, either in the field or nursery, may be a future tool in the restoration of rare species and communities. In addition, the potential for linkages by the hyphae of ectomycorrhiza within or even between species may promote nutrient exchange, reduce plant competition and promote recovery (Amaranthus & Perry 1994). Arbuscular mycorrhiza can also play a role in alleviating drought stress and in the stabilization of disturbed soil by enhanced recruitment of species (Garcia *et al.* 1999).

4.2 Ecological linkages within scrub systems

This section focuses on four groups of organisms: lichens and bryophytes, ground flora, invertebrates and birds. It reviews the importance of different aspects of the scrub environment for each group in turn. These species groups have been selected because they represent strikingly different life forms, with fundamentally different requirements, and embrace many species considered to be of special conservation importance in the context of scrub. Invertebrates and birds are particularly diverse in their responses to scrub development.

Clearly, scrub can be important to taxa other than those examined in detail here and the following should not be regarded as a comprehensive account. For example, open mosaics of scrub and heath or grassland may be important to reptiles. In the case of the adder *Vipera berus*, Wild & Entwistle (1997) state that 'Scrub is used for cover and is an important feature of many sites'. Successional changes may also affect many other groups of animals including, for example, small mammals (Churchfield & Brown 1987).

The development of increasing structural complexity within seral scrub stimulates a web of indirect interactions between organisms which has been inadequately researched. It is appropriate at this point to touch on the issue of climate change because it is becoming clear that plant communities and their associated invertebrates will be potentially altered, but not necessarily in a predictable way (Masters *et al.* 1998). Hence, it is possible that scrub species may show a variety of responses to changing climate and that this may affect their associated ground floras and invertebrate communities in complex ways.

4.2.1 Effects of scrub floristics

This is concerned with the effects of the species composition and diversity of shrubs.

4.2.1.1 Lichens and bryophytes

For bryophytes, the dominant tree species is generally of secondary importance to microclimate and microhabitat (Hodgetts 1993). Therefore, apparent associations with particular shrubs or trees may merely reflect these other factors. In western Britain, some of the richest assemblages of bryophytes are associated with oakwoods but in north-west Scotland hazel *Corylus avellana* and birch stands can also be rich in bryophytes (Hodgetts 1993). Some of these latter woodlands are, in structural terms, effectively scrub. Ratcliffe (1977) also mentions that stands of northern and western hazel scrub can be rich in bryophytes. Elder *Sambucus nigra* provides a locally important habitat for epiphytic mosses (Ratcliffe 1977). Lichen communities show a certain amount of variation according to tree species (Harding & Rose 1986). This is probably a response to factors such as the texture, chemistry and moisture retention of the bark. These differences appear to manifest themselves mainly on mature, or even veteran, trees so they may not be especially relevant to scrub. Nonetheless, western Scottish hazel stands are of particular interest for lichens, supporting several species endemic to the British Isles. The older, larger hazel stems are the richest in these lichens. Ecological continuity, as well as climate, appears to be a key factor influencing the importance of these stands for lichens.

4.2.1.2 Ground flora

The exact shrub species composition of the scrub is far less significant to plants growing in the field layer than are nutrient conditions, soil dampness and shading. Nonetheless, certain types of scrub stand out as having an especially rich ground flora. These are frequently associated with chalk or limestone and consist of mixtures of shrub species. Where this calcicole scrub exists as a mosaic with rank grassland a diverse ground flora can be present including tall herbs that are intolerant of grazing e.g. bloody crane's bill *Geranium sanguineum*, goldilock's aster *Aster linosyris* and lesser meadow-rue *Thalictrum minus* (Hopkins 1996). Hazel scrub on limestone, as in the Derbyshire Dales, can have a very rich herb flora (Ratcliffe 1977). Montane willow scrub also appears to be associated with sites that have rich ledge and tall herb floras (D. Gilbert pers. comm.). Notwithstanding the above comments, it should be noted that a diverse ground flora does not always occur in scrub. The extent to which there is a rich ground flora depends on factors such as site history and management, proximity of potential colonists and successional stage of the scrub.

4.2.1.3 Invertebrates

The majority of phytophagous insects are specific to plant family and this is discussed in detail in section 3.2.4.1. Non phytophagous insect groups are also closely associated with scrub, though are not generally related to the species composition, but rather to its physical structure and to the biotic and abiotic conditions which this imparts. While parasitoids and predators exploit the increased complexity of structure over herbaceous vegetation, to provide sites for prey capture, resting, basking and mating, other feeding groups are influenced by the scrub cover and related attributes. Scavengers and decomposers, especially primitive insect groups, such as the Collembola or spring tails, and other epigeal invertebrates are often present in large numbers under scrub, because of the shade and higher humidity that the cover provides. The build up of organic matter is also an important factor driving changes in the soil and ground fauna. As with phytophagous taxa, the highest levels of diversity are associated with seral scrub communities, comprising a mosaic of woody and herbaceous species (Brown & Southwood 1987).

Finally, attention should be drawn to the fact that scrub can be important to a wide range of 'dead wood invertebrates', both as nectar sources for adults and as larval food (K. Alexander pers. comm.). The flowers of various species, for example hawthorn and privet, are important sources of nectar. The stem wood and bark of several species of scrub provide specific habitats for saproxylic insects. Examples include the jewel beetles *Agrilus sinuatus* and *Agrilus viridis* which are associated with hawthorn and willow respectively. Old gorse stems support several scolytid beetles. Elder and alder are also important for invertebrates, some associated with the wood itself, others with fungi specific to these trees. More research is needed

on communities of dead wood invertebrates, both in climax scrub and in dead and dying stems within seral scrub.

4.2.1.4 *Birds*

Birds using scrub generally do not show strong associations with particular plant species and are far less dependent on particular shrub taxa than are invertebrates (Fuller 1995, 1996). The structure of the vegetation is probably of greater significance to many birds than its exact species composition. Perhaps the most striking exeption in Britain is the dependence of the Dartford warbler *Sylvia undata* on gorse (see chapter 3). Different species of shrubs create different vegetation structures so it is not straightforward to isolate the effects of structure and floristics. This point is illustrated by a study of bird communities on chalk downland in which a comparison was made of pure hawthorn scrub and mixed scrub containing a diversity of shrubs (Fuller 1987). The samples of scrub were at similar stages of successional development. The hawthorn scrub held higher densities of breeding birds than the mixed scrub, however this may have been accounted for by the fact that hawthorn scrub tended to be taller than the mixed scrub. Another example is the apparent preference shown by nightingales *Luscinia megarhynchos* for blackthorn scrub in many regions (Fuller *et al.* 1999). This may not reflect a preference for blackthorn *per se*, but rather for the dense thicket structures formed by this rapidly suckering species. Most scrub provides few nest sites for hole-nesting birds such as tits but an important exception is elder which, when old, offers cavities for these birds.

Apart from structural differences, one of the main ways in which scrub species composition is likely to affect birds is through food supply. This applies to both insectivores and frugivores. There have been extremely few studies of the diet of the insectivorous foliage-gleaning species, notably warblers, that are characteristic of scrub. However, it seems likely that the available biomass of invertebrates of suitable size is likely to be more critical to these species than the abundance of particular invertebrate species. We are unaware that estimates of invertebrate biomass are available for different types of scrub. Casual observation, however, would suggest that scrub with considerable quantities of hawthorn or with diverse shrubs such as found on much calcareous soils provides rich feeding for many foliage gleaning birds. Notwithstanding these comments, it is likely that subtle differences exist in foraging ecology and usage of individual plant species between different insectivorous birds. This was found to be the case in a detailed study of the foraging ecology of *Sylvia* warblers in Mediterranean scrub (Martin & Thibault 1996). Similar work in temperate scrub would be worthwhile.

A wide range of shrubs provide fruit resources for warblers, thrushes, pigeons, starlings, robins, tits and finches (Snow & Snow 1988). Among especially important sources of food are hawthorn, elder, dogwood *Cornus sanguinea* and sea buckthorn. Most frugivores will feed on the berries of a wide range of shrubs but different species of birds often show apparent preferences for the berries of particular shrub species that are not reviewed here in depth. These preferences are often mediated by the availability of alternative berry supplies in the local area. Complex relationships exist between the birds and shrubs which involve mutualistic relationships in which birds act as seed dispersers. The main avian dispersers of British native shrubs are listed in Table 4.1. Not all birds that benefit from the food resources provided by berry-bearing shrubs actually diperse the seed. Some birds act as seed predators i.e. they consume the seed and do not disperse it. Bullfinch *Pyrrhula pyrrhula*, greenfinch *Carduelis chloris* and tits are examples of species that act mainly as seed predators. Some birds may act as pulp predators i.e. they consume pulp without dispersing the seed. Few, if any, fruit-eating birds depend on a single or a small number of fruit species. This lack of specialisation may be a consequence of different fruits providing complementary resources (Whelan *et al.* 1998).

Table 4.1 The principal avian dispersers of shrubs, trees and climbres with fleshy fruits native to England, Wales and Scotland. Adapted from Snow and Snow (1988).

Species	*Growth form*	*Fruit*[1]	*Principal (minor) bird dispersers*[2]
Cupressaceae			
Juniper *Juniperus communis*	Shrub	fleshy cone	thrushes, (robin)
Taxaceae			
Yew *Taxus baccata*	tree	arillate	thrushes, starling, (robin, blackcap)
Berberidaceae			
Barberry *Berberis vulgaris*	shrub	berry	?
Hypericaceae			
Tutsan *Hypericum androsaemum*	low shrub	fleshy capsule	?
Aquifoliaceae			
Holly *Ilex aquifolium*	tree	drupe	thrushes (robin, blackcap, woodpigeon)
Celastraceae			
Spindle *Euonymus europaeus*	small tree/shrub	arillate	thrushes, robin, (blackcap)
Rhamnaceae			
Buckthorn *Rhamnus catharticus*	small tree/shrub	berry	thrushes, starling, (robin, blackcap)
Alder buckthorn *Frangula alnus*	"	"	?
Rosaceae			
Wild raspberry *Rubus idaeus*	shrub	compound drupelets	thrushes, robin, blackcap
Blackberry *Rubus fruticosus*	"	"	thrushes, warblers, robin, starling
Dewberry *Rubus caesius*	procumbent shrub	"	probably as for blackberry
Field rose *Rosa arvensis*	shrub	fleshy receptacle with achenes	thrushes?
Burnet rose *Rosa pimpinellifolia*	low shrub	"	?
Long-styled rose *Rosa stylosa*	shrub	"	?
Dog rose *Rosa canina*	"	"	thrushes (robin, blackcap, woodpigeon)
Sweet briar *Rosa rubiginosa*	"	"	?
Blackthorn *Prunus spinosa*	small tree/shrub	drupe	thrushes (starling, corvids)
Wild cherry *Prunus avium*	tree	"	thrushes (woodpigeon)
Bird cherry *Prunus padus*	"	"	thrushes (robin, warblers, corvids)
Woodland hawthorn *Crataegus laevigata*	small tree/shrub	"	thrushes?
Hawthorn *Crataegus monogyna*	"	"	thrushes, starling (robin, woodpigeon)
Rowan *Sorbus aucuparia*	tree	pome	thrushes (robin, starling corvids)
Whitebeam *Sorbus aria*	"	"	thrushes (starling, corvids)
Service *Sorbus torminalis*	"	"	thrushes?
Pear *Pyrus pyraster*	"	"	?
Crab-apple *Malus sylvestris*	"	"	blackbird, carrion crow
Grossulariaceae			
Red currant *Ribes rubrum*	shrub	berry	thrushes, warblers, robin
Blackcurrant *Ribes nigrum*	"	"	?
Gooseberry *Ribes uva-crispa*	"	"	blackbird
Thymelaeaceae			
Spurge laurel *Daphne laureola*	low shrub	drupe	robin
Mezereon *Daphne mezereon*	"	"	blackbird (robin? warblers?)
Elaeagnaceae			

Table 4.1 The principal avian dispersers of shrubs, trees and climbres with fleshy fruits native to England, Wales and Scotland. Adapted from Snow and Snow (1988).

Species	*Growth form*	*Fruit*[1]	*Principal (minor) bird dispersers*[2]
Sea buckthorn *Hippophae rhamnoides*	small tree/shrub	drupe-like	thrushes? robin, blackcap, (corvids)
Cornaceae			
Dogwood *Cornus sanguinea*	shrub	drupe	thrushes, starling, robin (blackcap, corvids)
Araliaceae			
Ivy *Hedera helix*	climber	berry	thrushes, robin, blackcap, starling
Cucurbitaceae			
White bryony *Bryonia dioica*	climber	berry	thrushes, warblers (robin)
Ericaceae			
Bearberry *Arctostaphylos uva-ursi*	low shrub	drupe	probably as for bilberry
Cowberry *Vaccinium vitis-idaea*	"	"	probably as for bilberry
Bilberry *Vaccinium myrtillus*	"	"	grouse, thrushes, corvids
Empetraceae			
Crowberry *Empetrum nigrum*	low shrub	drupe	probably as for bilberry
Oleaceae			
Privet *Ligustrum vulgare*	shrub	berry	thrushes, robin, blackcap (corvids)
Solanaceae			
Woody nightshade *Solanum dulcamara*	climber	berry	thrushes, warblers, robin (starling)
Rubiaceae			
Madder *Rubia peregrina*	climber	berry	robin?
Caprifoliaceae			
Elder *Sambucus nigra*	shrub	drupe	thrushes, robin, warblers, starling, (corvids)
Wayfaring tree *Viburnum lantana*	shrub	drupe	thrushes, robin, warblers
Guelder rose *Viburnum opulus*	"	"	thrushes, (robin, blackcap)
Honeysuckle *Lonicera periclymenum*	climber	berry	thrushes, robin (starling)
Liliaceae			
Butcher's broom *Ruscus aculeatus*	low shrub	berry	?
Dioscoreaceae			
Black bryony *Tamus communis*	climber	berry	thrushes, (robin, blackcap)

Notes

[1] Classification of fruit type follows Snow & Snow (1988)

[2] Species listed are those considered to be dispersers i.e. pulp predators and seed predators are excluded. Main sources are Snow & Snow (1988), Boddy (1991). Thrushes = large thrushes where several species are probably involved (i.e. mainly blackbird *Turdus merula*, song thrush *T. philomelos*, mistle thrush *T. viscivorus*, redwing *T. iliacus*, fieldfare *T. pilaris*). Warblers = *Sylvia* species. Species known to be dispersers of seeds on mainland Europe but not recorded as dispersers in Britain are excluded. Scientific names of other birds mentioned above: robin *Erithacus rubecula*, starling *Sturnus vulgaris*, blackcap *Sylvia atricapilla*, woodpigeon *Columba palumbus*, carrion crow *Corvus corone*.

4.2.2 Successional change in habitat factors

Scrub development is accompanied by large changes in the associated biological communities, though successional stage *per se* is of no particular significance. Successional change in communities is largely driven by the massive alteration of physical structure and other environmental conditions that accompany the invasion and growth of bushes. Here we outline successional changes in selected taxa and summarise the key environmental changes that are of particular significance to different groups.

4.2.2.1 Lichens and bryophytes

Habitat quality for both bryophytes and lichen will generally increase with successional age. Critical factors are shade, humidity, exposure and the availability of suitable substrates. Bryophytes are sensitive to hard frost and desiccation so they tend to be most luxuriant in regions and microhabitats that provide suitable temperatures and humidity (Hodgetts 1993). Most bryophyte-rich sites are found in the west of Britain where rainfall and temperatures are relatively high. The richest sites tend to be within woodland or long-established scrub, though Atlantic bryophytes can thrive outside woodland in suitable microhabitats such as ravines or block scree (Hodgetts 1993). Large trees are important to many lichens in terms of the substrate and microclimate they provide (Harding & Rose 1986) though they generally prefer lighter and warmer microclimates than bryophytes (Harding & Rose 1986, Hodgetts 1993). Coastal scrub in western and northern Britain is an important habitat for lichens as discussed above.

4.2.2.2 Ground flora

Increasing shade from the growth of woody plants is the overriding factor driving successional change in the field layer, though nutrient status may also be important. Once the cover of woody plants exceeds some 50%, shading starts to have a serious effect on the field layer (Ward & Jennings 1990a). Species that are dependent on short grazed swards are rapidly replaced by tall, coarse grasses (Ward & Jennings 1990b) and by tall herbs sensitive to grazing which are often associated with the edges of the scrub itself (Hopkins 1996). While these latter situations may be shaded to a certain extent, unchecked growth and expansion of scrub will eventually lead to loss of the open grassland and associated flora. As stressed above, the pattern of change in the ground flora will be strongly influenced by whether scrub is freshly colonising open grassland or whether it is regrowth from cut scrub. The change to a woodland flora will generally be slow due to the lack of nearby colonists in many landscapes and to the poor dispersal ability of many of the species. Changes in the seed bank are inevitable under long-established scrub with gradual reduction of viable seeds of species associated with the open vegetation. This was illustrated in a study conducted across a grassland-scrub-woodland gradient in Surrey by Davies & Waite (1998) which found that few species were recorded in the seed bank along the entire gradient.

4.2.2.3 Invertebrates

Many of the invertebrates associated with scrub are associated with specific vegetation structures. Unimpeded successional change in scrub habitats therefore results in an ongoing change in niches and in the composition of the invertebrate fauna. Invertebrate turnover does not necessarily proceed at a uniform rate. The effect of vegetation structure on invertebrates is considered in greater detail in 4.2.3.

Successional studies have, understandably, focused on changes in the vegetation in terms of species composition and structure. The few studies which have encompassed invertebrates (e.g. Southwood *et al.* 1979, Brown & Southwood 1987, Brown 1990) have also demonstrated clear successional trends. These are mainly related to the transition in plant growth forms as succession proceeds. Clearly, the invasion of woody scrub species into a perennial grass and herb community introduces not only new plant species for specialist herbivores, but additional and different structural and architectural complexity for groups with other trophic affinities. Indeed, the integral mix of scrub species, or of a single species at different seral stages, provides a complexity of 3-dimensional structure far in excess of grassland communities.

As succession proceeds, specialist predators and parasitoids either track the changes in the phytophages directly or benefit from using scrub as 'an interceptor' in the grassland sward for host capture, resting, basking or mating. In addition, male bush crickets (Orthoptera: Tettigoniidae) also select scrub as a substrate on which to stridulate and thereby project their courtship song (e.g. Cherrill & Brown 1987).

Knowledge of the subterranean invertebrate community is extremely limited and, to our knowledge, there have been no studies specific to scrub. Even so, such faunal groups are likely to provide key resources for birds and small mammals, especially the larval stages of holometabolous insects.

It is interesting that some phytophagous insect species are only found associated with specific stages of scrub succession or indeed after scrub clearance. While many of these species are associated with the scrub species themselves, others are related to herbaceous plant species tracking the changes in the scrub species. One such species of flea beetle, *Epitrex atropae*, feeds on deadly nightshade *Atropa belladonna* which is a successful early coloniser of cleared scrub.

Invertebrate communities vary seasonally as well as successionally, a trend even seen in the soil micro-arthropod community (Parr 1978), even though subterranean taxa tend to be buffered from changes in abiotic conditions. Such temporal variation is an important dimension in the role of invertebrates as a source of food for higher trophic levels.

4.2.2.4 Birds

In lowland calcareous scrub, the numbers of species and of individuals of breeding birds increases rapidly with scrub encroachment. The relationship is not a linear one, however, for numbers do not increase, and perhaps even drop, after canopy closure (Fuller 1987, 1995). As with invertebrates, birds show a large turnover in species composition with growth of the scrub. This is summarised in Figure 4.1 for birds breeding in scrub on the escarpment of the Chiltern Hills. Species show considerable individuality in their distribution across the habitat gradient. Some species are confined to the earliest stages (skylark *Alauda arvensis* and pipits *Anthus* spp.), others are associated with open-canopy scrub and rapidly disappear once the canopy has closed (e.g. yellowhammer *Emberiza*

citrinella and linnet *Carduelis cannabina*), while some reach greatest abundance around canopy-closure (e.g. garden warbler *Sylvia borin*, lesser whitethroat *Sylvia curruca*). Densities of breeding warblers can be extremely high in the canopy-closure phase but decrease thereafter. Long-distance migrants contribute an exceptionally high proportion of the total songbird territories in these early and mid stages of secondary woodland succession and their densities are also highest at that stage (Helle & Fuller 1988).

The rates of turnover in species composition are greatest in the early stages of scrub development (Figure 4.2). An increase of scrub from 5 to 25% cover has a larger impact on species composition than does an increase from 35 to 60% cover. This effect occurs partly because grassland species will tolerate only a limited amount of scrub encroachment. But it also arises because several species that live in old scrub will actually colonise scrub at a relatively early stage of growth, before the canopy closes. This turnover in bird species is driven mainly by the species-specific responses to the ever changing physiognomy of the scrub, defined as its canopy openness, its height and its foliage density. Effects of scrub structure on birds are examined further in 4.2.3.

Successional changes in breeding bird communities of upland scrub have been studied in birch, pine and juniper scrub in the central and eastern Highlands (Gillings *et al.*1998, Gillings & Fuller 1998, Fuller *et al.* in press). Avian species richness increases across the series: moorland – open birch scrub – closed birch scrub – old birch woodland. This is broadly consistent with the pattern for lowland scrub described above, but in other respects the findings were different. The numbers of species and densities of birds in all stages of scrub development were relatively low. The commonest breeding birds of scrub – tree pipit *Anthus trivialis*, willow warbler *Phylloscopus trochilus* and chaffinch *Fringilla coelebs* – were widely distributed in woodland as well as in scrub habitats. The scrub was not characterised by concentrations of scrub specialists, such as the *Sylvia* warblers so typical of southern scrub. Those scrub specialists that were present occurred at very low density, for example black grouse *Tetrao tetrix*, redpoll *Carduelis flannea*, yellowhammer, whinchat *Saxicola rubetra* and stonechat *Saxicola torquata*. Fuller *et al.* (in press) made several predictions about the consequences for birds of large-scale expansion of scrub and woodland in this region. Scrub expansion would be beneficial for the above scrub specialists and this was highly desirable in the black grouse which is in serious national decline. However, a wider range of species would benefit from the long-term development of old woodlands through natural regeneration.

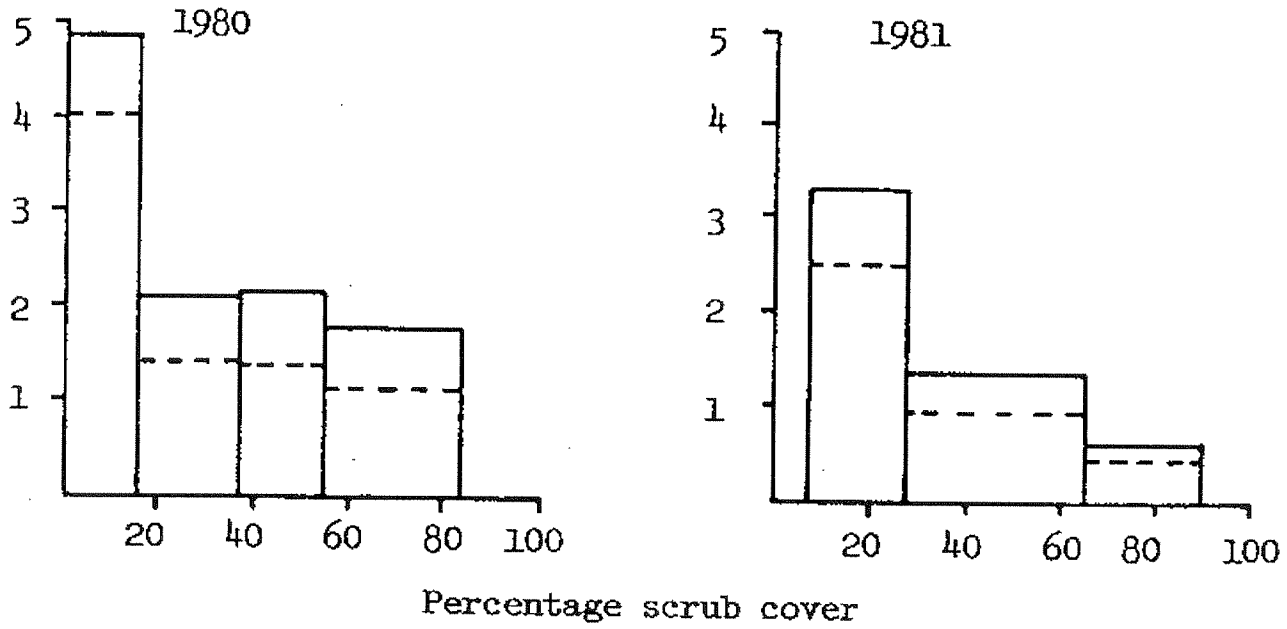


Figure 4.1 Abundance of breeding birds on the escarpment of the Chiltern Hills in relation to scrub growth. Based on point counts conducted in 1980 and 1981. The index of abundance is derived from numbers of birds counted within a 50 m radius at more than 90 locations. Reproduced from Fuller (1995) with the permission of Cambridge University Press.

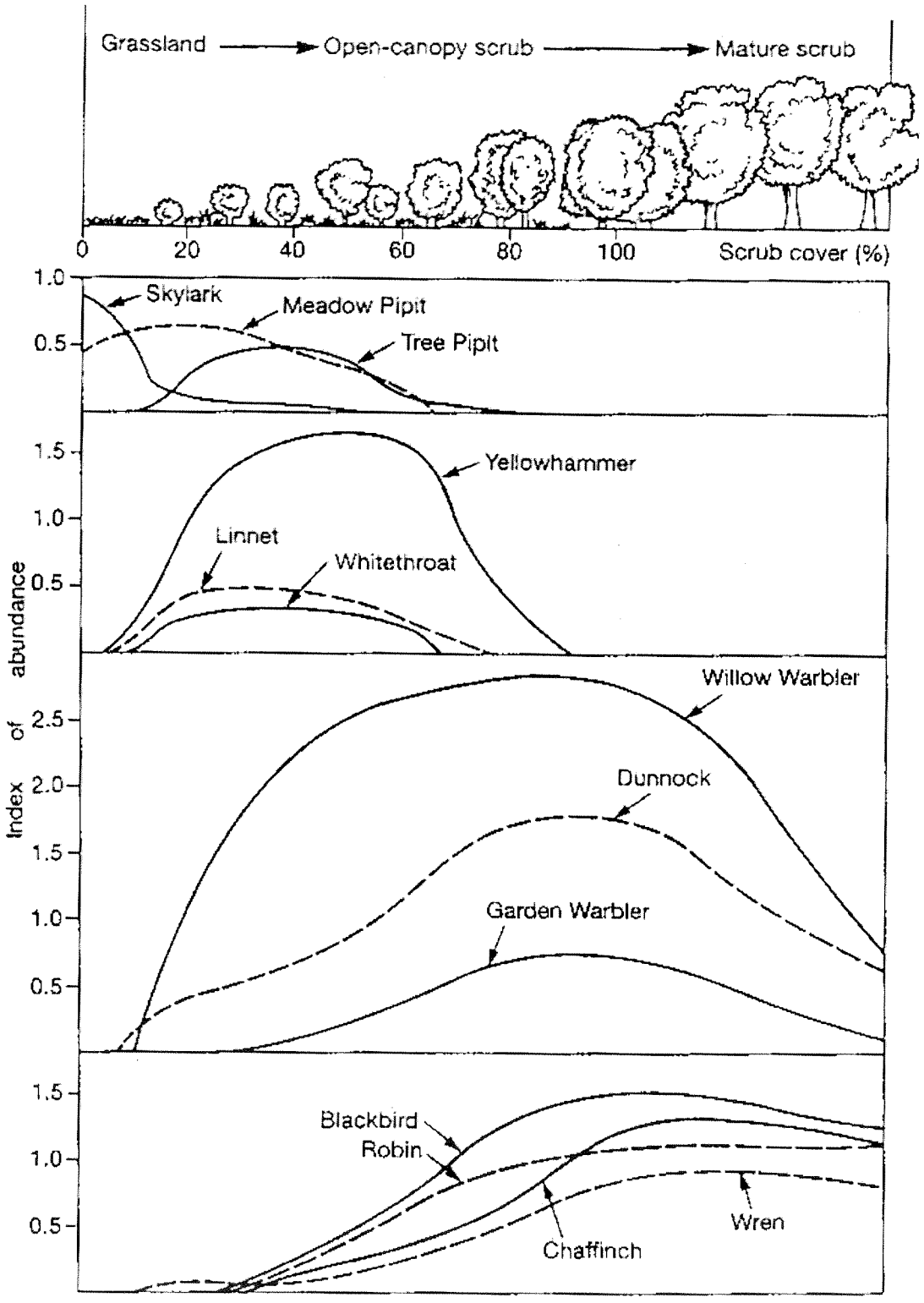


Figure 4.2 Turnover rates in bird species composition between successive stages of scrub development on the escarpment of the Chiltern Hills. Stages are described in terms of scrub cover. Solid lines indicate turnover rates as shown by the Jaccard Index, and broken lines by the Sorensen Index. The bars of the histograms are positioned centrally according to the average scrub cover of the sampling points in each stage. Reproduced from Fuller (1987).

4.2.3 Vegetation structure

4.2.3.1 *Invertebrates*

Very little published work exists on the effect of physical architecture on scrub invertebrates, but in general, the significance of vegetation structure to invertebrates cannot be overestimated (Kirby 1992). The architectural complexity of the host plant influences herbivore species richness and abundance. Larger, more structurally complex plants provide a greater variety of microhabitats, resulting in greater diversity and abundance of insect herbivores (Lawton 1978, Southwood 1978). For example, a greater variety of microhabitats support richer assemblages of sap feeders than simple-structured hosts (Denno & Roderick 1991). Habitat architecture has a major influence on the habitat preferences of spider species (both web and hunting taxa) (Rushton 1988, Uetz 1991) and may have a greater impact on spatial distribution than host plant species.

Many invertebrate species are so small that the microclimate they inhabit is profoundly influenced by the architecture of apparently similar plant species, and the wider the range of growth forms in which a plant species grows, the larger the assemblage of invertebrates it can support (Kirby 1992). In one of the few studies looking at invertebrates on scrub, Rushton *et al.* (1990) found that ground beetle communities under three scrub management regimes at Castor Hanglands NNR, Cambs, were very different. Vegetation structure was believed to be important in determining the composition of these beetle communities.

Plant architecture may influence invertebrate life-history traits, for example, aphids on trees need a sufficiently long stylet to pierce phloem elements in the host tree bark, and hence have a larger body size than herb-feeding taxa (Dixon 1985). A similar trait is shown by planthoppers, leaf hoppers and aphids which can exist in winged or brachypterous forms. Wingless forms are rare in arboreal habitats, with most late successional vegetation types, e.g. trees, exploited by winged taxa. Strong *et al.* (1984) suggests that trees provide a greater variety of niches for invertebrates than herbs, due to i) the greater diversity of microclimates available, ii) the range of phenologies and changes linked to plant age, and iii) the architectural complexity of a tree that provides a greater diversity of feeding and oviposition sites, hiding places from enemies, and overwintering sites than do structurally simple plants.

4.2.3.2 *Birds*

Many birds have specific requirements for certain vegetation structures and configurations (James 1971). These ecological differences underpin the large turnover in bird species that occurs with succession from open grassland or heathland to closed canopy scrub (section 4.2.2.4). For example, species such as whitethroat *Sylvia communis* and yellowhammer require open relatively low scrub structures, whereas garden warbler and blackcap *Sylvia atricapilla* are associated with much denser, more closed scrub. The functional basis of this habitat selection is probably mainly a combination of foraging needs and predation risk. Important though they are, these broad differences among species in structural habitat use are rather obvious to any competent naturalist. Less obvious are the microhabitat differences shown by often closely related species within particular successional stages. Some of these differences are subtle and many are likely to be adaptive i.e. associated with enhanced fitness (Martin 1998). There is, for example, growing evidence that nest site selection is linked to nest predation (Martin & Roper 1988, Kelly 1993, Martin 1993). Food availability probably also has a major effect on breeding success but this is far harder to measure.

Of particular interest in the context of scrub habitats is the coexistence of several species of closely-related warblers within broadly similar vegetation structures. The mechanisms of this coexistence have long been debated especially in the context of Mediterranean scrub where several species of *Sylvia* live in close proximity. Cody & Walter (1976) have argued that interspecific competition among Mediterranean warblers causes observed patterns of habitat selection among these species. This is refuted, however, by recent evidence demonstrating that fine-scale differences exist between foraging warblers in the plant species used, the height of individual shrubs used and the vegetation structures that are selected (Martin & Thibault 1996).

Similarly subtle differences of foraging habitat selection almost certainly occur in warbler communities in temperate scrub but they have not been described. However, distributions of territory-holding warblers have been examined in relation to scrub structure on the Chiltern Hills escarpment (R.J. Fuller, unpublished data). These data show that species differ considerably in the structural profiles that they use. Willow warbler has by far the widest habitat amplitude using scrub that ranges from 1.3 to 4.5 m in height and approximately 40 to nearly 100% canopy cover. Its habitat profile overlapped that of the other four warbler species present in the study area. Respective figures for the other warbler species were: whitethroat 1.4–2.3 m, 31–64 % cover; lesser whitethroat 2.1–2.7 m, 67–85% cover; garden warbler 1.0–3.8 m, 61–91% cover; blackcap 1.8–4.2 m, 56– 95% cover. Whilst there was considerable overlap in habitat use between the latter four species, each occupied a distinctive scrub structure. Lesser whitethroat showed the narrowest habitat amplitude.

Several of the migrant species that use scrub have a particular requirement for moderate to tall scrub with extremely dense low vegetation. This applies especially to nightingale and garden warbler, but to some extent to blackcap and lesser whitethroat. The preferred habitat structures of nightingale have been described in detail by Fuller *et al.* (1999). Once the scrub has grown to an extent where the low growth is completely shaded out and it becomes 'leggy' the habitat quality for migrants is greatly reduced.

4.2.4 Scale and spatial arrangement of habitats

At any one site, scrub is frequently extremely heterogenous. It may exist as patches of differing size mixed with other vegetation, especially grassland and woodland. The scrub patches themselves may differ in size, height and foliage density. The significance of this patchiness is discussed here for invertebrates and birds.

These two groups respond to habitat heterogeneity on very different scales. Many invertebrates are affected by extremely fine-grained habitat variation. Availability of preferred food plants and critical microclimates may alter within a few centimetres. Furthermore, large populations of invertebrates can be maintained within a few square metres of suitable habitat. This contrasts with the requirements of birds which are satisfied on a vastly larger

scale. The majority of songbird species typical of scrub have territories that are at least 0.25 ha, frequently much larger. Most breeding birds probably respond to the relatively coarse-grained physiognomy of the environment in selecting potential habitat, though exact selection of foraging sites within the territory may be a more subtle process. A further contrast is that many, but certainly not all, invertebrates meet their full life cycle requirements on one small patch of land. This is rarely true of birds that use scrub. Many of the breeding birds of scrub overwinter in other habitats or regions. Conversely, species that feed on the berries offered by scrub often derive from distant breeding populations. Birds are able to exploit these localised resources through their great mobility.

4.2.4.1 *Invertebrates*

Most invertebrates have very specific habitat requirements that may vary at different stages of their life cycle. Many species also have a relatively low mobility, or a low instance of long distance dispersal. Sufficient resources to fulfill all aspects of a taxa's life cycle may therefore be needed within an area of only a few square centimetres or metres. This requires a diverse mosaic of ages and species of scrub within a small area.

In general, a close-knit mosaic of vegetation age, structures (including edges) and species is more useful to invertebrates than large uniform blocks (Kirby 1991, Hopkins 1996). Scattered scrub may support different invertebrates to mature scrub. Large, isolated bushes may be major sources of food for nectar and pollen feeding insects, and provide favourable conditions linked to architecture such as shelter, in addition to supporting their associated communities.

The character of the habitat mosaic which includes scrub vegetation may be as important as the shrub species themselves, although this is difficult to demonstrate (Hopkins 1996). Edges are particularly important, as they provide the warm but sheltered conditions favoured by many invertebrate species (e.g. Kirby 1991). An intimate mix of grassland, scrub and woodland may be an advantage to many invertebrate species, providing a range of conditions in close proximity. Several invertebrates associated with scrub may be more usefully defined as woodland/grassland transition species, for example the Duke of Burgundy butterfly *Hamearis lucina*, which lays its eggs on the lush leaves of cowslip and primrose growing in shaded areas, and uses sunny, sheltered glades and clearings for basking and nectaring.

Herbivorous invertebrates are strongly influenced by host plant chemistry. The chemical composition of plant parts (e.g. leaves, sap, phloem contents) varies enormously in relation to many factors including water stress, herbivory history, disease and climatic conditions (Masters & Brown 1995). All of these factors will be influenced by the age and location of a shrub at a site, and will impact on the availability of niches to invertebrate taxa.

4.2.4.2 *Birds*

Mosaics consisting of patches of scrub at different ages, mixed with open grassland, tend to support extremely rich assemblages and high densities of breeding birds because a wide range of habitat structures and microhabitats are present.

In extremely patchy situations, individual birds may hold territories that comprise spatially separate patches of scrub (Haila & Hanski 1987). This may merely reflect an ability to exploit a mosaic rather than a particular requirement for a mosaic. However, there are several instances where birds do appear to have a requirement for a mosaic of habitats that incorporates scrub. One of the most striking is the black grouse. Essentially a bird of the moorland-woodland edge, the black grouse benefits strongly from mosaics of moorland, scrub and woodland. In the case of wetlands, mosaics of bushes and fen vegetation appear to be preferred by marsh warbler *Acrocephalus palustris* and Cetti's warbler *Cettia cetti*, rather than areas of dense scrub (Wotton *et al.* 1998). On lowland heathland, the presence of both gorse and heather appears to be a determinant of habitat quality in the Dartford warbler (Bibby 1979 a,b).

Mosaics of scrub and grassland probably offer two advantages to breeding birds though this has not been studied in detail. First, they may provide high quality habitats for species that forage in short open vegetation but nest in dense scrub. Blackbirds *Turdus merula* and song thrushes *Turdus philomelos* are examples of species that may benefit in this way. Second, the structure of scrub vegetation may be much denser at the edge of a scrub patch than the interior. This is likely to confer an advantage on birds such as nightingale and garden warbler that require dense low foliage. The edges of suckering blackthorn thickets often provide ideal cover for these birds (Fuller *et al.* 1999).

At a landscape scale, the songbirds breeding in upland scrub may provide important food resources for birds of prey nesting in adjacent moorland. This is especially true for upland raptors such as merlin *Falco columbarius* and hen harrier *Circus cyaneus* (see 4.3.3).

5 Management

5.1 Review of the literature on management of scrub

5.1.1 Overview

There are very few publications on scrub management in the open literature, but a great deal of unpublished information resides in unpublished sources. Many of these are available in the libraries of the country agencies and non-governmental organisations, including The National Trust, The National Trust for Scotland, local Wildlife trusts, The British Trust for Ornithology, The Royal Society for the Protection of Birds, and Highland Birchwoods.

The best available source of integrated current information on lowland scrub management in England is the 2nd edition of *The Lowland Grassland Management Handbook* (Crofts & Jefferson 1999). This gives information on the general principles which should be applied to determining when and where scrub is likely to be beneficial or a nuisance, taking into account the quality of the site without scrub and the value of the scrub for landscape and wildlife conservation. It provides guidance on prioritising areas for management and suggests management options for scrub eradication or reduction, maintenance and enhancement. This is followed by advice on the use of appropriate techniques to achieve the desired management objectives, including descriptions of their utility in particular circumstances. There is a bibliography that covers most of the relevant literature sources.

Limited information specifically relating to the management of scrub (mainly willow) on wet grassland sites is contained in, *The Wet Grassland Guide* (Treweek *et al.* 1997). There is less emphasis here on the beneficial contributions scrub can make to landscape and wildlife conservation, more attention being given to the need to control scrub. A case study describes the control of willow scrub on the RSPB Insh Marshes reserve in Inverness-shire involving scrub cutting by hand and chainsaw followed by stump treatment to prevent regrowth.

There is no guidance currently available on management of upland scrub in England and Wales comparable to that contained in Crofts & Jefferson (1999), but two reports (Hester 1995, Gilbert *et al.* 1997) provide a great deal of information on the management of montane scrub in Scotland. After describing the present distributions of the principal scrub types in the Scottish Highlands and their value for wildlife conservation, Hester (1995) concentrates on the encouragement of scarce scrub communities through the control of browsing (mainly by deer) and grazing and the planting or sowing of seed of key woody species. She acknowledges the need to manage scrub enhancement in such a way as to retain adequate open ground, recommending regular burning and controlled grazing, but emphasises that the need for scrub control is rare in the uplands of Scotland.

Gilbert *et al.* (1997) report a major conference on the ecology and restoration of montane and subalpine scrub habitats in Scotland. Several contributors deal in detail with the restoration of particular scrub communities, including willow scrub at Ben Lawers and Caenlochan NNRs and high elevation pine scrub in the Cairngorms.

5.1.2 Identifying desirable and undesirable scrub

Before deciding whether or not scrub needs to be controlled or eradicated on a particular site, it is necessary to assess the conservation value of the scrub habitat. Scrub of high conservation value will contain native shrub species appropriate to the area. In the case of scrub on lowland calcareous sites a wide range of shrub species will add to the conservation value but on less base-rich sites in the lowlands, and more generally in the uplands, one or perhaps a few shrub species will be all that can be expected. Structural complexity both within the body of the scrub itself and where it meets adjacent habitat is generally believed to enhance the nature conservation value of scrub. More structurally complex communities offer a wider range of niches for associated species. Evidence that a scrub habitat supports a wide range of rare or local plants and/or animals obviously confirms its wildlife conservation value. Hence wherever possible if the value of the scrub for these species is not known, survey and, where time allows, monitoring should be carried out before major intervention to eliminate scrub is planned.

Scrub of low conservation value will generally have few shrub species (but see comment above about Scotland) or lack species which are appropriate to the area, and may contain or be dominated by non-indigenous species. It will tend to be structurally simple with little variation in shrub density or height and with a uniform edge-area ratio, and hence minimum opportunity for the development of a range of edge habitats. In the case of lowland scrub it will tend to lack the tall herb and grass communities associated with the most valuable grassland/scrub habitat mosaics. It will attract few or no rare or local species of associated flora and fauna.

In practice most scrub will fall between these two extremes, or parts of it will fall into one category and parts into the other. Also lowland juniper or box, or treeline pine or birch scrub in Scotland, while relatively species poor compared with some other types are nevertheless highly valuable for nature conservation.

5.1.3 Prioritising areas for management

Areas where scrub is rapidly invading valued habitat (Hurford 1993, Russell *et al.* 1993, Ball 1994) are obviously prime candidates for control or whole or partial eradication. At the other end of the spectrum are areas where scrub would make a valuable contribution to nature conservation but from which it is currently absent or present in insufficient amount or condition to do so. Both are instances of situations demanding high priority for management, but with very different objectives,

emphasising the need to approach scrub management with an open mind. In many situations there will be no need for immediate action because scrub is present in acceptable amounts and condition, but there may be a need for prioritisation of management on a medium- to long-term basis to ensure that the scrub does not become a nuisance or loose its value because of loss of structural diversity with the passage of time. It is easier and more effective to maintain scrub in 'good' condition with frequent intervention than to try and revitalise it. Scrub which has been mature for many years tends to develop a very dense, even canopy which excludes light, precluding the development of ground flora and associated fauna. It also causes soil eutrophication, especially nitrogen and phosphorus enrichment, as shown by Hodgkin (1984) with hawthorn *Crataegus monogyna* scrub invasion of the dune system at Newborough Warren on Anglesey. It is likely to be difficult and costly to reverse such eutrophication in the event that it is desired to return the land to other low fertility habitats

In the uplands of England and Wales there is little scrub management of any kind, so prioritisation does not currently arise. However, there are good opportunities to promote scrub as part of the drive to increase the naturalness of plantation forests. Over substantial areas of land where timber production is currently uneconomic and likely to remain so there may be opportunities to include scrub as a major element in areas cleared of conifers at the end of the current rotation. In many of these areas scrub development may take place slowly in the absence of intervention because of absence of nearby seed sources. On the other hand, it may be difficult to control scrub development in such areas where seed sources are available.

In Scotland extensive investigations have been made recently into the distribution of desirable montane scrub and of management priorities for its protection and enhancement (MacKenzie, in prep). Plans are also underway or in hand to conserve and develop scrub both on some of the best known sites and more generally (Quelch 1997, Gilbert 1997). The Forestry Commission in Scotland is promoting scrub in appropriate locations as part of its native woodlands policy while the Millenium Forest for Scotland project has a montane shrub project.

5.1.4 Management options and methods

Having prioritised area for scrub management there may be a range of options for management and a range of methods for achieving objectives once options have been decided. Decisions whether to eradicate troublesome scrub may be influenced by the size of the problem and the costs of addressing it. Opportunities to create or enhance scrub may be acted upon or delayed depending on other priorities. If a decision is made to act in either case it is essential that the means and costs of doing so, including follow-up treatment, are carefully estimated. It is best to be pessimistic since both scrub control and (surprisingly) scrub creation and enhancement usually take longer and cost more than expected. It is worth noting also that techniques are being constantly invented or improved and that it pays to ask around before adopting a plan of action. This is not an appropriate place to go into the plethora of methods and machinery used for scrub control and eradication but there is need for this information to be brought together in one publication/web page which is regularly updated and made available to all scrub management practitioners. Many of the techniques in use around the country are described in some detail by respondents to the survey questionnaire listed in appendices 5.3-5.5.

Having said this, scrub control as practised by most scrub managers or contractors comes down to three main procedures:

1. Cutting followed by either chipping, burning on site or removal of the debris (see Ward 1990 for a description of methods used on calcareous grassland sites);
2. Grazing to control scrub encroachment or regrowth following cutting (Large & King 1978);
3. Herbicide treatment either to kill the bushes (rare) or to control regrowth from cut stumps (see Marrs 1985 for a discussion of scrub control experiments on lowland heathland).

Refinements to physical methods include stump grinding or removal to obviate the need for herbicide treatment. On stoneless soils a root-cutting chainshaw has been used successfully to enable removal of stumps. Grazing, while usually by sheep and/or cattle may involve horses or goats and, in Scotland, deer. A novel approach with herbicides involves injection to kill the bushes but leave them as deadwood habitat. Weed wipers have been used successfully to control birch scrub development on wetland sites. Many of these techniques are described and discussed in Gough & Fuller (1998).

Where it is desirable to create or enhance existing scrub it may be sufficient merely to fence off areas from grazing and/or browsing animals. This is being done on a substantial scale in Scotland to encourage development of treeline birch and pine scrub and extension of willow scrub from its currently restricted habitats on and among rocks (Mardon 1997, French *et al.* 1997). This technique has also been used for protection and enhancement of juniper scrub (Barrett 1997) but in many instances where seed production is low or absent or seed predation is high (Ward 1989) it may be necessary to grow on young plants from seed or cuttings and plant them into gaps (Barrett 1997)

Management techniques for conservation of specific groups of organisms (plants, invertebrates, birds etc.) and individual species associated with scrub are described in chapters 3 and 4 of this report.

5.2 Funding available for scrub management

Farming has a fundamental influence on the ecology and appearance of the landscape. Agri-environment schemes form a package of measures that are a major source of funding for the conservation and enhancement of the rural environment. Prescriptions funded within these schemes thus have a potentially major impact on the future of the British landscape. The most widely used agri-environment schemes in England of relevance to scrub management are the Countryside Stewardship (CS) and Environmentally Sensitive Area (ESA) schemes. In Scotland, the Countryside Premium (CP) and Environmentally Sensitive Area (ESA) schemes provide a similar dual approach. The CP, ESA and Organic Aid schemes are due to be replaced in Scotland by the Rural Stewardship scheme in Spring 2001. No other information is available. Tir Gofal is currently taking its first round of applications.

The contrasting emphases placed on scrub management in England, Scotland and Wales by the agri-environment schemes described below (i.e. clearance *versus* conservation/enhancement) reflect primarily the distribution of upland areas in Britain. Scrub in upland areas is frequently climax vegetation of high conservation value, whilst scrub in lowland areas is usually seral, highly invasive, and requires control (Chapters 2, 3 and 4).

The information below is taken from guidelines available to farmers and land managers applying for agri-environment schemes. This approach may however underestimate the commitment to scrub conservation of funding organisations. For example, the Blackdown Hills ESA Environmental Guidelines (ADAS 1995a) includes willow carr as a typical land cover in water logged areas, and describes scrub confined to the higher, wet slopes as adding to the mosaic of vegetation. The Somerset Levels ESA Environmental Guidelines (ADAS 1995b) also mentions traditional 'shelters' of hawthorn, willow scrub and alder carr providing valuable nesting and feeding areas for non-wading birds, invertebrates and other animals, although there is no specific mention of scrub or carr in the Guidelines for Farmers (MAFF 1997a).

5.2.1 Overview

5.2.1.1 *Countryside Stewardship scheme*

The need for scrub control to avoid encroachment on to other habitats is highlighted by the Countryside Stewardship (CS) scheme in relation to chalk and limestone grassland, old meadows and pastures and lowland heath landscape types (MAFF 1999b). All applicants are required to draw up a scrub management plan, which should aim to maintain a balance between scrub and open land, taking into account landscape, wildlife, and archaeological considerations. Large-scale clearance other than on sites of archaeological interest (e.g. hill-forts) is discouraged. Payments for scrub clearance are made under Capital Items, i.e. are one-off payments. In addition there is a base payment, which is available to all farmers or land managers claiming for capital payments for scrub clearance, to assist with implementing work on a small area. A supplement for follow-up treatment is also available.

Table 5.1 Payments for scrub clearance through capital works (Countryside Stewardship scheme 1999).

Item	*Code*	*Payment*
Scrub clearance	SS	£50/ha
<25% ground cover	SA	£100/ha
25-75% ground cover	SB	£250/ha
>75% ground cover	SC	£500/ha
Scrub control supplement	SD	£40/ha

Higher payments per hectare for areas of high percentage ground cover (cf. ESA scheme, which uses density) reflect the higher costs of clearance, rather than an incentive to clear more dense areas of scrub. The likelihood of funding will depend on the key stewardship objectives within the Target Areas promoted.

Enhancement of species composition of scrub is not an option available within CS (cf. for example grassland enhancement supplement GX). However, Capital Item funding for small-scale tree planting and management (TSP, TR, TT in CS) also includes shrubs often found in species-rich scrub.

Carr ('a marshy copse, especially of alder or willow') is considered separately from scrub (MAFF 1999a, individual Natural Area target notes), and is the only type of scrub that qualifies for annual management payments. Payments are available for managing fens, reedbeds and carrs (Code F), although guidance for management of existing carr, as separate from reedbeds or fens, is not specified. Supplementary payments are available for a maximum of five years for initial measures to establish willow or alder carr (Code FX).

5.2.1.2 *Environmentally Sensitive Area (ESA) scheme*

England

Unlike the CS scheme, there are no clearly stated scheme-wide aims for scrub management (MAFF 1998b). Management aims and attitudes towards scrub vary between ESAs, and are dealt with within the individual Guidelines for Farmers available for each ESA. In common with the CS scheme, the emphasis is on scrub management and control. Detailed Environmental Guidelines are available to ESA Project Officers, and are used to provide a basis for an integrated environmental approach within each ESA (e.g. ADAS 1995a,b), but these guidelines are not widely available.

Payments for scrub control or management are made through the Conservation Plan, which funds one-off capital works to enhance the character of the landscape, wildlife habitats and protect historical features (MAFF 1998a). Payments are standard across England, and are made at the same rates as those of the CS scheme.

Table 5.2 Payments for scrub clearance through capital works (Environmentally Sensitive Area scheme, 1999).

Item	*Payment*
Management of scrub	
<25% ground cover	£100/ha
25-75% ground cover	£250/ha
>75% ground cover	£500/ha

A single payment of £50 (estimated 80% of total cost) is additionally available through the Conservation Plan in some ESAs for management of scrub on small free-standing features of archaeological interest (e.g. in the Broads ESA).

Neither willow nor alder carr is mentioned in management prescriptions listed for any of the English ESAs, although carr is reported as "contributing to the varied lowland of high value in the landscape" of the Avon and Test Valley ESAs (MAFF 1998b). Carr is not included in descriptions of fenland.

Scotland

Upland habitats constitute a major part of all of the 10 Scottish Environmentally Sensitive Areas. Scrub is mentioned in the Appendix (equivalent to Guidelines for Farmers in England) of each of the Scottish ESAs (not the Scottish ESA explanatory booklet (Scottish Office 1999a)). Scrub is defined in most Appendices as 'low growing woody vegetation'. The Cairngorms Straths ESA scheme booklet uses a fuller definition: 'low growing woody vegetation of small trees and shrubs including linear scrub along field margins containing dog rose, gorse, broom, blackthorn, etc.'. Neither Countryside Stewardship nor English Environmentally Sensitive Area schemes define scrub, although species composition is mentioned in the introductory passages of several ESA booklets.

The emphasis in Scottish ESAs is very much on avoiding damage to scrub (e.g. Argyll Islands Tiers 1 and 2 (Scottish Office 1999b)) rather than clearance. However, the removal of scrub from features or areas of historic or archaeological interest, and implementation of a grazing plan to prevent recolonisation, is encouraged. The removal of rhododendron *Rhododendron ponticum* scrub is also funded by the ESA scheme in the Loch Lomond and Breadalbane areas. Most payments relate to scrub management rather than control or clearance, and are paid annually (in contrast to English ESA schemes) (but see also Tir Gofal).

Applicants are required to implement a grazing plan that includes measures to conserve, enhance or extend areas of shrubs. This is a mandatory requirement of joining the ESA scheme in Scotland.

Tier 1 (mandatory) payments for all land, inbye, or rough grazing require avoidance of damage to scrub. Scrub management is funded through Tier 2 (mandatory) payments for woodland, wetland and grassland management (£80/ha/year; £100/ha/year in Stewartry and Cairngorms Straths). In contrast to both English ESA schemes and Tir Gofal, none of the Scottish ESA schemes include scrub control or clearance, other than *Rhododendron*, under Capital Items. *Rhododendron* control is funded at £200/ha (for a maximum of 5 years). Four of the 10 ESA Appendix leaflets also suggest Woodland Grant Schemes as an alternative to ESA woodland payments, plus a payment of £20/ha (paid through the ESA scheme) for the exclusion of stock (e.g. Scottish Office 1999b) (see also Tir Gofal).

5.2.1.3 Tir Gofal

Tir Gofal replaces and combines Tir Cymen and ESA schemes in Wales. The scheme considers scrub as a habitat in its own right (see also Countryside Premium Scheme), and requires scrub management as a condition of entering the scheme (CCW 1999). Tir Gofal promotes management of dense blocks of scrub to provide a series of uneven aged patches of shrubs interspersed with small areas of open grassland (CCW 1999). The scheme offers both single payments for scrub clearance (e.g. CS and ESA (England) schemes) but also payments for annual management (Table 4.3). The lack of provision for annual, follow-on management of scrub, is viewed as a significant problem in CS and English ESA schemes, despite the additional Control supplement available within CS (section 6.2.1.3). Cessation of grazing is generally encouraged, as reflected by the substantially higher payment rates for ungrazed woodland (ungrazed: £125/ha/year *v.* existing grazing: 10/ha/year, Table 5.3) and funded according to the type of underlying grassland.

Capital works payments for scrub clearance by hand (£500/ha) are equivalent to those paid for clearance of dense scrub (>75% cover) by CS and ESA schemes in England. Lower rates for clearance by machine are a novel feature of Tir Gofal.

Table 5.3 Payment rates for land management under Tir Gofal (CCW 1999).

Part	*Habitat or task*	*Management*	*Payment (/ha/yr)*
Part 1 (Mandatory)	Broad-leaved woodland		
		Ungrazed	£125
"	"	Lightly grazed	£95
"	"	Existing grazing	£10
"	Scrub		£30
Part 2 (Optional)	Creation of broadleaf woodland and scrub	Establishment (<0.25ha)	£1600 single payment
"	"	Annual management	£140
Capital works	Habitat management, restoration and creation	*Rhododendron* control (outside woodlands)	£1,500/ha single payment
	"	Scrub clearance by machine	£150
	"	Scrub clearance by hand	£500

The Tir Gofal scheme funds creation and subsequent annual management of small areas of scrub (<0.25ha), reflecting the value placed on scrub in Wales as a habitat in its own right. Of the other agri-environment schemes, only the Countryside Stewardship scheme funds scrub creation (carr only).

Because management prescriptions relating to scrub are contained in Part 1 (mandatory prescriptions) of Tir Gofal guidelines (farmers handbook), and there are no additional regional guidelines (cf. ESA, CS schemes), there is no apparent divide between management viewed as suitable for lowland or upland scrub.

5.2.1.4 *Countryside Premium Scheme*

The Countryside Premium (CP) Scheme operates alongside the Environmentally Sensitive Area scheme in Scotland. In common with Tir Gofal and Scottish ESA schemes, the emphasis of the CP scheme is on increasing the extent, and enhancing the condition, of existing scrub. Annual management payments of £55/ha/year are available for grazed land with suppressed scrub. The General Environmental Conditions (conditions of good agricultural and environmental practice applying to all agreement land) specify that scrub must not be removed from agreement land (Appendix 2, Scottish Office 1999c). However, natural regeneration of trees within 20 metres of ancient monuments should not be encouraged. Management of a site of archaeological or historic interest (including scrub management) is funded at £80 per 0.25 ha, up to 1.5 ha, and £20 per 0.25 ha thereafter. In common with Tir Gofal, CP does not include scrub clearance or management under Capital Items.

Countryside Premium Scheme is unique amongst British agri-environment regulations in funding scrub management on flood plains (£25/ha/year), but does not mention carr habitat.

5.2.2 Regional variation

5.2.2.1 *Countryside Stewardship scheme*

Lowland England

Countryside Stewardship Target Areas in England encompass much of the geographical range outside of the ESAs. Almost all Target Notes covered by the Countryside Stewardship scheme mention scrub (Appendix 5.1). Although the CS Information Pack (MAFF 1999a) refers to the need to maintain a balance between scrub and open land, most management prescriptions advocate scrub clearance in order to restore or maintain other more valuable habitats such as heathland or chalk grassland. This trend is apparent throughout England.

The importance of maintaining scrub in a mosaic with other habitats is noted for the Morecambe Bay Limestones in Cumbria and Lancashire, which are identified as supporting scrub of high conservation value (Hopkins 1996). This is not apparent for other areas that Hopkins highlights as important, for example target notes for the Chilterns (Bedfordshire, Berkshire, Buckinghamshire and Oxfordshire) do not refer to the national importance of the scrub communities found in these areas. The conservation value of structure is noted at both the woodland edge (Teme Valley, Worcester) and within scrub stands (Surrey and London North Downs). Removal of exotics is mentioned for a single Target Area (New Forest Heritage Area, Hampshire) which includes clearance of rhododendron scrub in management prescriptions.

Enhancement or re-establishment of alder carr is identified as important in several target areas (Derbyshire, Hartlepool, Hertfordshire, Durham and Yorkshire Dales National Park), and is mentioned as a distinctive landscape feature of the river valleys of Berkshire. The role of scrub as bankside cover for otters is highlighted, and scrub regeneration promoted, in the Tees Lowland (North Yorkshire). Other Target Notes refer to bankside vegetation for otters, but do not specify scrub (e.g. culm grassland in Devon, Severn and Avon Vale in Warwickshire and West Midlands). Only the North Somerset Levels and Moors (Somerset) encourages the removal of scrub hedges along ditches, to improve the aquatic habitat.

Upland England

A single Target Area (South West Peak, Derbyshire) gives conservation management of existing scrub as a key stewardship objective (cf. Tir Gofal, Scottish ESAs). This area is also unusual in that target notes detail species composition of scrub (gorse/hawthorn) (South West Peak, Derbyshire and Staffordshire). The only other area where species composition is listed is the North Pennines, where a reduction of grazing in juniper woods on moorland is encouraged. Countryside Stewardship puts less emphasis on scrub clearance in upland than in lowland areas, but preventing scrub from encroaching on to other valued habitats is still a priority.

5.2.2.2 *Environmentally Sensitive Area scheme*

Scrub is mentioned in the Guidelines for Farmers booklets of 21 of the 22 English ESAs, almost exclusively in the context of scrub management and control (Appendix 5.2). In contrast, Appendix 1 of all of the 10 Scottish ESAs require applicants to conserve and enhance existing scrub, and do not fund scrub clearance.

Lowland England

Scrub is highlighted as an ecologically important habitat within several lowland Environmentally Sensitive Areas, for example its role as a source of cover and food for birds is mentioned in the Cotswolds, South Downs and South Wessex Downs Guidelines for Farmers (MAFF 1999c, MAFF 1997a, MAFF 1998c). Scrub in the southern Cotswolds is also noted as a habitat of high conservation value (Hopkins 1996).

The potential of scrub to encroach on to, and diminish the value of, other more valuable habitats is also recognised in these and many other ESAs, and reflected in the requirement to agree scrub control programmes within the first year of the agreement. Only the Breckland ESA's Guidelines for Farmers does not temper positive statements about the value of scrub with provisos warning of potential for encroachment and spread. The importance of scrub in wetland habitats is mentioned in relation to only three English ESAs: the Test and Avon Valleys ESAs, which recognise the contribution of scrub and willow carr to creating a varied lowland landscape of high value, and the Breckland ESA, which aims to maintain a mosaic of habitats within the river valley grasslands.

Upland England

Five of the Guidelines for farmers of English ESAs containing upland areas cover scrub management (Appendix 5.2). Although scrub control (management) is funded in these areas, the beneficial value of scrub is also mentioned in three of these (Dartmoor, Exmoor and the Lake District), reflecting the higher value of scrub in upland habitats (see also Scotland, below). Scrub management on Exmoor requires the Ministry's written prior approval. Scrub management in the North Peak and Shropshire Hills ESAs is mentioned in relation to moorland management only, reflecting the scarcity of scrub in these areas.

Standard requirements relevant to scrub management (Tier 1) (i.e. basic standards of environmental management), and other management measures and works (Tier 2) (i.e. for the enhancement of habitats and features of conservation interest), show little regional variation between Scottish ESAs (Appendix 5.2). Only the Shetland ESA Appendix does not include the requirement to conserve, enhance or *extend* areas of shrubs. Removal of scrub without authorisation is specified as unacceptable within the Appendix leaflet of Loch Lomond, Breadalbane, Western Southern Uplands and Central Southern Uplands ESAs. Management of wetlands is mandatory within Breadalbane and Cairngorms Straths ESAs, and implementation of a grazing plan to conserve, enhance or extend areas of wetland is required. Herbicide application is not permitted in ESAs, with the exception of *Rhododendron* control in the Argyll Islands.

5.2.2.3 *Tir Gofal*

No regional variation in scheme targeting is used when assessing applications for Tir Gofal funding (in contrast to ESA and CS schemes). Uptake figures from the first year might be useful to identify regional variation in distribution of scrub and wet woodland (which includes alder and willow), as management of these habitats is mandatory under Tir Gofal, but these data are not currently available (Ruth Taylor, pers. comm.).

5.2.2.4 *Countryside Premium Scheme*

Local conservation priorities were initially used to judge the suitability of applications for funding within the Countryside Premium Scheme (cf. CS and ESA schemes). However, this approach has recently been replaced by a ranking system. Applicants answer a series of questions relating to site designations, proposed management for species and habitats of high conservation value, ongoing agri-environment schemes, etc.. Entry into the scheme is based on a comparison between application points and acceptance thresholds.

Ranking is used to decide entry into other agri-environment schemes (e.g. CS), but the decision-making processes are not in the public domain.

5.2.3 Other grants relevant to scrub conservation

5.2.3.1 *Woodland Grant Scheme*

The Woodland Grant Scheme, administered by the Forestry Commission, pays grants to create new woodlands and to encourage the good management and regeneration of existing woodlands in Britain (Forestry Commission Aug 99). Grants for new woodlands include the option to plant tall woody shrubs (up to a limit of 10% of the application area) such as hazel, buckthorn or juniper, as long as they fit in with the woodland and ecology of the area. Grants to enhance the value of existing woodland for conservation are covered by the Woodland Improvement Grant, Project three - Woodland Biodiversity, which provides a single payment to assist woodland owners to manage their woods in ways which will implement forestry aspects of the UK Biodiversity Action Plan (Anon 1995).

5.2.3.2 *Farm Woodland Premium Scheme*

Land eligible for the Arable Area Payments Scheme, or that has been in agricultural use for three years prior to application, and which fulfils the requirements of the Woodland Grant Scheme, may also be eligible for the Farm Woodland Premium Scheme (MAFF 1997c). This scheme offers annual payments to compensate for agricultural income foregone.

5.2.3.3 *Wildlife Enhancement Scheme*

English Nature's Wildlife Enhancement Scheme is used by some site managers to fund scrub clearance on SSSIs in England, for example where scrub is encroaching onto areas of chalk grassland. Management of scrub of high conservation value, or enhancement of existing scrub, is not an option within this scheme. Applications are dealt with on an individual merit basis, rather than measured against a set of published criteria (William Du Croz, pers. comm.).

5.2.3.4 *Scottish Natural Heritage grants*

Grants are available to land managers, farmers and crofters through Scottish Natural Heritage, for nature conservation and enhancement or creation of habitats. There is no equivalent of EN's Wildlife Enhancement Scheme in Scotland. Applications for funding are dealt with by SNH at a local level, although a more unified approach is being developed.

5.3 Survey of scrub managers

The information presented here comprises some information from the literature and from unpublished sources but mostly views and comments extracted from replies to the questionnaire circulated to land managers (Appendices 5.3 - 5.6). Where the replies from Scotland differed appreciably from those in England and Wales the fact is noted. The contributions of questionnaire correspondents are presented anonymously in single quotation marks. Where necessary for clarity geographical locations to which comments refer are given. It should be borne in mind that while responses were sought and obtained from all regions throughout the UK, they are biased somewhat towards the south-east of England since there were more people involved in scrub management in that region. It should be noted that whereas in the south of Britain, especially in the lowlands scrub communities are generally seral, in the uplands, and especially in Scotland, coastal and montane scrub communities are often climax communities maintained by climate and/or isolation from sources of seeds of forest trees. The coverage of the survey responses can be gauged by referring to the addresses of respondents given in Appendix 5.7.

5.3.1 Conservation and enhancement of desirable scrub habitats

5.3.1.1 Deciding habitat and species priorities

Scrub can be 'desirable' for a number of reasons. A few questionnaire correspondents considered it to be important for wildlife in urban areas in which there are often few locations that contain semi- natural habitats. Many felt that scrub provides essential conditions for rare communities and/or red data book species. For example, one correspondent commented that, 'scrub supports important species (black hairstreak *Strymonidia pruni*, nightingale *Luscinia megarhynchos*/other warblers *Sylvidae*, Red Data Book invertebrates) also adds diversity to other habitats and enhances woodland/grassland transition zone' (see also Section 3.3). Scrub is also valued as wildlife corridors and for its landscape value, which can be very important in some localities. Some scrub types are considered to have intrinsic value. Juniper *Juniperus communis* scrub was mentioned most often in this connection, e.g. 'juniper scrub (is) a scarce habitat with interesting associated invertebrates', and, 'juniper scrub is important in own right (and is a BAP species)'.

In answer to the question 'is scrub a valued habitat in your area' only 3% replied 'no'. (Table 5.4).

Table 5.4 Proportion of questionnaire correspondents in England and Wales who replied to the question, 'is scrub a valued habitat in your area?'.

Yes	89%
No	3%
Yes and no	8%

Correspondents can be roughly grouped according to the geographical locations of the sites that they manage as shown in Table 5.5.

Table 5.5 Approximate geographical distribution of sites managed by questionnaire correspondents in England and Wales.

Geographical distribution	*Number of correspondents*
Lowland	105
Lowland and upland	28
Upland	9
No address given	1

Taking these geographical distributions the responses of correspondents to the same question are given in Table 5.6.

Table 5.6 Proportion of questionnaire correspondents in England and Wales managing sites who replied to the question, 'is scrub a valued habitat in your area'.

Geographical distribution	*No*	*Yes*	*Yes and no*
Lowland	5	92	8
Lowland and upland	0	26	2
Upland	0	8	1
No address given	0	1	0
Total	5	127	11

Therefore the view of correspondents throughout Great Britain is overwhelmingly that scrub is a valued habitat both in the uplands and the lowlands, but it can also be undesirable when encroaching on to other habitats (see Section 5.3.2.1). Decisions about the management of scrub must take into account the relative merits of both the scrub and any other communities involved. Some correspondents mentioned this, for example, 'We need a policy on scrub and need to bring scrub into SSSI selection guidelines in order that the relative values of scrub and other habitats can be properly assessed'. Habitat and species priorities may be different, not only for each site, but also for different areas within sites. The sorts of question to be answered for each parcel of land are:

- Is there a conflict between habitats?
- If so, which gets priority?
- If scrub has priority, for all or part of a site, is this for the scrub type (and/or its associated ground vegetation and/or fauna) or for a particular plant or animal species, or a combination of these factors?
- What are the conservation requirements of the scrub type, vegetation community, plant or animal species?
- How must the scrub be managed to meet these requirements?

A few scrub types (notably juniper scrub and coastal scrub dominated by pruniose species) are valued in their own right in England and Wales, and most scrub types are considered important in Scotland, at least in the uplands (see Section 3.2.1). Scrub is often more highly valued, however, for the communities it harbours. Many rare plants and animals are dependent upon or associated with

scrub (see Section 3.2) and should be given high priority, but it also supports much common flora and fauna. Often adding to the biodiversity at the landscape as well as the individual site scale. Almost all correspondents commented on its importance for birds and invertebrates, particularly butterflies. Many birds use scrub as breeding and roosting sites, song posts, shelter for migrants and a food source. In addition to the rare/scarce species (see Section 3.3.3 and 4) there are several less scarce and commoner ones (see Box A). But if trends of the recent past continue today's common birds may become tomorrow's rarities. Management for the rarer species can also benefit the commoner ones. For example, one correspondent mentioned 'scrub valued in reed-beds for Cetti's warbler *Cettia cetti* also (provides) valuable habitat for reed warblers *Acrocephalus scirpaceus* and sedge warblers *Acrocephalus schoenobaenus*, for singing posts/feeding'.

Box A Bird species commonly associated with scrub.

Linnet *Carduelis cannabina*
Reed bunting *Emberiza schoeniclus*
Grasshopper warbler *Locustella naevia*
Sedge warbler *Acrocephalus schoenobaenus*
Yellowhammer *Emberiza citrinella*
Song thrush *Turdus philomelos*
Reed warbler *Acrocephalus scirpaceus*
Common redpoll *Carduelis flammea*
Tree pipit *Anthus trivialis*
Common whitethroat *Sylvia communis*
Turtle dove *Streptopelia turtur*
Bullfinch *Pyrrhula pyrrhula*
Common stonechat *Saxicola torquata*
Common redstart *Phoenicurus phoenicurus*
Whinchat *Saxicola rubetra*
Blackcap *Sylvia atricapilla*
Garden warbler *Sylvia borin*
Long-eared Owl *Asio otus*

A wide range of invertebrates in disparate taxonomic groups is also favoured by scrub, including a number of Red Data Book species (see Section 3.2.4). However, respondents to the questionnaire appeared only (with rare exceptions) to be concerned about managing scrub as a habitat for butterflies. Species mentioned frequently in responses are listed in Box B.

Box B Butterflies mentioned as receiving special attention when managing scrub.

Black hairstreak *Strymonidia pruni*
Brown hairstreak *Thecla betulae*
Pearl bordered fritillary *Boloria euphrosyne*
Dark green fritillary *Argynnis aglaja*
Small pearl bordered fritillary *Boloria selene*
Brimstone *Gonepteryx rhamni*
High brown fritillary *Argynnis adippe*
Small blue *Cupido minimus*
Green hairstreak *Callophrys rubi*
Ringlet *Adantopus hyperantus*
Gatekeeper (Hedge brown) *Pyronia tithonus*
White admiral *Ladoga camilla*
Purple hairstreak *Quercusia quercus*
Chequered skipper *Carterocephalus palaemon*
Wood white *Leptidea sinapis*

5.3.1.2 *Determining management requirements to achieve these objectives*

Of those sites in England and Wales managed for conservation or enhancement of scrub about half had management specifically tailored to particular species, 30% for the habitat as a whole and 6% for a combination of these reasons (Table 5.7).

Table 5.7 Proportions (%) of scrub sites managed by questionnaire correspondents in England and Wales for conservation of particular species, for the scrub habitat in general and for a combination of these objectives.

Managed for particular species	51%
Managed for scrub habitat	30%
Managed for both particular species and scrub habitat	6%
No answer	13%

In Scotland scrub is equally likely to be managed as a habitat (25%) as for particular species (27%). This indicates a higher perceived value of scrub habitats in their own right in Scotland.

Many managers feel that they need more information to plan and implement the most effective scrub management, e.g. 'we need to know what we want! i.e. what sort of scrub, where, what state we want (i.e. grazed, ungrazed, grazed sometimes). I guess also what sort of scrub is the most diverse? - grazed, ungrazed etc.'. Another correspondent asked, 'how do insects and birds use blocks of scrub, e.g. is it better to have large or small blocks. If they are coppiced, what time span should the cycle take. Is young scrub better than old ?'. It seems that the needs of some species are fairly well known. This is reflected in the number of correspondents who mentioned management in hand for particular species, e.g. nightingale (17), Dartford warbler *Sylvia undata* (8), Duke of Burgundy *Hamearis lucina* (11), brown hairstreak Thecla betula (10) and Black hairstreak (7).

5.3.1.3 *Devising and implementing effective management requirements*

Techniques to maintain existing scrub, by arresting succession (see also Appendices 5.3 and 5.5)

Most management by questionnaire correspondents to maintain existing scrub involved:

- cutting/burning to remove excess growth (i.e. where the scrub is becoming too dense, or progressing into woodland);
- burning or removing the cut material and grazing and/or the use of chemicals to control re-growth.

Coppicing was frequently used and even when a strict coppice cycle was not imposed, cutting was often rotational. For example, one correspondent mentioned, 'cyclical cutting on a small scale - I suppose every 15-20 years or so (though we are nowhere near achieving a cycle as yet)'. Another correspondent from South Wiltshire gave a detailed reply that provides a good example of the range of techniques employed: 'coppicing mature scrub in large blocks. Areas of typically 0.1 ha in a block cut on approximately 20 year rotation. Use of Hi-tip forage harvester to cut and remove cuttings in small gorse *Ulex*

spp. to maintain gorse/grass habitat for dark green fritillary *Argynnis aglaja*. Cutting also used to maintain heath on chalk. Cut and treat stumps in small blocks in areas of scrub/grass mix to maintain the balance required, especially for Duke of Burgundy. Species not controlled by cut and treat, e.g. wild privet *Ligustrum vulgare* and gorse may be spot-sprayed with 'Garlon 2' in these situations. 'Swipe' - used to vary age structure in gorse - approx. 6 year rotation. Hedge - cut on a 3 year rotation in sections of 30 m (60 m uncut) either with a blade or flail'.

Some management is very focused and hence most likely to be successful provided it is based on sound knowledge of species conservation requirements, e.g. '1. Coppicing - clearfell in groups or along edges to renew succession, sometimes fenced to protect from Deer. 2. Layering - "hedge-laying" blocks or strips of scrub, esp. along edges. Creates 'instant' 5-year old scrub structures and avoids damage to black hairstreak eggs in winter'.

Prevention of re-growth by chemical treatment of stumps sometimes formed part of the management package e.g.'rotational cutting, some stump treatment, foliar treatment, grazing'. Equally common was 'complete coppicing of existing scrub and allowing regeneration of cut stumps'. Thinning and/or coppicing was sometimes selective to remove particular trees (species or age classes). Removal of non-native tree and shrub species was also a commonly stated objective e.g.'coppicing of native species, felling and poisoning of sycamore/cherry laurel *Acer pseudoplatanus/ Prunus laurocerasus* etc.'. Controlling grazing where possible is a commonly used tool in scrub management. Reduction of grazing is sometimes needed to allow new scrub regeneration but in other situations increased grazing is required to keep regenerating scrub in check.

Techniques to enhance existing scrub, by increasing diversity or increasing extent (see also Appendices 5.3 to 5.5)

Here there are two different approaches depending on the state of the area to be enhanced/increased. If woody growth is already thick then cutting, thinning or coppicing are often used to enhance the quality of scrub habitat. On small sites these management practices are often done manually e.g.'coppicing/glade management/ride management, by hand'. If the scrub is considered to be too open in structure the area may be fenced to exclude livestock and/or deer to allow re-growth of woody species. Sometimes scrub is established, or more often enhanced by planting. In such cases the ecological advantages of using local seed or vegetative propagules are widely understood.

A good example of the way various techniques are used to enhance scrub habitat is provided by the following questionnaire response: 'Edges are coppiced to create a transitional zone with tall herbs, bramble, etc.. This is further diversified by re-coppicing short stretches beginning after c.5 years re-growth. A similar effect has been obtained by allowing scrub to colonize neighbouring grassland edge, then coppicing short blocks'. Another correspondent referred to 'cyclical cutting to create mosaics of scrub of different ages. Exclosure to allow grassland to develop to scrub. Stump treatment (with 'Triclopyr') to create frilly edges, glades etc. in extensive blocks. Sheep grazing/cattle grazing to maintain mosaics'.

5.3.2 Control and removal of undesirable scrub

5.3.2.1 Identifying undesirable scrub

Situations where scrub could be considered a nuisance were reported by 87% of those questioned. However in many cases (36%) this only applied to less than 10% of the total scrub managed (Table 5.8).

Table 5.8 Proportions (%) of questionnaire correspondents in England and Wales who considered scrub to be a nuisance on the land that they manage and proportion (%) of the scrub they managed which was undesirable.

Proportion of scrub considered 'nuisance' scrub (%)	*Proportion of correspondents (%)*
<10	36
11-25	19
26-50	15
51-75	10
>75	3
No answer	16

When asked why the scrub could be a nuisance most stressed the need for a balance between scrub and other habitats. Small areas of scrub can be desirable to add structure and diversity, for example shelter and invertebrate food sources. Nearly all defined nuisance scrub as that which encroaches onto other 'more valuable' habitats.

Grasslands

Scrub invasion of species rich/unimproved grassland is a very common problem. It was mentioned by 29 questionnaire correspondents. The problem is most severe on calcareous soils, but also to a lesser extent on neutral and acidic soils. Scrubbing over of open grassland habitats alters the grassland flora and large amounts can also impede management by mowing, thus allowing further deterioration. Insect populations can lose food-plants due to shading and it also divides large areas of open sites which can affect invertebrate distribution. One correspondent noted that scrubbing up of grassland habitats affects not only the grassland communities but associated species such as the marsh fritillary butterfly *Eurodryas aurinia*. Open grassland is also vital for a few important species such as nesting stone curlew *Burhinus oedicnemus* and wood lark *Lullula arborea*.

For the scrub/grassland edge a common management aim is to maintain a gradual transition from medium length grassland through long grassland to thick scrub (Crofts & Jefferson 1999, Hopkins 1996). This habitat is very rich for wildlife providing shelter and a variety of food sources. However, maintaining it depends upon the provision of controlled levels of grazing and/or cutting. Overgrazing can easily remove the taller grassland with its rich assemblage of herbs, whereas undergrazing will allow invasion of the grassland by scrub. In practice, apart from on land managed specifically for nature conservation where grazing and/or cutting can be closely controlled, whether such a balance is maintained depends on agricultural markets for the grazing animals, and other less

quantifiable socio-economic factors that determine land management practices. One questionnaire correspondent working in South Wiltshire described the use of grazing to maintain this ecotone, thinning scrub occasionally as part of a cutting and stump treatment regime. In this particular situation wild privet was found not to be controllable by cutting and stump treatment because of its suckering habit and the large number of stems produced. It was controlled by spot spraying in September with the herbicide 'Garlon 2' (12:1000 in water) using a hand-held lance from a tractor mounted spray tank.

Heathland and wet habitats

Heathland and wet habitats are also commonly invaded by scrub. Many examples were mentioned by questionnaire correspondents, especially on lowland heath/wetland (35 cases), and on wet heath/mire (12 cases). A good example of the problems that scrub can cause in such situations was provided by one correspondent. 'Birch/willow scrub has developed on an area of wet heath/mire over the last 40-50 years, fragmenting the wetland basin into three areas separated by dense scrub and secondary birch woodland. This has fragmented a population of silver-studded blue butterflies *Plebejus argus* and has shaded out areas where their foodplant (heather *Calluna vulgaris*) grows'. One might have also expected encroachment onto heathland, and conversely loss of scrub/heathland habitat to have been an issue in relation to sand lizards *Lacerta agilis*, smooth snakes *Coronella austriaca* and adders *Vipera berus* (where habitat is changed or destroyed), but this was not recorded. Adders, for example, need a mix of scrub and open areas. Scrub is used for cover and to forage in, whilst open areas are needed for basking (Wild & Entwistle 1997).

Scrub can also destroy habitat by lowering the water table allowing colonization by more aggressive species of drier habitats e.g., 'Pine and birch scrub has devastated Bettisfield Moss, (and parts of Fenns Moss), eradicating the bog wildlife below. Birch scrub is drying out other areas allowing purple moor-grass *Molinia caerulea* and bracken *Pteridium aquilinum* to invade and take over both bog and heathland'. Another correspondent makes a similar case suggesting that, 'On lowland raised mires scrub increases the evapotranspiration rates, causes localised drying out of mire surface and enrichment causing a localised change in vegetation communities'. Reedbeds and fens are also prone to scrub invasion, often by willow *Salix* spp., alder *Alnus* spp. and birch *Betula* spp.. Ponds can be adversely affected by shade from overhanging scrub.

Coastal

Several coastal habitats are at risk from scrub invasion. For example, there is a problem in Pembrokeshire of "scrubbing up" of the coastal slopes, which are internationally important for maritime grassland and heathland and species such as red-billed chough *Pyrrhocorax pyrrhocorax*. This process is due to the retreat of traditional farming from the coastal fringe. Similarly, on other habitats such as dune heath and saltmarsh spread of scrub can destroy habitats that are of more value to nature conservation (e.g. Biodiversity Aciton Plan (BAP) and Special Area of Conservation (SAC) habitats). Invasive birch scrub on coastal dune heath causes loss of interesting features while in Lincolnshire scrub encroachment onto dune grassland is a problem and natterjack toad *Bufo calamita* breeding pools are adversely affected. Natterjacks require open habitat with short-grazed vegetation and bare sand (Houston 1997). Dune grassland and slacks can be invaded by several scrub species for example birch, alder and sea-buckthorn *Hippophae rhamnoides*. As one questionnaire correspondent put it, 'Dominant sea-buckthorn and white poplar *Populus alba* and balsam poplar *Populus trichocarpa* are of little conservation importance, highly invasive, lead to nutrient enrichment and replace internationally important habitats and animal species'. When and where sea-buckthorn needs to be controlled is not necessarily easy to decide. Sea-buckthorn cannot be regarded simply as a pest species of sand dune systems but has considerable interest in its own right and can, in certain circumstances, contribute positively to the scientific interest of an area (Ranwell, 1972). It is considered a problem partly because of its ability to fix atmospheric nitrogen thus enriching nutrient poor dune soils (Houston, 1997), and is generally unwanted in the west of Britain where it is probably not native.

Woodland and plantations

Perhaps surprisingly, scrub may dominate some woodland communities and is also detrimental to establishing both native broadleaf woodland and conifer plantations. It competes with planted trees inhibiting woodland establishment. As one questionnaire correspondent notes, 'In some cases dense scrub patches can inhibit natural regeneration or tree planting. In most cases it is retained as long as it does not interfere with other conservation interests. Some recent Woodland Grants Scheme Challenge Fund woodland creation schemes had to be amended to conserve valuable scrub and open space'. Another correspondent opined that, 'Some areas of scrub can be a nuisance on re-stock sites because scrub hinders crop establishment. It can inhibit crop development by out-competing newly planted seedlings or indeed taller saplings'. While this may be true for commercial conifer plantations, on sites where broadleaved woodland establishment is the aim the 'nuisance' value of scrub may easily be overplayed. The woodland which develops from seral scrub, assuming that it is semi-natural, may be more diverse and will certainly be more natural than planted woodland. Perhaps grant schemes for establishment of native woodland should be more flexible in allowing payments for creation of woodland from scrub in this way.

Problems associated with non-native woody plant species

Alien scrub species compete with native British species whilst not being able to support as many species of our native fauna as native species.

Invading alien scrub species were a problem for 73% of survey correspondents. The offending species with the number of times they were mentioned are shown in Table 5.9.

Urban areas

In urban areas people living near to scrub or using areas with scrub for recreation often perceive scrub as untidy and/or a potential security threat. It is seen to encourage problem behaviour, especially among children and young people. Scrub can also overhang rights of way, obstruct highway visibility and attract fly tipping. It is a challenge to develop a more positive attitude to scrub in urban areas.

Table 5.9 Genera and species of exotic trees and shrubs which were cited by questionnaire correspondents in England and Wales as being a 'nuisance', and number of times cited.

English name	*Latin name*	*Number of times cited*
Rhododendron	*Rhododendron ponticum*	79
Laurel	*Prunus* spp.	26
Cotoneaster	*Cotoneaster* spp.	15
Snowberry	*Symphoricarpus albus*	10
Japanese Knotweed[1]	*Fallopia japonica*	9
Turkey Oak/ Evergreen Oak	*Quercus cerris/Quercus ilex*	8
Sycamore	*Acer pseudoplatanus*	7
Shallon	*Gaultheria shallon*	6
Butterfly-bush	*Buddleja* spp.	4
Pine	*Pinus* spp.	3
Himalayan Honeysuckle	*Leycesteria formosa*	2
Cherry	*Prunus* spp.	2
Sea-buckthorn[2]	*Hippophae rhamnoides*	2
Duke of Argyll's Teaplant	*Lycium barbarum*	1
Laburnum	*Laburnum anagyroides*	1
Mock-orange	*Philadelphus coronarius*	1
Grey Poplar	*Populus x canescens*	1
Grey and Italian Alder	*Alnus incana and cordata*	1
Oregon-grape	*Mahonia aquifolium*	1

[1] Not a woody species but often treated similarly.
[2] Considered native in the east of England

This might be aided by more active control of where scrub is and is not allowed to develop and more positive management of retained scrub, including maintenance of sight lines by maintaining open areas within scrub.

Damage to archaeological and geological features

Growth of scrub can cause damage to scheduled ancient monuments and may be considered a nuisance where it is growing on ancient earthworks and damaging them by roots and providing cover for rabbits. Exposed geological features can also be obscured and damaged by uncontrolled scrub invasion.

5.3.2.2 Determining the need for scrub control or removal

Where scrub is undesirable management will be needed to either remove or reduce it. Eighty-nine percent of those in England and Wales who responded to the questionnaire were involved in active scrub management and a similar figure in Scotland. In both cases most managed only a small proportion (<25%) of their scrub. (Table 5.10).

Table 5.10 Proportion (%) of scrub being actively managed by questionnaire correspondents in England and Wales and proportion (%) of correspondents managing scrub in each class.

Proportion of scrub managed (%)	*Proportion of correspondents (%)*
0-25	54
26-50	20
51-75	13
76-100	13

Some species are almost always considered to be undesirable by managers, e.g. elder, rhododendron and sea-buckthorn (although the importance of sea-buckthorn berries for fieldfare *Turdus pilaris* and redwing *Turdus iliacus* was noted and of elder for bryophytes). Conversely, juniper is always valued and never removed to conserve another habitat. Many species appear in all four columns in Table 5.11 indicating that they are considered desirable in some habitats and undesirable when spreading into others, e.g. birch, blackthorn, gorse, hawthorn, mixed scrub and willow.

Rhododendron was by far the most common offender, in Scotland as well as in England and Wales. It is particularly troublesome as its dense shade allows very little ground flora to develop. It occurs most commonly in woodland but also occurs on heathland and on fens and bogs. Laurel is a problem mainly in woodland but is also sometimes found in native scrub, on heathland and in limestone gorges. Cotoneaster species most often caused problems on calcareous grassland, but also on limestone ledges and scree, limestone pavement, and in woodland.

Table 5.11 Summary of proportions (%) of questionnaire correspondents actively managing main scrub types and the reasons for that management (see Appendix 5.4 for full list of scrub types).

	Conserve		*Enhance*		*Increase*		*Remove*	
	Scotland	*England and Wales*	*Scotland*	*England and Wales*	*Scotland*	*England and Wales*	*Scotland*	*England and Wales*
Birch (*Betula* spp.)	14%	12%	5%	13%	7%	4%	5%	26%
Blackthorn (*Prunus spinosa*)	2%	9%		10%		3%		10%
Bramble (*Rubus fruticosus*)		3%		3%		2%	2%	4%
Elder (*Sambucus nigra*)								3%
Gorse (*Ulex*)	9%	19%	5%	15%	2%	3%	5%	20%
Hawthorn (*Crataegus monogyna*)	7%	31%	5%	26%	9%	5%	2%	43%
Hazel (*Corylus avellana*)	14%	3%	14%	5%	14%	2%		1%
Juniper (*Juniperus*)	16%	7%	16%	6%	18%	7%		
Mixed	14%	12%	9%	10%	9%	2%	9%	10%
Oak (*Quercus*)		2%		2%			2%	3%
Rhododendron (*Rhododendron ponticum*)							9%	6%
Sea-buckthorn (*Hippophae rhamnoides*)							2%	4%
Willow (*Salix*)	14%	18%	11%	14%	14%	4%		25%

There is more management aimed at removing scrub of native species in England and Wales than in Scotland suggesting that encroachment by such species as birch, gorse and especially hawthorn is much more of a problem in the south of Britain. It should be noted, however, that the number of questionnaire responses was much less for Scotland than for England and Wales and that this skews some of the results. Thus the figures for hazel *Corylus avellana* and juniper in Table 5.11 are based on similar numbers of responses and hence can be compared directly while those for the other main scrub types are based on widely differing numbers and hence should be interpreted with caution.

5.3.2.3 *Devising and implementing appropriate control/ removal techniques*

Techniques to control scrub, to prevent encroachment onto other habitats (see also Appendices 5.3 to 5.5)

Scrub control techniques are mostly based on cutting and stump treatment followed by grazing or mowing, of which examples have already been given. Another approach where invasion is in the early stages involves removing individual saplings manually. However, this is very labour intensive as described by one correspondent: 'It can involve removing a lot of young trees, e.g. cutting and pulling young pine and birch from lowland heath - c. 20,000 per ha in one case'. An interesting innovative idea is to kill scrub standing using stem notch injection with herbicides. This provides useful dead wood habitat while involving little disturbance to the underlying habitat.

Most grazing involves the use of sheep or cattle but sometimes other domestic animals are used. For example, 'rotational grazing with Exmoor ponies to maintain scrub/grassland mosaics following cutting of scrub'. Goats are being used in some places but they are difficult to control unless tethered, which requires regular attention.

There is ample advice for control of scrub on lowland grassland sites in general in The Lowland Grassland Management Handbook (Crofts & Jefferson 1999) and on wet grassland sites in particular in the EN/RSPB/ITE publication, The Wet Grassland Guide (Treweek *et al.* 1997). Management of woody vegetation on the Ouse Washes SSSI, including control of invasive scrub is described in Lambert (1993).

Techniques to restore or create other habitats (see also Appendices 5.3 to 5.5)

Unless scrub encroachment is stopped in its early stages this is not just a question of removing the offending scrub and allowing the original habitat to return. Scrub growth will have added nutrients to the soil thus affecting the composition of the 'restored' habitat. It is then necessary to remove the added nutrients and this is being done in some places, for example, 'sometimes litter clearance is done to expose mineral soils to enhance recovery'.

When aiming to clear scrub rather than control its spread the follow-up needs to be more intensive and sustained. A fearsome armoury of techniques was revealed in the responses to the questionnaire, involving various combinations of pulling, strimming, cutting, flailing, burning, bulldozing, rotovating, stump grinding, and herbicide application by a variety of means including stump treatment, foliar spraying, weedwiping. Almost always some form of grazing to prevent reinvasion was mentioned. Rather than burning or removing the cut or poisoned material some managers are being more creative, stacking the wood on site or chipping it and leaving it on site to provide habitat for fungi, invertebrates or grass snakes *Natrix natrix*. Even using the wood chips to surface heavily used paths through reserves may be considered preferable to burning the material on site or removing it.

The need for extra care in wetter areas is generally appreciated by managers. One reported as follows: 'Large-scale mechanical scrub/woodland removal is starting in the Broads this winter, using a tracked vehicle to cut and chip, rather than gangs with chainsaws, to reduce ground damage in wet areas'.

Herbicides used for stump treatment and weed spraying were Glyphosate, Triclopyr, Grazon 90 (Clopyralid & Triclopyr), Amcide (Ammonium sulphate), and Krenite (Fosamine-ammonium). Often stumps are treated to prevent regrowth but this is not always advisable. For example, one correspondent wrote, 'On sites where we wish to convert to organic it seems stump treatment will not be allowed. This is a major problem as, despite widespread requests for help, no satisfactory alternative has been suggested'. One possible alternative was suggested by another correspondent who is 'moving more to accepting shorter term cyclical cutting as a chemical free alternative'.

The type of cutting equipment used was not always noted but included by hand, flail, tractor mounted brushcutter, mini-brush cutter vehicle, tirfor winch, forage harvester and removal by lifting out of ground using hydraulics of 3 ton excavator.

In Wiltshire a range of techniques were tried, for example a New Holland double chop forage harvester had been used on young gorse scrub, forage harvesters pick up the cut material and scarify the soil surface depending on how low the machine is set. The gorse cut by the New Holland forage harvester has been colonised by both chalk grassland plants and species usually found on more acid soils. In some places these have formed a chalk heath community. Violets are abundant in these areas. The combination of young gorse re-growth and violets *Viola* spp. sheltered by the gorse provides an excellent habitat for the dark green fritillary butterfly.' A tractor mounted swipe that leaves the cut material on the ground (Wessex Scrubmaster 66) was also used on gorse scrub. 'Cut gorse material has a high Carbon to Nitrogen ratio and therefore takes a long time to break down. The areas cut by swipe are slowly colonised by a few species of plant able to grow through the cut gorse material. The gorse re-grows from cut stumps and eventually forms thick stands of young growth intermixed with grassy patches. The mixture of bare litter, tall grass and gorse in this compartment is used by breeding birds including nightjars *Caprimulgus europaeus* and linnets, Dartford warblers have visited the gorse in recent years.'

5.3.3 Success of various management techniques

Table 5.12 indicates the success questionnaire correspondents have had in managing different types of scrub, whether for its positive benefits or to control or clear it. It is clear that there is a very wide range of success in most cases. Lack of success appears to be greatest when attempting to managing invasive scrub of gorse, hawthorn, willow and sea-buckthorn.

Table 5.12 Range of success achieved by questionnaire correspondents in managing different types of scrub (1 = unsuccessful to 5 = very successful).

Scrub type	*Success rate*
Birch (*Betula*)	2 TO 5
Blackthorn (*Prunus spinosa*)	2 TO 5
Bramble (*Rubus fruticosa*)	2 TO 4
Dogwood (*Cornus sanguinea*)	1 TO 5
Gorse (*Ulex*)	1 TO 5
Hawthorn (*Crataegus monogyna*)	1 TO 5
Hazel (*Corylus avellana*)	3 TO 4
Juniper (*Juniperus*)	2 TO 4
Mixed scrub	3 TO 5
Rhododendron (*Rhododendron ponticum*)	2 TO 5
Willow (*Salix*)	1 TO 5
Sea-buckthorn (*Hippophae rhamnoides*)	1 TO 4

Table 5.13 shows the most successful management procedures used by those responding to the questionnaire for each of these major scrub types. It is clear that control of some invasive species (birch *Betula* spp., blackthorn, rhododendron) is easier than others (dogwood, gorse, sea-buckthorn). In the case of species with light, wind-blown seeds (e.g. willows, rhododendron) there is a constant danger of re-invasion where seed sources remain nearby.

Table 5.13 Most successful management procedures for each of the main scrub types and estimated success rates (1 = unsuccessful to 5 = very successful).

Scrub type	*Most successful management*	*Success rate*
Birch (*Betula*)	Uprooting (gave massive disposal problem)	2
	Cutting and grazing re-growth	2-3
	Clearance by saws - without chemicals followed by mowing 1-2 a year	2-3
Blackthorn (*Prunus spinosa*)	Cutting/topping +/- treatment	2
	Cut and herbicide etc.	2
Bramble (*Rubus fruticosa*)	Digging roots out and flailing to prevent encroachment on grassland	2
Dogwood (*Cornus sanguinea*)	Mowing.	1
	Swipe	1
	Weed-wipe	1
Gorse (*Ulex*)	Burning to maintain scrub/grass mosaics	1
	Burning - some accidental, some deliberate. Success very variable - best if grazed after	1-5
Hawthorn (*Crataegus monogyna*)	Coppicing and aftermath grazing	1-4
	Pony grazing	1 (we are therefore going to change to sheep/goats)
	Layering to provide Black Hairstreak (*Strymonidia pruni*) habitat	1 (colonisation seems very slow)
Hazel (*Corylus avellana*)	Remove any exotic species	3
	Cut/clear/winch	3-4
Juniper (*Juniperus*)	Graze grassland and clear scrub	2
	(climate plays big part in germination so out of our control)	
	Modification of grazing levels	2
	Protecting young, raised plants from grazing	2 (very intensive for scale of return)
Mixed	Grazing to produce short scrub/grass mosaics	3
	Coppicing for structural diversity	3
	Coppicing	3
	Scrub enhancement techniques as 15B	3
	Scrub control techniques as 15D	5
Rhododendron (*Rhododendron ponticum*)	Remove and treat with herbicide	3 (success varies with site type and thoroughness of treatment. Areas re-infested from outside seed sources)
	Cut - chemical treatment	2
Willow (*Salix*)	Cutting - often very low success rates unless grazed or herbicided	1-3
Sea-buckthorn (*Hippophae rhamnoides*)	Manual control and herbicide	1 (we are therefore going to reintroduce grazing)
	Hand cutting/pulling	1

6 Recommendations

6.1 Research and education requirements

The following research and education requirements were identified during an expert workshop held at English Nature headquarters, Peterborough, in November 1999. Additional comments have been added from the results of a questionnaire circulated to 125 conservation professionals (see Section 6.2).

6.1.1 Classification

Describing vegetation types according to the plant species present provides a common currency, or template, on which discussion of issues linked to scrub types can be based.

6.1.1.1 Survey

Many species (plant and animal) of scrub habitats are perceived to be rare, but this rarity cannot be quantified because insufficient distribution data for individual species or scrub types are available. This requires a structured inventory of the geographical distribution of key species (e.g. Biodiversity Action Plan (BAP) species) and habitat types, for example by region or Natural Area. A list of scrub habitats, mapped to NVC level at regular intervals (e.g. every 5 years) on all SSSIs, would provide an excellent basis for comment on species and habitat distributions. Phase 1 databases from Wales are being used to produce scrub distribution maps, with interesting results (J. Latham, pers. comm.) The rapid rates of change of scrub habitat (stand areas, size and architecture of species, community composition, etc.) are acknowledged to be a problem when compiling distribution lists and maps, as the nature of the resource can change rapidly. This is more relevant in lowland than upland areas, because of more rapid growth rates and therefore community change. Identifying and mapping the geographical distribution of species which are key indicators of change is thus viewed as the most practical approach to identifying current and future scrub distribution.

Key species could be divided into those indicative of:

- Pressures (factors driving the change, e.g. socio-economic factors);
- State (condition of the habitat type as a result of the pressures);
- Response (changes resulting from management and restoration, including those resulting from political response to states and pressures).

6.1.1.2 Spatial structure

Spatial structure (architecture and physionomy) within a stand of scrub is thought to be important for many taxa, and might provide a suitable basis for a new, easy to use, habitat classification. Work on birds, such as nightingales, has highlighted the importance of structure when identifying suitable habitat (Fuller *et al.* 1999). Identifying a suitable measure of structure might thus be a major component of, or addition to, habitat classification. The role of a mosaic of scrub habitats, particularly at the scrub/grassland or scrub/wetland edge, in species distribution is considered to be important. This includes the optimum scrub/grassland ration for different species that benefit from scrub cover, including scattered bushes, and the value of different densities of scattered scrub.

6.1.1.3 Life form

Regenerative strategy and physical structure varies greatly between plant species, and may be one of the factors influencing the associated species present. For example, juniper *Juniperus communis* and bramble *Rubus fruticosus* agg. have very different life forms and associated invertebrate fauna.

6.1.1.4 Successional dynamics

The impact on associated species of the pace and trajectory of succession within a stand is likely to be major, but little information is available. The rate of succession (e.g. illustrated by the speed of canopy closure) is likely to vary with geographical location. An upland/lowland split is expected due to much slower growth rates of the same species in upland areas.

6.1.2 Physical conditions

6.1.2.1 Nutrient cycling

The rates of nutrient cycling and associated soil dynamics are influenced by community composition and structure. An understanding of these fluxes gives us an idea of both the visible and microbial communities, and the likely influence on these of current and future management .

6.1.2.2 Water relations

Watershed management is influenced by the quantity and distribution of scrub present. Scrub removes large quantities of water from the soil and surroundings through evapo-transpiration, yet some physical structures impede water flow. An increase in scrub on flood plains may thus increase flooding, which can be perceived as either a positive or a negative event, depending on the remit of the manager. Investigation of the role of individual species, habitat types and physical structures on watershed management would enable compromise between the requirements of managers to minimise unacceptable flooding whilst maximising the ecological values of wetland scrub types.

6.1.2.3 Soil stability

Establishment of scrub can be a useful tool for stabilising soil. A list of the most suitable species and groupings for different situations is needed. If this information exists (e.g. unpublished data and anecdotal information within the Environment Agency), then it needs to be more widely disseminated.

6.1.2.4 Implications of land-use history

Land-use history impacts on the outcome of current and future management, and must be considered when undertaking work on scrub. Past land management is known to influence subsequent grassland communities (Wells *et al.* 1976, Dutoit & Alard 1995) and is also likely to influence scrub community composition and development. This is a major area that needs to be investigated.

6.1.2.5 Microclimatic aspects

The range of microclimates available within a scrub type impact on both the scrub species and the associated organisms. Knowledge of the microclimatic conditions within scrub types, and the criteria influencing those conditions, would provide insights into the requirements of associated species.

6.1.3 Biotic interactions

6.1.3.1 Scrub species/habitats attributes

Each scrub species and habitat type provides a set of ecological conditions (template) used by associated groups of organisms such as birds or insects with those specific requirements. Knowledge of the template available should make it possible to predict the potential for associated species with known requirements occurring at a given location.

6.1.3.2 Range attributes

Matching species and habitat type attributes is not always sufficient to predict the presence of a species. For example, some species of insects associated with juniper (Ward 1973) are absent from large areas of apparently suitable juniper scrub, due to differences in geographical range. Information on ranges of individual species is therefore needed in addition to species attributes in order to judge the importance of a scrub habitat type for associated species.

6.1.3.3 Habitat characteristics in terms of species assemblages

The three-dimensional structure, food sources available, and the life-strategies of both shrub and associated species all contribute to the habitat characteristics of a scrub type. Knowledge of all these factors is required if the likelihood of a species being present is to be estimated. Collation of existing data on the value of different scrub types for species linked to scrub would be useful for site managers planning management aimed at key or BAP species such as Black grouse *Tetrao tetrix*, or juniper.

6.1.3.4 Patterns of colonisation processes - modelling

Colonisation depends on a range of biotic interactions and physical attributes. Modelling using these parameters may be a suitable approach to identifying colonisation patterns, and therefore predicting likely outcomes of clearance, or problems of scrub encroaching onto other, more highly valued habitats.

6.1.3.4 Seed dispersal

Seed size, weight, numbers produced, dispersal method and life cycle influence distribution of scrub species. These factors limiting colonisation are known for only a limited number of species (e.g hawthorn *Crataegus monogyna* and dogwood *Cornus sanguinea*), but have a major impact on the outcome of management such as scrub clearance.

6.1.3.5 Herbivore effects on scrub dynamics

Herbivory plays a central role in most ecosystems, including scrub habitats. Insect herbivory is likely to have the greatest impact on scrub dynamics, but relatively little work has been done on scrub habitats *per se* (but see Ward 1972, 1973, Ward & Spalding 1993).

6.1.3.6 Mini-island biogeography

The non-uniform spatial distribution of shrubs within a stand of scrub frequently creates a mosaic of habitat types. Factors such as patch size, distance from other suitable patch, and age of patch may all influence the species present. A combination of island biogeography and metapopulation theories may be suitable to explain species distribution within this framework. This approach has been successfully used to predict species distribution within large geographical areas. The location of scrub in relation to other habitats is likely to influence the species composition of both habitats, but little such work has been carried out on species associated with scrub.

6.1.4 Management

The management options available to site managers, and the methods practiced, are influenced by the criteria listed above (classification, perception and ecological interactions sections).

6.1.4.1 Agri-environment values influence management options

The type of land management practiced varies between stakeholders, but is invariably dictated by the time and money available. For example, a conservation organisation might be able to use volunteers to carry out a labour-intensive method of management, but this would not be an option for a farmer (see section on stakeholder perception) unless sufficient finances were made available, for example through agri-environment schemes.

6.1.4.2 Organic vs. conventional farming practices

Scrub dynamics will be influenced by the agricultural systems practised in the landscape. The most dramatic contrasts are seen between organic and conventional farming practices. This will be most pronounced in scrub stands with a high edge : area ratio, such as scrub/ grassland mosaics.

6.1.4.3 Intervention vs. natural regeneration

The vegetation communities resulting from natural regeneration following scrub clearance often contain a high proportion of tall, weedy species. These may be very different from those of the target habitat envisaged by the site manager. These sites may be viewed as 'failed' restoration areas, despite the extremely short time-scale within this perception is formed (months, as opposed to the decades it routinely takes until the success of a site restoration project can fairly be judged). Weedy communities can also be viewed as providing useful diversity on some sites, and are by their nature transitory. Many managers however prefer to minimise the unkempt appearance of a site, and seed newly cleared areas with a

species-mix similar to that of their target community. Opinion as to the efficacy and possible complementarity of the two approaches is divided, and a set of guidelines for managers on the best approach for identifying, and achieving, their target communities on newly cleared sites is urgently needed.

6.1.4.4 *'Tweaking' succession*

Most scrub types (other than exposed cliffs, some upland areas etc) inhabit mid-successional seral stages which require management to prevent succession. Ideally, a stand of scrub would be dynamic, and would constantly change its location within the landscape, providing a full array of seral stages and merging into the surrounding habitats (e.g. grassland/scrub mosaic on the edge of chalk grassland). However, this is not practical under the current agricultural climate, so stands need to be maintained *in situ*. This is both labour intensive, and of limited success. There is an urgent need for more information on the success of existing management methods (e.g. rotational management by cutting, length of rotation, follow-up management), and an exploration of novel, innovative approaches, such as the combined effect of cutting and browsing or grazing.

6.1.4.5 *Criteria for success*

Key targets for cleared areas are needed, so managers can identify what they are trying to achieve when managing an area. Management such as rotational cutting is very resource costly, often carried out on an *ad hoc* basis, and informed by insufficient knowledge of the likely outcomes of management on an area. The use of indicator species, or key structure measurements, could inform decisions on what, where, when and how to manage.

6.1.4.6 *Thresholds for management*

Age and composition of scrub habitat type, size of block, and surrounding land-uses, will influence the end result of management. The most suitable management of different scrub types, taking into account age, species present, structure, and level of canopy closure, could be identified using a set of thresholds. For example, if the required outcome of scrub clearance was restoration of abandoned chalk grassland, natural regeneration might be recommended if canopy closure was less than 50% and chalk grassland of high nature conservation value was present within 50 m; but if the canopy was closed, and there was no suitable seed source within 200 m, soil stripping and sowing with native seed might be the most viable option. Alternatively, a different target end community might be suggested. This approach would be both useful to guide managers, and essential to maximise value for money of operations such as scrub clearance under agri-environment schemes.

6.1.4.7 *Alien invasive species*

A sound knowledge of the geographical distribution and ecology of the range of alien species occurring in scrub is required. Many are regarded as undesirable invasives, for example butterfly-bush *Buddleja, Cotoneaster,* aromatic wintergreens *Gaultheria* and rhododendron *Rhododendron ponticum*. Information on these species is required in order to understand the extent of the problem and advise on effective management.

6.1.5 Perception

Conservation of valuable scrub will only be successful if the needs of the majority of stakeholders are addressed, which requires a knowledge of how scrub is perceived by non-conservationists.

6.1.5.1 *Education*

Factual information on scrub, and the key issues surrounding its ecology and conservation, should be disseminated to a wide audience. This informs stakeholders, and can be used to influence perception of scrub.

6.1.5.2 *Stakeholder perception*

Stakeholder perception of the socio-economic, and economic, factors linked to scrub conservation and management need to be surveyed. Surveys can be used to identify the types of information or actions most likely to engender a more favourable attitude towards scrub. For example, a large stand of species-rich scrub encroaching onto adjacent pasture might be considered as a problem by a lowland farmer with insufficient resources to prevent rapid spread. However, if the nature conservation value of that scrub type were recognised, and sufficient agri-environment funding made available for appropriate management, the farmer would no longer view the scrub as a problem.

6.1.5.3 *Guidelines*

Practical information guiding management of scrub to optimise its conservation value is required. Broad management recommendations are currently available in disparate publications focussing on specific habitats or groups (e.g. lowland grassland (Crofts & Jefferson 1999, Jefferson & Robertson 1996); butterflies (NCC 1986); birds (Fuller 1995). A single publication focussing on the management options (pros and cons) suitable for the full range of scrub habitat types is viewed as essential. Information could be drawn from published and unpublished information, and could include advice on best practice for scrub habitat creation and restoration and consider scrub management in context with other habitats present on a site or the surrounding landscape. This might usefully follow the format used by Dryden (1997). Scrub is often considered as a problem by managers because they have insufficient information to identify the most suitable management options (see Section 5.3).

6.2 Site management and agri-environment policy

6.2.1 Survey of specialists and advisors

6.2.1.1 Background

All the opinions expressed below were gathered as part of a survey of specialists and advisors with responsibility for providing advice or awarding grants at the county or regional level. A total of 125 questionnaires (Appendix 6.1) were sent out, although a greater number may have been circulated as recipients were encouraged to copy the questionnaire to other relevant members of their organisation. The breakdown of responses is shown in Table 6.1.

Table 6.1 Breakdown of responses to questionnaire on changes in scrub policy by affiliation and area of responsibility.

Body	Comments relating to:				
	Lowland only	Lowland/ Upland	Upland only	Country/ region	Total
EN	8	0	0	0	8
CCW	0	2	0	3	5
SNH	3	3	1	0	7
FWAG	18	5	0	0	23
FRCA	15	5	1	0	21
Other	0	2	0	1	3
Total	***44***	***17***	***2***	***4***	***67***

A combination of the concentration of Farming and Rural Conservation Agency and Farming and Wildlife Advisory Group personnel in England, and lack of experience of administering Tir Gofal, has resulted in a much greater input into this section from England than the other countries. However, some responses represent the view of an organisation (e.g. Brian Pawson responded with CCW official policy on Tir Gofal), rather than the personal opinion of individual area representatives (e.g. FRCA and FWAG). Sixty individuals responded (Appendix 6.2)

6.2.1.2 General comments not referring to specific schemes

Thirty nine respondents commented on the general constraints (including current policy) limiting their promotion of scrub conservation. There was little apparent upland/lowland division of opinion over the omissions in existing policy on scrub management options individual schemes, which was unexpected given the more widespread, invasive nature of scrub in lowland areas.

The consensus of opinion (30% of responses) was that farmer perception of scrub as a low value/priority habitat needed to be addressed. The importance of promoting scrub 'as a habitat in its own right and in a mosaic with other habitats', was recognised by many respondents. This approach is already being piloted in Wales by the Tir Gofal scheme (CCW 1999), but is too early to assess the impact of this on attitudes towards scrub conservation. National Vegetation Classifications W21 (*Crataegus monogyna–Hedera helix*), W22 (*Prunus spinosa – Rubus fruticosus*), W23 (*Ulex europaeus-Rubus fruticosus*) and W24 (*Rubus fruticosus–Holcus lanatus*), W1 and W2 (*Salix cinerea* woodlands), are recognised as scrub within Tir Gofal. The Rural Stewardship Scheme (replacing the Countryside Premium Scheme) to be launched by Spring 2001 in Scotland addresses the management of native or semi-natural woodland and scrub. However, documentation was unavailable at the time of writing to compare this with existing Forestry Commission grants such as Woodland Grant Scheme and Farm Woodland Premium Scheme, or to assess the potential impact of this new scheme.

Farmers, landowners and staff were seen as having little interest in scrub as a habitat, preferring to either remove scrub completely, or to 'avoid touching scrub', rather than undertake any intermediate management.

Common reasons attributed to farmers and land managers for wanting to clear scrub included: to increase the areas available for grazing; avoiding deductions made for ungrazed/ungrazable areas; to reduce the cover for predators such as corvids; or because many land managers view scrub as a sign of abandonment and therefore poor land management. 'Persuading farmers not to clear scrub unnecessarily' was viewed as an up-hill struggle, requiring time and patience. Common reasons attributed to farmers and land managers for non-intervention included: 'because it provides good shelter'; insufficient 'agreement holder/contractor skills'; length of time period commitment required to manage scrub effectively; physical site restraints (distance, steep/rough terrain); financial constraints; and 'lack of sufficient livestock' to provide follow-on grazing.

Many respondents were keen to avoid this 'all or nothing' approach to scrub management, and suggested that 'annual management payments for keeping scrub as a habitat' would be a useful addition to existing agri-environment and Forestry Commission policies. Current policy for the Countryside Stewardship and English Environmentally Sensitive Area schemes funds scrub management as an item of capital expenditure, but has no provision for annual management of scrub (cf. grassland management; Scottish ESAs; Tir Gofal; Countryside Premium Scheme). Increased incentives for better management of scrub on habitats where neglect is resulting in loss of habitat/ diversity' were suggested. Several respondents felt that 'lower financial limits in conservation plans' were not enough, and that grant rates were 'not sufficient inducement for farmers to carry out necessary work'. Grants 'to increase the amount of scrub, for example by planting on improved grassland or arable sites', were suggested. Management of a site to include selective removal of plants/shrubs to maintain it as scrub, not woodland, was also proposed. It was also proposed that a 'more generous view of native scrub in peripheral areas' should be included in schemes relating to scrub management.

Although this was not the general feeling amongst respondents, there was the suggestion that the role of scrub 'as a component of a range of habitats' was sometimes overlooked by advisors in their desire to clear scrub to increase the area of existing habitats of known

conservation value. The potential for give poor management advice, because of insufficient information on the most valuable types of scrub (including requirements of Biodiversity Action Plan species), was seen as a major problem. The suggestions given above for modifications to scrub policy were tempered by a desire to avoid further mistakes caused by adopting new policies without a sufficiently robust science base. This was a concern for several individuals, particularly those involved in providing advice at a regional level. Research into the value of scrub stand types, within a regional context, and including mammals, birds, rare invertebrates and their habitat regimes, was suggested as requiring attention (see Section 6.1).

6.2.1.3 *Individual schemes funding scrub management*

Woodland Grant Scheme (Forestry Commission)

Thirteen respondents, of which eleven were affiliated to FWAG, specifically mentioned the WGS as needing amendment. This constitutes nearly 50% of FWAG representatives returning the questionnaire, suggesting that a desire for changes in the WGS is widespread amongst 'hands on' professionals offering practical advice to farmers.

The common thread running through responses was that the 'Woodland Grant Scheme does not seem to like scrub', and does not promote conservation of scrub as a valuable habitat in its own right. Adaptation of WGS and FWPS was suggested to include payments for managing and increasing the area of existing scrub, for example by thinning/removing trees, or encouraging scrub regeneration. An annual payment spread over, for example, 10 years (equivalent to grassland management), was suggested as a way of 'presenting scrub creation and management as a valid practice in the eyes of the landowners'. The detrimental effects on scrub of some WGS payments were raised several times. The existing 50% funding rule, which leaves farmers unable to match funds with other grants, was criticised, as was the dilemma posed by the 'difficulty of advising on the retention of scrub when there is generally no management payment available against destruction by tree planting under WGS'.

Several respondents were concerned that the percentage of shrubs allowed to be planted in a new woodland (currently a maximum of 10%) was too low (20% was suggested as a more useful value). The WGS approach towards scrub management was perceived as failing to take into account that 'all schemes need to be flexible as scrub is not a fixed habitat'. Management of smaller blocks, possibly to include coppicing after 5 years (currently 30 years) was also proposed.

Countryside Stewardship Scheme

Many of the suggestions for future changes of WGS were also proposed for the Countryside Stewardship scheme. Of the 14 respondents that mentioned the CS scheme, nearly half were concerned that the scheme was aimed, or perceived to be aimed, at scrub removal rather than management. Although CS scheme guidelines for scrub present lowland scrub as a potentially valuable habitat, payments are made for scrub clearance only, with no funding for a management component. Management payments to enhance or increase the extent of scrub of high nature conservation value were considered by many to be a missing element of the Countryside Stewardship scheme; many would like to see 'scrub conservation properly incorporated into CS, i.e. management guidelines in pack, payment specified, compliance management specified, included in targets/objectives, etc.'. This would 'involve a longer term commitment on behalf of the landowner', but a sympathetic scrub management agreement, which might include creation and management, such as dividing up large blocks, or coppicing, was seen as highly beneficial to scrub conservation.

Interestingly, interpretation of CS regulations may vary between individuals, with several respondents (both upland and lowland areas) commenting that 'the flexibility of CS allows sympathetic scrub management', and that there are 'no constraints' to scrub management within the CS scheme.

The issue of level of annual payments was raised by several individuals in relation to CS. The base payment for scrub management in upland areas is less (£55/ha/year) than for management of other habitats (£80/ha/year) which might lead to a perception amongst farmers that scrub is less valuable than other habitats. This is particularly relevant in upland areas, where scrub is often severely under represented in the landscape, and could be addressed by advisors promoting 'a greater understanding of the value of scrub as a habitat'. Lowland areas might benefit from higher payments for scrub management, as this could enable a more useful balance between prevention of scrub encroachment on to more highly valued habitats such as chalk grassland or lowland heath, and retention of scrub of high nature conservation value.

Environmentally Sensitive Area scheme

Relatively few responses (five) were received referring to scrub in ESAs, of which four were from FRCA staff, three of which related to upland areas. The fourth FRCA respondent was based within a lowland ESA, and found that there were 'few constraints on the promotion and conservation of scrub' under the ESA scheme. Responses recorded by the questionnaire suggest that guidelines in place in lowland ESAs may be sufficient for scrub conservation.

For example, current and future measures for scrub conservation in one southern lowland ESA 'are already in place', and 'if a situation arose when it was deemed necessary to promote or conserve scrub, the use of the 'catch-all' item 50 within the Conservation Plan ('other works for the restoration or enhancement of wildlife habitats') could be used'. This item appears to be infrequently used by project officers, and was not identified as commonly used for scrub conservation.

Generally, the existing policy on scrub was viewed favourably: 'with care it should be possible to manage/control scrub where desirable using conservation plan items 7 and 23 (management/control of scrub; management/control of bracken). It should also be possible to create scrub using items 24 (reversion of land to heathland) and 50 (see above)', although the amount of Project Officer time required to convince farmers of the value of scrub management was emphasised for one northern upland ESA. The only suggested modification was for a 'specific management tier supplement to be paid over and above the basic tier appropriate to the land' for example a supplementary

payment of £15-£25 per hectare in exchange for following an agreed management agreement.

Countryside Premium Scheme

A single recipient commented on the Countryside Premium Scheme (CPS), probably reflecting the low number of the recipients in Scotland who responded to this policy questionnaire. The CPS contains 'a scrub management option to regenerate scrub, but which does not require the exclusion (or eradication) of deer and rabbits.' It was felt that 'this should been a requirement. The CPS definition was that it (scrub) should contain a variety of species, failing to recognise that in upland areas a single species can still be of high conservation value'.

Tir Gofal

As Tir Gofal was opened for applications in March 1999, no agreements are yet operational. However, 'lessons learned from Tir Cymen were used in developing Tir Gofal. In particular, the key advance in Tir Gofal is the recognition that scrub was worthy of treatment as a separate habitat in its own right' (B. Pawson, pers. comm.

Sites of Special Scientific Interest

SSSI policy relating to scrub was suggested by representatives of EN providing advice at a regional level as needing modification. Identification of neglect as an operation likely to damage the interest of SSSIs, and the need to allow enforcement of appropriate scrub management in order to secure favourable conditions, were highlighted. 'Increased resources would inevitably be required to satisfy the resulting resource implications for restoration management'.

Biodiversity Action Plans

Production of a national Biodiversity Action Plan for scrub, and the inclusion of scrub as a component of other BAPs, was suggested as likely to enable English Nature to maximise its impact on scrub conservation. Inclusion of objectives for scrub in Local BAPs was suggested by a representative of SNH as likely to improve the case for expenditure or management.

Future policies to benefit scrub conservation

Most suggestions for improvements to scrub conservation policy focussed, perhaps realistically, on modifications to existing schemes rather than new policies. However, there was a call for 'a more holistic land-use approach, particularly a more integrated approach to agricultural and forestry schemes such that scrub habitat does not fall outside'.

6.3 Recommendations

6.3.1 Classification and distribution

- The nature conservation value of scrub is generally related to its structure, including elements of both vertical canopy structure and horizontal spatial structure in relation to other habitats. The National Vegetation Classification, being based on floristic inventory of homogenous stands, is therefore inadequate for ascribing conservation value to scrub stands.
- There is a need for a structural classification of scrub that is ecologically meaningful in terms of the requirements of scrub-associated organisms, especially invertebrates and birds. This classification must take account of spatial structure (mosaics / patchiness), scrub height and foliage profiles.
- In order to assess the absolute and relative importance of scrub to nature conservation, whether regionally, nationally or within Europe, there is a need for better information on the distribution and extent of the major scrub types.
- Treatment of scrub within land cover surveys adopted by various agencies varies considerably. Much information on national distributions is potentially available within the ITE Countryside Survey 1990 and Countryside Survey 2000 databases but it is currently in aggregated form under the main category 'Shrub'. Dis-aggregation of this databases would provide information at the required level of detail.

6.3.2 Conservation status

- Certain rare scrub types (e.g. juniper scrub) or scrub composed of rare shrub species (e.g. woolly willow *Salix lanata*) have Habitat or Species Action Plans within the UK Biodiversity Action Plan. No changes to the definitions of broad or priority habitats are considered necessary. However, the conservation value of scrub as a structural component of many priority habitats needs to be fully acknowledged in relevant Habitat Action Plans.
- An assessment is needed of the extent to which scrub within SACs and SSSIs is representative of the wider resource and to decide whether further designations are required to cover under-represented scrub communities.
- Better information is needed on the status and management of scrub within existing SSSIs, including occurrence of scrub types, structural characteristics, associated species, conservation importance within the SSSI and management objectives.
- An assessment is needed of the ecological contexts in which scrub should form a criterion for SSSI designation. In addition, citations for existing SSSIs and definitions of 'favourable condition' may need to be changed to take account of the nature conservation value of scrub.
- Research is needed to determine for which species and under what circumstances scrub is a primary (or sole) habitat and when and where it is of secondary importance.
- Characterisation of the unique attributes of British scrub types in relation to those of mainland Europe is essential in order to set conservation priorities within the UK. A meeting of key European specialists could provide a starting point for a European network on managing scrub vegetation for nature conservation.

6.3.3 Ecology

- This review has identified the importance of mosaics of vegetation, of which scrub is an integral part, for several taxa. There is a need for research that identifies the optimum mosaic structures for ground flora, invertebrates and birds. This work needs to take account of the different scale requirements of these taxa and should take account of the importance of edges and glades within scrub.
- The processes of scrub establishment and the development of patchiness within scrub are poorly understood. In particular, there is a need to examine more closely the role of birds in seed dispersal and how their behaviour influences the distribution and spatial structure of scrub.
- A landscape approach to the importance of scrub for conservation needs to be developed. This could have two main components. First, an assessment of how the proximity of other habitats, especially woodland and grassland, affects the plant and animal communities found within scrub. Second, there is a need to determine the contribution that scrub makes to biodiversity within different landscape types relative to other habitats. The latter work would help to identify the extent to which species are dependent on scrub compared with other habitats and, therefore, clarify the complementarity of scrub and other habitats.
- Research is needed on the successional dynamics of animal communities (especially invertebrates, birds and small mammals) within developing scrub. Such research should seek to identify which are the richest stages of successional development, both in terms of species richness and the presence of species of particular conservation interest. These data would be valuable in helping to underpin management policies that sought to maintain rich communities of animals within scrub habitats.
- Carr has been remarkably little researched, especially concerning its animal communities and how these are influenced by factors such as successional stage and wetness. Further research in this area seems highly desirable in view of the current conservation interest in riparian woodland.
- Very little is known about the mycorrhizal associations of scrub species and, indeed, how these might benefit the rare communities. Manipulation may enhance the success of establishment or restoration of these communities, especially when soil conditions are not optimal.

6.3.4 Management

- Carefully controlled experimental research is needed to determine the effectiveness of differing procedures for scrub management, including those for maintaining scrub as well as controlling it. This should take account of existing guidelines and the considerable amount of information contained within the responses to the questionnaire carried out as part of the current study.
- In the context of scrub control, there is a need to identify whether critical thresholds of scrub development exist, beyond which scrub clearance is ineffective as a means of restoring habitats such as lowland calcareous grassland or fen.
- Research is especially needed on appropriate management techniques for maintaining patchiness and mosaics. Rotational large-scale cutting of scrub is unlikely to be adequate for maintaining complex vegetation mosaics and approaches that adopt grazing or combinations of grazing and selective cutting are likely to be more successful.
- A scrub management handbook should be developed outlining best practice for managing scrub, especially means of encouraging sustainable mosaics of scrub and other habitats.

6.3.5 Dissemination and Education

- A major constraint on the conservation of scrub and its associated species is the widely-held opinion that scrub is of low conservation value and primarily a threat to other more valuable habitats. Methods of addressing this problem of perception need to be developed.
- In particular, there is currently insufficient guidance concerning situations where scrub is valuable and in which contexts other conservation priorities take precedence. This problem is exacerbated by the linkages between the conservation value of scrub and its intimate association with other communities in habitat mosaics.
- It would be highly desirable to establish a network of scrub demonstration sites where different approaches to difficult scrub management issues can be viewed and discussed with site managers.

6.3.6 Agri-Environmental Policy

- In most situations, scrub is primarily considered as a threat to other habitats, and capital payments allocated for clearance. Funding for agri-environment schemes needs to take account of both the efficacy of scrub clearance for restoring species-rich herbaceous communities, such as chalk grassland, and the intrinsic nature conservation value of scrub or habitat mosaics including scrub.
- The introduction of annual management payments to conserve and enhance scrub of high conservation value in England (as opposed to one-off capital payments for clearance) would benefit scrub conservation, and bring the English agri-environment schemes into line with those in Wales and Scotland.
- Little attention is paid to the roles of landscape processes when funding scrub management, despite the likely impact of the surrounding landscape on the value of individual habitat patches. A consideration of the large-scale spatial processes should be taken into account when allocating funding for scrub management. This approach relies on scrub of high conservation value being identified in funding applications, something that is currently not addressed.

6.3.7 Landscape Policy

- Conservation of seral scrub can only be achieved on a large spatial scale, enabling management to produce mosaics of scrub at different successional stages.
- Wherever appropriate, scrub should be encouraged as part of natural vegetation dynamics. For example, in the Scottish Highlands there may be increasing opportunities to regenerate natural woodland cover in which scrub is present not just in the initial establishment phase but also in the longer term as a natural component of the forest dynamics following disturbance by windblow or fire.
- A more positive approach to scrub habitats is required in the uplands of England and Wales to match that adopted in Scotland. For example, it would be interesting to consider how treeline scrub communities may be enhanced in Snowdonia and the Lake District; how scrub communities may play an important role in 'wild-wood' developed on former conifer forest sites; how upland hawthorn scrub may be regenerated and extended under agri-environment schemes; how willow scrub may be used to enhance and link wet woodland habitats.
- Landscape policies that promote the large-scale expansion of scrub on lowland flood plains would contribute significantly to the conservation of residual alluvial forest (a priority habitat in the Habitats Directive) and delivery of the Habitat Action Plan for wet woodland.
- Scrub and associated wet woodland communities frequently develop on abandoned mineral extraction sites. Promoting the nature conservation value of such sites amongst mineral planning officers would provide opportunities for expansion of these habitats and their appropriate management.
- Within the context of agricultural land, abandonment may provide opportunities for the creation of scrub habitats. Issues of negative perceptions of the value of scrub amongst landowners need to be addressed.
- The use of scrub buffer strips adjacent to new farm woodlands would contribute significantly to the nature conservation value of such plantations.
- The nature conservation value of scrub, and of mosaics of scrub, woodland and herbaceous communities, needs to be recognised in the planning of new lowland woods and national forests.

Acknowledgments

The authors of this report wish to thank the participants in the workshop (Appendix 1.1) and all of the respondents to the two questionnaire surveys (see Appendices 5.7 and 6.2). Isabel Alonso, Jim Foster, Jeanette Hall, John Hopkins, Richard Jefferson, Michael Rebane, Sue Rees and David Sheppard (all English Nature), Kate Holl and Angus MacDonald (Scottish Natural Heritage), Adrian Fowles (Countryside Council for Wales) and Diane Gilbert (Highland Birchwoods) made useful comments on the first draft. The authors would also like to thank Heather Roberts (CEH), Su Gough and Nicki Read (BTO), and Pauline Beavis, Alex Brook, Heidi Cunningham, Steph Harris and Karen Haysom (CABI) for their help in preparing the report.

References

Adam, P, Birks, HJB, Huntley, B & Prentice, IC 1975 Phytosociological studies at Malham Tarn moss and fen, Yorkshire, England. *Vegetatio, 30:* 117-132.

ADAS 1995a Blackdown Hills Environmentally Sensitive Area: Environmental Guidelines.

ADAS 1995b Somerset Levels Environmentally Sensitive Area: Environmental Guidelines.

Alexander, KNA 1999 The invertebrates of Britain's wood pastures. *British Wildlife 10:* 108-117.

Alexander, KNA, Green, EE & Key, R 1996 The management of overmature tree populations for nature conservation - the basic guidelines. *In: Pollard and veteran tree management II,* ed. Read, H. Corporation of London, London.

Amaranthus, MP, Perry, DA 1994 The functioning of ectomycorrhizal fungi in the field - linkages in space and time. *Plant and Soil, 159:* 133-140.

Ball, AJ 1994 *The invasion of* Salix *scrub on Malham Tarn Fen North Yorkshire: an historical and biological evaluation of the Fen with recommendations for management.* BSc Thesis, Edge Hill College, Ormskirk.

Barbour, D & Young, M 1993 Ecology and conservation of the Kentish Glory moth (*Endromia versicolora* L.) in eastern Scotland. *The Entomologist, 112:* 25-33.

Barkmann, JJ 1990 A tentative typology of European scrub and forest communities based on vegetation texture and structure. *Vegetatio, 86:* 131-141.

Barrett, J 1997 Regenerating juniper. *Enact, 5:* 8-9.

Berry, R 1979 Nightjar habitats and breeding in East Anglia. *British Birds, 72:* 207-218.

Bibby, CJ 1978 A heathland bird census. *Bird Study, 25:* 87-96.

Bibby, CJ 1979a Foods of the Dartford Warbler *Sylvia undata* on southern English heathland (Aves: Sylviidae). *Journal of Zoology, 188:* 557-576.

Bibby, CJ 1979b Breeding biology of the Dartford warbler *Sylvia undata* in England. *Ibis, 121:* 41-52.

Bibby, CJ 1986 Merlins in Wales: site occupancy and breeding in relation to vegetation. *Journal of Applied Ecology, 23:* 1-12.

Birks, HJB 1988 Long-term ecological change in the British uplands. *In: Ecological change in the uplands,* ed. by MB & DBA Thompson, 37-56. Special Publication of the British Ecological Society No.7. Oxford, Blackwell Scientific Publications.

Boddy, M 1991 Some aspects of frugivory by bird populations using coastal dune scrub in Lincolnshire. *Bird Study, 38:* 188-199.

Boddy, M 1992 Timing of Whitethroat *Sylvia communis* arrival, breeding and moult. *Ringing & Migration, 13:* 65-72.

Borders Forest Trust 1997 Common juniper (*Juniperus communis* L.): a review of its biology and status in the Scottish Borders. BFT Occasional Paper No. 1. BFT/REV/97/1, pp. 1-35. London, Chapman & Hall.

Brown, VK & Southwood TRE 1987 Secondary succession: patterns and strategies. *In: Colonisation, Succession and Stability,* ed. by AJ Gray, MJ Crawley & PJ Edwards. Blackwell Scientific Publications. 315-337.

Brown, VK 1990 *The effects of changes in habitat structure during succession in terrestrial communities,* ed. by SS Bell, ED McCoy & HR Mushinsky, 141-168. Chapman & Hall, London.

Carillo Garcia, A, de la Luz, JLL, Bashan, Y & Bethlenfalvay, GJ 1999 Nurse plants, mycorrhizae, and plant establishment in a disturbed area of the Sonoran Desert. *Restoration Ecology, 7:* 321-335.

Cherrill, AJ & Brown VK 1990 The habitat requirements of adults of the Wart-biter *Decticus verrucivorus* (L.) (Orthoptera: Tettigoniidae) in southern England. *Biological Conservation* 53: 145-157.

Chilterns Conference 1994 *Management plan for the Chilterns Area of Outstanding Natural Beauty: The framework for action.* Chilterns AONB office, High Wycombe.

Churchfield, S & Brown, VK 1987 The trophic impact of small mammals in successional grasslands. *Biological Journal of the Linnean Society, 31:* 273-290.

Clifton, SJ, Ward, LK, Ranner, DS 1997 The status of juniper *Juniperus communis* L. in North-East England. *Biological Conservation, 79:* 67-77.

Connell, JH & Slatyer, RO 1977 Mechanisms of succession in natural communities and their role in community stability and organization. *American Naturalist, 111:* 1119-1144.

Countryside Council for Wales 1999 *Tir Gofal: farmer's handbook.* CCW, Wales.

Crawley, MJ 1997 The structure of plant communities. *In: Plant ecology.* 2nd ed. ed. by MJ Crawley, 475- 531. Oxford, Blackwell Science.

Crofts, A & Jefferson RG 1999 *The lowland grassland management handbook.* 2nd ed. Peterborough, English Nature/The Wildlife Trusts.

Crofts, A & Jefferson RG, *eds.* 1994. *The lowland grassland management handbook.* EN/RSNC. Peterborough: English Nature.

Davies, A & Waite, S 1998 The persistence of calcareous grassland species in the soil seed bank under developing and established scrub. *Plant Ecology, 136:* 27-39.

Denno, RF & Roderick GK 1991 Influence of patch size, vegetation texture, and host plant architecture on the diversity, abundance, and life-history styles of sap-feeding herbivores. *In: Habitat structure: the physical arrangement of objects in space,* ed. by Bell SS, McCoy ED & Mushinsky HR, 169-210. Chapman and Hall, London.

Dixon, AFG 1985 *Aphid ecology.* Blackie, London.

Dryden, R 1997. Habitat Restoration Project: Fact Sheets and Bibliographies. English Nature *Research Reports* No. 260. English Nature, Peterborough.

Duffey, E, Morris, MG, Sheail, J, Ward, LK, Wells, DA & Wells, TCE 1974 *Grassland ecology and wildlife management.* London, Chapman and Hall.

Eden, S & Eden, R 1999 Dormice in Dorset – the importance of hedges and scrub. *British Wildlife, 10:* 185-189.

Edgar, RDM 1986 Some results of the study by ringing of warbler migration at Beachy Head from 1960 to 1985. *Sussex Bird Report for 1985:* 76-84.

English Nature (undated) *SSSI notification of Dancers End, Buckinghamshire.* EN site files, Foxhold House, Newbury.

English Nature 1999 *Chilterns Chalk Scrub Day, October 1999* (details of workshop). EN, Foxhold House, Newbury. Unpublished.

Finegan, B 1984 Forest succession. *Nature, 312:* 109-114.

French, DD, Miller, GR & Cummins, CP 1997 Recent development of high altitude *Pinus sylvestris* scrub in the northern Cairngorm mountains, Scotland. *Biological Conservation, 79:* 133-144.

Friday, L & Colston, A 1999 Wicken Fen – the restoration of a wetland nature reserve. *British Wildlife, 11:* 37-46.

Fuller, RJ 1982 *Bird habitats in Britain.* BTO and NCC. T. & A.D.Poyser.

Fuller, RJ 1987 Composition and structure of bird communities in Britain. PhD Thesis, University of London.

Fuller, RJ 1995 *Bird life of woodland and forest.* Cambridge, Cambridge University Press.

Fuller, RJ 1996 Native and non-native trees as factors in habitat selection by woodland birds in Britain. *In: Native and non-native in British forestry,* ed. by PR Ratcliffe, 131-140. Proceedings of a discussion meeting. Edinburgh, Institute of Chartered Foresters.

Fuller, RJ & Gough, SJ 1999 Changes in sheep numbers: implications for bird populations. *Biological Conservation, 91:* 73-89.

Fuller, RJ & Henderson, ACB 1992 Distribution of breeding songbirds in Bradfield Woods, Suffolk, in relation to vegetation and coppice management. *Bird Study, 39:* 73-88.

Fuller, RJ, Gillings, S & Gough, SJ *Variation in assemblages of breeding birds in British scrub: implications for conservation management.* Unpublished manuscript.

Fuller, RJ, Gillings, S & Whitfield, DP in press Responses of breeding birds to expansion of scrub in the eastern Scottish Highlands: preliminary implications for conservation strategies. *Vogelwelt.*

Fuller, RJ, Henderson, ACB & Wilson, AM 1999 The nightingale in England - problems and prospects. *British Wildlife, 10:* 221-230.

Gange, AC, Brown, VK & Farmer, LM 1990 A test of mycorrhizal benefit in an early successional plant community. *New Phytologist, 115:* 85-91.

Garcia, D, Zamora, R, Gomez, JM & Hodar, JA 1999 Bird rejection of unhealthy fruit reinforces the mutualism between juniper and its avian dispersers. *Oikos, 85:* 536-544.

Gilbert, D 1997 The Millenium Forest for Scotland montane shrub project. *In: The ecology and restoration of montane and subalpine scrub habitats in Scotland,* ed. by D Gilbert, D Horsfield & DBA Thompson, 121-122. *SNH Review No. 83.* Edinburgh: Scottish Natural Heritage.

Gilbert, D, Horsfield, D & Thompson, DBA. eds. 1997 The ecology and restoration of montane and subalpine scrub habitats in Scotland. *SNH Review No. 83.* Edinburgh, Scottish Natural Heritage.

Gillings, S & Fuller, RJ 1998 The breeding bird community of upland juniper scrub in eastern Scotland. *Scottish Birds, 19:* 231-238.

Gillings, S, Fuller, RJ & Henderson, ACB 1998 Avian community composition and patterns of bird distribution within birch-heath mosaics in north-east Scotland. *Ornis Fennica, 75:* 27-37.
Godfray, HCJ 1985 The absolute abundance of leaf miners on plants of different successional stages. *Oikos, 45:* 17-25.
Good, JEG, Bryant, R & Carlill, P 1990 Distribution, longevity and survival of upland hawthorn (*Crataegus monogyna*) scrub in North Wales in relation to sheep grazing. *Journal of Applied Ecology, 27:* 272-283.

Gough, S 1999 Distribution of birds across different habitats at Castor Hanglands National Nature Reserve. *Nature in Cambridgeshire, 41:* 11-21.
Gough, SJ & Fuller, RJ 1998 Scrub management for conservation in lowland England: practices, problems and possibilities. *BTO Research Report No. 194.*

Grubb, PJ & Key, BA 1975 Clearance of scrub and re-establishment of chalk grassland on the Devil's Dyke. *Nature in Cambridgeshire, 18:* 18-23.

Haila, Y & Hanski, IK 1987 Habitat and territory overlap of breeding passerines in the mosaic environment of small islands in the Baltic. *Ornis Fennica, 64:* 37-49.

Harding, PT & Rose, F 1986 Pasture-woodlands in lowland Britain: a review of their importance for wildlife conservation. Huntingdon, Institute of Terrestrial Ecology.

Helle, P & Fuller, RJ 1988 Migrant passerine birds in European forest successions in relation to vegetation height and geographical position. *Journal of Animal Ecology, 57:* 565-579.

Herrera, CM 1989 Frugivory and seed dispersal by carivorous mammals, and associated fruit characteristics, in undistrurbed Mediterranean habitats. *Oikos, 55:* 250-262.

Hester, A & Miller, GR 1995 Scrub and woodland regeneration: prospects for the future. *In: Heaths and moorland: cultural landscapes,* ed. by DBA Thompson & MB Usher, 140-153. Edinburgh, HMSO.

Hester, AJ 1995 Scrub in the Scottish uplands. *SNH Review No. 24.* Edinburgh, Scottish Natural Heritage.
HMSO 1995 Biodiversity: the UK Steering Group report. Volume 2:Action Plans. London, HMSO.

Hodgetts, N 1993 Atlantic bryophytes on the western seaboard. *British Wildlife, 4:* 287-295.

Hodgkin, SE 1984 Scrub encroachment and its effects on soil fertility on Newborough Warren, Anglesey, Wales. *Biological Conservation, 29:* 99-119.
Hopkins, J 1996 Scrub Ecology and Conservation. *British Wildlife, 8:* 28-36.

Horsfield, D & Thompson, DBA 1997 Ecology and conservation of montane scrub. *In: The ecology and restoration of montane and subalpine scrub habitats in Scotland,* ed. by D Gilbert, D Horsfield & DBA Thompson, pp. 21-31. *SNH Review No. 83.* Edinburgh, Scottish Natural Heritage.
Houston, J 1997 Conservation Management Practice on British Dune Systems. *British Wildlife, 8:* 297-307.

Huntley, B & Birks HJB 1979a The past and present vegetation of the Morrone Birkwoods National Nature Reserve, Scotland. I. A primary phytosociological survey. *Journal of Ecology, 67:* 417-446.
Huntley, B & Birks HJB 1979b The past and present vegetation of the Morrone Birkwoods National Nature Reserve, Scotland. II . Woodland vegetation and soils. *Journal of Ecology, 67:* 447-467.
Hurford, C 1993 A baseline survey to monitor the effects of scrub clearance on vegetation at Ogmore Down, June 1992. Countryside Council for Wales Species and Monitoring Report 92/2/6. Countryside Council for Wales, Bangor.

James, FC 1971 Ordinations of habitat relationships among breeding birds. *Wilson Bulletin, 83:* 215-236.

Jefferson, RG & Robertson HJ 1996. Lowland grassland: wildlife value and conservaiton status. *English Nature Research Reports* No. 169. English Nature, Peterborough.

Kelly, JP 1993 The effect of nest predation on habitat selection by dusky flycatchers in limber pine-juniper woodland. *Condor, 95:* 83-93.

Key, RS & Ball, SG 1993 Positive management for saproxylic invertebrates. *In: Dead wood matters: the ecology and conservation of saproxylic invertebrates in Britain,* ed. Kirby, KJ & Drake, CM. *English Nature Science 7.* English Nature, Peterborough.
Key, RS 1996 Invertebrate conservation and pollards. *In: Pollard and veteran tree management II,* ed. Read, H. Corporation of London, London.

Kirby, P 1992 *Habitat management for invertebrates: a practical handbook.* RSPB, Sandy.
Lambert, S 1993 Ouse Washes management strategy: management of woody vegetation topic paper. *Internal EN report.*

Large, RV & King, N 1978 The integrated use of land for agricultural and amenity purposes: lamb production from Soak sheep used to control scrub and improve the grass cover of chalk downland. Grassland Research Institute Technical Report No. 25. Hurley; Grassland Research Institute.

Lawton, JH & Schroder, D 1977 Effects of plant type, size of geographical range and taxonomic isolation on the number of insect species associated with British plants. *Nature, 265:* 137-140.
Lawton, JH 1978 *Host plant influences on insect diversity: the effects of space and time. Symposium of the Entomological Society of London 9:* 105-25.

Leather, SR 1986 Insect species richness of the British Rosaceae: the importance of host range, plant architecture, age of establishment, taxonomic isolation and species-area relationships. *Journal of Animal Ecology, 55:* 841-860.
MacKenzie, NA 1996 Upland and Montane Scrub Communities in NW Region: a consolidation of existing knowledge. *Report to SNH.* Edinburgh, Scottish Natural Heritage.
MacKenzie, NA 1999 High Altitude Tree-lines, Montane and Sub-alpine Scrub Communities. *Report to Highland Birchwoods.* Munlochy, Ross-shire, Highland Birchwoods.
MAFF 1997a Environmentally Sensitive Areas: Somerset Levels and Moors ESA Guidelines for Farmers. PB 2931/SLM

MAFF 1997b Environmentally Sensitive Areas: South Downs ESA Guidelines for Farmers. PB 2931/SD.

MAFF 1997c Farm Woodland Scheme rules and proceedures. PB 2990.

MAFF 1998a Environmentally Sensitive Areas: Explanatory Notes. PB 3362. ESA/1.

MAFF 1998b Environmentally Sensitive Areas: Test Valley and Avon Valley ESAs. Guidelines for Farmers. PB 3361/AT.

MAFF 1998c Environmentally Sensitive Areas: South Wessex Downs ESA. Guidelines for Farmers. PB 3361/SWD.

MAFF 1999a The Countryside Stewardship Scheme: Information and how to apply. PB 3950A.

MAFF 1999b Environmentally Sensitive Areas: Cotswold Hills ESA Guidelines for Farmers. PB 4309/CH.

Manson, RH & Stiles, EW 1998 Links between microhabitat preferences and seed predation by small mammals in old fields. *Oikos, 82:* 37-50.

Mardon, D 1997 Eight years of montane scrub restoration at Ben Lawers NNR. In: *The Ecology and Restoration of Montane and Subalpine Scrub Habitats in Scotland.* Edited by D Gilbert, D Horsfield and DBA Thompson. Scottish Natural Heritage Review No. 83. Scottish Natural Heritage, Edinburgh. Pp. 65-74.

Martin, J-L & Thibault, J-C 1996 Coexistence in Mediterranean warblers: ecological differences or interspecific territoriality? *Journal of Biogeography, 23:* 169-178.

Martin, TE 1993 Nest predation and nest sites: new perspectives on old patterns. *BioScience, 43:* 523-532.

Martin, TE 1998 Are microhabitat preferences of coexisting species under selection and adaptive? *Ecology, 79:* 656-670.

Martin, TE & Roper, JT 1988 Nest predation and nest-site selection of a western population of the hermit thrush. *Condor, 90:* 51-57.

Masters, GJ & Brown VK 1995 *Host plant mediated interactions between spatially separated herbivores: effects on community structure*, ed. by AC Gange & VK Brown, 217-237. Blackwell Science, Oxford.

Masters, GJ, Brown, VK, Clarke, IP, Whittaker, JB & Hollier, JA 1998 Direct and indirect effects of climate change on insect herbivores: Auchenorrhyncha (Homoptera). *Ecological Entomology, 23:* 45-52.

Matthews, JR 1955 *Origin and Distribution of the British Flora.* London, Hutchinson.
McBride, A 1997 The Status of Common Juniper (*Juniperus communis* L.) in the Scottish Borders. *Report to the Borders Forest Trust by McBride Habitats.* Ancrum, Roxburghshire, Borders Forest Trust.
McClanahan, TR & Wolfe, RW 1993 Accelerating forest succession in a fragmented landscape: the role of birds and perches. *Conservation Biology, 7:* 279-288.

McVean, DN 1964 The forest zone. *In: The vegetation of Scotland,* ed. by JH Burnett, 144-167. Edinburgh, Oliver and Boyd.
Morgan, RA 1978 Changes in the bird community at Gibraltar Point, Lincolnshire, between 1965 and 1974. *Bird Study 25:* 51-58.
Mucina, L 1997 Conspectus of classes of European vegetation. *Folia Geobotanica et Phytotaxonomica, 32:* 117-172.

Nash, DR, Agassiz, DJL, Godfray, HCJ & Lawton, JH 1995 The pattern of spread of invading species: two leaf-mining moths colonizing Great Britain. *Journal of Animal Ecology, 64:* 225-233.
Nature Conservancy Council 1986. *The managment of chalk grassland for butterflies.* NCC, Peterborough.

Oates, M 1999 Sea cliff slopes and combes - their management for nature conservation. *British Wildlife, 10:* 394-402.

Parr TW 1978 An analysis of soil micro-arthropod succession. *Scientific Proceedings of the Royal Dublin Society 6A:* 185-196.

Parr, R & Watson, A 1988 Habitat preferences of Black Grouse on moorland-dominated ground in north-east Scotland. *Ardea 76:* 175-180.

Pearsall, WH 1918 The aquatic and marsh vegetation of Esthwaite Water. *Journal of Ecology, 5:* 53-74.

Pigott, CD & Wilson, JH 1978 The vegetation of North Fen at Esthwaite in 1967-69. *Proceedings of the Royal Society of London, Series A, 200:* 331-351.

Proctor, MCF 1974 The vegetation of the Malham Tarn fens. *Field Studies, 4:* 1-38.

Ranwell, DS, *ed.* 1972 *The management of sea buckthorn (Hippophae rhamnoides L.) on selected sites in Great Britain.* Norwich, The Nature Conservancy Council.

Ratcliffe, DA 1977 *A nature conservation review: the selection of biological sites of national importance to nature conservation in Britain.* Cambridge, Cambridge University Press.

Ratcliffe, DA & Thompson, DBA 1988 The British uplands: their ecological character and international significance. *In: Ecological Change in the Uplands,* ed. by MB Usher & DBA Thompson, 9-36. *Special Publication of the British Ecological Society No.7.* Oxford, Blackwell Scientific Publications.

Riddiford, N 1997 The Distribution and Health of the Prostrate Juniper *Juniperus communis nana* population on Fair Isle, 1997. *Report to SNH and The National Trust for Scotland.* Edinburgh, SNH.

Rodwell, JS 1997 *A phytosociological conspectus of British plant communities.* Lancaster, Unit of Vegetation Science Report to JNCC.

Rodwell, JS, Dring, JC, Averis, ABG, Proctor, MCF, Malloch, AJC, Schaminee, JHJ & Dargie, TCD 1998 *Review of coverage of the National Vegetation Classification.* Lancater, Unit of Vegetation Science Report to JNCC.

Rodwell, JS, *ed.* 1991 *British plant communities Vol. 1: Woodlands and scrub.* Cambridge, Cambridge University Press.

Rushton SP 1988. The effects of scrub management on the spider fauna of chalk grassland, at Castor Hanglands National Nature Reserve, Cambridgeshire, UK. *Biological Conservation 46:* 169-82.

Rushton SP, Eyre MD & Luff ML 1990. The effects of scrub management on the ground beetles of oolithic limestone grassland at Castor Hanglands National Nature Reserve, Cambridgeshire, UK. *Biological Conservation 51:* 97-111.

Russell, B, Plunkett, J & Williams, P 1993 Vegetation monitoring of a scrub cleared area at Wye NNR: initial analysis of results of monitoring carried out by Wye NNR staff in June 1991 and 1992. *English Nature Internal Report.* English Nature, Peterborough.

Santos, T, Telleria, JL & Virgos, E 1999 Dispersal of Spanish juniper *Juniperus thurifera* by birds and mammals in a fragmented landscape. *Ecography, 22:* 193-204.

Scott, R 1997 *Betula nana* in Scotland. *In: Insects associated with Birch. Proceedings of the Royal Society of Edinburgh, Section B-Biological Sciences,* ed. by MR Shaw, 85, 169-181.

Scottish Natural Heritage 1994 *Red deer and the natural heritage: a policy review.* Battleby, Scotland, Scottish Natural Heritage.

Scottish Office 1999a Environmentally Sensitive Areas: explanatory leaflet for farmers, crofters and common grazings committees. The Stationery Office B6112 3/99 (13161).

Scottish Office 1999b Argyll Islands Environmentally Sensitive Area Scheme Appendix. PMC03330.

Shaw, MR 1984 Insects associated with Birch. *Proceedings of the Royal Society of Edinburgh, Section B-Biological Sciences, 85:* 169-181.

Shirt, DB 1987 *British red data book: 2. Insects.* Nature Conservancy Council.

Simms, E 1971 *Woodland Birds.* New Naturalist. Collins.

Sisitka, L 1996 *Guide to the care of ancient trees.* English Nature, Peterborough.

Sitters, HP 1985 Cirl Buntings in Britain in 1982. *Bird Study, 32:* 1-10.

Smith, CJ 1980. *Ecology of the English chalk.* Academic Press, London.

Smith, SE & Read, DJ 1997 *Mycorrhizal symbiosis.* London, Academic Press.

Sneddon, P & Randall, RE 1993 *Coastal vegetated shingle structures of Great Britain: main report.* Peterborough, JNCC.

Snow, B & Snow, D 1988 *Birds and berries: a study of an ecological interaction.* Calton, Poyser.

Southwood TRE, Brown VK & Reader PM 1979 The relationships of plant and insect diversities in succession. *Biological Journal of the Linnean Society of London 12:* 327-348.

Speight, MCD 1989 Saproxylic invertebrates and their conservation. *Nature and Environment Series 42:* 79.

Stace, C 1991 *New Flora of the British Isles.* Cambridge University Press.

Staines, BW, Balharry, R & Welch, D 1995 The impact of red deer and their management on the natural heritage in the uplands. *In: Heaths and moorland: cultural landscapes,* ed. by DBA Thompson & ME Usher, 294-308. Edinburgh, HMSO.

Steven, G & Biron EM 1992 *Oxfordshire chalk grassland survey 1991-92.* English Nature, Newbury.

Strong, DR, Lawton, JH & Southwood, R 1984 Insects on Plants. Oxford, Oxford University Press.
Stubbs, AE 1972 Wildlife conservation and dead wood. *Journal of the Devon Trust for Nature Conservation,* suppl., 1-18.
Tansley, AG 1939 *The British Isles and their vegetation.* Cambridge, Cambridge University Press.

Tansley, AG 1965 fourth impression. *The British islands and their vegetation.* Cambridge University Press.

Treweek, J, José, P & Benstead, P, *eds.* 1997 *The wet grassland guide.* Sandy, Royal Society for the Protection of Birds.

Uetz GW 1991 Habitat structure and spider foraging. *In: Habitat structure: the physical arrangement of objects in space,* ed. by Bell SS, McCoy ED & Mushinsky HR Chapman and Hall, London.
Usher, MB & Thompson, DBA 1993 Variation in the upland heathlands of Great Britain: conservation importance. *Biological Conservation, 66:* 69-81.
Usher, MB & Thompson, DBA 1993 Variation in the upland heathlands of Great Britain: conservation importance. *Biological Conservation, 66:* 69-81.

Ward, LK 1972 The fauna of Hippophae. *In: The management of sea buckthorn, Hippophae rhamnoides L. on selected sites in Great Britain. Report of the Hippophae Study Group,* ed. by DS Ranwell, 12-17. The Nature Conservancy.
Ward, LK 1973 The conservation of juniper: 1. Present status of juniper in Southern England. *Journal of Applied Ecology, 10:* 165-183.
Ward, LK 1988 The validity and interpretation of insect food-plant records. *British Journal of Entomology and Natural History, 1:* 153-162.
Ward, LK 1989 *Seed viability in juniper* (Juniperus communis). Wareham, Institute of Terrestrial Ecology.

Ward, LK 1990. Management of grassland-scrub mosaics. In: *Calcareous Grasslands – Ecology and Management,* ed. by SH Hillier, DWH Walton & DA Wells, 134-139. Huntingdon, Bluntisham Books.

Ward, LK & Jennings, RD 1990a Succession of disturbed and undisturbed chalk grassland at Aston Rowant National Nature Reserve: dynamics of species changes. *Journal of Applied Ecology, 27:* 897-912.

Ward, LK & Jennings, RD 1990b Succession of disturbed and undisturbed chalk grassland at Aston Rowant National Nature Reserve: details of changes in species. *Journal of Applied Ecology, 27:* 913-923.

Ward, LK & Spalding, DF 1993 Phytophagous British insects and mites and their food-plant families: total numbers and polyphagy. *Biological Journal of the Linnean Society, 49:* 257-276.
Warren, MS & Key, RS 1989 Woodlands: Past, present and potential for insects. *In: Conservation of insects and their habitats – the 15th Symposium of the Royal Entomological Society,* ed. Collins, NM & Thomas, JA. Academic Press, London.
Wells TCE, Sheail, Ball DF & Ward LK 1976. Ecological studies on the Porton Ranges: relationships between vegetation, soils and land-use history. *Journal of Ecology 64:* 589-626.

Whelan, CJ, Schmidt, KA, Steele, BB, Quinn, WJ & Dilger, S 1998 Are bird-consumed fruits complementary resources? *Oikos, 83:* 195-205.

Whitney, GC 1994 From coastal wilderness to fruited plain: a history of environmental change in temperate North America from 1500 to the present. Cambridge, Cambridge University Press.

Wild, C & Entwistle, C 1997 Habitat management and conservation of the adder in Britain. *British Wildlife, 8:* 287-295.

Williamson, K 1975 The breeding bird community of chalk grassland scrub in the Chiltern Hills. *Bird Study, 22:* 59-70.
Williamson, K 1967 A bird community of accreting sand dunes and salt marsh. *British Birds, 60:* 145-157.
Wilson, A 2000 Boom and bust – mixed news from the 1999 nightingale survey. *BTO News, 227:* 6-7.
Wotton, S, Gibbons, DW, Dilger, M & Grice, PV 1998 Cetti's warblers in the united kingdom and the Channel Islands in 1996. *British Birds, 91:* 77-89.

Wyatt, BK, Greatorex-Davies, JN, Hill, MO, Parr, TW, Bunce, RGH & Fuller, RM 1994 *Comparison of land cover definitions.* London, Department of the Environment.

Yela, JL & Lawton, LH 1997 Insect herbivore loads on native and introduced plants: a preliminary study. *Entomologia Experimentalis et Applicata, 85:* 275-279.

Appendices

Appendix 1.1 Participants in, and invites to, an expert workshop on scrub conservation held in Peterborough, 5 November 1999.

Participants

Dominic Ash, Defence Estates, Westdown Camp, Tilshead, Salisbury SP3 4RS.

Neil Bayfield, Institute of Terrestrial Ecology, Banchory Research Station, Hill of Brathens, Glassel, Banchory, Kincardineshire, AB31 4BY.

Val Brown, CABI Bioscience: Environment, Silwood Park, Ascot, Berkshire SL5 7TA.

Chris Damant, Bernwood Environmental Consultancy Services, 29 Nearton End, Swanbourne, Buckinghamshire MK17 0SI.

Brian Eversham, The Wildlife Trust for Bedfordshire, Cambridgeshire, Northamptonshire and Peterborough, Lings House, Billing Lings, Northampton, NN3 8BE.

Rob Fuller, British Trust for Ornithology, The Nunnery, Thetford, Norfolk IP24 2PU.

John Good, Institute of Terrestrial Ecology, Bangor Research Unit, University of Wales, Deiniol Road, Bangor, Gwynedd LL57 2UP.

Phil Grice, English Nature, Northminster House, Peterborough PE1 1UA.

Jeanette Hall, English Nature, Northminster House, Peterborough PE1 1UA.

John Hopkins, English Nature, Northminster House, Peterborough PE1 1UA.

Simon Mortimer, CABI Bioscience: Environment, Silwood Park, Ascot, Berkshire SL5 7TA.

Matthew Oates, National Trust, 33 Sheep Street, Cirencester, Gloucestershire GL7 1RQ.

Mick Rebane, English Nature, Northminster House, Peterborough PE1 1UA.

David Sheppard, English Nature, Northminster House, Peterborough PE1 1UA.

David Smallshire, Farming and Rural Conservation Agency, Staplake Mount, Starcross, Exeter, EX6 8PU. Tel. 01626 892268, e-mail d.smallshire@frca.maff.gov.uk.

Paul Toynton, Defence Estates, Westdown Camp, Tilshead, Salisbury SP3 4RS.

Andrea Turner, CABI Bioscience: Environment, Silwood Park, Ascot, Berkshire SL5 7TA.

Lena Ward, Institute of Terrestrial Ecology, Furzebrook Research Station, Wareham, Dorset BH20 5AS.

Invited but unable to attend

Graham Burton, RSPB, The Lodge, Sandy, Beds, SG19 2DL.

John Everett, The Wildlife Trusts, The Kiln, Waterside, Mather Road, Newark, Notts NG24 1WT.

Katherine Hearn, National Trust, 33 Sheep Street, Cirencester, Gloucestershire, GL7 1QW.

Kate Holl, Scottish Natural Heritage, 2/5 Anderson Place, Edinburgh, Scotland EH6 5NP.

Jonathan Humphrey, Forest Research, Norther Research Station, Roslin, Midlothian, Scotland EH25 9SY.

Richard Jefferson, English Nature, Northminster House, Peterborough PE1 1UA.

Jim Latham, Countryside Council for Wales, Plas Penrhos, Fford Penrhos, Bangor, Gwynned, Wales LL57 2LQ.

Brian Pawson, Countryside Council for Wales, RVB House, Llys Felin Newydd, Phoenix Way, Swansea Enterprise Park, Llansamlet, SA7 9FG.

Appendix 3.1 Coastal, lowland grassland and heathland sites in the Nature Conservation Review (Ratcliffe 1977) with areas of scrub of major (**) or minor (*) nature conservation value.

Grade	*Code*	*Site Name*	*County*	*Area (ha)*	*Scrub types: Coastal*	*Acidic*	*Calcar.*	*Mixed*
1	C2	Folkestone Warren	Kent	480	*			
1	C10	Needles - St Catherine's Point	Isle of Wight	480	**			
2	C11	North Solent Marshes	Hampshire	2250	*			
1	C21	Saltfleetby/Theddlethorpe Dunes	Lincolnshire	900	**			
1	C24	Durlston Head - Ringstead Bay	Dorset	600	**			
1	C31	Boscastle - Widemouth	Cornwall	345	**			
1	C32	Steeple Point - Blackchurch Rock	Cornwall-Devon	800	**			
1	C41	South Gower Coast: Glannau de Gwyr	Glamorgan	830	**			
1	C42	Burry Inlet	Glamorgan	5000	*			
1	C59	Morecambe Bay (incl. Wyre - Lune)	Lancashire		*			
2	C68	Beast Cliff/Robin Hood's Bay	Yorkshire	350	**			
2	C70	Hart Warren - Hawthorn Dene Coast	Durham	270	**			
1	C73	Mull of Galloway - Crammag Head	Wigtownshire	265	*			
1	C75	St. Abb's Head	Berwickshire	285	*			
2	C77	Borgue Coast	Kirkcudbrightsh.	1200	**			
1	C100	Ross of Mull	Argyll	160	**			
1	C110	Loch Fleet	Sutherland	1400	**			
2	C116	Ardmeanach, Mull	Argyll	400	**			
1	L3	Wye & Crundale Downs	Kent	415		*		
1	L4	Castle Hill	Sussex	190		*		
1	L6	Lullington Heath	Sussex	63			*	**
1	L7	Box Hill - Headley	Surrey	570			*	**
1	L8	Harting Down	Sussex	200			**	
1*	L9	Kingley Vale	Sussex	160			**	
1	L10	Wouldham - Detling Escarpment	Kent	440			**	
1	L11	Halling - Trottiscliffe	Kent	650			**	
1	L12	White Downs	Surrey	225			**	
2	L15	Folkestone - Etchinghill Escarpment	Kent	205			*	
2	L16	Heyshott Down	Sussex	40			*	
2	L19	Fulking Escarpment/Newtimber Hill	Sussex	370			*	**
1	L21	Aston Rowant	Oxfordshire	130			**	
1	L22	Aston Upthorne Downs	Berkshire	40			**	
1	L24	Martin Down	Hampshire	115			*	
1	L25	Old Winchester Hill	Hampshire	80			*	
1	L36	Porton Down	Wilts - Hants	1700			**	
1	L37	Tennyson Down	Isle of Wight	80			*	**
1	L38	Ellesborough Warren	Bucks	60			**	
1	L39	Burghclere Beacon	Hants	125			**	

Grade	*Code*	*Site Name*	*County*	*Area (ha)*	*Scrub types: Coastal*	*Acidic*	*Calcar.*	*Mixed*
1	L40	Rushmore Down	Hants	105			**	
1	L41	Bulford Downs	Wilts	560			**	
2	L55	Ivinghoe Hills, Steps Hill & Pitstone Hill	Bucks-Herts	230			**	
2	L56	Coombe Hill, Wendover	Bucks	55			**	
1	L58	Dunwich Heaths & Marshes	Suffolk	1900		*		
1	L60a	Stanford Practical Training Area	Norfolk	4740		*		
1	L60b	East Wretham Heath	Norfolk	150		*		
1	L61a	Cavenham - Tuddenham Heaths	Suffolk	175		*		
1	L62b	Wangford Warren - Airfield Lights	Suffolk	60		**		
1	L62e	Maidscross Hill	Suffolk	26		*		
1	L64	Weeting Heath	Norfolk	140				*
1	L65b	Sketchvar Heath	Suffolk-Norfolk	20				*
1	L68	Barton Hills	Beds	60			*	
2	L75	Holt Lowes	Norfolk	50		**		
2	L77	Barnham Heath	Suffolk	80		*		
2	L78	Thetford Warren	Norfolk	130		*		
2	L81	Castor Hanglands	Cambs	45			**	
1	L98	Boxwell	Gloucs	5			**	
1	L102	Avon Gorge	Gloucs-Somerset	105			*	
1	L103	Cheddar Gorge	Somerset	255			*	
1	L104	Brean Down & Uphill Cliff	Somerset	145			*	
2	L112	Crook Peak	Somerset	90			*	
2	L113	Dolebury Warren	Somerset	115			*	
1	L121	Great Ormes Head: Pen y Gogarth	Caernarvon	345			*	
1	L124(i)a	Dove Valley & Biggin Dale	Derbys	540			**	
1	L124(i)b	Lathkill Dale	Derbys	142			**	
1	L124(i)c	Cressbrook Dale	Derbys	132			**	
1	L124(i)d	Monk's Dale	Derbys	66			**	
1	L124(i)e	Long Dale & Gratton Dale	Derbys	80			*	
2	L124(ii)a	Coombs Dale	Derbys	65			**	
2	L124(ii)b	Miller's Dale	Derbys	120			**	
2	L124(ii)c	Topley Pike & Deep Dale	Derbys	50			**	
1	L133	Humphrey Head	Lancs	30			**	
1	L134	Gait Barrows	Lancs	70			**	
1	L135	Hutton Roof Crags & Farleton Knott	Cumbria	630			**	
1	L136	Whitbarrow Scar	Cumbria	1000			**	
1	L137	Scout & Cunswick Scars	Cumbria	215			**	
1	L140	Crosby Gill	Cumbria	150			*	
2	L147	Arnside Knott & Warton Crag	Cumb/Lancs	180			**	

Appendix 3.2 Examples of Special Areas of Conservation (SACs) with scrub types of nature conservation importance

Code	*Site Name*	*County or District*	*Area (ha)*	*Habitats Directive Annex I types with scrub of conservation importance*
12734	Avon Gorge Woodlands	Avon	152	Tilio-Acerion ravine forests
30031	Barnack Hills and Holes	Cambridgeshire	23	Semi-natural dry grasslands and scrubland facies on calcareous substrates (Festuco-Brometalia) important orchid sites
13044	Barry Links	Angus	1027	Humid dune slacks
12951	Ben Alder and Aonach Beag	Highland	182	Sub-Arctic willow scrub
12901	Ben Heasgarnich	Argyll & Bute, Stirling	2780	Sub-Arctic willow scrub
12895	Ben Lawers	Perth & Kinross, Stirling	5027	Sub-Arctic willow scrub
12900	Ben Lui	Argyll & Bute, Stirling	2060	Sub-Arctic willow scrub
12570	Braunton Burrows	Devon	1347	Dunes with *Salix arenaria*
19865	Breckland	Norfolk, Suffolk	7600	Semi-natural dry grasslands and scrubland facies on calcareous substrates (Festuco-Brometalia)
20019	Burry Inlet: Dunes Cilfach Burry: Twyni	Carmarthenshire, Swansea	1208	Dunes with *Salix arenaria*
12821	Caenlochan	Aberdeenshire, Angus, Perth & Kinross	5204	Sub-Arctic willow scrub
16412	Cairngorms	Aberdeenshire, Highland, Moray	57474	Caledonian forest, Bog woodland, *Juniperus communis* formations on heaths or calcareous grasslands
12836	Castle Hill	East Sussex	115	Semi-natural dry grasslands and scrubland facies on calcareous substrates (Festuco-Brometalia) important orchid sites
17076	Chesil and the Fleet	Dorset	1632	Mediterranean and thermo-Atlantic halophilous scrubs (Arthrocnemetalia), Perennial vegation of stony banks
12724	Chilterns Beechwoods	Buckinghamshire, Oxfordshire	523	*Juniperus communis* formations on heaths or calcareous grasslands
12766	Coed y Cerrig	Monmouthshire	9	Residual alluvial forests (Alnion glutinoso-incanae)
13575	Conon Islands	Highland	120	Residual alluvial forests (Alnion glutinoso-incanae)
12884	Corsydd Môn Anglesey Fens	Anglesey	416	Alkaline fens
12889	Cothill Fen	Oxfordshire	44	Alkaline fens

Code	*Site Name*	*County or District*	*Area*	*Habitats Directive Annex I types*
14776	Craven Limestone Complex	North Yorkshire	5328	Semi-natural dry grasslands and scrubland facies on calcareous substrates (Festuco-Brometalia), Limestone pavements
12955	Creag Meagaidh	Highland	6144	Sub-Arctic willow scrub
19807	Culbin Bar	Highland, Moray	613	Perennial vegetation of stony banks
12679	Culm Grasslands	Devon	769	Molinia meadows on chalk and clay (Eu-Molinion)
19806	Dornoch Firth and Morrich More	Highland	6249	Dune juniper thickets (*Juniperus* spp.)
13031	Drigg Coast	Cumbria	1391	Dunes with *Salix arenaria*
12942	Drumochter Hills	Highland, Perth & Kinross	9446	Sub-Arctic willow scrub
13059	Dungeness	East Sussex Kent	3224	Perennial vegetation of stony banks
12835	Folkestone to Etchinghill Escarpment	Kent	182	Semi-natural dry grasslands and scrubland facies on calcareous substrates (Festuco-Brometalia) important orchid sites
20021	Glannau Môn: Twyni Anglesey Coast: Dunes	Anglesey	908	Dunes with *Salix arenaria*
12959	Glen Coe	Highland	2978	Eutrophic tall herbs
12685	Gower Commons Tiroedd Comin Gwyr	Swansea	1750	Northern Atlantic wet heaths with *Erica tetralix*
14788	Great Orme's Head Pen y Gogarth	Conwy	305	Semi-natural dry grasslands and scrubland facies on calcareous substrates (Festuco-Brometalia)
12787	Inchnadamph	Highland	1283	Sub-Arctic willow scrub, Limestone pavements
12782	Ingleborough Complex	North Yorkshire	5769	Limestone pavements, *Juniperus communis* formations on heaths or calcareous grasslands
13041	Invernaver	Highland	295	Dune juniper thickets (*Juniperus* spp.), Dunes with *Salix arenaria*
19861	Isle of Portland to Studland Cliffs	Dorset	1432	Vegetated sea cliffs of the Atlantic and Baltic coasts
12566	Kenfig Cynffig	Bridgend	1029	Dunes with *Salix arenaria*
12759	Kinveachy Forest	Highland		Caledonian forest
12832	Lewes Downs	East Sussex	147	Semi-natural dry grasslands and scrubland facies on calcareous substrates (Festuco-Brometalia) important orchid sites

Code	*Site Name*	*County or District*	*Area*	*Habitats Directive Annex I types*
12750	Loch Etive Woods	Argyll & Bute, Highland	2238	Old oak woods with *Ilex* and *Blechnum* in the British Isles
13573	Loch Lomond Woods	Argyll & Bute, Stirling, West Dunbartonsh.	1458	Old oak woods with *Ilex* and *Blechnum* in the British Isles
19803	Loch Sunart Woodlands	Highland	3161	Old oak woods with *Ilex* and *Blechnum* in the British Isles
19978	Lower River Spey/ Spey Bay	Moray	640	Perennial vegetation of stony banks, Residual alluvial forests (Alnion glutinoso-incanae)
12834	Lydden and Temple Ewell Downs	Kent	62	Semi-natural dry grasslands and scrubland facies on calcareous substrates (Festuco-Brometalia) important orchid sites
12952	Meall na Samhna	Highland	1883	Sub-Arctic willow scrub
12804	Mole Gap to Reigate Escarpment	Surrey	640	Stable *Buxus sempervirens* formations on calcareous rock slopes (Berberidion p.)
14774	Moor House - Upper Teesdale	Cumbria, Durham	38796	Semi-natural dry grasslands and scrubland facies on calcareous substrates (Festuco-Brometalia), *Juniperus communis* formations on heath or calcareous grasslands
14777	Morecambe Bay Pavements	Cumbria	2230	*Juniperus communis* formations on heaths or calcareous grasslands, Limestone pavements, Semi-natural dry grasslands and scrubland facies on calcareous substrates (Festuco-Brometalia)
30049	Morfa Harlech a Morfa Dyffryn	Gwynedd	1061	Dunes with *Salix arenaria*
12894	Morrone Birkwood	Aberdeenshire	315	*Juniperus communis* formations on heaths or calcareous grasslands
19958	Morven and Mullachdubh	Aberdeenshire	917	*Juniperus communis* formations on heaths or calcareous grasslands
13574	Mound Alderwoods	Highland	298	Residual alluvial forests (Alnion glutinoso-incanae)
12890	Newham Fen	Northumberland	13	Alkaline fens
19838	North Norfolk Coast and Gibraltar Point Dunes	Lincolnshire, Norfolk	3454	Perennial vegetation of stony banks, Mediterranean and thermo-Atlantic halophilous scrubs (Arthrocnemetalia)
17097	North Northumberland Dunes	Northumberland	1148	Dunes with *Salix arenaria*
19859	Peak District Dales	Derbyshire, Staffordshire	1344	Semi-natural dry grasslands and scrubland facies on calcareous substrates (Festuco-Brometalia)
19860	Peak District Dales Woodlands	Derbyshire, Staffordshire	804	Tilio-Acerion ravine forests
12559	Penhale Dunes	Cornwall	626	Dunes with *Salix arenaria*
12833	Queendown Warren	Kent	14	Semi-natural dry grasslands and scrubland facies on calcareous substrates (Festuco-Brometalia) important orchid sites

Code	*Site Name*	*County or District*	*Area*	*Habitats Directive Annex I types*
19767	Reidside Moss	Aberdeenshire	87	Active raised bogs
12826	Rodborough Common	Gloucestershire	104	Semi-natural dry grasslands and scrubland facies on calcareous substrates (Festuco-Brometalia)
12683	Salisbury Plain	Hampshire, Wiltshire	21114	Juniperus communis formations on heaths or calcareous grasslands, Semi-natural dry grasslands and scrubland facies: on calcareous substrates (Festuco-Brometalia)
13077	Sandwich Bay	Kent	1190	Dunes with *Salix arenaria*
13076	Sefton Coast	Merseyside	4102	Dunes with *Salix arenaria*
19864	Sidmouth to West Bay	Devon, Dorset	897	Vegetated sea cliffs of the Atlantic and Baltic coasts
30061	South Wight Maritime	Isle of Wight	19863	Vegetated sea cliffs of the Atlantic and Baltic coasts
19863	St Albans Head to Durlston Head	Dorset	278	Vegetated sea cliffs of the Atlantic and Baltic coasts, Semi-natural dry grasslands and scrubland facies on calcareous substrates (Festuco-Brometalia) important orchid sites
13045	St David's Ty Ddewi	Pembrokeshire	954	Vegetated sea cliffs of the Atlantic and Baltic coasts
12785	Strath	Highland	1377	Limestone pavements
14739	Strathglass Complex	Highland	23582	Caledonian forest Sub-Arctic willow scrub
13577	The Broads	Norfolk, Suffolk	5282	Residual alluvial forests (Alnion glutinoso-incanae)
12557	The New Forest	Hampshire, Wiltshire	29262	Residual alluvial forests (Alnion glutinoso-incanae), Bog woodland, Northern Atlantic wet heaths with *Erica tetralix*, Dry heaths (all sub types)
17075	The Wash and North Norfolk Coast	Lincolnshire, North Norfolk	107802	Mediterranean and thermo-Atlantic halophilous scrubs (Arthrocnemetalia), Perennial vegation of stony banks
12838	Thrislington	South Yorkshire	23	Semi-natural dry grasslands and scrubland facies on calcareous substrates (Festuco-Brometalia)
12793	Thursley, Ash, Pirbright and Chobham	Surrey	5101	Dry heaths (all sub types)
13047	Tintagel - Marsland - Clovelly Coast	Cornwall, Devon	2435	Vegetated sea cliffs of the Atlantic and Baltic coasts
12816	Tyne and Allen River Gravels	Northumberland	37	Calaminarian grasslands
12831	Wye and Crundale Downs	Kent	112	Semi-natural dry grasslands and scrubland facies on calcareous substrates (Festuco-Brometalia) important orchid sites
12727	Wye Valley Woodlands Coetiroedd Dyffryn Gwy	Gloucestershire Hereford & Worc	876	Tilio-Acerion ravine forests

Appendix 5.1 Summary of Countryside Stewardship scheme management prescriptions relevant to scrub in England.

Area or county	*Target Areas*	*Key objectives*	Management prescription relating to scrub
Predominantly lowland			
Bedfordshire	The Chilterns	Chalk grassland management	Scrub control where necessary
"	Land outside target areas	Management of important historic sites	Restore or enhance the feature by scrub clearance
Berkshire	North Wessex Downs and Chilterns AONB	Chalk grassland	Conservation of neglected chalk grassland, through control of invasive plants including scrub
"	River valleys of the Thames, Kennet, Lambourne, Pang, Blackwater and Loddon	The flood plains contain distinctive landscape features such as pollards, reed beds and alder carr	Distinctive landscape features such as alder carr
"	Heathland/acidic grasslands	Existing heathland	Restore and improve management of areas by clearing scrub
Buckinghamshire	Chilterns	Chalk grassland	Management of neglected chalk grassland, including appropriate scrub management
Cambridgeshire	Land Outside Target Areas	Management of important historic sites	Scrub clearance
Cornwall	Lowland Heath country-wide	Conserve and enhance existing heath	Management may include controlled removal of invasive scrub
"	Culm grassland	Management of culm grassland	May include programmes of controlled removal of invasive scrub
Cumbria	Eden Valley	Management of lowland heath or raised mires	Consideration of scrub management
Derbyshire	Trent Valley washlands	Characterised by pasture, unimproved flood meadows, pollards and scrub	
"	"	Conservation and restoration of field boundaries and water features	Alder carr is important and should be enhanced or re-established where appropriate
Devon	Culm grassland	Management of culm grasslands	May include removal of invasive scrub
"	East Devon AONB	Management of old meadows and pastures	Proposals should consider control of invasive scrub
"	"	Conservation of coastal grassland	Control of invasive scrub where needed
"	"	Conservation and re-creation of lowland heath	Scrub control
"	Haldon and Bovey Basin heaths	Conservation of lowland heath	Careful removal and control of scrub
"	North Devon coast	Management of coastal grassland or heath	Scrub control where needed
"	South Devon AONB and coastal fringe	Conservation of coastal grasslands and heath	Scrub control where needed
Dorset	Dorset Heaths	Management and/or restoration or existing heathland and acid grassland	Should consider the need to manage invasive scrub
"	Blackmore Vale	Old Meadows and Pastures	Restoration and management by appropriate scrub control
"	South Purbeck	Management Grassland	Measures to control invasive scrub
"	Old meadows and pastures in Wessex	Grassland management	Control of invasive scrub
Durham	Tees Lowland	Wetlands, fens and carrs	Management of grazing and water levels, to provide carr vegetation
"	Magnesium limestone plateau	Wetlands, fens and carrs	Improved management and safeguarding of carrs
East and West Sussex	Heathland	Remaining areas are under threat from lack of management which leads to scrub encroachment Existing heathland	Restore and improve management by scrub clearance

Essex	Land Outside Target Areas	Management of important historic sites	Scrub clearance
Gloucestershire	Old meadow and pasture	Conservation of semi-natural species rich grassland	Management of invasive plants including scrub
"	Sherborne Cotswolds	Conservation of semi-natural species rich grassland	Control of invasive plants including scrub where appropriate
"	"	Conservation of significant archaeological sites	Control of invasive scrub
"	Rivers in East Gloucester	Conservation of species rich neutral grassland	Control of invasive plants including scrub
"	Newnt, Dymock and Leadon	Conservation of significant archaeological sites	Control of invasive scrub
Hampshire	New Forest Heritage Area	Heathland and bogs	Clearing scrub including Rhododendron
"	East Hampshire AONB	Chalk grassland	Control invasive plants including scrub
"	Heathland in the Thames Basin and Western Weald	Existing heathland	Clear scrub to promote the expansion of heathland vegetation
Hartlepool, Middlesborough, Redcar and Cleveland Stockton	Tees Lowlands	Wetland fen and carrs	Enhance carr vegetation
Herefordshire	Herefordshire river catchments	Conservation of species rich semi-natural grassland	Management of invasive plants including scrub
"	"	River and stream bankside enhancement	Coppicing alder
"	Old meadow and pasture	Conservation of semi-natural species rich grassland	Control of invasive plants including scrub
"	Teme Valley	Conservation of old meadows and pastures	Control of invasive plants including scrub
"	"	Enhancing river and streambank conservation	Coppicing alder to maintain the character of streams and rivers
"	"	Whole farm and landscape restoration	Providing a structural edge to woodland through management of scrub
Hertfordshire	River valleys of the Rib, Quin, Beane, Ash and Stort	Semi-natural habitat management including old grassland, fens, alder carr	Scrub control as appropriate
"	Chilterns	Chalk grassland management	Should consider scrub control
"	Watling Chase Community Forest	Heathland/acid grassland	Reinstate/improve management by clearing scrub
"	Land Outside Target Areas	Management of important historic sites	Scrub clearance
Isle of Wight	Chalk grassland	Chalk grassland	Control of invasive plants including scrub
"		Old meadows and pastures	Scrub management may also be required on neglected sites
Kent	North Downs	Chalk grassland	Where scrub is invading chalk grassland, all or some of it should be cleared
"	High Weald	Existing heathland/acidic grassland	Restore and improve management of areas by clearing scrub
Lancashire	Lancashire and Amounderness Plain	Mosslands	Management to control scrub
Leicestershire and Rutland	Trent Valley washlands	The Trent Valley Washlands are characterised by pastures and flood meadows, pollards and scrub	
"	Charnwood	Conservation of heathland and acid grassland	Controlling scrub on existing sites a main aim
"		Conservation of agriculturally un-improved or semi-improved grasslands	Controlling scrub on existing sites a main aim
"	Leicestershire and South Derbyshire coalfield	Conservation of heathland and acid grassland	Controlling scrub
"	Leicestershire and Nottinghamshire Wolds	Conservation of agriculturally un-improved or semi-improved grasslands	Controlling scrub
"	High Leicestershire	Conservation of agriculturally un-improved or semi-improved grasslands	Controlling scrub

Leicestershire and Rutland	High Leicestershire	Conservation of agriculturally un-improved or semi-improved grasslands	Controlling scrub
"	Leicestershire Vales	Conservation of agriculturally un-improved or semi-improved grasslands	Controlling scrub
Lincolnshire	Central Lincolnshire Vale	Conserve and re-create grassland	Scrub removal where necessary
"	North Lincolnshire Edge with Coversands	Conserve and enhance acid grass and heathland with appropriate re-creation	Control scrub
London	North Downs	Chalk grassland	Where scrub is invading chalk grassland, some or all of it should be cleared Established scrub should be managed to achieve a varied age structure and species composition
"	Countryside around towns including the Thames Chase and Watling Chase Community Forests	Heathland/acid grassland	Management by clearing scrub
N/NE Lincolnshire, East Riding of Yorkshire and Kingston upon Hull	Lincolnshire Wolds	Chalk grassland management	Improve habitat for wildlife, which may include scrub clearance
"	Central Lincolnshire Vale	Lowland heath	Conservation and extension of heathland habitats, with site management including scrub clearance
"	North Lincolnshire Edge with Coversands	Lowland heath	Conservation and extension of heathland habitats, with site management including scrub clearance
"	Humberhead Levels	Lowland heath	Management and recreation of heathland habitats, with site management including scrub clearance
"	Yorkshire Wolds	Chalk grassland	Maintain and enhance, management may include scrub clearance
"	Vale of York	Lowland heath	Enhanced management, including scrub clearance
Norfolk	North West Norfolk	Heathland management	Scrub clearance on neglected heaths
"	Horsford Area and the Holt/Cromer Ridge	Heathland management	Scrub clearance on neglected heaths
"	Land Outside Target Areas	Management of important historic sites	Scrub clearance
North Yorkshire	Tees Lowland	Waterside landscape	Increasing bankside cover for otters by scrub regeneration
"	Selby Lowland	Lowland heath	Management of invading scrub
"	Yorkshire Wolds	Chalk grassland	May include scrub clearance
Northumberland/ Tyne and Wear	North Northumberland coastal plain	Natural and semi-natural grasslands	Scrub management where necessary
"	Tyne and Wear Lowlands	Conservation of important wildlife habitats, including species rich grasslands and wetlands	Restoration and management through scrub management
Nottinghamshire	Leicestershire and Nottinghamshire Wolds	Conservation of neutral grassland and associated historical features	Scrub removal where necessary
Oxfordshire	Chilterns and North Wessex Downs	Chalk grassland	Conservation of neglected chalk grassland by control of invasive plants including scrub
"	Midvale Ridge	Existing heathland	Restore and improve management by clearing scrub
"	Wychwood Project Area	Old meadows and pastures	Scrub management may be required on some sites

Somerset and the four Unitary Authorities of South Gloucester, Bath and North East Somerset, Bristol City and North Somerset	Quantock Hills	Heathland and unimproved pastures	Manage invasive scrub
Somerset and the four Unitary Authorities of South Gloucester, Bath and North East Somerset, Bristol City and North Somerset	North Somerset Levels and Moors	Restoration of key landscape features	Removal of scrub "hedges" alongside ditches to improve the aquatic habitat
"	Forest of Avon Community Forest	Grassland management	Control of invasive scrub
"	The Avalon Marshes	Special Project	Create a new landscape of carr
"	Ham Hill and Yeovil Sands and East Somerset Hills and Vales	Historic features	Scrub clearance
"		Grassland management	Control of invasive scrub
"	Southern Cotswolds	Grassland management	Control of invasive scrub
"	Mid Somerset Hills	Grassland management	Control of invasive scrub
"	Old Meadows and Pastures	Grassland management	Control of invasive scrub
South Yorkshire	Yorkshire Coalfields	Wet grasslands and riverside habitats	Waterside land may be improved for conservation through scrub clearance
"	Humberhead Levels	Lowland heath	Management of scrub where required
Staffordshire	Forest of Mercia	Lowland heath	Control of invasive plants including scrub
"		Conservation of old meadows and pastures	Control of invasive plants including scrub
"	Potteries and Churnet Valley	Heathland	Restoration and management by cutting scrub heath
"	White Peak in Staffordshire	Acid grasslands and heathy areas	Restoration of limestone heaths where dwarf shrubs are still present in the sward
Suffolk	Sandlings	Manage heath	Control scrub where suppressing heathland grass and heather species
"	High Suffolk and South Suffolk Claylands	Manage tyes, greens or commons	To prevent scrub encroachment
"	Land outside target areas	Management of historic sites	Scrub clearance
Surrey	North Downs	Chalk grassalnd	Where scrub is invading chalk grassland, some or all of it should be cleared Established scrub should be managed to achieve a varied age structure and species composition
"	Thames Basin Heath and Wealden Greensands	Existing heathland	Restore and improve by clearing scrub
Warwickshire and West Midlands	Old meadow and pasture	Conservation of semi-natural species rich grassland	Management of invasive plants including scrub
"	Arden	Conservation of acidic and neutral grassland sites and lowland heath	Management of invasive plants including scrub
"	Forest of Mercia	Conservation and restoration of lowland heath	Control of invasive plants including scrub
"		Conservation of old meadows and pastures	Control of invasive plants including scrub
"	The Cotswolds outside the ESA	Conservation of semi-natural species rich grasslands	Control of invasive plants including scrub
"		Conservation of significant archaeological sites	Control of invasive scrub
"	Feldon and East Warwickshire	Conservation of old meadows and pastures	Control of invasive plants including scrub

West Yorkshire	Great Western Community Forest	Grassland management	Measures to control invasive scrub
"	Braydon Forest	Grassland management	Measures to control invasive scrub
"	Wiltshire Downs	Grassland management	Measures to control invasive scrub
"	South Cotswolds	Grassland management	Measures to control invasive scrub
Wiltshire	Old Meadows and Pastures	Grassland management	Measures to control invasive scrub
"	Arden	Conservation of acidic and neutral grassland sites and lowland heath	Measures to control invasive scrub
"		Conservation of old meadows and pastures	Control of invasive plants including scrub
Worcestershire	Wyre Forest and Mid Severn Sandstone plateau	Conservation of unimproved species rich grassland	Management of invasive plants including scrub
"		Conservation and restoration of Lowland heath and a mosaic of acid grassland	Control of invasive plants including scrub
Predominantly upland			
Cheshire, Merseyside and Greater Manchester	South West Peak ESA Fringe	Moorland	-
Cumbria	Border Moors and Border Pennines	Protection of archaeological features	Protect from scrub invasion
"	Orton Fells	Limestone grassland/pavements	Conservation and enhancement through possibly scrub management
"	Morecambe Bay Limestones	Conservation of limestone grassland and heath	Conservation/enhancement, including scrub management to create a mosaic of habitats
"	Yorkshire Dales	Protection of archaeological features or historical landscape	Appropriate scrub management
Derbyshire	Southern Magnesian Limestone in Derbyshire	Appropriate management of calcareous and neutral grassland	To protect historic features through scrub management
"	Dark Peak	Management of moorland and upland intakes	Scrub management on historic sites
"	South West Peak	Conservation management of gorse/hawthorn scrub	In mosaic with heathland /grassland habitats
"	Derbyshire Peak Fringe		Steeper slopes characterised by scrub and woodland
Durham	North Pennines	Wet pastures and riverside land	Reduction of grazing within juniper woodlands
Hartlepool, Middlesborough, Redcar and Cleveland Stockton	North York Moors and Cleveland Hills	Heathland	Manage dwarf shrub community to increase floral and bird diversity
Lancashire	Morecambe Bay Limestones	Conservation of limestone grassland and heath	Conservation/enhancement, including scrub management to create a mosaic of habitats
Northumberland/ Tyne and Wear	Border Moors and Forests	Archaeological features	Protection of archaeological features and other historic features from scrub invasion
"	Northumberland Sandstone Hills	"	Conserve and protect from scrub encroachment through scrub clearance as appropriate
North Yorkshire	Yorkshire Dales National Park	Riverside and wetland habitats	Carr management
Shropshire	The Shropshire Hills, Clun Hills and Teme Valley	Limestone grassland on Wenlock Edge	Restoration and management of limestone grassland where scrub has developed and grassland is reverting to woodland
"	Oswestry Uplands	Applications enhanced by fenland management and restoration	

Somerset and the four Unitary Authorities of South Gloucester, Bath and North East Somerset, Bristol City and North Somerset	The Mendip Hills	Grassland/heathland management	Control of invasive scrub
"	Quantock Hills	Heathland and unimproved pastures	Manage invasive scrub
South Yorkshire	Dark Peak	Heather moorlands	Where appropriate, clear scrub
	Pennine Fringe	Wet grasslands and riverside features	Clear scrub from degraded grasslands
		Heather moorland	Control of scrub
	Southern Magnesian Limestone	Intensive arable farming has lead to the development of a large, open landscape and a scarcity and fragmentation of grasslands and scrub in the landscape	
Staffordshire	The South West Peak ESA Fringe	Exclusion of livestock from clough woodlands	Encouraging scrub such as gorse and hawthorn to establish
West Yorkshire	Southern Magnesian limestone	Intensive arable farming has lead to the development of a large, open landscape and a scarcity and fragmentation of grasslands and scrub	

Appendix 5.2 Summary of ESA management prescriptions relevant to scrub in England and Scotland.

ESA	*Tier*	*Scheme Prescriptions*	*Information sheet - Conservation Plan*	
		Tier	*Work code*	*Eligible item*
ENGLAND				
Predominantly lowland				
Avon Valley	Tier 1C. Scrub and willow carr contribute to creating a varied lowland landscape of high value. Wet grassland. Proportion of scrub assessed as part of Conditions of Entry	-	7. Management of scrub	Management of scrub
Blackdown Hills	Tier 1D. Unimproved pasture and rough land. Under management is leading to scrub encroachment and lack of environmental interest	-	7. Control of scrub	Control of scrub
Breckland	Tier 3. River valley grassland. Objective - to maintain a mosaic of habitats, including scrub	-	7. Management of scrub	Management of scrub
Broads	Fen Tier. Scrub management may be needed	-	7. Control of scrub	Control of scrub
Clun	-	-	7. Management of scrub	Management of scrub
Cotswold Hills	Tier 1A. Arable and ley grassland all land. Farmland within the ESA contains many important elements, including areas of scrub	Tier 1A. All land. 11. Manage scrub	7. Management of scrub	Management of scrub
Essex Coast	-	Tier 1. Permanent grassland. 16. Obtain written advice on scrub management	7. Control of scrub	Control of scrub
Pennine Dales	-	-	1. Protection of historic features	Scrub management on free-standing features of archaeological interest
Shropshire Hills	Tier1A. Arable and ley grassland all land. Scrub and rush management - Scrub can provide a habitat for management, but if left unchecked areas spread and may become dense. Management may be required	Tier 1A All land. Scrub management.	7. Control of scrub	Control of scrub
Shropshire Hills	Tier 1B. Permanent grassland. Grassland management - undergrazing can lead to the spread of scrub	-	7. Control of scrub	-
Somerset Levels and Moors	-	-	7. Management of scrub	Scrub management on free-standing features of archaeological interest
South Downs	Tier 1. Permanent grassland on the chalk prevent loss of chalk grassland through scrub encroachment. Scrub management - Scrub management section: scrub is widespread in some parts of the Downs, and provides valuable food sources for birds and invertebrates. When left uncontrolled, it can spread rapidly and become dense and shade out the valuable grassland and wildflower communities. Implement scrub management	Tier 1. Permanent grassland on the chalk. 16. Scrub management programme must be agreed. Tier 2. Permanent grassland in the river valleys. 34. Scrub management programme must be agreed	7. Management of scrub	Management of scrub

South Wessex Downs	Tier 1 Part 1. Arable and ley grassland (all land). Farmland contains many important elements, including areas of scrub	Tier 1 Part 1. All land. 5. Do not allow any scrub to become established without the Ministry's prior written approval	7. Removal of scrub	Removal of scrub. Scrub management on free-standing features of archaeological interest
South West Peak	Tier 1 part 2. Enclosed permanent grassland. Grassland management - under grazing can lead to spread of scrub	-	*Information unavailable*	*Information unavailable*
Suffolk River Valleys	Fen Tier. Management - scrub will need to be managed	-	7. Management of scrub	Management of scrub
Test Valley	Tier 1C. Scrub and willow carr contribute to creating a varied lowland landscape of high value. Wet grassland. Proportion of scrub assessed as part of Conditions of Entry	-	7. Management of scrub.	Management of scrub.
Upper Thames Tributaries	-	-	7. Control of scrub	Control of scrub
West Penwith	-	Tier 1. All land additional prescriptions for rough land only. 15. Any burning of scrub must be done in accordance with a programme agreed in advance	7. Management of scrub	Management of scrub
"	Tier 1C. Extensive permanent grassland. Scrub management - scrub is widespread in many parts of the Cotswolds and provides a valuable source of cover and food for birds and invertebrates. If left uncontrolled it can spread rapidly and become dense and shade out the valuable grassland and wildflower communities. Scrub control may be necessary	-	-	-
"	Tier 1 Part 3. Scrub management - scrub is widespread in some parts of the Downs, and provides valuable food sources for birds and invertebrates. When left uncontrolled, it can spread rapidly and become dense and shade out the valuable grassland and wildflower communities. Implement scrub management if necessary	-	-	-
"	-	Tier 1D. Unimproved pasture and enclosed rough land. 36. Agree a grassland management plan, including any scrub management necessary	-	-
"	-	Tier 1. Permanent grassland. Written advice on scrub management.	-	Fen restoration to enable a return to Broadland fen management.
Predominantly upland				
Dartmoor	Common conditions for all land receiving ESA payments: scrub. Too much scrub can be a management problem. However, scrub can provide important habitats for rare butterflies, such as fritillaries, and other animals.	Tier 1A. All Land. 13. Manage scrub	7. Control of scrub	Control of scrub
"	Tier 1D. Unimproved pasture and enclosed rough land, e.g. scrub	Tier 1D. Unimproved pasture and enclosed rough land. Grassland management programme will include any necessary scrub management		

"	Tier 1E. Moorland. A moorland management plan is required, which includes scrub management	Tier 1E. Moorland. Do not apply herbicides except to carry out stump treatment of cleared scrub. Agree a moorland management programme to include any necessary scrub management		
Exmoor	Common conditions for all land receiving ESA payments: scrub. Scrub can be an important habitat, but too much can be a problem. Plans for scrub control must be agreed before any work done	Tier 1 part 1 - All land. 12. Do not remove scrub except with the Ministry's prior written approval	7. Control of scrub	Control of scrub
"	"	Tier 1 Part 2B - Low input permanent grassland. Do not apply herbicides to cleared scrub. Do not burn any scrub without the Ministry's written approval. Tier 1 Part 3 - enclosed unimproved permanent grassland. Do not burn any scrub without the Ministry's written approval.		
"	"	Tier 1 Part 4 - Moorland. Agree an integrated plan of moorland management. This may include a programme of scrub control		
Lake District	Tier 1A. Arable and ley grassland (all land). Scrub such as juniper and gorse are important in the landscape and as wildlife habitats. Management of scrub must be carried out in accordance with an agreed programme	Tier 1 Part 1. All land. Scrub management in agreement with Project Officer	-	-
North Peak	Tier 1C. Moorland	Tier 1C. 39. Agree a plan of moorland management. This may include a programme of scrub control	7. Control of scrub	Control of scrub
Shropshire Hills	Tier 1D. Moorland	Tier 1D. 38. Agree a plan of moorland management. This will include any necessary scrub management	7. Control of scrub	Control of scrub

SCOTLAND

Predominantly upland

Area or county	*Tier and requirements*	*Additional details*
Argyll Islands	Tier 1. 1. Avoid damaging shrubs by ploughing, new drainage, modifying existing drains, mechanical peat cutting, levelling, re-seeding or cultivating or by clearing shrubs	Definition of scrub – low growing woody vegetation
"	Tier 1. 2. Avoid damaging shrubs by poaching, feeding practices or overgrazing	Environmental damage caused by overgrazing, as indicated by a deterioration in the structure and cover of, for example, dwarf shrubs, will occur before agricultural production starts to suffer due to overstocking
"	Tier 1. 3. Do not apply herbicides to shrubs. except that herbicides may be applied to *Rhododendron*	
"	Tier 1. 4. Make any Muirburn in accordance with SNH standards	Do not burn areas of whins, broom or juniper. Do not burn into areas of scrub woodland
"	Tier 1. 6. Avoid damaging or destroying any features or areas of historic or archaeological interest	Avoid damage from gorse, scrub and woody plants
"	Tier 2. 12 (mandatory). Prepare a grazing plan to conserve, enhance or extend areas of scrub	In native woodland the first aim should be to encourage natural regeneration by native trees and shrubs
"	Tier 2. 15 (mandatory). Grazing plan to conserve, regenerate, maintain or enhance areas of heather	May include a muirburn programme (Do not burn areas of whins, broom or juniper. Do not burn into areas of scrub woodland)
"	Tier 2. 18 (optional). Measures to improve the condition of features or areas of historic or archaeological interest	The removal of scrub is encouraged To prevent recolonisation by scrub, etc, a grazing plan should be prepared.
Breadalbane	Tier 1. 1. Avoid damaging shrubs by ploughing, new drainage, modifying existing drains, mechanical peat cutting, levelling, re-seeding or cultivating or by clearing shrubs	Definition of scrub – low growing woody vegetation
"	Tier 1. 2. Avoid damaging shrubs by poaching, feeding practices or overgrazing	Environmental damage caused by overgrazing, as indicated by a deterioration in the structure and cover of, for example, dwarf shrubs, will occur before agricultural production starts to suffer due to overstocking
"	Tier 1. 3. Do not apply herbicides to shrubs	
"	Tier 1. 4. Make any Muirburn in accordance with SNH standards	Do not burn areas of whins, broom or juniper. Do not burn into areas of scrub woodland
"	Tier 1. 5. Do not remove any scrub, unless authorised to do so	
"	Tier 1. 6. Avoid damaging or destroying any features or areas of historic or archaeological interest	Avoid damage from gorse, scrub and woody plants
"	Tier 2. 10 (mandatory). Prepare a grazing plan to conserve, enhance or extend areas of scrub	In native woodland the first aim should be to encourage natural regeneration by native trees and shrubs
"	Tier 2. 11 (mandatory). Prepare a grazing plan to conserve, enhance or extend areas of wetland	Moderate grazing during the autumn is valuable and should be encouraged in order to prevent invasion of trees and shrubs
"	Tier 2. 13 (optional). Grazing plan to conserve, regenerate, maintain or enhance areas of heather	May include a muirburn programme (Do not burn areas of whins, broom or juniper. Do not burn into areas of scrub woodland)
"	Tier 2. 16 (optional). Measures to improve the condition of features or areas of historic or archaeological interest	The removal of scrub is encouraged To prevent recolonisation by scrub, etc, a grazing plan should be prepared

Cairngorms Straths	Tier 1. 1. Avoid damaging shrubs by ploughing, new drainage, modifying existing drains, mechanical peat cutting, levelling, re-seeding or cultivating or by clearing shrubs	Definition of scrub – low growing woody vegetation of small trees and shrubs including linear scrub along field margins containing dog rose, gorse, broom, blackthorn, etc
"	Tier 1. 2. Avoid damaging shrubs by poaching, feeding practices or overgrazing	Environmental damage caused by overgrazing, as indicated by a deterioration in the structure and cover of, for example, dwarf shrubs, will occur before agricultural production starts to suffer due to overstocking
"	Tier 1. 3. Do not apply herbicides to shrubs	
"	Tier 1. 4. Make any Muirburn in accordance with SNH standards	Do not burn areas of whins, broom or juniper. Do not burn into areas of scrub woodland.
"	Tier 1. 6. Avoid damaging or destroying any features or areas of historic or archaeological interest	Avoid damage from gorse, scrub and woody plants
"	Tier 2. 10 (mandatory). Prepare a grazing plan to conserve, enhance or extend areas of scrub	In native woodland the first aim should be to encourage natural regeneration by native trees and shrubs
"	Tier 2. 11 (mandatory). Prepare a grazing plan to conserve, enhance or extend areas of wetland	Moderate grazing during the autumn is valuable and should be encouraged in order to prevent invasion of trees and shrubs
"	Tier 2. 13 (optional). Grazing plan to conserve, regenerate, maintain or enhance areas of heather	May include a muirburn programme (Do not burn areas of whins, broom or juniper. Do not burn into areas of scrub woodland.)
Central Borders	Tier 1. 1. Avoid damaging shrubs by ploughing, new drainage, modifying existing drains, mechanical peat cutting, levelling, re-seeding or cultivating or by clearing shrubs.	Definition of scrub – low growing woody vegetation
"	Tier 1. 2. Avoid damaging shrubs by poaching, feeding practices or overgrazing	Environmental damage caused by overgrazing, as indicated by a deterioration in the structure and cover of, for example, dwarf shrubs, will occur before agricultural production starts to suffer due to overstocking
"	Tier 1. 3. Do not apply herbicides to shrubs	
"	Tier 1. 4. Make any Muirburn in accordance with SNH standards	Do not burn areas of whins, broom or juniper. Do not burn into areas of scrub woodland
"	Tier 1. 6. Avoid damaging or destroying any features or areas of historic or archaeological interest	Avoid damage from gorse, scrub and woody plants
"	Tier 2. 10 (mandatory). Prepare a grazing plan to conserve, enhance or extend areas of scrub	In native woodland the first aim should be to encourage natural regeneration by native trees and shrubs
"	Tier 2. 16 (optional). Measures to improve the condition of features or areas of historic or archaeological interest	The removal of scrub is encouraged To prevent recolonisation by scrub, etc, a grazing plan should be prepared
Central Southern Upland	Tier 1. 1. Avoid damaging shrubs by ploughing, new drainage, modifying existing drains, mechanical peat cutting, levelling, re-seeding or cultivating or by clearing shrubs	Definition of scrub – low growing woody vegetation
"	Tier 1. 2. Avoid damaging shrubs by poaching, feeding practices or overgrazing	Environmental damage caused by overgrazing, as indicated by a deterioration in the structure and cover of, for example, dwarf shrubs, will occur before agricultural production starts to suffer due to overstocking
"	Tier 1. 3. Do not apply herbicides to shrubs	
"	Tier 1. 4. Make any Muirburn in accordance with SNH standards	Do not burn areas of whins, broom or juniper. Do not burn into areas of scrub woodland.
"	Tier 1. 5. Do not remove any scrub unless authorised to do so.	
"	Tier 1. 6. Avoid damaging or destroying any features or areas of historic or archaeological interest	Avoid damage from gorse, scrub and woody plants
"	Tier 2. 10 (mandatory). Grazing plan to conserve, regenerate, maintain or enhance areas of heather	May include a muirburn programme (Do not burn areas of whins, broom or juniper. Do not burn into areas of scrub woodland)
"	Tier 2. 11 (mandatory). Prepare a grazing plan to conserve, enhance or extend areas of scrub	In native woodland the first aim should be to encourage natural regeneration by native trees and shrubs
"	Tier 2. 13 (optional). Measures to improve the condition of features or areas of historic or archaeological interest	The removal of scrub is encouraged To prevent recolonisation by scrub, etc, a grazing plan should be prepared

Loch Lomond	Tier 1. 1. Avoid damaging shrubs by ploughing, new drainage, modifying existing drains, mechanical peat cutting, levelling, re-seeding or cultivating or by clearing shrubs	Definition of scrub – low growing woody vegetation
"	Tier 1. 2. Avoid damaging shrubs by poaching, feeding practices or overgrazing	Environmental damage caused by overgrazing, as indicated by a deterioration in the structure and cover of, for example, dwarf shrubs, will occur before agricultural production starts to suffer due to overstocking
"	Tier 1. 3. Do not apply herbicides to shrubs	
	Tier 1. 4. Make any Muirburn in accordance with SNH standards	Do not burn areas of whins, broom or juniper. Do not burn into areas of scrub woodland
"	Tier 1. 5. Do not remove any scrub unless authorised to do so	
"	Tier 1. 6. Avoid damaging or destroying any features or areas of historic or archaeological interest	Avoid damage from gorse, scrub and woody plants
"	Tier 2. 10 (mandatory). Prepare a grazing plan to conserve, enhance or extend areas of scrub	In native woodland the first aim should be to encourage natural regeneration by native trees and shrubs
"	Tier 2. 11 (mandatory). Prepare a grazing plan to conserve, enhance or extend areas of wetland	Moderate grazing during the autumn is valuable and should be encouraged in order to prevent invasion of trees and shrubs
"	Tier 2. 13 (optional). Grazing plan to conserve, regenerate, maintain or enhance areas of heather	May include a muirburn programme (Do not burn areas of whins, broom or juniper. Do not burn into areas of scrub woodland.)
"	Tier 2. 15 (optional). Measures to improve the condition of features or areas of historic or archaeological interest	The removal of scrub is encouraged. To prevent recolonisation by scrub, etc, a grazing plan should be prepared
Machair of the Uists and Benbecula, Barra and Vatersay	Tier 1. 3. Avoid damaging or destroying any features or areas of historic or archaeological interest	Avoid damage from gorse, scrub and woody plants
"	Tier 2. 11 (optional). Measures to improve the condition of features or areas of historic or archaeological interest	The removal of scrub is encouraged To prevent recolonisation by scrub, etc, a grazing plan should be prepared
Shetland Islands (Common grazings committees only)	Tier 1. 1. Avoid damaging shrubs by ploughing, new drainage, modifying existing drains, mechanical peat cutting, levelling, re-seeding or cultivating or by clearing shrubs	
"	Tier 1. 2. Avoid damaging shrubs by poaching, feeding practices or overgrazing	Environmental damage caused by overgrazing, as indicated by a deterioration in the structure and cover of, for example, dwarf shrubs, will occur before agricultural production starts to suffer due to overstocking
"	Tier 1. 3. Do not apply herbicides to shrubs	
"	Tier 1. 4. Make any Muirburn in accordance with SNH standards	Do not burn areas of whins, broom or juniper. Do not burn into areas of scrub woodland.
"	Tier 1. 6. Avoid damaging or destroying any features or areas of historic or archaeological interest	Avoid damage from scrub
"	Tier 2. 13 (mandatory). Prepare a grazing plan and other measures necessary to conserve or enhance areas of trees and shrubs	
"	Tier 2. 15 (optional). Measures to improve the condition of features or areas of historic or archaeological interest	The removal of scrub is encouraged To prevent recolonisation by scrub, etc, a grazing plan should be prepared

Shetland Islands (farmers and crofters)	Tier 1. 1. Avoid damaging shrubs by ploughing, new drainage, modifying existing drains, mechanical peat cutting, levelling, re-seeding or cultivating or by clearing shrubs.	
"	Tier 1. 2. Avoid damaging shrubs by poaching, feeding practices or overgrazing	Environmental damage caused by overgrazing, as indicated by a deterioration in the structure and cover of, for example, dwarf shrubs, will occur before agricultural production starts to suffer due to overstocking
"	Tier 1. 4. Make any Muirburn in accordance with SNH standards	Do not burn areas of whins, broom or juniper. Do not burn into areas of scrub woodland.
"	Tier 1. 6. Avoid damaging or destroying any features or areas of historic or archaeological interest	Avoid damage from scrub
"	Tier 2. 14 (mandatory). Prepare a grazing plan to conserve or enhance areas of shrubs	
"	Tier 2. 15 (optional). Grazing plan to conserve, regenerate, maintain or enhance areas of heather	May include a muirburn programme (Do not burn areas of whins, broom or juniper. Do not burn into areas of scrub woodland)
"	Tier 2. 17 (optional). Measures to improve the condition of features or `areas of historic or archaeological interest	The removal of scrub is encouraged To prevent recolonisation by scrub, etc, a grazing plan should be prepared
Stewartry	Tier 1. 1. Avoid damaging shrubs by ploughing, new drainage, modifying existing drains, mechanical peat cutting, levelling, re-seeding or cultivating or by clearing shrubs	Definition of scrub – low growing woody vegetation
"	Tier 1. 2. Avoid damaging shrubs by poaching, feeding practices or overgrazing	Environmental damage caused by overgrazing, as indicated by a deterioration in the structure and cover of, for example, dwarf shrubs, will occur before agricultural production starts to suffer due to overstocking
"	Tier 1. 3. Do not apply herbicides to shrubs	
"	Tier 1. 4. Make any Muirburn in accordance with SNH standards	Do not burn areas of whins, broom or juniper. Do not burn into areas of scrub woodland
"	Tier 1. 6. Avoid damaging or destroying any features or areas of historic or archaeological interest	Avoid damage from gorse, scrub and woody plants
"	Tier 2. 10 (mandatory). Prepare a grazing plan to conserve, enhance or extend areas of scrub	In native woodland the first aim should be to encourage natural regeneration by native trees and shrubs
"	Tier 2. 16 (optional). Measures to improve the condition of features or areas of historic or archaeological interest	The removal of scrub is encouraged To prevent recolonisation by scrub, etc, a grazing plan should be prepared
Western Southern Uplands	Tier 1. 1. Avoid damaging shrubs by ploughing, new drainage, modifying existing drains, mechanical peat cutting, levelling, re-seeding or cultivating or by clearing shrubs	Definition of scrub – low growing woody vegetation
"	Tier 1. 2. Avoid damaging shrubs by poaching, feeding practices or overgrazing	Environmental damage caused by overgrazing, as indicated by a deterioration in the structure and cover of, for example, dwarf shrubs, will occur before agricultural production starts to suffer due to overstocking
"	Tier 1. 3. Do not apply herbicides to shrubs	
"	Tier 1. 4. Make any Muirburn in accordance with SNH standards	Do not burn areas of whins, broom or juniper. Do not burn into areas of scrub woodland.
"	Tier 1. 5. Do not remove any scrub unless authorised to do so.	
"	Tier 1. 6. Avoid damaging or destroying any features or areas of historic or archaeological interest	Avoid damage from gorse, scrub and woody plants
"	Tier 2. 10 (mandatory). Grazing plan to conserve, regenerate, maintain or enhance areas of heather	May include a muirburn programme (Do not burn areas of whins, broom or juniper. Do not burn into areas of scrub woodland)
"	Tier 2. 11 (mandatory). Prepare a grazing plan to conserve, enhance or extend areas of scrub	In native woodland the first aim should be to encourage natural regeneration by native trees and shrubs
"	Tier 2. 13 (optional). Measures to improve the condition of features or areas of historic or archaeological interest	The removal of scrub is encouraged To prevent recolonisation by scrub, etc, a grazing plan should be prepared

Appendix 5.3 Techniques used for scrub conservation, enhancement, control and clearance.

Key: Lowland, *Upland and lowland*, **Upland.**

ID no.	***a) Scrub conservation***	***b) Scrub enhancement***	***c) Scrub control***	***d) Scrub clearance***
	To maintain existing areas by arresting succession	*To increase diversity or extent of existing scrub*	*To prevent encroachment onto other habitats*	*To restore/create other habitats*
1	Thinning	Scrub coppicing	Cut and treat with follow up grazing; spray/burn	Cut and treat with follow up grazing; spray/burn
3		Rotational felling	Cutting and stump treatment	Clear fell and stump treatment
4	Coppice (rotational)	Coppice rotational, natural regeneration (through careful management of adjacent land)	Coppice, stump treatment and burning. Grazing	Removal with winch, cutting with stump treatment and burning (grazing)
5	Rotational cutting, some stump, foliar treatment, grazing	As (a), JCB's and large machinery where appropriate	As (b) and sheep, cattle	As (b) and rotivators, mowers
6	Coppicing of Birch (*Betula*)/Oak (*Quercus*)/Hawthorn (*Crataegus monogyna*) with Blackthorn (*Prunus spinosa*) suckers. Clearance around Crab Apple (*Malus sylvestris*)/Wild Service-tree (*Sorbus torminalis*)/Buckthorn (*Rhamnus cathartica*). Forest - accidental fires 'manage' a large % of Gorse (*Ulex*) scrub		Grazing - only 14ha at present - but proposed a further 315ha (cattle to be used). Clearance with chainsaws and stump grinding. Considering use of 'Krenite' - chemical manufactured by DuPont.	Clearance with chainsaws and stump grinding. Use of mini-brush cutter vehicle (Estesia AV88 Attila)
7			Cutting/burning/stump treatment if necessary	As (c)

8	As (d) but without stump killing. These coppice areas being un-mowable support a tall-herb flora	Edges are coppiced to create a transitional zone with tall herbs, Bramble (*Rubus fruticosus*) etc. This is further diversified by re-coppicing short stretches beginning after c. 5 years re-growth. Similar effect has been obtained by allowing scrub to colonize neighbouring grassland edge, then coppicing short blocks.	Selective felling of larger Hawthorn (*Crataegus monogyna*)/Rose (*Rosa*) and stump treatment (Garlon) and rotational mowing, each parcel mown every 3 years and further stump treatment. Individuals/clumps of valuable native species or self-sown exotics where they reveal the history of the site, are retained. Individual large bushes are retained where visually prominent e.g. territory markers for Green Hairstreak butterfly (*Callophrys rubi*). Problem (1) This done by contractors, so cannot give too precise instructions Problem (1) Age class 3-10+ years poorly represented - bias toward very young and very old bushes. (2) Grazing to prevent Willow (*Salix*) encroachment in grassland - Hebridean sheep at one site only.	Cut down and treat stumps. Formerly burned, now stack 100mm+. Chip smaller materials into heaps (for fungi/invertebrates/ Grass Snakes [*Natrix natrix*]) or for surfacing paths. (chipper very valuable kit).
9	Coppicing on rotation, selective clearance of taller vegetation.	Coppicing, allowing succession to proceed in appropriate areas	Cut, using volunteers, contractors. Treat stump/re-growth with herbicides where necessary. Grazing has been re-introduced on some sites.	As (c)
10	Coppicing rotation	Layering, coppicing	Coppice, mow	Coppice, mow
11	Strimming/mowing off	Strimming/mowing off	Sow and weedkill	Grazing by longhorn cattle
12	Mechanical and herbicide control and through grazing	Coppicing and allowing re-growth; selective clearance etc.	Mechanical control with herbicide treatment and grazing	As (c)
13		Coppicing	Flailing/mowing	Digging out roots – Bramble (*Rubus fruticosus*), rock salt on Willows (*Salix*), ring barking on Alders (*Alnus*)
14	Hand tools, chainsaw,- coppicing	Planting of other suitable species		Coppicing and re-growth management. Uprooting where possible
15			hand pulling	
16	Coppice management	Natural regeneration, through careful management of adjacent land	Coppice management and removal of scrub with tirfor winch	Coppice management and removal of scrub with tirfor winch

17			Mechanical clear felling/ clearance (+possibly spraying with a chemical herbicide to prevent re-growth	Mechanical clearance e.g. chainsaw / brush cutter
18			clearance as required	
19	Coppicing of native species, felling and poisoning of Sycamore (*Acer pseudoplatanus*)/ Cherry Laurel (*Prunus laurocerasus*) etc.	Thinning and coppicing with some additional planting of native species	Usually uprooting of invading scrub to allow dormant seed to re-colonize	
20	Coppice	Coppice and clearance to increase edge and increase complexity of edges	Cut and poison stumps (attempt to poison stumps!). Browsing experiments using semi-feral goats	See (c). Also gradual removal by raising canopy 2-3 years before removing a tree/bush
21				Use machinery to reduce to ground level. If a low value area just introduce a cutting regime or of higher value reinstate and seed
22		Coppice (leaving older Hawthorn [*Crataegus monogyna*]/Blackthorn [*Prunus spinosa*] as standards), creating scalloped edges, clearing islands in dense stands as 'oases' with view to later connection by corridors	Cut - treat - burn - grazing	Cut - treat - burn - grazing
23	Coppice	Coppice	Clear and treat stumps	Clear and treat stumps
24	Complete coppicing of existing scrub and allowing regeneration of cut stumps	Selective coppicing of existing scrub and allowing regeneration of cut stumps.	(1) annual mowing with tractor rotary mower. (2) three year scrub removal in building/mature Heather (*Calluna vulgaris*). (3) rotational grazing with Exmoor ponies	(1) cut to ground level with clearing saw/chainsaw and burn (2) Stumps <15cm treat with herbicide (Grazon 90). (3) Stumps >15 cm stump grind and back fill material. (4) Annual mowing (3 cuts per year) with tractor rotary mower until desired heathland vegetation restored.
25			Individual pruning and tree removal at boundary of our land	
26				Cutting: chain saws or bow saws (areas are also 'managed' involuntarily by arson)
27	Coppicing		Cut and poison or cut and allow browsing	See (c)

29	Cutting manually, treating chemically, grazing, repeated cutting by tractor	Manage existing scrub so that it becomes penetrable by thinning manually - no need to increase extent as we are trying to reverse 20 years of neglect and chemical treatment and grazing	Manual cutting or tractor and scrub master i.e. it depends what's under the scrub - ant hills etc. then no tractor and chemical treatment or repeated cutting and grazing	As (c)
30	Removal of pioneer woodland trees (Sycamore [*Acer pseudoplatanus*] /Ash [Fraxinus excelsior]) and the treatment of stumps. We will be introducing cyclical coppicing to scrub blocks in certain areas, to diversity age structure.	As (a) with the introduction of cyclical coppicing in certain areas.	In the past, where spreading onto chalk grassland. Scrub removal by combination of tractor mounted swipe/chainsaw following by stump treatment/regular topping by tractor of re-growth	(1) Removal from scheduled ancient monuments i.e. Round Barrows. (2) Removal from escarpment ridges, to restore open downland skyline, open up views. (3) Removal to help restore - extend quality chalk grassland areas, especially for invertebrate habitat i.e. Horseshoe Vetch (*Hippocrepis comosa*) for Blues/Silver-spotted Skipper (*Hesperia comma*) butterflies. The spread of pioneer woodland is a perceived problem upon the eastern escarpment.
31			Brashing and mowing of margins	Cutting and brashing and mowing of site
32	Coppicing or laying	Scalloping edges, opening up rides (increase scrub edge)	Grazing with cattle / annual hay cutting	Cut and herbicide stumps then grazing
33	Cut and clear , but mostly leave as barrier around outside of site.	Cut and clear glades allow to re-grow	Cut and clear, not poison, new re-growth, graze (cattle)	Cut and clear and poison, new re-growth graze (cattle)
35	Coppicing, for example in the case of Willow (*Salix*)	Small scale mosaic cutting of shrub to promote structural and age diversity	Brush cutting / felling Birch, (*Betula*) for example to prevent its invasion of heathland	Brush cutting / felling Birch (*Betula*) / Pine (*Pinus*) on heathland
36		Planting with whips		Cut at ground level during winter and treat stumps with herbicide. Mowing/sheep grazing
37	Mechanical and manpower	Planting up small areas and using plugs	Mechanical and manpower	Mechanical and manpower
38	Cutting back/ strimming	Allow it to get on i.e. leave an area to regenerate	Cut/slash	We are currently clearing some areas of scrub to encourage butterflies and wild flowers on chalk lowland. Some pockets of scrub will be maintained.
39	Coppice on 15 year rotation	Occasionally cut rides through dense patches	Grazing, Amcide/drilling of cut stumps	Removal through lifting out of ground using hydraulics of 3 ton excavator

40		Mainly coppicing with chainsaw	As (b) and chemical stump treatment	As before also mechanical flailing
42				Cutting of scrub with chainsaw, spray strips, mow regeneration or preferably reinstate grazing
43	Rotational cutting		Cutting and grazing	Combination of machine/volunteer/ contractor
44	Patchwork felling, 10m diameter. Material removed and/or burned	Patchwork felling. Cut material burned or used to block paths elsewhere	Along edge initially felled (material burned), then cut with brushcutter (and eventually regularly mown - not got there yet).	As (c). No creation of habitat planned at present
45		Cutting of rides, coppicing, scalloping into scrub (but not treating stumps), allow re-growth. - structural/age diversity	Removal and treatment of stumps (brash is burnt on site or taken away). Grazing ~sheep, cattle and Exmoor ponies	As (c)
47	Coppicing; selective thinning of natural regeneration; tree shelter	Coppicing; selective thinning; tree shelters	Cut and treat stumps with herbicide	Cut and treat stumps; sometimes litter clearance to expose mineral soils to enhance recovery
48	Clear felling	New planting	Clear felling, mechanical flailing and grazing (cattle). Also herbicide treatments	As (c)
49		planting, natural regeneration	grazing, mowing	cutting and treatment with Amcide
51	Removal of invasive tree species, selective coppicing	As (a)	Removal and mowing	Removal, mowing and stump grinding
52	Mechanical mulcher/volunteers/our staff and forestry contractors	As (a)	As (a)	As (a)
101	Clearing by use of volunteers, staff using chainsaw or brushcutter	Cut by staff using chainsaw		Gorse (*Ulex*) - cut and burnt, re-growth treated with herbicide or preferably grazed or mown
102	*Modifying grazing regimes to allow new scrub regeneration*	*Modifying grazing levels or removal of stock temporarily*	*Cutting/Browsing Tenants routinely burn Gorse to (Ulex) limit encroachment*	*cutting followed by grazing stock*
103	Do not get involved in arresting succession. May consider it for butterfly conservation - cutting	N/A	N/A	N/A
104	None	Planting Willow (*Salix*)/Birch (*Betula*)	Gorse (*Ulex*)/ Rhododendron (*Rhododendron ponticum*) clearance - using flail	As above

105	Mainly coppice cutting - predominantly as the trees become saleable, but exceptionally at cost - but area limited due to high cost	Note - Deer damage a key cost issue, hugely increasing costs where required	Principally cutting and pulling young Pine (*Pinus*) and Birch (*Betula*) from lowland heath – c.20,000 ha in Deer Forest	Principally cutting and pulling young Pine (*Pinus*) and Birch (*Betula*) from lowland heath – c.20,000 ha in Deer Forest
106	*Felling/high pruning (infrequently)*	*Natural regeneration and some planting. Deer Control*	*Felling ("cleaning")/ chemical control/flailing*	*(Infrequently) felling/flailing*
107	*Reduction of grazing - removal of non-native trees*	*Minimal intervention, maintain grazing at low level*	-	-
108	*None - try to follow natural processes*	*Leave greater areas for natural regeneration*	*Some control within forest crops*	*Very rarely*
109	*No action*	*No action*	*Occasional re-spacing - mechanically or chemically*	*No action*
112	Just leave the bits we are prepared to retain!	None	Brushcutting, hand cutting, with volunteers in some cases, a few examples of burning on Gorse (*Ulex*) scrub	Brushcutting, hand cutting, with volunteers in some cases, a few examples of burning on Gorse (*Ulex*) scrub, but grazing is often required
113	Rotational cutting or browsing (by goats). Pollarding woodland/mature scrub edges	-	-	Cut and stump treatment - (all scrub) Removal by 360° excavator (Sea- buckthorn)
114	-	-	*Cutting, but presumption to leave a proportion (10%) in the form of small groups of bushes or larger areas*	*Felling - but leaving 10% canopy cover*
115	Coppicing	Coppicing	Chemical/sheep grazing	mechanical/chemical grazing
116	*Clear-fell larger woody species and climbers such as Clematis (*Clematis*). Plant Hawthorn (*Crataegus monogyna*), reduce grazing levels. Increase grazing levels to keep in check*	*Plant with stock protection*	*Pull up, cut, poison*	*Pull up, cut, poison*
117	*N/A*	*N/A*	*N/A*	*N/A*
118	*Cutting, burning cut material, chemical*	*Allow natural succession to progress - sometimes planting*	*Cutting, burning cut material or removal off site, chemical*	*Cutting, burning cut material or removal off site, chemical*
119	N/A	Hand cutting and tractor-mounted brushcutter	Hand cutting and tractor-mounted brushcutter + grazing	Hand cutting and tractor-mounted brushcutter plus possible treatment of stumps with herbicide.
120	Burning, Cutting, Grazing	As above plus fencing off areas to encourage regeneration	Cutting and stump treating, flail	Cutting and stump treating, flail
121	Cutting, Burning, Grazing	Cutting, Burning, Grazing	Cutting, Burning, Grazing	Cutting, Burning, Grazing
122	Removal of large trees, coppicing, thinning	Fencing to allow regeneration	cutting and stump treating	cutting and stump treating
123	N/A	N/A	occasional for archaeological sites	N/A

124	Grazing/browsing; rotational coppicing; removal of tree species from scrub areas. Gorse (*Ulex*) burning	As (a) plus some scrub clearance to create more open habitat mosaics, link glades within scrub etc. Also reduced moorland grazing or fencing to encourage scrub regeneration	As (a) plus some scrub clearance to create more open habitat mosaics, link glades within scrub etc. Also reduced moorland grazing or fencing to encourage scrub regeneration	As (a) plus some scrub clearance to create more open habitat mosaics, link glades within scrub etc. Also reduced moorland grazing or fencing to encourage scrub rgeneration
125	Mainly cutting and burning with followup spraying of re-growth	Cutting, stump treatment, spraying re-growth	Cutting, stump treatment, spraying	Cutting, stump treatment, spraying, some grubbing out.
126	-	*Fencing out grazing animals – under planting*	*Chainsaw/scrub cutter*	-
128	Coppicing or removing mature tree species	-	Cutting by tractor or by hand. Grazing cattle.	Cutting by tractor or by hand. Grazing cattle. Herbicide treatment
129	Management planning/periodic intervention including cutting unwanted species. Periodic flailing to diversify age/size classes	Scarification/bracken control with herbicides	Cutting/flailing/stump treatment/foliar treatment	Cutting/flailing/stump treatment/foliar treatment and ploughing/seeding and mowing
130	*Thinning to lay over*	-	*Flailing/cutting and chemical treatment*	*Flailing/cutting and chemical treatment*
131	Cutting/coppicing	Natural regeneration/ colonisation	Cutting/swiping/ herbicide	Cutting/swiping/ herbicide
132	*Coppicing - usually by hand*	*Planting or natural regeneration encouragement*	*Cutting, treating or removing stumps. Coppicing*	*Cutting, treating or removing stumps.*
133	Cutting	-	Cutting	Cutting
134	Cutting	planting/seed dispersal	Herbicide	Cut and burn
135	Selective removal of tree specie. e.g. Ash (*Fraxinus excelsior*) on downland sites +/- stump treatment	Coppicing 'scrub in small blocks and increase edge	Cut +/- treat stumps + foliar re-growth- brushcutter or tractor mounted swipe	Cut +/- treat stumps + foliar re-growth- brushcutter or tractor mounted swipe
136	Successional cutting in coups	-	Flailing/cutting around edges - grazing or cutting and stump treatment	Cutting and stump treatment followed by sheep grazing
137	Coppice cycle, managing blocks within an area	Plant new species in desired location	Cut and treat stumps/weed wiping, grazing with livestock	Cut and treat stumps
138	Scrub control by removal and coppicing by hand	Coppicing/glade management/ride management, by hand	Control by hand and herbicide on some stumps	-
139	For Willow (*Salix*) we cut and leave. Cut and treat Gorse (*Ulex*) stumps	For Willow (*Salix*) we cut and leave. Cut and treat Gorse (*Ulex*) stumps	For Willow (*Salix*) we cut and leave. Cut and treat Gorse (*Ulex*) stumps	For Willow (*Salix*) we cut and leave. Cut and treat Gorse (*Ulex*) stumps
140	-	-	-	Cutting and stump treatment
141	-	-	-	Mechanised wet scrub clearance methods being devised
142	Periodic/rotational cutting/coppicing	-	Cutting and treatment Cutting and grazing	Cutting and treatment Cutting and grazing
143	Cutting	Cutting	Forage Harvester	Forage Harvester

144		*Rotational cutting regimes in order to vary structure of existing scrub habitats*	*Manual/mechanical cutting and treatment of stumps. Uprooting.* *Foliar spraying (minimal)*	*Manual/mechanical cutting and treatment of stumps. Uprooting.* *Foliar spraying (minimal)*
145	Cutting blocks, strips, patches on rotation and not treating stumps	Cutting blocks, strips, patches on rotation and not treating stumps	Should be prevented by grazing or hay cuts. On some sites we pull saplings by hand (where not grazed or grazing pressure not adequate to prevent unwanted regeneration. White Poplar (*Populus alba*) suckers and Willows (*Salix*) are problems on 2 sites).	Cut and treat stumps with Amcide. On sites where we wish to convert to organic it seems stump treatment will not be allowed. This is a major problem as, despite widespread requests for help, no satisfactory alternative has been suggested.
146	Coppicing	Collect seed for propagation/planting	Felling with aftermath grazing. Treating stumps with herbicide. Coppicing	Felling with aftermath grazing. Treating stumps with herbicide. Coppicing
147	-	Open up thickets of Gorse (*Ulex*)/Blackthorn (*Prunus spinosa*) to provide more edge. In grassland/fen edge.	Latest method is to kill scrub standing, using stem notch injection with Glyphosate, this leaves trees standing. Mow areas of Bog-myrtle (*Myrica gale*) using clearing saws or tractors.	Sometimes clear scrub using tracked excavators
148	N/A	N/A	Tractor mounted swipe, some clearing saw	Tractor mounted swipe, some clearing saw
149	*Coppicing, removal*	*Coppicing,* *Rotational cutting*	*Removal,* *Cutting,* *Poisoning,* *Grazing,* *Pulling*	*Cutting and poisoning,* *Pulling.*
150	Programmes of regular cutting	Programmes of regular cutting	Cutting and treatment	Cutting and treatment.
151	-	-	Cutting and removal, usually without stump treatment	Cutting and removal, usually without stump treatment
152	*Trimming, planting, coppice*	-	*Cut/clear/chemical treat cut/clear/winch cut/clear*	*Cut/clear/chemical treat cut/clear/winch cut/clear*
153	Unnecessary - coastal site prevents succession beyond scrub	Annual planting of *Salix* spp. (Willow).	Brushcutting, hand-pulling. Encourage Rabbit (*Oryctolagus cuniculus*) grazing	Brushcutting
154	-	*Manual "coppicing"*	*Manual cutting then grazing with appropriate stock*	*Manual cutting then grazing with appropriate stock for grassland.* *On raised mires, seedlings are pulled, older birch are then treated with herbicide (Glyphosate).*

155	Cut, treat stumps as necessary - periodic and annual. Grazing	Cut edges or areas on rotation	Grazing/cutting.	Cut (manually)
156	Cutting with scrub cutters or manually and raking and stacking or burning cut material	Weed out problem species. Thin manually, cut with machinery or manually to create scallops and graded edges	Cutting by machine or hand and stump treatment where necessary – e.g. Gorse (*Ulex*), Birch (*Betula*).	Cutting by machine or hand and stump treatment where necessary – e.g. Gorse (*Ulex*), Birch (*Betula*).
157	Coppicing	coppice edges of blocks to create dense edge	Fencing/flail	-
158	Rotational cutting	Minimum intervention/cutting	Cutting back of scrub. Grazing	Cutting and chemical treatment of stumps
159	*Grazing, cutting*	*Reduction of grazing pressure, e.g. Juniper (Juniperus). Rotational cutting e.g. Gorse (Ulex) scrub on coast and uplands*	*Grazing.* *Cutting.* *Pulling young seedlings and young conifers.* *Winter burning.*	*Cutting, then treatment of stumps with Krenite or other approved herbicides.*
160	30-50m sections of old hedgerows/wood margins cut on rotation - power tools	Rotational cutting to rejuvenate 'old' stands	Removal of some scrub and stump treatment to leave a proportion	Removal of moribund scrub (Blackthorn [*Prunus spinosa*]/ Hawthorn [*Crataegus monogyna*]) and larger trees to extend grassland back to boundaries – power tools/stump treatment
161	Coppice	Rotational coppicing (plus exclusion of grazing for Juniper (*Juniperus*)- one small site only and then just localised area)	Strimming, burning, cutting, flailing, bulldozing, rotovating, treating with herbicide, spraying with herbicide, weedwiping with herbicide, pulling out (wet habitats), grazing – ponies, sheep, cattle.	Strimming, burning, cutting, flailing, bulldozing, rotovating, treating with herbicide, spraying with herbicide, weedwiping with herbicide, pulling out (wet habitats), grazing – ponies, sheep, cattle.
162	-	Open denser pockets to maintain diversity of structure and prevent alteration to ground bog flora - stump treatment, brushcutting and chainsaw with 1:4 Roundup	-	Tractor mounted circular saw cutting followed by pesticide stump application. Digging up using excavators. Spraying Krenite and Roundup. Cutting down Pine (*Pinus*)and handweeding Pine (*Pinus*) and Birch (*Betula*) seedlings
163	-	Cutting with tractor and flail	-	Tractor and flail, application of Krenite, clearance using clearing saws, raising water levels - raise water levels - peat forming vegetation

164	*Very few –* *Many sites with scrub present are fairly stable when considering succession due to location (e.g. upland) or natural grazing pressures of rabbit (*Oryctolagus cuniculus*) and deer. Also physical removal on rotation.*	*Usually physical removal of selected scrub on a rotational basis, and reduced grazing pressure*	*Grazing or haymaking on grassland sites physical removal - cutting and stump treatment*	*Physical removal - cutting and stump treatment*
165	*Coppicing*	-	*Raising water tables. Grazing*	*Cutting and stump treating*
166	Cutting mature scrub on 15 year cycle		Cutting/stump treatment	Cutting/stump treatment
167	*Burning/cutting*	*Burning/Cutting*	-	-
168	-	-	*Cut – treat cut stumps – burn out material at suitable location - graze*	*Cut – treat cut stumps – burn out material at suitable location - graze*
169	Coppicing mature scrub in large blocks. Areas of typically 0.1 ha in a block on approx. 20 year rotation. Use of Hi-tip forage harvester to cut and remove cuttings in small gorse to maintain Gorse (*Ulex*)/grass habitat for Dark Green Fritillary (*Argynnis aglaja*). Also to maintain heath on chalk. Cut and treat stumps in small blocks in areas of scrub/grass mix to maintain the balance required, especially for Duke of Burgundy (*Hamearis lucina*). Species not controlled by cut and treat, e.g. Wild Privet (*Ligustrum vulgare*) and Gorse (*Ulex*) may be spot-sprayed with Garlon 2 in these situations. Swipe - used to vary age structure in gorse - approx. 6 year rotation. Hedge - cut on a 3 year rotation in sections of 30 m (60 m uncut) either with a blade or flail.	-	Where coppiced scrub comes back totally dominated by e.g. Blackthorn (*Prunus spinosa*) or Wild Privet (*Ligustrum vulgare*) On the edge of grassland it may be controlled by spot-spraying. Cut and treat stumps. Spot-spraying of species not susceptible to cut and treat e.g. Wild Privet (*Ligustrum vulgare*), Gorse (*Ulex*) and some thick Blackthorn (*Prunus spinosa*). Grazing with sheep and trialing goats in areas of grassland with scattered scrub and scrub/grass mix. Generally retards scrub growth and specifically used on Ash (*Fraxinus excelsior*) seedlings and Clematis (*Clematis*).	Use of droth to remove scrub especially for restoration of chalk heath
170	Naturally restricted by agriculture and poor soils	Hand cutting	Hand cutting/pulling/ felling Cattle and sheep and Rabbits (*Oryctolagus cuniculus*)	Hand cutting/pulling/ felling Cattle and sheep and Rabbits (*Oryctolagus cuniculus*)

171	Coppicing along woodland/fen edge on approx. 10 year rotation to maintain standard diversity of scrub fringe. Extensive grazing schemes coming up soon may enhance this.	-	Removal of scattered scrub by cutting, stump treatment by herbicide (Roundup) or grinding, follow-up foliar treatment (Roundup)	Removal of scattered scrub by cutting, stump treatment by herbicide (Roundup) or grinding, follow-up foliar treatment (Roundup). Large-scale mechanical scrub/woodland removal starting in Broads this winter, using tracked vehicle to cut and chip, rather than gangs with chainsaws, to reduce ground damage in wet areas.
172	*Grazing, cutting*	*Managed grazing. Stock exclusion. Enrichment by planting*	*Cutting, herbicides*	*Cutting, herbicides*
173	*Gorse (*Ulex*) cut small area each year in Feb/March allow to regenerate and graze from July.* *The grazing effectively kills off tree species but allows Gorse (*Ulex*) to get away*	-	*Birch (*Betula*)-* *< 1 m tall spray with Krenite July-Sept –* *>1m cut, leave or chip if large amounts spray following Summer with Krenite.*	-
174	Coppicing, periodic cutting of scrub boundary	Control of invasive species e.g. Sycamore (*Acer pseudo-platanus*). Coppicing to create range of age structures	Cutting and removal; stump treatment with herbicides; control of re-growth and general control with goats and ponies. Some grubbing/bulldozing with removal of litter layer.	Cutting and removal; stump treatment with herbicides; control of re-growth and general control with goats and ponies. Some grubbing/bulldozing with removal of litter layer.
175	Coppicing	-	Clearance by hand/machine depending on ground conditions slope etc., followed by chemical treatment of re-growth or cut stumps with Trichoplyr or Glyphosate	Clearance by hand/machine depending on ground conditions slope etc., followed by chemical treatment of re-growth or cut stumps with Trichoplyr or Glyphosate
176	-	-	Cutting by chainsaw/hand and treatment of stumps	Cutting by chainsaw/hand and treatment of stumps and grazing with range of cattle/sheep etc.
177	Rotational coppicing to improve age structure	Rotational coppicing to improve age structure	Scrub removal usually with stump treatment; also appropriate grazing	Scrub removal usually with stump treatment; also appropriate grazing
178	Periodic clearance, then allow to re-grow coppicing	Coppicing, removal by machine - allowed to re-grow	Cut/treat stumps (remove by machine)	(Cut/treat stumps) Remove by machine. Pull saplings up.

179	1. Coppicing - clearfell in groups or along edges to renew succession, sometimes fenced to protect from Deer. 2. Layering - "hedge-laying" blocks or strips of scrub, esp. along edges. Creates 'instant' 5-year old scrub structures and avoids damage to Black Hairstreak (*Strymonidia pruni*) eggs in winter.	1. Coppicing - clearfell in groups or along edges to renew succession, sometimes fenced to protect from Deer. 2. Layering - "hedge-laying" blocks or strips of scrub, esp. along edges. Creates 'instant' 5-year old scrub structures and avoids damage to Black Hairstreak (*Strymonidia pruni*) eggs in winter. 3. Grazing to produce grass/scrub mosaics.	Clearing/coppicing as necessary	1.Clearing/Coppicing – Hawthorn (*Crataegus monogyna*), Rose (*Rosa*), Wild Privet (*Ligustrum vulgare*) etc. 2. Clearing and chemical treatment (foliar application of "Roundup" - Turkey Oak (*Quercus cerris*)
180	*Grazing/browsing; cutting*	-	*Grazing/browsing; cutting*	*Grazing/browsing; cutting*
181	-	Control stock grazing (fencing; paying for differential grazing) Rabbit (*Oryctolagus cuniculus*) control (all forms but mostly netting and drop boxes)	Small scale - pulling saplings; cutting +/- stump-treatment	-

182	Rotational coppicing	Re-introduction of grazing to produce grass/scrub mosaic. Growth of young Juniper (*Juniperus*) from seed/cuttings and planting out in protected exclosures	Sheep grazing, clearance and treatment of stumps	Various means inc. removal with machinery, chainsaw, ring-barking of young trees, manual cutting using volunteer groups
183	Extensive grazing. Clearance and stump treatment	Local coppicing, particularly on habitat transitions i.e. scrub - fen, heath	Extensive grazing. Clearance and stump treatment	Extensive grazing. Clearance and stump treatment
184	*Cyclical cutting on a small scale –* *I suppose every 15-20 years or so* *(though we're nowhere near achieving a cycle as yet).*	*Cyclical cutting to create mosaics of scrub of different ages.* *Exclosure to allow grassland to develop to scrub.* *Stump treatment (with Tricloplyr) to create frilly edges, glades etc. in extensive blocks.* *Sheep grazing/cattle grazing to maintain mosaics.*	*Sheep grazing July - March (though this relatively late turn-out date may in fact be allowing much Hawthorn* (Crataegus monogyna*) in - so may change).*	*Mechanical - bowsaw, loppers, chainsaw, brushcutter and subsequent herbicide applied with paint brush (Timbrel), though we are moving more to accepting shorter term cyclical cutting as a chemical free alternative. Would like to try cutting followed up with browsing stock.*
185	*Cut/coppice to stop succession to woodland*	-	*Undercliffs - mowing twice a year on grassland area*	*Undercliffs - mowing twice a year on grassland area*
186	Rotational cutting at different ages	None	Cutting and stump or foliar herbicide	Cutting and burning
187	Chainsaw clearance/stump treatment (Farmer preferred). Have pulled out Willow (*Salix*) in past on Otmoor (and got Fen Violet [*Viola persicifolia*] back in its place!)	Coppicing	Chainsaw clearance/stump treatment (Farmer preferred). Have pulled out Willow (*Salix*) in past on Otmoor (and got Fen Violet [*Viola persicifolia*] back in its place!)	Chainsaw clearance/stump treatment (Farmer preferred). Have pulled out Willow (*Salix*) in past on Otmoor (and got Fen Violet [*Viola persicifolia*] back in its place!)
188	Grazing. Clearance and chemical control.	Light grazing regimes.	Grazing and chemical.	Clearance. Chemical. Grazing.
190	Cutting on rotation	Cutting in more *ad hoc* way	Mowing, herbicidal control, limited amount of mattock work on fens	Cutting and stump treatment. Mechanical removal roots and all - very limited. Hand removal - very limited
191	Removal by chainsaw/clearing saw. Grazing by cattle/ponies/sheep.	Coppicing of scrub using chainsaw	Removal by chainsaw/clearing saw. Grazing by cattle/ponies/sheep. Spraying using approved chemical -grazing by cattle/ponies/sheep.	Clearance by chainsaw/clearing saw. Clearance using tracked machines

Appendix 5.4 Main scrub types managed and reasons for their management

Key: Lowland, *Upland and lowland,* Upland.

BIRCH (*Betula*)

Respondent number	*Scrub type*	*a) conserve existing scrub*	*b) enhance value of existing scrub*	*c) increase area of particular scrub type*	*d) remove in order to conserve another habitat*
17	Birch (*Betula*)		X		X - higher forest
29	Birch (*Betula*)				X - lowland heath
35	Birch (*Betula*)	X	X		X - sometimes on heathlands
37	Birch (*Betula*)	X	X		X - heathland
44	Birch (*Betula*)	X			
4	Birch (*Betula*) - lowland				X - lowland heath
16	Birch (*Betula*) - lowland	X			X - acid/neutral grassland
17	Birch (*Betula*) - lowland		X		X - higher forest
47	Birch (*Betula*) - lowland	X	X		X
12	Birch (*Betula*) and Pine (*Pinus*)	X	X		X - heathland
9	Birch (*Betula*) /Oak (*Quercus*) - lowland				X - lowland heath
19	Birch (*Betula*) /Oak (*Quercus*) with large amounts of Sycamore (*Acer pseudo-platanus*)		X - some areas remove Sycamore (*Acer pseudo-platanus*) and replace with native species		X - to regain and preserve lowland heath/grassland habitats
1	Birch (*Betula*)/Oak (*Quercus*)/Gorse (*Ulex*)(heath)	X			X
9	Birch (*Betula*) /Scots Pine (*Pinus sylvestris*) - lowland			X	X - lowland heath
32	Birch(*Betula*) /Willow (*Salix*) - lowland	X	X		X
41	Silver Birch (*Betula pendula)*				X - heathland
172	*Birch (Betula)*	*X*	*X*		
114	*Birch (Betula)*				*X*
120	Birch (*Betula*)				X - (rhos pasture)
189	Birch (*Betula*)		X		X
171	Birch (*Betula*) -coastal dune heath	X			X - dune heath
135	Birch (*Betula*) - lowland	X	X		X - lowland heath/neutral grassland
163	Birch (*Betula*) - lowland cut-over peatland		X		X - lowland peat bog
103	Birch (*Betula*) - upland		X	X	

106	Birch (*Betula*) - upland	X	X		X - conifer plantation
159	Birch (*Betula*) – Willow (*Salix*) - lowland				X - (wet grassland, important for Marsh Fritillary [*Eurodryas aurinia*])
159	*Birch (Betula) and conifer saplings and Rhododendron (Rhododendron ponticum)*				*X - (lowland raised mire)*
186	Birch (*Betula*) and mire edge	X			
105	Birch (*Betula*) in conifer stands				X - removal never total
162	Birch (*Betula*) scrub - lowland				X - lowland raised bog and heath
162	Birch (*Betula*) scrub - lowland		X Scrub on bog		
175	Birch (*Betula*) /Alder (*Alnus*) etc.				X - mire
132	*Birch (Betula) /Elder (Sambucus nigra)/Elm (Ulmus)/non natives*				*X - cut,remove to create/restock high forest or meadow*
155	Birch (*Betula*) /Gorse (*Ulex*)/Broom (*Cytisus scoparius*)		X		X - Fen/marsh heathland
186	Birch (*Betula*) /Pine (*Pinus*) on heath	X cut on rotation			X
131	Birch(*Betula*) /Rowan (*Sorbus aucuparia*)		X	X	X
129	Birch (*Betula*) /Willow (*Salix*)				X - lowland heathland
173	*Birch(Betula) /Willow (Salix)*				*X - Peat Bog*
149	*Birch (Betula) - conifer*				*X - Peat Bogs*
180	Upland – Birch (*Betula*)	X		X	X - moorland Heather (*Calluna vulgaris*)
124	Upland Birch (*Betula*)	X	X	X	X - (dwarf shrub moor)
107	Upland Birch (*Betula*) /Willow (*Salix*)	X	X	X	
161	W4 (Young) Birch (*Betula*) (and Purple Moor-grass [*Molinia caerulea*])				X - Heathland and Mire (H & M)

BLACKTHORN (*Prunus spinosa*) (all lowland)

Respondent number	*Scrub type*	*a) conserve existing scrub*	*b) enhance value of existing scrub*	*c) increase area of particular scrub type*	*d) remove in order to conserve another habitat*
44	Blackthorn (*Prunus spinosa*) / Hawthorn (*Crataegus monogyna*) - lowland	X	X		X - (acid grassland)

3	Blackthorn (*Prunus spinosa*)		X		
13	Blackthorn (*Prunus spinosa*)		X		
30	Blackthorn (*Prunus spinosa*) - downland coombes and cliff tops	X - by rotational coppicing/removal of pioneer woodland	X - by removal of pioneer woodland trees		X - chalk grassland/open downland landscape / archaeological features
4	Blackthorn (*Prunus spinosa*) - lowland				X - old orchard grassland (neutral)
10	Blackthorn (*Prunus spinosa*) - lowland	X	X		
16	Blackthorn (*Prunus spinosa*) - lowland				X - lowland heath
44	Blackthorn (*Prunus spinosa*) - lowland		X		X - (acid grassland)
52	Blackthorn (*Prunus spinosa*) - lowland	X			
32	Blackthorn (*Prunus spinosa*)/Hawthorn (*Crataegus monogyna*) - lowland	X	X	X	
1	Blackthorn(*Prunus spinosa*)/Hawthorn (*Crataegus monogyna*)/ Dogwood (*Cornus sanguinea*) (downs)	X			X
11	Blackthorn (*Prunus spinosa*), lowland	X	X		
121	Blackthorn (*Prunus spinosa*)		X		X - neutral grassland
128	Blackthorn (*Prunus spinosa*)	X	X	X	X - Neutral grassland
134	Blackthorn (*Prunus spinosa*)	X			X
119	Blackthorn (*Prunus spinosa*) - lowland				X - (calcareous grassland)
135	Blackthorn (*Prunus spinosa*) - lowland				X - neutral grassland
137	Blackthorn (*Prunus spinosa*) - lowland	X	X - species specific		
179	Blackthorn (*Prunus spinosa*) - lowland	X	X	X	
187	Blackthorn (*Prunus spinosa*) - lowland				X - calcareous grassland/heath mosaic
112	Blackthorn (*Prunus spinosa*) & Hawthorn (*Crataegus monogyna*) etc.				X - (limestone and neutral grassland)
147	Blackthorn (*Prunus spinosa*) /Gorse (*Ulex*) - lowland grassland	X - Belts of Willow (*Salix*), Alder (*Alnus glutinosa*) and Birch (*Betula*) along water courses	X	X - Alders (*Alnus glutinosa*) have been planted along river banks at Cors Geirch	

122	Lowland Blackthorn (*Prunus spinosa*)	X	X	X	
161	W22 Blackthorn (*Prunus spinosa*) – Bramble (*Rubus fruticosa*) scrub		X		X - Grasslands (CG & MG & mires (M))

BRAMBLE (*Rubus fruticosa*)

Respondent number	*Scrub type*	*a) conserve existing scrub*	*b) enhance value of existing scrub*	*c) increase area of particular scrub type*	*d) remove in order to conserve another habitat*
13	Bramble (*Rubus fruticosa*)				
17	Bramble (*Rubus fruticosa*)		X		X - higher forest
32	Bramble (*Rubus fruticosa*)	X	X	X	X
45	Bramble (*Rubus fruticosa*)				X - chalk grassland
4	Bramble (*Rubus fruticosa*) - lowland	X	X	X	X - acid/neutral grassland
16	Bramble (*Rubus fruticosa*)- lowland	X	X	X	X - old orchard grassland (neutral)
173	*Bramble (Rubus fruticosa)*	*X*			
161	W24 Bramble (*Rubus fruticosa*) - Yorkshire Fog (*Holcus lanatus*)				X - Grassland (MG, CG & U) and Heathland (H)

ELDER (*Sambucus nigra*) (all lowland)

Respondent number	*Scrub type*	*a) conserve existing scrub*	*b) enhance value of existing scrub*	*c) increase area of particular scrub type*	*d) remove in order to conserve another habitat*
4	Elder (*Sambucus nigra*) - lowland				X - acid/neutral grassland
16	Elder (*Sambucus nigra*) - lowland				X - acid/neutral grassland
22	Elder (*Sambucus nigra*) - lowland				X
170	Elder (*Sambucus nigra*)/Hawthorn (*Crataegus monogyna*)				X - dune grassland toad pools

GORSE (*Ulex*)

Respondent number	*Scrub type*	*a) conserve existing scrub*	*b) enhance value of existing scrub*	*c) increase area of particular scrub type*	*d) remove in order to conserve another habitat*
12	Gorse (*Ulex*)	X	X		X - heathland
13	Gorse (*Ulex*)	X	X		
29	Gorse (*Ulex*)				X - lowland heath
35	Gorse (*Ulex*)	X	X		X - sometimes on heathland
37	Gorse (*Ulex*)	X	X		X - heathland
40	Gorse (*Ulex*)				X - chalk grassland
45	Gorse (*Ulex*)		X		X - chalk grassland in some areas

26	Gorse (*Ulex*) - lowland				X - remove or coppice
172	*Gorse (Ulex)*	*X*			*X*
120	Gorse (*Ulex*)	X	X		X
124	Gorse (*Ulex*)	X	X		X
125	Gorse (*Ulex*)	X	X		X - chalk grassland
129	Gorse (*Ulex*)	X	X	X	
133	Gorse (*Ulex*)	X	X		
134	Gorse (*Ulex*)	X			X
152	*Gorse (Ulex)*	*X*			
154	*Gorse (Ulex)*		*X*		
156	Gorse (*Ulex*)				X - Heathland (some kept)
173	*Gorse (Ulex)*	*X*	*X*		
104	Gorse (*Ulex*)				X - native species woodlands
159	Gorse (*Ulex*) - coastal	X			X - (saltmarsh)
119	Gorse (*Ulex*) - lowland		X		X - (neutral and acid grassland)
131	Gorse (*Ulex*) - lowland	X	X		X - Heathland
135	Gorse (*Ulex*) - lowland	X	X		X - lowland heath
179	Gorse (*Ulex*) - lowland	X			
112	Gorse *U.gallii* & *U.europeaus*				X - (limestone grassland, limestone heath and other heaths)
119	Gorse (*Ulex*) - upland	X	X		X - (moorland and acid grassland)
164	Gorse (*Ulex*) - upland				X - acid grassland neutral and calcareous grassland
167	Gorse (*Ulex*) - upland	X - rotational management			
118	*Gorse (Ulex) & Hawthorn (Crataegus mongyna)*	*X - to keep in balance with other communities on coastal heath*		*X - and promote further succession*	*X - limestone grassland*
191	Gorse (*Ulex*) and Birch (*Betula*) lowland	X	X - coppicing		
169	Gorse (*Ulex*) block	X	X		
130	Gorse (*Ulex*) Lowland				X - Woodland
174	Gorse (*Ulex*) lowland	X			X - chalk heath and chalk grassland)
101	Gorse (*Ulex*) scrub				X - magnesian limestone grassland
121	Gorse (*Ulex*) scrub	X	X		X - maritime grassland and heathland

191	Gorse (*Ulex*), Bramble (*Rubus fruticosus*) - lowland				X - chalk grassland
132	*Gorse (Ulex), Broom (Cytisus scoparius)*		*X*		
160	Gorse (*Ulex*) /Birch (*Betula*)/Willow (*Salix*)- lowland	X	X		X - (heathland)
180	Upland – Gorse (*Ulex*)	X		X	
161	W23 Gorse (*Ulex europaeus*) – Bramble (*Rubus fruticosus*) scrub	X	X		X - Grassland (MG & U) and Heathland (H)
184	*Western Gorse (Ulex gallii)*			*X*	

HAWTHORN (*Crataegus monogyna*)

Respondent number	*Scrub type*	*a) conserve existing scrub*	*b) enhance value of existing scrub*	*c) increase area of particular scrub type*	*d) remove in order to conserve another habitat*
14	Hawthorn (*Crataegus monogyna*)	X			
14	Hawthorn (*Crataegus monogyna*)				X
29	Hawthorn (*Crataegus monogyna*)		X - where downland meets woodland		X - chalk grassland
30	Hawthorn (*Crataegus monogyna*) - downland coombes and cliff tops	X - by rotational coppicing/removal of pioneer woodland	X - by removal of pioneer woodland trees		X - chalk grassland/open downland landscape / archaeological features
3	Hawthorn (*Crataegus monogyna*) - lowland				X - natural grassland
4	Hawthorn (*Crataegus monogyna*) - lowland	X			X - acid/neutral grassland
6	Hawthorn - lowland	X	X - to create thick coppice re-growth		X - grassland
20	Hawthorn (*Crataegus monogyna*) - lowland	X	X		X - chalk grassland/neutral grassland
22	Hawthorn (*Crataegus monogyna*) - lowland		X		X
23	Hawthorn (*Crataegus monogyna*) - lowland	X	X		
27	Hawthorn (*Crataegus monogyna*) - lowland				X - neutral and chalk grassland
39	Hawthorn (*Crataegus monogyna*) - lowland	X			X - chalk grassland

43	Hawthorn (*Crataegus monogyna*) - lowland	X	X		X
38	Hawthorn (*Crataegus monogyna*) - wasteland	X	X		X
8	Hawthorn (*Crataegus monogyna*)/ Dog-rose (*Rosa canina*)	X	X		X - calcareous grassland and Oxford Clay and limestone
22	Hawthorn (*Crataegus monogyna*), Blackthorn (*Prunus spinosa*), Elder (*Sambucus nigra*)		X		
11	Hawthorn, (*Crataegus monogyna*), lowland	X	X		
40	Hawthorn (*Crataegus monogyna*) /Blackthorn (*Prunus spinosa*)	X	X		X - chalk grassland
41	Hawthorn (*Crataegus monogyna*) /Blackthorn (*Prunus spinosa*)	X	X		X - chalk grassland
45	Hawthorn (*Crataegus monogyna*) /Blackthorn (*Prunus spinosa*) -lowland		X		X - chalk grassland
49	Hawthorn (*Crataegus monogyna*)/ Blackthorn (*Prunus spinosa*) - lowland				X - chalk grassland
48	Hawthorn (*Crataegus monogyna*)/ Bramble (*Rubus fruticosa*)	X		X	
10	Hawthorn (*Crataegus monogyna*) /Dog-rose (*Rosa canina*)- lowland				X - flower rich grassland
9	Hawthorn (*Crataegus monogyna*) /Oak (*Quercus*)/Bramble (*Rubus fruticosus*) - lowland	X	X		
48	Hawthorn (*Crataegus monogyna*) /Willow (*Salix*)/other species				X

172	*Hawthorn (Crataegus monogyna) /Blackthorn (Prunus spinosa)*	*X*	*X*		
125	Hawthorn (*Crataegus monogyna*)				X chalk grassland
152	*Hawthorn (Crataegus monogyna)*	*X*			*X (Limestone)*
189	Hawthorn (*Crataegus monogyna*)				X
122	Hawthorn (*Crataegus monogyna*) - Grassland				X
101	Hawthorn (*Crataegus monogyna*) - lowland	X	X		
115	Hawthorn (*Crataegus monogyna*) - Lowland	X	X		X chalk grassland
119	Hawthorn (*Crataegus monogyna*) - lowland		X		X (neutral and calcareous grassland)
127	Hawthorn (*Crataegus monogyna*) - lowland		X		X chalk grassland
128	Hawthorn (*Crataegus monogyna*) - lowland	X	X	X	Neutral grassland
129	Hawthorn (*Crataegus monogyna*) - lowland	X	X		
131	Hawthorn (*Crataegus monogyna*) - lowland	X	X		X Chalk grassland
137	Hawthorn (*Crataegus monogyna*) - lowland	X chalk downland			X chalk downland
145	Hawthorn (*Crataegus monogyna*) - lowland	X	X		X
168	Hawthorn (*Crataegus monogyna*) - lowland				X neutral grassland
177	Hawthorn (*Crataegus monogyna*) - lowland		X Wood/grass edge (The Wyre Forest)		
177	Hawthorn (*Crataegus monogyna*) - lowland				X neutral grassland
179	Hawthorn (*Crataegus monogyna*) - lowland	X	X		X Blackthorn (*Prunus spinosa*) scrub mixed calcareous scrub
190	Hawthorn (*Crataegus monogyna*) - lowland		X		X

177	Hawthorn (*Crataegus monogyna*) - lowland (including Birch (*Betula*)/ Sycamore, *Acer pseudoplatanus*)				X Acid grassland (1) Wetland (2) 1 = The Malvern Hills 2 = Castlemorton Common and other sites
157	Hawthorn (*Crataegus monogyna*) - Lowland/riverside	X	X		
102	Hawthorn (*Crataegus monogyna*) - upland	X		X	
116	Hawthorn (*Crataegus monogyna*) - upland			X	
122	Hawthorn (*Crataegus monogyna*) - Upland	X	X	X	
124	Hawthorn (*Crataegus monogyna*) - upland	X	X		
146	Hawthorn (*Crataegus monogyna*) - upland				X
167	Hawthorn (*Crataegus monogyna*) - upland	X non-intervention			
158	Hawthorn (*Crataegus monogyna*) (lowland)				X
146	Hawthorn (*Crataegus monogyna*) + mixed scrub (invertebrates)	X	X		
164	Hawthorn (*Crataegus monogyna*) and Blackthorn (*Prunus spinosa*) - lowland	X			X neutral grass
116	Hawthorn (*Crataegusmonogyna*) in parkland			X plant Hawthorn (*Crataegusmonogyna*) as nectar source	
116	Hawthorn (*Crataegus monogyna*) in uplands		X	X plant Hawthorn (*Crataegus monogyna*) in uplands	
187	Hawthorn (*Crataegusmonogyna*) lowland	X for Hairstreaks etc.			
168	Hawthorn (*Crataegus monogyna*) upland				X limestone grassland
164	Hawthorn (*Crataegusmonogyna*) , Blackthorn (*Prunus spinosa*) and young trees				X geological exposures

191	Hawthorn (*Crataegus monogyna*), Blackthorn (*Prunus spinosa*), Hazel (*Corylus avellana*) - lowland	X Coppicing		
144	Hawthorn (*Crataegus monogyna*), Gorse (*Ulex*), Blackthorn (*Prunus spinosa*)- lowland		X	X limestone grassland
144	Hawthorn (*Crataegus monogyna*) , Gorse (*Ulex*), Blackthorn (*Prunus spinosa*) - lowland			X species rich hay meadows
112	Hawthorn (*Crataegus monogyna*), Hazel (*Corylus avellana*)			X geological exposures
164	Hawthorn (*Crataegus monogyna*), Rose (*Rosa*) and Blackthorn (*Prunus spinosa*) upland	X	X	X neutral and calcareous grassland
154	*Hawthorn (Crataegus monogyna)/ Blackthorn (Prunus spinosa)*			*X Limestone grassland*
142	Hawthorn (*Crataegusmonogyna*) / Blackthorn (*Prunus spinosa*) - lowland	X		X chalk grassland
157	Hawthorn (*Crataegusmonogyna*) / Blackthorn (*Prunus spinosa*) lowland	X	X	X flower rich rides
116	*Hawthorn (Crataegus monogyna)/ Blackthorn (Prunus spinosa), in grassland*			*X semi-improved pasture- remove Bramble (Rubus fruticosa), Blackthorn (Prunus spinosa), Hawthorn (Crataegus monogyna)*
160	Hawthorn (*Crataegusmonogyna*) / Blackthorn (*Prunus spinosa*)/ Elder (*Sambucus nigra*)/ Dogwood (*Cornus sanguinea*)	X		X (chalk grassland)
132	*Hawthorn (Crataegus monogyna)/ Blackthorn (Prunus spinosa)/ Willow (Salix)/ Hazel (Corylus avellana)*	*X regenerate by coppicing*		

176	Hawthorn (*Crataegus monogyna*)/ Bramble (*Rubus fruticosa*) lowland				X Calcareous grass neutral meadows
166	Hawthorn (*Crataegus monogyna*)/ Sloe (*Prunus spinosa*) lowland	X			X neutral grassland MG5
166	Hawthorn (*Crataegus monogyna*)/ Sloe (*Prunus spinosa*) lowland				X limestone grassland CG5
179	Hawthorn (*Crataegus monogyna*)/ Turkey oak (*Quercus cerris*)				X limestone grassland X neutral grassland
149	*Hawthorn (Crataegus monogyna) –Birch (Betula)-Gorse (Ulex)*				*X Metalliferous grasslands*
149	*Hawthorn (Crataegus monogyna) -Gorse (Ulex)*				*X Calcicole grasslands*
142	Bramble (*Rubus fruticosus*)/ Hawthorn (*Crataegus monogyna*) - lowland	X			X neutral grassland
175	Calcicolous scrub Hawthorn (*Crataegus monogyna*) etc. NVC W21, 22		X		X calcareous grassland
184	*Daleside Hawthorn (Crataegus monogyna)*	*X*	*X*		*X (calcicolous grassland)*
176	Ditches with Hawthorn (*Crataegus monogyna*)				X Ditches of invertebrate/ botanical interest
155	Lowland Hawthorn (*Crataegus monogyna*)		X		X chalk grassland, neutral grassland
174	Mixed deciduous Hawthorn (*Crataegus monogyna*) dominant lowland	X	X		X (chalk grassland)
105	Thorn & similar	X			
161	W21 Hawthorn (*Crataegus monogyna*) – Ivy (*Hedera helix*)	X esp. W21d	X esp W21d	X only Juniper (*Juniperus*) (one or two bushes in Dorset in W21d)	X Grasslands (CG, MG & U)

HAZEL (*Corylus avellana*)

Respondent number	*Scrub type*	*a) conserve existing scrub*	*b) enhance value of existing scrub*	*c) increase area of particular scrub type*	*d) remove in order to conserve another habitat*
17	Hazel (*Corylus avellana*)		X		X - higher forest
172	*Hazel (Corylus avellana)*	*X*	*X*		
103	Hazel (*Corylus avellana*) - upland		X	X	
107	Hazel (*Corylus avellana*) - upland	X	X	X	
147	Hazel (*Corylus avellana*) (Woodland) lowland		X Coppice on long rotation 15+ years		
121	Hazel (*Corylus avellana*)/ Bramble (*Rubus fruticosus*)	X	X	X	
184	*Hazel (Corylus avellana) retrogressive*	*X*	*X*		

JUNIPER (*Juniperus*)

Respondent number	*Scrub type*	*a) conserve existing scrub*	*b) enhance value of existing scrub*	*c) increase area of particular scrub type*	*d) remove in order to conserve another habitat*
5	Juniper (*Juniperus*)	X	X	X	
102	*Juniper (Juniperus)*	*X*		*X*	
104	Juniper (*Juniperus*)	X			
107	*Juniper (Juniperus)*	*X*	*X*	*X*	
125	Juniper (*Juniperus*)	X	X	X	
127	Juniper (*Juniperus*)	X	X	X	
158	Juniper (*Juniperus*)	X	X	X	
190	Juniper (*Juniperus*)	X	X	X	
115	Juniper (*Juniperus*) - Lowland		X	X	
182	Juniper (*Juniperus*) - lowland	X	X	X	
159	*Juniper (Juniperus)- upland and lowland on both acidic and calcareous soils*	*X*	*X*	*X*	

MIXED (ALL LOWLAND)

Respondent number	*Scrub type*	*a) conserve existing scrub*	*b) enhance value of existing scrub*	*c) increase area of particular scrub type*	*d) remove in order to conserve another habitat*
9	mixed deciduous lowland	X	X		X - unimproved grassland
51	mixed lowland	X	X	X	X - wet meadow (or rough meadow)
24	mixed scrub	X			
24	mixed scrub		X		
24	mixed scrub				X - acid heath
24	mixed scrub				X - calcareous heath
42	mixed scrub - woodland fringe	X	X - leave undulating lines for butterflies		
14	Mixed species	X			

42	mixed species scrub - chalk grassland		X - leave undulating lines for butterflies		X - chalk grassland
135	Mixed - lowland	X	X		X chalk downland
137	Mixed - lowland			X Habitat restoration	
190	Mixed calcareous	X	X		X
179	Mixed calcareous scrub - lowland	X	X		
182	Mixed chalk scrub	X	X		X chalk grassland
174	Mixed deciduous Hawthorn (*Crataegus monogyna*) dominant lowland	X	X		X (chalk grassland)
150	Mixed Gorse (*Ulex*), Hawthorn (*Crataegus monogyna*), Willow (*Salix*)	X	X		X (heathland-lowland)
148	Mixed native broadleaf	X			X Deer lawns upland heath
125	Mixed scrub	X	X		X chalk grass
146	Mixed scrub (for birds)	X			
169	Mixed scrub blocks	X	X		
185	Mixed scrub lowland coastal	X	X		X coastal grassland
128	Mixed woodland edge	X	X	X	
102	Mixed-spp scrub lowland				X limestone grassland

OAK (*Quercus*)(ALL LOWLAND)

Respondent number	*Scrub type*	*a) conserve existing scrub*	*b) enhance value of existing scrub*	*c) increase area of particular scrub type*	*d) remove in order to conserve another habitat*
29	Oak (*Quercus*)				X - lowland heath
	Oak (*Quercus*) - lowland	X	X		X - neutral grassland and grassy heath
16	Oak (*Quercus*) - lowland	X	X		X - neutral grassland and grassy heath
6	Oak (*Quercus*)/Birch (*Betula*)/ Aspen (*Populus tremula*)		X - to create thick coppice re-growth		X - heath acid grassland
183	Oak(*Quercus*) /Birch (*Betula*)	X conserve some - not all			X Heathland

RHODODENDRON (*Rhododendron ponticum*)

Respondent number	*Scrub type*	*a) conserve existing scrub*	*b) enhance value of existing scrub*	*c) increase area of particular scrub type*	*d) remove in order to conserve another habitat*
7	Rhododendron (*Rhododendron ponticum*)				X - woodland heath
29	Rhododendron (*Rhododendron ponticum*)				X - woodland
37	Rhododendron (*Rhododendron ponticum*)				X - heathland
4	Rhododendron (*Rhododendron ponticum*)- lowland				X - woodland
172	*Rhododendron (Rhododendron ponticum)*				*X*
104	**Rhododendron (*Rhododendron ponticum*)**				**X**
175	Rhododendron (*Rhododendron ponticum*)				X Sessile oakwood heathland mire
191	Rhododendron (*Rhododendron ponticum*) lowland				X Heath

SEA-BUCKTHORN (*Hippophae rhamnoides*)(ALL LOWLAND)

Respondent number	*Scrub type*	*a) conserve existing scrub*	*b) enhance value of existing scrub*	*c) increase area of particular scrub type*	*d) remove in order to conserve another habitat*
154	Sea-buckthorn (*Hippophae rhamnoides*)				X Dune habitats
175	Sea-buckthorn (*Hippophae rhamnoides*)				X sand dune
153	Sea-buckthorn (*Hippophae rhamnoides*)				X meso grassland
170	Sea-buckthorn (*Hippophae rhamnoides*) - coastal				X dune grassland toad pools
113	Sea-buckthorn (*Hippophae rhamnoides*) - dune				X
159	Sea-buckthorn (*Hippophae rhamnoides*) and Gorse (*Ulex*)				X (sand dune)

WILLOW (*Salix*)

Respondent number	*Scrub type*	*a) conserve existing scrub*	*b) enhance value of existing scrub*	*c) increase area of particular scrub type*	*d) remove in order to conserve another habitat*
8	Willow (*Salix*)	X	X		X - neutral / Acid grassland
12	Willow (*Salix*)	X	X		X - heathland, wet grassland
13	Willow (*Salix*)	X	X		X
35	Willow (*Salix*)	X	X		
37	Willow (*Salix*)	X	X		X - water margins
7	Willow (*Salix*)				X - neutral grass and ditches
4	Willow (*Salix*)- lowland	X	X	X	X - seasonal ponds and marshy grassland
16	Willow (*Salix*)- lowland	X	X	X	X - seasonal ponds and marshy grassland
47	Willow (*Salix*)- lowland	X			
52	Willow (*Salix*) carr - lowland	X			
11	Willow (*Salix*) /Sloe (*Prunus spinosa*)				X - grassland
161	W1 Willow (*Salix*)		X		X Fens and Mires (M)
172	*Willow (Salix)*	*X*			*X*
104	**Willow (*Salix*)**	**X**	**X**	**X**	
129	Willow (*Salix*)				X Wetland areas unimproved grassland
134	Willow (*Salix*)	X			
152	Willow (*Salix*)	X			X
160	Willow (*Salix*)	X	X		X (fen)
176	Willow (*Salix*)				X mires/bogs/ fens
190	Willow (*Salix*)				X
112	Willow (*Salix*)- Alder (*Alnus g;utinosa*)- wetlands				X (wetland and mire communities)
122	**Willow (*Salix*)- lakeside**		**X**		**X**
103	**Willow (*Salix*)- upland**		**X**	**X**	
106	**Willow (*Salix*)- upland**	**X**	**X**		
146	Willow (*Salix*)- wetlands Birch (*Betula*)-grassland/ heathland				XX
181	**Willow (*Salix*) and Birch (*Betula*) on fen and raised bog**				**X**
101	**Willow (*Salix*) Hawthorn (*Crataegus monogyna*)**				**X wetland (or coppice scrub)**

168	Willow (*Salix*) lowland				X fen
165	*Willow (Salix) scrub*	*X*			*X*
113	Willow (*Salix*) /Alder (*Alnus glutinosa*) - wetlands	X			X
182	Willow (*Salix*) /Alder (*Alnus glutinosa*) lowland		X		X calcareous fen
113	Willow (*Salix*) /Birch (*Betula*) - dune	X			X
116	*Willow (Salix) /Birch (Betula) in peatland*				*X remove young Birch (Betula) & Willow, (Salix) Bramble (Rubus fruticosa) etc.*
147	Willow (*Salix*) /Birch (*Betula*) lowland wet heath				X Control but leave scattered trees
160	Willow (*Salix*) /Birch (*Betula*) /Alder (*Alnus glutinosa*)	X	X		X MG5/reedbed
147	Willow (*Salix*)/ Birch (*Betula*)/ Alder (*Alnus glutinosa*) - lowland fen				X Control, but leave scattered trees and islands
120	**Grey Willow (*Salix cinerea*)/ Eared Willow (*Salix aurita*)**		**X**		**X (rhos pasture)**
124	**Moorland Willow (*Salix*)**	**X**	**X**	**X**	
153	Salix (Willow) spp.	X	X	X	
171	Sallow (*Salix*)- dune slacks	X			X
171	Sallow (*Salix*)- fen - W2a woodland	X			X open fen usually S74
135	Sallow (*Salix*)- lowland	X	X		X mire
178	Sallow (*Salix*)- lowland	X	X		X (fen/mire)
183	Sallow (*Salix*) /Alder (*Alnus glutinosa*)	X As above			X Fen/bog

Appendix 5.5 Main scrub types and management techniques adopted, ranked in decreasing order of their success.

Key: Lowland, *Upland and lowland,* **Upland.**

BIRCH (*Betula*)

ID	*Scrub type*	*Management*	*Success (5 high, 1 low)e*
9	Birch (*Betula*)	Grazing with cattle	5
32	Birch (*Betula*)/Willow (*Salix*)	Coppicing	5
163	Birch (*Betula*)	Application of Krenite	5
163	Birch (*Betula*)	Raising water levels - quickly during summer	5
162	Birch (*Betula*) scrub	Weedwiping	5
172	*Birch (Betula)*	*Enhance by expansion and depending on site type enrichment with other site native species. Exclude stock on some sites to allow natural regeneration*	*4-5*
29	Birch (*Betula*) - heath	Cut - introduce chemical treatment and grazing	4
12	Birch (*Betula*) /Pine (*Pinus*)	Mechanical and herbicide	4
35	Birch (*Betula*) on heathland	Remove using power tools/hand tools followed by pesticide treatments	4
35	Birch (*Betula*) scrub in woodland	Coppice / thin to promote age diversity and structure	4
9	Birch (*Betula*)/Scots Pine (*Pinus sylvestris*)	Cut, treat re-growth, to prevent encroachment and restore heath	4
32	Birch(*Betula*)/Willow (*Salix*)	Grazing	4
41	Silver Birch (*Betula pendula*)	Removal by volunteers to encourage spread of Heather (*Calluna vulgaris*)(in conjunction with Bracken [*Pteridium aquilinum*] control)	4
120	**Birch (*Betula*)**	**Cut and treat to prevent encroachment**	**4**
163	Birch (*Betula*)	Machine & flail	4
173	*Birch (Betula)*	*Cutting and spraying. Krenite very effective*	*4*
103	**Birch (*Betula*) - upland**	**Remove any exotic species**	**4**
186	Birch (*Betula*) and mire edge	Coppicing of scrub/existing trees. Grazing with cattle.	4
191	Birch (*Betula*) lowland heath	Graze with cattle/ponies to control encroachment	4
162	Birch (*Betula*) scrub	Spraying	4
175	Birch (*Betula*)/Alder (*Alnus glutinosa*)	Cutting followed by chemical treatment	4
132	*Birch (Betula)/Elder (Sambucus nigra)/Elm (Ulmus)/non natives*	*Needs repeating*	*4*
191	Birch (*Betula*)/Gorse (*Ulex*) lowland heath	Coppice/remove to control succession/coppice rotation	4
186	Birch (*Betula*)/Pine (*Pinus*) on heath	Cut on 5 year rotation. Maintain circa 10% / grazing	4
106	*Birch (Betula)/Willow (Salix) scrub*	*Deer control to encourage natural regeneration*	*4*
129	Birch (*Betula*)/Willow (*Salix*) scrub	Flailing/stump treatment	4
124	**Upland Birch (*Betula*)**	**Clearance to restore moorland**	**4**
107	**Upland Birch (*Betula*)/Willow (*Salix*)**	**Heavy deer cull, exclusion of grazing and removal of shading non-native trees**	**4**

19	Birch (*Betula*)	Uprooting and scraping to subsoil to allow natural regeneration	3-4
9	Birch (*Betula*)/Scots Pine *(Pinus sylvestris*)	Allow succession	3
32	Birch (*Betula*)/Willow (*Salix*)	Cut and herbicide	3
114	*Birch (Betula)*	*Reduce area to restore wet heath habitat for rare butterfly - too early to judge success*	*3*
146	Birch (*Betula*)	Felling and treating with herbicide	3
163	Birch (*Betula*)	Raising water levels - slowly through year	3
159	*Birch (Betula) & conifers*	*Manual cutting and treatment with herbicide - continual cycle*	*3*
105	Birch (*Betula*) in conifer		3
162	Birch (*Betula*) scrub	Cut stump treatment (have to go back over areas 70-90% success)	3
171	Birch (*Betula*) coastal	Cutting/stump/foliar treatment	3
149	*Birch (Betula) -conifer*	*Pulling self seeds, cutting and poisoning.*	*3*
161	W4 (*Betula pubescens/Molinia caerulea* [Downy Birch/Purple Moor-grass] woodland)	Ponies for ring back more mature scrub	3 not much used yet
162	Birch (*Betula*) scrub	Uprooting (gave massive disposal problem)	2
6	Birch (*Betula*)/Oak (*Quercus*)/*Aspen (Populus tremula*) - acid grassland	Clearance by saws - without chemicals followed by mowing 1-2 a year	2-3
7	Birch (*Betula*)/Pine (*Pinus*)on heathland	Cutting and grazing re-growth	2-3
6	Birch (*Betula*)/Oak (*Quercus*) /Aspen (*Populus tremula*)	Coppicing to produce good bird habitats	too early
106	*Birch (Betula)/Willow (Salix) scrub*	*Cleaning/chemical control to prevent encroachment *but can be difficult to keep on top of situation when covering large areas*	

BLACKTHORN (*Prunus spinosa*) (all lowland)

ID	*Scrub type*	*Management*	*Success (5 high, 1 low)e*
32	Blackthorn (*Prunus spinosa*)/Hawthorn (*Crataegus monogyna*) – lowland	grazing etc.	5
122	Lowland Blackthorn (*Prunus spinosa*)	Fencing to increase density	5
32	Blackthorn (*Prunus spinosa*)/Hawthorn (*Crataegus monogyna*) – lowland	Coppicing / laying	4
134	Blackthorn (*Prunus spinosa*)	Herbicide	4
121	Blackthorn (*Prunus spinosa*)	Cutting (coppicing) for benefit of Brown Hairstreaks (*Thecla betulae*). Cutting to prevent encroachment	4
161	W22 *Prunus spinosa/Rubus fruticosus* (Blackthorn/Bramble) scrub	Strimming and flailing edges	4 Good for Bramble (*Rubus fruticosus*) and young scrub but needs repeating
161	W22 *Prunus spinosa/Rubus fruticosus* (Blackthorn/Bramble) scrub	Cutting and treating cut stems with herbicide. Arisings removed and burnt.	4 Usually some re-growth. Doesn't always go back to desired habitat
161	W22 *Prunus spinosa/Rubus fruticosus* (Blackthorn/Bramble) scrub	Spraying re-growth with herbicide	4

13	Blackthorn (*Prunus spinosa*)	Rotational coppicing over 8 years, 1 block per 2 years to provide dense blackthorn thicket.	3
16	Blackthorn (*Prunus spinosa*)	Conserve/enhance scrub margins - exclude animals/direct cuts	3
44	Blackthorn(*Prunus spinosa*)	Patchwork	3
4	Blackthorn (*Prunus spinosa*) in old orchard	Conserve/enhance scrub margins - exclude animals/direct cuts	3
32	Blackthorn (*Prunus spinosa*)/Hawthorn (*Crataegus monogyna*) – lowland	Scalloping etc.	3
10	Lowland Blackthorn (*Prunus spinosa*)	Layering to maintain new growth on old thorn. Coppicing to maintain clearings and sheltered areas	3
119	Blackthorn (*Prunus spinosa*) - lowland	Hand cutting and tractor-mounted brushcutter	3
161	W22 *Prunus spinosa/Rubus fruticosus* (Blackthorn/Bramble) scrub	Machine flailing (cutting) of main blocks and shredding arisings	3 Not used much yet because of steep slopes or problems of leaving or removing arisings
32	Blackthorn (*Prunus spinosa*)/Hawthorn (*Crataegus monogyna*) – lowland	Cut and herbicide etc	2
187	Blackthorn(*Prunus spinosa*)	Chainsaw. No grazing available, so nettles a problem at Fenilford.	2
135	Blackthorn (*Prunus spinosa*) - lowland	Cutting/topping +/- treatment	2
30	Blackthorn (*Prunus spinosa*) – coombes	Exclude domestic livestock to encourage natural regeneration - for rotational coppicing	to be started
161	W22 *Prunus spinosa/Rubus fruticosus* (Blackthorn/Bramble) scrub	Grazing - young scrub	

BRAMBLE (*Rubus fruticosus*)(all lowland)

ID	*Scrub type*	*Management*	*Success (5 high, 1 low)e*
32	Bramble (*Rubus fruticosus*)	Cutting and flail	4
32	Bramble (*Rubus fruticosus*)	Grazing	4
161	W22 *Prunus spinosa/Rubus fruticosus* (Blackthorn/Bramble) scrub W23 *Ulex europaeus/Rubus fruticosus* (Gorse/Bramble) scrub W24 *Rubus fruticosus/Holcus lanatus* (Bramble/Yorkshire Fog) underscrub	Strimming and flailing edges	4 Good for Bramble (*Rubus fruticosus*) and young scrub but needs repeating
32	Bramble (*Rubus fruticosus*)	Scalloping	3
161	W22 *Prunus spinosa/Rubus fruticosus* (Blackthorn/Bramble) scrub W23 *Ulex europaeus/Rubus fruticosus* (Gorse/Bramble) scrub W24 *Rubus fruticosus/Holcus lanatus* (Bramble/Yorkshire Fog) underscrub	Machine flailing (cutting) of main blocks and shredding arisings	3 Not used much yet because of steep slopes or problems of leaving or removing arisings
161	W24 *Rubus fruticosus/Holcus lanatus* (Bramble/Yorkshire Fog) underscrub	Weedwiping re-growth - small scattered plants in dune grazed sward	2 Not much used
13	Bramble (*Rubus fruticosus*)	Digging roots out and flailing to prevent encroachment on grassland	2

45	Bramble (*Rubus fruticosus*)	Livestock grazing for 'removal'	3-4
161	W22 *Prunus spinosa/Rubus fruticosus* (Blackthorn/Bramble) scrub	Grazing - young scrub	
	W23 *Ulex europaeus/Rubus fruticosus* (Gorse/Bramble) scrub		
	W24 *Rubus fruticosus/Holcus lanatus* (Bramble/Yorkshire Fog) underscrub		

DOGWOOD (*Cornus sanguinea*)(all lowland)

ID	*Scrub type*	*Management*	*Success (5 high, 1 low)e*
115	Dogwood (*Cornus sanguinea*) - Lowland	Grazing in Summer with Sheep	4
34	Dogwood (*Cornus sanguinea*)	Revert chalk grassland	3
115	Dogwood (*Cornus sanguinea*) - Lowland	Chemical. Will be trying different chemicals next year. Have tried no mix system. Chemical brand name is Stirrup-Glyphosate based (no good).	2
115	Dogwood (*Cornus sanguinea*) - Lowland	Mowing.	1
169	Dogwood (*Cornus sanguinea*) dominated	Swipe	1
169	Dogwood (*Cornus sanguinea*) dominated	Weed-wipe	1
169	Dogwood (*Cornus sanguinea*) dominated	Drott	?

GORSE (*Ulex*)

ID	*Scrub type*	*Management*	*Success (5 high, 1 low)e*
13	Gorse (*Ulex*)	Coppicing on block rotation (varies in length - dependent upon areas) to regenerate Gorse (*Ulex*)	5
45	Gorse (*Ulex*)	Cutting to ground level to allow natural regeneration	5
35	Gorse (*Ulex*) blocks	Cut on a rotation to provide age diversity	5
173	*Gorse (Ulex)*	*The cutting has worked very well. Would consider burning if it could be controlled*	*5*
130	Gorse (*Ulex*) Lowland	Flailing/cutting and chemical treatment	5
121	Gorse (*Ulex*) scrub	Cutting/burning and follow-up grazing where appropriate	5
161	W23 *Ulex europaeus/Rubus fruticosus* (Gorse/Bramble) scrub	Burning on rotation	5
12	Gorse (*Ulex*)	Mechanical and herbicide	4
37	Gorse (*Ulex*)	Removal of Gorse (*Ulex*) to increase heathland	4
40	Gorse (*Ulex*)	Coppicing, chemical treatments, grazing	4
29	Gorse (*Ulex*) - heath	Cut - introduce chemical treatment and grazing	4
120	**Gorse (*Ulex*)**	**Bburning and/or cutting**	**4**
125	Gorse (*Ulex*)	Cutting and spraying re-growth	4
172	*Gorse (Ulex)*	*Remove where dominance is limiting desired woodland development. Retain some areas for diversity or where site sensitivities require this habitat type*	*4 Gorse (Ulex) may continue to spread inhibiting woodland development*

135	Gorse (*Ulex*) - lowland, Birch (*Betula*)- lowland	Coppicing for structural diversity	4
191	Gorse (*Ulex*) and Bramble (*Rubus fruticosus*) chalk grassland	Remove to conserve scrub habitat/grassland	4
169	Gorse (*Ulex*) block	Swipe	4
169	Gorse (*Ulex*) block	Drott	4
174	Gorse (*Ulex*) lowland	Bulldozing to remove litter and bushes to reinstate chalk heath	4
101	**Gorse (*Ulex*) on magnesian Limestone**	**Cut, spray re-growth, graze with suckler cows**	**4**
160	Gorse (*Ulex*) /Birch (*Betula*)/Willow (*Salix*)	Cutting, stump treatment to remove cutting on rotation and grazing	4
161	W23 *Ulex europaeus /Rubus fruticosus* (Gorse/Bramble) scrub	Strimming and flailing edges	4 Good for Bramble (*Rubus fruticosus*) and young scrub but needs repeating
161	W23 *Ulex europaeus /Rubus fruticosus* (Gorse/Bramble) scrub	Burning and if possible aftermath grazing (and removal of above ground remains)	4 Needs to be followed up by cattle grazing to deal
26	Gorse (*Ulex*) on lowland heath	Coppicing to reduce fire risk	3
129	Gorse (*Ulex*)	Cutting to promote structural diversity/scarification after bracken control	3
167	*Gorse (Ulex)*	*Rotational cutting/burning*	*3*
104	**Gorse (*Ulex*)**		3
119	Gorse (*Ulex*) – lowland	Hand cutting and tractor-mounted brushcutter	3
119	**Gorse (*Ulex*) – upland**	**Hand cutting and tractor-mounted brushcutter**	3
134	Gorse (*Ulex*) etc.	Cutting - ongoing	3
132	*Gorse (Ulex), Broom (Cytisus scoparius)*	*Planting - expensive, not always successful. Natural regeneration - great if it works, but variable.*	*3*
161	W23 *Ulex europaeus/Rubus fruticosus* (Gorse/Bramble) scrub	Machine flailing (cutting) of main blocks and shredding arisings	3 Not used much yet because of steep slopes or problems of leaving or removing arisings
161	W23 *Ulex europaeus/Rubus fruticosus* (Gorse/Bramble) scrub	Rotational Coppicing	3 (Expensive no marketable produce)
191	Gorse (*Ulex*) and Bramble (*Rubus fruticosus*) chalk grassland	Graze with cattle and sheep.	2
174	Gorse (*Ulex*) lowland	Cutting, clearing and burning to recover chalk grassland	2
124	**Gorse (*Ulex*)**	**Burning to maintain scrub/grass mosaics**	**1**
156	Gorse (*Ulex*)	Reduce area and prevent encroachment by manual, mechanical means and treat	2-3
112	Gorse (*Ulex*) on heaths	Burning - some accidental, some deliberate. Success very variable - best if grazed after	1-5
154	*Gorse (Ulex)*	*Manual coppicing to provide variety of structure and encourage breeding birds*	

147	Gorse *U.europaeas/ U.gallii*	Cut stems treated with herbicide. Strim and burn	Used by dead wood inverts and song/hunting perches.
118	*Gorse (Ulex) control*	*In progress - cutting and use of herbicides - some potential problems with regeneration of gorse*	
161	W23 *Ulex europaeus/Rubus fruticosus* (Gorse/Bramble) scrub	Grazing - young scrub	
184	*Western Gorse (Ulex gallii)*	*Ideally a couple of small exclosures for a few years (haven't done it yet)*	

HAWTHORN (*Crataegus monogyna*)

ID	*Scrub type*	*Management*	*Success (5 high, 1 low)e*
27	Hawthorn (*Crataegus monogyna*) – lowland	Coppice to prevent encroachment into grassland	5
27	Hawthorn (*Crataegus monogyna*) – lowland	Coppicing to prevent succession to woodland	5
45	Hawthorn (*Crataegus monogyna*) and Blackthorn (*Prunus spinosa*) - lowland	Scalloping and ride creation for structural and age diversity	5
39	mainly Hawthorn (*Crataegus monogyna*)	Excavator technique	5
125	Hawthorn (*Crataegus monogyna*)	Grubbing out	5
129	Hawthorn (*Crataegus monogyna*) - lowland	Periodic flailing/coppicing to promote structural diversity/exclusion of rabbits	5
115	Hawthorn (*Crataegus monogyna*) - lowland grassland	Remove: Chemical treat in summer with no mix lance system. Glyphosate based.	5
115	Hawthorn (*Crataegus monogyna*) - lowland grassland	Conserve: Fence out grazing stock	5
115	Hawthorn (*Crataegus monogyna*) - lowland grassland	Enhance: Coppice	5
177	Hawthorn (*Crataegus monogyna*) - neutral grassland	Only carried out where an appropriate grassland management regime can be introduced	5
157	Hawthorn (*Crataegus monogyna*) on lowland grassland	Coppicing of selected areas to increase age diversity	5
160	Hawthorn (*Crataegus monogyna*)/Blackthorn (*Prunus spinosa*)/Dogwood (*Cornus sanguinea*)/Elder (*Sambucus nigra*)	Cutting to remove to extend areas of chalk grassland and grazing	5
14	Hawthorn (*Crataegus monogyna*)	Coppicing, uprooting	4
29	Hawthorn (*Crataegus monogyna*) - chalk downland	Cut - introduce grazing	4
4	Hawthorn (*Crataegus monogyna*) - lowland	Grazing	4
20	Hawthorn (*Crataegus monogyna*) - lowland	Goat and Hebridean sheep browsing to reverse encroachment	4
22	Hawthorn (*Crataegus monogyna*) - lowland	Coppice, scallop	4
45	Hawthorn (*Crataegus monogyna)* and Blackthorn (*Prunus spinosa*) - lowland	Full removal and grazing to create chalk grassland areas	4
41	Hawthorn (*Crataegus monogyna*)/Blackthorn (*Prunus spinosa*)	Removal by contractors and volunteers to encourage spread of chalk grassland habitat	4
41	Hawthorn (*Crataegus monogyna*) /Blackthorn (*Prunus spinosa*) on chalk grassland	Limited control of spread using sheep to graze land	4
8	Hawthorn (*Crataegus monogyna*)/Dogrose (*Rosa canina*)	Marginal diversification by coppicing, or allowing spread then coppicing	4

48	Hawthorn (*Crataegus monogyna*)/Willow (*Salix*)	Remove most scrub and graze subsequently	4
39	mainly Hawthorn (*Crataegus monogyna*)	Sheep grazing (especially upland breeds)	4
39	mainly Hawthorn (*Crataegus monogyna*)	Amcide	4
152	*Hawthorn (Crataegus monogyna)*	*Cut/clear/chemically treat*	*4*
158	Hawthorn *Crataegus monogyna*)	Divided blocks of scrub up and devised annual cutting programme - a % at a time.	4
131	Hawthorn (*Crataegus monogyna*)	Cut/swipe/herbicide to return to chalk grassland	4
137	Hawthorn (*Crataegus monogyna*) - lowland	Cut and treat/grazing to halt encroachment	4
128	Hawthorn (*Crataegus monogyna*) - lowland	Cutting by tractor or by hand	4
115	Hawthorn (*Crataegus monogyna*) - lowland grassland	Remove: Cut and treat stumps	4
125	*Hawthorn (Crataegus monogyna) in chalk grassland*	*Sswiping (essentially fairly frequent cutting)*	*4*
116	*Hawthorn (Crataegus monogyna) in parkland*	*Plant with protection, or reduce grazing*	*4*
168	Hawthorn (*Crataegus monogyna*) lowland	Cut - treat cut stumps - burn out material at suitable location - graze	4
187	Hawthorn (*Crataegus monogyna*) mix	Chainsaw clearance with stump treatment	4
166	Hawthorn (*Crataegus monogyna*) on limestone grass	Cutting/stump treatment	4
166	Hawthorn (*Crataegus monogyna*) on limestone grass	Maintain matrix of scrub, butterfly glades on limestone grassland	4
166	Hawthorn (*Crataegus monogyna*) on neutral grass	Cutting/stump treatment	4
116	**Hawthorn (*Crataegus monogyna*) on upland grassland**	**Plant with protection, or reduce grazing**	**4**
142	Hawthorn(*Crataegus monogyna*) /Blackthorn (*Prunus spinosa*) – lowland	Cutting and treatment/grazing	4
142	Hawthorn (*Crataegus monogyna*)/Bramble (*Rubus fruticosa*) – lowland	Periodic/rotational cutting/coppicing	4
149	*Hawthorn(Crataegus monogyna) – Gorse (Ulex)*	*Grazing - still embryonic*	*4*
184	*Daleside Hawthorn (Crataegus monogyna)*	*Removal*	*4*
179	Lowland Hawthorn (*Crataegus monogyna*), Blackthorn (*Prunus spinosa*) and mixed calcareous	Coppicing to create variety of successional Stages and structures	4
179	Lowland Hawthorn (*Crataegus monogyna*), Blackthorn (*Prunus spinosa*) and mixed calcareous	Layering to provide/enhance structures	4
105	Thorn & similar	Limited action required	4
161	W21*Crataegus monogyna/Hedera helix* (Hawthorn/Ivy) scrub	Low density grazing	4 (problem of succession to woodland)
161	W21*Crataegus monogyna/Hedera helix* (Hawthorn/Ivy) scrub	Strimming and flailing edges	4 Good for Bramble (*Rubus fruticosus*) and young scrub but needs repeating
161	W21*Crataegus monogyna/Hedera helix* (Hawthorn/Ivy) scrub	Cutting and treating cut stems with herbicide. Arisings removed and burnt.	4 Usually some re-growth. Doesn't always go back to desired habitat

14	Hawthorn (*Crataegus monogyna*)	Coppicing	3
34	Hawthorn(*Crataegus monogyna*)	Revert chalk grassland	3
6	Hawthorn (*Crataegus monogyna*) - lowland	Coppicing to produce invertebrate/bird habitat	3 (early)
20	Hawthorn (*Crataegus monogyna*) - lowland	Fence to prevent stock access	3
20	Hawthorn (*Crataegus monogyna*) - lowland	Coppice and scallop edges (prejudiced by excessive Rabbit [*Oryctolagus cuniculus*] populations in places)	3
20	Hawthorn (*Crataegus monogyna*) - lowland	Cut and remove	3
48	Hawthorn (*Crataegus monogyna*)/Bramble (*Rubus fruticosa*)	Allow natural regeneration on derelict land	3
8	Hawthorn (*Crataegus monogyna*)/Dogrose (*Rosa canina*)	Selective clearance and rotational mowing and stump treatment - to conserve calcareous grassland	3
146	Hawthorn (*Crataegus monogyna*)	Coppicing and treating	3
167	*Hawthorn (Crataegus monogyna)*	*Non intervention*	*3*
187	Hawthorn (*Crataegus monogyna*)	Coppicing	3
177	Hawthorn(*Crataegus monogyna*) - acid grassland	Ongoing works to remove scrub will only be ultimately successful if grazing restored	3
145	Hawthorn (*Crataegus monogyna*) - lowland	Cutting on rotation to diversify structure and maintain present extent	3
119	Hawthorn (*Crataegus monogyna*) - lowland grassland	Hand cutting and tractor-mounted brushcutter	3
101	**Hawthorn (*Crataegus monogyna*) - magnesian limestone**	**Cut to vary age structure**	**3**
102	**Hawthorn (*Crataegus monogyna*) on upland grassland**	**Modification of grazing levels to encourage regeneration**	**3**
124	**Hawthorn (*Crataegus monogyna*) on upland grassland**	**Clearance to restore grassland habitat and mosaics**	**3**
122	**Hawthorn (*Crataegus monogyna*) upland**	**Fencing to allow regeneration**	**3**
191	Hawthorn (*Crataegus monogyna*), Blackthorn (*Prunus spinosa*), Hazel (*Corylus avellana*), chalk grassland	Can save existing scrub by coppicing	3
172	*Hawthorn (Crataegus monogyna)/Blackthorn (Prunus spinosa)*	*Exclude livestock and allow natural regeneration. Cut where dominance is limiting site conservation interest*	*3 Eventual development into woodland, or held in check by cutting*
142	Hawthorn (*Crataegus monogyna*)/Blackthorn (*Prunus spinosa*)– lowland	Periodic/rotational cutting/coppicing	3
132	*Hawthorn (Crataegus monogyna)/Blackthorn (Prunus spinosa)/Willow (Salix)/ Hazel (Corylus avellana)*	*Can be limited by age of plants (low vigour) and grazing (rabbits and deer)*	*3*
176	Hawthorn (*Crataegus monogyna*)/Bramble (*Rubus fruticosus*)	Cutting and treating stump / grazing	3
142	Hawthorn (*Crataegus monogyna*)/Bramble (*Rubus fruticosus*)– lowland	Cutting and treatment	3
149	*Hawthorn (Crataegus monogyna)-Birch (Betula) –Gorse (Ulex)*	*Cutting and poisoning*	*3*
184	*Daleside Hawthorn (Crataegus monogyna)*	*Conserve/enhance*	*3*
176	Ditch with Hawthorn (*Crataegus monogyna*) and other	Cutting or remove stump	3

161	W21*Crataegus monogyna/Hedera helix* (Hawthorn/Ivy) scrub	Machine flailing (cutting) of main blocks and shredding arisings	3 Not used much yet because of steep slopes or problems of leaving or removing arisings
161	W21*Crataegus monogyna/Hedera helix* (Hawthorn/Ivy) scrub	Rotational Coppicing	3 (Expensive no marketable produce)
44	Hawthorn (*Crataegus monogyna*) and Blackthorn (*Prunus spinosa*)	Prevent encroachment/reclaim grass	2
155	Hawthorn (*Crataegus monogyna*)	Graze: stop invasion of grassland	moderate 2
155	Hawthorn (*Crataegus monogyna*)	Cut then graze invasion of grassland	Poor 2
177	Hawthorn (*Crataegus monogyna*) - wetland	Ongoing works to remove scrub will only be ultimately successful if grazing restored	2
116	Hawthorn (*Crataegus monogyna*) and Blackthorn (*Prunus spinosa*) in lowland grassland.	Cut or increase grazing	2
122	Hawthorn (*Crataegus monogyna*) lowland	Cutting and stump treating	2
187	Hawthorn (*Crataegus monogyna*) mix	Chainsaw clearance without stump treatment	2
168	Hawthorn (*Crataegus monogyna*) upland	Cut - treat cut stumps - burn out material at suitable location - graze	2
161	W21*Crataegus monogyna/Hedera helix* (Hawthorn/Ivy) scrub	Juniper - no grazing (see 15b)	2
161	W21*Crataegus monogyna/Hedera helix* (Hawthorn/Ivy) scrub	Weedwiping re-growth - small scattered plants in dune grazed sward	2 Not much used
154	*Hawthorn (Crataegus monogyna)/Blackthorn (Prunus spinosa) on limestone grassland*	*Pony grazing*	*1 We are therefore going to change to sheep/goats*
4	Hawthorn (*Crataegus monogyna*) – lowland	Cutting, treatment	2-3
144	Hawthorn (*Crataegus monogyna*) on lowland grassland	Cutting/herbicide treatment	3-4
158	Hawthorn (*Crataegus monogyna*), Dogwood (*Cornus sanguinea*) Mixed Southern	Depending on size cutting scrub, treating stumps, or smaller stuff especially Dogwood (*Cornus sanguinea*), spray re-growth	2-3
158	Hawthorn (*Crataegus monogyna*)/mixed southern scrub	Cutting of scrub - some to re-grow, otherwise stumps treated, and grazing of unit	3-4
146	Hawthorn(*Crataegus monogyna*)	Coppicing and aftermath grazing	1-4
184	*Woodland edge – Hawthorn (Crataegus monogyna)*	*Exclosure of grassland adjacent to woodland, subsequent removal once scrub developed to maintain by casual browsing/occasional cutting*	*Early stages - 5*
30	Hawthorn (*Crataegus monogyna*) coombes	Exclude domestic livestock to encourage natural regeneration - for rotational coppicing	to be started
155	Hawthorn (*Crataegus monogyna*)	Cut and treat invasion of grassland	Fair 3+
157	Hawthorn (*Crataegus monogyna*)/Blackthorn (*Prunus spinosa*)– lowland	Yet to see results of coppicing (for enhancement) or flailing (for control)	
179	Lowland Hawthorn (*Crataegus monogyna*), Blackthorn (*Prunus spinosa*) and mixed calcareous	Layering to provide Black Hairstreak (*Strymonidia prunii*) habitat	? 1 - colonization seems very slow
161	W21*Crataegus monogyna/Hedera helix* (Hawthorn/Ivy) scrub	Grazing - young scrub	

HAZEL (*Corylus avellana*)

ID	*Scrub type*	*Management*	*Success (5 high, 1 low)e*
112	Hazel (*Corylus avellana*) etc. on geological site	Complete removal with JCB, including soil stripping	5
107	*Hazel (Corylus avellana)*	*Heavy deer cull and exclusion of grazing and removal of shading non-natives*	*4*
172	*Hazel(Corylus avellana)*	*Exclude or limit grazing, possibly enrich with site native tree species. Expand if possible through layering or natural regeneration*	*4 Management depends on a number of site factors and species present*
184	*Hazel (Corylus avellana) retrogressive scrub*	*Cyclical cutting to maintain mosaics of structure and with grassland*	*4*
121	Hazel (*Corylus avellana*)/Bramble *(Rubus fruticosus*)	Coppicing to promote re-growth in woodlands. Clearance to allow regeneration	4
103	Hazel *Corylus avellana*) - upland	Remove any exotic spp.	3
152	*Hazel (Corylus avellana)*	*Cut/clear/winch*	*3-4*

JUNIPER (*Juniperus*)

ID	*Scrub type*	*Management*	*Success (5 high, 1 low)e*
5	Juniper(*Juniperus*)	Stock grazing, digging scrapers for germination and careful management of protective light scrub manually work well if care is taken	4
115	Juniper (*Juniperus*) - Lowland	Enhance: Cut down scrub shadowing Juniper (*Juniperus*)	4
107	*Juniper(Juniperus)*	*Heavy deer cull and exclusion of grazing and removal of shading non-natives*	*3*
182	Juniper(*Juniperus*)	Protecting young, raised plants from grazing	2
102	*Juniper(Juniperus)*	*Modification of grazing levels*	*2*
104	**Juniper(*Juniperus*)**		**2**
115	Juniper (*Juniperus*) - Lowland	Expand area: Graze grassland and clear scrub (climate plays big part in germination so out of our control)	2

MIXED SCRUB (all lowland)

ID	*Scrub type*	*Management*	*Success (5 high, 1 low)e*
174	Mixed deciduous on chalk grassland	Cutting, clearing, burning and treatment of stumps to recover chalk grassland	5 (with stump treatment) 3 (without stump treatment)
22	Mixed lowland	Cut - treat - burn - graze, prevent encroachment	5
22	Mixed lowland	Cut - treat - burn - graze, removal	5
22	Mixed lowland	Island creation - improve age/structure diversity	5
24	Mixed scrub	(1) Cut to ground level with clearing saw/chainsaw and burn (2) Stumps <15cm treat with herbicide (Grazon 90). (3) Stumps >15 cm stump grind and back fill material. (4) Annual mowing (3 cuts per year) with tractor rotary mower until desired heathland vegetation restored.	5

174	Mixed deciduous and Gorse (*Ulex*) lowland	Use of goats and ponies to browse out and control re-growth from cut stumps	5
150	Mixed Gorse (*Ulex*), Hawthorn (*Crataegus*), Willow (*Salix*)	Regular cutting	5
169	Mixed scrub blocks	Coppice on rotation	5
102	Mixed species scrub (lowland)	Cutting followed by grazing	5
5	Lowland mixed thorn, Viburnum (*Viburnum*) etc.	Grazing, cutting, mowing, rooting out all successful if carefully applied to specific conditions	4
9	Mixed deciduous lowland grassland	Coppice on rotation to retain 'edge'	4
51	Mixed lowland	Removal of encroaching tree species	4
24	Mixed scrub	Complete coppicing of existing scrub and allowing regeneration of cut stumps	4
24	Mixed scrub	(1) annual mowing with tractor rotary mower. (2) three year scrub removal in building/mature Heather (*Calluna vulgaris*). (3) rotational grazing with Exmoor ponies	4
42	Mixed scrub – woodland fringe	Remove scrub	4
42	Mixed species chalk grassland	Cut scrub, spray and graze	4
135	Mixed - lowland, Gorse (*Ulex*) – lowland, Birch (*Betula*) - lowland, Sallow (*Salix*) – lowland	Cutting/topping +/- treatment	4
174	Mixed deciduous Hawthorn (*Crataegus monogyna*) lowland	Coppicing, periodic cutting of scrub boundary. Control of invasive spp. e.g. Sycamore (*Acer pseudoplatanus*). Coppicing to create range of age structures	4
150	Mixed Gorse (*Ulex*), Hawthorn (*Crataegus monogyna*), Willow (*Salix*)	Cutting and treatment	4
148	Mixed native broadleaf	Maintain and enhance to allow succession	4
148	Mixed native broadleaf	Remove to allow conifer growth	4
128	Mixed woodland edge		4
51	Mixed lowland	Coppicing	3
24	Mixed scrub	Selective coppicing of existing scrub and allowing regeneration of cut stumps.	3
42	Mixed species chalk grassland	Cut scrub, spray, mow	3
179	Lowland mixed including Gorse (*Ulex*)	Grazing to produce short scrub/grass mosaics	3
135	Mixed – lowland,	Coppicing for structural diversity	3
40	Mixed lowland Hawthorn (*Crataegus monogyna*)/Blackthorn (*Prunus spinosa*)	Coppicing, flailing/chemical, grazing	3-5
125	Mixed scrub in chalk grassland	Cutting to base. Stump treatment	too early
125	Mixed scrub in grassland	Cut to base spray re-growth	too early

RHODODENDRON (*Rhododendron ponticum*)

ID	*Scrub type*	*Management*	*Success (5 high, 1 low)e*
191	Rhododendron (*Rhododendron ponticum*) lowland heath	Remove using tracked machine	5
37	Rhododendron (*Rhododendron ponticum*)	Removal of Rhododendron (*Rhododendron ponticum*) to increase heathland	4
4	Rhododendron (*Rhododendron ponticum*) - woodland	Cutting, treatment	4
104	**Rhododendron (*Rhododendron ponticum*)**		**4**
175	Rhododendron (*Rhododendron ponticum*)	Cutting followed by chemical treatment	4
191	Rhododendron (*Rhododendron ponticum*) lowland heath	Remove using chainsaw	4
7	Rhododendron (*Rhododendron ponticum*) in woods and heaths	Cutting/burning/stump treatment	3
172	*Rhododendron (Rhododendron ponticum)*	*Remove and treat with herbicide*	*3 Success varies with site type and thoroughness of treatment. Areas re-infested from outside seed sources.*
29	Rhododendron (*Rhododendron ponticum*) – woodland	Cut - chemical treatment	2

SEA-BUCKTHORN (*Hippophae rhamnoides*)(all lowland)

ID	*Scrub type*	*Management*	*Success (5 high, 1 low)e*
170	Sea-buckthorn(*Hippophae rhamnoides*)/ Hawthorn (*Crataegus monogyna*)/Elder (*Sambucus nigra*)	Grazing	4
113	Sea-buckthorn (*Hippophae rhamnoides*) -dunes	Cut and stump treatment	4
170	Sea-buckthorn (*Hippophae rhamnoides*)/ Hawthorn (*Crataegus monogyna*)/Elder (*Sambucus nigra*)	Felling by chainsaw	3
153	Sea-buckthorn (*Hippophae rhamnoides*) on coastal grassland	Cutting, pulling to reduce area	2
154	Sea-buckthorn (*Hippophae rhamnoides*) on dunes	Manual control and herbicide	1 We are therefore going to reintroduce grazing
170	Sea-buckthorn (*Hippophae rhamnoides*)/ Hawthorn (*Crataegus monogyna*)/Elder (*Sambucus nigra*)	Hand cutting/pulling	1

WILLOW (*Salix*)

ID	*Scrub type*	*Management*	*Success (5 high, 1 low)e*
35	Willow (*Salix*) blocks	Continue a scheme of rotational coppicing	5
160	Willow (*Salix*)	Cutting and stump treatment to remove coppice to rejuvenate	5
187	Willow (*Salix*)	Bulldoze with haycut/grazing provided open conditions for reappearance rare Fen Violets (*Viola persicifolia*) at Otmoor.	5
160	Willow (*Salix*) /Birch (*Betula*)/Alder (*Alnus glutinosa*)	Cut to remove and stump treat. coppice	5
161	W1 *alix cinerea/Galium palustre* (Grey Willow/Common Marsh- bedstraw) woodland	Pulling out	5
178	Sallow (*Salix*) in fens	Clear by machine	5
171	Sallow (*Salix*) -fen	Coppicing woodland/fen transition	5
8	Willow (*Salix*)	Hebridean sheep	4
12	Willow (*Salix*)	Mechanical and herbicide	4
13	Willow (*Salix*)	Coppicing of Willow on block rotation to increase diversity of ground flora.	4
103	**Willow (*Salix*) - upland**	**Exclude domestic livestock, control deer numbers**	**4**
168	Willow (*Salix*) lowland	Cut - treat cut stumps - burn out material at suitable location - graze	4
165	*Willow (Salix) scrub*	*cutting and stump treatment*	*4*
182	Willow (*Salix*)/Alder (*Alnus glutinosa*)	Rotational coppicing, clearance from good quality fen	4
113	Willow/(*Salix*)/Alder (*Alnus glutinosa*)- wetlands	Cut and stump treatment	4
113	Willow (*Salix*)/Birch (*Betula*) - dunes	Cut and stump treatment	4
113	Willow (*Salix*)	Goat browsing	4
	Birch (*Betula*)- dunes		
183	Sallow (*Salix*)	Grazing, Cutting	4
	/Alder (*Alnus glutinosa*)		
13	Willow (*Salix*)	Removal of Willow from reedbed	3
37	Willow (*Salix*)	Removal of Willow in parts to prevent silting	3
120	Willow (*Salix*)	Cut or cut and treat to enhance or remove	3
129	Willow (*Salix*)	Cutting/stump treatment	3
124	**Moorland Willow (*Salix*)**	**Fencing to allow regeneration and better structure**	**3**
116	*Remove Willow (Salix)/Birch (Betula) in peatland*	*Cut and/or poison*	*3*
178	Sallow (*Salix*) in fens	Cut/treat stumps	3
171	Sallow (*Salix*) -fen	Cutting/stump treatment	3 (very labour intensive)
146	Willow (*Salix*)	Coppicing and raising water levels	2
146	Willow (*Salix*)	Coppicing and aftermath grazing	2
176	Willow (*Salix*)	cutting	2
104	**Willow (*Salix*) – upland**		**2**
122	**Willow (*Salix*) lakeside**	**Thinning, removing large bushes/trees**	**2**
7	Willow (*Salix*), grass/fell/ditches	Cutting/burning/stump treatment	4-5
152	*Willow (Salix)*	*Cut/clear/chemically treat*	*2-3*

152	*Willow (Salix)*	*Cut/clear/winch*	*3-4*
112	Willow (*Salix*) and Alder (*Alnus glutinosa*)on wetland	Cutting - often very low success rates unless grazed or herbicided	1-3
147	Willow (*Salix*)/Alder (*Alnus glutinosa*)/Birch (*Betula*) on Fen/heath	Stem injection using vertical notch and herbicide injection using Glyphosate. Less disturbance to fen surface.	Best method no disturbance less time and money dead trees still used
147	Willow (*Salix*)/Birch (*Betula*)/Alder (*Alnus glutinosa*)on Fen/heath	Excavation by tracked excavator. Scrub carried off site and burnt and this causes disturbance - Ideal nursery for more trees.	Good but have to follow up with sapling pulling
147	Willow (*Salix*)/Birch (*Betula*)/Alder (*Alnus glutinosa*)on Fen/Heath	cutting with bow saws/chainsaws cut stumps painted with paintbrush with Glyphosate. Willow stems have to move to try areas.	Good but takes time and money.
178	Sallow (*Salix*) in fens	Cut	
171	Sallow (*Salix*) -fen	Large-scale mechanical removal	?

Appendix 5.6. The questionnaire sent to land managers in England, Scotland and Wales to survey attitudes towards scrub conservation and management. Some modifications were made according to destination organisation (farmer, local authority, land agent, etc.).

THE NATURE CONSERVATION VALUE OF SCRUB

Questionnaire-based survey of landmanagers

Introduction

Purpose of the survey

English Nature (EN), Scottish Natural Heritage (SNH) and the Countryside Council for Wales (CCW) wish to assess current knowledge about scrub and determine priorities for conservation and research on scrub. A consortium led by CABI Bioscience: Environment, including the British Trust for Ornithology and the Institute of Terrestrial Ecology has been contracted to assess the current state of knowledge in this area.

Definition of scrub

Scrub is difficult to define precisely because it is often an intermediate stage in the succession from open ground to woodland habitats. However, the definition given in the new Tir Gofal agri-environment scheme in Wales is typical: 'Vegetation dominated by native shrubs less than 5m tall, typically hawthorn, blackthorn, common gorse, elder, willow, birch or bramble' (Welsh Office/CCW 1999).

Questionnaire

1. Do you use a definition of scrub that differs appreciably from that given above? If so, what is it?

2. In the context of you/your organisation's activities is scrub a valued habitat in your area: YES/NO (if 'YES' please give reasons, if 'NO' see question 5)

   Reasons:

3. Approximately what proportion of the land area you manage or advise upon could be described as scrub:

   <1% 2-10% 11-20% >20%

4. What is the approximate area of scrub involved (ha)?

5. In some situations scrub is considered to be a nuisance. Do you have such cases YES / NO.

6. If you answered 'YES' to question 5, what is the proportion of the total scrub in the area you/your organisation manage which is a nuisance:

   <10% 11-25% 26-50% 51-75% >75%

7. If you answered 'YES' to question 5, please explain why the scrub is a nuisance?

8. Do you/your organisation actively manage scrub? YES / NO

9. If you answered 'YES' to question 8, please describe briefly the scrub types that you manage in order to:

a) conserve existing scrub, maintaining it at a desired successional stage
b) enhance the value of existing scrub
c) increase the area of a particular scrub type
d) remove in order to conserve another habitat

Scrub type	a) conserve existing scrub	b) enhance value of existing scrub	c) increase area of a particular scrub type	d) remove in order to conserve another habitat (state which)
Example 1: Hawthorn - lowland				*√(chalk grassland)*
Example 2: Hawthorn - upland	*√*	*√*	*√*	

Please continue on a separate sheet if necessary

10. If you answered YES to question 8, what proportion (approximately) of the scrub on the land you manage or advise upon is managed:

0-25% 26-50% 51-75% 76-100%

11. Is this management a significant activity for you/your organisation in terms of manpower and other costs? YES/NO

12. Do you receive payments for scrub management (e.g. ESA, Countryside Stewardship, Tir Gofal etc.)? If so what is the source?

13. Do you have habitat/plant community maps for any of the sites you manage? If so, what categories do you use for scrub (e.g. only 'scrub', regardless of type, 'Hawthorn scrub', etc.)?

14. For those sites managed for conservation or enhancement of scrub, is management aimed primarily at the conservation of particular species (e.g. Duke of Burgundy fritillary, Nightingale, Whinchat) as opposed to conservation of the scrub type in general? If so, please list the species:

15. What techniques do you use for:

a. scrub conservation - in order to maintain existing areas by arresting succession

b. scrub enhancement - in order to increase diversity of existing areas or increase their extent

c. scrub control - in order to prevent encroachment onto other habitats

d. scrub clearance – in order to restore/create other habitat (e.g. grassland)

16. How successful are these techniques in achieving your aims? Please refer to the scrub types you have entered in the table in question 9.

Scrub type	**Management**	**Success***
Example: hawthorn on upland grassland	*Exclude domestic livestock to encourage natural regeneration*	*4*

Please continue on a separate sheet if necessary

* Score on scale from 1 (unsuccessful) to 5 (very successful)

17. Do invading alien scrub species (e.g. Buddleja, Rhododendron, Laurel, Cotoneaster) pose a threat to any of the habitats you manage or advise upon? YES/NO

18. If you answered 'YES' to question 17, which alien species are involved and in which habitats?

19. What do you think we need to know in order to manage scrub more effectively?

Thank you for taking the time to complete this questionnaire:

If you would like to receive the questionnaire by E-mail (WordPerfect or WORD format) please contact Heather Roberts (haj@ite.ac.uk).

Please return completed questionnaires by post or e-mail before **15 October 1999** to:

Prof. John Good or Mr Paul Stevens
Institute of Terrestrial Ecology
Bangor Research Unit
University of Wales, Bangor
Deiniol Road
BANGOR
Gwynedd LL57 2UP
Tel: 01248 370045
Fax: 01248 355365
e-mail: haj@ite.ac.uk

Your name:
Organization:
Address:

Tel:
Fax:
e-mail:

Appendix 5.7. List of respondents to landmanagers questionnaire.

Surname	*Christian Name*	*Organisation*	*Address*
Martin	John	Avon Wildlife Trust	32 Jacobs Wells Road, Bristol
Comont	John	Bedfordshire County Council	County Hall, Cauldwell Street, Bedford
Parry	Chris	Birmingham & Black Country Wildlife Trust	Unit 310 Jubilee Trade Centre, 130 Pershore Street, Birmingham B5 6ND
Robeson	Derek	Borders FWAG	Greycrook, St. Boswells
Douglas	Nigel	Borough of Poole	30-32 Northmead Drive, Creekmoor, Poole, Dorset
Sussex	Des	Bracknell Forest Borough Council	Ranger Service, The Look Out, Nine Mile Ride, Bracknell, Berkshire
King	J	Brecon Beacons National Park Authority	7 Glamorgan Street, Brecon, Powys
Thomas	Matthew	Brighton and Hove Council	Conservation and Regeneration Team, Town Hall, Norton Road, Hove,
Carey	Julia	Bucks County Council	Annexe A, County Hall, Aylesbury, Bucks
Bullivant	Nic	Cairngorm Ranger Service	Ski Area, Cairngorm, Aviemore
Watmough	Brian	Canterbury City Council	Military Road, Canterbury
Hulse	Jackie	Cheshire Wildlife Trust	Grebe House, Reascheath, Nantwich, Cheshire
Smethurst	Jil	Cheshire Wildlife Trust	Grebe House, Reascheath, Nantwich, Cheshire
Woodley-Stewart	Chris	Chilterns AONB	6a Cornmarket, High Wycombe, Bucks
Whitehouse	Victoria	Cornwall Wildlife Trust	Five Acres, Allet, Truro
Dagley	Jeremy	Corporation of London (Epping Forest)	The Warren, Loughton
Colley	Les	Countryside Council for Wales	Bryn Mwcog, Brynteg, Anglesey, North Wales
Hughes	Michael	Countryside Council for Wales	RVB House, Llys Felin Newydd, Phoenix Way, Swansea
Oliver	Doug	Countryside Council for Wales	Llys Eifion, Garndolbenmaen,
Peterken	Andrew	Countryside Council for Wales	South Wales Area, 4 Castleton Court, St Mellons, Cardiff
Rees	Iorwerth	Countryside Council for Wales	North East Area, Victoria House, Grosvenor Street, Mold, Flintshire
Woods	R G	Countryside Council for Wales	3rd Floor, The Gwalia, Ithon Road, Llandrindod Wells, Powys
Milligan	Kerry	Cumbria Wildlife Trust	Brockhole, Windermere, Cumbria
Lewis	Cameron	Dacorum Borough Council	Civic Centre, Marlowe, Hemel Hempstead, Herts
Baldock	N	Dartmoor National Park Authority	Parke, Bovey Tracey, Newton Abbot, Devon
Toynton	Paul	Defence Estates	Westdown Camp, Tilshead, Salisbury
Powage	R S	Derbyshire Wildlife Trust	Elvaston Castle, Derby, Derbyshire
Sterling	P H	Dorset County Council	Environmental Services, County Hall, Dorchester

Brunt	Roberts	Dorset Wildlife Trust	Brooklands Farm, Forston, Dorchester, Dorset
Baxter-Brown	Alex	Downlands Countryside Management Project	Highway House, 21 Chessington Rd, West Ewell, Epsom
Mearns	Richard	Dumfries & Galloway Council	Rae Street, Dumfries
Richardson	Mark	Durham Wildlife Trust	Rainton Meadows, Chilton Moor, Houghton-le-Spring, Tyne & Wear
Green	Kelley	East Cambridgeshire District Council	Nutholt Land, Ely, Cambs
Healey	Marin	East Hampshire District Council	Penns Place, Petersfield, Hampshire
Mills	Andrew	East Herts District Council	Wallfields, Pegs Lane, Hertford
Pearce	David	Eastbourne Borough Council	Tourism, Leisure and Amenities, 68 Grove Road, Eastbourne, East Sussex
Other	A N	Eastleigh Borough Council	
Page	David	Elmbridge Borough Council	Civic Centre, High Street, Esher, Surrey
Barton	David	English Nature	Parsonage Down NNR, Cherry Lodge Farm, Shrewton, Salisbury, Wiltshire
Bowley	A	English Nature	Ham Lane House, Ham Lane, Peterborough
Brodie James	Tim	English Nature	Slepe Farm, Nr Arne, Wareham, Dorset
Coleshaw	Tim	English Nature	Attingham Park, Shrewsbury
Daniels	J L	English Nature	Manor House, Moss Lane, Whixall, Shropshire
Edgington	M J	English Nature	Roughmoor, Bishops Hull, Taunton
Emmery	Malcolm	English Nature	Howard House, 31 High Street, Lewes, E. Sussex
Fisher	N	English Nature	Genesis 1, University Road, Heslington, York
Gardiner	Chris	English Nature	Beds/Cambs/Northants Team, 15 Castle Rise, Belmesthorpe, Stamford, Lincs
Holmes	Peter	English Nature	Bronsil House, Eastnor, Ledbury, Herefordshire
Holms	Phil	English Nature	The Smithy Workshops, Wolferton, King's Lynn, Norfolk
Irving	J A	English Nature	10/11/Butchers Row, Banbury, Oxon
Knott	Albert	English Nature	Yarner Wood, Bovey Tracey, Devon
le Bas	Ben	English Nature	Manor Barn, Overhaddon, Bakewell
Lord	Bob	English Nature	Hampshire and Isle of Wight Team
Mawby	Frank	English Nature	Wayside, Kirkbride, Carlisle
Maylam	David	English Nature	Coldharbour Farm, Wye, Nr Ashford, Kent
Millar	Andy	English Nature	60 Bracondale, Norwich, Norfolk NR1 2BE
Parker	Stephen	English Nature	Roughmoor, Taunton, Somerset
Payne	Keith	English Nature	Foxhold House, Crookham Common, Thatcham, Berks

Roworth	Peter	English Nature	Don Farm, Moor, Road, Crowle, Scunthorpe
Sampson	Karen	English Nature	Juniper House, Murley Moss, Oxenholme Road, Kendal, Cumbria
Smith	Simon	English Nature	Saltfleetby NNR, Lincs, 78 High Street, Boston
Southwood	Rick	English Nature	19 The Green, Woodbastwick, Norwich, NR13 6HH
Stephens	Dee	English Nature	Slepe Farm, Nr Arne, Wareham, Dorset BH20 5BN
Steven	Graham	English Nature	Foxhold House, Crookham Common, Thatcham, Berks
Trinder	Clare	English Nature	Manor Barn, Overhaddon, Bakewell
Walker	G J	English Nature	Attingham Park, Shrewsbury
Watt	T	English Nature	Holly Mead, 18 Kempton, Lydbury North, Shropshire
Welsh	Peter	English Nature	Thornborough Hall, Leyburn, N. Yorks
Whether	Heather	English Nature	Foxhold House, Crookham Common, Thatcham, Berks
Woodall	Corinna	English Nature	Thames & Chilterns Team, Foxhold House, Crookham Common, Thatcham, Berks
Wrojt	Dr	English Nature	Thames-Chiltern, Foxhold House, Crookham Common, Thatcham, Berks
Biglin	John	Epsom and Ewell Borough Council	The Town Hall, The Parade, Epsom, Surrey
Bedford	Neil	Essex Wildlife Trust	Fingringhoe Wick Nature Reserve, South Green Road, Fingringhoe, Colchester
Quelch	P R	FC Scotland	Whitegates, Lochgilphead, Argyll
Hair	John	Forest Enterprise	Aberfoyle Road, Stirling
Leslie	C	Forest Enterprise	Dornogh Forest District, Hilton of Embo, Dornogh, Sutherland
Leslie	Rod	Forest Enterprise	340 Bristol Business Park, Bristol
Owen	T	Forest Enterprise	Victoria House, Victoria Terrace, Aberystwyth, Ceredigion
Rider	Chris	Forest Enterprise	Mill Park Road, Oban, Argyll
Whitfield	Philip	Forest Enterprise	Moray Forest District, Balnacoul, Fochabers, Moray
Wield	Malcolm	Forest Enterprise	Fort Augustus Forest District, Strathoich, Fort Augustus
Crosby	M J	Forest Enterprise (Forestry Commission)	Forest Mill, Weavers Court, Selkirk
Ogilvie	John	Forest Enterprise [Scotland (North)]	West Argyll Forest District, Whitegates, Lochgilphead, Argyll
Wilson	Keith	Forestry Commision	National Office for England, Great Eastern House, Tenison Road, Cambridge
Coghill	Sinclair	Forestry Commission	Ordiquhill, Portsoy Road, Huntly, Aberdeenshire
Other	A N	Forestry Commission	Forest Enterprise, AE Village, Dumfries
Quelch	Peter	Forestry Commission Scotland	Whitegates, Lochgilphead, Argyll
Jenkins	Ruth	Forestry Commission Wales	Victoria Terrace, Aberystwyth

Atkinson	Molly	FWAG	P.O.Box 8116, Mauchline
Crossley	John	FWAG	66, Junction Road, Kirkwall, Orkney
Milner	Sophie	FWAG	77, North Street, Forfar
Sheehan	K A	FWAG	Alpha Centre, Innovation Park, Stirling
Lycett	Carol	Gosport Borough Council	Countryside Section, Grange Farm, Little Woodham Lane, Rowner, Gosport Hants
Penford	Nicola	Grampian FWAG	Thainstone Business Centre, Inverurie
Bell	Eoin	Hertfordshire County Council	Environment Department, County Hall, Pegs Lane, Hertford
Stewart	Mairi	Highland Perthshire Native Woodlands	1, Crieff Road, Aberfeldy
Andrews	Cliff	Ivel Valley Countryside Project	Biggleswade Library, Chestnut Avenue, Biggleswade, Beds
Harley	Will	Kennet District Council	Browfort, Bath Road, Devizes, Wilts
Kennison	Garry	Kent County Council	Invicta House, County Hall, Maidstone, Kent
Rennells	Keith	Kent High Weald Project	Council Offices, High Street, Cranbrook, Kent
Shelton	Jon	Kentish Stour Countryside Project	Sidelands Farm, Wye, Ashford, Kent
Taylor	Phil	Lake District National Park Authority	Murley Moss, Oxenholme road, Kendal
White	Steve	Lancashire Wildlife Trust	Seaforth Nature reserve, Port of Liverpool, Liverpool
Lewis	J	London Borough of Croydon	Parks and Open Spaces, Taberner House, Park Lane, Croydon
Roome	Colin	London Borough of Hillingdon	Leisure Service, Civic Centre, High Street, Uxbridge, Middlesex
Frith	Matthew	London Wildlife Trust	Harling House, 47-51 Great Suffolk Street, London
Seymour	Tony	Lothians FWAG	Vogrie House, Gorebridge, Midlothian
Dr. Tween	Trevor	Luton Borough Council	John Day Field Centre, Hancock Drive, Bushmead, Luton, Beds
Other	A N	Manor Farm Country Park	manor Farm Country Park, Brook Lane, Botley, Nr Southampton, Hampshire
Coppock	Chris	Milton Keynes Council	Environment Directorate, PO Box 113, Civic Offices, 1 Saxon Gate East, Milton Keynes
Wilson	Phillip	Norhumberland Wildlife Trust	Garden House, St Nicholas Park, Newcastle-upon-Tyne
Robertson	C Buist	North East Native Woodlands	Mid Pitmunie, Monymusk, Invererie
Sawford	Brian	North Hertfordshire District Council	Museums Resource Centre, Burymead Road, Hitchin, Herts
Davey	Matthew	North West Kent Countryside Project	Mead Crescent, Dartford, Kent
Charles	Rona	North York Moors National Park	The Old Vicarage, Bondgate, Helmsley, N. Yorks
Haines	Chris	Northamptonshire County Council	Countryside and Environment, County Hale, PO Box 163, Northampton
Rigg	Elaine	Northumberland National Park Authority	Eastburn, South Park, Hexham, Northumberland
Jackson	John	Norwich Wildlife Trust	72 Cathedral Close, Norwich

Fraser	Jeremy	Nottinghamshire Wildlife Trust	The Old Ragged School, Brook Street, Nottingham
Luxmore	R	NTS	28, Charlotte Square, Edinburgh
Thomas	Rhodri	Peak District National Park Authority	Aldern House, Baslow Road, Bakewell, Derbyshire
Howe	Mike	Pembrokeshire Coast National Park Authority	Winch Lane, Haverfordwest, Pembrokeshire
Jones	Richard	Portsdown Hill Countryside Service	Fort Widley, Portsdown Hill Road, Portsmouth
Gower	Tina	Reading Borough Council	Caversham Court Environmen Centre, Church Road, Caversham, Reading
Wright	Ian	Reigate and Banstead Borough Council	Town Hall, Reigate, Surrey
Coppins	R J	Royal Botanic Gardens, Edinburgh	Edinburgh
Barrett	D	RSPB	4 Benton Terrace, Sandyford, Newcastle-Upon-Tyne
Davidson	A	Rushmoor Borough Council	Council Offices, Farnborough Road, Farnborough, Hants
Bibby	Helen	Scottish Agricultural College	Glencruitten Road, Oban, Argyll
Hall	Jonathan	Scottish Landowners' Federation	Stuart House, Eskmills Business Park, Musselburgh
Parrott	John	Scottish Native Woods	The Old School, Errogie, Inverness
Cameron	Ewen	Scottish Natural Heritage	17, Rubislaw Terrace, Aberdeen
Duncan	Peter	Scottish Natural Heritage	Creag Mealady NNR, Aberawer, Kinlochlaggan, By Newtonmore
Walker	Lynn	Scottish Natural Heritage	Earmont House, the Crichton, Bankend Road, Dumfries
Morison	G W	Scottish Wildlife Trust	Cramond House, Cramand Glebe Road, Edinburgh
Wilcox	Neil	Scottish Wildlife Trust	
Albertini	Howard	Slough Borough Council	Planning Dept, PO Box 570, Slough
Hancock	C G	Somerset Wildlife Trust	Fyne Court, Broomfield, Bridgewater, Somerset
Busby	Malcolm	South Cambridgeshire District Council	Milton Country Park, Cambridge Road, Milton, Cambridge
Welch	Andy	Southampton City Council	The Hawthorns, The Common, Southampton
Deegan	Mike	Staffordshire Wildlife Trust	Coutts House, Sandon, Stafford
Grimshaw	Stephen	Suffolk County Council	Environment and Transport Department, St Edmund House, County Hall, Ipswich
Harkness	Gavin	Surrey County Council	Countryside Management, West House (Annexe), Merrow Lane, Guildford, Surrey
Voller	Gordon	Surrey Heath Borough Council	c/o Heathland Visitor Centre, Lightwater Country Park, The Avenue, Lightwater, Surrey
McGibbon	Robert	Surrey Heathland Project	Artington House, Portsmouth Road, Guildford
Murphy	Sarah	Surrey Wildlife Trust	School Lane, Pirbright, Woking, Surrey
Featherstone	Neil	Sussex Downs Conservation Board	East Area Office, Seven Sisters Country Park, Exceat, Seaford, East Sussex
James	Richard	Sussex Downs Conservation Board	Stanmer Park, Lewes Road, Brighton

Larkin	Monty	Sussex Downs Conservation Board	Exceat, Seaford,
Middleton	Bruce	Sussex Downs Conservation Board	Northern Area Office, Midhurst Depot, Bepton Road, Midhurst
Scott	Ro	SWT Belmadutly Reserve	Peddleston Cottage, Cromarty, Ross-shire
Cowen	Debbie	Tayside Native Woodlands	Buccaneer Way, Perth Aerodrome Business Park, Scone, Perthshire
Whittington	David	Thanet District Council	Thanet Council Offices, PO Box 9, Cecil Street, Margate, Kent
Bromham	Janet	The Cairngorms Partnership	14, The Square, Grantown-on-spey
Bull	Philip	The National Trust	Northumbria Regional office, Scots Gap, Morpeth, Northumberland
Hooson	John	The National Trust	The Hollens, Grasmere, Ambleside, Cumbria
Fenton	James	The National Trust for Scotland	The Old Granary, West Mill Street, Perth
Bellamy	Graham	The Wildlife Trust	Priory Country Park, Barkers Lane, Bedford
Glass	Sally	The Woodland Trust	Green Farm, Hornblotton, Shepton Mallet
Mageean	Simon	The Woodland Trust	Lilac Cottage, Fir Tree Lane, Littleton, Chester
Sincomb	Geoff	The Woodland Trust	2 Five Acres, Horbrook, Ipswich
Swift	Heather	The Woodland Trust	12 Sandy Lane, Leyland, Preston, Lancs
Young	Mrs	The Woodland Trust	6 Goodwood Close, Camberley, Surrey
Mason	James	The Woodland Trust (Devon)	Sunflower Cottage, Loddiswell, Devon
Douglas	Angela	The Woodland Trust Scotland	Glenruthven Mill, Abbey Road, Auchterander, Perthshire
Warren	Jonathan	Three Rivers District Council	Three Rivers House, Northwall, Rickmansworth, Herts
Budden	Steve	Tunbridge Wells Borough Council	Town Hall, Tunbridge Wells, Kent
Carreck	A	Tunbridge Wells Borough Council	Highways Maintenance Section, Town Hall, Tunbridge Wells, Kent.
Cleveland	Sarah	Tunbridge Wells Borough Council	Town Hall, Royal Tunbridge Wells, Kent
Coates	Mike	Waverley Borough Council	Council Offices, The Burys, Godalming, Surrey
Seaman	Keith	Welwyn Hatfield Council	Council Offices, Welwyn Garden City, Herts
Harris	Miller	West Highland Estates Office	33, High Street, Fort William
Gray-Stephens	Gordon	West Highland Native Woodlands	Middlehill, Lochgilphead
Griffiths	Ann	West Sussex County Council	County Planning Department, County Hall, Chichester, West Sussex
Hucker	Martyn	West Wiltshire District Council	Bradly Road, Trowbridge, Wilts
Gander	L	Wildlife Trust West Wales	Welsh Wildlife Centre, Lilgerran, Pembs
Kerr-Boyner	R J	Wiltshire County Council	Environmental Services Dept, County Hall, Trowbridge, Wilts
Hosie	Catherine	Wiltshire Wildlife Trust	Head Office, Elm Tree Court, Longstreet, Devizes

Page	Jenny	Woking Borough Council	Civic Offices, Glouceser Square, Woking, Surrey
Glencross	Andy	Wokingham District Council	Dinton Pastures Country Park, Davis Street, Hurst, Reading
Thom	Tim	Yorkshire Dales National Park Authority	Colvend, Hebden Road, Grassington, Skipton, North Yorks.

Appendix 6.1 The questionnaire used to survey attitudes towards scrub conservation and policy at a regional and county level. Some modifications were made according to destination organisation (FWAG, FRCA, country agencies, etc.).

THE NATURE CONSERVATION VALUE OF SCRUB

Questionnaire-based survey of project officers, regional staff and advisors

Purpose of the survey

English Nature, Scottish Natural Heritage and the Countryside Council for Wales wish to assess current knowledge about scrub, and determine research and policy priorities for its conservation. A consortium led by CABI Bioscience: Environment, including the British Trust for Ornithology and the Institute of Terrestrial Ecology, has been contracted to assess the current state of knowledge in this area. As part of this process, we wish to assess how scrub is perceived by those with responsibility for providing advice or awarding grants at the county or regional level.

Definition of scrub

Scrub is difficult to define precisely because it is often an intermediate stage in the succession from open ground to woodland habitats. However, the definition given in the new Tir Gofal agri-environment scheme in Wales is typical: 'Vegetation dominated by native shrubs less than 5m tall, typically hawthorn, blackthorn, common gorse, elder, willow, birch or bramble' (Welsh Office/CCW 1999).

Questionnaire

Please use a continuation sheet if required.

1. Do you use a definition of scrub that differs from that given above? If so, what is it?

2. What type of scrub work does your organisation fund/provide advice on? (please tick):

Management to:

increase the area of particular scrub types	☐
conserve existing scrub or enhance its value	☐
control spread of existing scrub into adjacent habitats	☐
remove existing scrub to restore/reinstate another habitat	☐ (please specify)

3. What are the primary aims of your organisation in funding/providing advice on this work?

4. What order of priority do the following criteria have in influencing funding/advice on scrub management. Please complete each column corresponding to the types of management you indicated in Question 3, using the following scale:

1	Usually the primary criterion
2	Usually one of several major considerations
3	Usually only a minor consideration
4	Usually has no bearing on decision making

Management to: **Evaluation Criteria:**	a) increase area of particular scrub type	b) conserve or enhance value of existing scrub	c) control the spread of scrub into adjacent habitat	d) remove in order to restore another habitat
LANDSCAPE CRITERIA				
Value of scrub in contributing to the landscape characterof the area				
Extent of scrub habitat (in general) in the surrounding area				
Extent of that particular scrub type in surrounding area				
HABITAT CRITERIA				
Rarity of that scrub type at regional or national level				
General conservation value of scrub as a habitat				
Potential conservation value of habitat which could be reinstated on that area				
SPECIES CRITERIA				
Scrub stand contains rare plant species				
Scrub stand contains rare invertebrate species				
Scrub stand contains rare bird species				
Scrub stand contains rare mammal species				
Scrub stand contains a range of rare species				
SITE CRITERIA				
Area of scrub stand				
Amenity/recreation considerations				
Archaeological/historical considerations				
SCHEME CRITERIA				
Land-owner/applicant has strong desire to include scrub management				
Scrub management is necessary to secure funding for a wider application				
OTHER (please state)				

5. What changes in current policy (e.g. ESA, Countryside Stewardship, Woodland Grant schemes, nature conservation schedules) are needed to improve the efficacy of your organisation in undertaking and/or promoting scrub conservation?

6. What future policies would enable your organisation to maximise its impact on scrub conservation?

7. Would additional research or survey information aid decision-making within your organisation on scrub-related issues? YES / NO

If YES, what research or information would be useful? (Please prioritise on a scale of 1 – 5, where 1 = limited use, and 5 = essential).

Information	Priority

Is work on the future provision of this information currently underway in your organisation?
YES / NO / DON'T KNOW

If YES, please specify:

Thank you for taking the time to complete this questionnaire.

Appendix 6.2 Details of all individuals responding to a second scrub questionnaire surveying opinion on policy relevant to scrub conservation.

Scottish Natural Heritage

Alan McDonnell
Scottish Natural Heritage
Bowman
Isle of Islay
PA43 7JJ

Mary Harman
Scottish Natural Heritage
Stilligarry
South Uist
HS8 5RS

Scottish Natural Heritage
Newton Stewart
Wigtownshire
Dumfries & Galloway

Alison Matheson
Scottish Natural Heritage
Forvie NNR
Little Collieston Croft
Collcston
Aberdeenshire
AB41 8RU

Chris Wright
Scottish Natural Heritage
17 Pultency Street
Ullapool
Ross Shire
IV26 2UP

M Faulkner
Scottish Natural Heritage
Wynne Edwards House
16/17 Rubislaw Terrace
Aberdeen
AB10 1XE

Andrew Campbell
Scottish Natural Heritage
Glencruitten Road
Oban
Argyll
PA34 4DN

Anne Garrett
SERAD
I-J77 Victoria Quay
Edinburgh
EH6 6QQ

Liz Buckle
Scottish Natural Heritage
22 Bannatyne Street
Lanark
ML11 7JR

Countryside Council for Wales

Brian Pawson
CCW
BWB House
Phoenix Way
Swansea Enterprise Park
Swansea
SA7 9FG

Dr Sian Whitehead
CCW
Plas Penrhos
Ffordd Penrhos
Bangor
Gwynedd
LL57 2LQ

Jim Latham
CCW
Plas Penrhos
Ffordd Penrhos
Bangor
Gwynedd
LL57 2LQ

Farming and Rural Conservation Agency

Stephanie Payne
FRCA Bristol
Government Buildings
Burghill Road
Westbury on Trym

Sally Mousley
FRCA
Block 7
Chalfont Drive
Nottingham
NG8 3SN

Peter Bowden
FRCA Exeter
Matford Business Park
Exeter

Richard Belding
FRCA
Quantock House
Paul Street
Taunton
TA1 3NX

Tony Phillips
FRCA
Woodthorne
Wergs Road
Wolverhampton
WV6 8TQ

C R Hitchman
FRCA
Southgate Street
Bury St Edmunds
Suffolk IP33 2BD

David Ragbourne
FRCA
Woodthorne
Wergs Road
Wolverhampton

Hannah Gay
FRCA
Crewe
Cheshire

Clare Lancaster
FRCA
Electra Way
Crewe
Cheshire

R Gilbert
FRCA
Electra Way
Crewe
Cheshire

Paul Cobbing
FRCA
PO Box 77
Block C
Government Buildings
Whittington Road
Worcester
WR5 2YJ

Chris Jankiewiczcz
FRCA
Oxford Spires Business Park
Kidlington
Oxford
OX5 1FR

Monica O'Donnell
FRCA
Brooklands Avenue
Cambridge
CB2 2BL

Darren Braine
FRCA
Block C
Government Buildings
Broadlands Avenue
Cambridge

Paul Curtis
FRCA
Northallerton

Mervyn Edwards
FRCA
Agricola House
Unit 5
Cowper Road
Gilwilly Industrial Estate
Penrith
Cumbria CA11 9BN

Simon Huguet
FRCA
Electra Way
Crewe
CW1 6GR

Michelle Leek
FRCA
Coley Park
Reading
RG1 6DE

Geoff Newsome
GTVS
Olantigh Road
Wye
Ashford
Kent

Rod Starbuck
FRCA
Block 7
Government Buildings
Chalfont Drive
Nottingham
NG8 3SN

English Nature

Dave Maylam
English Nature
Coldharbour Farm
Wye
Ashford
Kent
TN25 5DB

(anon)
English Nature
Lyndhurst
Hampshire

Donna Radley
English Nature
Ham Lane House
Ham Lane
Orton Waterville
Peterborough
PE2 5UR

Katie Lloyd
English Nature
Prince Maurice Court
Hambleton Avenue
Devizes
Wiltshire SN10 2RT

Mr J Edgington
English Nature
Roughmoor

Bishops Hull
Taunton
Somerset TA1 5AA

Graham Steven
English Nature
Foxhold House
Thatcham
Berkshire
RG19 8EL

(anon)
English Nature
Howard House
31 High Street
Lewes
East Sussex
BN7 2LU

Peter Holmes
English Nature
Bronxil House
Eastnor
Ledbury
Herefordshire
HR8 1EP

Ben Le Bas
English Nature
Manor Barn
Over Haddon
Bakewell
Derbyshire DE45 1JE

Farming and Wildlife Advisory Group

Peter Bowman
FWAG
Lodge Farm
Pitsford Road
Moulton
Northampton
NN3 7QL

Lisa Coward
FWAG
Longacre House
Frome Road
Trowbridge
Wiltshire BA14 ODQ

George Dodds
Northumberland FWAG
Bridge Street
Rothbury
Morpeth
Northumberland
NE65 7SG

Sophie Milner
FWAG
77 North Street
Forfar
DD8 3BL

D Nichols
FWAG
C/O MAFF
Oxford Spires Business Park
The Boulevard
Kidlington
OX5 1NZ

Roland Stonex
FWAG
Environment 7 Property Dept
County Hall
Taunton
Somerset
TA1 4DY

John Crossley
FWAG Scotland
66 Junction Road
Kirkwall
Orkney
KW15 1AR

Mr J Simpkin
FWAG
C/o Myerscough College
Bilsborrow
Preston
Lancashire
PR3 ORY

Mary Combe
Cornwall FWAG
Planning Directorate
County Hall
Truro
TN1 2AY

Sara Barrett
FWAG (Derbyshire)
Agriculture House
Smedley Street
East
Matlock
Derbyshire
DE4 5GH

Ralph Hobbs
FWAG Weal of Kent & Sussex
Corner Farm
Hastings Road
Flimwell
East Sussex
TN5 7PR

Mr E Gallia
FWAG
MAFF
Burghill Road
Westbury on Trym
Bristol
BS1 6NJ

Ros Willder
FWAG
Elmbridge Court
Cheltenham Road
Glos GL3 1AG

Doug Hill
FWAG
Reaseheath College
Nantwich
Cheshire
CW5 6DF

Oxford FWAG
Oxford Spires
Kidlington
Oxford
OX5 1NZ

Kieran Sheehan
FWAG
Alpha Centre
Innovation Park
Stirling
FK9 4NF

Rebecca Russell
Lanarkshire FWAG
Lanark Auction Mart
Muirglen
Lanark
ML11 9AX

Peter Tierney
FWAG
Upper Bryn Farm
Longtown
Herefordshire

Mark Ward
FWAG
National Agricultural Centre
Stoneleigh
Kenilworth
Warwickshire
CV8 2RX

Molly Atkinson
FWAG
PO Box 8116
Mauchline
KA5 6YB

Adam Gretton
Suffolk FWAG
100 Southgate Street
Bury St Edmunds
IP33 2BD

Other

Trefor Thompson
Moira Young
Denbighshire Co Council
Trem Clwyd
Ruthin
LL15 1QA

Mr L Starling
Forestry Commission
Clawdd Newydd
Ruthin
Denbighshire
LL15 2NL