8. THE FUTURE

8.1 National policy and habitat creation.

This guide has regularly stressed that habitat creation should never be considered as a replacement for semi-natural habitat. However, given that the UK has lost considerable areas of semi-natural habitat through changes in agricultural management, afforestation, urbanisation and development, there is considerable scope for habitat creation to offset these losses.

Habitat creation is forming part of a number of Government and statutory agency policies, for example:-

* English Nature's own current *Natural Areas* policy assumes that habitat creation expertise exists given its promotion of certain forms of land management and habitat creation which have the aim of linking isolated protected areas, such as SSSIs and SINCs. Habitat creation is also promoted in English Nature's *Strategy for the 1990s*.

* Countryside Stewardship (Countryside Commission) and Tir Cymen (Countryside Council for Wales) also assumes that habitat creation expertise exists given the payments which are available for the extension of habitats such as upland moorland.

* The new *habitat scheme* under the European Union (EU) Agri-environment Regulation will support the creation of new intertidal habitats, targeting saltmarshes in particular. It is also possible that the *habitat scheme* will tie-in with long term (20 year) set-aside.

* Grant awards in Environmentally Sensitive Areas (ESAs) also have a habitat creation element.

With rising sea levels and major economic concerns regarding coast protection schemes in some parts of the country, managed coastal retreat (setback) programmes are being discussed as realistic options. These will provide major opportunities for intertidal habitat creation such as saltmarshes (cf. the new *habitat scheme*) and dune systems. These have not been considered in any detail in this *Guide* as this is a new field where more experimentation is required. However, the number of areas which were formally reclaimed from the sea which subsequently became intertidal again, such as Pagham Harbour, West Sussex, provides evidence that such programmes can be successful.

At the present time there is a major road building programme in the UK which is providing opportunities for habitat creation schemes. Many of these schemes are attempting to mitigate for the loss of semi-natural vegetation and, not the least for this reason, their success is being examined with some interest. The Department of Transport have recently published a revised *Design Manual for Roads and Bridges* which includes *The Good Roads Guide* and *The Wildflower Handbook*, which include sections on the design of habitat creation schemes, tree planting and the use of wild flower seed mixes.

The wise use of limited financial resources available to different government agencies and NGOs to undertake habitat creation, restoration or protection is an important issue. Is it desirable, cost-effective or *sustainable* to undertake habitat creation? This *Guide* has certainly presented evidence that resources have been wasted undertaking habitat creation. However, habitat creation, if planned well, can be highly effective, but it should only be seen as one element of the UK's nature conservation resource. There is a need for an overall cross-government strategy for habitat creation.

Habitat creation can help to reduce the isolation and fragmentation of existing semi-natural habitats. It can also assist with the development of effective corridors/stepping stones both in urban areas and in the wider countryside.

Finally, habitat creation should be seen within the framework of UK biodiversity. UK biodiversity has been sadly depleted, especially in grassland and woodland environments. Much of this loss has occurred since 1945 although few species have become extinct. Whereas there is great potential for habitat creation schemes to increase biodiversity, there is some conflict with the widespread use of wildflower seeds and trees/shrubs from different, especially continental European origins, which could damage the genetic base of the British flora.

8.2 Lessons from wetland habitat creation programmes

There are important lessons to be learnt from wetland habitat creation, the most significant being the vital element of long term management. Much wetland habitat creation has had the benefit of being carried out by organisations having a great deal of continuity, such as RSPB and Wildfowl and Wetlands Trust, who can create and subsequently manage their wetlands. Good examples of these projects are the Sevenoaks Wildfowl Reserve, Kent (Kent Trust for Nature Conservation), Great Linford Lakes, Milton Keynes (ARC and Game Conservancy) and Martin Mere, Lancashire (Wildfowl and Wetlands Trust).

The habitat creation projects studied in this *Review* have highlighted the lack of and need for, long term management with most grassland, heathland and woodland schemes. The most successful schemes of this kind have been found to be managed as part of an existing land management operation. Good examples of this are at Durlston Country Park, Dorset (Dorset County Council; case study 8), Seven Sisters Country Park, East Sussex (East Sussex County Council; case study 9) and Ropers Heath, Suffolk (NCC, now English Nature; case study 17).

8.3 The need for better project planning and monitoring.

A critical element for the success of habitat creation projects is good project planning; the checksheets presented at the end of Chapter 2 have outlined the most important elements which are required. The analysis of the case studies in this *Review* has revealed that habitat creation projects should not be too ambitious; they should be in harmony with surrounding habitats and landuse, and costed within the constraints of available finance. Finance which is available for the construction/establishment of the project should be separated from that required for long-term management. The financial element can be offset to a greater or lesser extent by local enthusiasm, but how long will this last?

Inadequate recording of site preparation, methods and monitoring of a habitat creation project results in a problem with deciding whether the project has achieved its objectives. This situation has been reached in the Levenhall Links Leisure Park, East Lothian (East Lothian District Council; case study 1), with the creation of hay meadows on fly-ash lagoons in 1987. The management continues, but no systematic monitoring is being carried out. The regularity of monitoring is important. One could argue that monitoring at Levenhall Links only needs to take place every 3-5 years; but this should have been established at the project planning stage.

There is also evidence confirming recent research which suggests that the most successful projects are those which take place adjoining semi-natural habitat. Durlston Country Park is a good example of this where the seed rain from adjoining vegetation has entered the created sward and increased its diversity. Within the wider countryside there is a good case that these projects should receive the most support.

8.4 The special case of urban habitat creation.

In urban areas, where semi-natural vegetation may not be present, habitat creation is taking place for amenity and educational reasons as well as for its ecological interest. Urban habitat

creation achieved a high degree of creativity in the 1980s and, in the 1990s, the experience gained has resulted in urban habitat creation projects being more focussed and of higher quality. This trend is to be welcomed as it is achieving more effective habitat creation despite the restricted financial resources which are available.

8.5 Further research in habitat creation.

There is no doubt amongst environmental scientists that habitat creation is a developing science. There is far more written about the subject than has actually been put successfully into practice. Whereas the subject of open water and wetland habitat creation has proved to be highly successful in many instances, this stage has not yet been reached with the creation of woodlands although it is somewhat closer with heathlands/moorlands and some lowland grasslands.

The faunal element of habitat creation must not be ignored. During the *Review* we have recorded very little monitoring of fauna on habitat creation projects. An exception to this is again Durlston Country Park where butterfly recording takes place on the created calcareous grasslands. There is work being carried out by ITE (Nigel Webb) and others on the faunal colonisation of lowland heathlands which should yield information from this important perspective.

We have found whilst undertaking the *Review* that only a small proportion of projects are being properly recorded and published. We have examined a number of good projects, some more than 10 years old, where a published record of the planning, methods, results, monitoring and management of the project would be invaluable to other practitioners. If this is difficult to do, then a short note in, for example, *Habitat Management News* in *British Wildlife* would be a good start. The *Review* also found very little reporting of failed projects; whereas this is understandable, it is not helpful as this information could prevent the same mistakes being made again. Possible methods of assisting publication and recording would be to make the writing up of work a condition of funding a habitat creation project.

It is necessary in order to progress the science of habitat creation that the research programmes of the statutory countryside/nature conservation agencies, the Department of the Environment, and non-statutory organisations (NGOs), devote more of their attention to habitat creation research.

8.6 Conclusion

Despite the acceptance and inclusion of habitat creation within present government and statutory agency policies and initiatives, this *Guide* has indicated a fundamental lack of ecological scientific information and documented practical examples relating to the topic. This raises the question as to whether there is yet sufficient technical and practical knowledge available to achieve the policy objectives which have been set.

Those projects which have demonstrated greatest success have had the following characteristics: narrow range of objectives; correct substrate conditions; long term - but flexible - finance, plans and management commitment; and some degree of "luck" such as favourable weather or committed staff/volunteers.

There is some degree of promise for habitat creation in certain areas, especially in the creation of heathlands, saltmarshes and some grasslands, but we are still not certain, even in the long term, that the created habitats will achieve the value of semi-natural ones. There remains, therefore, no substitute for the conservation of all semi-natural habitats and this should remain at the centre of nature conservation planning.

FURTHER BIBLIOGRAPHY

ADAS, (1986), *Practical Work in Farm Woodlands*. MAFF, Alnwick.

ANDREWS J., (1990), *The Management of Lowland Heathlands for Wildlife* British Wildlife 1: 6, pp 336-346.

ANDREWS J. and Kinsman D,. (1991) *Gravel pit restoration for wildlife: a practical manual.* RSPB.

BERENDSE, F., OOMES, M.J.M., ALTENA, H.J. & ELBENSE, W. 1992. Experiments on the restoration of species-rich meadows in the Netherlands. Biol. Conserv., 63, 59-65.

BTCV (1976), *Waterways and Wetlands*. London.

DOVER J., (1991), The Conservation of Insects on Arable Farmland. In N.M. Collins & J.A. Thomas, (Eds.) *The Conservation of Insects and their Habitats*. pp 294-315. Academic Press, London.

DUFFEY (1974), *Grassland ecology and wildlife management*, Chapman and Hall, London.

GOUGH, M.W., & MARRS, R.H. 1990. A comparison of soil fertility between semi-natural and agricultural plant communities: implications for the creation of floristically rich grassland on arable land. Biol. Conserv. 51, 83-96.

GRIME J.P., HODGSON J.G., and HUNT, R. (1988). *Comparative Plant Ecology - a functional approach to common British species*. Unwin Hyman, London.

KENDLE, A.D. & BRADSHAW, A.D. 1992. The role of soil nitrogen in the growth of trees on derelict land. Aboricultural Journal, 16(2), 103-122.

KENNEDY, C. E. S. & SOUTHWOOD, T. R. E. (1984). The number of species associated with British trees: a reanalysis *J. Anim. Ecol.* 53: 455-478.

MARRS, R.H. (1985), *Techniques for reducing soil fertility for nature conservation purposes: a review in relation to research at Roper's Heath.* Biological Conservation, 34, 307-332.

MARRS, R.H. 1985. An assessment of change in *Calluna* heathlands in Breckland, Eastern England, between 1983 and 1991. Biol. Conserv., 65, 133-139.

NATURE CONSERVANCY COUNCIL, (1988), *Site Management plans for Nature Conservation: a working guide*. Nature Conservancy Council, Peterborough.

RACKHAM O., (1976) *Trees and woodland in the British landscape*. Dent & Sons, London.

ROBERTS, D. & BRADSHAW, A. D. (1985). Hydraulic seeding techniques 149. Landscape Design 156, pp. 42-47.

ROBINSON, G.R. & HANDEL, S.N. 1993. Forest restoration on a closed landfill - rapid addition of new species by bird dispersal. Conserv. Biol,, 7(2), 271-278.

SOUTHERTON, N.W. 1991. Conservation headlands: a practical combination of intensive cereal farming and conservation. In: L.G. Fairbank *et al* (Eds.). *The ecology of temperate cereal fields*. 373-397. Blackwells, Oxford.

WILLIAMS, E.D., (1978), *Botanical Composition of the Park Grass Plots at Rothamsted*, Rothamsted Experimental station, Harpenden.

APPENDIX A

HABITAT CREATION REVIEW - LIST OF CASE STUDIES

HABITAT CREATION REVIEW - LIST OF CASE STUDIES (ASSEMBLED FROM THE QUESTIONNAIRE)

No.	Site name & location	Target habitat type	Start date
1. MESOTROPHIC GRASSLAND			
G1	Towns Pasture, Derwent Ings SSSI	Flood meadow	1983
G2	Mussellborough Lagoons, E. Lothian	Neutral meadow	1986/7 (vague)
G3	Benwell Nature Park, N'castle on Tyne	Neutral grassland	1985/86
G4	Hallow Hill SSSI, N'castle on Tyne	Species-rich grassland	1985
G5	Isle of Rhum	Herb-rich grassland	N/K
G6	Ryewater Meadow, Sherborne, Dorset	Species-rich neutral grassland	1986
G7	Hampstead Heath, London	Wildflower meadow	c1987
G8	Barn Hill/Fryent Way (L.B. Brent)	Wildflower meadow	N/K
G9	Wirral	Species-rich meadow	N/K
G10	Blairadam Conservation Project	Neutral meadows	1986
G11	Wolverhampton Meadows, Pendleford	Species-rich neutral hay-meadows	1986/7
G12	West Sedgemoor, Somerset	Herb-rich wet meadows	N/K
G13	Daws Hall Reserve	Wildflower meadow	1988
G14	Iron Latch Meadow	Flower-rich grassland	1982
G15	Durlston Meadows, Dorset	Neutral grassland (see C8)	1982
G16	Edinburgh City Bypass	Wildflower meadow	1989
G17	Yardley Gobian Bypass/Bozeat Bypass	Wildflower areas	1988-1990
G18	Brandon Hill, Bristol	Grassland etc.	1982&1988
G19	Barnett Demesne, Belfast	Species-rich meadow	1984
G20	Gleedown Farm, Much Wenlock, Salop	Species-rich meadow	1990
G21	Moor Green Lakes	Wildflower meadow	1989-1990
G22	Dary's Bing, Orkney Islands	Wildflower meadow	1987/87
G23	South Hoe Farm etc.	Wildflower meadows	1989/1990
G24	Stadtmoers Park, Knowlsey	Wildflower meadow	1985&1988
G25	Ranston Covert, Bucks	Wildflower meadows	10 yrs ago
G26	Kenton Rough, Harrow	Wildflower meadow	c.1990
G27	Melling meadow, Sefton	Wildflower meadow	N/K
G28	Sites in Knowsley	Grasslands	1988
G29	Eaton Meadows, Cheshire	Wildflower meadows	N/K
G30	Factory site, Invergordon	Wildflower grassland	N/K
G31	Nursing Home, Inverness	Wildflower grassland	N/K
G32	Airfield, Moray Firth	Wildflower grassland	N/K

HABITAT CREATION REVIEW - LIST OF CASE STUDIES (cont.)

No.	Site name & location	Target habitat type	Start date
2. ACID GRASSLAND			
No case studies detailed			
3. CALCAREOUS GRASSLAND			
C1	Redbourn Road Verges, Hertfordshire	Chalk grassland	1989
C2	Salisbury Plain & Porton Down	Chalk grassland	N/K
C3	Seven Sisters Country Park, E. Sussex	Chalk grassland	1971
C4	Dorchester Link Rd, Dorset	Chalk grassland	1988
C5	Devils Dyke SSSI, Cambridge	Chalk grassland	1990
C6	Betchworth, Surrey	Chalk grassland	?1985/6
C7	Kern Down, Isle of Wight	Chalk downland	1988
C8	Durlson Meadows, Purbeck, Dorset	Neutral/chalk grassland	1982
4. DUNE			
D1	Porthtowan Dunes, N. Cornwall	Coastal sand dunes	1989
D2	Sefton Coast, Merseyside	Coastal general	N/K
D3	Les Quennevais, Jersey	Sand dune	1985
5. SALT MARSH			
S1	Essex coast	Coastal salt marsh	N/K

HABITAT CREATION REVIEW - LIST OF CASE STUDIES (cont.)

No.	Site name & location	Target habitat type	Start date
6. HEATH AND MOOR			
H1	Bricket Wood Common, Herts	Heathland	N/K
H2	Ferndown Bypass, Dorset	Heathland	1983
H3	Symondshyde Heathland Experiment	Heathland	1986
H4	Glaslyn (Pt.of Pumlumon SSSI, Dyfed)	Heathland	1989
H5	Bramshill, Forest of Eversley	Heath/Heathland Pools	
H6	Glaslyn Heather Regen.Project, Powys	Upland moorland	1989
H7	Thorne & Hatfield Moors, S. Yorkshire	? Fen/acid mire	N/K
H8	Gallows Hill, Wareham, Dorset	Dry and wet heath	1987
H9	Cove Radio Station, RAE Farnborough	Heathland	1984 (1990)
H10	Ropers Heath, Suffolk Breckland	Heathland	1987
H11	Glaisedale Moor, North York Moors NP	Upland moorland	1979
7. BOG			
B1	Merridale School, Wolverhampton	*Sphagnum* bog	1984
B2	Blackburn Meadows Nat.Res. Sheffield	*Sphagnum* bog	1989
B3	Risley Moss SSSI, Cheshire	Raised mire	Early 1980s
B4	Danes Moss SSSI, Cheshire	Bog	?1985
B5	Westhay Moor, Meare, Somerset	Bog and some fen	1987
B6	Thorne Moors NNR, South Yorkshire	Bog	1985
8. FEN			
F1	Llyn Ystumllyn, Criccieth, N. Wales	Freshwater marsh	N/K
F2	Flitton Moor, Bedfordshire	Fen/wet grazing meadow	1987/88
9. RIPARIAN HABITATS			
R1	River Wye, Brecknock	River bank	1986/87
R2	Henalt Wood Scheme, Builth Wells	Bankside vegetation	1986/87

HABITAT CREATION REVIEW - LIST OF CASE STUDIES (cont.)

No.	Site name & location	Target habitat type	Start date
10. WOODLAND AND SCRUB			
W1	Darenth Wood, N. Kent	Ancient woodland	N/K
W2	Weely Hall Wood	Woodland	1987
W3	Davies Brig, Mainland, Orkney	?Woodland	1987
W4	South Coppy Wood, Co. Durham	Woodland	1985/86
W5	Oakbank Bing, West Lothian	Trees/shrubs	1989
W6	Moorclose-Ellerbeck, Workington	Woodland	1970s
W7	Blackburn Meadows Nat. Res. Sheffield	Woodland(Transfer)	1989
W8	Long Meadow Wood, Eascote, Lond.Bor.	Woodland	1979
W9	Wordsley Wood, City of Salford	Woodland	N/K
W10	Oxleas Wood Road Cutting	Old(Anc.) Woodland	?1992
W11	Sankey Valley Park, Warrington	Woodland	c1982
W12	Ladyloan Wood, Glasgow	Woodland	1986

HABITAT CREATION REVIEW - LIST OF CASE STUDIES (cont.)

No.	Site name & location	Target habitat type	Start date
11. MISCELLANEOUS			
M1	Crossgar Nature Centre, Co.Down	Mix	N/K
M2	Rother Valley Country Park	Mix	1982-3
M3	Channel Tunnel Dev. Site, Kent	Misc.	N/K
M4	Lower Farm Rd, Bromham, Beds	Mix	1986
M5	Flitton Moor, Bedfordshire	Mix	1987/88
M6	Rutland Water Reserve, Oakham	Misc.	Early 1970s
M7	Norton School, Berkshire Rd,Norton	Mix	1987
M8	Not known	Mix	N/K
M9	Newton Farm East Ecol. Park, Harrow	Mix	1987
M10	Blackburn Meadows Nat.Res., Sheffield	Mix	N/K
M11	Rugby High School for Girls	Mix	N/K
M12	Royden Park, Wirral (walled garden)	Mix	N/K
M13	White Hart Lane Schools,Havering	Mix	1986
M14	Billing Beck Valley, Cleveland CC	Mix	N/K
M15	Cobtree Conservation Centre	Mix	Planning
M16	Chelmarsh, Shropshire Wildl.Trst.Res.	Scrape	1987
M17	Field Margin Demo. Cardyke etc.	Arable field margins	1987
M18	Rotherhithe Ecol. Park, Southwark	Mix	1987
M19	Gillespie Park, Islington	Mix	1983
M20	Newton Farm Nat.Pk, Hillingdon	Mix	N/K
M21	Scrubbs Wood, Hammersmith & Fulham	Misc.	1990
M22	Kinneil Island	High water roost	N/K
M23	Camley Street	Nature Park	Info on file
M24	Wm. Curtis Ecological Park, London	Mix	Info on file
M25	Kemerton Court Farm, Tewksbury	Misc.	1987
M26	Kraft Meadow, Sefton	?Urban Common	N/K
M27	Witton Lime Beds SSSI, Cheshire	Calcicolous grassland	1983

APPENDIX B

CASE STUDY SUMMARIES

1. INTRODUCTION

In March 1989 the Environmental Advisory Unit Ltd. (now SGS Environment) was commissioned by the Nature Conservancy Council (NCC) to undertake an investigation of terrestrial habitat creation techniques in the UK.

The initial stages of the investigation involved an extensive questionnaire survey to establish the range and nature of experience within the field of habitat creation. The findings of this survey were published in Jones (1990).

A further objective of the questionnaire survey was to identify potential case study projects. Case studies were also selected from a literature search and from company contacts. From these sources a shortlist of 26 case study projects was compiled.

Case studies were chosen to illustrate the broad range of practical experience that the results of the questionnaire survey suggested exist. The case studies were also chosen to highlight the range of organisations involved and circumstances under which habitat creation projects have been undertaken and funded.

Most of the shortlisted case study projects were visited and assessed during the summer of 1990. Visits to the remaining projects were made in 1991.

The following report briefly describes each of the case studies and draws some initial conclusions relating to the current level and range of experience within the field of terrestrial habitat creation.

1993/94 update

This report was originally submitted in January, 1991. This updated version includes two additional tranches of information, as follows:-

(a) Information from the 1991 field visits to the case study sites where a visit had not been possible in 1990.

(b) Further information obtained in 1993/94. With the exception of case study no.14, information was obtained by consultation only and no field visits were made.

2. CASE STUDIES

1. Levenhall Links Leisure Park, Musselburgh, East Lothian (G2).

Outline

East Lothian District Council proposed to create areas of herb-rich grassland during the restoration of fly-ash lagoons.

Background

As a result of a higher than expected coal burn at Cockenzie Generating Station, the South of Scotland Electricity Board sought to increase the capacity for ash disposal at Musselburgh by constructing four new lagoons. Consent was given to proposals with planning conditions attached. The conditions were designed to protect the local environment during the construction and to achieve a landform and landscape upon handover to the District Council which is capable of development for leisure and recreational purposes.

During the initial restoration works 150mm of topsoil were spread over the site and an *Agrostis/Festuca* amenity grass mix was sown. A programme of progressive release of the land to the local authority was agreed.

The landscape proposals agreed with the Board provided for a water feature within the landforms. Since the area was turned over to East Lothian District Council they have attempted to establish herb-rich grassland on land adjacent to this new water feature.

Project Details

The project was started in May 1987 and funded entirely by East Lothian District Council.

In 1987 an experimental area (c. 2000m^2) was delimited with wooden stakes. The *Agrostis/Festuca* amenity grass sward established during the reclamation works was sprayed with a herbicide. The site was then ripped to loosen the soil and break up any pans that had formed during the reclamation works. A special wildflower seed mix was purchased; the mix being loosely based on the results of grassland surveys at a Local Nature Reserve and a Country Park in the County. The seed was mixed with sand/sawdust and broadcast over the site. Nursery raised stock were also planted. The seed mix and nursery species are listed in Table B1. No initial weed control was carried out.

Management

A hay-meadow management regime was introduced which involves a late Summer/early Autumn cut and the subsequent removal of the hay crop. This is the standard approach used by the local authority on areas of semi-natural grassland in their ownership. The area is not mown again following the initial hay cut and there are no cuts earlier in the season.

Soil Characteristics

A moderately fertile, sandy topsoil covers the experimental area to a depth of 200mm. A coarse (clinker) material is present throughout the top 200mm of the profile. The soil pH ranges from 7.16 in the top 150mm to 7.62 at depths greater than 200mm where fly-ash becomes the major soil component.

Vegetation Description

A moderately diverse artificial sward has developed which is dominated by grass species characteristic of low productivity grassland (*Agrostis capillaris* and *Festuca rubra*). The vigorous growth of the grass species reflects the moderate fertility associated with the imported topsoil and this has restricted the establishment of grassland forbs. As a further consequence of the elevated levels of soil fertility, a number of 'weed' species have become established; creeping thistle *Cirsium arvense* being particularly abundant. Of the 26 species which were introduced as seed, 15 were recorded during the field visit. 12 further species (mainly weeds) were also recorded. These have presumably colonised from nearby wasteland areas or have germinated from the soil seed bank. Bare ground is generally absent.

Comments

The importation of fertile topsoil to the site during the reclamation works has limited the level of success achieved at Levenhall Links Leisure Park. Furthermore, the degree to which the topsoil was mixed with the underlying fly-ash was minimal. The established grassland sward is productive and supports a number of weed species.

Under a regular hay-meadow cutting regime the soil fertility levels may be reduced producing conditions more suited to the development of a more diverse sward. However, the maintenance of consistent management may be potentially difficult to achieve. The area was not cut in 1989 and a grass thatch has started to accumulate.

1993/94 Update

Consultation revealed that the management of the grassland by annual cutting is continuing but that no monitoring of the vegetation was taking place. There is therefore, no mechanism for monitoring information to feed back to the management which is being carried out. Lack of funds was the reason given for monitoring not being carried out.

Table B1. The seed mixture used at Levenhall Links Leisure Park (1)

Species		Kg/Ha
Common Bent	*Agrostis capillaris*	2.60
Meadow Foxtail	*Alopercurus pratensis*	0.60
Sweet Vernal Grass	*Anthoxanthum odoratum*	0.60
Kidney Vetch	*Anthyllis vulneraria*	0.50
Betony	*Stachys officinalis*	0.15
Black Knapweed	*Centaurea nigra*	0.25
Vipers Bugloss	*Echium vulgare*	0.05
Sheeps Fescue	*Festuca ovina*	7.00
Red Fescue	*Festuca rubra*	5.00
Meadow Cranesbill	*Geranium pratense*	0.10
Bloody Cranesbill	*G. sanguineum*	?
Hawkweed	*Hieracium sp.*	?
Cat's-ear	*Hypochoeris radicata*	0.10
Rough Hawkbit	*Leontodon hispidus*	0.05
Birdsfoot Trefoil	*Lotus corniculatus*	0.40
Musk Mallow	*Malva moschata*	0.45

Common Forget-me-not	*Myosotis arvensis*	0.05
Ribwort Plantain	*Plantago lanceolata*	0.15
Smooth-stalked Meadow-grass	*Poa pratensis*	4.00
Cowslip	*Primula veris*	?
Common Sorrel	*Rumex acetosa*	0.02
Alexanders	*Smyrnium olusatrum*	?
Goat's-beard	*Tragopogon pratensis*	?
Yellow Oat-grass	*Trisetum flavescens*	0.40
Bush Vetch	*Vicia sepium*	?
Wood Vetch	*V. sylvatica*	?

2. Benwell Nature Park, Atkinson Road, Newcastle-upon-Tyne (G3).

Outline

Benwell Nature Park is an example of an urban 'ecology' park created with the primary objective of providing an environmental education resource for city schools and members of the public. After several unsuccessful initial attempts, wildflower seed mixtures have been used to produce herb-rich meadows in areas of the park.

Background

Benwell Nature Park was created on the derelict site of several rows of old mining cottages in the west of Newcastle-upon-Tyne. The area was considered unsafe for further housing or industry due to a network of underground shafts and the distinct possibility of subsidence. The initial ideas of developing a Nature Park were developed following visits to the well known but now sadly defunct William Curtis Park in London. The park is run by the education department of Newcastle City Council with funding from the Inner City Partnership and start up sponsorship from the Shell Better Britain Campaign.

Project Details

The project was started in 1983. The initial launch was sponsored by the Shell Better Britain Campaign who also produced a video of the establishment phases. The site is managed by a full time 'teacher in charge' with the help of an assistant; the salaries and other teaching costs being paid by Newcastle City Council Education Department. The annual running costs are currently funded by the Inner City Partnership.

The project is now well established and Shell Better Britain Campaign have made a second video as part of the campaign's 25th birthday celebrations which shows how the park has developed and how it is used. The establishment details of the different habitats within the park are now vague, partly due to changes in the teaching staff. Only the meadow areas at the park will be discussed as part of the habitat creation review.

During the initial park design, certain areas were designated for the creation of a spring and a summer meadow. The site is elevated, steeply sloping and south facing and as a consequence the site remains dry for much of the year. Furthermore, rain water tends to run off from the clay soils of the site. The soil is also particularly infertile. This combination of factors presented a harsh environment in which to attempt to introduce plants. For these reasons initial attempts to establish wildflower meadows using purchased and hand collected seed failed.

In an attempt to establish a cover of vegetation, 100 tonnes of topsoil from a local meadow were purchased and taken to the park, mixed with horse manure and spread over the bare

clay soils of the meadow areas. The imported topsoil was reported to have never received artificial fertiliser or herbicides and possibly contained a relatively rich seed bank. It is likely that further seed was purchased and also collected locally and broadcast over the meadow areas. The details of the approaches to seeding are, however, vague and no records have been kept.

Management

Two different cutting regimes are used to manage the meadow. An early summer cut has been introduced to one area in an attempt to encourage spring flowering herbs, whilst the remainder is cut in late summer/early autumn to allow the summer flowering species to flourish. In both cases the hay is baled once dry, using an old fashioned baler. The bales are then removed from the site.

Vegetation Description

The meadow area now supports a moderately diverse, albeit visually artificial, sward. A total of 45 plant species were recorded during a field survey, 10 of which may be considered to be weeds of cultivation. There was, however, a high level of bare ground, and a low cover of grass species. This presumably reflects the harsh edaphic and climatic conditions. The meadow areas therefore had an unnatural appearance. This was emphasised by the unusual growth form of certain species, notably *Trifolium pratense*. It is often the case that agricultural cultivars of such species are supplied in commercial wildflower seed mixtures in place of native forms.

Comments

The created meadow area within the park may be considered successful in terms of the objectives with which the park was established. In combination with the rest of the park, it does provide an excellent and well used environmental education resource for the City.

1993/94 Update

Consultation in 1993 revealed that the Nature Park is still in operation and well used. The meadow habitat within the Nature Park is not being routinely monitored but it is being managed according to the programme set up at its inception. However, in 1994, it was reported that funding for the project was reduced and the "teacher on-site" had been made redundant.

3. Kenwood Meadow, Hampstead Heath, London (G26).

Outline

An attempt by the City of London (Superintendent of Hampstead Heath) to create 3 acres of herb-rich meadow on part of Hampstead Heath by sowing a wildflower seed mixture onto an area which previously supported amenity grassland. The conditions and time of seed storage are believed to be the main cause of failure.

Background

Hampstead Heath as a whole has an interesting and varied flora and several areas, primarily woodland, have been designated as Sites of Special Scientific Interest (SSSI). An area in the north-east of the Heath adjacent to Kenwood had remained unploughed since at least 1928 and supported semi-natural grassland of limited diversity. The area was grazed up to 1956 but since the grazing management ceased the grass has been cut regularly using a flail mower. The clippings were not collected. The main objective of

the management was to prevent the establishment of scrub (although, in retrospect, scrub may have been a suitable habitat creation objective).

Project Details

In September 1981 a 3 acre area of the grassland was used in an experiment. The experimental site is immediately bordered to the north and west by Oak dominated woodland, to the east by a pond and marginal vegetation and to the south by permanent grassland. The intention was to plough, disc harrow, cultivate and sow with a wildflower seed mix in the autumn of 1981. A wildflower seed mixture was purchased in anticipation (no record remains of the source or content of the seed mix used).

Bad weather in the autumn of 1981 prevented the preparatory works from being completed and sowing was postponed until the spring of 1982. Further bad weather prevented any work being carried out on the site until April 1982, by which time there was sufficient regrowth from the original sward to necessitate the use of herbicides before seeding. When the area was finally sown the seed had been stored for at least 8 months in conditions considered unsuitable for maintaining maximum seed viability.

Management

The hay was cut in September 1982 and again in both spring and autumn 1983 using a forage harvester. In subsequent years management was restricted to an autumn cut with a forage harvester until 1990 when, in late summer, hay was made for the first time. The grass crop was removed following the cut, specifically to take nutrients from the soil.

Soil Characteristics

The surface soils are dry and freely draining Bagshot sands. The sands are variable in depth and generally infertile. The sands overlay London Clay and where this approaches the surface the ground can become damp although this doesn't occur in the experimental area.

The soils have remained unploughed and have supported permanent grassland for at least 70 years. There is a moderate accumulation of organic material in the soil although this was turned over during site preparation. Soil compaction has occurred along tracks which cross the site.

Vegetation Description

Hay had been made at the time of the field visit and accurate descriptions of the vegetation were therefore impossible.

The sward which has developed on the experimental area is grass dominated. The poor germination of forbs has been put down to the inappropriate conditions under which the wildflower seed was stored prior to seeding.

Despite a low species diversity, a good grass sward has developed, the species composition and appearance of which reflect the impoverished soil conditions. Bare ground is generally absent and the current management will prevent a deep thatch from developing.

It is interesting that a sward of moderate diversity has established along the line of a gas main installed several years before the meadow creation works began. There is no immediate explanation for the growth of species such as ox-eye daisy *Leucanthemum vulgare* here although it may be possible that the nutrients made available as a result of soil disturbance during installation produced more favourable conditions for such species.

It is also possible that ox-eye daisy was in the seed mix used to re-seed the line of the gas main. However, these factors do not explain the total absence of the species elsewhere on the site and the assumption that poor storage had resulted in low seed viability.

Comments

In our view the experiment has not been successful. A herb-rich meadow sward has not been established and this is believed to be due mainly to the poor conditions and the length of time that the wild flower seed mix was stored.

There are no immediate plans to attempt to increase the species diversity of the study area or to create new meadows on the Heath. The hay making regime will be continued on the Kenwood Meadow, however, and this may ultimately produce conditions suitable for the development of a more diverse sward.

1993/94 Update

Consultation revealed that the hay meadow management was continuing but that no monitoring of the vegetation of the meadow is taking place. However, the meadow is being included in a study which is underway on the more effective management of the whole of Hampstead Heath.

4. Richards West, Fryent Country Park, London Borough of Brent (G8).

Outline

Natural colonisation has been used to reinstate a moderately diverse meadow on public open space following severe damage to the original grassland as a result of the use of the area by a group of travellers.

Background

Fryent Country Park is an urban country park of approximately 100 hectares managed and retained by the London Borough of Brent as a public open space. Historical evidence suggests that much of the site was ploughed and used as arable land during the Second World War with some fields perhaps also being ploughed once during the 1960's. Hay meadows now form the largest part of the park and range from National Vegetation Classification communities MG6 to MG1. A few areas have been reseeded and support MG7 communities.

Several fields to the west of the A4140 Fryent Way, which bisects the site, have been disturbed by travellers. One, a field of approximately 2ha known as Richards West, was so severely damaged that the surface had to be bulldozed when the travellers left. Since then the vegetation has been allowed to recolonise naturally. This site has been included as a case study due to the use of natural colonisation as a method of habitat creation or, more accurately, habitat rehabilitation.

Richards West has a complicated and inconsistent management history. It is understood that much of the park was under rough grazing until the Second World War during which certain areas were ploughed and used for arable. Personal records suggest that land to the west of the Fryent Way was maintained as rough grassland during the 1970's. The lack of management during this period is presumably the reason for the abundance of rank *Arrhenatherum elatius* grassland. Between 1979 and 1987 hay production was resumed on grassland on both sides of the Fryent Way.

Project Details

Prior to Autumn 1986 Richards West supported a grassland community which apparently fell into the MG1 category of the National Vegetation Classification reflecting the rather inconsistent management history on the site. The site was bulldozed in the early part of 1987 to remove the debris left behind by the travellers. The remaining surface vegetation and a layer of topsoil were removed over the entire site leaving the clay topsoil bare. The area was not seeded, mainly as a result of the high cost implications, and the meadow sward now present is a direct result of natural colonisation from both the soil seed bank and adjacent meadows.

Management

After Richards West was bulldozed early in 1987 cutting was not possible on the site until September 1989 when a flail cutter was used and the hay was removed. A further cut took place in June 1990. It is proposed to return the field to a hay-meadow regime in due course.

Soil Characteristics

The soil pH is approximately 7.5 and the shallow, clayey topsoil is approximately 12 inches deep and overlies London Clay. The soil is moderately fertile although it has not received artificial fertilisers or manure for many years.

The site is damp and rain water remains near to or at the surface. The soil in the field becomes saturated during the winter months. A small pond at the northern end of the field represents the natural collection point for surface water.

Vegetation Description

At the time of the survey (25 July 1990) the sward was short having been cut in June and species composition was therefore not obvious. Records obtained from the countryside ranger responsible for the park suggest that in 1990 the sward was grass dominated by coarse species such as *Dactylis glomerata*, *Holcus lanatus*, *Lolium perenne* and *Elymus repens*. *Cirsium arvense* was abundant and other herbs of disturbed grassland situations such as *Urtica dioica* and *Rumex crispus* were also frequent within the sward. The area covered by bare ground was small. These results bare some similarity to the sward present prior to bulldozing although they also reflect the high level of disturbance.

Arrhenatherum elatius is not present at the levels recorded before the travellers moved onto the site. A consistent hay cutting regime should eventually eliminate this species. Desirable species such as *Lathyrus pratensis*, *Ranunculus acris* and *Rumex acetosa* were recorded at their former levels of abundance.

Sanguisorba officinalis is a characteristic species of several of the meadows within the park and was introduced to Richards West prior to the travellers occupation. This species appears to have survived the bulldozing.

Comments

The objectives of the project remain unclear but the project has proved generally unsuccessful to date. A weedy sward has been produced which supports only a limited range of common grassland forbs. The project is at a very early stage of development, however, and it is possible that a more diverse sward may develop provided a consistent form of management is introduced to the area.

1993/94 Update

No further information is available.

5. Wolverhampton Meadows, Wolverhampton (G11).

Outline

This case study is a long term investigation of the use of a green hay crop from existing species-rich meadows as a seed source for meadow creation projects. The project is being carried out by the University of Wolverhampton and Wolverhampton Metropolitan Borough Council and several species-rich hay-meadows have been created on amenity land throughout the Borough.

Background

The use of freshly cut green hay from existing species-rich meadows has been under investigation in Wolverhampton since 1982/3 following a visit to Holland where diverse meadows created using the technique were seen. Initial experiments produced two species-rich meadows which, upon analysis, compared well with the original source meadows. Since the initial experiments, approximately fifteen more meadow areas have been created using similar, but modified, techniques.

Project Details

Several projects have been considered as part of the case study. All have involved the use of species-rich hay as a source of seed.

Different approaches to the collection of green hay and the preparation of experimental sites have been used, including investigations of methods to reduce the level of soil fertility prior to meadow establishment.

Management

In general, the management of the meadow areas has been carried out by either the Parks of Wolverhampton Metropolitan Borough Council or commercial contractors under the supervision of the project coordinators. However, early management, such as weed eradication, was often carried out directly by the project coordinators.

The management regimes introduced to the different meadow areas have varied according to the type of meadow being established but generally involve a late summer hay cut, with subsequent cuts of the aftermath where possible. At one site a late season grazing regime has successfully been introduced.

Soil Characteristics

The soil characteristics of each of the meadow sites varied. As far as practically possible, attempts were made to match the soil conditions of the source and 'receiver' sites so as to optimise the growing conditions for introduced species.

Vegetation Characteristics

During the initial stages of meadow establishment the relative abundance of the plant species was variable and usually different to that recorded at the donor meadows. Forbs such as *Leucanthemum vulgare* became dominant, exploiting the soil disturbance and

increased availability of plant nutrients associated with site preparation. Initially the abundance of grass species remained low but gradually increased as the sward developed.

The use of green hay appears to provide fresh seed and the viability was generally high. Furthermore, seed for individual species was introduced in relative proportions identical to those present at the donor meadows. Many of the species present at the donor meadows, regardless of its species composition, were transferred to the experimental areas in Wolverhampton although the less competitive species often failed to germinate in the first few years after seeding. The indication from the older meadows in Wolverhampton is that after an initial establishment period, created meadows settle down and conditions become suitable for the development of a more diverse and naturalistic sward. Species such as Cowslip *Primula veris*, Eyebright *Euphrasia officinalis agg.* and Quaking grass *Briza media* become established at this stage.

The introduction of a suitable management regime is critical to the success of the meadows. The sward at one meadow, to which access for suitable equipment has proved difficult, has become rank. Many of the meadow species originally introduced have been eliminated and replaced by coarse grasses such as Cock's-foot *Dactylis glomerata*.

Comments

Herb rich meadows have been established with some success on several sites in the Borough. The use of green hay has proved to be a valuable method of producing diverse meadow vegetation but may involve higher labour and transport costs. This is, however, offset to some extent by the cheaper cost of the seed.

1993/94 Update

Consultation with Dr Grant Jones has revealed that work is proceeding on the monitoring and management of the created meadows. It is expected that publications by Ian Trueman and Grant Jones on these important, long term projects, will appear during 1995.

6. Factory Site, Invergordon; Nursing Home, Inverness; and Airfield, Moray Firth (G30-32).

Outline

Three areas where commercial seed mixtures had been used to produce wildflower areas were examined in this case study. However, the level of information available about the projects is minimal and all of sites have now either been destroyed or abandoned. Unfortunately, these sites have not provided any useful information on successful habitat creation.

7. West Sedgemoor, Somerset (G12).

Outline

An RSPB project during which the drainage ditches surrounding a 300 acre area of Somerset levels meadowland have been isolated from the water authority pumping station in an attempt to maintain seasonally high water levels (to attract birds). Most of the meadows present are already botanically rich and the project has been shown to be a conservation management exercise rather than habitat creation.

8. Durlston Meadows, Durlston Country Park, Dorset (G15/C8).

Outline

Several former rye-grass leys on impoverished chalk soils have been reseeded with a special wildflower seedmix. Each is at a different stage of development; the oldest now supports a diverse plant community which includes species of orchid.

Background

Durlston was established as Dorset's first country park in 1973. It lies in the Purbeck Heritage Coast and Area of Outstanding Natural Beauty and also includes a Site of Special Scientific Interest. The park contains a mosaic of farmland, downland and coastal habitats and forms a valuable countryside resource administered by Dorset County Council's Planning Officer and managed by a team of wardens.

The farmland within the park consists of a patchwork of small fields enclosed from the rough downland by stock-proof dry stone walls. The major use of the enclosed fields in the past was sheep grazing although arable crops have also been produced. Most of the fields have at some time been ploughed and reseeded with agricultural grasses and have received spring fertiliser applications.

Recently a programme has been developed to increase the botanical diversity of some of the farmland fields by cultivating and sowing selected wildflower seed mixes. The longest established field is considered as the case study.

Project Details

The project was started in 1983 and funded entirely by Dorset County Council. Following a cereal crop in 1981 the field was left unfertilised and fallow during 1982 and 1983. The 'weed' growth was removed as a hay crop in July 1983 and the field shallow ploughed soon afterwards. On 25 October 1983, the 1 acre area was handsown with 36 kg of a native wildflower seed mixture formulated by the Wardens at Durlston and "Naturescape" (see Appendix 3b). The meadow was then rolled.

The wildflower mix was modelled on species lists made for local downland and herb-rich meadows prior to the start of the project. The number of species available when the seed mix was formulated was limited, however, and the species range was therefore restricted.

Management

The meadow usually receives a late hay cut during August. The first such cut took place in August 1984, the first year after meadow establishment. No cuts are taken subsequent to the initial hay cut due to a limited aftermath growth. The hay has limited commercial value but is used as feed for cattle.

Soil Characteristics

The meadow has free draining, friable, calcareous soil (pH 7.5) influenced by the underlying limestone geology. The soil fertility is impoverished due to natural leaching of the freely draining soils. The soil fertility was further reduced in 1981 and 1982 by allowing a fallow period prior to seeding. Litter accumulation is low and the organic content of the soil is very low.

Vegetation Description

The meadow sward has a very low stature (average height of the vegetation approximately 150mm) reflecting the impoverished nature of the soil. The vegetation is thin at ground level and bare ground is present.

The meadow sward is visually attractive and diverse. Ox-eye daisy *Leucanthemum vulgare* is an abundant and locally dominant species and also the most obvious in terms of its visual impact. Meadow Barley *Hordeum secalinum* was also abundant in 1990 although it had not been recorded in such quantities in previous years. The reasons for its unusually high abundance are not clear but may be related to the unusually dry conditions and mild winters experienced in recent years.

Other grasses present in quantity include Bents *Agrostis spp.*, particularly Creeping Bent *A. stolonifera*. Rye-grass *Lolium perenne* is also abundant in the meadow having survived in the sward from before the experiment. However, its vigour is low and its abundance is reported to be diminishing.

The overall diversity of the sward is quite high and is apparently increasing as previously unrecorded species are becoming established. 40 species were recorded in 10 $1m^2$ quadrats in 1990 and a total of 74 species have been recorded in the meadow as a whole since its establishment. All of the 23 species included in the original seed mixture except Yarrow *Achillea millefolium* and White Campion *Silene alba* are present in the meadow sward. It is of interest that only 4 of these species, namely Meadow Barley *Hordeum secalinum*, Yellow Oat-grass *Trisetum flavescens*, Rough Hawkbit *Leontodon hispidus* and Hoary Plantain *Plantago media*, were recorded in 1984 - the first year after the area was seeded. Obviously, with these species it is uncertain whether we are dealing with delayed germination or with seed coming in from adjacent areas.

Conditions also appear to be suitable for the colonisation of species from adjacent areas. Such species now present in the meadow sward include Greater Knapweed *Centaurea scabiosa*, Wild Carrot *Daucus carota*, Grass Vetchling *Lathyrus nissolia*, Wild Parsnip *Pastinaca sativa* and Bladder Campion *Silene vulgaris*. Additionally 129 flower spikes of Pyramidal Orchid *Anacamptis pyramidalis* were noted within the meadow by park wardens during 1990.

One of the most abundant and characteristic weed species in newly created meadows within the park is Bristly Ox-tongue *Picris echioides*. This species is present in the case study meadow although its abundance is reported to be decreasing.

Comments

This has been a relatively successful project although the meadow sward still appears to be developing and it may be some years before the level of diversity and species composition becomes stable. The proximity of sources of seed to assist in the natural diversification of the created sward has proved to be a great advantage.

1993/94 Update

Consultation has revealed that the management and monitoring of the grasslands by the Country Park is continuing. They also reported that additional meadows were being created as part of the same programme.

Table B2 The seed mixture used at Durlston Meadow.

Species		% (by weight)
Meadow Foxtail	*Alopecurus pratensis*	11
Crested Dog's-tail	*Cynosurus cristatus*	14
Red Fescue	*Festuca rubra*	40
Yorkshire Fog	*Holcus lanatus*	9
Meadow Barley	*Hordeum secalinum*	11
Yellow Oat-grass	*Trisetum flavescens*	6
Yarrow	*Achillea millefolium*	0.1
Black Knapweed	*Centaurea nigra*	0.7
Ox-eye Daisy	*Leucanthemum vulgare*	1.5
Field Scabious	*Knautia arvensis*	0.7
Meadow Vetchling	*Lathyrus pratensis*	0.4
Rough Hawkbit	*Leontodon hispidus*	0.2
Birdsfoot Trefoil	*Lotus corniculatus*	0.3
Toadflax	*Linaria vulgaris*	0.6
Restharrow	*Ononis repens*	0.3
Hoary Plantain	*Plantago media*	0.3
Cowslip	*Primula veris*	0.4
Self-heal	*Prunella vulgaris*	0.9
Meadow Buttercup	*Ranunculus acris*	0.9
Yellow Rattle	*Rhinanthus minor*	0.3
White Campion	*Silene alba*	0.3
Red Campion	*Silene dioica*	0.2
Goat's-beard	*Tragopogon pratensis*	0.7

9. Seven Sisters Country Park, East Sussex (C3).

Outline

500 acres of arable farmland on chalk were re-seeded with an amenity grass seed mix in 1971 during the development of the Country Park. The area has been managed for 18-20 years under a low intensity sheep grazing regime but diversification during this period has been limited.

In addition, a 30 acre area was used by the University of Sussex during an early wildflower seeding experiment.

Background

Most of the land now within the Seven Sisters Country Park boundary was used as mixed farmland until 1971 when the holder of a life tenancy died. The owner approached the County Council who bought the land and began developing it as a country park in the same year.

The original objectives of the County Council were to develop an area for public amenity and recreational usage whilst maintaining the high intrinsic landscape and conservation value of the area. When the County Council took over, much of the agricultural land was under arable (rye and barley), ley or permanent pasture. The arable fields and leys were

therefore reseeded. Areas of permanent semi-natural grassland were retained. Three specific areas of the park, in which the prior land use is known, were monitored for the *Review* in order to assess the level of diversification that has occurred. One area was permanent grassland when the County Council became the owners, the second was ley pasture while the third was being used to grow oats.

During the initial stages of the development of the park, a 30 acre area was set aside and used by workers at the University of Sussex to investigate the use of wild flower seed during the rehabilitation of farmland. This project will be considered as a supplementary part of the case study.

Project Details

The County Council took possession of the land and opened the area as a country park in 1971. The exact methods and seed mixtures used during the restoration of the farmland are not known as no records can be located. It is understood, however, that the farmland was ploughed, harrowed and sown with an amenity grass mixture containing rye-grass. No attempt was made to introduce wild-flowers. The grass dominated sward which developed fulfilled the original amenity objectives of the County Council. It was proposed at an early stage that a low intensity management regime be introduced to encourage the development of a more natural grass sward.

Management

The early management of the site is unclear but there would have been a programme of topping and pulling to eradicate weeds such as thistles and ragwort on many areas of the park. Cattle may have been grazed initially in certain areas.

The long term management of the grassland within the park has involved sheep grazing. Approximately 800 sheep have been grazed on the whole park which has a total area of approximately 650 acres. There is no record of how many sheep have been used to graze the three study areas at any one time. Tenancy agreements exist for certain areas of the park and restrictions prevent the use of fertiliser and pesticides and imposes further limitations on the method of management used in these areas. A management plan to NCC specifications is currently in production and Environmentally Sensitive Areas (ESA) agreements also cover the park.

Soil Characteristics

The majority of the park has a typical rendzina soil profile. The soils are friable, dry and freely draining with little organic content and have a mean pH of 8.0. Most areas are very infertile.

Vegetation Description

All areas of the park now support a grass dominated sward although the botanical diversity and ecological value are very variable and generally reflect previous land usage. The two areas which were under cultivation in 1971 only support a limited diversity of chalk downland herbs and a relatively high proportion of rye-grass *Lolium perenne*. The areas which were already classified as permanent grassland have a much higher diversity of chalk grassland species and are dominated by less vigorous grass species.

University of Sussex Experimental Plots

The experimental area used by the University of Sussex was ploughed in the winter of 1972/73. In an attempt to kill the Couch Grass by bringing its rhizomes to the surface, the area was also ploughed twice during the spring of 1973. Two seed mixtures were devised as shown in Table B3.

Table B3 The seed mixtures used in the experimental area at Seven Sisters Country Park.

MIX A

Species		proportion (by weight)
Rye-grass	*Lolium perenne*	6
Crested Dog's-tail	*Cynosurus cristatus*	5
Red Fescue	*Festuca rubra*	4
Creeping Bent	*Agrostis stolonifera*	2.5
Timothy	*Phleum pratense*	2.5
White Clover	*Trifolium repens*	1
Red Clover	*Trifolium pratense*	1

MIX B

Species		proportion (by weight)
Red Fescue	*Festuca rubra*	10
Creeping Bent	*Agrostis stolonifera*	5
Cat's-tail	*Phleum bertolonii*	5
Smooth-stalked meadow-grass	*Poa pratensis*	5
White Clover	*Trifolium repens*	5
Yarrow	*Achillea millefolium*	1
Kidney Vetch	*Anthyllis vulneraria*	2
Salad Burnet	*Poterium sanguisorba*	2

One mix (Mix A) was a normal pasture mix, the second (Mix B) included a limited range of wildflower seed with an adapted mix of grasses. The seed was supplied for the experiment by J Pichard & Co. (Seed Merchants) Ltd. The range of native seed available at this time was very limited.

The experimental area was divided into five plots, each of which was treated according to the following schedule:

Plot I - Control. Turf left to re-establish naturally.

Plot II - Seed mix A. Cutting management.

Plot III - Seed mix B. Cutting management.

Plot IV - Seed mix A. Grazing management.

Plot V - Seed mix B. Grazing management.

The edaphic conditions within the five plots varied.

Initially an abundance of Charlock (*Sinapis arvensis*), which occurs naturally in the area as a weed of disturbed, arable land, was a cause for concern. Apparently the area has now settled down and supports a good assemblage of calcicolous species. The initial experimental treatments have not been maintained but the area as a whole represents an early attempt at wildflower seeding.

Comments

The diversity of the new swards remains low and indicate the extended time scales often required to reproduce semi-natural vegetation types, particularly when natural colonisation is used.

1993/94 Update

The monitoring and management of the created grasslands is continuing within the overall management of the Country Park. There has been no further habitat creation within the park, but vegetation monitoring is being carried out by Sussex University. Advice is also being provided by the East Sussex County Ecologist. A large project has been started nearby in 1992 by Eastbourne Borough Council who are, as part of the ESA scheme for the area, creating 200 acres of species-rich grassland from further arable land next to the Seaford to Beachy Head SSSI.

10. i) Betchworth, Surrey (C6). ii) Redbourn Road Verges, Hertfordshire (C1).

Outline

i) A private landowner has carried out scrub clearance and other conservation management on downland within his estate. Certain areas have also been reseeded with special wildflower mixes but the accuracy of the information obtained is questionable.

ii) A replicated experiment using a wildflower seed mixture was sown onto chalk. The experiment was carried out by Hertfordshire County Council in conjunction with W.W. Johnson & Son Ltd., seed suppliers. The experimental details and results were published in Buckley (1989).

1993/94 Update

Consultation with Geoff Taylor of W.W. Johnson & Son revealed that the instigators of the Hertfordshire project at both the County Council and Johnson's had moved to other positions and, for this reason, the original project is not being monitored and standard highway management is probably now being practiced.

11. Porthtowan Dunes, N. Cornwall (D1).

Outline

This case study is in the early stages of an attempt to create herb-rich sand dune grassland communities. A grass seed mix has been used to produce conditions suitable for colonisation by other sand dune herbs.

Background

The 'beach' at Porthtowan used to support a sand dune system but this was degraded and 10 years ago all that remained was several relic, fescue dominated ridges. The area was used as a car park until a few years before the restoration programme started and, as a result, tin and copper mine waste, originally used to prevent erosion by cars, are present on the site. There are, however, no signs of significant toxic effects on plant growth.

Members of the County Council planning department have experience of dune restoration and developed a restoration plan for the Porthtowan system. In 1983 a Marram grass dune ridge was established along the seaward edge of the project area using sand piled over rubble and stabilised using nylon netting. Marram was planted successfully over a three year period as the ridge built up and a stable dune has now been formed.

Behind this dune ridge, work has been carried out to create a Fescue dominated dune grassland. Different approaches have been adopted and, although at an early stage of development, a reasonable level of success has been achieved.

Project Details

The attempt to re-establish Fescue grassland began in spring 1988 and has been funded by Carrick District Council. An experimental area was fenced off to prevent public access and drilled with a grass seed mix using agricultural equipment. Further seed was sown in autumn 1988 and the area was rolled using a ring roller to assist root penetration after a summer drought. In the spring of 1989 seed was spread by hand onto bare patches within the developing sward.

In addition, topsoil was spread over several small rectangular strips within the survey area and seeded as before. The import of topsoil appears to provide a suitable base for the initial establishment of the grassland sward although the higher levels of fertility produce a more vigorous growth and consequently there is a need for regular cutting.

It was originally intended to inject the area with sewage sludge which would act as a slow release fertiliser and a source of organic material. However, this approach proved to be impossible at the time and the site was therefore fertilised with five low level applications of 20:10:10 NPK during the establishment phase. This approach had the disadvantage of releasing nutrients rapidly and did not provide organic material.

Other problems have also occurred. Recent long periods of summer drought have restricted vegetation establishment. Also several severe winter storms have damaged the experimental area.

Management

It is hoped that in two or three years it will be possible to reduce the maintenance to zero although regular cutting is still necessary in more fertile areas which support a more vigorous grass sward.

Soil Characteristics

Most of the area is freely draining, infertile coastal sand although, as discussed above, topsoil has been introduced in several places.

Vegetation Description

The plots where topsoil has been applied support a dense grass dominated sward with a limited number of other species. The vegetation cover in other areas is patchy. However a reasonably diverse, grass dominated sward is generally present and a range of coastal pioneer and sand dune species have established naturally.

Comments

This project is at an early stage but it does appear that some success is being achieved in the creation of semi-natural type sand dune communities. However, a balance has to be struck between the instability base sand which is a natural feature of a sand dune system, and dune stabilisation required for human reasons.

1993/94 Update

Consultation has revealed that this project is continuing although the level of monitoring is small.

12. Essex Coast, Essex (S1).

Outline

The saltmarshes of the Essex coast act as a natural buffer for sea defences by reducing the energy of incoming waves. Extensive areas of the saltmarsh are suffering from severe erosion and many stretches of sea wall are coming under increasing pressure from wave attack. The Essex Saltings Restoration Project was started in 1986 with the aim of investigating the potential use of restoration methods modified from European techniques. A wide range of work has been carried out although the main objective has been to restore damaged coastal defenses. Despite encouragement from NCC (now English Nature), little consideration has been given to the creation of herb-rich saltmarsh.

1993/94 Update

This programme is continuing and managed retreat is being developed as a serious technique for coastal management and which offers major habitat creation opportunities.

13. Gallows Hill, Wareham, Dorset (H8).

Outline

Several approaches have been used by ARC (Southern) Ltd. to recreate heathland following quarrying for sand and gravel in Dorset. EAU have established permanent quadrats and are monitoring the success of the different approaches used. The results are not available for use in the *Review* because ARC were not willing to release the information at this time.

1993/94 Update

Results from this site have been published as a Department of the Environment case study in their publication: ***Amenity Reclamation of Mineral Workings*** *produced in 1992. These results have been used in the* ***Guide*** *(pages 89 and 92).*

14. Cove Radio Station, RAE Farnborough, Hampshire (H9).

Outline

The Environmental Advisory Unit Ltd (EAU, now SGS Environment) established field trials in 1984 to investigate several different approaches to heathland creation at this site. The aim was to apply the most successful technique in the creation of heathland vegetation on a former forest area which was cleared for the construction of a radio station. This was done in 1990 and, by 1993, acid grassland with large areas of heather were present together with heather seedling growth all across the site suggesting that there was a *Calluna* seed bank in the forest area.

Background

In the early 1980s, the Ministry of Defence decided to relocate the Cove Radio Station within the boundary of the Royal Aircraft Establishment, Farnborough on a woodland area known as Pyestock Wood. This woodland consisted predominantly of Scots pine which has progressively colonised open *Calluna* heath. There was also large areas of bracken *Pteridium aquilinum* on the site. The site was part of the Eelmore Marsh SSSI, a nationally important valley bog system. Pyestock Wood formed part of the catchment for the SSSI and this required that any major works on the site take account of this adjacent sensitive site.

The first Plan for the Cove Radio Station was to clear the majority of Pyestock Wood, construct the aerials and then import topsoil to the site to create a managed grassland. It was then pointed out that a cheaper solution was available involving using the on-site soils to create a low maintenance acidic grassland and, at the same time, encourage the colonisation of *Calluna* and other heathland species. The level of maintenance, at one cut per year coupled with the saving on topsoil costs, led to the adoption of a revised scheme.

Project detail

The project had the advantage of a field trial programme which was able to model different techniques for the establishment of target vegetation on this site. These trials ran from 1984-1990, when the site works took place. The techniques used for the establishment of vegetation were based on the results of the experimental trials. They included the use of a nurse grass mix, based on *Agrostis capillaris, Festuca rubra*, and *Deschampsia flexuosa* and the planting of some 10,000 *Calluna vulgaris* plants.

The *Calluna* plants were raised in cultivation using cuttings taken from *Calluna* plants in the Pyestock Wood area. At the time of planting the plants were in small biodegradable pots and some 50mm high. They were planted in patches, mainly on the sloping ground, at a density of 4/m2; some plants of *Erica cinerea* were also raised in the same manner. The cost of these plants was about £10,000 which gives a cost of £1.25/m2, but for material of local provenance. At this density, some 0.8ha of *Calluna* was planted.

The substrate was formed from a mixture of the native sandy subsoil of the site mixed with the topsoil/organic matter (leaf-mould) from the pine woodland. The field trials had not suggested that a significant seedbank was present in the woodland soils. In certain

areas, where there was no need to alter the topography of the site, the soil profile was left intact.

Hydroseeding techniques were used to apply the nurse grass mix. The field trials had indicated that low levels of fertiliser were required and this was included in the hydroseeding mix. Unfortunately, at the last minute, the contractor insisted that Westerwolds ryegrass was added to the grass mix to ensure that the site "greened up" before the winter. The hydroseeding took place in September, 1990 and the heather planting in October, 1990 when the grass sward, mainly *Lolium* was well established.

Management.

The site was then managed for the first year by cutting which avoided the *Calluna* planting areas but caused the plants to be somewhat swamped by the grass growth. Management in 1992 was by a single cut in late summer which has resulted in the successful elimination of *Lolium* and the control of pine invasion. The cutting was at a height of between 100 and 150mm which is a little low for the heather. Bracken is being controlled less successfully and will require control by herbicide application in the future.

1993/94 Update.

The site was visited in late 1993 to examine the vegetation created as part of the scheme. The whole site was covered with an open grassland sward mainly composed of Agrostis capillaris, *with some* Deschampsia flexuosa *and the Westerwold's rye-grass nurse had been eliminated from the site. The planted heather had established well and was spreading based on seed recruitment. By November, 1993, there had been an excellent survival of* Calluna *in the planted areas where a close to 100% cover had been achieved. Furthermore, these areas had acted as a source of seed and much downslope spread of* Calluna *had been achieved.*

A significant result was the presence of large quantities of heather seedlings and plants throughout most of the remaining parts of the site. These were within the nurse sward which had the open character required for enabling the establishment of Calluna. *This establishment was most pronounced in the areas where the soil profile had been left intact. This results suggests that there was a significant* Calluna *seed bank in the dense pine woodland area despite the loss of open heathland character some 20-30 years before. Some* Erica cinerea *is also establishing in this manner. This seed bank was not detected from the use of mulch in the field trial; this indicates that a proper seed-bank experiment should have been carried out at an early stage.*

The site will continue to be managed by the authorities of the Defence Research Agency (DRA) and has total security, there being no public access. The North East Hampshire Heathland Project is advising on the site management together with their work on the adjacent Eelmore mire system. The 1984 field trials are still present and continue to yield useful information. Scientific details of the field trials have been published (Parker & McNeilly, 1991).

The site continues to be managed by an annual cut in the late summer which is controlling scrub invasion but keeping the vegetation to a 200mm height. Whilst not ideal for nature conservation purposes, this is preferable to invasion by pine, birch and gorse.

The 1984 field trial experiment has been retained within the development. The main observation on this trial is the dominance of Calluna *and a disappearance of the nurse grasses.*

15. Westhay Nature Reserve, Meare, Somerset (B5).

Outline

Intensive peat cutting in the past combined with agricultural improvement, has resulted in the eradication of much of the wetland in the Somerset levels. The Westhay Moor project represents an attempt to reverse this process on the 27 ha site using experience gained from a number of past projects.

Background

Westhay Moor is a Somerset Trust for Nature Conservation reserve. A programme to convert 27 ha of worked out peat to a system of open water, reed swamp, wet heath and mire, initiated in 1987, is now well underway despite initial problems caused by drought.

Earth moving machinery was used to create a variety of water depths down to 2 metres and a number of islands. The project relied on both the introduction of plant species and natural colonisation from surrounding ditches.

In order to regulate water levels, an automatic diesel pump was purchased with Grant Aid from the Nature Conservancy Council and the World Wildlife Fund.

Project Details

Work began in spring 1987 with the planting of Willows *Salix spp.* along the existing banks. Freshly cut 2 metre staves of local provenance were used for this. Once the trees have reached a suitable size, they will be pollarded in the tradition of the Levels.

The unworked peat area was retained within the project design and its mire vegetation safeguarded by control of the water level. It is the aim of the project to retain and hopefully enhance the mire vegetation.

In April 1987 the winter water was pumped out of the site, and earth moving machinery was used to create ditches and islands, with the aim of creating a mosaic of open water and reed bed, divided by islands which act as wave breaks. Rhizomes of *Phragmites* present on the site in existing ditches, and from the surrounding area were planted on a 10 by 10 meter grid over the site. Strong winds and dry conditions in April led to many of the rhizomes suffering from drought. However, mortality was low enough to allow the continuation of the project.

To allow the *Phragmites* to establish and spread the water level was then raised to 0.5 metres and held at this level for two growing seasons. After this time the water level was raised to its full height of 1 metre. Float switches were employed to govern the water level and to maintain it within set limits.

Management

A full and comprehensive management plan has been drawn up for the reserve by the STNC. This management plan includes provision for continuing maintenance of open water by dredging and reed cutting, and for the pollarding of the willow trees.

Vegetation

The site supports an abundance of dense *Phragmites* stands separated by corridors of open water. In addition to this natural colonisation from surrounding waterways has resulted in the development of a community similar to the surrounding semi-natural vegetation types.

Comments

This site is a good example of a wide-ranging wetland habitat creation project. In terms of the *Review*, it is the mire habitat which is of significance and this has proved to have a conservation and enhancement, rather than a habitat creation objective.

1993/94 Update

Results from this site have been published as a Department of the Environment case study in their publication: ***Amenity Reclamation of Mineral Workings*** *published in 1992. These results have been used in the* ***Guide*** *(page 113).*

16. Symondshyde Great Wood Heathland Creation Trials, Hertfordshire (H3).

Outline

Several different approaches to the creation of *Calluna* dominated heathland are being investigated by Hertfordshire County Council in a small experimental area at Symondshyde Great Wood. The most successful approach will be applied during heathland restoration elsewhere on the site.

Background

Heathland was formerly an extensive habitat in Hertfordshire, although now, as in many parts of the UK, heather is a declining species in the county. Heathland is now restricted to several small, isolated sites including Symondshyde Great Wood.

Symondshyde Great Wood is included in the NCCs "Inventory of Ancient and Semi-Natural Woodland" although only 4ha of its total 58ha remain as semi-natural woodland. Several small areas of the site now support open acidic grassland and heathland communities, dominated by either common bent *Agrostis capillaris* or heather *Calluna vulgaris*.

At Symondshyde and other sites within the County, Hertfordshire County Council plan to restore areas of degraded *Calluna* dominated heathland and have started an experiment to establish the best approach relevant to the Hertfordshire situation.

Project Details

The ground preparation at the experimental site commenced in October 1988 when an area of 333m^2 (9m x 37m) was cleared of birch and other trees. The topsoil (4-10cm depth) was removed to expose the underlying sandy sub-soil, the surface of which was raked to produce a fine tilth. The trial area was fenced to exclude rabbits and members of the public.

A number of replicated experimental plots have been established within the trial area. The use of heather seed or heather litter as seeding media is under investigation, in combination with a number of additional treatments. These include the use of a nurse crop

of companion grasses; forest brashings to provide sheltered micro-habitats for heather regeneration; and burning to simulate natural fires on heathland. Control plots have also been included which have not been seeded or received other treatments.

The experiment is at a very early stage of development and will be monitored by the County Council for a further three years who then intend to publish the results. In 1990 several of the trial plots supported a good growth of heather seedlings and it is likely that a valuable dry heath regeneration technique will be identified as a result of the trial.

1993/94 Update

Consultation revealed that the experimental work had discontinued although the site is still in existence. Funding problems were given as the cause although there is some land management and habitat creation activity nearby.

17. Ropers Heath, Suffolk Breckland (H10).

Outline

The Nature Conservancy Council (now English Nature) have tested natural colonisation during attempts to restore an area of Breckland heath following a period of agricultural usage.

Background and Project Details

Some 90% of the unique heathlands of the Breckland have been lost this century. Those which remain are an invaluable biological resource and most are classified as Sites of Special Scientific Interest or National Nature Reserves.

Cavenham Heath NNR covers 502 acres and comprises Cavenham Heath in the east, Tuddenham Heath in the west and Ropers Heath between the two. The Nature Conservancy Council purchased Cavenham Heath in 1952 and Tuddenham Heath in the mid 1960s and both areas support heather *Calluna vulgaris* dominated heathland. Ropers Heath was purchased by the NCC in 1978 from a local farming family who had used the area to grow arable crops since 1954. Prior to this, Ropers Heath too had supported heather dominated heathland.

When the NCC purchased Ropers Heath they intended to restore the former heathland vegetation using natural colonisation of plants from adjacent heathland areas. However the soil fertility levels were artificially high as a result of regular applications of fertiliser during its period of arable use and were thus unsuitable for the immediate re-establishment of heathland vegetation. Consequently, the NCC allowed crops to be grown on the land for a further three years, but without the additional use of fertilisers, in an attempt to deplete the nutrient status of the soil. A final crop of rye was harvested in 1981, after which it was considered that the soil fertility levels had been reduced sufficiently. Since this time the area has been left to recolonise naturally.

Management

Both Cavenham Heath and Tuddenham Heath are grazed by sheep and cattle. Since 1981 stock have had free access to the regenerating heathland on Ropers Heath.

An experimental area has been established by English Nature within the regenerating heathland from which grazing animals are excluded. A further rabbit exclusion plot has also been set up. English Nature are thus monitoring the effect of removing grazing on the re-establishment of the heathland vegetation.

Topping to remove the flowering heads of weeds such as thistle *Cirsium sp.* and ragwort *Senecio sp.* has been necessary on occasions although the general abundance of such weeds has been limited by the reduced fertility levels.

Soil Characteristics

The soil of Ropers Heath is typical of that present elsewhere in the Breckland being freely draining, acidic glacial sands and gravels. The fertility levels within the soil were high in 1978 when the land was purchased by the NCC. Since this time the soil fertility on the heath has decreased.

Vegetation Description

The regenerating heathland is currently dominated by grasses and sedges. Sheeps fescue *Festuca ovina*, sand sedge *Carex arenaria* and common bent *Agrostis capillaris* are the most abundant species, while flowering plants like common stork's-bill *Erodium cicutarium* and heath bedstraw *Galium saxatile* are locally common. Heather *Calluna vulgaris* is colonising but is currently restricted to the eastern part of the area and within approximately 200m of the boundary with Cavenham Heath.

Comments

The establishment of *Calluna vulgaris* has been slow and restricted to peripheral areas of the experimental area. It may be many years before the area is converted to heather dominated heath and the experiment can be considered successful in line with the original objectives.

1993/94 Update

Consultation has revealed that the monitoring of the habitat creation project is continuing carried out by the English Nature warden and a number of researchers. There seems to be some disappointment with the project but, in terms of the standard achieved by many of the projects in the Review, *this project has been (and continues to be) quite successful.*

18. Glaisdale Moor, North Yorks Moors National Park (H11).

Outline

Extensive areas of moorland in the North Yorks Moors National Park are still recovering after severe fires during 1976. The National Park Committee have established a 500 acre area in which they are investigating natural and assisted colonisation during a programme of moorland restoration.

Background

Severe fire in the summer of 1976 destroyed approximately 1300 acres of Glaisdale Moor in the North Yorks Moors National Park. Following the fire, initial monitoring of heather regeneration was carried out by the National Park Committee. From 1979 onwards several research projects were established on Glaisdale Moor to investigate the problem of moorland regeneration following fire. Several important conclusions were reached which have significant implications on the approach to future management to promote successful moorland regeneration.

Firstly, it was found that fencing to exclude sheep was essential for successful heather regeneration on burnt moorland. Secondly, natural succession to heather may be restricted

by the availability of heather seed and this can be remedied by applying seed and heather mulch.

The studies also indicated that wavy hair grass (*Deschampsia flexuosa*) could be used as a nurse crop to aid moorland regeneration. Furthermore, the use of correct strains of other grass species and the use of limited fertiliser inputs to encourage an initial growth of some species were also shown to be beneficial.

In 1984 the National Park Committee's Moorland Management Programme fenced a 500 acre area of Glaisdale Moor to exclude sheep. Within the fenced area they are monitoring the natural regeneration of the moorland and are also assisting regeneration by introducing heather seed.

Project Details

The fenced section of moorland includes areas of (i) deep peat, (ii) thin peat and (iii) mineral soils. The National Park Committee are monitoring natural colonisation processes on both deep and thin peat and have also laid cut heather stems as a method of introducing heather seed to assist the colonisation process. (Other approaches, including the use of nurse crops have also been applied but have not been monitored for the current review).

Management

No formal moorland management is carried out due to the early stage of regeneration.

The area will remain fenced until 1994 after which it is hoped that the moorland will have regenerated to an extent that limited grazing pressure can be tolerated.

Soil Characteristics

The mean pH of the different soil types are i) deep peat - 3.4 ii) thin peat - 3.4 iii) mineral sub-soil - 4.1.

Vegetation Description

Much of the exposed mineral sub-soil has remained naturally uncolonised although the introduction of heather seed is planned.

The colonisation processes on deep and thin peat vary and are characterised by different pioneer species. On deep peat, common cotton grass *Eriophorum angustifolium* forms dense circular patches. The older central areas of these patches degenerate and subsequently become colonised by *Calluna*. The level of *Calluna* colonisation on different areas of the deep peat is variable and the species is absent from the most severely burnt places. The more established stands are now co-dominated by *Eriophorum* and *Calluna* and resemble neighbouring unburnt areas.

On thin peat *E. angustifolium* is usually absent during the initial stages of colonisation and is replaced by *Polytrichum spp*. The moss aids surface stabilisation and acts as a nurse to the *Calluna* which eventually colonises naturally.

Where heather brashings have been laid down the initial stages of the natural colonisation process are avoided and *Eriophorum angustifolium* and *Calluna* regenerate simultaneously to co-dominate the sward. In 'seeded' areas only four years old, the level of heather establishment is far greater than in areas left to colonise naturally. This shows that even when there is a plentiful source of local *Calluna* seed (ie. unburnt areas of moorland), natural heather colonisation after severe fires is very slow. If it is not assisted by the introduction of seed from heather cuttings which act to stabilise the peat, erosion of the

unstable surface often changes the substrate and produces conditions which remain unsuitable for heather colonisation for many years.

Comments

This is a successful long term project which has a well planned habitat creation element.

1993/94 Update

Consultation with the North York Moors National Park revealed that the Management Programme was continuing and a full report had been published in 1991 (see Chapter 5 references).

The consultation also revealed that a new phase of work at Nab Farm was taking place involving the creation of moorland vegetation from improved farmland adjoining the moor.

19. Ferndown Bypass, Dorset (H2).

Outline

Dorset County Council have achieved some success in creating heathland on new road embankments using stored heathland topsoil.

Background

Following a public inquiry held in 1982 the Secretaries of State for the Environment and Transport approved a route for the A31 Ferndown By-pass which affected Slop Bog and Uddens Heath.

Uddens Heath is a small area of dry heathland with important reptile populations. Slop Bog lies on deep peats and is botanically rich and supports a range of animals including rare species of dragonflies and grasshoppers. The areas were notified as Sites of Special Scientific Interest by the Nature Conservancy Council in 1985.

In an attempt to reinstate heathland on the road verges where the new road passes through Uddens Heath, topsoil salvaging and respreading operations were incorporated into the road building contract. The contract was let at the end of 1984 and the works were carried out during 1985 and 1986.

Project Details

The heathland vegetation on the line of the proposed road was cut in May 1985. The top 50mm of soil was rotavated and removed from the site immediately and stored in a long mound some 2m high and 3m wide. The storage period was from May 1985 to September/October 1986.

The topsoil was respread to a depth of 75mm over a similar depth of standard topsoil brought in during the construction works. The new road verges were seeded at a rate of 15g/m^2 with a grass nurse crop containing Westerwolds rye-grass (20%), creeping red fescue (30%), chewing fescue (10%) and Agrostis sp. (40%). Heathland species established from the seed bank which persisted in the stored soil.

Management

No long-term management was budgeted for. However, gorse *Ulex europaeus* and bracken *Pteridium aquilinum* are invading and need controlling.

Soil Characteristics

The topsoil on the road verges through Uddens Heath is, as explained above, of heathland origin. It was generally spread to a depth of approximately 75mm over 75mm of standard topsoil imported during the construction works. The mean pH of the top 75mm is 5.2.

Vegetation Description

Heathland vegetation has re-established on the road verges successfully. There are, however, significant differences between the north and south facing verges.

The sward on the south facing verge is dominated by heather *Calluna vulgaris* and bell heather *Erica cinerea* but the cover of the vegetation is patchy with between 10-50% bare ground and dead plant material. Many of the heather plants which established initially died during 1990 as a result of drought. Nevertheless, bare ground, especially that which is south facing is valuable for a range of invertebrates. The north facing slopes support a much healthier and more diverse heathland sward which is also dominated by *Calluna vulgaris* and *Erica cinerea*. There has been little or no death of *Calluna* as a result of drought.

Heath grass *Danthonia decumbens* is abundant on both verges although the nurse grass species appear to have survived on the north facing verge only. Other species which appear on both verges, but generally in more abundance on the north facing one, include heath bedstraw *Galium saxatile*, sheepsbit *Jasione montana*, sheeps sorrel *Rumex acetosella* and tormentil *Potentilla erecta*.

Common gorse *Ulex europaeus* is becoming abundant locally on the verges and, as suggested above, could present a management problem in the future as well as being a potential fire risk.

Comments

A level of success has been achieved at reproducing heathland vegetation, particularly on the north facing slopes. The viability of seed of a number of species appears to have been preserved by sensible soil storage. There is, however, no data available with which to compare the created vegetation to that which was lost during road construction.

1993/94 Update

Consultation with the Dorset County Ecologist revealed that the Department of Transport were about to commence the management of the created heathlands as per undertakings given in the public inquiry. Some adjoining mire and heathland habitat at Slop Bog (part of an SSSI) has just come into Dorset County Council ownership and it may prove possible to combine the management of the roadside verges with the adjacent heathland.

20. Merridale School, Wolverhampton (B1).

Outline

A successful attempt to create an artificial *Sphagnum* bog in the grounds of a Wolverhampton school.

Background

Sphagnum bog is a fragile habitat and one which is considered by many to be impossible to reproduce artificially. Workers in Wolverhampton have attempted to reproduce the vegetation of several Shropshire mosslands within the grounds of Merridale School in Wolverhampton.

Project Details

The project was started in 1983 and was grant aided by the West Midlands County Council.

The experimental area originally supported regularly mown amenity grassland and was used as part of the school playing field. Three pools were excavated using a JCB digger. Two were 10m in diameter and the third 7m. All were approximately 0.5m deep. A layer of fine sand was spread over the bottom and sides of the pools and butyl liners were then installed. The two larger pools were filled with *Sphagnum* moss peat and it is into these that the bog vegetation was introduced.

The smaller pool was developed as a moorland pool and the fertile topsoil excavated from the three pools was piled in low banks and covered with a thick layer of acid sand and gravel spoil to give a well drained, nutrient impoverished substrate suitable for the establishment of peatland plants.

One of the peat bogs (bog 1) was planted with turves collected from a small valley bog near Oswestry. The turves were left as islands within the peat from which species could colonise adjacent bare areas. A small wet bog 'pool' was also excavated in this bog to provide suitable conditions for a wider range of peatland species.

The second peat bog (bog 2) was planted with material obtained from Wem Moss, Shropshire, where turves are regularly cut and removed during ongoing management to create pools.

Management

The created bog at Merridale School is not formally managed but the removal of leaves falling from adjacent trees has been necessary. It has also been necessary to 'top up' the bogs with tap water during periods of drought.

Soil Characteristics

The soil in the bogs is saturated, moss peat with a pH of between 3.8 and 4.6. The peat is approximately 0.5m thick and lies on top of butyl (pond) lining material.

Vegetation Description

Both bogs now support a diverse vegetation in which the bog mosses *Sphagnum spp.* are 'building' and new peat has started to accumulate. The species composition in each bog is subtly different, and reflects the initial species introductions. Many of the species originally introduced have persisted although their relative abundance has varied as the bogs have developed. Common Cotton Grass was the most abundant species during the early stages of development of both bogs but this species, although still frequent, has decreased. Several of the more uncommon species such as Bog rosemary *Andromeda polifolia*, sundew *Drosera spp.* and bog asphodel *Narthecium ossifragum* appear to have persisted but are of limited abundance.

In places a more mesotrophic vegetation has started to become established with soft rush *Juncus effusus* and weeds such as willowherbs *Epilobium spp.* and ragwort *Senecio sp.* The presence of such species suggests slight eutrophication and may be a result of the accumulation of leaf material from an adjacent ash tree. The effect of the use of tap water to top up the bogs is not clear but the buffering effect of the peat has kept the pH low.

Comments

The project has been successful, mainly due to the small scale and relatively controlled circumstances under which the bogs were constructed and are being maintained. The *Sphagnum spp.* are beginning to 'build' although there are also signs that, in places, the bogs may be becoming more mesotrophic.

In combination with the moorland pools, adjacent heathland and areas of rough meadow (which support Marsh Orchids), the bogs represent a good example of a small scale habitat creation project and provide the school with a unique environmental education resource. However, the use of imported peat cannot be recommended because it is not a sustainable approach.

1993/94 Update

The artificial bog is still present although eutrophication continues to take place.

Table B4. Species introduced into the artificial bogs at Merridale School, Wolverhampton.

Species in the turves introduced into bog 1 included:

Cross-leaved heath	*Erica tetralix*
Heather	*Calluna vulgaris*
Heath bedstraw	*Galium saxatile*
Heath milkwort	*Polygala serpyllifolia*
Cladonia lichens	*Cladonia spp.*
White sedge	*Carex curta*
Bottle sedge	*Carex rostrata*
Cotton grasses	*Eriophorum spp.*
Cranberry	*Vaccinium oxycoccus*
Bog mosses	*Sphagnum spp.*
Bog asphodel	*Narthecium ossifragum*
Heath rush	*Juncus squarrosus*

Royal fern (*Osmunda regalis*) and great sundew (*Drosera anglica*), both raised in cultivation, were also planted.

Species in the turves introduced into bog 2 included:

Cross-leaved heath	*Erica tetralix*
Heather	*Calluna vulgaris*
Cotton grasses	*Eriophorum spp.*
Round-leaved sundew	*Drosera rotundifolia*
Bog rosemary	*Andromeda polifolia*
Bog myrtle	*Myrica gale*
Narrow buckler fern	*Dryopteris carthusiana*
Cladonia lichens	*Cladonia spp.*
Bog mosses	*Sphagnum spp.*

21. Thorne Moor NNR, South Yorkshire (B6).

Outline

At Thorne Moor National Nature Reserve English Nature are attempting to maintain high water levels to allow the natural colonisation of areas which have become degraded by previous drainage.

Background

The whole of Thorne Moors has been affected by peat cutting in the past. In 1894 an area, including that now covered by the NNR, was purchased by the Dutch Griendstveen Moss Litter Company who dug 23 km of canals to allow peat to be removed from the Moors by barge. Peat was dug and piled on adjacent baulks to dry before being removed. Blocks of wetter dug areas therefore lay next to dry baulks in rows and each row was divided by a canal. Peat cutting was carried out in this way until a block of moor had been worked. The dry baulks were then cut and removed so that the whole block was eventually worked.

This process was used to extract peat from the area now included in the NNR. However, in 1922, before the whole block could be worked, peat cutting was abandoned. As a consequence a mosaic of wet cut areas and dry baulks has persisted largely untouched and the plants associated with raised mire gradually became re-established and, although greatly altered by man, have a high wildlife interest. The Nature Conservancy Council purchased the 180 acre block of land in 1985 from Fisons plc who own much of the remainder of the moorland and continue to extract peat for horticultural use. The small area of Moor now within the NNR is considered to support the best example of raised mire vegetation and the greatest depth of peat remaining on the moors.

The drainage associated with peat extraction elsewhere on the Moors has had an effect on the land within the NNR, causing it also to dry. Accordingly, the plants associated with raised mire therefore tend to persist in the lower lying, wetter areas ie. those from which the most peat has been removed. The drier baulks now support a less diverse and untypical vegetation type and are gradually becoming scrubbed over. English Nature is therefore monitoring water levels very carefully and taking steps to prevent the area from drying further.

Project Details

The principal aim of English Nature is to ensure that the water table is kept as high and as stable as possible to encourage further recolonisation by raised mire vegetation. Ditches and drains from the NNR have been blocked and the water level is monitored continuously. Research into other sources of water loss is also being carried out. Along the northern edge of the NNR a sealed lagoon has been constructed in which high water levels will be maintained during summer months. It is thought that such a system would present a barrier to water being drawn from the NNR and thus enable water to be retained on the reserve. The water levels are being monitored with an extensive network of dip wells.

Problems have arisen in drought years when there has not been sufficient water available to top up the lagoon, but if the system does prove successful it will be extended so that the whole NNR is surrounded and thus isolated.

Vegetation Characteristics

As discussed above, the wetter areas from which the most peat has been extracted actually support the most interesting vegetation. They are typically dominated (up to 90% cover)

by common cotton-grass *Eriophorum angustifolium*. Cross-leaved heath *Erica tetralix* is abundant and locally there are carpets of bog mosses *Sphagnum spp*. Bog rosemary *Andromeda polifolia*, round-leaved sundew *Drosera rotundifolia* and cranberry *Vaccinium oxycoccus* are also frequent members of the community.

The drier baulks are dominated by heather *Calluna vulgaris*. Birch *Betula pendula* and bracken *Pteridium aquilinum* are locally abundant and are spreading.

Comments

The value of this experiment as an example of habitat creation is limited. The main objectives appear to be to maintain the habitat in its present condition and enhance/restore it where possible.

1993/94 Update

The agreement between Fisons and English Nature has continued and there are now some additional programmes under way.

22. Risley Moss, Cheshire (B3).

Outline

An attempt is being made to provide suitable conditions for the natural regeneration of the mire flora at Risley Moss. The project is being conducted by Cheshire County Council, in conjunction with the Nature Conservancy Council, and the aim is to prevent water from leaving the site via drainage ditches and thus to maintain a high water table. Unfortunately, due to the gently sloping nature of the site, the rewetting process has only been partially successful.

Background

Risley Moss is one of the largest remaining fragments of the raised bog system that once covered large areas of South Lancashire and North Cheshire. The surface of the moss has been drained and cut for peat although a significant amount of peat remains; indeed the site was notified in part for its potential for restoration to lowland raised mire. The site is for the most part flat although it does slope very gently from the north-east to north-west, falling approximately 2.5 metres. The northern part of the site holds two large mounds of non-toxic waste from a Royal Ordnance Factory, these are only partially vegetated. In addition to this there are twelve pockets holding toxic pyrotechnic smoke bomb residue scattered over the site.

Project Details

A Management Plan for Risley Moss was drawn up in 1977 and part of this envisaged a programme to start the natural regeneration of the bog by raising water levels. In response to this, the major outfall drains were dammed in the early 1980s. This has resulted in the rewetting of the more low lying areas of the moss.

By 1987, a number of years after the rewetting process had started, the site was considered ready for the introduction of a number of peatland plant species which were formally on the site but had become extinct. These were round-leaved sundew *Drosera rotundifolia*, common butterwort *Pinguicula vulgaris*, and lesser bladderwort *Utricularia minor*. In addition to this colonisation of the lower lying areas of the site by bog mosses (*Sphagnum spp.*) is of particular interest as it shows promise that peat accumulation may be restarting on the site.

Comments

The project has, to date, been quite successful. The rewetting of a portion of the site has allowed a regeneration of *Sphagnum* communities to occur and the mire flora to improve. Unfortunately, rewetting has not occurred on the main body of the site and approximately 70% of the area still remains purple moor-grass *Molinia caerulea* dominated mire of low species diversity. Partial success has also been achieved by the introductions; the lesser bladderwort is now thought to be extinct, although the sundew and butterwort are still present.

1993/94 Update

Consultation has revealed that Risley Moss has been designated a Local Nature Reserve (LNR) and is managed by the Countryside Management Service of Cheshire County Council's Heritage and Recreation Department. .

23. River Wye, Builth Wells, Wales (R1).

Outline

Two attempts have been made to re-establish bank side vegetation following a road widening scheme adjacent to the River Wye in Builth Wells. One section of the restoration works, carried out by the Nature Conservancy Council using locally collected stock, was successful. Another section, where bought in stock was used by the BTCV, was unsuccessful.

Background

The habitat creation work formed part of a mitigation package for the A470 road improvement scheme. The works were necessary to prevent a meander of the river Wye undermining that portion of the A470 and to enable the road to be widened. The restoration was funded by the Welsh Office, acting through their agents, Ove Arup and Partners and the work was undertaken by the Nature Conservancy Council (NCC) and the British Trust for Conservation Volunteers (BTCV).

Project Details

By 1987 the road works had been completed. To prevent further river erosion, rocks were heaped on the river bank and, to initiate the habitat creation scheme, soil and shale head material was used to fill the voids and crevices. The remaining area of the site was weeded thoroughly prior to planting. BTCV decided to use trees from a commercial grower which had to be transported a great distance by truck. The NCC, however, used feathers grown locally by the Forestry Commission. These were transplanted in the months between October and March and every effort was made to prevent root damage by desiccation. Alder *Alnus glutinosa*, ash *Fraxinus excelsior* and oak *Quercus robur* were planted as feathers (between 1.2m and 1.5m tall), while a number of 0.5m to 1.0m high hazel *Corylus avellana*, elder *Sambucus nigra* and willow *Salix caprea* were transplanted.

Unlike the BTCV project, the NCC project included the introduction of suitable ground flora and river bank vegetation and all the species used were of native British provenance. The river margins were planted with giant wood-rush *Luzula sylvatica*, reed canary-grass *Phalaris arundinacea* and meadowsweet *Filipendula ulmaria*, while the remaining area was planted with musk mallow *Malva moschata*, common toadflax *Linaria vulgaris*, yarrow *Achillea millefolium*, birds-foot trefoil *Lotus corniculatus* and a number of fern species. After planting, the site was thoroughly watered.

Management

For the first year the following management practices were undertaken; competitive weed growth was cut back and weed species were removed either by hand or by spot treatment with herbicide. After any four week period with less than 30mm of rainfall, the plants were watered. All dead or missing plants were replaced with individuals of the same species.

Comments

The site visit in 1991 revealed that the great majority of species introduced to the site were still present, and that no tree mortality had occurred. It was also evident that a range of plant species has naturally colonised the site including Yorkshire fog *Holcus lanatus*, creeping bent *Agrostis stolonifera*, soft rush *Juncus effusus*, cuckoo-flower *Cardamine pratensis*, and the rare jacob's ladder *Polemonium caeruleum*. Since jacob's ladder is recorded further up stream on the Wye, its establishment is of particular interest in illustrating a dispersal mechanism of the species.

An indication of the value of the careful introduction and management techniques used here by the NCC is given by the comparison between the trees planted by the NCC and the BTCV. Those planted by the BTCV clearly suffered desiccation during transportation to the project site and, five years later, still present a poor stature in comparison with those planted by the NCC, having attained perhaps two thirds their height.

1993/94 Update

No additional information has been found and we are forced to conclude that no monitoring and management are currently taking place.

24. Sankey Valley Park, Warrington, Cheshire (W11).

Outline

Herbaceous woodland ground flora species have been introduced into a relatively new tree planting in an attempt to create a more naturalistic woodland habitat. This is one of the few examples of a woodland habitat creation scheme involving ground flora.

Background

Sankey Valley Park is a liner feature surrounded by urban development within Warrington. Previously the area held a number of derelict factories and associated buildings. The area was cleared and restored by Gillespie Environmental Management on behalf of Warrington Borough Council.

Project details

After the site was cleared, a 300mm deep layer of clay subsoil was spread which was topped by a further 300mm of peaty soil and spent mushroom compost. The trees were planted into this substrate using the notch planting method. A mixture of whips (0.5 to 1.0m tall) and feathers (1.0 to 1.5m tall) were used in order to create rapid visual cover. The tree species used were selected from species typically found in the area and a regime of immediate weed control was initiated to help the trees become established.

The woodland was planted (in *circa* 1982) so that oak *Quercus robur* and ash *Fraxinus excelsior* dominated, but also included alder *Alnus glutinosa* and downy birch *Betula pubesens* within the stand. The woodland edges were planted with blackthorn *Prunus spinosa*, elder and hawthorn.

After seven years of growth, a range of forb species were introduced into the woodland. These species were selected for their suitability as woodland ground flora species and had been container grown. They included pendulous sedge *Carex pendula*, ground ivy *Glechoma hederacea*, selfheal *Prunella vulgaris*, red campion *Silene dioica*, wood sage *Teucrium scorodonia*, garlic mustard *Alliaria petiolata*, hairy brome *Bromus ramosus* and foxglove *Digitalis purpurea*. These species were planted out in groups within the woodland.

Management

Before the project was initiated a Management Plan was drawn up which commits the site managers to an on-going programme of weeding, thinning and coppicing.

Comments

As the site is linear in shape and becomes narrow in places, there is a problem of excess light penetration to the ground layer. In addition to this, slow growing tree species have given the canopy an uneven nature which has also exacerbated the problem of excess light penetration. Because of this problem, the continuing weeding, both by hand and through the use of herbicide, has been a very necessary part of the management programme.

In addition to the existence of a long term Management Plan, this project demonstrates good habitat creation planning including the careful selection of species, ecologically orientated planting with distinct woodland edge communities, the inclusion of ground flora in planting regime and good on-site management which has enabled weed control to be achieved.

1993/94 Update

The management of the Sankey Valley Park has been taken over by the Community Services Directorate of Warrington Borough Council. Consultation with John Campion of Gillespies has indicated that the management of the woodland area is practised as parts of two Management Plans which are in operation, the Sankey Valley Park Management Plan and the Structure Planting Management Plan. Fortunately, there was continuity in the site management staff when the takeover took place. It is not clear whether monitoring is being carried out which can guide the management.

25. Ladyloan Wood, Glasgow (W12).

Outline

The objectives of this scheme, carried out by the Central Scotland Countryside Trust (CSCT), are mixed but an attempt has been made to establish woodland using adapted forestry techniques. Little consideration has been paid to the introduction of woodland ground flora.

Background

The site was formally agricultural grazing land which fell into disuse after the building of Drumchapel housing estate. In 1986 CSCT was invited to design, cost and implement a woodland creation scheme by Glasgow District Council. Funding was provided by forestry grants, and through Glasgow District Council, the Scottish Development Agency, and Strathclyde Regional Council.

Project details

The ground was prepared for planting by shallow ploughing with a 2 metre interval. The site was planted using bare-root forestry transplants. Not all the species used were native, and none of the stock was of local origin. The main body of the site was planted with ash, silver birch, wild cherry, alder and spaing rowan. The edges were planted with hazel, blackthorn, hawthorn, elder, dog-rose and rugosa rose. These species were also planted throughout the main body of the site to provide an understory. Scots pine and European larch were also planted in small blocks throughout the site. Herbicide was applied to suppress weeds, and grass was regularly cut along the rides; this was thought important as arson was considered to be a major threat to the site.

Management

It was decided that once the trees and shrubs had become established, herbicide treatments would stop. To reduce the risk of fire and for cosmetic reasons, the grass would continue to be cut along the rides. As the tree canopy develops, thinning operations will be employed to remove the conifer species.

Comments

This project made no attempt at the introduction of the ground flora species that are associated with woodland habitats. The resultant habitat therefore may be considered to be a mixed and somewhat diverse plantation which, in itself, is doing well. Since the site is isolated from any natural source of woodland ground flora, the plantation is unlikely to develop further towards a woodland habitat without the deliberate introduction of these species.

1993/94 Update

According to John Walls of the City of Glasgow District Council, tree growth at Ladyloan Wood is doing well, with trees up to 6 m tall. Following the five year establishment phase of the woodland, carried out by CSCT, from 1986-1992, the site was handed over to the City Council. It then became part of the Kirlpatricks Urban Fringe Management Project who have been carrying out some ad hoc management. It is currently proposed to take the site within the City of Glasgow's internal progamme of management.

26. Witton Lime Beds, Cheshire (M27).

Outline

This site was a transplantation experiment and field programme and not a habitat creation project. For this reason, it has not been considered further in the *Review*.

3. DISCUSSION

1. It became clear during the review of the returned questionnaires and the assessment of the shortlisted case study sites that the term habitat creation has been used to describe a wide range of projects. This has included those where existing semi-natural vegetation is being managed to maintain its diversity, as seen at Thorne Moor (21) and West Sedgemoor (7), and those involving the rehabilitation of degraded ecosystems as at Risley Moss (22). This emphasises the uncertainty relating to what constitutes habitat creation.

2. Buckley (1989) suggests that four of the main reasons for undertaking habitat creation are to:

   i) create visually attractive vegetation
   ii) provide educational and possibly scientific interest
   iii) safeguard rare species or scarce ecological communities
   iv) construct low maintenance landscapes

   All these objectives are represented by examples in the case studies chosen for the *Review*.

3. Some projects, included as case studies on the basis of returned questionnaires and after consultation with the Nature Conservancy Council, provided little information on approaches to habitat creation (eg. Chalk grassland seeding at Betchworth, Surrey and Redbourne Road Verges, Hertfordshire: case study 10). In extreme cases the project sites no longer exist as, for example, with the wildflower seeding experiments in Invergordon, Inverness and the Moray Firth (6).

4. Two projects were not considered to be examples of ecological habitat creation *per se*, but had been carried out for landscaping (Ladyloan Wood, Glasgow: case study 25) or civil engineering (saltmarsh restoration, Essex: case study 12) purposes. It is recognised that in many circumstances an objective to reproduce semi-natural habitat types can be combined with the objectives inherent in these disciplines. However, in the case of the cited projects, ecological objectives appear not to have been considered.

5. Several case study projects were carried out with alternative primary objectives. Benwell Nature Park (2), for example, was created to provide a major environmental education resource for city schools in Newcastle-upon-Tyne. However, despite an unnatural sward structure and appearance, the meadow was created with a semi-natural target community in mind and every effort was made to use an ecologically sensitive and traditional management approach. The project also represents what is often considered to be a typical approach to habitat creation.

6. Case studies have shown that three of the major considerations during habitat creation are the need for i) suitable edaphic conditions particularly with regard to soil fertility, ii) appropriate sources of viable seed and iii) appropriate initial and long term management.

7. Problems associated with both high and low fertility experimental substrates have been reported (Levenhall Links Leisure Park, Musselburgh: case study 1 and Benwell Nature Park: case study 2 respectively). Furthermore, attempts have been made to lower the soil fertility during the initial stages of several projects including those at Ropers Heath (17) and the Wolverhampton Meadows (5).

8. The fragility of wild flower seed and the need for suitable seed storage is highlighted by the experiment at Kenwood Meadow, Hampstead Heath (3) which failed despite the otherwise 'text-book' approach used. Some workers, aware of the peculiarities of seed supplied commercially, have investigated alternative sources (eg. Wolverhampton Meadows: case study 5) whilst a reliance on natural colonisation has been the approach during other projects (Seven Sisters Country Park: case study 9, and Ropers Heath: case study 17).

9. Management has proved to be one of the biggest drawbacks to the success of habitat creation projects. The availability of suitable equipment and labour is often inadequate. Long-term management, in particular its labour and cost implications, is something which is often underestimated or otherwise neglected. Even if the

management requirement is recognised, there may be difficulties in arranging appropriate aftercare (eg. Wolverhampton Meadows: case study 5).

10. The philosophy that total reliance on natural processes produces more natural communities (Newbold, 1989) may be true in some circumstances. However, as discussed by Buckley (1989), natural colonisation as an approach to habitat creation often has "a number of attendant ecological snags, even if the site in question already adjoins good habitat". In some situations, for example, soil erosion can result in the complete modification of a substrate before many plant species can become established naturally (eg. Glaisdale Moor: case study 18). Furthermore, the soil seed bank of desirable species may have become exhausted during a period of intensive agricultural use. When such species also have poor dispersal mechanisms, the habitat creation timescale may be greatly extended if left to natural processes alone (eg. Seven Sisters Country Park: case study 9, Ropers Heath: case study 17, Glaisdale Moor: case study 18). Under such circumstances assisted seed introduction can prove essential in order to produce a more desirable sward.

11. In appropriate situations, however, and provided suitable gaps into which plants can colonise and become established are present, the processes of natural colonisation may result in the rapid diversification of a sward. This has been demonstrated at Durlston Country Park (8) where a recently created meadow now supports several species, including orchids, which have colonised from adjacent land. This is in addition to a range of species introduced in a wildflower seed mix.

12. The *Review* suggests that emphasis in habitat creation generally remains on the reproduction of semi-natural vegetation. This is despite suggestions that the creation of simpler habitats which have less scientific credibility and may involve the use of colourful exotic species may be appropriate in certain situations. It is suggested that these habitats may have more popular appeal and they have been described as 'political habitats' (Baines, 1989). This approach may result in simplified habitats which are often unnatural in appearance. However, the intentional use of introduced or exotic species has not been found to be widely used or necessary.

13. Some success has been achieved in habitat creation. However, in most cases the results are not always as intended and the composition of created habitats only partially reflects that of the semi-natural model. The reasons for this are varied, but often related to the poorly planned circumstances under which many schemes are carried out. Successful habitat creation is very much more difficult than many people anticipate and requires a great deal of planning and subsequent long term management. The labour and cost implications of proposed projects need to be established and considered during the earliest planning stages. Furthermore the time period required for projects to achieve a significant level of success is very often underestimated.

14. Many attempts at habitat creation have not been successful. The biotic component of the target ecosystem is often the first, and sometimes the only, consideration. It is, however, only one component of a functioning ecosystem. The edaphic environment, the prevailing climatic characteristics of the experimental area and the proximity of sources of seed of desirable species are also major considerations and are often overlooked. If wildlife habitats are to be created successfully, an approach is required in which all the factors that make up an ecosystem are considered. Such an approach is particularly necessary when habitat creation is offered as mitigation for the loss of semi-natural habitat as a result of development.

15. A great deal more research and experience are required before habitat creation can be considered as a valuable and reliable method of replacing lost habitat. However, the practical knowledge and experience derived from the range of projects that have already been carried out is a useful source of information.

4. REFERENCES

BAINES, J.C. 1989. Choices in Habitat Re-creation. In: Buckley, G.P. (Ed). *Biological Habitat Reconstruction*. Belhaven Press. pp. 5-8.

BUCKLEY, G.P. (Ed.) 1989. *Biological Habitat Reconstruction.* Belhaven Press. pp. 1-2.

JONES, G.H. 1990. Learning From Experience. *Landscape Design*, 193, 40-44.

NEWBOLD, C. 1989. Semi-natural Habitats or Habitat Re-creation: Conflict or Partnership. In: Buckley, G.P. (Ed). *Biological Habitat Reconstruction.* Belhaven Press. pp. 9-17.

GLOSSARY

Amelioration	Improvement of soil or soil forming material to make it suitable for plant establishment and growth, eg. addition of fertiliser, amendments, cultivation.
Amenity after-use	Any land use which is not productive agriculture or forestry, or industrial or other development.
Ancient woodland	Semi-natural woodland on a site which has been continuously wooded since 1600 and has possibly been continuously wooded since prehistoric times.
Available nutrients	The nutrients in the soil which are available for plant growth.
Bryophyte	Mosses and liverworts.
Calcareous	Soils containing a large amount of calcium carbonate, usually on chalk or limestone; pH >7.5.
Calcicole	Plants that will only flourish on calcareous soils.
Calcifuge	Plants that dislike calcium carbonate and will only flourish on soils with a low calcium level; such soils are almost always acidic.
Companion species	Fast growing and relatively short lived species (both trees and herbaceous) which can be planted to assist in the process of soil formation and aid the growth of desired species by providing shelter and shade.
Hay Meadow	A meadow which is closed to grazing animals in spring and early summer; the long grass and herbs are then cut for hay and stock are allowed to graze the meadow until the early spring; traditionally, no artificial fertilisers of herbicides have been used on such meadows and they are often rich in species.
Hydroseeding	A method of applying seeds and fertilisers to areas inaccessible to normal cultivation machinery, such as steep slopes, by spraying a mixture of seed, organic matter (such as chopped straw), fertiliser and water. Chemical soil stabilisers can also be part of the hydroseeding mix.
Hydrosere	The vegetation forming a transition between dry land and open water.
Inorganic fertiliser	Fertilisers from non-organic sources.
Leaching	The removal of plant nutrients from the soil by percolating water. The physical and chemical nature of a soil influence the rate of leaching.
Macro-nutrients	The main nutrients essential for successful plant establishment and growth, in particular nitrogen, phosphorus, potassium, calcium, magnesium and sulphur.

Mesotrophic	Condition of soils and waters with moderate nutrient levels and a near neutral pH.
Micro-nutrients	Nutrients required in small quantities for successful plant growth and establishment, including iron, manganese, boron, copper, zinc and molybdenum.
Micro-climate	The climate of the immediate surroundings or habitat, modified by local topography, aspect, vegetation and soil, etc.
Micro-habitat	Plant habitat at the level of the germinating seed and establishing seedling usually created by variation in soil level and the presence of vegetation, eg. a companion grass. This can also apply to such sites as dead wood habitat in woodland.
Mineralisable Nitrogen	A test which reveals the amount of nitrogen which may become available through microbial decomposition of the organic matter present in the soil, using standard incubation techniques under controlled temperature and moisture conditions.
Mulch	The application of a layer of suitable material to the surface of the soil to conserve moisture, reduce fluctuations in soil temperature and reduce competition from weeds.
Natural colonisation	The colonisation of ground by plant species, unaided by man.
Nurse species	See "Companion species" above.
Nutrients	Mineral elements essential for plant growth which are mainly obtained from the soil.
Organic fertiliser	Fertiliser from an organic source, such as cow manure.
pH	A measure of acidity or alkalinity on the scale 1-14; acidic = pH < 7; neutral = 7; alkaline = > 7.
Phytotoxicity	Concentration of chemical substances preventing plant establishment and growth.
Ripping	Deep cultivation to loosen compacted soil using vertical or angled tines either singly, in pairs or in threes attached to a crawler tractor.
Scarification	Breaking up or loosening the soil/mineral surface with an appropriate implement prior to seeding or in preparation for natural regeneration.
Secondary woodland	Woodland on a site which at some period since 1600 has not been wooded; the most likely use during this period was for pasture or arable land.
Seed bank	The accumulation of viable seeds in the soil which are likely to germinate if the soil is disturbed; Most of the seed bank lies in the top 40mm of soil.

Semi-natural	The use of this expression in relation to a plant community indicates that the community has been modified by human management but that its dominant and constant plant species are accepted native UK species and that the structure of the community conforms to the range of natural types.
Soil-forming material	Mineral or organic matter which has at least some of the properties of a soil and can be used as a medium for plant growth.
Species-rich grassland	Low fertility sward such as that which occurs on unimproved chalk and limestone grassland which supports a wide range of different herbaceous species within a small area.
Subsoil	The soil material beneath the topsoil and overlying the weathered bedrock; it is composed of weathered parent material and is low in organic matter.
Succession	The gradual and predictable process of progressive community change and replacement in vegetation which leads towards a stable climax plant community.
Topsoil	The biologically active, organic rich surface layers of a soil which provide a medium for plant growth.
Unimproved	The use of this word in relation to soils and especially grasslands implies that no agricultural improvement has taken place involving the use of inorganic fertilisers, ploughing, reseeding, etc.
Units	1 ha = 2.47 acres 1 kg = 2.20 lb 1 kg/ha = 0.89 lb/acre 10 kg/ha = 1 g/m2
Vernalisation	The effect of cold weather on seeds which is needed by some species to break dormancy.
Weathering	Physical, chemical and biological breakdown of geological materials by water and atmospheric processes leading to the formation of natural soils.