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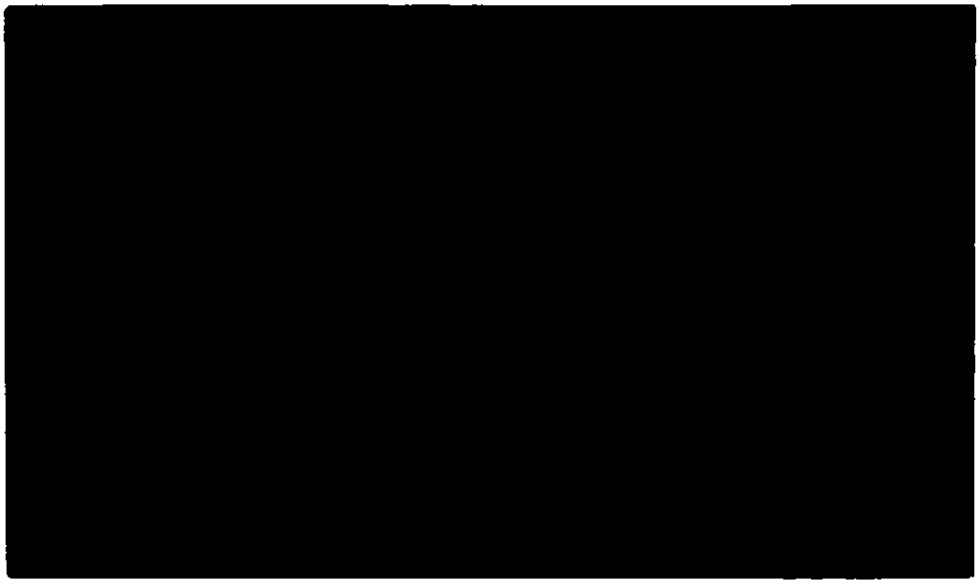

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The Institute of Terrestrial Ecology will develop long-term, multidisciplinary research and exploit new technology to advance the science of terrestrial ecology, leading to a better understanding and quantification of the physical, chemical and biological processes of the land.

Priority is placed on developing and applying knowledge in the following areas:

- the factors which determine the composition, structure, and processes of terrestrial ecosystems, and the characteristics of individual plant and animal species
- the dynamics of interactions between atmospheric processes, terrestrial ecosystems, soil properties and surface water quality
- the development of a sound scientific basis for monitoring, modelling and predicting environmental trends to assess past, present and future effects of natural and man-made change
- the securing, expansion and dissemination of ecological data to further scientific research and provide the basis for impartial advice on environmental protection, conservation, and the sustainable use of natural resources to governments and industry.

The Institute will provide training of the highest quality, attract commissioned projects, and contribute to international programmes.

ITE will promote the use of research facilities and data to enhance national prosperity and quality of life.

DRAFT

ITE contract report
to the
Department of the Environment

ECOFACT Workshop:

Review of techniques for botanical survey and monitoring

Edited by

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CONTRACT
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ECOFACT WORKSHOP: REVIEW OF TECHNIQUES FOR BOTANICAL SURVEY AND MONITORING

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SUMMARY

1. As part of the ECOFACT Module '*Review of techniques for botanical survey and monitoring*' a workshop was held at Grange over Sands on 17/18 April 1996. Participation was by invitation only and most Government Departments and Agencies with an interest in countryside research were represented, together with staff from research institutes and universities who have been the practitioners in the field.

2. The aims of the workshop were:
   i. To review and discuss common standards of botanical monitoring.
   ii. To assess whether there is scope for convergence in the methodologies used.

3. To provide the review of current survey and monitoring techniques, a number of papers were presented, each followed by discussion. Two group workshop sessions then discussed current and future techniques for botanical survey and monitoring.

4. It was clear from the presentations and subsequent discussion that there was a wide range of survey and monitoring approaches being practiced in the UK. It was generally agreed that approaches varied because of different survey objectives ('horses-for-courses') and that there was unlikely to be much convergence in methodology.

5. In terms of botanical standards, the meeting felt that there was considerable scope for improving quality control in many survey techniques and that there was potential for encouraging the use of existing standards where appropriate. Although some nomenclatures and definitions were already fixed, it was important to understand how these related, one to another, in order to make comparison of results easier.

6. It was recognised that a wide range of quadrat sizes were being used in different surveys. It was generally agreed that nested quadrats allowed better comparison of survey results and that an attempt to define common standards of quadrat should be made.

7. There was some support for developing more technical approaches to botanical survey on the basis that much of the current methodology was 'old' and that it was relatively expensive to implement

8. A number of detailed recommendations are given at the end of this report.

9. In relation to the next Countryside Survey, in particular, a number of recommendations were made to address issues such as: optimal survey timescales; assessment of new technology; providing previous survey results to current field surveyors; the collection of management information; the quality of vegetation mapping and the use of a grid system as a surrogate; better and more interesting delivery of research results; and improved research collaboration.

10. The workshop was useful in bringing together practitioners and users and included a plea for continuing communication and collaboration between these groups in future.

1. SOME INTRODUCTORY COMMENTS

1.1 The Institute of Terrestrial Ecology (ITE) is undertaking a programme of work under the broad heading of 'Ecological Factors Controlling Biodiversity in the British Countryside' (ECOFACT). The programme has funding from DOE, MAFF, SOAFD and ITE and runs for three years from 1996.

1.2 One of the ECOFACT research modules is called 'Review of techniques for botanical survey and monitoring', jointly funded by DOE and ITE. As part of this module, two workshops have been planned. The first is to discuss common standards for future biological recording. A second workshop is planned to be held in 1997 to review techniques for data analysis.

1.3 The first workshop was held on 17 and 18 April 1996 in Grange-over-Sands, Cumbria. Details of the programme are given in Appendix 1. This report of the first workshop contains both written contributions from speakers and comment and discussion from ITE.

1.4 The background to this work relates to the proliferation of different botanical recording techniques which has developed in response to different surveys, with different objectives. Many of these have not been published in the open literature and the details are not widely known; the recording schemes are not consistent and yet there is a wealth of experience and valuable information available which could help to standardise practice, where appropriate. We believe that this is especially relevant to both the UK Action Plan on Biodiversity and Countryside Survey 2000.

1.5 In setting up the ECOFACT programme, and especially with an eye to the next Countryside Survey, DOE and ITE agreed to review the range of techniques for botanical survey and monitoring to see if there is scope for bringing different methodologies closer together so that results may be more easily compared. Mindful of the need to avoid interfering too fundamentally with basic methodologies (for fear of invalidating change results on the basis of changed methods), the present workshop was organised to see what points of general agreement might be found.

1.6 Participants were invited in order to represent the range of survey and monitoring which has been undertaken in the UK in the last few years. Most Government Departments and Agencies with an interest in countryside research were represented, together with staff from research institutes and universities who have been the practitioners in the field.

2 MEETING PAPERS AND DISCUSSION

2.1 The following papers have been provided by the speakers at the meeting and have not been altered or amended in any way except to provide consistency in style, and wording where appropriate.

INTRODUCTION: THE POLICY CONTEXT

Dr Andrew Stott, Wildlife and Countryside Directorate, Department of the Environment

Ecological factors controlling biodiversity in the British Landscape (ECOFACT)

Following publication of the Countryside Survey 1990 (CS1990) main report (Barr *et al.* 1993), the ECOFACT programme of research, funded by DOE, MAFF, NERC and SOAEFD, has been initiated with the following broad aims:

1. to improve analysis of botanical data
2. to develop links with other surveys and classifications
3. to understand the causes of observed changes in botanical diversity
4. to identify patterns of biodiversity at the landscape level
5. to review techniques for botanical survey and monitoring
6. to start technical planning for Countryside Survey 2000

The current workshop has been convened to address the fifth of these and will consist of two workshops:

1. Workshop 1 Survey Methods, April 1996
2. Workshop 2 Analytical Procedures, February 1997

The 1990's policy context

The following provide a policy context for the workshop:

- UN Rio Declaration and Agenda 21
  - UK Sustainable Development Strategy 1994
  - Indicators of Sustainable Development 1996

- UN Convention on Biological Diversity
  - UK Biodiversity Action Plan 1994
  - Steering Group Report 1995
  - Species/Habitat Actions Plans

- EU Habitats and Species Directive
  - SACs, (SSSIs/ASSIs)

- EU Reform of Common Agriculture Policy
  - Agri-environment schemes, ESAs, Countryside Stewardship

- UK Environment White Paper 1990

- UK Rural White Paper 1995

In particular, the Rural White paper (England) 1995 includes the following important statements:

- "If we are to make sound decisions about the management of the countryside environment, and where necessary change our priorities, **we need reliable information about the state of the environment** and the many factors which impact upon it."
- "We must therefore base our policies on the best information available, **by monitoring trends in the countryside and improving access to this information."**
- **The Government will carry out a repeat of Countryside Survey in the year 2000.**

and the Indicators of Sustainable Development 1996 document says: **"If we are to improve our** policies, we need to monitor how effective they are." Wildlife and habitat indicators which relate to vegetation include:

- native species at risk
- plant diversity in semi-improved grassland (CS1990)
- area of chalk grassland
- plant diversity in hedgerows (CS1990)
- habitat fragmentation
- plant diversity in streamsides (CS1990)

The UN convention on biological diversity, article 7: monitoring, includes the following recommendations:

- monitor through sampling and other techniques the components of biological diversity...
- identify processes...which have ...adverse impact on the conversation of biological diversity and monitor their effects...
- maintain and organise....data derived from...monitoring activities...

The UK Biodiversity Action Plan 1994 includes the following:

- "There is an urgent need to establish an agreed **baseline set of data for key aspects of biodiversity** in the UK, and to monitor this over time."
- "A biodiversity monitoring scheme should include the ability both to monitor **the environment generally** and to quantify the **extent of threats** from environmental factors with measures of their impact."

- "The development of a **co-ordinated national monitoring system of trends** which threaten biodiversity must be a priority."
- "There is a need to examine options to increase the **co-occurrence** of monitoring activity."
- "It would be logical to link other datasets on species and habitats to the **Countryside Survey 1990** framework."
- **"The Government and its agencies will examine and develop the integration of monitoring studies..."**

The Biodiversity Steering Group report, 1995, says:

- "Data and information are essential if **broad aims, specific objectives and precise targets** are to be achieved."
- "We need to know where we start from, and what is changing, in order **to understand what is causing the change**, whether we need or can prevent the change, and to identify any remedial action we might take."
- "The Steering Group attaches high importance to monitoring **key species and habitats in a cost effective way."**
- "The monitoring programmes will need to be modulated to take account of **European and international obligations and existing survey commitments."**

The UK Habitat Action Plans have the following objectives:

- to clarify the extent, distribution, composition and status of each habitat
- to produce site inventories or full coverage habitat surveys
- to sample surveys at 10 year intervals
- to expand range of sites for long term monitoring
- to undertake rapid monitoring for management assessment
- to monitor effectiveness of prescriptions

The Planta Europa conference (Ref) concluded that the following were the policy requirements for botanical survey and monitoring

- Setting targets (e.g. designations and action plans)
- Measuring targets (site integrity and action plans)
- Effectiveness of policy (e.g. agri-environment schemes)
- Indicators and information
- Identification of impacts, processes & prediction
- Policy development (e.g. hedgerow protection)
- Management decisions

Thus, in conclusion, the policy requirements for botanical survey and monitoring can be listed as follows:

- Setting targets (e.g. designations and action plans)
- Measuring targets (site integrity and action plans)
- Effectiveness of policy (e.g. agri-environment schemes)
- Indicators and information

- Identification of impacts, processes & prediction
- Policy development (e.g. hedgerow protection)
- Management decisions

Issues for the workshops

In the light of the policy context described above the issues that should be addressed during the workshops are:

1. The requirements for botanical monitoring

2. The context of botanical monitoring especially in relation to:
   - site-based monitoring,
   - monitoring of types of site,
   - monitoring of areas of different size (including regional, national, and EU)

3. Methodological issues, including:
   - spatial framework/scale
   - sampling strategy
   - timing/replication
   - survey techniques
   - quality control
   - skills, training and organisation
   - resources

Expectations

It is expected that the first Workshop will:

- Review current requirements, activities and approaches
- Identify opportunities for greater coordination/collaboration/integration.
- Identify technical/institutional constraints.
- Consider next steps
- Inform thinking about the design and implementation of CS2000.

A HIGHLY TARGETED APPROACH TO VEGETATION RECORDING IN THE AGRICULTURAL ECOSYSTEM

Dr Helen Smith, Wildlife Conservation Research Unit, Department Of Zoology, Oxford.

Introduction

Vegetation recording in agricultural systems has a dichotomous background. On the one hand, the economic necessity of controlling common crop weeds has fostered some of the longest term and most rigorous approaches to botanical recording. These have included repeated surveys (surveillance), consistency of methodology, and regulatory monitoring, to check populations against pre-defined action thresholds. On the other hand, survey and monitoring either of plant assemblages, or of single species not of economic importance, has lagged behind that in most semi-natural ecosystems. This reflects the profound but understandable lack of interest by many conservationists in non-prime sites. This attitude began to change during the 1970s as concern grew about the effects of agricultural intensification on wildlife. Changing economic circumstances in the 1980s gave new impetus and opportunities to this change in attitude. In particular, initiatives such as the Game Conservancy's promotion of conservation headlands to benefit game rearing, the Hedgerow Incentive Scheme and the introduction of the set-aside schemes, have resulted in a proliferation of botanical survey work in both cropped and un-cropped agricultural habitats.

The work that is the main subject of this paper was instigated in 1987 and arose from a demand for advice on the conservation management of arable field boundaries. It was concerned specifically with the band of herbaceous vegetation between the boundary feature and the edge of the crop (the 'field margin'). Despite the enormous potential of this ubiquitous habitat for wildlife conservation in the agricultural landscape, it has suffered a history of neglect and mis-management. Erosion in width by close ploughing, elevation of soil nutrient status by indiscriminate fertiliser application and the effects of pesticide drift, as well as the direct use of herbicides as a management tool, have all contributed to the development of species-poor plant communities dominated by pernicious weeds. Management prescriptions were therefore needed which combined the requirements for effective weed control and restoration of wildlife interest.

The work was carried out by the University of Oxford's Wildlife Conservation Research Unit and funded by the then Nature Conservancy Council. It comprised two large-scale but single-site experiments. The monitoring methods were highly targeted, to give robust answers to the experimental objectives. I consider below the objectives, design and methods for each experiment separately and discuss the limitations that these methods place on comparability with other work. Further details of the work are given by Smith *et al.*(1993).

Experiment 1: the management and restoration of conventional field margins

The first experiment was designed to evaluate the effects of simple, contrasting management regimes on development of the flora of expanded width field margins. Existing margins around arable fields at the University's farm at Wytham were expanded in width from around 0.5 m to a total width of 2m by fallowing cultivated land in autumn 1987. Vegetation was established on the fallowed extensions either by allowing natural regeneration or by sowing a mixture of indigenous wild grasses and forbs. The existing (old) and newly-fallowed (new) zones of the margins were then managed as a single unit using regimes which either controlled for common, existing field margin management practices or represented common agricultural or conservation grassland management practices. These regimes also gave rise to contrasting predictions about their likely effects on species richness and on species with differing phenologies. Both sown and unsown swards were either left unmanaged or were managed by cutting (with cuttings removed) in (a) summer only (b) spring and summer and (c) spring and autumn. Two further regimes were imposed on unsown swards only: (a) cut in spring and summer with cuttings left *in situ* and (b) sprayed annually, in summer, with a broad-spectrum, non-residual herbicide.

The experimental design and recording methods had three broad objectives:

1. To measure the effects of the management regimes on temporal changes in overall plant species richness, and in the abundance of individual species, on the old and new zones of the field margins. Four groups of species were of particular importance: (i) pernicious weeds (ii) species of particular importance in the context of nature conservation or amenity (iii) for economic reasons, species included in the wild flower seed mixture and (iv) species likely to host or harbour important groups of invertebrates or mammals. The effects of management on characteristics of the vegetation other than species composition which were likely to be important to other taxa, were also considered in this context.

2. To measure the effects of the management treatments on weed populations in the adjacent crop.

3. To assess the extent to which the success of natural colonisation of the newly-fallowed extensions to the margins could be predicted from the composition of potential source floras.

Experimental design

Although the experimental design is only of secondary importance in the context of this workshop, it is critically linked to the recording methods. Moreover, the over-riding need for adequate replication of treatments placed pragmatic constraints on the intensity and type of recording that was possible. The ten sward-type/management combinations were each imposed on contiguous 50m-long plots of field margin. They were replicated in eight complete randomised blocks, with each block being located within a single field. This experimental design allowed us, for example, to compare the effects on species richness or individual species abundances, of sown and unsown swards, of varying the timing or the frequency of cutting, or of collecting or leaving cut material.

Recording methods

We used permanent quadrats as our main recording unit. In each plot these were located at 10, 20 and 30m from the end of each plot, in three parallel banks in each of the old and new zones of the margin, and at 0.5m and 10m into the crop. The quadrats were 0.5 x 1m, with their long axes running parallel to the field boundary. Their width was determined by the minimum width of the old zone of the field margins and their length by what was easily examined from outside the quadrat.

Species richness and frequency

We chose percentage frequency as our primary measure of abundance and assessed this by recording all species rooted in each of eight 25 x 25cm sub-cells in each quadrat. This method generated species richness data at the same time as individual species frequencies. Since the data for each cell were stored as a unique record, it also allowed crude mapping of the spread of species within the quadrats.

Percentage frequency is a relative measure that depends on quadrat-size. It therefore restricts the comparability of the data from this study to other studies using quadrats the size, either of our main quadrat, or of any of its sub-divisions. The preferred alternative, of measuring percentage cover, was not feasible because it could not be recorded accurately in the often very tall and dense vegetation on the field margins. Assessment of cover by visual estimation, using pseudo-quantitative scales, was rejected because of problems with maintaining comparability.

All quadrats were recorded four or five times a year, and recording rounds were completed within 12 days because of the rapidity of vegetation change at some times of year. There were two reasons for this frequency of recording. First, it allowed more precise identification than would have been possible from a single annual record, of the time at which particular management regimes started to have significant effects. This often gave a good indication of the processes underlying the effect. Second, a single recording date can result in significant underestimation of the importance of some species because of differences in phenology. Even so-called absolute measures of abundance, such as percentage cover, become relative for this reason, if measurements are made only once a year, or if comparisons are made from different times of year.

Density

One drawback of recording frequency is that it becomes insensitive to changes in abundance when the species are very common and evenly distributed. For this reason, we used measures of density to record changes in the abundance of some key species. For example, we recorded panicle densities of the commonest pernicious annual grass weeds within the permanent quadrats. We also measured densities, in whole plots, of key species which occurred too infrequently in the quadrats to allow analysis of treatment effects.

Other botanical measures relevant to animal taxa

We obtained a relative measure of vegetation height and density using a sward stick based on the design used by the Butterflies Under Threat Team. The height at which a 30 cm diameter, hardboard disc came to rest in the vegetation was measured at four points within each permanent quadrat, at each recording round.

The potential availability of nectar, on the old and new zones of the margin, and in the boundary feature of each 50m plot, was assessed by estimating numbers of flowers of all species on a six-point scale, at monthly intervals from May to October in one year.

Recording potential source floras

Comprehensive lists of the date first recorded of all species present in the boundary feature, the old and new zones of the margin and the first 10m of the adjacent crop, were accumulated from the outset of the experiment. The soil seed bank in the new margin also sampled at three points in each 50m plot, at the outset of the experiment. Seedling germination was recorded from the samples for the next three years.

Experiment 2: the management of wide field margins for alternative land uses

The second field margin experiment at Wytham had different objectives from the first, and consequently a different methodology. While the first experiment was designed to evaluate management methods for the margins of conventional, intensively managed arable fields, this experiment was concerned with management of larger-scale field margins, and potentially of whole-fields, devoted to alternative land-uses. These might include set-aside, or subsidised conservation and amenity uses under Countryside Stewardship, or extensified farming within ESAs or organic systems.

Conventional agricultural grass leys have been used extensively for green cover on set-aside land and for amenity purposes on farmland, because of their low cost and ready availability. However, because they are designed to give high productivity, they are likely both to present management problems under the set-aside rules and to have very limited value for wildlife. We therefore compared, in terms of productivity, ease of management by mowing, and benefits to wildlife, a conventional mixture of cultivars of *Phleum pratense*, *Lolium perenne* and *Trifolium repens* and an alternative, more species-rich ley. Its composition was based on 19th Century grass mixtures and included a small proportion of forbs in addition to indigenous grasses.

We examined the effects of fertility and cutting regime on differences between the two leys. Both were cut either once a year (as hay) or twice a year (as silage) and we applied either no fertiliser or fertiliser levels appropriate for normal agricultural practice under each management regime. The hay and silage regimes were treated as separate experiments, in which the four ley/fertiliser combinations were replicated and fully randomised in contiguous plots on the fallowed margins of separate fields.

Recording methods

Because we were interested in productivity, as well as in species composition and richness, we used above-ground standing crop as our basic measure of abundance. The vegetation in four, randomly located, 25 x 25 cm quadrats in each plot was harvested by clipping at ground level. To minimise edge effects, sampling was restricted to the central 30m x 3m area of each plot. Samples were sorted to species, dried and weighed.

The experiment was sampled in the establishment year and again three years later. The hay margins were sampled in mid-June, prior to cutting, and the silage margins were sampled in mid-July, just before their second cut.

The species richness data from this experiment are quadrat size dependent but, in contrast to the previous experiment, the measure of individual species abundance is absolute. However, comparisons with standing crop measurements from other studies still require great caution because of the substantial effects of the timing of measurement in relation to season and management operations.

Comparability between survey/monitoring projects in the agro-ecosystem

I have addressed above, detailed points concerning intrinsic limitations in the methodology of the Oxford experiments which restrict their comparability with other studies. In general, this study entailed more detailed and intensive data collection than is usually the case in wider scale survey or monitoring approaches in a non-experimental context. This difference resulted from the need, first, to detect the development of initially subtle differences between experimental treatments and, second, to understand the processes underlying observed vegetation changes.

A review of other recent survey/monitoring projects in agricultural ecosystems shows a great diversity of methodology. Most were concerned with measuring aspects of vegetation change and involved surveillance. Only the ADAS work on the ESAs was designed as a monitoring exercise in the strict sense, with vegetation change being assessed against defined criteria.

There was little consistency in sampling strategies: both permanent and transient quadrats have been positioned both randomly and systematically, in both random and subjectively chosen areas and along linear or even w-shaped transects.

Nor has there been any consistency in measurements made. Species richness data from different studies can rarely be compared because of wide variations in quadrat size. Abundance measures suffer the same problem because frequency is the most commonly used measure. At one extreme the BSBI Scarce Plant Survey, which provides the most up-to-date information on rare arable weed distributions, is based on tetrads and 10km squares. ITE's Countryside Survey used linear, 10 x 1m quadrats while 1m, 0.5 m, 0.25m and 0.1m quadrats are all commonly used. Percentage cover measures, which should allow comparability of species abundance data, at least between data sets collected at similar times of year, are also widely used. However, many published accounts in conference proceedings have omitted to specify whether cover data are quantitative or are based on visual estimation. Whether or not this and other differences in methodology are seen as a problem must depend on the extent to which it is practicable or desirable to compromise the objectives of a particular study for the greater good of increasing comparability.

Key Reference:

Smith, H., Feber, R.E., Johnson, P., McCallum, K., Plesner Jensen, S., Younes, M., & Macdonald, D.W. (1993) *The conservation management of arable field margins.* English Nature Science No.18. Peterborough: English Nature.

Discussion

Mr R. Cummins - It was difficult to collect enough quadrat data, allowing for financial constraints, from herb-rich grassland to detect changes which occurred over a short period of time. There is often a problem with deciding how permanent these changes are. However, it is essential to set achievable targets when designing a monitoring scheme.

Dr H. Smith - Many monitoring programmes have no target other than to detect changes. They do not attempt to define these changes.

Dr J. Hopkins - When looking at changes over time it was essential to make a decision on scale (eg whether a quadrat or whole-field scale was to be adopted).

Dr H. Smith - Methodology should be standardised and guidance should be made available. It is necessary to use different size quadrats for different vegetation types.

General

There is inevitably a tension between (a) the need to adopt methods finely tuned to addressing the questions asked by different monitoring projects and (b) the need to achieve comparability in the method of data gathering and the variables measured so that disparate projects can contribute to a larger e.g. GB wide, monitoring framework. There is a difference between surveillance and monitoring.

RECORDING IN GRASSLAND SYSTEMS

Dr John Hodgson, UCPE Sheffield

[Paper to follow]

Discussion

Dr T. Parr - What is the optimum quadrat size when using the 'FIBS' approach.

Prof. P. Grime - There will be a different size for different vegetation and for different species within any stand. Thus the usefulness of a nested quadrat.

Dr R. Bunce - You could use any size you wanted but it might not be the right one so that when you analysed your data it would be a case of 'rubbish in...rubbish out'.

Mr J. Hodgson - Although the size of quadrat was not an issue it was essential that the data were quantitative and that there was a difference between data that was collected at time one and two. $1m^2$ was suitable for most habitats other than woodland.

Dr A. Cooper - Would the approach work equally well at the community and sub-community level.

Mr J. Hodgson - The community level did not matter as long as the data were comparable.

Prof. P. Grime - It is essential to use different sizes of quadrats so that it is possible to adjust to the different needs of vegetation and species.

Mr R. Cummins - In the Hodgson and Grime approach they picked homogenous stands. This is not possible or desirable in survey and monitoring. Consequently this will affect the choice of quadrat size.

RECORDING IN WETLANDS

Owen Mountford, ITE Monks Wood

Background - the context for monitoring

The impetus to monitor wetland vegetation in Britain has partly arisen from two causes:

1. Concern over the ***impact of water- and agricultural-management*** on the composition of wetland communities, and upon the survival of individual species.

2. Opportunities for the ***restoration*** of wetland communities in areas released from intensive agriculture and industry - particularly through Environmentally Sensitive Area and Countryside Stewardship schemes.

In terms of the ITE's applied research, these factors have in turn resulted in two scientific programmes. From 1981-91, funded first by the then Nature Conservancy Council, and latterly by the Ministry of Agriculture, the impact of agricultural land-drainage was assessed both at a regional level (Romney and Walland Marshes, Somerset Levels and Moors, and the Humberhead Levels) and at a catchment scale (the Swavesey fens, Cambridgeshire). From 1986 onward, commissioned by MAFF, working with Silsoe College, and more recently with the ADAS, the ITE has sought to i) assess the water-regime requirements of wetland plants; and ii) using this knowledge, to develop techniques for the restoration of wetland communities in agricultural land. In the lowland farmed landscape of the British Isles, seven broad categories of wetland habitat might be identified:

Wet woodland
Acid bog, poor fen and wet heath
Tall-herb fen, small-sedge fen and fen meadow
Old, moist mesotrophic grassland
Open water and margins *including*:
Rivers, lakes and other natural water-bodies
Ditches and pools of grazing marsh and fen
Shallow water of springs and rills
Bare wet mud and peat
Saline habitats

For land likely to remain under agricultural use, *lowland wet mesotrophic grassland* and associated *ditches and pools* would be priority habitat types for restoration, whilst surviving *tall-herb fen, small-sedge fen and fen meadow* might be especially vulnerable to further drainage for agricultural purposes. The ITE research has focused on such farmed sites.

Wetland habitats - the central importance of hydrology

The composition of wetland plant communities may be influenced by a very wide range of environmental and management factors. However, it is arguable that the water-regime, expressed in terms of amount, seasonal distribution, and quality is fundamental to an understanding of wetland habitats and their dynamics. Approaches to wetland survey, and particularly to monitoring, must take the water-regime and its variation into account. To that end, the monitoring points should be characterised and selected on the basis of their water-regime - depth, table, and quality, each in turn affected by soil-type. Alternatively, where such hydrological characterisation is not undertaken in advance, monitoring sites may be chosen on the basis of other factors, and their hydrological regime typified *post hoc*.

Such a characterisation of the study area can be derived from a combination of immediate measurement and predictive modelling. Direct measurement may include the installation of dip-wells, piezometers, and water-level recorders, but locally may gain from historical records of levels in a water-management area e.g. stage-level records held by the Environment Agency (NRA and its water authority/company predecessors).

Techniques used to assess standing-water habitats e.g. drainage channels:

An approach to survey and monitoring might be as follows (see Mountford *et al.*, in press):

i. Classify each segment (e.g. 100m length) of the drainage channel network in terms of its soil-type (regional survey), or soil type and land-use (catchment study).

ii. Measure the total length of channel in each soil/land-use stratum, and allocate the recording effort in proportion to this "population" of channel segments.

iii. Use random pairs of grid co-ordinates to select sites in each stratum - survey points being in turn measured from (reasonably) fixed locations e.g. channel junctions.

iv. Measure out a 20m length of ditch, and list all species rooted in the water. Their abundance may be assessed in terms of a) visual estimates of percentage cover; and/or b) percentage frequency within a regular grid of cells. Species abundance should be separately assessed for the submerged, floating and emergent components of the vegetation - one species may contribute to two or all components.

v. Over the same 20m length, record the presence of species rooted on the adjacent channel banks: a) noting which bank(s) each occurs on; and b) estimating the maximum and minimum rooted height of each species above water level. These data may again be supplemented by either visual estimates of percentage cover, or percentage frequency within a cell grid.

vi. Measure channel width, maximum depth, freeboard (both banks), bank width and slope angle, water pH, conductivity, and percentage shade of channel from bank-rooted vegetation. Record evidence of management, supplemented with data from land-owner, IDB and/or EA/NRA.

vii. At each monitoring date, re-record all data categories (iv-vi).

viii. Install channel water-level recorders at a range of points determined by the drainage hierarchy (field-ditch to main-river), and to cover a range of drainage sub-units.

ix. Obtain continuous traces of water-levels for period of monitoring; and employ data-loggers where appropriate (e.g. to record automatic usage of pumps).

x. Use water-level data from sample points (viii) to characterise depth-regime at all botanical monitoring sites, including a) prediction of bank vegetation inundation; and b) exposure of aquatic vegetation to atmosphere.

Assess any changes in aquatic and marginal terrestrial vegetation in context of measured and predicted variation in water-regime

Techniques used to assess lowland wet grassland and tall-herb rich fen

1. Characterising the hydrological regime:

With terrestrial vegetation in fields or within blocks of fenland, linkage to water-regime may be achieved through the use of hydrological models which cover many lowland wetland situations (see Spoor *et al.*, 1996):

a) The "Youngs" two-dimensional model for land drained by surface channels with deep permeable soils (loamy peats etc.).
b) The "Cricklade" model for less permeable soils overlying a shallow aquifer
c) The "Ridge-and-furrow" model for slowly permeable soils with undulating micro-topography.

These models use data on meteorology, topography, spacing of water-bodies, water-levels in these bodies (present and historical), dip-well records, and soil-type, in order to predict the water-regime at any point within the block of land. The models may subsequently be validated at new sites through a network of dip-wells.

In this way, water-regimes can be derived for all sample positions that have been mapped and levelled. These regimes are expressed in terms of Sum Exceedence Values (SEV). The SEV are subsequently compared with the botanical distribution data derived from quadrats to generate tolerance ranges which reflect the ability of each species to compete under conditions of stress, due either to drought or lack of aeration.

"Total station" surveying equipment can be used to obtain levels for all the sampled points, enabling the exact monitoring positions to be re-located, and the quadrats to be set out more rapidly in subsequent years. Where a site has been subject to hydrological survey in advance of botanical assessment, points may be selected for sampling to cover a range of water-regimes, efficiently focusing any monitoring effort.

2. Monitoring the vegetation:

Intensive methods of the type advanced by UCPE etc. provide a highly accurate appraisal for a small area. Hence, where monitoring points have been selected on the basis of predictive modelling, the resulting small number of positions may be efficiently recorded using that type of approach.

However, the present technique applied to wet grassland and fen vegetation may equally use an assessment that is made over as large a spatial range as possible within the site, with many individual sample points for the flora. In this context, any loss of quantitative accuracy in a particular quadrat, is offset by accurate frequency information for many species, and better coverage of the hydrological, micro-topographic and floristic variation within the site. Monitoring points may thus be laid out in a dense regular grid, or in transects, with each position accurately spatially referenced. At each position, all species are recorded.. Simple presence/absence information may be sufficient, provided the number of samples is high. Alternatively, the recorder may use visual assessment of percentage cover (or Domin) or, where time allows, the use of a subdivided quadrat to provide frequency information. Such cover/abundance estimates supplement the distributional data.

The suggested approach links botanical monitoring to a major, and probably crucial, environmental factor, enabling ready interpretation of spatial patterns and trends in time. In addition, it allows accurate relocation of very many monitoring points, providing information on the range of botanical composition, and hydrological variation.

Acknowledgements

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Discussion

Dr A. Cooper - A lot of effort was put into recording hydrology, was general field management also recorded?

Mr O. Mountford - The sites that were used have a good record of field management.

Prof. P. Grime - The hydrology was used to stratify sites and hydrological variables were subsequently measured for the detection of change. Wouldn't it have been better if they had been kept apart? Also was sufficient note taken of other factors, so that unexpected changes could be properly understood?

Mr O. Mountford - Hydrology levels are constantly monitored, so that any unusual conditions are noted.

Dr J. Hopkins - How long did it take to conduct the fieldwork and analyse the data for Tadham Moor on the Somerset Levels?

Mr O. Mountford - To do 600 quadrats took 70 person days and the levelling took 2 days. The computer models already existed which meant that the analysis took only 5 - 10 days from the reception of data.

MONITORING METHODS FOR TERRESTRIAL SEMI-NATURAL VEGETATION IN THE UK ENVIRONMENTAL CHANGE NETWORK

Dr Terry Parr, ECN Co-ordinator, ITE Merlewood

Background to ECN

The Environmental Change Network is the UK's, recently established, long-term monitoring network. It undertakes integrated monitoring designed to identify and quantify environmental changes associated with man's activities, distinguishing man-made change from natural variations and trends, and giving warning of undesirable effects. ECN is operated by a consortium of 14 sponsoring organisations with an interest in land-use and the environment, and is managed by the Natural Environment Research Council.

The objectives of ECN are:

a. To establish and maintain a selected set of sites within the UK from which to obtain comparable long-term data sets by means of measurement at regular intervals of variables identified as being of major environmental importance.

b. To provide for the integration and analysis of these data sets, so as to identify environmental change and improve understanding of the causes of change.

c. To make these long-term data sets available as a basis for research and prediction.

d. To provide, for research purposes, a range of representative sites where there is good instrumentation and reliable environmental information.

ECN Sites

The UK has many sites with a long history of environmental data collection and repeated surveys. ECN has capitalised on this resource by selecting sites with known management histories, existing data and a background of environmental research. There are currently 11 terrestrial sites (ranging from small 2 km^2 intensively-managed lowland agricultural establishments to large, 65 km^2, semi-natural upland areas) and 38 freshwater sites. Each site is sponsored by a Government Department or Agency which is then responsible for the long-term management and monitoring of the site according to a series of strict protocols.

ECN Measurements

Standardised recording began at most terrestrial sites in 1993 and covers 11 sets of 'core' measurements on: meteorology, surface water drainage, surface water quality, atmospheric chemistry, precipitation chemistry, soil solution chemistry, soils, vegetation, invertebrates (moths, butterflies, ground predators and tipulids), vertebrates (rabbits, bats, common birds, moorland birds, frogs) and site management. Vegetation data and aerial photograph coverage are available for each site. Recording began at the freshwater sites in 1995.

The measurements relate to variables which are expected to be important in driving environmental change, and to ecosystem response variables which have been identified as being sensitive or responsive to such change. On terrestrial sites, some measurements are concentrated on a designated area of one hectare, the Target Sample Site (TSS), whilst others are more appropriately carried out on other, and often more extensive, areas or along designated transects.

Data are collected at each site according to standard protocols developed at the outset of the monitoring programme in 1992. Rigorous quality assurance procedures in data collection, data processing and data management have also been developed to ensure that the quality of the data is as high as possible.
Data from all sites are collected and maintained centrally by the ECN Central Co-ordination Unit at ITE, Merlewood. Data licensing arrangements have been agreed with the site sponsors, and over the next year it is planned to provide licensed users with access to summary data in the ECN database through a user-friendly interface on the Internet (http://www.nmw.ac.uk/ecn).

Vegetation monitoring at ECN sites

The aim of vegetation recording at ECN's terrestrial sites is to map and monitor change among semi-natural vegetation types. Recording is done to a standard protocol using standard recording forms, recording conventions and quality codes for vegetation records. The following sections are adapted from the ECN protocols which will be published later in 1996.

The two main features of vegetation recording in ECN are that (i) it is based on the objective recording of presence /absence of species and makes no use of more subjective cover estimates and (ii) change is assessed in permanently marked plots. The vegetation protocol has four main components:

- baseline vegetation mapping to characterise the vegetation at each site and provide the stratification for more detailed monitoring;
- coarse-grain monitoring at intervals of 9 years on at least fifty permanently marked plots;
- fine-grain monitoring at intervals of 3 years in the TSS and at least one location in each of the vegetation types identified by the baseline mapping;
- supplementary measurements on boundaries, linear features, woodlands, permanent grasslands and arable fields at whichever sites these measurements are appropriate. The additional monitoring of permanent grass and arable fields are not discussed in this paper.

Vegetation Mapping

A vegetation map is an essential pre-requisite for characterising the vegetation types of each site and monitoring change. If a map showing accurate boundaries is not already available, one is prepared using any available remotely-sensed imagery, land-use cover and NCC Phase I survey data, with ground-truthing of boundaries. The map is done at a scale of 1:10000 for sites up to 50 sq. km in extent, 1:25000 for sites over 50 sq. km.

An approximately regular grid, aligned with the National Grid, is superimposed on the site map, scaled so as to provide approximately 400 sample grid positions. The purpose of the grid is to provide unbiased, re-locatable plot locations. If a site includes short-term leys and arable areas or experimental plots likely to be subject to changing management over the duration of ECN, these are excluded from subsequent survey. Remaining grid positions, falling within semi-natural vegetation, permanent grass and conifer or broadleaf plantations, are used for characterising the vegetation, together with additional randomly-located sample positions placed in other distinguishable vegetation types unrepresented or under-represented on the grid. There should be at least two sample points in such additional vegetation types, with no more than 100 in total. Hence, a maximum of 500 sample positions are used for characterising the vegetation.

A 2m x 2m plot is centred on each grid and infill point. A species list of all vascular plants, bryophytes and lichens, except those growing on rock or wood, is recorded using Tutin et al. (1964 et seq.), Corley & Hill (1981) and Purvis et al. (1993) as standards for nomenclature. Where points fall in woodland or scrub, trees and shrubs in a surrounding 10m x 10m plot, are listed separately.

Vegetation types are named by reference to The National Vegetation Classification (Rodwell 1991 et seq.) which provides a comprehensive national coverage of all British semi-natural vegetation, improved grasslands and plantations and is compatible with the EC CORINE Biotope Classification. Samples are allocated to NVC vegetation types individually or in groups characterised from the data using a multivariate classificatory technique like TWINSPAN.

Coarse-grain vegetation monitoring (every 9 years)

Coarse-grain monitoring is done at intervals of 9 years on at least fifty permanently marked plots, each 2 m x 2 m and divided into 25 cells (each 40cm x 40cm) in which are recorded the presence of plant species and of bare soil, rock, litter or open water. All vascular plants rooted in each cell are recorded, with the exception of those growing on rock or wood; non-vascular plants should be recorded in the same way but in three groups, Sphagna, other bryophytes and lichens. The presence of bare soil, bare rock, litter, dead wood or open is recorded in the same way.

For each 2m x 2m plot, altitude, slope, aspect, land use and slope are noted (using the terminology of Hodgson 1974) and also biotic or treatment effects such as grazing and browsing, trampling and dunging by stock or wild herbivores, burning or disturbance.

Fine-grain vegetation monitoring (every 3 years)

Fine-grain monitoring is done at intervals of 3 years in 10m x 10m plots in the TSS and at least one location in each of the vegetation types established as a result of the earlier vegetation characterisation exercise. In each plot, ten randomly-selected 40cm x 40cm cells are used for recording the presence of all species of vascular plants rooted in the cell (apart from trees and shrubs), bryophytes and lichens, except those growing on rock or wood. The cells are permanently marked and recorded on each occasion.

Additional coarse-grain monitoring in woodland (every 9 years)

Where grid and infill samples fall in scrub or woodland, a 10m x 10m plot, centred on the 2m x 2m plot is also used for recording trees and shrubs. Tree and shrub species are listed, with a note on whether they are represented as canopy dominants, sub-dominants, intermediate, suppressed, shrub layer, saplings or seedlings. Ten cells, each 40cm x 40cm, are selected at random and then marked, for relocation. The diameter at breast height (dbh) (1.3m above the ground, measured to the nearest 0.1cm with a tape) and height (measured to the nearest 0.5m using a hypsometer or poles) of up to ten trees or shrubs of >5cm dbh is recorded. Seedlings are counted by species and then individually marked.

Forest health is assessed using UN-ECE guidelines (Forestry Commission Field Book No 12. Assessment of Tree Condition: HMSO 1990). Assessment should be carried out annually and arrangements are being made for this to be conducted by the Forestry Commission.

Additional monitoring of vegetation boundaries including hedgerows (every 3 years)

Having defined the boundary to be sampled, one or more transect lines are selected at random and laid out at right angles to the boundary. Permanently marked cells of 40cm x 40cm are located at regular intervals along the transect line as closely spaced and extending as far on each side of the boundary as required. All species of vascular plants rooted in the cell, bryophytes and lichens are recorded. Where boundaries shift, the transect line and number of cells will be extended accordingly.

Where a hedgerow is sampled, species composition of a 10m length of hedge, generally accepted as the standard length for hedgerow recording, is recorded. The sample is centred on the transect line used in 7.1/7.2, ie taking a 5m length of hedge on both sides of the transect line. Woody species occurring in the whole width of hedge are listed.

Workload

Since the size and character of the ECN sites, and the amount of existing remotely-sensed, cartographic sand survey data are so variable, it is difficult to estimate the time needed to prepare a basic vegetation map. Estimated times for the collection of initial plot records for characterisation of the vegetation types and for subsequent monitoring are as follows. Estimates are based on an initial array of 500 plots (400 grid + 100 infill), and make some allowance for walking-time and bad weather.

Initial recording	30 mins/plot	10 weeks	year 1
Location & marking of monitoring plots	30 mins/plot	2 weeks	year 1
Coarse-grain monitoring	1 hour/plot	4 weeks	years 1,10,19 etc.
Fine-grain monitoring	1 hour/plot	4 weeks	years 1,4,7,10 etc.
Woodland monitoring	½ day/plot	2 weeks	years 1,10,19 etc.

Estimated times required for additional monitoring of hedges and field margins are as follows:

Initial plot establishment	15 days/year
Boundaries	15 days/year

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Purvis, O W, Coppins, B J, Hawksworth, D L, James, P W, and Moore, D M (1993). Lichen Flora of Great Britain and Ireland. London: Natural History Museum.

Rodwell, J S editor (1991 et seq). British Plant Communities. Cambridge: Cambridge University Press.

Tutin, T G et al (1964 et seq). Flora Europaea. Cambridge: Cambridge University Press.

Discussion

Dr A. Cooper - ECN site are not necessarily representative. Do you intend to explore the possibility of increasing their number?

Dr T. Parr - The ECN considers all the biogeographic zones and has sites in most major meteorological and soil zones. However, the main constraint on the number and distribution of sites is finding sponsors to fund them. It is not financially viable to get a statistical coverage of the whole of Great Britain.

Dr A. Stott - Is management recorded at ECN sites?

Dr T. Parr - Yes. Site managers are asked to send in management records.

Dr A. Cooper - How do you account for major changes which are not due to environmental change?

Dr T. Parr - All of the site are managed by agencies and because they are already long-term study sites, we know that major changes have not occurred: changes have been more gradual.

Mr R. Cummins - When looking for long term change, is annual variation a problem?

Dr T. Parr - When looking at the results after 30 years, annual fluctuations should not be a problem. However, after 12 years it will be difficult to say whether any changes are part of a major change or part of some kind of cycle. Annual monitoring (of vegetation) would make it easier to pick up major changes, but this is not financially viable.

THE BSBI RECORDING SCHEME: PART I - PAST AND PRESENT RECORDING PROJECTS

Dr Trevor Dines, Atlas 2000 Principle Organiser, Bangor

Introduction

The Botanical Society of the British Isles has been collecting data on the distribution of vascular plants since it began in 1836. Since the war, it has been responsible for three major recording projects - the Atlas of the British Flora, the Monitoring Scheme and the Scarce Plants Project. It is currently undertaking a fourth, the Atlas 2000, which was officially launched only yesterday (April 16th 1996). This exciting new project aims to produce an updated *Atlas of the British Flora*, drawing on records in the Vascular Plant Database at the Biological Records Centre, Institute of Terrestrial Ecology.

Before discussing this project, I will briefly describe the previous three projects, examining what they aimed to do, what they achieved and how they have influenced our approach to the Atlas 2000.

The Atlas Of The British Flora

The *Atlas of the British Flora* was first published in 1962. Its aim was to illustrate the distribution of vascular plants in Britain and Ireland through the use of dot-maps. To achieve this, it drew on existing records, and topped these up with a period of intensive fieldwork between 1955 and 1959. In order to collate the records, a system of vice-counties was implemented, with one person in each vice-county responsible for the collection and verification of records. This successful system still operates today and is the central facet of BSBI recording. A second legacy of the *Atlas* is the use of the hectad (10 km square) as the principle unit of measurement in this type of survey. Although this method has its limitations, it has proved both reliable and robust when providing an indication of species distribution at a national level.

The Monitoring Scheme

By the late 1980's, it had become apparent that the existing *Atlas* had become seriously outdated, despite its reprint in 1982. The need for a less intensive, more organised and, most importantly, repeatable survey of the flora was also recognised. The BSBI Monitoring Scheme was established in 1987 to provide this baseline for future monitoring. It also allowed a comparison of the current situation with that before 1960 (the *Atlas)* and gauged the need for a new *Atlas*.

The scheme selected 1 in 9 hectads on a regular grid across Britain and Ireland. Within each hectad, three tetrads (2 km squares) were selected (A, J and W). These were intensively surveyed at least 3 times during the 2 year duration of the Scheme and the resulting records, just under 1 million, were entered into a database.

The scheme was very successful in obtaining a baseline for future monitoring, taking a 'snapshot' of the state of the British and Irish flora in 1987 and 1988. Its greatest strengths are its highly organised sampling structure and its repeatability, not only for plant monitoring but for other groups as well (the same grid squares, for example, were sampled by the British Trust for Ornithology). It also illustrated just how important recording biases are in the collection of data. This bias depends on the skill and particular expertise of the recorders, the time and route taken while recording, and the accessibility of different habitats. For example, 2 squares in Ireland were recorded by 2 groups. The first group recorded 249 species, the second 340. Only 56% of these were common to both surveys, the total number of taxa recorded being 379. Such errors arise because sampling within each tetrad was unstructured - recording areas within the square could be selected at will. Additionally, many tetrads were poorly recorded because there were insufficient resources to cover them comprehensively. Recorders should have been advised that, if this was the case, they should have visited only squares A and J, for example. Without more specific instructions like this, such schemes will always produce highly variable results.

A comparison between the Monitoring Scheme and the Atlas proved difficult, mainly because the two surveys were designed for different purposes and had different aims. 1 in 8 Monitoring Scheme records, for example, did not match an Atlas record and many Scarce and Red Data Book species went unrecorded. Any extrapolation of the results to give an indication of the national status of these species proved very unreliable. This was due to the aforementioned recording biases and also to the fact that the Scheme only sampled a small part of the total area of Britain and Ireland for a 2 year period, intrinsically limiting any attempt at illustrating national distribution.

The Scarce Plants Project

The next recording scheme undertaken by the BSBI responded to the need for a more thorough investigation of Scarce Species, those plants recorded from between 16 and 100 hectads nationally. Plants recorded from less than 16 hectads, the Red Data Book species, had been monitored for many years, work which is now being continued by the JNCC. The aim of the Scarce Species Project was to produce a database reflecting the Status of such species as they stood from 1970 onwards and to gather sufficient pre-1970 records to indicate their pre-1970 distribution. 1970 was chosen as a cut off date so as to obtain up-to-date information with maximum geographical and taxonomic coverage. Existing records from the original Atlas were computerised to produce vice-county scarce species lists. These lists were circulated to the vice-county recorders, who then verified and updated the records. A new Scarce Species list was then prepared and distributed to all members of the BSBI. Records were again verified and updated by the members, with a final list of 254 species being produced from a total of 167,500 records. This project was important as it illustrated in detail just how out of date the current *Atlas* is. Many species were recorded from more hectads than the Atlas, while a few were recorded from less and therefore qualified, unfortunately, as new Red Data Book species. Most important, however, was the marked change in distribution of many species since the 1970's. Where applicable, time sequence dot-maps were prepared to illustrate these changes (e.g. *Mentha pulegium).* Although dot-maps showing species distribution were used again, it was recognised that *plant frequency* is equally important. For the first time, an idea of frequency was given by illustrating the number of tetrads within each hectad a given species was recorded. This was done for about 70 species (e.g. *Carex rupestris)* and provided valuable additional information.

The Atlas 2000

The need for a new, up-to-date and comprehensive *Atlas* has become indisputable. In 1995, funding was secured from the DoE for the Institute of Terrestrial Ecology to undertake this exciting new project. The collection of records has been sub-contracted to the BSBI, and will result in the publication of the *New Atlas of the Flora of Britain and Ireland*, or *Atlas 2000* as it has become known (we aim to complete it for publication in the year 2000).

The Atlas 2000 aims to map all native and alien taxa that are given an account in Stace's *New Flora of the British Isles*. This flora is the first scientifically rigorous Flora since 1952 and covers many subspecies, hybrids and aliens for the first time. As the total number of taxa now stands at around 3500, many of which are considerably difficult to identify, you can begin to appreciate the scale of this project.

It will cover the whole of Britain and Ireland and will use existing records in the Vascular Plant Database at Monks Wood. These include records from the Red Data Book, the Scarce Plants Project, the Monitoring Scheme, the original Atlas and several additional datasets from recent surveys, such as one of aquatic plants and one on *Rosa* for the new Rose identification handbook. Many new records will also come from the considerable number of county floras. These are often tetrad floras that were stimulated by work on the original *Atlas*.

The database will be substantially bolstered, however, by records collected through intensive fieldwork over the next 4 seasons. This fieldwork will be targeted to known areas of under-recording, assessed on data from previous surveys and on a recent vice-county questionnaire. To aid BSBI members in the project, an 'Instruction Book' and a 'Guide to the Identification of some Critical or Difficult Species' have been produced. These were circulated with the launch of the scheme in our newsletter today. Throughout the scheme we also hope to add many records from herbaria and from the results of survey work by other organisations such as the Countryside Agencies, the RSPB and the Wildlife Trusts.

Three date classes have been selected to fully illustrate recent changes in distribution. These are pre 1970, 1970 to 1986, and 1987 onwards. This latter date class is designed to include data from the Monitoring Scheme, and we hope to have complete coverage of all hectads for this class, although post 1970 records will be acceptable for upland areas. Records will again be collected and presented on a hectad basis, although we ask for more detailed information on Rare and Scarce species. However, unlike the original Atlas, all hectads will be treated separately - small areas of land will not be amalgamated with neighbouring squares. This practice was one recommendation to come from the Monitoring Scheme and has resulted in a 'squaring-off' of most vice-counties. Not only does it improve the quality of the data, making it more robust in statistical analysis, but it also simplifies the task of record collection on vice-county boundaries.

As with the Scarce Plants Project, we hope to provide frequency maps of certain species. However, these will now be based on a new method of statistical analysis that incorporates a large proportion of Monitoring Scheme data, the first time such data will be used. As you can see, there are obvious reasons why such attractive maps are useful.

As in previous schemes, the lynch-pins of the project will be our network of vice-county recorders. They will co-ordinate record collection at the local level and be responsible for passing records on to Monks Wood. This task is obviously easier if data is transferred on computer disk, and so, to assist them in this, the BSBI are undertaking an exciting program of computerisation. To tell us more of this, I will now hand over to the BSBI co-ordinator, Cameron Crook.

THE BSBI RECORDING SCHEME: PART II - COMPUTERISATION OF RECORDS

Cameron S Crook, BSBI Co-ordinator, Lostock Hall, Preston, Lancs

Introduction

It has been estimated that the number of records held by the Biological Record Centre (BRC) is in the region of 3.5 million The number of records held by BSBI through its network of VC Recorders however, is estimated to be in excess of 100 million. Traditionally, this vast amount of information has been kept as manual record cards whereas those at BRC are held on a Computerised Database. It has been recognised by BSBI that the flow of data between vice county recorders and BRC needs improving. This has become significantly more important in light of the New Atlas and planned updates to the Scarce Plants project for instance. It is for these reasons that BSBI decided to break with tradition and enter into the world of technology.

Computerisation of Vice County Recorders

The first step down the road of computerisation of VC Recorders was to send out a questionnaire to find out how many Vice County Recorders were computerised, what software was used, what methods were used to transfer data and how many wanted to be computerised who weren't already so endowed. The results indicated a large number of different software packages in use amongst those currently with computers and a majority of non computerised VC Recorders wanting to become computerised one way or another. In all, of those who replied to the questionnaire, 73 (out of a total 138 VC Recorders) have, or will soon have, their records on computer, and of those, 44 want a recommendation for suitable software, the remainder being happy with what they have got. A further 18 would like to become computerised and 20 more VC Recorders want their records kept on computer by a third party. The latter would be achieved by a setting up a network of Computer Link persons whose role will be to keep records on behalf of one or more VC Recorders. Only five of those Vice County Recorders who replied to the questionnaire did not want their records computerising.

Botanical Records on Computer

The 100 million + records held by BSBI (roughly 63,000 per Vice County) would, if stored on a computerised database, require in the region of 1.6-2.0 Gb* memory if stored as *Relational Data* using *Variable Field-Length* Software. Somewhat more would be needed for *Non-Relational Data* (e.g. ASCII Flat File) ~1.9-2.3 Gb which highlights the importance of the software chosen for the task. This equates to less than 15 Mb** of computer memory per Vice County, well within the capacity of the average Personal Computer. Of course there are both pros and cons with keeping records on computer. The advantages of computerised record holding are:

1. *Compact Storage:* with current technology, the whole 2.0 Gbytes of data required to hold all BSBI's data-set could be feasibly held on one Personal Computer.
2. *Improved Flow of Data.* Importing/exporting data on disc is immensely quicker and less labour intensive than on record cards.
3. *Quick Searching and Reporting.* Reports or species lists can be produced, literally, in seconds.
4. *Easy Management of Data.* Data can be sorted by numerous criteria, updated and erased with ease.

On the negative side:

1. *Verification of Records and Errors.* Erroneous records can slip through the net without being verified although with strict data checking and filtering routines this can be avoided.
2. *Loss of data.* This can be due to a number of factors but perhaps most infamously through computer virus infection. Regular and routine scanning of data reduces the risk of this and regular back-up of data reduces the incidence of losses by other means.
3. *Time Entering Data.* When dealing with vast amounts of data, it can be very time-consuming entering it onto computer. However, the effort more than pays off in the end.
4. *Cost.* Computers are more costly than paper and filing cabinets (but have many more uses).
5. *Coping with New Technology.* Many BSBI VC recorders are totally new to computers. But, with training and support, this can be overcome.

*1 Gigabyte (Gb) = 1.024^{09} bytes
**1 Megabyte (Mb) = 1000 kilobytes or 102400 bytes

Suitable Software

On the whole the advantages outweigh the disadvantages. But if data is to be entered onto computer, managed and extracted as required, it is necessary to have the most suitable software for the job. Therefore, a set of specifications for such were drawn up. To be suitable for use in storing botanical (or other such data) software must be:

1. User-friendly and Reliable.
2. Compatible between users of other software and that used by BRC (Oracle).
3. Relatively inexpensive.

4. Capable of running on older PCs if necessary.
5. Based on a fully Relational Database.

Specifications based on these criteria were sent out to a number of developers and ultimately, a list of three suitable packages were chosen and subsequently recommended to VC Recorders.

1. *Recorder*, developed by JNCC, probably the most comprehensive biological recording software available but too complex for some BSBI users.
2. *Aditsite*. An easy to use, powerful, windows based database, based on Microsoft Access, developed for use by BSBI.
3. *ERICA*. A comprehensive DOS based package specifically modified for BSBI by the Cornish Biological Records Unit.

Data Flow and Standards

This software will be supplied to VC recorders according to their individual requirements. However, there are a number of VC Recorders and other BSBI members with other software which they have no desire to change. These range from full commercial database management systems such as Paradox to small packages written by the user and even word processors used to store ASCII files! For this reason, Data Transfer Standards were drawn up to ensure that no matter what software is used, the same data, in the same format is produced.

Briefly, the BSBI Data Transfer Standards require that:

1. Same Data Fields are utilised with the same maximum lengths.
2. Same format adopted for transfer of data on disc (i.e. IBM compatible 3.5 inch floppy, Delimited ASCII etc.).
3. The preferred Data Flow Route is followed.

Ideal Data Flow would be seen as:

1. Field Recorders to VC Recorders (Record Cards or floppy disc)
2. VC Recorders to BRC (Electronic - floppy disc or e-mail)
3. BRC to VC Recorders for verification (Electronic - floppy disc or e-mail). This is necessary to verify data sent in by other routes than VC Recorders.
4. Back to BRC on Disc after checking.

Of course this will not always happen in practice, but it is an ideal to strive for.

Conclusion

In conclusion, by computerising data and following specific guidelines such as these, the flow of data collected during projects such as the new Atlas of the British Flora or Scarce Plants projects will be vastly improved and this should go a long way towards BSBI's contribution to the aims of the Biodiversity Steering Group Report.

[There was no time for discussion following the last two presentations]

ENVIRONMENTALLY SENSITIVE AREA (ESA) MONITORING IN ENGLAND

Nigel Critchley, ADAS Newcastle, Kenton Bar, Newcastle upon Tyne

Introduction

In England, 22 Environmentally Sensitive Areas (ESAs) were designated between 1987 and 1994. One of the principal aims of the scheme is to arrest the decline in the wildlife conservation value of land which happens as a result of either intensive agricultural management or neglect. Thus the selection of areas was dependent on both their value and the threat of deterioration. The scheme functions by encouraging farmers to use lower inputs than would normally be employed in intensive agricultural management, or to re-introduce management where it had been withdrawn. This is done by requiring them to adhere to sets of management prescriptions in return for compensatory hectareage payments. These prescriptions are common to all land for which management agreements within a particular ESA are established, although varying levels of input (Tiers) attract different payments. Since 1987, the aims of ESAs were also extended to further the enhancement of wildlife conservation value at some sites. Botanical monitoring schemes have been established in all English ESAs. The objectives are to assess the success of ESAs and to provide information to assist with improving management prescriptions. The most widespread habitat types in these ESAs are enclosed and unenclosed grasslands (containing a wide range of plant communities). Concentrating on these, this paper outlines 1) the methods used to collect field data and 2) how these data are used to assess the success of ESAs.

Field methods

In the first ESAs, a method was used based on the recommendations of Smith *et al.* (1985). Within each enclosed field in the sample, five 2 m x 2 m quadrats were located systematically on a transect, and permanently marked with underground metal pipes. In each, a 1 m x 1 m quadrat was located centrally and from this, presence of plant species and visual estimates of their cover on the Domin scale recorded. Surveys have been done three times during the period 1987/8 to 1994/5. Although satisfactory results have been obtained, it was recognised that there was potential for making improvements on this method which was adapted from descriptive survey (as opposed to monitoring) techniques. In particular, to reduce observer variation to satisfactory levels, field botanists were required to work together in pairs, thus increasing resources required. To this end, a new method was developed for later ESAs, taking into account observer precision, the theoretical requirements for botanical monitoring, and the work being done concurrently by others.

An experiment was set up to investigate observer consistency in recording the presence of species in quadrats and estimates of their abundance, and to compare precision for different estimate types, for different species and for species groups. At 14 sites with a range of plant communities and vegetation structure, a total of 17 experienced observers were used in a replicated, blocked design. Species presence/absence, subjective cover estimates, local frequency and nested quadrats (adapted from Hodgson *et al.* (1994))were compared using a range of quadrat layouts and sizes. There was significant bias between observers for records of species presence/absence, and fewer species were recorded from open quadrats than gridded quadrats. For quantitative estimates, bias between observers was detected and consistency was always poorer for cover than frequency, while nested quadrats had better consistency. Intra-observer variation was also high but less so, with cover again performing less well than frequency.

Species occurring at low abundance were less likely to be found using cover or frequency quadrats than nested quadrats. Precision was slightly better for dicotyledons than monocotyledons, for rosette species than semi-rosette or leafy species, and for species with potential for greatest lateral spread. Precision for individual species did not exactly match that expected, and is likely to vary with site characteristics. It was concluded that presence/absence in open or gridded quadrats, cover and local frequency estimates did not give sufficient precision in grassland if observers are required to work alone, that nested quadrats showed more promise as the basis for a monitoring method, and that limiting records to certain types of species is unlikely to improve precision by much.

Because there is often some confusion as to the merits of fixed versus non-fixed quadrats, we find the concept of the fixed unit useful. Monitoring is dependent on repeated observations, so it always makes use of fixed units. A fixed unit is typically a whole site or field, or a fixed quadrat. Within the fixed unit, observations may consist of a complete search of the area (a census, as is normally done within a fixed quadrat) or of a sample of sub-units (for example a sample of non-fixed quadrats within a field). A second useful concept is that conventional recording methods all measure species abundance (and distribution) in essentially the same way. They are all based on counts of species presence in sub-units of the fixed unit. The key difference between them is the size of the sub-unit, i.e. variation in scale. For example, cover (whether estimated by eye or using a point frame) estimates species presence in (theoretically) infinitely small sub-units, frequency uses sub-units of a more tangible size, and presence/absence is where the fixed unit and sub-unit are the same size giving a maximum count of one.

Within a fixed unit, plant species occur at a range of scales and patterns. Methods which record at a single scale or sub-unit size are thus less likely to be capable of detecting changes than those which use a range of sub-unit sizes. Hence a method such as nested quadrats will be superior to more conventional methods. The size of the fixed unit itself will determine whether data for individual species are likely to be collected, but above a certain size it becomes impractical to census all sub-units.

The method designed for ESA monitoring comprises a fixed unit (called a stand) which is a rectangular area of 32 square sub-units (nests) in an 8 × 4 grid. Each holds a series of cells of increasing size (adapted from the nested quadrats of Hodgson *et al.* (1994)). The cell sizes form an approximate geometric series, with each successive cell doubling in area. The exception to this is the smallest "cell", which is in fact a single point, defined by a pin located in cell number 2. Within a monitoring programme, a number of stands of constant size are used. The size is chosen to reflect the overall scale of the vegetation and is usually a compromise between being large enough to encompass the majority of species present, and small enough to be managed within available resources. The most commonly used size is 8 m x 4 m. The number of nests and the cell sizes remain constant for all stand sizes, so it is the number of cells per nest that varies with stand size. In each nest, the first hit only of the point is recorded, followed by presence of all species rooted in cell 2, and each subsequent cell is searched in turn for additional species not already recorded. Stands are positioned in randomly selected positions in unenclosed land. In enclosed fields, a single stand is located randomly on a field diagonal. Because stands are fixed, and are sized such that a complete census of each can be carried out, there is no sampling error within a stand. Using data from surveys in 1993 and 1995, it has been demonstrated that fewer changes in plant species frequencies can be detected at any single scale than at the optimum scale for each species. The optimum scale for detecting change is defined as the scale where a species' frequency in the first year of survey is closest to the mid-point (i.e. 16). This provides the greatest capacity for detecting change in either direction.

Use of field data

The same principles have been applied for both the NCC quadrat method and the newly developed ADAS method, but the former is used here to illustrate the approach used. Because different plant community types show different responses to the same management, it was necessary to analyse them separately. Quadrats were classified using TWINSPAN (Hill, 1979) and the variation within and between end-groups assessed within the framework of the National Vegetation Classification (NVC) (Rodwell, 1991 *et seq.*). In ESAs, the aim of monitoring is to test whether their objectives are being met. Generally, for a defined vegetation type, these are to maintain, and in some cases enhance, its value. More specifically, vegetation of high conservation value is normally that associated with the environmental conditions which result from low intensity agriculture. Hence, the field data were used to measure the extent to which the vegetation contained species suited to these conditions. Each component of the management prescriptions was addressed. For example, for a particular vegetation type the proportion of species suited to moderate levels of grazing, low nutrient availability and high water levels could be measured in turn. The criteria by which the success of the ESA was judged were the extent to which each group of species was present. To determine the status of species, autecological data were compiled from various sources including Hodgson *et al.*. (1995), Ellenberg (1988) and Fitter & Peat (1994) to construct a species-attribute matrix. Rules were then formulated to select species with sets of attributes commonly associated with the specified environmental conditions. For example, species suited to grazed conditions ("suited species") might be characterised by the nature of their canopy structure, potential canopy height and life history. Once established, rule sets were applied objectively to the matrix to ensure a consistent and repeatable approach. For each criterion, a "suited species score" was calculated for each quadrat, which was the proportion of suited species present. Differences between scores were analysed using Generalised Linear Modelling and significance testing by randomisation tests. Additionally, it has become possible to ascertain the expected scores for different NVC community types, which can be used as target values either to be maintained or to aim towards.

Acknowledgement

I wish to thank Simon Poulton, Graham Myers, Simon Smart and many other colleagues who collaborated in this work.

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Discussion

Mr A. Brown - Using the methodology described how do you prevent extensive trampling of delicate plant communities and, secondly, are there spatial autocorrelation problems using such a block of contiguous nested quadrats?

Mr N. Critchley - Trampling might be a problem especially on wet soils but this probably matters little in an agricultural grassland situation. Also the recording technique used in the field tries to ensure that the surround of each quadrat is only trodden on once. This technique is not recommended in delicate communities such as sphagnum mire which could be damaged by trampling. Auto-correlation had to be taken into consideration.

THE 'COUNTRYSIDE SURVEY APPROACH'

Caroline Hallam, ITE Merlewood

Introduction

The 'Countryside Survey approach' refers to a methodology developed by ITE's Land Use Section, for a sample-based national survey of land cover and vegetation, as carried out in 1990 (Barr *et al.* 1993). It is designed to assess botanical status and change at a landscape level. The survey approach is aimed at the countryside in general, most of which is intensively managed, rather than concentrating on the less common semi-natural habitats.

This approach incorporates the use of the ITE Land Classification system (Bunce *et al.* 1996) as the sampling framework, the choice of the 1km square as the sampling unit, and two basic data recording techniques : (a) mapping land cover in the whole of each 1 km square to provide national estimates of land cover categories, as well as spatial data for analysis of pattern; and

(b) sub-sampling the 1 km square with permanently marked quadrats to give a more detailed record of change in the type and quality of vegetation.

Historical development

The methods used in the Countryside Survey approach have been developed, tested and refined during the course of a number of projects:

Year of survey	Survey Title	Scope of survey	Land Cover Mapping	Quadrats
1971	Woodland Survey	NCR woodlands in GB	No	16 randomly-located $200m^2$ plots per wood
1974	Cumbria Survey	Cumbria	No	8 or 16 randomly-located $200m^2$ plots per square
1977/8	Ecological Survey of Britain	GB : 256 squares	Land cover and boundaries mapped and allocated to descriptive categories	5 randomly-located $200m^2$ plots per square, plus 6 $10m^2$ linear plots on hedges, streams and verges
1984	Ecological Survey of Britain	GB : 384 squares	Land cover and landscape features mapped and described using standard codes	None
1990	Countryside Survey	GB : 508 squares	Land cover and landscape features mapped and described using standard codes	As 1978 plus 11 additional linear plots, and 5 plots targeted at less common habitats
1992	Key Habitats Lowland Heath Survey	England and Wales	Land cover and boundary features described at 25 points on a grid	$4m^2$ plots recorded at grid points
1993	Key Habitats Calcareous, Coastal and Upland Surveys	England and Wales	Land cover and boundary features described at 16 points on a grid	Plots recorded at grid points, plus additional linear and targeted plots.

Objectives

The Countryside Survey approach has been devised to meet the objectives of national surveys. For example, the objectives of the 1990 survey were:

> 'to provide information on the stock of land cover, landscape features and habitats of GB in 1990, to identify change in these by reference to earlier data, and to establish a new baseline for the measurement of future change.'

There are two main principles influencing the Countryside Survey approach :

1. The techniques used must be objective and quantitative; they must be capable of being applied consistently by different surveyors, and must be reproducible over time, in order to allow the statistically reliable estimates of stock and change.

2. The sampling strategy must provide a representative sample for GB, to provide national estimates of land cover types with measures of reliability This requires a large number of sample sites. The ITE national surveys aim to cover the 'wider countryside' and are not expected to provide data on scarce habitats or rare species. In this, they differ from many other monitoring projects which involve a more intensive site-specific approach.

Sampling strategy

1. **The sampling unit** : the Countryside Survey Approach uses the 1 km squares of the OS National grid as its sampling unit. This is a compromise between 10x10 km blocks which include too much variation, and smaller units e.g. quarter km squares, which may be misclassified because they include too little information about their surroundings. The 1 km square is convenient because many environmental datasets are held on this basis.

2. **Site selection** : the sampling framework is provided by the ITE land classification system which divides GB into 32 strata or 'land classes' based on a wide range of environmental parameters. Within each land class, squares for field survey are selected randomly from squares at the intersection of a 15x15 km grid. This provides an efficient method for sampling features which are likely to be associated with underlying environmental characteristics, and for producing national estimates.

3. **Number of survey squares** : in 1978, 256 squares were recorded by the field survey, 8 from each land class. In 1984 this was increased to 12 per land class, 384 in all. In 1990, the sample was further extended to 508, with the additional squares being allocated to provide a sample more proportional to land class size. The squares recorded in previous years have been repeated in subsequent surveys; this provides more reliable information on actual changes than the use of estimates based on separate samples, as well as indicating what has changed to which land cover category.

Mapping of land cover and landscape features

In 1978, land cover was recorded by allocated each parcel of land to one of 79 categories. In 1984, there was more emphasis on land use and land cover. The mapping exercise was undertaken in more detail with parcels of land, linear and point features being mapped and described in detail using lists of standard codes. In addition to a broad land cover category, parcels of land were described in terms of dominant species and use, and boundaries in terms of component parts, height and condition. Spatial data was recorded on 5 maps (1:10,000 enlarged) covering physiography, agriculture/semi-natural vegetation, forestry/woodlands/trees, boundaries, and built environment/recreation.

In 1990, this approach was continued with the addition of some extra standard codes at the request of the Forestry Commission (on woodland condition) and Countryside Commission (on footpath condition). Aerial photographs were obtained to improve the accuracy in mapping landscape features and vegetation boundaries which were not shown on the OS maps.

The 1984 and 1990 surveys provide very detailed information which can be used at a variety of levels, including aggregation up to 58 land cover categories. This system of land cover description differs from habitat classifications produced by other organisations, e.g. the NCC Phase I and CORINE system. However the 'Comparison of Land Cover Definitions' project commissioned by DOE has provided a means of comparing various classifications

In the 1992/3 surveys, the Countryside Survey approach to mapping land cover was adapted to provide a quicker procedure for the Key Habitats project. In this case, estimates of land cover categories were required, but there was no need for spatial data. Rather than map the whole square, land cover was recorded at 25 points on a grid, each point representing 4 ha. This approach was tested in a pilot study and was found to be reasonably accurate for the prediction of the most extensive or widely distributed land cover types, but poor for rarer types or those with limited geographical distribution.

Quadrats

More detailed information on vegetation has been obtained by recording the presence and cover of plant species in quadrats. The Countryside Survey approach is based on the use of randomly-located quadrats to provide a representative sample which can be analysed statistically to describe the relative proportions of different vegetation types present as well as change in vegetation over time. These randomly located plots were only moved where they crossed a vertical boundary such as a hedge. There was no attempt to place them in homogenous vegetation units, since their purpose was to record vegetation as it is, ie. including a pattern of micro-habitats and transitions, not to record vegetation types as recognised in an existing classification. All classification of the quadrat data has been done statistically post-survey.

The use of nested $200m^2$ quadrats began in 1971 when used in an ITE national woodland survey. Large quadrats were considered most appropriate for describing different woodland types. They were used again in 1974 in the Cumbria Survey for recording fields and moorland, where they were thought to be more representative than smaller quadrats. It has been found that large quadrats with longer species lists are less likely to be misclassified due to insufficient species data. They are also more robust for recording change, since there is less impact if there is a small difference in plot location.

In the first national survey in 1978, five $200m^2$ quadrats (Main plots) were recorded in each survey square, along with two $10m^2$ linear plots on each of hedges, verges and streamsides. The number of plots was constrained by the time available for recording each square. Subsequent work has shown that five $200m^2$ plots will cover the main types of vegetation present in most squares, but not the smaller fragments. Because between-square variation is greater than within-square variation, it has been considered more important to increase the number of squares surveyed than to record more plots within squares.

In Countryside Survey 1990, the 1978 plots were recorded again to provide information on vegetation change. The survey was expanded to include both more squares and more plots within squares. Analysis had shown that much of the botanical variation, especially in lowland squares is associated with the linear features, so an additional three plots were recorded on each of streamsides and verges, plus an additional five boundary plots on the field boundaries nearest to the Main plots, to assess the field margins. The NCC wished for more information on the less common habitats occurring in the wider countryside, and so initiated a further five $4m^2$ plots (Habitat plots) in each square which were targeted at the habitats recorded by the land cover mapping but which had not been sampled by the randomly-located plots. Because these plots are not randomly-located, they can be used to indicate the presence of these subsidiary habitats, but not their prevalence. Altogether, this made a maximum of 27 plots in each square, to describe the vegetation present in 1990 and to provide a base-line for future monitoring.

All quadrats recorded in 1990 were permanently marked to allow more accurate location in future. This involved burying metal plates, sketch maps with bearings and measurements, and photographs. Permanent marking techniques have been further refined in the subsequent Key Habitat surveys.

Data Quality

Prior to the 1990 survey, ITE commissioned independent consultants (Ecological Surveys, Bangor) to assess the recording methodology and to produce recommendations to reduce observer differences. This led to decisions to permanently mark quadrat positions, and demonstrated the need for experienced botanical surveyors. Much emphasis was also given to the Survey Training Course, to the preparation of a detailed Field Handbook, and to supervision in the field over the period of the survey.

After the survey, some of the survey squares were repeated to assess data reliability and the efficiency of the permanent marking. 21 squares were visited in the autumn of 1990, and a further 37 squares in 1991 as part of this quality assurance exercise. Land cover descriptions were checked in one quarter of each square, and six plots (one of each type) were repeated. 87% of plots were reliably relocated within 5 minutes. Correspondence in species recording varied between 74% and 83%, with higher levels of agreement for Main plots and verges, and lower levels for Habitat plots and streamsides. Of the 20 species most frequently forming cover, two were recorded at significantly different levels - both grasses. For the land cover mapping, there was between 71% and 95% agreement on the primary category with better correspondence in the lowlands than the uplands. These results from the quality assessment led to further recommendations which were implemented in the Key Habitat surveys, and which will need to be carefully considered for Countryside Survey 2000.

Information on the methods used in Countryside Survey 1990 is published in 'Countryside Survey 1990 Main Report' (Barr *et al.* 1993), and is available in more detail in the Countryside Survey 1990 Field Handbook (available by arrangement from ITE).

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Discussion

Mr O. Mountford - Was there any evidence of observer bias when recording?

Ms. C. Hallam - The Quality Assessment exercise found no evidence of bias.

Dr R. Bunce - A less experienced surveyor may miss species but this is not done consistently and therefore should not influence the ecological status of the plot.

Mr A. Brown - When a plot is revisited do surveyors take a copy of the previous survey results?

Mr C. Barr - No, but this is a question that needs consideration before Countryside Survey 2000.

Mr A. Brown - CCW have found that by taking out the previous recording sheet they have come across surveyors who constantly misidentify species.

Mr N. Critchley - ADAS have found that the most common error is not mis-identification but missing species.

Mr A. Brown - The more information that is available to the surveyors the better.

Dr A. Cooper - Giving the surveyor data which had been recorded previously could bias the new recorder.

Mr A. Hooper - Giving the surveyor previously recorded data may help to distinguish changes due to observer error from real changes.

Mr R. Cummins - Mis-identification is purely down to botanical experience. Problems encountered when mapping vegetation are more difficult to overcome.

Mr N. Critchley - Perhaps a grid of points could be recorded.

Dr A. Cooper - Good definitions lead to more consistent mapping.

Mr R. Cummins - Even with good definitions there are still problems with mapping and cover estimates. Particularly in more open situations such as the uplands.

Dr D. Birnie - Aerial photograph interpretation can be useful. If you ask the surveyor to write down all the vegetation types they feel are represented and any other possibilities then, from this information, it is possible to build a confusion matrix; this knowledge can then be built back into the interpretation. It is best to give the surveyors as much information as possible to reduce errors.

Mr A. Hooper - ADAS steer clear of vegetation mapping because of the errors involved.

Dr R. Bunce - Grey areas do cause mapping problems and a grid is less prone to errors. However a grid does not produce a map of an ITE survey square.

Mr R. Cummins - Depending on the resolution of the grid it is possible to obtain areas from a grid.

Mr A. Hooper - It is all a case of intensive versus extensive data. The ITE approach is intensive and costs a lot in time and resources. At the moment the National Audit Office is looking at the cost of ESA monitoring and looking at how best to invest its resources.

GENERAL DISCUSSION SESSION

Prof. P. Grime - Different monitoring techniques fulfill different functions: English Nature is interested in small, site-based changes; ITE Countryside Survey is interested in coarser grain shifts.

Mr A. Brown - When monitoring statutory sites, you often monitor the species or community for which the site was designated. But you also need fine grain monitoring in case there is something else which you need to know about in the future.

Prof. J. Miles - Biological monitoring is often open-ended; there is a need to set simple objectives. For instance it may be possible to simply measure the presence and absence of heather when looking at the state of a heath.

Mrs. L. Turl - Before survey and monitoring techniques are decided, clear well defined objectives need to be devised.

Mr A. Hooper - MAFF have retrospective objectives for ESAs.

Mr D. Askew - Objectives have to have a scale. Monitoring methods need to be able to adapt to temporal scales.

Dr N. Webb - Temporal scale is important; an adverse change may happen faster than a beneficial change.

Mr A. Hooper - When monitoring it is necessary to distinguish between noise and changes due to processes.

Mr N. Critchley - When ungrazed heaths came under an ESA, plots were fenced off. This was done to show what the vegetation would have been like if grazing had not been reintroduced into the ESA.

Dr J. Hopkins - When devising a monitoring programme there is a problem with unforeseen variables which may be found to be important in the future.

Mr A. Hooper - The results from ESA monitoring have fed back into management advice for ESAs. However, not enough information has been collected to be sure of cause and effect.

Prof. J. Miles - The BSBI survey of the British Isles is probably the single most used survey; it influenced the Government Biodiversity Action Plan.

Dr J. Hopkins - People are often interested in small-scale changes on sites but on very few sites is management driven by monitoring.

Prof. J. Miles - Farmers have a very *ad hoc* approach to monitoring; however it does influence the management of their land.

Prof. P. Grime - The Willis plots represent 38 years of monitoring at the same time of year by the same person. Their use is only now coming to light as the plots show the delayed effect of climate on vegetation.

Mrs. L. Turl - Aphid monitoring only works because data is collected year on year.

Prof. P. Grime - Annual data collection is becoming uneconomic, but it will be important in the future, especially when considering climate change.

Mr A. Hooper - More of an understanding of the lag effect due to drought is needed. Originally ADAS wanted to survey annually. However, the sample size was too small for observed changes to be statistically significant.

Prof. J. Miles - Most surveys which have been discussed today are policy lead. The BSBI survey was curiosity lead. ECN is original science lead. We have heard a lot about quadrats, tetrads, mapping and sampling strategies. Simple things are often the most useful.

Dr T. Parr - Vegetation should be monitored annually; this is a shortcoming of current practice. There is a need for a standard quadrat size so that sites and data, from other surveys, can be easily compared.

Prof. P. Grime - ECN need to use nested quadrats, they have problem simply because they are trying to compare different landscape types.

Dr R. Bunce - There is extensive literature on quadrat size - Ellenberg recommended using $200m^2$ quadrats in woodland. When monitoring it is best to just chose one size and stick with it.

Mr N. Critchley - Nested quadrats do not take much longer than quadrats of the same size, but they yield far more information.

THE NVC FOR BOTANICAL SURVEYING AND MONITORING

Dr John Rodwell, Unit of Vegetation Science, Lancaster University

Over the past decade, the National Vegetation Classification has become almost universally accepted in the UK as a standard for vegetation survey and site description. It now provides a common language for statutory conservation, environment, forestry and agriculture agencies, NGOs, local authorities, utilities and corporate industry.

The classification itself, published as the five volume *British Plant Communities* (Rodwell 1991 *et seq.*) includes vegetation types of all natural, semi-natural and major artificial habitats in England, Scotland and Wales. Over the past decade, the approach has also been extended to Northern Ireland and surveys so far suggest that most of the vegetation there can be related directly to NVC types (Cooper *et al.* 1994). Overall, NVC-type data is available from well over 80% of the 10x10km squares of the National Grid.
The NVC comprises 284 plant communities with units at sub-community level. The modular accounts in *British Plant Communities* provide details of floristic composition and vegetation structure for each community, habitat, zonations and successions and distribution, usually with a map of available samples. The affinities of the NVC vegetation types with previously described assemblages are summarised and relationships to phytosociological associations from elsewhere in Europe are discussed. In the final volume of *British Plant Communities*, a conspectus will present a phytosociological overview of all the NVC communities.

The NVC covers about 90% of the variation found among British vegetation types and the conspectus will identify the major gaps as a basis for remedial survey.

Many vegetation surveys now use the NVC to provide inventories of plant communities on designated or threatened sites or in the wider landscape. Often, a measure of goodness of fit of vegetation types to the NVC is given in such surveys. Maps are increasingly used, usually on scales of 1:2,500 or 1:10,000, to display the extent and disposition of the vegetation types.

In addition to the classification itself, the NVC also provides a simple technique for vegetation survey, developed originally for the project itself, long available in an outline Field Manual and now about to be published in expanded form by JNCC as an *NVC Handbook* (Rodwell 1996*a*). This sets minimum data standards for NVC-type vegetation samples and for NVC survey, and it outlines some acceptable economies with an indication of benefits and costs.

Software for analysing and managing multivariate survey data of the NVC format is in widespread use at over 250 centres in the UK. The VESPAN package (Malloch 1988) includes TWINSPAN and DECORANA (Hill 1979), together with a range of ancillary routines for editing, tabling and mapping data. VESPAN is also used for managing the UK Vegetation Database which was funded by JNCC to encode information from over 30,000 NVC samples at Lancaster. More recently, MATCH (Malloch 1988) and TABLEFIT (Hill 1995) have provided computerised keys to the NVC classification. Such 'expert systems' are attractive but sometimes seen as a substitute for ecological judgement in vegetation survey.

Over the past ten years, a training programme in the Unit of Vegetation Science at Lancaster has provided a general introduction to the NVC classification, its use in botanical survey and its application for management and monitoring to over 300 staff of agencies, research institutes, universities and consultancies.

The NVC survey methodology and classification are completely compatible with phytosociological methods used widely in other parts of Europe. Through the NVC, the UK is now seen as playing a lead role in setting data standards for vegetation survey across the Continent, developing an overview of European vegetation and establishing an international data network (Mucina *et al.* 1993, Rodwell *et al.* 1995). The DoE Darwin Initiative and UK Environmental Know-How Fund support vegetation survey skill-transfer using the NVC approach in partnerships with various east European countries.

The NVC has been used by the conservation agencies to interpret the CORINE biotopes included in the Habitats Directive and as part of the basis for designating SACs.

The NVC and monitoring

The NVC was never intended to be itself a monitoring technique. Repeating NVC samples in marked locations or remapping an area using the NVC survey techniques and the classification is generally speaking not sufficiently informative to be worth calling monitoring.

However, the NVC can inform and assist both the practice and principles of monitoring by providing a variety of tools and concepts. It is already used in a range of major UK monitoring programmes and, particularly with the Countryside Council for Wales (Rodwell 1996*b*), is helping develop approaches to monitoring that are likely to have an impact at European level (see Brown in this report).

The first application of the NVC that is of value for monitoring is in baseline survey of sites and landscapes to provide a descriptive framework within which quite different types of monitoring can then be located. Such baseline survey can use the NVC field technique itself, collecting samples of standard NVC format, and providing lists of vegetation types and maps of their extent and boundaries. However, it is possible to use certain other sampling techniques and still relate the results of data collection and analysis to the NVC classification. In the Environmental Change Network, for example, a grid of 400 points across each site, with qualitative recording in 2x2m quadrats (Sykes 1994) has yielded data which in most cases can be allocated fairly unambiguously to NVC plant communities.

In the ECN, the vegetation types identified by baseline survey at each site are then used to stratify a sampling array for vegetation monitoring using a coarse- and fine-grain protocols. Because the NVC is a national classification, it also enables the development of an overview of the vegetation types represented across the whole network, bringing a degree of integration to the monitoring exercise. A similar advantage is seen in the DoE Air Quality Calcicolous Grassland Monitoring Network (Rodwell *et al.* 1993) where 150 permanent monitoring plots were stratified within recognised NVC plant communities represented on over 50 sites across the UK. Again, the monitoring technique employed in this project is not NVC sampling but a more fine-grained recording protocol.

The second contribution of the NVC to monitoring is to help set targets. Broad surveillance can watch for all manner of general changes on a site or in the landscape but, for economy and precision in monitoring, particular goals are needed (Rowell 1993). The NVC can provide or inform such goals - the continued presence of a recognisable vegetation type could be a target of monitoring, for example, or the maintenance of a given hectareage of a plant community, or the presence of a distinctive mosaic defined in NVC terms. Even where the NVC is not conceived in such normative terms, it can serve as part of a descriptive frame within which particular targets for monitoring can be defined. Such targets could be populations of plant species, distinctive structural features or vegetation boundaries, or even other biota such as butterflies or passerines.

Third, the NVC had a powerful predictive capacity which can help define the impact of possible changes, threats or options in the landscape. In the NVC classification, each vegetation type is related to environmental conditions as far as we understand them -

combinations of climatic, soil and biotic factors which influence the composition and distribution of the plant communities and their sub-communities. Spatial contrasts and evidence from observed successions enable predictions to be made about the possible or likely impacts of environmental change. At a course level, this allows identification of stock-at-risk from particular threats: the NVC has been used in this way in the DoE Air Quality programme to develop exceedance maps for the impacts of nitrogen deposition on major types of vegetation in the UK. Monitoring of impacts can then be focused on locations which are predicted to be especially vulnerable.

In relation to controllable environmental shifts, the NVC can be used to predict the impact on existing types of vegetation of particular changes in management, such as abandonment of mowing, increased frequency of flooding or reduction in fertilising. It can thus help set targets for programmes of nature reserve management or extensification over wider landscape and assist the definition of 'desired condition' or 'favourable conservation status' as defined in the Habitats Directive. In the SOAEFD Micronet project, for example, the NVC is being used to provide a descriptive and predictive framework relating upland pasture types to the intensity of fertilising. Within this, a consortium of six institutions are examining spatial correlations between sward composition and the microbial flora and monitoring impacts of nitrogen perturbations (Millard 1995). In this project, there is also great interest in the NVC as a scaling tool which can demonstrate the implications of changes monitored in monoliths and microcosms at the level of the landscape.

Where it is feasible to develop a variety of possible vegetation types with shifts in management in a habitat characterised by a particular combination of climatic and soil conditions, the NVC can help define the range of options and provide some basis for calculating costs and benefits of different courses of action. In the Yorkshire Dales, for example, an exercise for English Nature (Cooper & Rodwell 1995) has developed such a framework for limestone, shale and grit landscapes with grazing, mowing, burning and non-intervention regimes of management.

A fourth contribution of the NVC is in helping specify indicators of desired condition or of environmental change which can be monitored as informative surrogates. The best indicators are likely to have rather precise significance, changes in their frequency, abundance or vitality relating to specific management objectives or possible threats in a particular vegetational context rather than being simply an expression of a basic life strategy. It is very important to remember that the indicator value of particular species or features does not remain constant or equally informative throughout their distribution. Also, features of concern or interest in vegetation, or 'flagship species' are not necessarily themselves the most sensitive indicators of the conditions necessary to sustain them in a desired state.

Characterising such indicators may not always be simple (Wheeler & Shaw 1992, Hodgson 1994, Leach 1994). Indicators may deliver a noisy message and provide it too late. However, use of the NVC to characterise indicators in NERC-funded research developed from the DoE Calcicolous Grassland Monitoring Network, in the SOAEFD Micronet project and for administering the Forestry Commission Better Land Supplement protocol suggest that this is not such an elusive goal. As in the MAFF/ADAS ESA Monitoring Scheme (Critchley *et al* 1996), it is also possible to use the NVC with other sources of data and expertise, like Ellenberg values, Grime strategies (Grime *et al.* 1988) and the Ecological Flora Database (Fitter & Peat 1994).

Monitoring brings responsibilities and, by providing a widely-accepted methodology and classification, the NVC can be seen as a transparent framework of accountability. It offers common standards for survey and description, is a reliable basis for responsible risk-taking in developing predictions and can give added value to particular monitoring programmes by its claim to be a common language.

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Discussion

Prof. J. Miles - How is it that the NVC covers 90% of the vegetation in the UK?

Dr J. Rodwell - If you look at how the NVC is being used in areas not previously sampled, you find few communities not previously described. For example in Northern Ireland, when the coastal strip was surveyed only two new communities were found. Having tested the NVC in the market place for 10 to 12 years it is known where it is weak (the remaining 10%) and remedial action is needed.

LIFE IN WALES

Alan Brown, CCW

Alan Brown described the LIFE project which had recently started in Wales.

There were no questions.

STRATEGIC REQUIREMENTS FOR POLICY

Dr John Hopkins, JNCC, Peterborough

In recent decades there has been an increasing commitment of national government, local government and other statutory and non-statutory bodies to support the protection of what has come to be called biodiversity. The scale of the commitment is impressive. The SSSI series covers approximately 8% of the land surface of the UK and since 1986 a suite of ESAs has been developed on a similar geographical scale; other countryside management schemes are promoted by a range of statutory and non statutory organisations with a range of types of official support. The UK Biodiversity Action plan is a new umbrella framework in which all of these activities are being integrated.

The scale of this development of policy and practice has, by comparison with the period before 1980, been extremely rapid. There is clearly therefore a developing need for a body of survey data to assist targeting of these initiatives, and strategic monitoring data which demonstrates whether these schemes are meeting their objectives and how efficient they are. The Countryside Survey 1990 and related studies, the ecological monitoring of ESAs, monitoring programmes related to SSSIs and other statutorily designated sites, and other initiatives with a strategic frame of reference, are therefore needed to provide the base load of information for policy evaluation and development. Given the rapid development of many of these policy initiatives it is also reasonable to assume that in the next few years such scientific programmes will need adjustment to meet policy needs.

However it is mistaken to think that policy development is ponderous and predictable as is implied above. Policy changes constantly, at varying rates, both proactively'and reactively, and in response to a wide range of factors. This poses considerable practical difficulties for those who try to integrate scientific programmes and policy requirements. It is axiomatic that even the best designed scientific programmes are unlikely to yield information to support every new policy problem and initiative as it arises. Indeed, it is an inherent property of many high profile, reactive policy issues that they arise because scientific understanding is poor. This sometimes results in tension between environmental scientists, who may see the questions they are asked to answer as unreasonable in terms of timescale and character, and those advising on, or developing policies who find the scientific community cannot respond in a way which is relevant to the policy environment.

To answer the pressing policy questions which cannot be answered from the body of existing science, research is often commissioned. However, the timescales required for many types of scientific investigation are such that by the time the research results are available the most significant policy decisions have been taken. In practice these results, although having no impact upon initial policy development, provide an important check upon whether the right policy choices were made. Work carried out to study fertiliser use on Somerset Levels following the heated conflict between environmentalists and farmers in the 1980s, is a good example of this phenomenon in the domain of nature conservation, because the results have been of great value in refining and developing management prescriptions for a range of management schemes long after the conflict has finished.

The ingenuity of individuals and small groups when faced with novel problems is also a resource we should attempt to harness more successfully. In the commercial world techniques are being developed to increase creativity and it is worth asking if these may have relevance to scientific development, where insights may not always depend upon new primary research. A good example of the creative thinking which may be possible is provided by the ingenuity which was brought to bear upon historical documents in the 1970s by the UK school of "historical ecologists" who gave new and important insights into the way in which contemporary habitat and species characteristics are due to past human activities, providing important models for the management of these resources.

Policy problems often have a strong social and economic implication and the most relevant science tends be seen as that which is highly empirical and focused on the specific problem. However, there is a strong argument that while theoretical work may not bring the precision needed for answering policy problems, none-the-less in the absence of this specific scientific information a strong body of tested theory should be of help in developing the first approximation of a response to any policy problems. It is therefore a danger that the heavy burden of cataloguing biodiversity will inhibit the development of theory and its application to policy.

Mathematical and other models of systems may prove to be of even greater value as tools, but given the difficulty of applying models to macro-economic policies some caution is appropriate. Notably good models rely heavily on a sound theoretical basis. Purely empirical models with no theoretical base can be powerful tools, and are used widely in agriculture, civil engineering, medicine and other disciplines. However it should be noted that such models rarely perform satisfactorily outside of the parameters in which they were developed. Their application to novel situations is likely to yield erroneous results, as for example is true of models of intensive grassland production applied to low intensity farming systems.

An interesting question is whether we have institutions both in the policy community and scientific community which allow for a rapid deployment of scientific data and minds upon specific problems. Our view of ecology has increasingly been borrowed from that of the physical sciences although this is not the only appropriate model for ecologists to base their methods upon. The replicated experiment, statistical test, and peer reviewed publication have become central to our thinking about ecological methods. However it may be that additional more rapid or appropriate methods are required and that there are new patterns of organisation which can speed up the response to policy problems, perhaps using new technical solutions and different combinations of professional skills.

To make its best contribution the scientific community should not simply respond to policy issues but plan to meet future needs. Many of the greatest contributions of scientific community have made to policy development have been proactive, bringing to the fore the special insights of the scientific approach. We should not forget Sir Arthur Tansley and other leading ecologists of the day who established the framework for statutory nature conservation in the UK.

However to contribute toward policy development requires that the policy environment is well understood by ecologists. In the past it was possible to view such policy development from a purely national perspective. Environmental policy is now globalised and international and national legal instruments and policies interact in a complex and sometimes unpredictable way.

Increasingly the distinction between domestic and international policies and actions is becoming indistinct, making the task of anticipating future issues especially difficult. For example the 1981 Wildlife and Countryside Act has arguably had a more profound effect upon nature conservation than any preceding nature conservation legislation and is seen by most as a purely domestic issues. It set the tone for most of the data requirements of nature conservationists in the 1980s. However the Wildlife and Countryside Act would not exist at all if the UK government had not earlier entered into obligations under the Bonn Convention, Bern Convention and EC Birds Directive. A rapid pace of legislative and policy development at an international level continues and this is setting the current conservation agenda in the UK. The UK Biodiversity Action Plan has been developed since 1992 as a direct response to commitments under the UN Convention on Biological Diversity, the Habitats Directive was also approved in 1992 and will create new demands for information related to Special Areas of Conservation. The Council of Europe's Pan - European Strategy for the Conservation of Landscapes and Biodiversity signed in 1996, and the establishment of the European Environment Agency in 1994, are steps which establish new but as yet difficult to interpret demands for survey and monitoring data.

If we are to respond to these increasingly diverse international requirements the proactive involvement of ecologists in the design and implementation of survey and monitoring activities will clearly be needed for some years to come.

<u>Discussion</u>

Mr C. Barr - The way in which the Countryside Survey has been reported is not always compatible the way that policy makers want information. However, the basic data set contains much more information and remains a largely untapped resource.

Dr J. Hopkins - I couldn't use CS1990 data for estimating size of remaining area of Caledonian Forest.

Dr R Bunce - Since there is less than 3,000 ha left, it was below the resolution required for estimation. However, CS1990 recorded 'conifer woodland' by species.

Mr R. Cummins - Although there is an EU directive to protect Caledonian Forest, CS1990 was a general survey of the British countryside and was not designed to cover rare habitats.

Dr A. Cooper - Science and policy are two different cultures. Some ecological models take one month to run but policy decisions take place within a day. If science is to be policy lead how good are policy makers at designing objectives? Science demands precision, unlike policy!

Dr J. Hopkins - Simplicity is the key one sentence can influence policy, complicated data and diagrams will be ignored. Giving information to politicians requires simplicity and brevity. For maximum impact it should be delivered as a 'story' not just in the more easily ignored form of cold facts and figures, set in no particular context. If we didn't act swiftly to deliver the fruits of our research in an appropriate form to decision makers, the same results are likely to be hijacked by lobbyists who will put their own gloss on them, usually involving a moral dimension.

Prof. J. Miles - There are natural scientists in the civil service. My job is to interpret scientific data for the policy makers.

Dr A. Cooper - There is a problem in that, traditionally, scientists communicate only amongst themselves.

Prof. J. Miles - I am expected to keep up to date in scientific research, for instance the main message in the CS1990 was the loss of vascular plants to the wider countryside.

Dr L. Turl - It is essential that scientific information can be interpreted in a meaningful way so that it can be acted on.

Dr J. Rodwell - It is worrying that scientific research is increasingly policy driven, thus simplicity and a superficial treatment of complex systems is built in at the very start of a research program. Not only government, but also NGOs, require this kind of simplistic, quick and inevitably cheaper approach.

Dr A. Stott - Survey and monitoring take time and may report at a time when the information is not needed. It is still essential that research is carried out to answer questions when they do arise. However we need to be able to tap into this information quickly.

Mr R. Cummins - Often in research the customer, makes demands and suggest methods that will not produce the results they need or answer their questions. There are problems over the dogmatic prescription of the NVC as a monitoring tool, by bodies such as EN. This results in the tail wagging the dog since ITE end up contractually obliged to embark upon a methodological course that they would not otherwise use.

3. ADDITIONAL CONTRIBUTIONS

3.1 The following two papers were not heard at the Workshop. The first of these was to have been presented but Dr Porter was taken ill shortly before the day of the meeting. The second paper, by Dr Cooper, was offered subsequent to the meeting for inclusion in the proceedings.

APPROACHES TO VEGETATION MONITORING BY ENGLISH NATURE

Dr Keith Porter, English Nature, Peterborough

Introduction

The role of the Statutory conservation agencies is focused on the responsibilities set out in the Wildlife & Countryside Act 1981, and those arising from European legislation or International initiatives such as the Habitats and Species Directive and the UK Biodiversity Action Plan. The majority of our work to date has focused on the selection, notification and maintenance of the Sites of Special Scientific Interest, and these provide a framework for the delivery of many of the Habitats and Species targets. However, for some species we need a wider view of their status outside statutory sites, and for habitats we need better information on their extent and condition outside statutory sites. This means that we need an approach to monitoring that reflects differing needs of site-based and wider countryside monitoring.

In this paper I describe the model for SSSI monitoring that has been developed in parallel with the other country agencies, and which will enable us to report on the condition of the whole SSSI series and the favourable conservation status of features on SSSIs. An introduction is also given to our thinking on how we will monitor the resource outside statutory sites and how this links into many of the schemes and initiatives existing or planned. We are very keen to play an active role in the development of Countryside Survey 2000 and ensure that links can be made between the high quality end of the resource and the wider aspects of countryside monitoring. We recognise the need to integrate special sites within the matrix of countryside, and particularly recognise the need to implement a landscape scale approach to nature conservation.

Monitoring has always been a challenge to nature conservationists. The first instinct of biologists is to attempt to measure change through replicated, statistically sound, recording of species abundance and cover. This traditional approach can produce the required results, but the cost is very high if variance between recorders or seasons is controlled. With over 3,800 SSSIs in England alone the real challenge is to develop monitoring methodologies which can be applied to all SSSIs in a manner which is consistent across Great Britain, and which meet the needs of European legislation. The challenge facing the statutory agencies is to achieve this within their restricted budgets without recourse to the expensive, traditional approaches on every site.

Our response has been to develop a model which defines favourable condition and limits of acceptable change for each feature of a site, then establishes criteria against which assessments can be made of site condition against defined objectives. These assessments will be carried out by staff of the statutory agencies against agreed common standards for generic features across GB. We are currently developing practical ways of implementing the model and this paper describes some of the processes and progress.

English Nature's monitoring strategy

In 1992 we put in place a strategy for the development of a new approach to SSSI monitoring. The strategy contained four strands which informed our development of methods and systems, these were:

- a strategic sample survey of SSSIs;
- production of site objective and site management statements for all SSSIs;
- an SSSI information system to support operational use;
- a quality assurance, or validation, monitoring programme for SSSIs.

This strategy has been modified in the light of the development of common standards across the country agencies, as described in a contract report "Common Standards for Monitoring SSSIs" (Rowell, 1993). The first three elements of the English Nature strategy are currently being implemented and current thinking on the fourth is described here.

The link across all four strands is a methodology we call Site Unit Recording (SUR) which is applied to all sites by our local conservation officers when they visit SSSIs. This methodology incorporates the standards agreed between the country agencies which are that on every SSSI we will identify:

- the **interest feature**, which refers to the special interest for which the SSSI was notified, or could be notified given the current state of knowledge of the site. These are variously defined from the published SSSI Selection Guidelines and are documented in the Site Objective Statement and Site Management Statements. They are also recorded within the SSSI Information System. An individual SSSI can have several interest features, including habitats, individual species, or earth science features.

- an **optimal condition** for each interest feature. This desired condition will be explicitly described within the objective for the interest feature. The optimal condition provides a constant reference point against which condition assessments can be made.

- **limits of acceptable change** will be set for each interest feature, as a way of defining how far the feature may move away from its optimal condition before it is no longer considered optimal. These limits must allow for natural cyclical fluctuations that may be inherent in the interest feature.

- The agreed reporting unit across agencies is for features on sites. English Nature's variant on this approach is to divide each SSSI into **site units**. Each site unit is defined to a set of rules and generally divide SSSIs to reflect tenure. This is in line with our philosophy of achieving positive management of sites by emphasising the role of the land manager. We will report at whole site level by aggregating assessments of units within a site.

- **site fabric** is defined for each site as any natural or semi-natural, physical or biotic aspect, other than the *interest feature*, or any other physical or biotic aspect that either directly supports the *interest feature* or would, if damaged, detrimentally affect the *interest feature*.

Condition assessment

This is the practical method at the heart of our SUR methodology and is a subjective judgement, based upon our officer's experience, knowledge of the site, and guidance on how to define optimal condition. For each interest feature we are developing, along with the other agencies, generic objectives or criteria. These will provide a generic definition of what the structure, quality and quantity of each feature would be if optimal conditions prevailed. Draft examples of current thinking are given below but should be treated as indicative, not definitive as yet:

Draft Example 1. UlO Moss-heath & H19 Lichen heath

Characteristics	Management "Objective"	Limits of Acceptable Change
Quality	Only sporadic occurrence of heath bedstraw and tormentil.	
	Low frequency of fine-leaved grasses such as *Deschampsia cespitosa* and *Festuca ovina*.	Less than 10% of vegetation cover, or less than 20% in lime-rich areas.
	Absence of broad-leaved grasses e.g. *Agrostis*, *Anthoxanthum* or *Poa* spp.	
Structure	Very little bare ground.	Less than 10% of green leaves grazed.
	Little or no grazing except of grasses.	
	Negligible signs of browsing on dwarf shrubs.	Difficult to find without detailed and extensive search.

Draft Example 2. MG5 Mesotrophic grassland

Characteristic	"Generic criteria"	Limits of Acceptable Change
Quality	Rich in forbs including *Centaurea nigra*, *Ophioglossum vulgatum*, *Orchis morio* in sward in May/June.	difficult to find in May/June.
Structure	Open sward structure, no significant leaf litter	Leaf litter not to exceed 5% cover within sward.
Extent	'x' hectares.	Recoverable damage not to exceed 5% of area of MG5.

The development of generic criteria for all relevant habitats and species will enable equivalent features to be compared across the United Kingdom, with the recognition that regional variation in species will be needed to accommodate geographical variance. The ultimate goal of this exercise is to produce a guidance manual as a reference point for judgments of feature condition. This will help to overcome some of the variance between observers.

The Common Standards report Rowell (1993) which has been adopted by the country agencies defines the following categories of condition and assessments are made of each interest feature to these definitions:

Optimal Condition:

This 'is the management objective for the abundance, distribution, vigour of an interest feature or some other performance criterion. They should be based on informed judgements of the carrying capacity of the site following, if appropriate, recovery management.'

Optimal maintained:

'A feature of interest can be recorded as *maintained* when it is present in the condition and abundance formally set as the desired optimal condition or, at least, within the limits of acceptable change.'

Optimal recovered:

'A feature of interest can be recorded as *recovered* if it has regained, following sub-optimal condition, the condition and abundance formally set as the desired optimal condition.'

Sub-optimal recovering:

'A feature of interest can be recorded as recovering after a damaging activity if it has begun to show, or is continuing to show, a trend towards'.... optimal condition. This may be natural recovery after a damaging activity or recovery as a result of positive management.

Sub-optimal stabilised:

'An interest feature may be retained in a more or less steady state by repeated or continuing damage; it is sub-optimal but neither declining nor recovering. In rare cases an interest feature might not be able to regain its original condition following a damaging activity, but a new, stable situation might be achieved.'

Sub-optimal declining:

'An interest feature can be said to be *declining* when its abundance, distribution or vigour is decreasing and is below the acceptable limits of change, within the confines of the site in question... In this case, recovery is possible and could occur spontaneously or if suitable management input is made.' The condition of the interest feature has declined since the last assessment.

Destroyed or partially destroyed:

'The recording of a feature as *destroyed* will indicate that an entire interest feature has been affected to such an extent that there is no hope of recovery, perhaps because the supporting site fabric has been destroyed or irretrievably altered.'

Implementing the strategy: achievements to date

The SUR methodology has been tested, and continues to be tested, by using it to assess the state of a sample of SSSIs, as set out in the first element of English Nature's monitoring strategy. The programme has been put in place to establish a baseline for a national overview of the state of broad habitat types within the SSSI series. The first sample was taken for lowland grassland on SSSIs and the final report was published this year (National SSSI Sample Survey of Lowland Grasslands: Pilot project, Sketch, 1996). We are currently gathering data for similar reports on lowland heath, upland moor, and woodlands. The results from these will be published 1996/97.

The application of the SUR to such samples enables us to draw broad conclusions about overall condition of broad features, issues affecting them, and the effectiveness of our management schemes.

The programme to document the features, site units, objectives and limits of acceptable change as Site Objective Statements is underway for all SSSIs. These will provide the reference points from which assessments can be made and pragmatic management objectives agreed with land owners. The latter will be set out in Site Management Statements for all SSSIs. This programme will take time in view of the number of SSSIs (over 3,800 in England) and the number of owner/occupiers (around 20,000).

The first phase of the SSSI information system went live in Spring 1996 with data stored on a central ORACLE database and accessed through a wide area network in all our 21 local teams. This system is known as ENSIS and contains all core information on SSSI features, units, legal history and tenure. In addition it accepts details from field visits to assess condition of features and provides a tracking system for previous visits and a reminder of due visits. The current phase is being expanded by a continuing project to include additional supporting data and functionality. The system was intended to be a tool on the desks of local officers and a reporting tool for national overview.

Implementing the strategy: the next stages

The element of the strategy that is as yet to be operational is that of quality assurance on SSSI monitoring. The developments described here are currently an English Nature initiative and need to be agreed with the other country agencies. The model does utilise the common standards and will be developed to allow us to satisfy UK reporting requirements. This approach is currently being developed around the SUR methodology and can be described in three phases:

The first phase involves the establishment of generic criteria, or objectives, for features. This is likely to follow the general direction of the examples already given here for mesotrophic grassland and lichen heath/moss heath. A contract is currently being completed on behalf of the country agencies to define generic criteria for all priority features given in the Habitats and Species Directive. These criteria will be tested in operational assessments and in a series of sites which will be selected to cover the range of feature types. This series of sites is currently termed the site validation network and will be preferentially selected from Special Areas for Conservation (SAC sites) and National Nature Reserves. We anticipate a national network of between 200 and 400 sites which are representative of geographical variation and include replicates of each feature type. Once tested on sites where we have a high degree of management control, the generic criteria can be published as guidance for our operational staff.

Phase two involves the use of the network of validation sites to establish more traditional monitoring schemes which will provide a 'control' on observations made on equivalent interest features using SUR. The whole approach to SUR infers that declines in feature condition will respond to management action. In view of climatic trends and of the natural cyclical fluctuations in species we believe that knowledge of national trends, as seen for example in the Butterfly Monitoring Scheme, will enable better interpretations to be made of the site specific observations in SUR. This phase will effectively create a national network of reference sites against which individual site observations can be judged.

Phase three will provide information on the favourable conservation status of features, particularly species. This phase is currently termed assurance monitoring in that it builds upon the presence/absence observations of SUR by a rolling programme of specific measures to assess the abundance and viability of features across a sample of sites where they are known to occur. Features will be selected on the basis of their degree of threat or vulnerability to serious decline.

This model will apply to all SSSIs, yet enable reporting on the status of features to fulfill the requirements of Habitats and Species, and the BAP targets which substantially occur on SSSIs.

This model can be represented in simple terms as shown in the diagram above which shows the relationship between each phase:

The requirement for reporting outside SSSIs

Many species, and some habitats, which are included within the Habitats and Species Directive have wide distributions outside statutory sites. Whilst some are dependent upon semi-natural habitats, others are typically mobile and present across a range of land cover types. Our dilemma is how to report on the status of such species or habitats. Many of these features have distributions coincident with particular land-use patterns, especially where matrices of semi-natural vegetation exist.

We are currently considering what approaches may be suitable for monitoring outside SSSIs. Our view is that we need a way of selecting a series of 1 km^2's from 'relevant' patches. The existing framework of 1 km^2 within the CS1990 contains too few samples to detect changes in the status of key species and habitats. The Countryside Survey framework was not designed to address this problem and it is fair to say that the bias of such conservation features is towards land patches which are characterised by high semi-natural interest.

A suitable sub-set of the English countryside from which a 1 km^2 sample might be taken are Prime Biodiversity Areas. These are areas of land which can be defined by considering the pattern of known sites of semi-natural habitat and critical species. We have a project currently considering how to define such areas as an aid to targeting landscape scale programmes. This work is still developmental and will benefit from wider discussion with bodies engaged in similar targeting exercises.

There is great potential for linkage between the approaches we are exploring and those being considered for the next Countryside Survey. I hope that this paper provides an insight into the thinking of English Nature and the opportunities for the exchange of ideas and development of partnerships. Our role remains firmly linked to legislative requirement and the role for monitoring has been emphasised by the requirements of recent legislation. We look forward to an exchange of ideas and playing a role in helping gain a better understanding of the natural environment.

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BOTANICAL SURVEY AND MONITORING TECHNIQUES IN THE NORTHERN IRELAND COUNTRYSIDE SURVEY

Dr Alan Cooper, University of Ulster

The methods adopted for botanical survey and monitoring in the NI Countryside Survey (NICS) differ from those of the GB Countryside Survey. Different objectives in NI led by scale differences and pragmatic considerations such as user needs and the timing of decision-making have led to methodological divergence from a common standard. This progress paper outlines recent developments in NI to facilitate comparison with GB.

The Northern Ireland Countryside Survey

Land cover survey and monitoring in the NI Countryside Survey is based on a sampling programme structured around multivariate land classification. The objectives of the study are ecological and have a landscape scale. The NI Land Classification (NILC) is used as a flexible field sampling framework for estimating ecological biodiversity, monitoring change and assessing the ecological consequences of change at the species, species assemblage and land cover levels. Recent reviews and management plans of Areas of Outstanding Natural Beauty have used baseline information from the NICS. Land cover estimates for the Mourne and Glens of Antrim ESAs and land cover monitoring in the Mourne ESA, have contributed to the revision of ESA management prescriptions. The application of the NICS land cover database to define biodiversity targets is currently being assessed for the Biodiversity Challenge initiative in NI.

Land Classification

The NI land classification (23 land classes) was constructed by Two-way Indicator Species Analysis of 700 (1 in 9), 1km squares, based on 198 map attributes. A hierarchical key of 65 indicator attributes resulting from the classification was used to allocate the remaining grid squares and the original sample squares to a land class. The structure of the land classification reflects the balanced set of map attributes used to construct the classification. The land classes (i.e. sampling strata) have a resolution appropriate for the scale of the region and the objectives of the NI Countryside Survey. The relatively small area of NI and the direct classification method of the NILC gives it a high degree of local resolution.

Comparison with GB has been carried out by land classification, based on a reduced set of map attributes common to both regions. This classification gives wider context with GB and allows regional comparisons to be made. It shows, e.g. 70% of NI belonging to a single GB land class with a structure similar to the North-west of England.

Land cover descriptors

Standard land cover definitions were based on the Nature Conservancy Council Phase 1 Habitat Mapping Scheme, modified following pilot survey to take account of NI vegetation and land use. The level of uncertainty in defining the resulting 41 semi-natural vegetation types, was reduced by defining them in terms of an indicative list of key dominant and other species, and their structure. Vegetation structure and management were defined explicitly by independent descriptors based on quantitative assessment, e.g. dominance defined as plant cover >25%.

Land cover terms that could not be defined unambiguously, and which were therefore highly subjective and prone to observer error, were not used to define land cover types. These in included terms such as "unimproved" and "lowland".

Comparison of land cover types between baseline and re-survey, and with other projects, is achieved by structured database analysis. The NICS database is held as dBASE files. Differences in land cover definitions and recording procedures between studies mean that comparisons are approximate and that the database codes used to extract land cover types and their aggregates need to be stated explicitly, otherwise interpretation errors can occur. In particular, land cover types from one survey, can comprise more than one type in another. For example, "species-rich dry grassland" in the NICS would be approximated in the GB Countryside Survey with the primary code "unimproved grassland". The "unimproved grassland" code also represents the NI land cover types "species-rich wet grassland", 'fen meadow", "species-rich bent-fescue hill pasture" and "grassland mosaics with other semi-natural vegetation land cover types".

Land cover recording

NI land cover was surveyed between 1986 and 1991 with 628, ¼ km grid squares sampled at an intensity of 1.1%. This land cover sampling intensity gives the NICS a high degree of ecological resolution, leading, for example, to its application in AONB management planning. The scale of recording was defined by reference to a minimum patch area of 10 m x 10 m and a minimum linear feature length of 10 m. Variation below this scale was ignored during field mapping. Adoption of the same scale of recording is essential for comparisons between projects and for monitoring change.

Land cover mapping was carried out by experienced, professional botanists. Field survey methods were piloted and refined by two senior research staff who carried out much of the initial field survey (428 grid squares). In the later stages of the project, when completion within a single field season was essential, a team of six post-graduate, professional botanists was employed. They were given a three-week training course on field methods to standardise their approach and control the consistency with which the recording procedures were applied. This is essential when the experience and perceptions of field surveyors differs. Training was provided by the two research staff managing the project. A field handbook of land cover descriptors was provided to supplement standardised field data sheets.

Most of the training course was carried out in the field, with emphasis on applying recording procedures over the full range of land cover types in NI. Comparison between the performance of field surveyors working in different paired combinations, was conducted in grid squares recorded during previous surveys. Feedback to field surveyors was by seminar discussion.

During the first four weeks of the survey, on-the-job training continued, with research staff accompanying the field surveyors. A checking procedure was carried out on completed grid squares throughout the field season, with weekly group seminars to feed back comments on performance and to answer queries. There was a central base from which all field surveyors worked, to facilitate communication and reduce systematic recording error. Field surveyors also worked in pairs, with pairings changed at mid- field season.

A high level of training is critically important to reducing systematic errors in land cover mapping, which is essentially a subjective process carried out by the application of professional judgement guided by an explicit set of quantitatively defined mapping units. Checking procedures were applied to completed field data sheets and supervisory staff revisited grid squares to investigate recording errors. Feedback to field surveyors was integral. Of the 200 sample squares in the survey, 93 were revisited to check informally for recording errors.

Common errors associated with field recording were: the omission of management or structure codes from the data sheet, codes entered in wrong columns of the data sheet, inaccurately mapped boundaries between semi-natural vegetation types, over-complicated mapping, misidentification of species and entering wrong species codes onto the data sheets. Manual checks on field data sheets and systematic computer checks on processed data can eliminate many of these errors. Thoughtful field data sheet design (layout and size) can also eliminate errors, e.g. by standardising column entries for particular land cover attributes, limiting attribute choice, and selecting from a tick list that is integral to each data sheet. Colour aerial photographs can be used to define spatial mapping standards and mapping complexity criteria.

Estimates of the accuracy of land cover recording are needed to quantify error in addition to quality assurance measures. A further 26 squares were selected randomly to assess error quantitatively, by recording land cover at nine regularly placed points. These were visited by supervisory staff without reference to field survey records. There was a 79% correspondence, with error notably associated with the mis-identification of Italian and perennial rye grass swards and their relative abundance, particularly in newly-cut silage fields. This figure defines field survey accuracy before the incorporation of detected errors.

Monitoring land cover change

Two land cover monitoring projects have been completed on: (a) 206 grid squares, to assess the rate of change of machine peat cutting in upland AONBs; (b) 60 grid squares in the Mourne ESA and AONB.

In the machine peat cutting study, the same field surveyor involved in baseline survey carried out re-survey, during which newly cut parcels were recorded onto the baseline field data sheets. The baseline maps facilitated re-survey by reducing errors of patch boundary relocation and search time in the field.

Land cover re-survey in the Mourne ESA and AONB was carried out by a field surveyor experienced in the NICS methods but who had not been involved in baseline survey. Baseline field maps were again used to facilitate re-survey. Few inconsistencies or errors were detected in the baseline survey at an informal level of analysis. The field surveyor and the project supervisor made the assessment that the methodology was appropriate for assessing land cover change and that in relation to the magnitude of land cover change, error was minimal. This was primarily because most change was major and categorical, involving land use change e.g. agricultural rotation, afforestation, conversion from semi-natural vegetation to agriculture.

A major advantage over re-surveying with blank data sheets, was that professional decisions on whether or not land cover change had taken place, could be made in the field. The drawback of introducing bias (e.g. differences of land cover interpretation between recorders and decisions on baseline errors) was minimised by recording change or error only if they were categorical (e.g. ecologically impossible). Criteria for recording change were based on the standardised land cover descriptors. All decisions on land cover change and baseline errors were target noted and checked independently by the project supervisor.

Vegetation quadrat sampling and monitoring

Studies on the regional species composition of NI in grassland and upland heath/mire land cover types were carried out by recording from a stratified random sample of 1141, fixed $4m^2$ and $200m^2$ quadrats. Stratification of the quadrat sample was by grassland and heath/mire land cover types, giving a data set which was unbiased and representative of a wide range semi-natural vegetation and agricultural grasslands.

Field survey was carried out by experienced post-graduate botanists working in pairs, in a May-August field season. This followed a training course to control the consistency with which standard methods were applied. All species were identified within the constraints of the time allocated for field survey. One hour was piloted as a maximum search period for each quadrat. This served to standardise the identification effort. Specimens that could not be identified to species level were labelled with genus or species aggregate on the field data sheet.

Quality assurance, including relocation error, was carried out by the project supervisor, on a random sample of quadrats stratified by land cover type and field worker team. Working practices and recording standards were also checked throughout the field season.

Re-survey of a sub-sample of the grassland quadrats was carried out after a period of two years, by two field surveyors experienced in the NICS methods. Baseline land cover and quadrat relocation maps were used but quadrats were resurveyed without reference to baseline species lists. Quality assurance and error assessment procedures are integral to maintaining consistency. Informal analysis of the quality assurance exercise showed that differences between pairs of field surveyors and seasonality were the main causes of variation. As with land cover survey and monitoring, an explicit standardised method, quality assurance to reduce error, and the quantification of error are essential requirements. The quadrat survey has subsequently been used to refine the land cover type descriptors in terms of indicator species and dominants. Cross-tabulation of land cover type by independent quadrat classification has shown them to be highly correlated, with discriminant function analysis allocating 90% of grassland quadrats and 86% of heath/mire quadrats to the same land cover type from which they were recorded.

Field work standards

Objectives define the type of data to be recorded and the level of recording accuracy needed. Assessing changes in land cover (i.e. switches between types) needs a different methodology to assessing qualitative changes in land cover parcels.

Baseline land cover survey is descriptive (and can be used for inference) but there is an expectation of change that represents a hypothesis. Field survey and monitoring objectives should be specified precisely and should be purposeful i.e. designed with a baseline protocol that will detect specific types of change. For studies with a high degree of scientific rigour, the objectives are defined precisely. Replicated, reproducible data with error terms are minimum requirements. This needs high levels of funding. Redundant information should not he collected in the hope that it will be useful. Open-ended. inadequately considered surveys, objectives that are wide-ranging, and subjective/observational approaches, collect redundant information and are expensive/wasteful.

Key indicators of land cover change are land cover types, species assemblages, and species, sampled with quadrats or mapped. They need to be defined precisely to allow measurement or assessment that can be used for scientific analysis.

Field studies have errors which can be reduced without bias if they can be isolated. The scientific quantification of error is under-researched. A limitation of land cover survey and monitoring is in determining whether differences between studies are due to recording errors (i.e. measurement errors and errors introduced by subjective decisions made in the field). For this reason, methods and key indicators need to be defined precisely with explicit descriptors. Subjectivity errors can be reduced by incorporating rigorous quality assurance measures. The independent quantification of error is an essential requirement. Ambiguous descriptors (i.e. subjective/observational) do not allow quantitative comparison e.g. by database analysis, or error terms to be defined. They lead to interpretation errors.

The type, magnitude and rate of land cover change as it interacts with spatial pattern and time scale in botanical survey and monitoring projects also need to be considered in relation to assessment methods. The magnitude of differences between studies or baseline/re-survey affects the statistical power of the analysis and therefore accuracy. Successive refinement in knowledge of the distribution of ecological resources, the factors that influence them, the development of survey techniques and changing research priorities, can make the adoption of common standards impractical. Successive refinement helps to focus on key indicators of change and optimum methods for their measurement.

Re-survey of single elements is straightforward if there is a clear descriptor. Full land cover survey has a wider spread of variables so that error is more difficult to control. Providing field surveyors with baseline land cover maps is appropriate for: relocation purposes; to determine boundary shifts between vegetation/land cover types; or if there are mapping errors. Professional decisions made in the field on the basis of land cover descriptors and criteria for determining if change has taken place reduce data redundancy. This offsets the drawback of introducing recorder bias. In this case, quality control and error assessment procedures must be an integral part of the study.

Quadrat survey demands similar levels of quality assurance and error assessment to land cover survey. Methods for reducing differences between recorders in recording species and assessing their abundance are needed. Providing species lists for quadrat re-survey can help to identify identification errors and facilitate re-survey but they introduce bias if used as a quadrat relocation aid.

4. WORKSHOP - PART 1 - WHERE ARE WE NOW?

4.1 The overall aims of the meeting were:

i. To review and discuss common standards of botanical monitoring.

ii. To assess whether there is scope for convergence in the methodologies used.

4.2 As a way of exploring these aims, the attendees were asked to consider the following aspects:

- The **needs** for botanical monitoring, including monitoring for biodiversity, monitoring of management objectives, monitoring biodiversity (quality and quantity).
- The **approaches** which might be suitable, including consideration of monitoring units (species, communities, associations, functional types) in relation to needs, statistics and strategy.
- The **practice** of monitoring to include methods, skills, resources.
- **Convergence** - is it appropriate to integrate methods in the light of needs? If so, how might this be done.

4.3 To help consideration of these aspects from a range of viewpoints, the meeting was divided into three groups. The groups considered the aspects of monitoring, listed above, in the context of three different requirements:

- Site-based monitoring

- Thematic monitoring (groups of sites with common or similar management objectives)

- Broader countryside monitoring

4.4 Each group had a rapporteur who reported back to the full meeting before the final summing up:

Group 1 Site-based monitoring - Chair: Dr George Boobyer - Rapporteur: Alan Brown

Group 2 Thematic monitoring (groups of sites)- Chair: David Askew - Rapporteur: Roger Cummins

Group 3 Broader countryside monitoring - Chair: Dr Terry Parr - Rapporteur: Paul Corbett

REPORT FROM GROUP 1 (SITE-BASED MONITORING)

The Group recognised that there was currently more than one definition of habitat, ranging from 'an ecosystem' to a 'plant association'.

Similarly, a distinction was drawn between 'monitoring' which is linked to particular aims and objectives (e.g. to see if particular management prescriptions are working), as opposed to 'surveillance' (just seeing what was happening, in general terms). The term monitoring tended to be used generically to cover both of these.

Historically, monitoring has concentrated on species or particular sites, not looking at the wider countryside and less rare species. Common species may have been overlooked.

There is a lack of a European context for species and sites.

Issues

The reporting of surveillance of common species and techniques for species grouping need to be made more 'user-friendly' and thus more easily understood by 'policy-makers'. Scientists and 'policy-makers' should work together to achieve more targeted monitoring

Discussion

Dr N Webb - Species together should form a viable system which should be sustainable

Prof J Miles - Monitoring has been unfashionable and consequently no one has made much progress in developing methods.

REPORT FROM GROUP 2 (THEMATIC MONITORING - GROUPS OF SITES)

The Group considered sites that were 'bounded designated areas', some of which would have multiple designations.

The scale of these sites ranges from a few hectares (e.g. some SSSIs) to several thousand hectares (e.g. National Parks). The heterogeneity of these sites would tend to vary with size and both factors may affect the monitoring methodology.

Setting targets:

The group identified a need for *precise targets*, especially when these were set by people other than those carrying out the research. Too often targets are qualitative and fuzzy. Precise targets have the advantage of being more cost-effective to monitor but precluded the collection of incidental information which might be (unexpectedly) of future value. Targets should be backed by an *explicit rationale* which will reduce any ambiguity about the requirements of the monitoring. The demands of information technology were considered by some to encourage precision, so that unambiguous information could be readily retrieved.

Techniques and processes to assist in targeting are relatively recent and generally limited in scope: there is scope here for development.

Measuring change:

Targets and monitoring requirements may be *iterative* but monitoring may be committed to previous more or less rigid methodologies.

Site selection is usually driven by the set targets which may indicate a selective, rather than random, procedure.

Baseline data are necessary not only for determining change but also may be useful for assessing threats to the environment and, hence, for setting the targets for monitoring.

Acceptable limits of change need to be defined so that suitable methodologies are adopted to detect change at the requisite level(s). Possible rates and extent of change must be considered.

Comparisons with areas *outside the site* may be important in assessing the importance, and causes, of changes within the site.

While *census* methods may be relatively straightforward (but often expensive for large sites with many features) *sampling* methods can be problematical.

Stratification is often essential for cost-effective sampling but the stratification <u>must</u> be appropriate for the type of information required from the monitoring. Inappropriate stratifications may be requested by the 'customer'. Common bases for stratification include:

- Land cover (perhaps determined from aerial photography or other types of remote sensing,
- Land classifications (e.g. ITE Land Classes, Biogeographical zones)
- NVC
- *ad hoc* stratifications (e.g. by management methods)

Methods

The methods employed for monitoring are generally dependent on *scale* and the set *targets*; this can limit the possibilities for common methodologies between monitoring programmes. Where the target is, for example, detecting the total loss of a feature, methods can be rapid with low inputs (but should still produce quantitative results). Detecting minor changes in components requires more refined (and expensive) methods.

The group agreed that most methodologies, with the exception of satellite remote sensing, were *old* (mapping, transects, quadrats). There is a need to develop new methods including low level aerial photography (e.g. from tethered wing-kites), local remote sensing (e.g. low level ATM-type scanners), the integration/overlaying of aerial photography and satellite remote sensing (thus gaining extra information from the texture apparent on aerial photos), and knowledge-based classification methods.

Processes

Again there is scope for development. Current monitoring techniques tend to be more or less descriptive, not hypothesis-testing, and therefore correlative. Determining the effects of different processes is often limited by a lack of adequate historical information (e.g. on management). Land cover recording alone may not be enough; management and other inferential data sources are often helpful (though sometimes ignored by scientists). Management needs to be monitored more.

Prediction

Predictive methods range from simple mathematical extrapolations of results to theoretical models (e.g. FIBS) and include 'mixed models' such as the MLURI grazing models. However, the group considered that a lack of knowledge about the processes involved could be a limiting factor.

Policy and management

There was not time to consider this aspect.

REPORT FROM GROUP 3 (WIDER COUNTRYSIDE MONITORING)

The Group questioned whether it was possible to separate the wider countryside from the other themes.

It was stressed that monitoring exercises increase in value with time.

Setting Targets

Government policy - most countryside targets are big and look for sustainability and maintaining quality and to detect change,; they are concerned with surveillance rather than monitoring.

Targets should not have too narrow a focus but, rather, should be broad so that nothing is missed.

There is a need for perspectives at the local, international level and all levels in-between

Examples of these sorts of projects have included Countryside Survey 1990, Phase I habitat survey, ESA monitoring, Land cover maps, and the UCPE work.

Measuring targets

The technical requirements of monitoring in the broader countryside include:

- A continuous long-term need to link small plots with the wider countryside
- An inventory of what is there and what is changing

Effectiveness of policy

Indicators of change have to look at the effectiveness of policy (this is real monitoring). Wider countryside surveillance can be used as a control to measure the effectiveness of other schemes (eg ESA monitoring)

Impacts and processes

Monitoring identifies change and direction. We have sufficient information to find the reasons for change and should be able to interpret change data.

Fewer monitoring stations may be required in the future.

Overall

We are conservative in our methodology; we are not good at interrelating surveys from the wider countryside down to the local level. We have enough information to identify change but we still do not understand the processes of change.

Dr T. Parr - There is not enough work done on the processes of change. We need to understand processes to know how to set targets. There is a need to link surveys at management level and countryside scale.

5. WORKSHOP 2 - WHERE DO WE GO NEXT?

5.1 Having considered what tools were currently being used to address monitoring requirements, delegates were then asked to look forward and discuss likely future requirements and the monitoring tools that might be necessary. The same three groups that had formed for Workshop 1 considered these further aspects.

Group 1 Site-based monitoring - Chair: Dr Nigel Webb - Rapporteur: Chris Preston

Group 2 Thematic monitoring (groups of sites) - Chair: Prof John Miles - Rapporteur: Dr Alan Cooper

Group 3 Broader countryside monitoring - Chair: Dick Birnie - Rapporteur: Alan Hopkins

REPORT FROM GROUP 1 (SITE-BASED MONITORING)

Resources

Resources for monitoring/surveillance are decreasing; the Government is unlikely to be able to meet commitments on monitoring which were made when signing up to European objectives.

Objectives

The following needs were recognised:

- to obtain agreed minimum standards for monitoring
- to make clear the quality of results from any monitoring exercise
- to encourage more communication between research groups so that we get more mileage from a survey.
- to integrate across scales
- to attempt a census for common (not too common) species.

CS2000

Any future Countryside Survey should ensure the minimum standards to allow results to be related to other surveys

It was not clear whether CS2000 should be maintained as a broad-scale survey or whether it should be refined.

Had CS1990 come up with anything surprising? The fact that previous surveys had not yielded unexpected results was useful confirmation of 'conventional wisdom'.

Results should be presented in a more interesting way.

REPORT FROM GROUP 2 (THEMATIC MONITORING - GROUPS OF SITES)

A number of needs were identified for future work:

- new 'intellectual effort' to be put into monitoring, especially in relation to defining surveyed features.
- cheap high-powered processors to overlay data sets.
- techniques for surveying non-grass, non woodland vegetation so that the vegetation itself was not damaged.
- more co-operation and collaboration to develop new ideas for protocols and information; a lack of existing protocols creates problems in collaboration.
- better quality control
- to detect and identify errors; we need to know the amount of variation in a data set.
- greater development of collaboration within the UK and especially ways round commercial forces and property rights limiting collaboration.
- better dissemination of information to help encourage technical and scientific developments.
- a better idea on how quickly change (of all types) takes place.
- in implementing CS2000, mapping procedures need to be improved.
- more analysis and opinion from researchers is required by policy-makers.

REPORT FROM GROUP 3 (BROADER COUNTRYSIDE MONITORING)

Discussion focused on an 'ideal system' in relation to four main areas: procedures, methodology, interpretation of processes and research requirements.

Procedures

The existence of CS1990 was viewed as a basis for follow-up surveys to enable changes over time to be identified. Procedural modifications could include:

- additional bolt-on studies (e.g. agricultural management)
- additional sites (between-sites variation is greater than within-site).
- selective sampling on a limited number of sites at more frequent intervals (e.g. annually) to allow more rapid changes to be detected.
- collecting information on functional groups, either by re-interpretation of existing data or by future modification of data collection.

Methodology

- Improvements in techniques could include photographic records, novel bio-assay techniques, remote sensing.
- Links with landscape ecology, including relationship between processes and indicator species.
- Possibility of an on-going study of a range species - effectively a 'common plant census' analogous to BTO bird census.
- Strengthening of the hierarchical approach of CSS90.
- Integrated approach: develop compatibility with the NVC and ECN.
- Spatial studies to provide information on specific areas, such as SSSIs and ESAs
- Establish basis for defining quality control in surveys and data interpretation.

Interpretation of processes

- Need to identify different types of change, and the causes of change, that have occurred between surveys 1 and 2, and between 2 and 3. This requires better information on land management.
- Need to interpret results to identify sites where change is reversible, i.e. that have potential for regeneration.

Other research requirements

- Socio- economic dimension, both in terms of socio-economic effects on processes of change, and the socio- economic consequence of change.
- Genetic aspects, e.g. genetic implications of isolation of species and plant communities.
- Refinements of remote sensing techniques.

Constraints

- There is a gap between that is desirable and the resources to achieve it accurately. The lack of collaboration in survey/monitoring studies, both between sponsors and between different contractors was identified. Competition between contractors for resources contributes to this problem.
- Cultural attitudes towards large-scale projects, and monitoring studies in general, were identified as possible constraints.

- Skills. The virtual disappearance of taxonomic botany in undergraduate teaching, and the poor career structure in ecology are factors which can limit availability of skilled staff.

Priorities

- Better integration of surveys.
- Strengthening of hierarchical approach.
- Better interpretation in terms of processes.
- Research to improve scope and accuracy of remote sensing techniques.

Dr J Hopkins - everyone seems to agree with the nested quadrat approach so we now need to define a minimum standard.

Dr A Stott - there needs to be a commitment for further collaboration between institutes and other groups

Dr R. Bunce - one of the ECOFACT modules will produce multivariate analysis to link various data sets.

6. CLOSING REMARKS

Prof Philip Grime, UCPE, University of Sheffield

In our attempt to say what we have learned from our experience of monitoring change, a number of points have arisen:

- there is a need for an adequate baseline if real changes are to be detected
- we need to set up systems which allow us to detect the unexpected, as well as expected, changes
- we need to understand change; this is not easy
- we should attempt to predict the consequences of current and future change
- we can plan interventions in changes to test hypothesis of the effects of change
- we are all agreed that there is a hierarchy of scales (Global, European, National (England, Wales, Scotland, Ireland), regional, local) and that monitoring must take place in the context of all of these.
- temporal scales are dependent on targets.
- Parallel monitoring objectives will never be met by a single approach; NVC and wider countryside monitoring both have their place
- there needs to be more and better interpretation of the results of monitoring through (i) correlative studies and (ii) screening and functional analysis of the type developed at UCPE (Integrated Screening Programme).

7. DISCUSSION: WHAT HAVE WE LEARNED?

7.1 Our aims

7.1.1 During the development of the ECOFACT programme and this Module in particular, two broad aims were set:

i. To review and discuss common standards of botanical monitoring.
ii. To assess whether there is scope for convergence in the methodologies used.

7.1.2 To address these aims, the workshop reported here was organised. Papers were invited from a wide range of researchers and others with an interest in the subject area. As well as providing all present with a useful update of the activities of individual organisations, these papers provided a focus for further discussion and served to remind participants of the varied and often competing demands of vegetation survey and monitoring.

7.1.3 As a way of structuring the workshop, participants were asked initially to consider the following from a range of scale perspectives:

- The **needs** for botanical monitoring, including monitoring for biodiversity, monitoring of management objectives, monitoring biodiversity (quality and quantity).
- The **approaches** which might be suitable, including consideration of monitoring units (species, communities, associations, functional types) in relation to needs, statistics and strategy.
- The **practice** of monitoring to include methods, skills, resources.
- The possibility of **convergence** and integration of methods in the light of needs.

7.1.4 This list was expressed in a slightly different way at the end of Dr Stott's opening paper where he stated his expectations of the workshop:

- Review current requirements, activities and approaches
- Identify opportunities for greater coordination/collaboration/integration.
- Identify technical/institutional constraints.
- Consider next steps
- Inform thinking about the design and implementation of CS2000.

7.1.5 It is this list that is used to structure the following section.

7.2 Current requirements, activities and approaches

The following section reviews the 'where are we now' aspects of the workshop in terms of a number of sub-headings.

"Survey and monitoring"

7.2.1 The papers presented during the workshop demonstrated a wide range of requirements for vegetation survey and monitoring and a similarly disparate number of ways of approaching the task. It became clear that while '***survey***' was a well-understood term, '***monitoring***' was a word that was used more precisely by some than others. Its more general use is to mean '*repeat survey*', while a more precise definition was 'repeat survey to assess progress towards specific target objectives'. In the context of this latter, more tightly defined meaning, ordinary '*repeat survey*' was considered to be '***surveillance***'. It may be important to know whether the general adoption of the term 'monitoring' to cover all types of repeat surveys is significant in terms of user understanding, or whether it is purely a matter of semantics. In this report, the term is used in its broader sense.

7.2.2 Other examples of differences in definition were noted during the workshop (eg in the use of the word 'habitat') but these tended to be associated with more technical or specific aspects to survey and are considered elsewhere.

Objectives

7.2.3 As might be expected, all of the survey and monitoring projects referred to in the given papers and in subsequent discussion had different detailed objectives although many had common themes. Some were extremely specific and targetted (eg see Dr Smith's paper) while others were much more general and broad-based (eg the Countryside Survey approach). The optimum strategy and methodology varied with the objectives but methods used in non-targetted surveys would inevitably form a compromise between what was ideal, what was practical and, very often, what was affordable.

7.2.4 At a time when Government funding for survey and monitoring was under scrutiny, it was especially important that survey work should be cost-effective; clearly defined objectives would assist in this.

7.2.5 The overriding message that was presented repeatedly was that objectives must be clearly thought out, made as simple as possible, clearly stated and constantly referenced during method development.

7.2.6 The point was also made that the identification of precise requirements was especially important if objectives were being set by people other than those carrying out the research. Targets should be accompanied by an explicit rationale which would then reduce any ambiguity about the requirements of the monitoring.

Frequency and timing of survey

7.2.7 Many speakers made the point that temporal scale is important and that the objectives of any monitoring activity should take this into account. The principle is that repeat surveys should only be carried out after sufficient time has elapsed for change in the surveyed feature to be detectable. Conversely, survey dates should not be so far apart that change between survey dates is left undetected, especially where such change is cyclical and this is seen as important.

7.2.8 In the Environmental Change Network, vegetation monitoring is carried out at three-year intervals (in Target Sample Sites) which is adequate for demonstrating long-term trends in vegetation change. However, annual monitoring would be more desirable and this would not only give more information about change at the individual sites but might also be used to 'calibrate' change in snap-shot surveys such as the Countryside Surveys.

7.2.9 The point was made that 'adverse' change (often involving destructive management practices) may happen faster than 'beneficial' change (such as natural vegetation recovery). If the former is important in policy terms, then monitoring timescales may need to be shortened.

7.2.10 There is some frustration in the timescales required for many types of scientific investigation are such that "by the time the research results are available the most significant policy decisions have been taken" (see paper by Hopkins). Survey and monitoring both take time and may report when the information is not, apparently, needed. However, it is still essential that research is carried out to answer questions when they do arise and there is a need to access research results quickly.

7.2.11 There was little discussion of the time of year that surveys should take place. However, Dr Smith's research results showed large seasonal variation in vegetation composition at a range of sites on agricultural land. In larger surveys (such as the Countryside Surveys) this effect was inevitable, given the amount of fieldwork involved but other, more targetted, surveys should consider the optimal survey period and the implications of sampling at different dates.

What to record

7.2.12 It was noted that most botanical monitoring is based on 'old' methodology and it was suggested that there were opportunities for fresh thinking and the adoption of new technology (see Recommendations). Despite the well established methods used by most groups, in nearly all of the presentations there were reported differences in what has actually been recorded as part of the survey or monitoring effort. These included:

- presence of certain species of interest (one or more)
- presence of all species
- the above, plus cover estimates (of various types, eg Domin or simple percentage classes)
- sampling of vegetation to apportion quantitative estimates of e.g. biomass as a measure of abundance

Some of these approaches were carried out by general searching in the area of interest, others in quadrats and/or transects, and yet more by field mapping. Thus, the opportunities for comparison of results are often limited when using extant data.

7.2.13 In some surveys, especially those where clear management targets have been set, it is often clear what attributes and variables need to be recorded. However, with more general surveys, there is a need to collect a wide range of information since this may become valuable in time. This latter situation was recognised as being a high-risk strategy as detailed surveys of this type were expensive and a proportion of the information might never be used.

7.2.14 The results of some survey and monitoring exercises had been mis-used through a lack of user understanding. This had been true of some of the CS1990 results which had been 'pushed' beyond their original intended applications. Such work needed a clear statement of the purpose and scope of the work.

7.2.15 In some cases, information from previous surveys had been made available to field surveyors and in other instances surveys had been done 'blind' at both dates. The CCW have found that by taking out the previous recording sheet they have identified surveyors who had constantly misidentified species on earlier occasions. ADAS have found that providing access to previous data reduced the apparent 'change' due to observer differences and has thereby helped with the detection of real change (see Change detection). The counter argument is that giving the surveyor data which had been recorded previously could bias the new recorder.

7.2.16 While the collection of vegetation *per se* was reasonably well understood and the detection of change well rehearsed, it was recognised that there was a paucity of supplementary information, such as field management, which would subsequently help with the identification of processes of change. Current monitoring techniques tend to be more or less descriptive, not hypothesis-testing, and therefore correlative. Determining the effects of different processes is often limited by a lack of adequate historical information (e.g. on management).

Definitions

7.2.17 It is axiomatic that good, clear, well-understood definitions of features to be recorded are needed. This is important both for consistency in recording and for appropriate use of results. However, it was clear that different definitions for features had been used in different surveys, as discussed below.

7.2.18 Several attempts had been made to use 'standard' nomenclatures and definitions (eg Tutin et al., Stace, NVC, NCC Phase I Habitat) and, while differences in species nomenclatures were relatively easy to resolve, vegetation mapping categories were variable. Attempts had been to understand these differences (eg the DOE Land Cover definitions project) and the reasons for them; these differences were due to a range of factors including historical precedents, differing backgrounds/disciplines and different objectives.

Scale and sampling units

7.2.19 Survey and monitoring have been carried out at a wide range of scales, from quadrats of a few cm^2 to whole 1 km squares. This makes direct comparison of results from different surveys more difficult to carry out. For example, a specific quote was that "we are conservative in our methodology: we are not good at interrelating surveys from the wider countryside down to the local level".

7.2.20 Historically, monitoring has concentrated on species or particular sites without considering the wider countryside and less rare species; as a result, changes in common species may well have been overlooked. The wider countryside was now coming under focus and there was an appreciation that monitoring needed to be carried out in the context of a range of scales (local, regional, national and international). There is, for example, a lack of a European context for species and sites in GB (although general statements may be made using the Flora Europaea).

Stratification

7.2.21 During the presentations and subsequent discussions, a wide range of stratification systems were considered. These ranged from no stratification at all, through single factor classifications (eg hydrology), to complex multi-factor approaches, as used in the Countryside Surveys. They included:

- Land cover (perhaps determined from aerial photography or other types of remote sensing,
- Land classifications (e.g. ITE Land Classes, Biogeographical zones)
- NVC
- ad hoc stratifications (e.g. by management methods)

7.2.22 While it was recognised that stratification was often essential for cost-effective sampling, the overall conclusion was that there is no optimal stratification which would meet all the requirements of all survey and monitoring projects. In the case of targetted surveys, the most relevant stratification should be carefully chosen but this should not be based on factors also being recorded in the survey.

Vegetation mapping

7.2.23 It was claimed that a vegetation map is an essential pre-requisite for characterising the vegetation types of each site and monitoring change. Various approaches were described including Phase I habitat survey, NVC mapping, Countryside Survey field mapping, and the use of remotely sensed information.

7.2.24 However, there was considerable discussion as to the real value of vegetation maps. ADAS no longer carried out vegetation mapping because of the errors involved. These were seen as of three major types:

- definitional (as discussed above)
- spatial (the accuracy with which lines are drawn on maps)
- overall observer ability (the summation of many things and especially dependent on experience)

7.2.25 The use of a grid of points was discussed as a surrogate for mapping. Opinions varied on the advisability of this; while accuracy would be increased at the point of survey, the overall spatial arrangement was no replacement for a map.

Quadrats

7.2.26 It was clear from the presentations and subsequent discussions that a wide range of quadrats had been used in different surveys and these varied in shape (square or linear) and size. Some were permanent and some transient; their spatial arrangement varied from random, through transect-located, to regular grids.

7.2.27 There was a well established scientific literature on the appropriate use of quadrats (eg Greig-Smith) and generally speaking, smaller quadrats were needed for more species-rich vegetation. However, this led to difficulties in comparison of results from different surveys and there was a strong case to be made for nested quadrats. There will be a different optimum size for different vegetation and for different species within any vegetation stand; thus the usefulness of a nested quadrat which allows comparison at a range of scales. The incorporation of a large quadrat with consequent longer species lists are less likely to be misclassified in subsequent analysis due to lack of sufficient species. They are also more robust for recording change, since there is less impact if there is a small difference in plot location. It was suggested that nested quadrats do not take much longer than quadrats of the same size, but they yield far more information.

Recording plant species

7.2.28 It was recognised that botanical recording was easiest and most consistently done at the species level (and became successively more difficult as species were aggregated into communities, or land cover types). However, some surveys had been more ambitious in which species had been recorded with, in some cases, lower plants omitted, or in others 'difficult' species being amalgamated into 'pseudo-species'.

7.2.29 There was a fundamental split between surveys where quadrats which were purposely placed in perceived homogeneous vegetation stands (eg NVC and UCPE) and those that were placed at random.

7.2.30 There were advantages to both approaches. The description of homogeneous stands (and mixtures thereof) is easier than that for more intrinsically heterogeneous vegetation. The NVC, for example has "become almost universally accepted in the UK as a standard for vegetation survey and site description". However, the NVC is a descriptive tool and does not give statistical information on vegetation types, nor is it wholly appropriate for monitoring purposes (see Dr Rodwell's paper).

Ability to detect change

7.2.31 Only little mention was made of the ability of different monitoring activities to detect real change. It was recognised that there were different quantitative and qualitative ways to express change and reference was made to statistical validity. However, in general the workshop failed to address this topic in depth.

7.2.32 It was claimed that by giving the surveyor previously recorded data it was easier to distinguish changes due to observer error from real changes. The paper by Dr Porter raises the interesting concept of 'acceptable limits of change' (as applied in SSSIs) which need to be defined so that suitable methodologies are adopted to detect change at the requisite level(s). Possible rates and extent of change must be considered.

Presentation

7.2.33 There was brief mention of the need to provide clear, concise, simple reports of survey and monitoring results, especially for policy readers. It was claimed that "one sentence can influence policy, complicated data and diagrams will be ignored". It was noted that there are natural scientists in the civil service whose job is to interpret scientific data for the policy makers. However, their job should be made as easy as possible.

Error and quality control

7.2.34 One of the persistent and recurring themes of the workshop was concerned with sources of error and the need for quality control. This was especially important for monitoring where it was essential to be able to detect real change and it was apparent that quality control had become intrinsic to most current survey approaches and estimates of error were usually given.

7.2.35 Broadly, quality declined with complexity or aggregation of basic recording units. Thus plant species were recorded 'better' than were vegetation communities/types or land use categories. Similarly consistency was poorer for estimates of cover than for species frequency. ADAS have found that the most common error is not mis-identification but missing species.

7.2.36 Dr Cooper's paper includes a useful list of common errors associated with field recording which summarise much of what others were reporting. The errors were:

- the omission of management or structure codes from the data sheet,
- codes entered in wrong columns of the data sheet,
- inaccurately mapped boundaries between semi-natural vegetation types,
- over-complicated mapping,
- misidentification of species
- entering wrong species codes onto the data sheets.

Dr Cooper then goes on to suggest how many of these errors may be remedied.

7.2.37 Finally, it was noted that the survey objectives should define the type of data to be recorded and the level of recording accuracy needed.

Staffing

7.2.38 Concern was expressed about the general lack of experienced field surveyors in the UK. The use of amateur recorders (eg for the BSBI schemes) was mentioned.

7.3. Opportunities for greater coordination/collaboration/integration

The current situation

7.3.1 The previous section highlights the wide range of survey and monitoring activities that have taken place recently, are on-going and are being planned for the near future.

7.3.2 One of the concerns that is being expressed is the lack of coordination, collaboration and integration between these activities. The reasons for this situation are many and varied and include aspects which have been described under nearly all of the sub-headings in the previous sections.

7.3.3 It is argued that there is an inevitable tension between (a) the need to adopt methods finely tuned to addressing the questions asked by different monitoring projects and (b) the need to achieve comparability in the method of data gathering and the variables measured so that disparate projects can contribute to a larger framework.

Future developments

7.3.4 The increasing requirement for efficient use of resources for such work have also been noted and there is a developing imperative for survey and monitoring results to be integrated so that the combined result gives greater benefits than just the sum of the separate parts. This is especially true of putting one set of research results in a broader context (see Scale above).

7.3.5 There is no lack of will on behalf of those concerned with monitoring to encourage collaboration and integration. However, this is bound to come second to the requirements of each individual study and it is unlikely that any methodology will be altered to encompass greater comparability with another survey, not least because changes in methodology may invalidate estimates of change. However, work in the current ECOFACT programme is going some way towards establishing links between different data sets, at different scales.

7.3.6 Parallel monitoring objectives will never be met by a single approach. However, what is important is that communication is maintained between all commissioners and practitioners so that each understands what the other is doing and why, and results from each survey may be considered in the light of the others.

7.3.7 Recommendations for improving these aspects are given in the next Chapter.

7.4. Technical/institutional constraints

7.4.1 The workshop failed to deal explicitly with this issue, although a number of factors emerged during discussion of other topics.

Technical constraints

7.4.2 As has been stated, survey and monitoring methodology is 'old' or, to put it another way, it is well developed. Current methodologies are 'low-tech' and unlikely to be technically constrained.

7.4.3 However, there is a view that research should be done to see if technology could help produce a faster, more cost-effective product eg by the use of low level aerial photography (e.g. from tethered wing-kites), local remote sensing (e.g. low level ATM- type scanners), the integration/overlaying of aerial photography and satellite remote sensing (thus gaining extra information from the texture apparent on aerial photos), and knowledge-based classification methods.

7.4.4 While the more remote forms of data recording will never log information at the individual plant level, by correlating some field work with other contemporary surveyed information, it may be possible to minimise what is thought to be relatively expensive forms of field-based survey. This needs further exploration.

7.4.5 Similarly, more technical forms of data capture (using hand-held, GIS-interactive, dataloggers), while not essential for field-based survey, may prove to be cost-effective and have been used in some instances.

Institutional constraints

7.4.6 Given the generally high levels of goodwill that currently exist between researchers in the field, any constraints that may exist are likely to exist at the organisational level, rather than at the level of the individual.

7.4.7 An important institutional constraint is that relating to understanding of research results. As was voiced at the workshop, scientists and policy makers tend to speak in a different language and they also work in different time-frames. Notwithstanding the efforts of those within the Departments and Agencies who are charged with interpreting results for policy customers, there is still a need for the suppliers and users of research to work more closely together towards a better understanding of requirements and technical limitations.

7.4.8 At a time when research funding is being squeezed, there are institutional constraints in terms of research priorities. In the Research Councils, for example, it is only relatively recently that survey and monitoring has regained a place in the research agenda. Similarly, a long-term commitment to monitoring is becoming a luxury within the funding Departments; there are overwhelming pressures to commission research that addresses short-term policy issues..

7.5. Next steps and Countryside Survey 2000

7.5.1 The current workshop has been organised in the context of a further Countryside Survey (currently planned to take place in 1998 and report in 2000). To that end, the

Department has set up a project to examine the policy requirements of Countryside Survey 2000 (CS2000) and ITE has set up a series of Technical Planning Groups to consider a range of aspects associated with the next survey.

7.5.2 One of these technical groups has been asked to consider botanical recording and another, land use mapping. It is anticipated that the output from this workshop will prove helpful in the work of these groups and that, conversely, many of the issues listed in the following Recommendations chapter, might be addressed through the work of the groups.

8. CONCLUSIONS AND RECOMMENDATIONS: WHAT NEXT?

8.1. Brief conclusions from the Workshop

8.1.1 The workshop achieved its first aim, to review and discuss common standards of botanical monitoring, by way of papers presented from a wide range of organisations concerned with a variety of survey and monitoring approaches, and by pooling the expertise and experience of those present to consider to what extent common standards exist, or should exist.

8.1.2 In this respect, the workshop was useful in pointing out that although the basic methodologies were broadly similar in nature, there were several differences which resulted from historical precedents, differing backgrounds/disciplines and different objectives.

8.1.3 The second aim, to assess whether there is scope for convergence in the methodologies used, was also addressed. The overall conclusion was that there were 'horses for courses' and that different methodologies were appropriate to meet different survey and monitoring requirements. While there was a will to collaborate, and to integrate research results where possible, it was felt unlikely that a single methodology was likely to emerge as a universally acceptable and appropriate answer to often parallel requirements.

8.1.4 However, there were many recommendations as to how survey and monitoring could be improved and more closely integrated. These are considered in the next section.

8.2. Recommendations

8.2.1 During the course of discussion at the workshop, many suggestions and ideas were put forward as to how survey and monitoring might be improved in the future and how some measure of collaboration and integration might be achieved. In addition, the second part of the group work was devoted to discussion of these issues.

8.2.2 Many of the recommendations echoed those made elsewhere (eg the DOE Policy Review of CS1990). Other recommendations relating specifically to the Countryside Surveys, given in Chapter 5, have not been included in the following table where they are already in hand (eg as part of the ECOFACT project).

8.2.3 In an attempt to structure the list of recommendations coming from the workshop, the following table shows the issues that have been identified as ripe for further consideration and the proposed recommendations for further research or consideration listed against each. The table is structured according to the headings used in the first part of the previous Chapter.

Theme	Issue	Recommendations
"Survey and monitoring"	Definitions of '***monitoring***' and '***surveillance***'.	Encourage those reporting results to make it clear in what sense they are using these terms, especially 'monitoring'
Objectives	Understanding the purpose of the work	State clear, unequivocal objectives before survey commences. Targets should be accompanied by an explicit rationale which will reduce any ambiguity about the requirements of the monitoring.
Frequency & timing of survey	The relevance of temporal scale to the objectives	Consider temporal when planning any new monitoring programme.
	Annual vegetation monitoring.	Support any initiative by ECN to carry out annual vegetation monitoring. Consider selective annual sampling on a limited number of CS1990 sites. Test a rolling programme of Phase I Habitat mapping.
	Incompatibility of research and policy timescales.	Improve communication between researchers and policy advisors, and deliver research results more speedily.
	The optimal time of year for botanical surveys.	ITE should assess the costs and quality of results given different number of surveyors taking different lengths of time to carry out survey.
What to record	Opportunities for adoption of new technology.	Basic research is needed to assess the cost effectiveness of new technology. Better dissemination of information to help encourage technical and scientific developments.
	Collection of targetted or broad range of data	The cost effectiveness, risk and usefulness of individual data items should be assessed prior to survey.
	Mis-use of survey results.	There should be clearer statements of the purpose and scope of the work.
	Provision of previous results to field surveyors.	ITE should carry out a pilot study ahead of CS2000.
	Inclusion of surveyed information to help interpretation of processes.	ITE should consult widely on what management information could be obtained from survey and what might be obtained from separate databases. Socio-economic dimension, both in terms of socio-economic effects on processes of change, and the socio- economic consequence of change.
Definitions	Definitions were not always consistent or clear	New 'intellectual effort' should be put into defining surveyed features.
Scale and sampling units	The need to link survey results from different scales.	Strengthen of the hierarchical (scale) approach of CS1990.

Theme	Issue	Recommendations
Vegetation mapping	The quality of information.	Assess the quality and cost-effectiveness of collecting botanical information using a variety of methods (eg remote sensing, field mapping, quadrats)
	The use of a grid of points as a surrogate for mapping.	The efficacy of this approach should be tested by pilot study before CS2000.
Quadrats	The adoption of nested quadrats as a routine sampling tool.	Define a minimum standard and assess the information content of different sizes of quadrat in relation to vegetation.
Recording plant species	Appropriateness of NVC for monitoring.	Assess the scale at which NVC can be used for monitoring.
Ability to detect change	Detection of 'real' change.	Ensure an adequate baseline and gain a better idea of how quickly change (of all types) takes place.
	Adopting the concept of 'acceptable limits of change'.	ITE should liaise with the conservation agencies in relation to thresholds of change and species quality.
	How to interpret change.	Ensure relevant information is recorded. Attempt to predict consequences of current and future change. Plan interventions in changes to test hypothesis of the effects of change. Make more use of the 'functional strategy' approach.
Presentation	The need to provide clear, concise, simple and interesting reports of survey and monitoring results.	Give much more thought to the best person (people) to write reports. Give particular attention to the interpretation and presentation of statistically derived vegetation classes.
	More analysis and opinion from researchers is required by policy-makers.	Encourage collaboration between users and researchers.
Staffing	The lack of experienced field surveyors in the UK.	ITE should consider this in advance of CS2000 and implement training where possible. The situation should be communicated to Universities.
Collaboration	Lack of genuine collaboration between research groups.	Set up a botanical survey Network (?) to encourage greater development of collaboration within the UK and especially ways round commercial forces and property rights limiting collaboration
	Different approaches to survey.	Integrated approach: develop compatibility with the NVC and ECN. Develop a framework for comparison of results from different surveys.
	Competition between contractors for resources.	Funding bodies should fund more collaborative work.

9. ACKNOWLEDGMENTS

9.1 Many people have been involved in the final production of this report,. In particular, I am grateful to:

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- Margaret Dixon for typing drafts of this report.
- Dr Bob Bunce for commenting on parts of early drafts of the report.
- and especially, the participants of the Workshop all of whom contributed in some way or other, providing papers, acting as Chairmen or Rapporteurs, and contributing to the group work and discussion sessions. I hope they found the meeting useful.

Annex 1 - Meeting Programme

Wednesday 17 April 1996

12.00 Lunch
12.50 Welcome (Colin Barr)
12.55 Introduction - Policy Context (Andrew Stott)

Chair: Lindsay Turl
13.15 Dr Helen Smith (WildCru, Oxford) - *Recording in agricultural systems*
13.45 John Hodgson (UCPE, Sheffield) - *Recording in grassland systems*
14.15 Owen Mountford (ITE, Monks Wood) - *Recording in wetlands*
14.45 Dr Terry Parr (ECN) - *Vegetation recording in the Environmental Change Network*
15.15 Tea

Chair: Alan Hooper
15.45 Dr Trevor Dines and Cameron Crook (BSBI) - *The BSBI Recording Scheme*
16.15 Nigel Critchley (ADAS) - *ESA monitoring in England*
16.45 Caroline Hallam (ITE, Merlewood) - *The 'Countryside Survey' approach*
17.15 Discussion

18.00 Reception

19.00 Dinner

Thursday 18 April 1996

Chair: Dr Bob Bunce
09.00 Dr John Rodwell (Lancaster) - *Use of the NVC for botanical surveying and monitoring*
09.30 Alan Brown (CCW) - *LIFE in Wales*
09.40 Dr John Hopkins (JNCC) - *Strategic requirements for policy*
10.10 Discussion
10.30 Coffee
10.55 Workshop Part 1 : *Where we are now*

12.30 Lunch

13.30 Report from Workshop I
14.00 Workshop Part 2 : *Where we go next*
15.15 Tea
15.30 Report from Workshop II
16.00 Prof Philip Grime (UCPE) - Concluding remarks

16.30 Close

Annex 2 - List of participants

David Askew (ADAS)
Colin Barr (ITE, Merlewood)
Dr Dick Birnie (MLURI)
Dr George Boobyer (DOE)
Alan Brown (CCW)
Dr Bob Bunce (ITE, Merlewood)
Dr Alan Cooper (Ulster)
Paul Corbett (DOE-NI)
Nigel Critchley (ADAS, Newcastle)
Cameron Crook (BSBI)
Roger Cummins (ITE Banchory)
Dr Trevor Dines (BSBI)
Caroline Hallam (ITE)
Dr John Hodgson (UCPE, Sheffield)
Alan Hooper (ADAS)
Alan Hopkins (IGER)
Dr John Hopkins (JNCC)
Prof Philip Grime (UCPE, Sheffield)
Prof John Miles (SOEnv)
Owen Mountford (ITE, Monks Wood)
Dr Terry Parr (ECN)
Simon Poulton (ADAS, Wolverhampton)
Chris Preston (ITE, Monks Wood)
Dr John Rodwell (Lancaster)
John Rose (Sheffield Hallam University)
Simon Smart, (ITE, Merlewood)
Dr Helen Smith (formerly WildCru, Oxford)
Dr Andrew Stott (DOE)
Mrs Lindsay Turl (SOAFD)
Samantha Walters (ITE, Merlewood)
Tony Waterman (DOE, NI)
Dr Nigel Webb (ITE, Furzebrook)
Trevor West (BBSRC)
Dr Stephanie Wray (Cresswell Associates)

Apologies received from:
Speakers
Des Thompson - Summoned to Whitehall
Keith Porter - illness
Others
Peter Costigan, MAFF
Jon Marshall, BBSRC Long Ashton - Summoned to Brussels (replaced by Trevor West)
Liz Howe, CCW - (replaced by Alan Brown)
Chris Moos, Countryside Commission - (nominated John Rose from Sheffield Hallam)
Lindsay Roberts, Welsh Office
Richard Weyl, DE Northern Ireland - (replaced by Tony Waterman)

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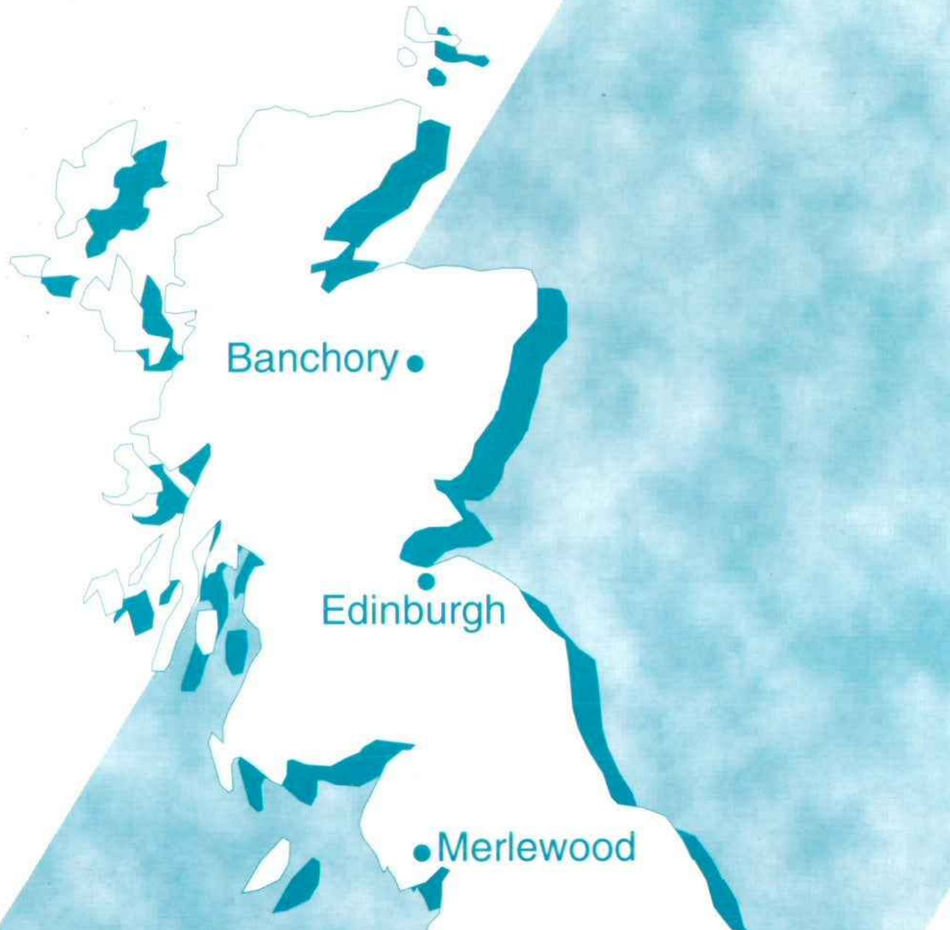

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