

UK Biodiversity Research Advisory Group

RESEARCH STRATEGY

for

Management of Habitats and Ecosystems

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on behalf of the Habitat and Ecosystem Management sub-group

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1. Introduction

1.1 The key drivers

Human activities are having a major impact on biodiversity, seen clearly at the levels of habitats and ecosystems. The four primary global change drivers are land use, climate change, N deposition and biotic exchange. All are likely to increase in intensity during the 21st Century.

These drivers of change, together with neglect, the continued impacts of previous fragmentation, and other land-use changes, will continue to impact on the quantity and quality of biodiversity in the UK. Behind many of these drivers are economic, social, political and technological factors, driven themselves by population growth and increases in the demand for the quantity and quality of goods.

The likely future pressure on biodiversity from drivers of change re-emphasises the continued importance of UKBAP and the need for HAPs (and SAPs) to deliver their objectives. One of the limitations on HAP delivery is the availability of relevant knowledge and information on which to base appropriate action.

1.2 Legislation and Regulatory Context

The loss of biodiversity is an acute environmental problem, which is addressed by a growing number of national and international policies such as the UK Biodiversity Action Plan (UK BAP) and the Convention on Biological Diversity (CBD). However, the continuing decline in biodiversity led to the European Union's 2010 target, which aims "...to protect and restore habitats and natural systems, and halt the loss of biodiversity by 2010."

In order to strengthen the "2010 Target", the European Platform for Biodiversity Research Strategy (EPBRS) prepared research proposals which fed into the "Message from Malahide" (EU, 2004), in which EU members have agreed to "...improve and apply the knowledge base for the conservation and sustainable use of biodiversity." From this, EPBRS has agreed an Action Plan for Biodiversity Research in Europe (EPBRS, 2005) http://epbrs.org/PDF/EPBRS-HU-2005-Action_plan_Release1_1.pdf

In addressing habitat and ecosystem management, the relevant legislation is The Convention on the Conservation of European Wildlife and Natural Habitats (The Bern Convention), which came into force in 1982. Among the Convention's principal aims is an attempt to ensure conservation and protection of all wild plant and animal species and their natural habitats. In order to implement the Bern Convention in Europe, the European Community adopted Council Directive 92/43/EEC on The Conservation of Natural Habitats and of wild Fauna and Flora (the EC Habitats Directive) in 1992.

For details see:

http://www.coe.int/t/e/Cultural%5FCo%2Doperation/Environment/Nature%5Fand%5Fbiological%5Fdiversity/Nature_protection/default.asp

Among other things, the Directive provides for the establishment of a European network of protected areas (Natura 2000).

The Convention was ratified by the UK in 1982, and implemented in UK law by The Wildlife and Countryside Act (1981, plus amendments).

The terrestrial and freshwater focus

Over 70% of the UK land area is farmland and, as such, constitutes one of the most diverse landscapes in the country. However, agricultural intensification, particularly since the 1970s, has had a damaging effect on habitats and their constituent flora and fauna. Countryside Survey 2000 has highlighted the continuing declines in the extent and quality of cherished habitats. This deterioration is of particular concern in relation to nationally important wildlife sites, many of which are on farmland, and Defra has therefore adopted a PSA target to bring 95% of such sites into favourable condition by 2010.

Concerns about the loss of biodiversity across all species and habitats have been expressed at a European level with the adoption of a community target to halt the loss of biodiversity by 2010. Within agriculture, reform of the Common Agricultural Policy (CAP) has a number of associated policy initiatives that will impact on the farmed environment, particularly cross-compliance and agri-environment schemes (such as Environmental Stewardship in England). Within Defra, the Environmental Stewardship Scheme (ESS) represents the Department's flagship farm biodiversity scheme. This will be the main policy instrument for contributing to the achievement of UKBAP targets and the Department's SSSI PSA target.

Another major contribution to the enhancement of biodiversity is expected to result from the implementation of the Water Framework Directive. The Directive is the most substantial piece of EC water legislation to date. It requires all inland and coastal waters to reach "good status" by 2015. Transposition and implementation of the WFD in the UK is devolved. In England, Defra is seeking to achieve reductions in Diffuse Water Pollution from Agriculture (DWPA) by encouraging more Catchment-Sensitive Farming which involves managing land in a way that is sensitive to the ecological health of the connected water environments.

The marine focus

The regulatory need to consider the ecological, economic and societal importance of habitat and ecosystem management is implicit within the wording of the revised Common Fisheries Policy, in which it is recognised that sustainable exploitation of fisheries will require a more 'ecosystem based' approach to management (EBM) of fishing activities. Nevertheless, the CFP has primarily regulatory powers to control fishing activity on the grounds of fish stock conservation. As yet there are no explicit powers to control fishing to preserve habitats (although there was a recent exception when all member states agreed to prevent further fishing on deep-water corals). Fishing on particular habitats can be controlled if this is deemed to be the necessary course of action to conserve commercially important stocks of fish or shellfish. The adoption of an EBM will require a consideration of the role of habitats and ecosystem components and health in the maintenance of commercially important stocks. In this sense, future fisheries management will require much broader management tools and ecosystem metrics against which to assess ecosystem health.

Implicit within an Ecosystem Approach to management is the need to consider other activities that have the potential to impact upon the marine environment in addition to fishing activities. Such activities also include: aggregate and sand dredging in coastal waters, dumping at sea, decommissioning of offshore platforms and exploration for hydrocarbons, developments of renewable sources of energy in coastal waters and offshore, land reclamation, aquaculture associated activities and associated environmental effects, and the transfer of exotic species into coastal waters.

2. Background and Scope of the Strategy

2.1 BRWG Statement

The Biodiversity Research Working Group, in the report *Science in Action for Biodiversity* (Defra, 2001), identified “Science-based management of habitats and ecosystems” as a key cross-cutting research theme. The aim is to develop knowledge, best practice and tools to enable management for biodiversity at a range of spatial scales, eg. regional, catchment and site scales for terrestrial habitats, and in all cases aimed at optimising landscapes and habitats for biodiversity. This programme arises from a need to complement the effort within individual species and habitat action plans by focussing on cross-cutting management issues that address the wider landscape and integrate with sustainable development objectives.

2.2 The authors

This Research Strategy has been developed on behalf of the UK Biodiversity Research Advisory Group (BRAG) by a specialist sub-group. Members of the sub-group were drawn from a variety of organisations, across all sectors – terrestrial, freshwater and aquatic, representing policymakers, researchers and practitioners. The sub-group was co-chaired by Kevin Charman of English Nature and Andrew Pullin of the Centre for Evidence-Based Conservation (CEBC) at the University of Birmingham. A full list of the members of the sub-group can be found in the Annex at the end of this Strategy.

The sub-group has been informed by earlier work, undertaken as two contracts, one to collate into a spreadsheet all existing habitat management research associated with the 45 HAPs (The Wildlife Partnership, 2004); and the second to interview key players involved with research and delivery of a selection of HAPs, to identify knowledge gaps and research needs (England Marketing, 2005).

2.3 What we are attempting to do in this Strategy?

The purpose of this Research Strategy is to highlight priority research themes which have been identified by the BRAG Habitat & Ecosystem Management sub-group as representing the most important knowledge gaps limiting progress for the 45 HAPs in the UKBAP; as well as identifying a number of generic research issues applicable across a range of spatial (and temporal) scales.

Our general view is that the information required to deliver HAPs falls broadly into five categories. We see the following sequence as being a logical order, but one which does not imply any priority. Indeed, this approach has been used as a method

to tabulate the information we have collected (see Annex 3). The habitat needs to be:

- (i) adequately defined so that
- (ii) its extent and distribution can be assessed. Information on trends needs to be collected through
- (iii) monitoring change to the resource and
- (iv) the effectiveness of management strategies evaluated with components related to maintenance, restoration or recreation of interest features. In addition
- (v) processes at a landscape scale beyond (or between) individual site units need to be understood and taken into account.

Assessing the extent of our knowledge in each of these areas is challenging but we have started to do this for all 45 HAPs. Our approach has been to use existing reporting information (from the 2002 Reporting Round, <http://www.ukbap.org/Library/2002ReportPamphlet.pdf>) to assess adequacy of current knowledge and, therefore, enable us to assess future priorities.

In addition to acquiring the necessary information, knowledge transfer mechanisms are required to deliver information to the user at the right time and in the right form to aid decision making. The communities involved in HAP delivery are very variable and there needs to be some consideration given to how activity is coordinated in a range of different circumstances.

In addition to highlighting research themes (1-15), and mapping these onto the Action Plan for Biodiversity Research in Europe (EPBRS, 2005), the Strategy aims to identify possible funding and delivery partnerships (indicative rather than prescriptive); as well as proposing mechanisms and activities for effective knowledge transfer and coordination of action.

3. Specific Research Objectives

SITE-BASED

3.1 Ecological Definition (what is it?)

Position Statement: Revisiting the appropriateness and utility of HAP definitions.

- 1. Identify those HAPs where definition is a limitation to progress [EPBRS 4]**
Funders – Defra/SE/Statutory Agencies
- 2. Basic ecological research to better understand habitats and thus discriminate between them? [EPBRS 4&5]**
Funders – Defra/SE/NERC

Commentary: We take the view that surveillance, monitoring and evaluation are forms of research. Defining the resource of particular conservation interest so that it can be identified in the field is clearly a crucial first step to taking action. In some situations definitions are poor and need refinement. In others, whilst the definition is

clear, it is too broad based and fails to form the basis on which to focus action. This appears to be especially true for marine habitats where some of the HAPs currently defined encompass very large areas. This is in part due to limited survey information. Developing an understanding of the content and distribution of marine ecosystems means that some of these definitions could now helpfully be refined and HAPs focused on a more limited area. The development of a framework for mapping European seabed habitats (MESH) is an important initiative. MESH is an international habitat mapping programme, which aims to produce seabed habitat maps for north-west Europe and develop international standards and protocols for seabed mapping studies (for details see <http://www.searchmesh.net/>).

Whilst various different habitat/vegetation classification systems exist (e.g. NVC, Corine, LCS'88 (Land Cover of Scotland)), there is no one system which is entirely suitable to map all UKBAP habitats. Furthermore, it is evident that some habitats are being lumped together due to lack of our understanding of the underlying ecology. Basic research is required to enable some HAPs to be established with any authority. Looking across all 45 HAPs, the level of research input to basic ecology is very uneven, and in some cases HAPs may have less credibility in terms of their evidence-base (see Annex 3).

While not strictly research, there is a need to assess and sort definitions, to move towards greater consistency and common understanding. It is important that we acknowledge the differences between the terrestrial/aquatic and marine environments, in that habitat definition is generally less developed in the marine context. This is both a technical issue and the result of the extensive area requiring classification. The way in which the UKBAP process has identified marine HAPs means that some habitats extend across the whole of the coastline.

Note: the BRAG sub-group concerned with *Monitoring of biodiversity and evaluation of actions* has focused on issues relating to surveillance and monitoring.

A problem of definition: Mud Habitats in Deep Water

Marine habitats are intrinsically problematic to quantify in terms of their extent due to the current technological difficulties with large-scale remote sensing of the marine environment. Only shoreline and shallow sub-tidal clear waters are suitable to rapid wide-scale assessment. Consequently, much of the UK offshore marine habitats below depths of 5 m are poorly known. The current state of knowledge of the extent of these habitats is confined to habitat maps of the seabed that are interpolated from site-specific samples that may occur many km apart. For many areas of the shelf sea it is possible to predict with reasonable accuracy the likely sedimentary environment from predictive models of surface and seabed currents and shear stress. Accordingly, mud habitats are found in areas subjected to low physical stress (low current, gyres, deep water, sheltered from wind stress). Nevertheless, the biological communities in mud habitat remains relatively poorly studied apart from a few case specific areas such as the mud habitats off Sellafield Nuclear Reprocessing Plant in Cumbria, and some Scottish Sea Lochs. Often these mud habitats host important high value commercial fisheries for Dublin Bay prawns (*Nephrops norvegicus*). Despite their value of mud habitats in terms of their contribution to fisheries, we understand relatively little about their ecosystem functions and health in a UK context and knowledge of their biological assemblages is patchy. Furthermore, it is likely that some of these habitats are relatively isolated by oceanography (e.g. the two mud patches in the Northern Irish Sea are associated with seasonal gyres that entrain larvae within each area and may contain genetically distinct stocks of biota).

3.2 Mapping and surveying (where are they?)

Position Statement: undertake an audit of the distribution of UKBAP terrestrial, freshwater and marine priority habitats across the UK, using comparable methods. This work will seek to support the *Action Plan for Biodiversity Research in Europe* (EPBRS, 2005), objective 1: Assess distribution, (status and trends) of European (species and) habitats, especially those of Community interest.

3. Develop and apply a unified system for auditing the distribution of priority habitats within the UK, compatible with existing European schemes

[EPBRS 1]

Funders – Defra/SE

Commentary: This is a fundamental task that may not be strictly viewed as research. Understanding the full distribution of a habitat (and understanding how this has changed or is changing over time – see monitoring, below) is crucial baseline information on which to base action. With only limited effort available for action this is particularly significant in order to develop cost-effective and efficient use of resources. Clearly, the size of the task is influenced by the distribution and abundance of the habitat in question, together with the complexity and speciality of the habitat content. These factors are especially pronounced in the marine habitats where expensive techniques (sampling) are frequently needed because of the nature of the environment. With the appropriate co-ordination, technological advances could significantly enhance our capability to achieve this task in a cost-effective manner.

While it is a relatively simple task to quantify the extent of different terrestrial habitat types using remote sensing techniques, the majority of the World's oceans (99%) are relatively inaccessible to rapid remote sensing. Consequently our knowledge of marine systems lags behind that for the terrestrial environment. This fundamental lack of knowledge means that it is difficult to assess the rate of habitat loss when we have imperfect knowledge of the baseline condition.

3.3 Ecological dynamics of sites (what's happening?)

Position Statement: develop an understanding of what is happening to sites, in terms of their condition (c.f. Favourable Conservation Status), composition and ecological function. This will require the development and implementation of monitoring and surveillance programmes of sufficient frequency, detail and extent to detect trends, and seeks to support the *Action Plan for Biodiversity Research in Europe* (EPBRS, 2005), objective 1: Assess distribution, (status and trends) of European (species and) habitats, especially those of Community interest.

4. Application of effective monitoring, surveillance and evaluation techniques within and between sites [EPBRS 1]

Funders – Defra/SE/Statutory Agencies

5. Understand responses to anthropogenic and natural drivers of change. [EPBRS 14,19&20]

Funders – Defra/SE/Research Councils/business/private sector

6. Ecosystem functioning, provision of goods & services [EPBRS 6,8,16,18&19]

Funders – Defra/SE/Research Councils/business/private sector

7. Autecology of species of conservation concern, indicator spp. And “keystones” [EPBRS 6,19&24]

Funders – Defra/SE/Statutory Agencies/NGOs

Commentary: Many habitats are very dynamic and yet we understand little about the drivers of change, natural or anthropogenic. Effective monitoring programmes need to be established for many HAPs, simply in order to understand what the baseline (in absence of intervention) is (see Annex 3 for details). We have the techniques to establish effective monitoring programmes, but our perception is that the issue is one of resourcing and coordination (see separate Research Strategy on *Monitoring of biodiversity and evaluation of actions* for more detailed recommendations).

Moreover to judge the effectiveness of current actions and to identify future trends and changes (that will need new actions designed around them) it is essential to understand what is happening on individual sites and on the full suite of the resource. The development of measures of favourable conservation status that can be applied at a number of scales is essential. The Common Standards monitoring framework provides some of this through assessments of the condition of individual features of interest. These data, and others, will form the basis of conservation status assessments for Habitats Directive features. Exactly how the results will be brought together is still being developed.

Identification of site and geographical trends is only one element. Linking changes to the impacts of individual drivers and specific responses is another. As well as changes in features there are also changes to functioning and processes which need to be identified and understood. The development of single- and multi-species indicators to help identify and understand what is happening may be important.

In addition to the standard species-specific approaches to monitoring in the marine environment, we should consider integrating the measurement of community metrics such as biomass and body-size spectra, which capture the structure and functional health of communities in a relatively simple but comparable manner. These metrics are relatively inexpensive and do not require high levels of taxonomic skills, but tell you immediately if, for example, all the large-sized biota in a habitat have declined and been replaced by smaller bodied opportunists.

The BRAG Monitoring and Evaluation Sub-Group has recognised the importance of attempting to work towards a UK monitoring strategy. However, this should recognise the importance of monitoring schemes to meet specific needs. Any such methods need to be considered a part of a wider programme of monitoring, with attempts made to “improve” compatibility across schemes, rather than aiming to achieve full integration within all monitoring elements but with loss of focus.

The frequency of monitoring will depend on the timescale of change and the scale of impact e.g. for climate change, invasive non-native species. For more

geographically-limited impacts, coordination could be at the local or Regional level but for many aspects of monitoring planning needs to be undertaken at a national scale. Establishing managing and co-ordinating a UK wide monitoring scheme is a high priority.

3.4 Site-based management (How are we doing?)

Position Statement: develop a clearer understanding of the effectiveness of current interventions for maintenance, restoration and (re)creation. This builds upon the Position Statement prepared by the monitoring sub-group, i.e. identification of novel approaches to management, which obviate or mitigate the impacts of change.

8. Evaluation of the effectiveness of current management strategies for site maintenance [EPBRS 16,18&21]

Funders – Defra/SE/Statutory Agencies/landowners/business/private sector

9. Feasibility/effectiveness of restoration and recreation (in rel. to above) [EPBRS 18&21]

Funders – Defra/SE/Statutory Agencies/landowners/business/private sector

10. Application of effective internal (i.e. site-based) monitoring and evaluation techniques (see also d above) [EPBRS 18&21]

Funders – Defra/SE/Statutory Agencies

11. Development of predictive models & Decision Support Systems to improve management [EPBRS 16]

Funders – Defra/SE/Statutory Agencies

12. What is the appropriate scale (range of scales) of management? [EPBRS 2&3]

Funders – Defra/SE/NERC

Commentary: By their very nature HAPs focus on action, and yet we know very little about the effectiveness of those actions. A combination of systematic review and original research (including monitoring) is required to evaluate current actions, including their cost effectiveness.

There needs to be a commitment to monitoring the effectiveness of management interventions, i.e. in relation to controls. Management objectives fall broadly into three basic categories. Interventions are either intended to maintain, restore or recreate habitat quality or quantity. Use of adaptive management cycles with formal, possibly independent, review and evaluation should be strongly encouraged. Consideration needs to be given to whether this should be mandatory. With improved monitoring, within an adaptive management framework, it will become possible to develop more realistic approaches to modelling and Decision Support Systems (DSS).

Research within this broad theme is focused at the site-level, which presents a number of problems in the marine environment (see 3.1, and 3.2 above). Within the

marine environment, there is a particular need to develop a more comprehensive management strategy. To do this most effectively, we need to consider sites as part of a wider, dynamic habitat mosaic, i.e. at the landscape scale (see below).

3.5 Landscape scale (what's the big picture?)

Position Statement: there is a need to set habitat patches within the context of larger spatial and temporal scales and processes

13. Understanding landscape/ecosystem processes and their impacts on sites, at a range of scales [EPBRS 2&3]

Funders – NERC

14. Modelling to explain & predict the impact of exogenous drivers, e.g. socio-economics, environmental change [EPBRS 14,15,16,18&20]

Funders – Defra/SE/NERC/ESRC/business/private sector

15. Monitoring (cross link to monitoring SG) & surveillance [EPBRS 1]

Funders – Defra/SE/Statutory Agencies

Moving from the site scale to the landscape scale.

Many decisions about actions and interventions will be made (and need to be made) at the site/local scale. We can also recognise that some actions and decisions need to be based on a consideration of a portfolio of sites and how they interact. Above this individual habitat, site or multi site approach there are landscape scale influences and processes across a number of habitats. These processes need to be understood and have predictive models developed in order to aid decision making. The main factors that need investigation are recruitment, mortality and dispersal (immigration and emigration) and are likely to be linked to the distribution of suitable habitats, to functional distances between sites and the permeability of the intervening countryside.

Landscape-scale planning needs to consider the wider forces operating beyond the site level (Watts and Selman, 2004). It is vital that we make the linkages between actions at the site scale, or on an individual HAP basis, to the impacts within the wider landscape. Certainly, one of the criticisms of the UKBAP has been that it concentrates too heavily on specific, often statutorily designated, sites where Lead Partners feel they have greatest control (Green, 2000). However, it is likely that decisions regarding the appropriate scale for management action will need to be taken in relation to individual HAPs.

The extent and spatial arrangement of priority habitats is an important issue, requiring research. As part of the 2005 UK BAP targets review process, it is important to be able to set indicative figures for the overall area of each of the priority habitat types, in order to achieve their long term viability. This has been attempted for lowland heathland, with the Lead Coordination Network (LCN) and RSPB determining the minimum heathland patch size necessary to support certain key bird and invertebrate species. This has been done in order to derive the heathland area and configuration required to support these species in a sustainable way. This

approach needs to be extended to other broad habitat types, utilising a scientific basis to underpin targets for the extent and spatial distribution required to secure safe status of both habitats and their dependent species. In order to do this, there is merit in exploring the use of monitoring scheme data (e.g. rare/scarce plant population data, butterfly monitoring scheme data).

However, given the uncertainty surrounding accelerating environmental change, particularly associated with climatic factors, pollution, or acidification, there is a need to think beyond the boundaries of existing HAP types. Management interventions need to enhance ecosystem resilience in the face of this change, allowing for shifts in species distribution. This requires management which takes account of landscape-scale processes impacting on sites/habitats/ecosystems, such as fragmentation, connectivity, and the dispersal capabilities of associated species.

Furthermore, biodiversity action at this scale requires an effective network of human and institutional interests, engaging people with a variety of economic and social concerns (Watts and Selman, 2004).

The need for a broader scale approach is highlighted further by the current move to try and reconstruct past marine ecosystems from archived information. The issue of the role of habitat fragmentation in the extinction rate of marine biota will be particularly problematic. While it is relatively simple to understand the processes of connectivity between habitats in terrestrial systems, this is a much more difficult concept for marine systems though no less relevant. While we understand many of the physical and chemical processes that might represent barriers and hence influence connectivity in marine systems, we have been slow to link biological considerations of processes that maintain population viability to abiotic boundaries.

Furthermore, exploitation of marine biological resources has failed to achieve management targets in many systems and has led to major ecosystem shifts in certain parts of the world. The 'open' nature of marine systems means that it is much harder to define discrete management units for which the biological and physical interactions are completely understood.

4. Knowledge Transfer

Within and between HAP partners

There is a wide variety of organisations and individuals involved in HAP groups and HAP delivery. The LBAPs play a key role in local/regional delivery of biodiversity objectives, and there is a definite need to improve communication between Lead Partners and LBAPs. Structures, communication and coordination mechanisms have evolved in the different circumstances. As far as we are aware no analysis of the different approaches has yet been undertaken. Such an assessment could help identifying best practice and provide pointers and guidance on how best to organise and manage HAP delivery.

16. Undertake an assessment of best practice in organisation and delivery of HAPs [EPBRS 22]. Funders: Defra

Wider KT

There is a wide variety of mechanisms currently in operation to exchange information: for example, organisations like FACT/GAP; websites of various kinds; magazines (e.g. the habitat management section in *British Wildlife*, 'Sitelines' produced by the Country Agencies etc.); traditional scientific journals; books. There is good evidence that such uncoordinated dissemination of information of variable quality is not effective or desirable (Pullin et al. 2004). How do we get to the point at which land managers change decisions, based on scientific research outputs? It is important to identify those delivery mechanisms that target the different audiences most effectively.

Valuable pointers are available from other disciplines such as the health services (cf Cochrane Collaboration www.cochrane.org). There is a need for appropriate and effective mechanisms to collect, review and disseminate information (best available evidence) to policymakers, advisors and practitioners. A co-ordinated and respected system is required that is objective (scientifically rigorous), independent and unbiased (transparent methodology). Dissemination mechanisms need to be tailored (e.g. language and format) to the needs of stakeholders. Users need to feel ownership of the mechanism. Successful mechanisms exist in other sectors (health services and social sciences) and a similar mechanism is already being piloted with NERC and EN funding (Centre for Evidence Based Conservation, <http://www.cebc.bham.ac.uk/index.htm>).

17. Establish a knowledge transfer infrastructure in environmental management by providing core funding for coordination of review and dissemination of scientific evidence [EPBRS 32].

Funders – Defra/SE/Statutory Agencies/NERC/business sector/landowners

5. Conclusions: where do we go from here?

The summary table presented in this report (Annex 3) is the first step in evaluating future research priorities. At this stage, we have not undertaken a full evaluation, but have laid down a framework for doing so. Synthesis and prioritisation (by activity and by HAP) are the crucial next step in this process. Linking this to the 2005 Reporting Round, necessitates a re-evaluation of the table when new Lead Partner data become available in March 2006. At this time, a full assessment of the knowledge gaps and research needs will be undertaken, in order to set priorities for research funding.

However, there are some clear messages that came through from discussions within the sub-group.

- The need for an adequate and coordinated monitoring and surveillance programme established against clear baseline information on the distribution and abundance of the resource is paramount.
- In addition, issues of process at the landscape scale and knowledge transfer are longer term elements which need to be addressed.

Whilst we will continue to refine the definition of research requirements there seems little point in doing this endlessly unless we can influence the resources available to pursue these objectives. We see the availability of resources being more of a constraint on acquiring and using information than the detailed definition of research topics. We would recommend that BRAG give careful consideration to how it should try to influence the availability of future funding. An element of this approach needs to be a strategy to influence external funding sources beyond BRAG membership itself. External influencing on behalf of BRAG should be seen as a significant component of the secretariat's duties.

Research themes can be grouped according to the likely lead funding agency (note: some overlap is possible, where a theme can be addressed in a variety of manners, by numerous funders). Below, we have outlined these groupings, beginning with themes that appear most relevant to the Research Councils UK (to be proposed via the Environmental Research Funders' Forum, ERFF).

ERFF priorities

- 2. Basic ecological research to better understand habitats and thus discriminate between them? [EPBRS 4&5]**
Funders – Defra/SE/NERC
- 5. Understand responses to anthropogenic and natural drivers of change. [EPBRS 14,19&20]**
Funders – Defra/SE/Research Councils/business/private sector
- 6. Ecosystem functioning, provision of goods & services [EPBRS 6,8,16,18&19]**
Funders – Defra/SE/Research Councils (NERC and ESRC)/business/private sector
- 12. What is the appropriate scale (range of scales) of management? [EPBRS 2&3]**
Funders –Defra/SE/NERC
- 13. Understanding landscape/ecosystem processes and their impacts on sites, at a range of scales [EPBRS 2&3]**
Funders – NERC
- 14. Modelling to explain & predict the impact of exogenous drivers, e.g. socio-economics, environmental change [EPBRS 14,15,16,18&20]**
Funders – Defra/SE/Research Councils (NERC and ESRC)/business/private sector
- 17. Establish a knowledge transfer infrastructure in environmental management by providing core funding for coordination of review and dissemination of scientific evidence [EPBRS 32].** Funders – Defra/SE/Statutory Agencies/NERC/business sector/landowners

6. Glossary

BRAG	Biodiversity Research Advisory Group
BRWG	Biodiversity Research Working Group
CAP	Common Agricultural Policy
CCW	Countryside Council for Wales
CEBC	Centre for Evidence Based Conservation
CFP	Common Fisheries Policy
DSS	Decision Support Systems
DWPA	Diffuse Water Pollution from Agriculture
EBM	Ecosystem Based approach to Management
EN	English Nature
EPBRS	European Platform for Biodiversity Research Strategy
ERFF	Environmental Research Funders' Forum
ESF	European Science Foundation
ESS	Environmental Stewardship Scheme
EU	European Union
FACT	Forum for the Application of Conservation Techniques
FC	Forestry Commission
GAP	Grazing Animals Project
HAP	Habitat Action Plan
LCN	Lead Coordination Network
MESH	Mapping European Seabed Habitats
NERC	Natural Environment Research Council
PSA	Public Service Agreement
RCUK	Research Councils UK
RELU	Rural Economy and Land Use Programme
RSPB	Royal Society for the Protection of Birds
SPA	Special Protection Area
SSSI	Site of Special Scientific Interest
UKBAP	UK Biodiversity Action Plan
UKPopNet	UK Population Biology Network
WFD	Water Framework Directive

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8. Annexes

Annex 1: membership of the BRAG Habitat and Ecosystem Management sub-group

Melanie Austen	Plymouth Marine Laboratory
Richard Brand-Hardy	Defra
Kevin Charman	English Nature
Mark Crick	JNCC
Richard Ferris	BRAG Secretariat, JNCC
Michel Kaiser	University of Bangor
Scot Mathieson	Scottish Environmental Protection Agency
Andrew Pullin	CEBC, University of Birmingham
Ro Scott	Scottish Natural Heritage
Kevin Watts	Forest Research

Annex 2: Summary of main themes of the *Action Plan for Biodiversity Research in Europe* (EPBRS, 2005)

Status and Trends

1. assess distribution, status and trends of European species and habitats, especially those of Community interest
2. develop methods to assess minimum viable areas, favourable conservation status and effective ecological networks
3. assess genetic diversity of species of conservation or economic importance
4. further develop the concept of dynamic ecosystems and improve the classification of habitats and ecosystems
5. improve understanding of biodiversity in poorly understood systems, including soils and the deep sea
6. understand the interaction between biological diversity and ecosystem function and resilience, and assess trends in key functional groups, e.g. pollinators
7. increase long-term taxonomic capacity and significantly step-up efforts to complete inventories in Europe
8. improve knowledge of goods and services provided by ecosystems
9. improve understanding of biodiversity in the urban environment and its role in the life and wellbeing of citizens
10. improve understanding of public beliefs, perceptions, attitudes and preferences regarding biodiversity
11. increase knowledge of the cultural, social, spiritual, economic and other values of biodiversity
12. quantify the contribution of biodiversity to livelihoods and further understand how changes in biodiversity and ecosystem functions influence livelihoods
13. understand the consequences of biodiversity change on health and the incidence of disease in humans and other species

Drivers of biodiversity loss

14. identify, quantify, understand and predict drivers of biodiversity change including their relation to degradation and loss of habitats
15. understand how trade and tourism affect biodiversity and how biodiversity is used in both sectors
16. assess and predict changes in ecosystem functioning due to unsustainable use, including marine biodiversity not directly targeted by fishing
17. investigate how public beliefs, perceptions, attitudes and preferences regarding biodiversity influence human behaviour and public policy
18. improve understanding of how the use of natural resources affects biodiversity, ecosystem goods and services and resilience of ecological-economic systems
19. greatly increase understanding of the causes and effects of biological invasions
20. understand interaction between biodiversity and climate change

Governance, policy and tools to address biodiversity loss and its impacts

21. develop methods to prevent, mitigate and, where possible, reverse degradation and loss of ecosystems, species and genetic diversity
22. develop governance and management options for biodiversity conservation and sustainable use, including intellectual property right regimes
23. develop indicators of sustainable management of renewable resources, ecosystem integrity and ecosystem goods and services, vulnerability of livelihoods, and funding to biodiversity
24. develop, test and evaluate indicators on the status and trends of biodiversity, the drivers of biodiversity change and the success of policies designed to halt the loss of biodiversity by 2010 and beyond
25. establish how to use biological resources, goods and services in a sustainable manner, incorporating lessons learned from traditional knowledge, innovations and practices
26. establish methods and guidelines to assess environmental risk posed by chemicals and biotechnology, including genetically modified organisms
27. further develop models at relevant scales, within and across disciplines, to understand and predict biodiversity change
28. further develop participatory and conflict management methods and effective and cost-effective policy instruments , implementing sustainable use and biodiversity conservation
29. develop methods to implement, evaluate and improve the principles and application of the ecosystem approach of the CBD
30. improve and assess strategies for promoting sustainable livelihoods, lifestyles and poverty alleviation in the context of biodiversity conservation
31. develop incentives and policies that motivate restoration and enhancement of biodiversity
32. improve the evidence-based conservation of biodiversity
33. develop biotechnological tools (e.g. gene banks and manipulation of soil organisms) to support conservation of biodiversity, and assess their cost-effectiveness in comparison to other conservation strategies
34. develop methodologies to evaluate and improve high nature value farming systems and sustainable forest management
35. improve understanding of how biodiversity policy is formed and implemented in relation to other policies
36. develop improved spatial planning instruments and tools that better integrate biodiversity issues

Summarised from “The Action Plan for Biodiversity Research in Europe”, formulated by the European Platform for Biodiversity Research Strategy (and adopted at its meeting in Budapest, Hungary, 31st March – 4th April 2005).

For further details of EPBRS, see <http://www.epbrs.org/>

Annex 3: Table showing provisional assessment of HAP knowledge gaps

Column headings represent the five broad themes for research, as identified by the BRAG *Management of Habitats and Ecosystems* sub-group. Based on the assessments provided by The Joint Nature Conservation Committee, an overall measure of the knowledge gaps is given for each HAP. HAP Lead Partners have, where possible, given a brief assessment of the state of knowledge (source: 2002 Reporting Round data).

High = good level of knowledge/information (i.e. well understood, much data available); Medium = reasonable level of knowledge/information, but requiring some further research; Low = poor level of knowledge/information (i.e. little understood, limited or no data available), and requiring urgent research.

* the mapping and surveying column is based on a statistical assessment of baseline and monitoring data provided by each HAP group and collated by Pete Brotherton (English Nature)

HAP Name	Ecological Definition	Mapping & Surveying*	Ecological dynamics of sites	Site-based management	Landscape scale	HAP Total	Lead Partner Assessment of state of knowledge
Ancient and/or species-rich hedgerows	MED	LOW	LOW	LOW	MED	LOW / MED	Agricultural practice, incl. CAP; lack of advice for owners; survey & monitoring required
Aquifer fed naturally fluctuating waterbodies	MED	HIGH	LOW	MED	LOW	MED	LBAP partnership not established/working effectively; survey & monitoring required; lack of involvement from managers/owners
Blanket bog	LOW	MED	MED	MED	MED	MED	Changes needed to funding structure and payments; agricultural practice, incl. CAP; insufficient staff resources
Cereal field margins	MED	LOW	MED	MED	LOW	LOW / MED	
Chalk rivers	HIGH	HIGH	MED	MED	MED	MED / HIGH	
Coastal and floodplain grazing marsh	LOW	LOW	LOW	MED	LOW	LOW	Agricultural practice, incl. CAP; coastal & marine policy; decline in water quality
Coastal saltmarsh	MED	MED	MED	MED	MED	MED	Changes needed to funding structure and payments; lack of advice for owners; Agency grant support needed
Coastal sand dunes	MED	HIGH	MED	MED	LOW	MED	
Coastal vegetated shingle	MED	MED	MED	MED	MED	MED	Coastal & marine policy; habitat creation & restoration not achieved; lack of public

HAP Name	Ecological Definition	Mapping & Surveying*	Ecological dynamics of sites	Site-based management	Landscape scale	HAP Total	Lead Partner Assessment of state of knowledge
							awareness
Eutrophic standing waters	HIGH	LOW	MED	MED	MED	MED	Baseline survey required; national policies & legislation; changes needed to funding structure and payments
Fens	LOW	MED	MED	MED	LOW	LOW / MED	Policy and legislation for water and wetlands; Action Plan process
Limestone pavements	HIGH	MED	MED	HIGH	MED	MED / HIGH	Lack of public awareness; changes needed to funding structure and payments
Littoral and sublittoral chalk	MED / HIGH	MED	MED / HIGH	MED	MED	MED	Work plan not established
<i>Lophelia pertusa</i> reefs	HIGH	LOW	LOW	MED	LOW	LOW / MED	Action Plan process; Common Fisheries Policy
Lowland beech and yew woodland	HIGH	MED	MED	MED	LOW	MED	Changes needed to funding structure and payments; lack of advice for owners; coordinated recording scheme needed
Lowland calcareous grassland	HIGH	MED	LOW	HIGH	LOW	MED	Problems with farming practice, including grazing regimes; lack of best practice guidance
Lowland dry acid grassland	LOW	LOW	MED	MED	LOW	LOW / MED	Grazing regimes causing problems; lack of public awareness; problems with farming practices
Lowland heathland	MED	MED	MED	MED	LOW	MED	Baseline survey required; habitat fragmentation; decline in habitat quality due to poor management
Lowland meadows	MED	MED	MED	MED	LOW	MED	Problems with farming practice; survey & monitoring required; habitat creation & restoration not achieved
Lowland raised bog	HIGH	MED	MED	MED	LOW	MED	Changes needed to funding structure and payments; policy and legislation for water and wetlands; baseline survey required
Lowland wood-pasture and parkland	HIGH	LOW	MED	MED	LOW	MED	Changes to funding structure and payments; poor understanding of habitat creation & restoration techniques; compilation of habitat inventory required
Machair	HIGH	HIGH	MED	MED	MED	MED / HIGH	
Maerl beds	MED	MED	MED	MED	LOW	MED	Coordinated recording scheme required; poor autecological knowledge; lack of national steering group

HAP Name	Ecological Definition	Mapping & Surveying*	Ecological dynamics of sites	Site-based management	Landscape scale	HAP Total	Lead Partner Assessment of state of knowledge
Maritime cliff and slopes	LOW	MED	LOW	MED	LOW	LOW / MED	Baseline survey required; insufficient staff resources; LBAP partnership not established/working
Mesotrophic lakes	MED	LOW	MED	MED	LOW	LOW / MED	Changes needed to funding structure and payments; baseline survey required; national policies and legislation
<i>Modiolus modiolus</i> beds	MED	MED	LOW / MED	MED	LOW	MED	Poor legal protection for species; baseline survey required; monitoring required
Mud habitats in deep water	LOW – ill defined	LOW	HIGH	L/M – localised	MED	MED	Lack of public awareness; baseline survey required;
Mudflats	LOW	HIGH	MED	MED	MED	MED	Data audit/review required; identification techniques required; poor understanding of monitoring techniques
Native pine woodlands	HIGH	HIGH	MED	MED	LOW	MED	Changes needed to funding structure and payments; decline in habitat quality due to poor management
Purple moor grass and rush pastures	HIGH	MED	MED	MED	LOW	MED	Survey & monitoring required; problems with farming practice; habitat creation & restoration not achieved
Reedbeds	MED	LOW	HIGH	MED	MED	MED	Policy and legislation for water & wetlands; baseline survey required
<i>Sabellaria alveolata</i> reefs	MED	MED	MED	LOW	LOW	LOW / MED	Little understanding of impacts and threats; habitat creation & restoration techniques poorly understood; compilation of habitat inventory required
<i>Sabellaria spinulosa</i> reefs	MED	MED	LOW	LOW	LOW	LOW / MED	Habitat creation & restoration techniques poorly understood; compilation of habitat inventory required; unrealistic timescale for Action Plan targets
Saline lagoons	HIGH	HIGH	MED	MED	LOW	MED	Change needed to funding structure and payments; water quality decline; habitat creation & restoration not achieved
Seagrass beds	HIGH	MED	MED	MED	LOW	MED	Insufficient local-national links; unrealistic timescale for Action Plan targets; compilation of habitat inventory required
Serpulid reefs	HIGH	HIGH	MED	MED	LOW	MED	Survey and monitoring required

HAP Name	Ecological Definition	Mapping & Surveying*	Ecological dynamics of sites	Site-based management	Landscape scale	HAP Total	Lead Partner Assessment of state of knowledge
Sheltered muddy gravels	LOW	LOW	LOW	MED	LOW	LOW	Decline in habitat quality due to poor management; compilation of habitat inventory required
Sublittoral sands and gravels	LOW	LOW	LOW	MED	LOW	LOW	Insufficient protection through UK designated sites; compilation of habitat inventory required
Tidal rapids	LOW	MED	LOW	MED	LOW	LOW / MED	Work plan not established; baseline survey required; insufficient local-national links
Upland calcareous grassland	MED	MED	LOW	MED	LOW	LOW / MED	Grazing regimes causing problems; agricultural practice, incl. CAP; change needed to funding structure and payments
Upland hay meadows	MED	LOW	LOW	HIGH	LOW	LOW / MED	Habitat creation and restoration techniques poorly understood; compilation of habitat inventory required; research required on management techniques
Upland heathland	MED	MED	LOW	MED	LOW	LOW / MED	Grazing regimes causing problems; agricultural practice, incl. CAP
Upland mixed ashwoods	HIGH	LOW	MED	MED	LOW	MED	Baseline survey required; change needed to funding structure and payments; insufficient staff resources
Upland oakwood	HIGH	LOW	MED	MED	LOW	MED	Change needed to funding structure and payments; staff resources insufficient; baseline survey required
Wet woodland	HIGH	MED	LOW	MED	LOW	MED	Change needed to funding structure and payments; baseline survey required; skills transfer/training required