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PU	Public	XX
PP	Restricted to other programme participants (including the Commission Services)	
RE	Restricted to a group specified by the consortium (including the Commission Services)	
CO	Confidential, only for members of the consortium (including the Commission Services)	

Manual Internet portal for presentation and download of methods and tools

Deliverable 28 of Work package 6.1

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Summary

The EuMon Internet Portal is an easily accessible internet site for information about the EuMon project and its results and products related to the monitoring of species and habitats. The site contains information about the EuMon databases on existing monitoring activities in Europe and on the involvement of volunteers in monitoring. It also provides access to the BioMAT internet tool that lets users explore the contents of the databases on monitoring, as well as approaches and methods for the design of monitoring and the analysis of monitoring data. EuMon portal provides guidance on several monitoring topics through the BioMAT as well as through various reports that summarise the results of the EuMon project. Parts of the EuMon Internet Portal are already available to external users. The final version is in the last stages of testing and implementation and will be accessible to users in the autumn 2008. The EuMon Internet Portal will also be further developed as part of the new EU-funded projects EBONE and SCALES.

1 EuMon Internet Portal

The EuMon Internet Portal is the internet platform for information about the EuMon project and its results. The address for the entry page of the EuMon Internet Portal is http://eumon.ckff.si/index1.php.

1.1 Aims of the EuMon Internet Portal

The overall purpose of the EuMon Internet Portal is to provide a one-stop-point for information about the EuMon project and its various results. The EuMon Internet Portal aims to be comprehensive in its documentation of the project and the presentation of the various results and products from the project, yet it shall simultaneously be easily accessible and understandable to expert and lay user alike. The structure shall guide the user to all items of interest as directly and through as few steps as possible. The text and associated illustrations shall be focused, informative and to the point.

The EuMon Internet Portal is targeted for a range of potential stakeholder groups, such as Decision makers and managers in national and European level management institutions, monitoring coordinators and participants. EuMon's products and tools represent various topics of interest to these stakeholder groups, covering overviews of monitoring activities, involvement of volunteers, strategic advice on design of monitoring and analysis of data, as well as advice on setting priorities for conservation.

The EuMon Internet Portal is the main vehicle for the comprehensive presentation of EuMon's results and products. It is therefore important to maintain and update the portal

and its key parts for the future. This will be achieved for the next few years by linking further development of the portal to new EU-funded projects.

1.2 Overall structure of the EuMon Internet Portal

The EuMon Internet Portal covers information on the EuMon project, the various topics that has been cover by this project, as well as results and products from the project. The opening screen for the portal is given in figure 1 and also shows the main elements of the portal.

Figure 1 *Opening screen for the EuMon Internet Portal.*

About the EuMon project

One important entry for the EuMon Internet Portal is the presentation of the project, its aims, partners, activities and news, as well as key presentations about the project and its topic for the interested public. This part of the portal had its main function during the active duration of the project. After its end, this information will mainly be of interest as documentation about the project.

BioMAT – Biodiversity Monitoring and Assessment Tool

The BioMAT monitoring and assessment tool represents an integration of information about biodiversity monitoring into one coherent framework. This tool contains Modules for (1) assessing the coverage of monitoring schemes in Europe, (2) assessing the state and trends in data from existing monitoring schemes, and (3) design or evaluation of monitoring schemes against specified criteria. The BioMAT tool is described in considerable detail in chapter 2 below.

The DaEuMon database

A major task of EUMon has been the collection and analysis of information about the monitoring of species and habitats in Europe. For this purpose the DaEuMon database has be constructed. Entries for this database have been invited through a web-based questionnaire, which is still open for additional entries through the EuMon Internet Portal. The various entries of the database can also be inspected on the portal, as can various results from the analysis of these entries in the form of pre-designed reports. The DaEuMon database contains the most comprehensive overview of existing species and habitat monitoring schemes in Europe. However, there is still considerable bias in its coverage, both respect to biodiversity components (species groups, habitat types) and geography. More details on the structure and content of the database are given as part of the description of BioMAT's Module 1 below (chapter 2.2). The results from the analysis of the entries of the database have been used in the assessment of biodiversity coverage in Europe, as presented in several of the deliverable reports from EuMon (cf EuMon products, below). The DaEuMon database is directly available at http://eumon.ckff.si/about_daeumon.php.

Volunteers in monitoring

EuMon has investigated how volunteers have been included in the monitoring of biodiversity, the extent and characteristics of such participatory monitoring networks (PMNs), and how volunteers may best be involved in biodiversity monitoring to achieve good returns for efforts and to develop a sense of ownership for biodiversity monitoring in the wider society. Information about this part of EuMon, as well as the results of the analyses of PMNs and recommendations on how best to involve volunteers in monitoring are available on the EuMon Internet Portal. Further information on PMNs is available at http://eumon.ckff.si/pmn.php.

A database of on-going participatory monitoring networks in Europe has been assembled as part of this work. This database is still open for new entries. The various entries in this database are available through the EuMon Internet Portal, as are some selected results from the analysis of these entries.

National responsibilities for conservation

EuMon has also tested existing methods for making priorities in nature conservation and has developed improved methods for assessing the conservation responsibility of countries for their native species and habitats. Such national responsibilities are crucial to focus conservation action plans. EuMon has also tested how conservation networks, such as the Natura 2000 network, satisfy the requirements based on such assessments of national responsibilities. This section of the EuMon Internet Portal presents the basic ideas behind such assessments and the results from this part of the project.

EuMon products

The various parts of the EuMon project have resulted in a range of products. These include a number of reports to satisfy specific deliverables for the project. These reports provide a broad and sometimes rather technical coverage of their respective topics. In addition to these reports, a more limited set of policy briefs have been developed to give short and coherent recommendations to policy makers and other users in need of clearly focused information on selected topics. Finally, the EuMon team has produces a considerable number of scientific articles and reports that cover various topics within the broader theme of biodiversity monitoring. An overview of all these products is available from the EuMon Internet Portal. The publicly available deliverable reports and the policy briefs can all be downloaded in pdf format. Some of the scientific articles and reports will also be available in digital format.

Contact information

The EuMon Internet Portal also contains the main contact information to the coordination of the EuMon project and an overview of other key participants such as work package leaders and members of the advisory board.

EuMon links

A number of links to other web sites with information related to biodiversity monitoring is provided. This covers links to key institutions like the European Environment Agency, national conservation agencies and non-governmental organisations as well as projects covering related topics.

2 The BioMAT Tool

2.1 BioMAT purpose and overview

The EuMon BioMAT tool is an internet-based tool for biodiversity monitoring and assessment. It has been devised to provide an accessible and scientifically based overview of approaches and methods for the monitoring of species and habitats. Its primary aim has been to provide a coherent and consistent framework for assessing the state and trends in selected components of biodiversity. However, it has been further developed as a framework for broader integration of biodiversity monitoring, covering essentially three aspects of integration:

- Integration of monitoring activities across Europe
- Integration of the analysis and assessment of data from existing monitoring
- Integration of approaches and methods into an consistent framework for biodiversity monitoring

These aims have been approached by designing three main modules for BioMAT (presented in more detail below):

1) assessing the coverage of monitoring schemes in Europe,

2) assessing the state and trends in data from existing monitoring schemes,

3) design or evaluation of monitoring schemes against user-specified criteria.

In addition to these main modules, the BioMAT also provides a number of background and explanatory notes to give broader information on the issues at various parts of the BioMAT structure. These notes partly give brief explanations of broader topics relevant to EuMon and BioMAT and partly motivate and explain the reasons for the choices offered at each stage of the navigation through BioMAT.

At the relevant end points in the BioMAT structure, recommendations for action are provided as well as references to additional background information on the topic at hand.

An overview of the main components of BioMAT is given in figure 2 and an illustration of the entry page in figure 3.

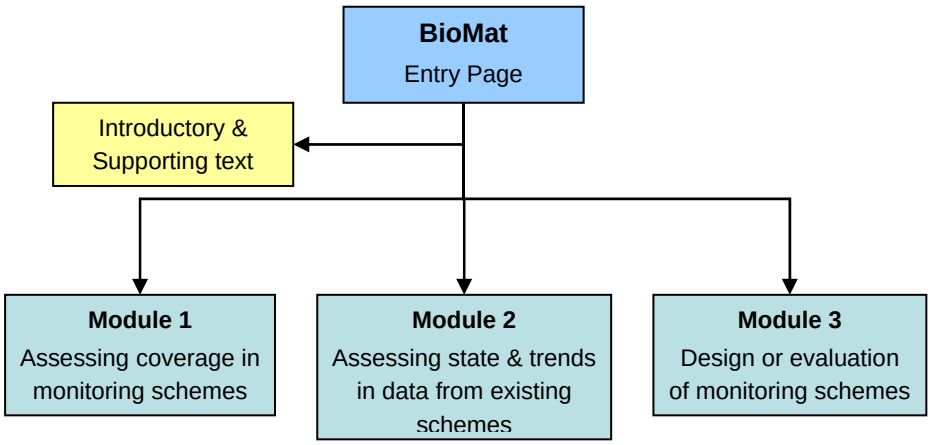

Figure 2 *The main structure of the BioMAT tool for monitoring and assessment of biodiversity.*

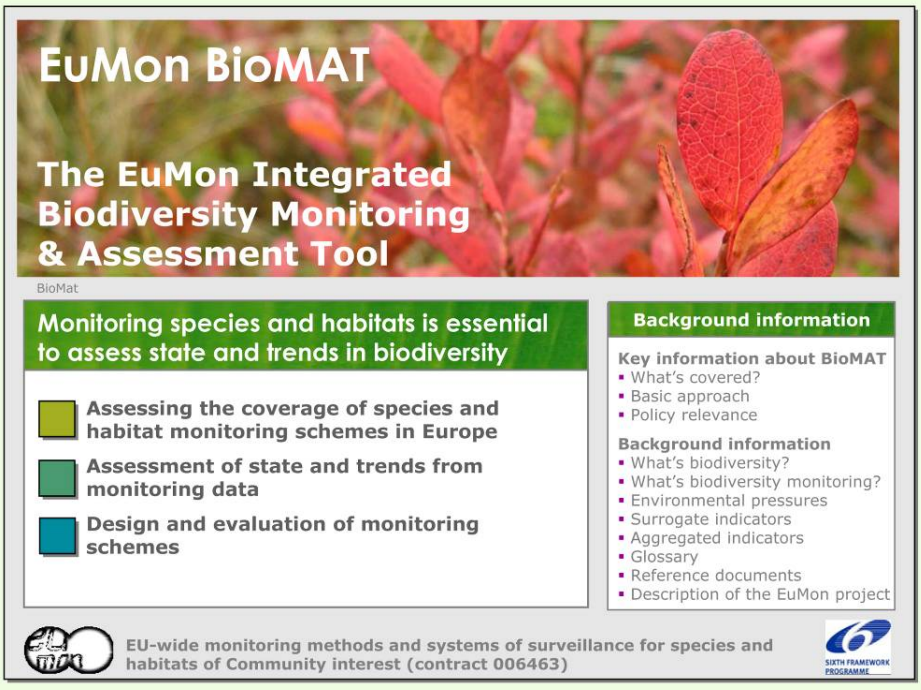

Figure 3 *Opening screen of the BioMAT tool for the monitoring and assessment of biodiversity.*

2.2 BioMAT Module 1: assessing coverage of species and habitat monitoring schemes in Europe

2.2.1 Purpose

The overall purpose of BioMAT's Module 1 is to provide users with the opportunity to explore the current distribution and characteristics of species and habitat monitoring activities in Europe, as reflected in the content of the DaEuMon database, as well as the information available in the database for Participatory Monitoring Networks.

The information in the DaEuMon database is important for identifying commonalities and potential gaps in current monitoring activities. This will give some indication of the potential for integration of biodiversity monitoring in Europe and our ability to provide consistent data to assess state and trends of Europe's biodiversity.

Through BioMAT's Module 1, users will also be able to compare the characteristics of specific monitoring schemes to the other schemes recorded in the database. This may provide a motivation for harmonisation of individual monitoring schemes with those already making up a substantial network in Europe.

2.2.2 Databases

The key component of BioMAT's Module 1 is the DaEuMon database which contains extensive information about a broad range of monitoring schemes for species and habitats in Europe. This information covers administrative and contact information for each scheme, monitoring objectives, types of data collected, statistical and methodological information, as well as resources used. Currently (July 2008), 617 different schemes, 449 for species and 168 for habitats, are recorded in the database (figures 4-6). However, the geographical distribution across Europe as well as the coverage of species groups and habitat types is not as representative as one could have wished. The database still contains the most extensive overview of such monitoring in Europe, and the obvious gaps may inspire efforts to enter information on existing schemes not yet recorded.

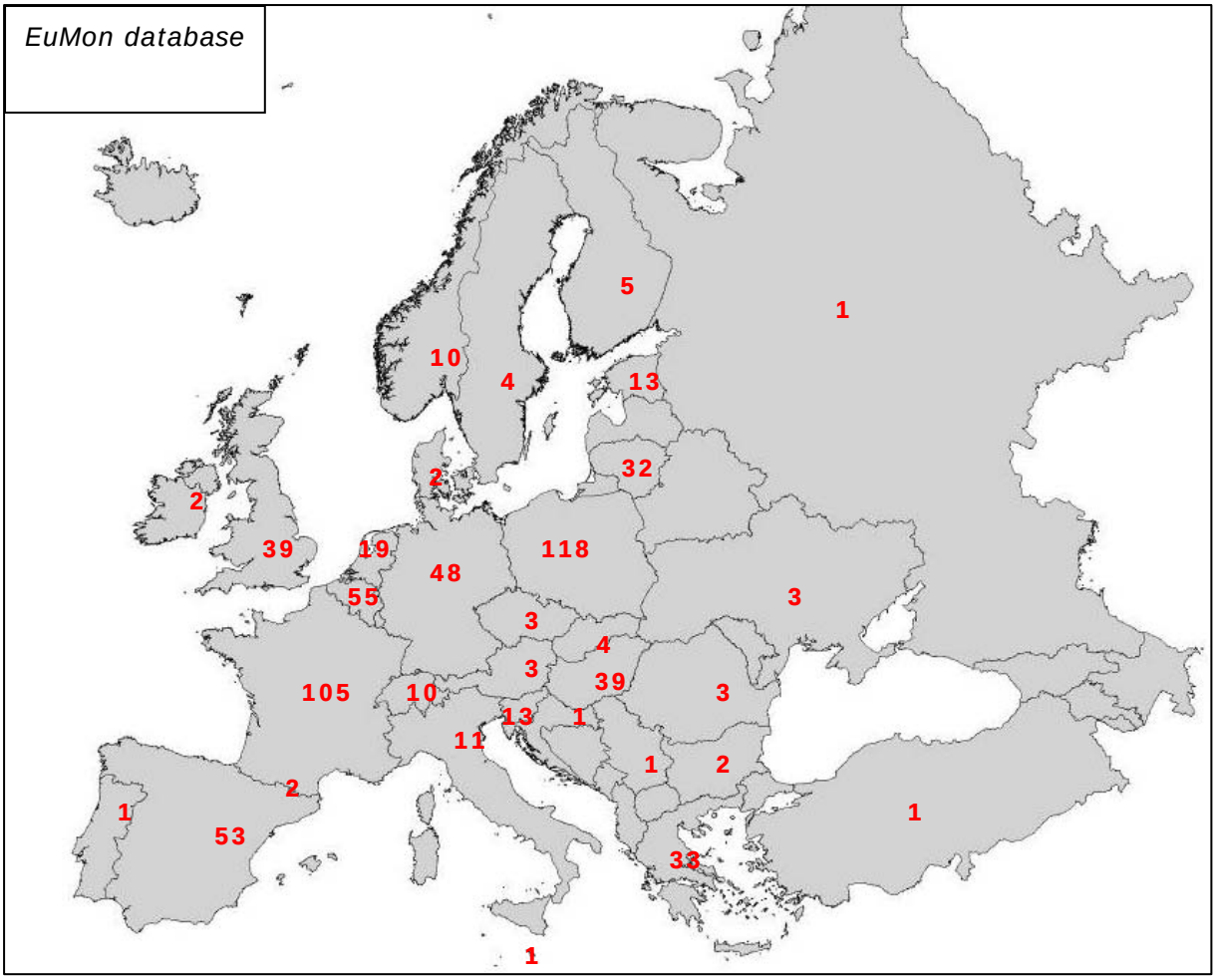

Figure 4 Distribution of the 449 species and 168 habitat monitoring schemes recorded in the EuMon database per July 2008. Numbers indicate the number of recorded schemes per country. An additional 4 schemes were entered as Europe wide, 4 for Cyprus and 1 for Israel.

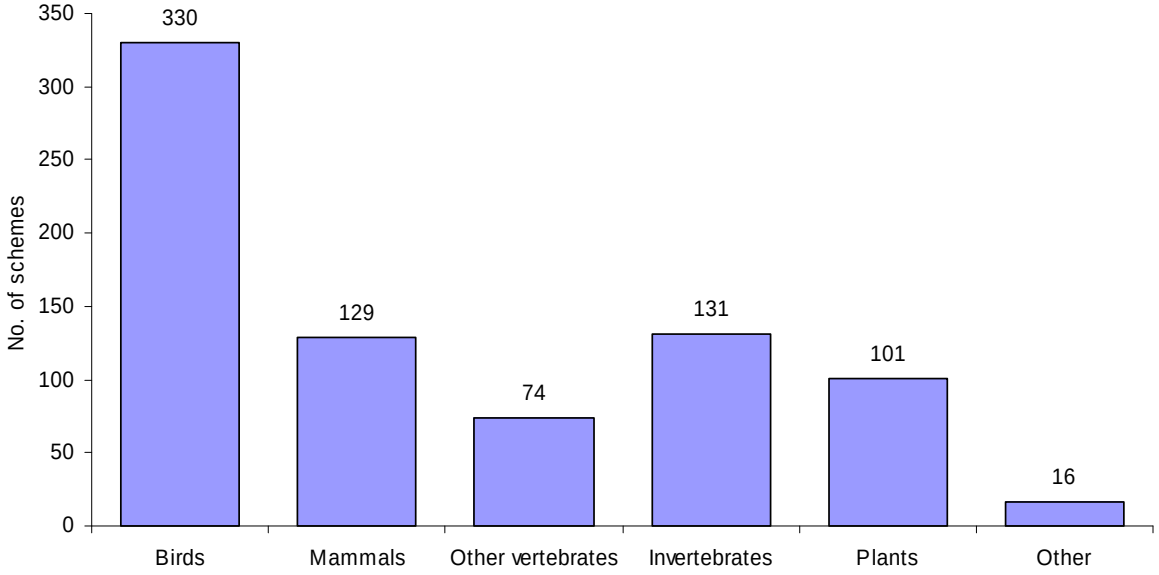

Figure 5 *Number of monitoring schemes recorded in the EuMon database covering various species groups (per July 2008).*

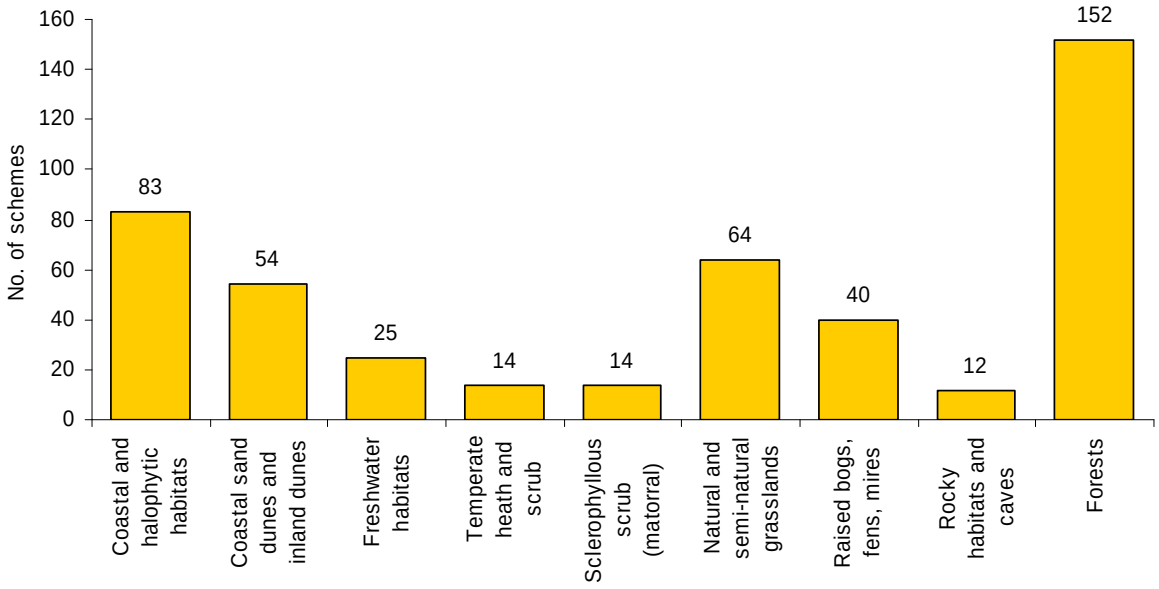

Figure 6 *Number of monitoring schemes recorded in the EuMon database covering various habitat types (per July 2008).*

In addition to the DaEuMon database on species and habitat monitoring schemes, Module 1 also refers to the content of the database on Participatory Monitoring Networks (PMNs) in Europe, assembled as part of EuMon's study of such networks. Entries for this database were invited through a questionnaire that was sent to a large number of institutions in Europe. Per July 2008, 257 organisations had responded to the questionnaire. The content of the database covers mainly various administrative aspects for the organisations involving volunteers, including questions related to motivation and involvement of

volunteers, as well as information on the biodiversity components monitored, how monitoring is conducted, and how the results are used.

2.2.3 Structure

Figure 7 shows the overall structure of BioMAT's Module 1, covering three main topics: monitoring of species and habitats in general, monitoring for the Nature Directives (Birds Directive and Flora, Fauna and Habitats Directive), and Participatory Monitoring Networks (PMNs). For each of these topics, users may choose to run one or more pre-designed reports. For monitoring in general and for the Nature Directives, users may also conduct detailed searches for specific monitoring schemes satisfying a set of conditions. This search option is not available for the database of PMNs. However, users may also inspect all information recorded for individual schemes in both databases. At various stages through the structure, the user may consult short supporting texts giving background or guidance for the topic at hand.

2.2.4 Content and output

The option for exploration of current monitoring of species and habitats in general is based on the full content of the DaEuMon database. The pre-designed reports are generated from this database upon the user's request and will therefore always reflect the database content at this time. These reports will contain a number of panels of figures and tables illustrating the distribution of the recorded schemes for various topics (biodiversity content, statistical, logistical and administrative issues). These reports can be limited to schemes covering species or habitats, or that select panels of particular interest to the public or to policymakers/managers. Users may also generate a full report with all the pre-designed panels. The reports will first be generated as dynamic panels in html format, allowing more detailed follow-up searches for some topics. Users may then request that these reports be saved as pdf documents for downloading by the user.

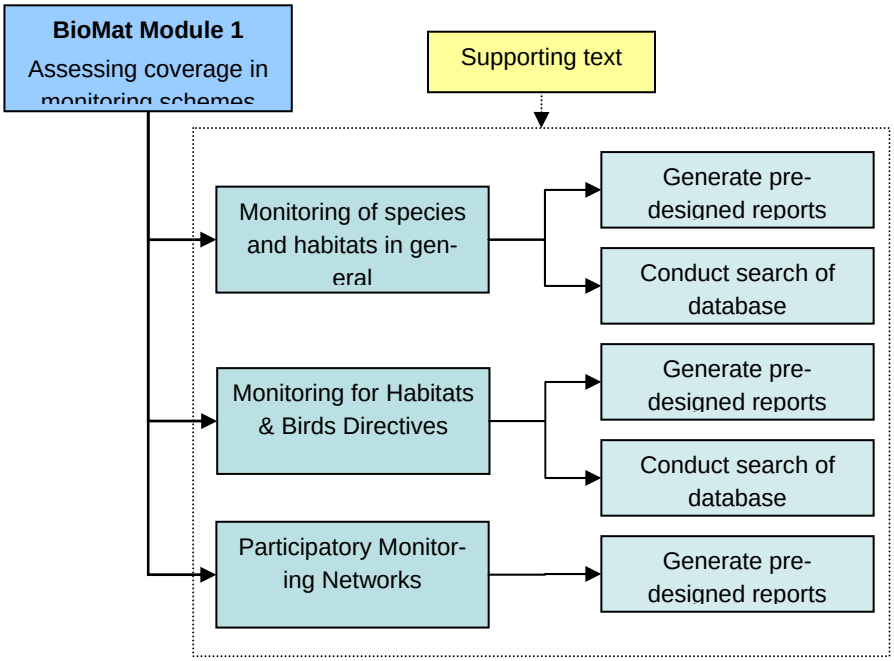

Figure 7 *Overall structure of BioMAT Module 1.*

Users may also search the database for schemes satisfying specific criteria and select various output options for the search results. Generally, the output will consist of a list of the selected schemes and a few summary tables giving an overview with respect to distribution by country, taxonomic group, habitat type and Nature Directive annexes. If more than 10 schemes are selected users may also request similar pre-designed reports for selected schemes as BioMAT generates for all schemes in the database. Users may also request country reports showing similar distributions of schemes on taxonomic groups, nature types etc. Summary tables and other collated information for the selected schemes are currently under final development and will be available in the autumn 2008.

The option for exploration of current monitoring for the Nature Directives is also based on the content of the DaEuMon database, but limited to those schemes that are either motivated by EU policy, or the Nature Directives specifically, or that cover species or habitats on the various annexes of these directives. Users may here specify pre-designed reports for various combinations of the Nature Directives and their annexes. These reports will function in the same way as the full reports based on all schemes of the database, but will here be limited to those schemes satisfying the conditions for the respective Nature Directives. In addition to the information covered by the standard pre-designed report, the reports for schemes selected for the Nature Directives also contain summary tables with information specific for these directives (distribution on annexes, Article 8 on cost information, Article 11 on trends information).

Users may also search the database specifically for schemes covering the Nature Directives and their various annexes. The search procedures are the same as for monitoring in general, with similar options for the output.

The option of investigating Participatory Monitoring Networks in Europe is based on the content of the special database assembled by EuMon on this topic. Here users may request a pre-designed report of all the recorded schemes. In addition, users may inspect the full list of schemes and the detailed information for individual schemes. An option for selecting parts of the entries in this database according to specific search criteria (cf the DaEuMon database) is not yet implemented.

2.3 BioMAT Module 2: assessing state and trends in biodiversity from monitoring data

2.3.1 Purpose

The overall purpose of BioMAT's Module 2 is to provide users with strategic advice on how to analyse data from monitoring schemes and to assess state and trends for biodiversity components on this basis. This covers both the analysis of data from single schemes and the integration of data or results from more than one scheme, with different degrees of compatibility in design and measurements across the schemes.

2.3.2 Structure

BioMAT's Module 2 consists of a decision tree which leads the user through several levels or branches where different types of issues need to be addressed by the user. Figure 8 illustrates the basic structure of this decision tree. The first split of the decision tree guides the user to the issue of analysis of data from one monitoring scheme versus integration of data or results from more than one scheme. The next split leads to a focus on either species or habitat monitoring. Thereafter, the divisions of the tree are more specific to each main branch, with different issues to resolve depending on whether the user is concerned with one scheme or several and species or habitats. The next section discusses some of these issues.

The decision tree will eventually lead the user to an end point where a conclusion is drawn and a recommendation for action is offered, together with links to further background or technical information related to that recommendation.

At various stages through the structure, the user may also consult short supporting texts giving background or guidance for the topic at hand.

2.3.3 Contents for analysis of data from single monitoring schemes

When providing users with strategic advice on how to analyse monitoring data, a number of issues needs to be clarified by the user. These relate to what kind of data is available and what types of questions the user would like to address with these data. Then there are more technical issues related to the detectability of the objects being monitored, the design of sampling, the precision of estimates etc. Here we will briefly sketch how Bio-MAT approaches such issues.

Species data and monitoring issues

The kind of monitoring questions that may be addressed and how the data may be analysed will much depend on what kind of data is available. We may monitor species in order to describe their state and possible changes in geographical (or more local spatial) distribution or in abundance or population density. We may also be interested in the state and changes in the population's demographic structure or processes, or, for multi-species systems, in the community structure or processes. We may also wish to follow the condition of individuals or the population in terms of physiological, genetic or other properties. To address such monitoring issues, we will typically collect data for species in the form of presence/absence data, simple counts of individuals, more advanced possibilities for following individuals over time (e.g. capture-mark-recapture, telemetry), measures of population structure (by age or size), or measures of individual properties by anatomical, physiological or genetic variables. Table 1 indicates the combinations of monitoring issues and the data types or measures that are likely to provide useful data for these issues.

An additional monitoring concern will be to relate observed changes for species to some underlying cause. This can only be addressed by also monitoring possible causes of such changes, preferably in an experimental design to be able to verify any causal relationship (otherwise, only correlative relations may be shown).

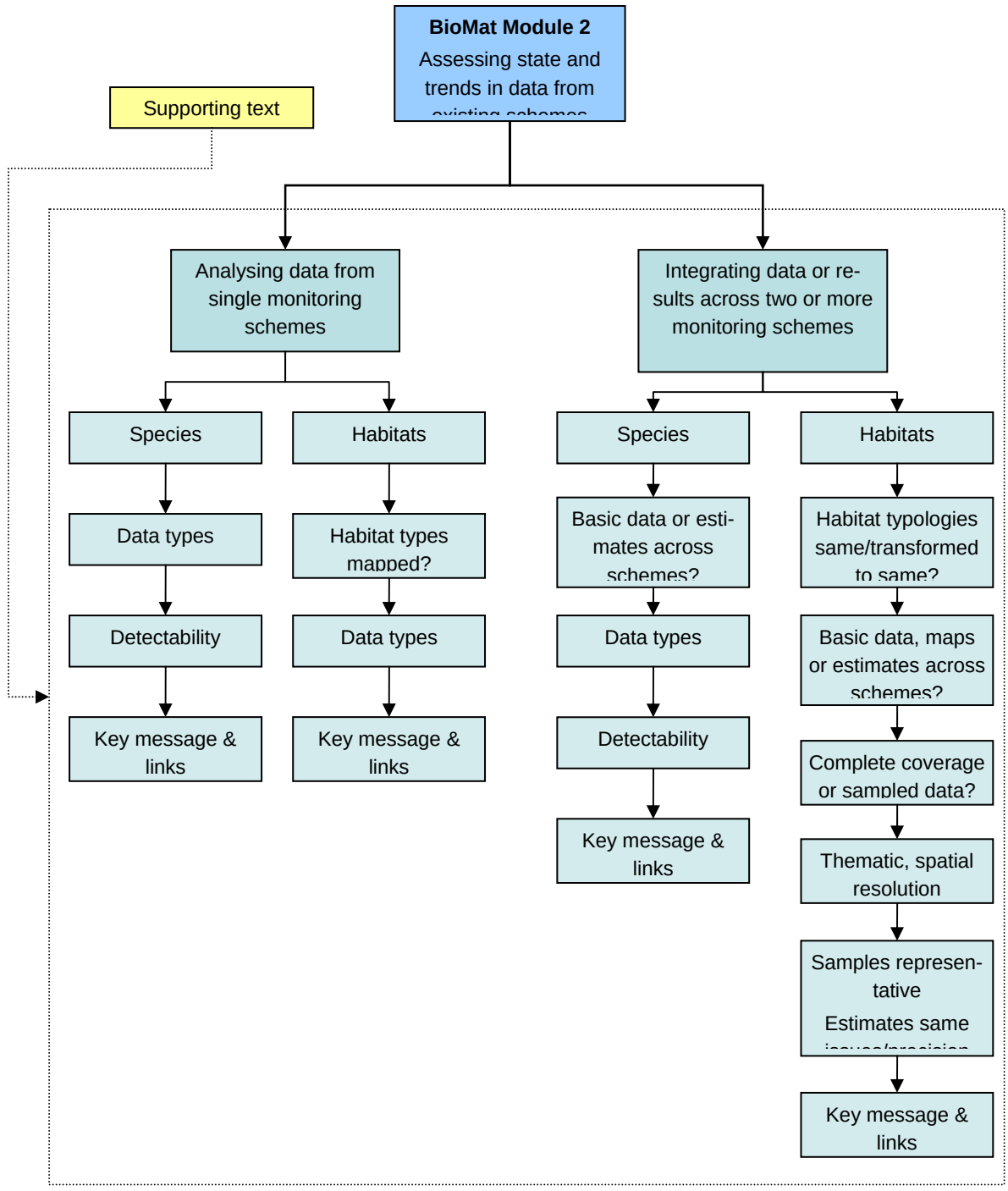

Figure 8 *A simplified flow chart for the overall structure of BioMAT Module 2. Note that in particular the structure for the integration of data from habitat monitoring schemes is more complex than illustrated here.*

With a particular monitoring interest in mind, a user should carefully consider what kind of data that can be used to address such an issue. And vice versa, given particular types of recorded data, only certain types of monitoring issues may be sensibly considered. In BioMAT's Module 2, we are assuming that the user is considering the analysis of already existing data and therefore focus on the types of data available, in particular whether the

data are presence/absence, counts of individuals (or frequencies or ranks) or more complex individual follow-up like catch-mark-recapture data. We are not explicitly considering data on structured populations or individual properties, as this has only been superficially considered in the EuMon project.

Table 1 *Data types commonly available in species monitoring and associated questions that may be addressed. The questions of interest will focus on status and trends of various properties at species or community levels.*

	Data types				
Monitoring issues	Presence/ absence	Counts of individuals (or frequencies or ranks)	Age or size structure	Individual follow-up (e.g. CMR, telemetry)	Individual measurements of anatomy, physiology, genetics etc
Distribution	**Optimal**	Sub-optimal, rarely adequate data for large enough areas	Not used	Ideal but field intensive; often only on a local scale	Not used
Abundance	Appropriate but relatively low power to detect trends	**Optimal**	Not used	Ideal but field intensive; often only on a local scale	Not used
Demographic structure/ processes		Appropriate for estimation of abundance rate changes only	Appropriate	**Optimal**	Genetics may give optimal information on structure
Community structure/ processes	**Optimal**	Possible but often difficult to get correct detection probability for all species	Not yet adequately developed theory	Not yet adequately developed theory	Not used
Individual condition, quality	Not used	Not used	Appropriate for age/size and related measures	Not directly used but be coupled to individual measures	**Optimal**
Phenology	Appropriate for some measures	Appropriate for some measures	Appropriate for some measures	Not used	Appropriate for some measures
Causes of change	Needs monitoring coupled to potential causal factors, preferably through experimental design				

Sampling design and detectability

In order to draw correct conclusions from available monitoring data, users need to consider the spatial and temporal distribution of the sampling. In general, sampling should be distributed across the geographical area of interest by some form of random or systematic sampling to ensure that results apply to the entire area of interest and not just to the points sampled. Also, the temporal distribution of the sampling must be adapted to the seasonal or multi-annual patterns of the life cycle of the organisms targeted by the monitoring. However, in the choice of methods for the analysis of existing data from single monitoring schemes these considerations are not directly addressed. They are therefore not an explicit issue in the decision tree for BioMAT's Module 2, but are treated briefly in supporting text.

When we make observations in nature we rarely observe the true value of the phenomenon of interest. We may account for observation or measurement errors by replicating

our sampling (repeated samples at the same site within a sampling period) and thereby increase the precision of the estimates made from the observations.

Not all the phenomena of interest will have the same probability of being observed in nature. For instance, in bird observations, our detection probability will typically vary for different species. Also, different individuals in a population (e.g. varying by sex, age or individual conditions) may have different detection probability. Hence, to avoid biased results, it will be essential to account for detection probability when analysing data where detection probability varies over time or space or for different parts of the observations. In the decision tree of BioMAT's Module 2 the issue of detection probability is important for the type of data analysis that may be performed.

Habitat data and monitoring issues

Monitoring habitats is in some ways more complex than monitoring species (although individual habitat patches do not move rapidly like species). Whereas the species concept and the classification of species are reasonably well established, that is not the case for habitats. When studying habitats we can choose to work with primary attributes of habitats, i.e., properties that may be continuously distributed over the landscape without any specific link to given habitat types, such as terrain form, soil structure, vegetation density or 'greenness' etc. Often, however, we need to address units or patches of specific habitat types, and then need to relate these habitat types to a specific habitat classification or typology. Such habitat typologies may originate for different purposes and typically vary much among different countries. Some habitat typologies are developed at the European level, such as the Corine Land Cover typology, EUNIS habitat classification and the classification of the Habitat Directive's Annex I. In BioMAT's Module 2, we are assuming that the user is interested in monitoring habitats as units in space and that the user has a particular habitat typology in mind that will allow consistent identification of each habitat type. The various methodological problems related to the classification of habitat units in the landscape based on various primary attributes is not part of the BioMAT Module 2 decision tree but is only briefly discussed in a supporting note.

Habitat monitoring may focus on several issues. We may be concerned about how much there are of certain habitat types, in terms of area or the number of habitat patches. We may wish to assess the geographical distribution of the various habitat types (as area or patches) over a given focal area. Or we may be interested in the size distribution within each habitat type. Even more complex habitat monitoring issues may relate to the spatial layout of the various patches of different habitat types, e.g. the degree of fragmentation of certain habitat types. Such an issue will typically require the mapping of the entire focal area and the extraction of various metrics for landscape or patch spatial structure. Finally, we may be concerned about the habitat quality, measured in terms of biological (e.g. species composition), chemical or physical properties of the habitat types of interest. As is the case for species monitoring, the kinds of issues we may address will depend on the types of monitoring data we have available for habitats.

The types of data we may generate in habitat monitoring will in principle come from either field samples of various properties of habitats or ecosystems or some kind of remote sensing of properties on the ground based on data from aerial or satellite-born instruments. In field sampling, the data will most often represent samples of the properties of

interest from the focal area, but it may be possible to use field sampling also to describe the habitats of the entire focal area as long as this is not too large. With remote sensing data, both sampled data from the focal area and complete coverage of the area may be possible, depending on the size of the focal area (the spatial extent), the spatial resolution (grain) of the data, and the amount of data that can be handled.

With complete coverage of the focal area, the data may be converted to maps showing the position of the patches of the various habitat types. BioMAT's Module 2 does not cover the methodological issues related to create such maps from primary attributes (cf habitat classification above). But whether the habitat information already exists in the form of a map of delimited habitat patches will be relevant for the further options of analysis and assessment.

For sampled data, similar concerns about the distribution of samples in space and time, as well as replication of samples, apply as for species (cf Sampling design and detectability above). The problem of detectability, i.e. the probability of discovering the true value of the phenomenon of interest, also applies to habitat sampling. However, the focus in habitat sampling is mainly on measurement and classification errors and would normally be handled in the classification process from primary attributes to classified habitat patches. BioMAT's Module 2 does not address the methodological issues related to habitat classification as part of the decision tree.

With a particular monitoring interest in mind, users should carefully consider what kind of data that can be used to address such an issue. And vice versa, given particular types of recorded data, only certain types of monitoring issues may be sensibly considered. In table 2 these relationships between types of habitat data and monitoring issues are summarised.

In the decision tree for BioMAT's Module 2, we are assuming that users are considering the analysis of already existing data and therefore focus on the types of data available. The relationships between data types and various monitoring issues is summarised in a supporting note.

Table 2 *Data types commonly available in habitat monitoring and associated questions that may be addressed. The questions of interest will focus on status and trends of various properties for habitats classified to different types. RS data refers to data collected by remote sensing (collected by aerial or satellite sensors).*

	Data types				
Monitoring issues	Sampled field data	Sampled RS data	Complete coverage, field data	Complete coverage, RS data	Map of habitat patches
Amount, number of patches per habitat type	Not used	Not used	Suitable, only for limited areas	**Optimal**	**Optimal**
Amount, area per habitat type	Suitable	Suitable	Suitable, only for limited areas	**Optimal**	**Optimal**
Distribution of habitat types over focal area	Suitable	Suitable	Suitable, only for limited areas	**Optimal**	**Optimal**
Distribution of patch sizes per habitat type	Not used	Not used	Suitable, only for limited areas	**Optimal**	**Optimal**
Spatial structure of patches per habitat type	Not used	Not used	Suitable, only for limited areas	**Optimal**	**Optimal**
Habitat quality per habitat type	**Optimal**	Suitable for some habitat properties	Suitable, only for limited areas	Suitable for some habitat properties	Not used
Phenology	**Optimal**	Appropriate for some measures	Suitable, only for limited areas	Appropriate for some measures	Not used
Causes of change	Needs monitoring coupled to potential causal factors, preferably through experimental design				

2.3.4 Contents for integration of data across more than one scheme

When we consider integration of data or results from at least two monitoring schemes we may have the same kinds of monitoring issues in mind as for data from single monitoring schemes. Hence, the relationships between data types and monitoring issues summarised in tables 1 and 2 also applies for integration across schemes. However, here we have the additional challenge that the monitoring design and data types may vary across schemes. The central issue for integration of data or results across monitoring schemes is therefore how one may get the most powerful common result from monitoring data that may vary in their compatibility in several ways. This part of BioMAT's Module 2 leads the users through some key questions for the integration of data or results across schemes.

Note that here we assume that users only want to integrated data or results across schemes for phenomena that are compatible. This implies that we assume users are concerned about the same basic monitoring issue for the schemes (e.g. trends in abundance of similar types of species or changes in the amount of certain habitat types) and represent these phenomena by the same types of biodiversity variables.

Species data across schemes

When we are integrating monitoring data or results for species across schemes, we first need to clarify whether we have basic data or observations, estimates or other trend information for the schemes of interest. We may also have combinations of such data or information types for the schemes in question.

If all the schemes have basic data on the variables of interest, we need next to identify whether these data are presence/absence, counts, catch-mark recapture (cf 2.3.4 above) or some combination of these types. Then we must consider if detectability is known, and if so similar or different for the schemes involved. If the schemes have different kinds of basic data (e.g. presence/absence in one and counts in another), the recommendation is to convert to the more complex data to the simpler kind, even if this leads to a loss of information.

For other combinations of data and estimates or trends across schemes, the general recommendation is to estimate the relevant properties from the basic data (depending on the type of basic data and whether detectability is known). These estimates are then used in a combination of results across schemes, depending on some specified statistical conditions for the estimates. The coarsest level of integration of results across schemes involves the combination of trend measures for separate schemes with the help of meta-analyses.

Habitat data across schemes

As for the analysis of data for single schemes, the integration of habitat monitoring data or results across schemes is more complex than for species. This relates especially to the need for compatible habitat typologies and similar thematic and spatial resolution of the data or results form the schemes in question. As for the analysis of habitat monitoring data for single schemes, we here assume that users are interested in habitat data related to properties of identified habitat types, not primary attributes de-coupled from any habitat typology.

BioMAT Module 2 starts this section of the decision tree by asking whether the habitat typologies are the same or can be transformed to a common typology. If this is not the case, no integration is possible. If the habitat data can be related to the same typology, the next level of questions is what type of information that is available on habitat properties across schemes. This can be basic data on the habitat patches and types (cf 2.3.4, Habitat data, above), maps of the habitat patches, estimates of the properties in questions or combinations of these.

If the schemes of interest all have basic data for the habitat properties, the question then is whether these are sampled or complete coverage data (from field or remote sensing) or some combination of these (cf 2.3.4, Habitat data, above). Then must ensure whether complete coverage data have comparable thematic and spatial resolutions, and whether sampled data also are spatially representative for the focal area. With maps for the schemes of interest, we also need to ensure that they have comparable thematic and spatial resolution. For estimates of habitat properties, we must ensure that estimates address the same monitoring issues with similar measures. With combinations of basic data, maps and/or estimates, the general approach is to make maps or estimates from the basic data or estimates from the maps and combine the results at the most refined level warranted by statistical conditions. As for species, the coarsest level of comparison

is based on developing individual trends in the properties of interest from each scheme and combining these trends in a meta-analysis.

2.3.5 Output

At the various end points of the decision tree, a short key message is offered to indicate a course of action. This is linked to a supporting text that offers a more a somewhat expanded explanation of the issue. In addition to this supporting text within BioMAT, there will in most cases also be links and references to other EuMon documents on the same topic as well as to external references (on the web or in print). These external references will typically address more technical topics of data analysis, like text books, guides to relevant programmes etc.

2.4 BioMAT Module 3: design and evaluation of monitoring schemes

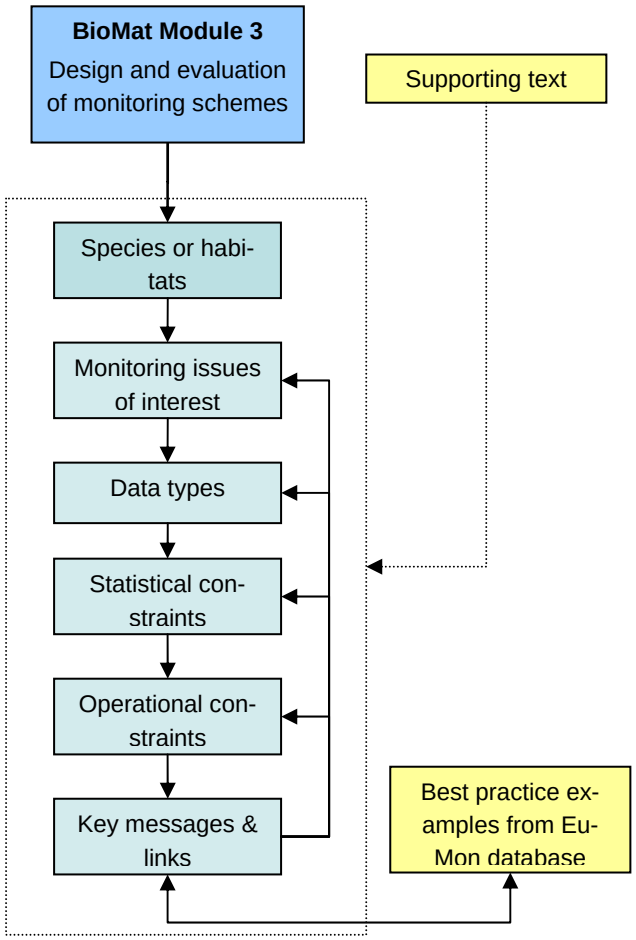

Figure 9 *Overall structure of BioMAT's Module 3.*

2.4.1 Purpose

The overall purpose of BioMAT's Module 3 is to guide the users towards an optimal monitoring framework for species and habitats, given specific monitoring objectives and statistical and operational constraints. For users interested in setting up a new monitoring scheme, Module 3 will lead them through the key decisions to an optimal generic scheme in terms of sampling design and practical setup. Users may also assess their own monitoring scheme against the criteria in Module 3 to see where their strong and weak points may be, and how their scheme compares to what BioMAT recommends.

2.4.2 Structure

For BioMAT to provide users with clear recommendations, users will have to specify their monitoring objectives and any statistical and practical constraints that may limit their options for a monitoring framework. The structure of BioMAT's Module 3 will lead the users through a decision tree with a number of questions focused on the clarification of these monitoring objectives and constraints. Potentially, many combinations of monitoring objectives, statistical and practical constraints are possible, but here we focus on those we consider to be the critical ones. We have chosen a rather strict hierarchical approach to cover the various topics, even if individual users may approach monitoring from rather different perspectives. However, as the compromise between monitoring objectives, data types of measurements, statistical and operational constraints may have more than one solution, users will have the opportunity of going back to previous steps in the process to explore alternative combinations of these decisions The basic structure of Module 3 is illustrated in figure 9.

2.4.3 Contents

In BioMAT's Module 3, we first clarify the objectives of the monitoring that users may want to set up or evaluate. The first question is whether the monitoring is primarily aimed to cover species or habitats. This leads on to the question of what kinds of issues the monitoring of species or habitats should cover. We are here considering similar issues as discussed in chapter 2.3.4 (cf tables 1 and 2). Here, the main focus for species is on state and trends in distribution or abundance. The more complex issues related to within-population properties, phenology or community properties are only treated summarily and as derived variables from species distribution or abundance monitoring where appropriate.

For habitats, we assume that users are interested in properties related to patches of specific habitat types (within a given habitat typology) and not only in primary attributes not coupled to a habitat typology (e.g. biomass, soil chemistry etc). The main focus for habitat monitoring is on amount of various habitats, their geographical distribution and their quality. The more complex issues of size and spatial distribution, phenology and causal factors are only treated summarily and as derived variables where appropriate. As in BioMAT's Module 2, we do not offer specific advice on how to develop habitat classifications or how to delimit and classify spatial units into specific habitat typologies. For this we only point to existing references.

The next step covers the types of data that may be collected to describe the changes in the properties on which the monitoring is focused (cf above). Here users may have certain preferences, e.g. linked to what they perceive as the most rational data to collect and other practical concerns. However, as illustrated in tables 1 and 2, different types of data may be more or less suitable for informing us about the various monitoring issues of interest. Hence, Module 3 does not make a definitive conclusion on the type of data to measure or collect at this stage, but sees this in relationship to the statistical and practical constraints considered further down in the decision tree.

Statistical aspects should be a major concern when designing a sound framework for monitoring. The aim is to generate data that will allow us to make precise and unbiased inferences about the phenomena that the monitoring is intended to cover. Users then need to clarify whether the focal area of interest is defined and the sampling over this area can be made representative with respect to the variables that will be measured. The latter issue may require some knowledge about the spatial variation of these variables. There is a similar issue of representativity in time. Species or habitat properties may vary through the year or between years and users need to take account of this when deciding when to monitor. To increase the precision of estimates, replicated sampling (repeated sampling within the spatial area and time period defined as a sampling unit) is recommended. However, there may be a trade-off between replicated sampling and a higher intensity of distributed sampling in space or time.

Closely related to these statistical aspects are the issues of response time and sensitivity. This may be formulated as the ability to discover a specific magnitude of change in nature within a certain time period at a specified level of certainty, e.g. an 80% probability of discovering a 10% change within a 5-yr period. Users may have particular needs or preferences in this regard, and this will have considerable consequences for the sampling design of the monitoring. For instance, some form of replicated sampling will be needed to quantify the standard errors to address such issues of response time and sensitivity. In BioMAT's Module 3 these statistical issues are explored in a dialogue with the user to specify the statistical constraints that will be a major factor in the design of any monitoring scheme.

The final factor in the design of a monitoring scheme is the operational constraints. These include the level of expertise and person-power required, the resources for staff, equipment and consumables, infrastructure, accessibility to monitoring sites, as well as the long-term commitment and predictability of all these factors. Altogether, there many more operational constraints than we can handle within the decision tree of Module 3. We therefore focus on the key factors related to person-power and expertise within the decision tree and only briefly discuss the other factors in an explanatory note. For expertise required, the opportunities to use volunteers as a supplement to professionals are explored with reference to EuMon's study of Participatory Monitoring Networks.

2.4.4 Output

After proceeding through the various branches of the decision tree, users are offered a short recommendation on the best strategic approach to monitoring, given the various options and constraints decided at the different levels of the decision tree. There are also links to somewhat more extensive explanations of the offered recommendations and to relevant EuMon documents and external references. Module 3 will also present the users with 'best practice examples' fitted to the recommendation. These examples are harvested from the EuMon database on existing monitoring schemes for species and habitat (DaEuMon).

As there will be many possible combination of monitoring objectives and statistical and operational constraints (cf 2.4.2 above), users are also offered the opportunity to go

back to previous levels in the decision tree to explore the consequences of different choices. At a strategic level, however, there are only few recommended approaches to designing a sound monitoring scheme or framework. An indication of where particular improvements can be made is therefore offered as well.

3 EuMon Internet Portal: status and the future

The EuMon Internet Portal has been under development and updating since early on in the EuMon project. Several of the key components of the portal, like the DaEuMon database and many of the deliverables, have been available to the public in earlier versions for some time. The portal is now in the final development stage to incorporate all the components described here and streamline the user interface. The EuMon Internet Portal will be fully operational and publicly available in the autumn 2008.

Key aspects of the EuMon project will be carried forward in two new EU-funded projects that have started or will start in 2008, EBONE and SCALES. Here the DaEuMon database will most likely be expanded to include also other types of biodiversity monitoring in addition to species and habitats. Also the BioMAT tool will be adapted to the needs of these projects. This guarantees that these key EuMon products will be actively maintained and developed well past the life of EuMon as a project, and they will be available to potential users for several years to come.

Appendix 1: Technical description of the EuMon Internet Portal

For the electronic presentation of EuMon's products and tools, CKFF has established an internet portal with online databases, manuals, and various information about the EuMon project. Recommendations on methods for analysing monitoring data and designing cost effective and successful monitoring regimes are partly presented through various EuMon documents (deliverables and journal articles) and partly through the BioMAT internet-based tool. People who are involved in monitoring (professionals and amateurs) can use the methodology to review success and design of monitoring regimes they are involved in. References to additional background information and software tools for analysing monitoring data will be downloadable..

The work of the BioMAT-tool and of the whole portal consisted mostly of computer programming and assembling the already available and extremely cost-effective Open source software packages:

The database is located on a co-hosted server (within premises of one of the largest Internet providers in Slovenia) and maintained by CKFF.

The main part of the software used and needed for the database operation is open source (OSS).

It consists of:

- Apache web server
- Php scripting language
- PostgreSQL database server
- PostGis spatial data extension for PostgreSQL.
- Two proprietary pieces of software are also used:
- Php Pdf library (Pdflib)
- Charting package (ChartDirector)

The database and the actual code are and will remain "very small" in terms of data storage capacity needs.

No equipment based performance bottlenecks have been observed in the past nor are expected in the future.

Backup of the complete EuMon Internet site (including the database) is scheduled and run twice a day. First backup stores on a separate disk of the same server, while the second one stores over Internet to a disk located at the CKFF local office in Ljubljana

Particular attention has been paid to the cross-platform accessibility of all the EuMon-Portal contents. The site yields the same user experience and functionality on all the major computer platforms (Windows, Linux, Mac) and its usage should be transparent also to non-technical/skilled users.

The user-friendliness of the beta-Version of BioMAT tool will be tested by potential end-users in autumn 2008.