Handbook for Surveillance and Monitoring of European Habitats

Handbook for Surveillance and Monitoring of European Habitats

First Edition

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(Eds)

"Here then Plant Geography as a botanical science gives place to Plant Geography as geographical science. We shall consider vegetation as an expression of the climate, and life forms of plants as a means of determining the biological characteristics of the different climates."

Raunkiaer 1907.

Alterra-rapport 1219

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ABSTRACT

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The primary objective of this Handbook is to describe the methodology appropriate for coordinating information on habitats in order to obtain statistically robust estimates of their extent and associated changes in biodiversity. Such detailed rules are necessary if surveillance; i.e., recording information at a point in time; is to be repeated subsequently as monitoring, otherwise real changes cannot be separated reliably from background noise. The BioHab procedure will also map all Pan-European classifications, such as EUNIS, where possible, as a basis for their surveillance and monitoring throughout Europe.

The basis of the General Habitat Categories is the classification of plant Life Forms produced by the Danish botanist Raunkiaer early in the 20th century. These Life Forms e.g. annuals or trees, transcend species. They are based on the scientific hypothesis that habitat structure is related to the environment. The BioHab General Habitat Categories cover the pan-European region (except Turkey) with 130 GHC's derived from 16 Life Forms (LF's). They have been field tested in all the environmental zones in Europe. Variation within a General Habitat Category is then expressed by environmental and global qualifiers, which are combinations of soil humidity, nutrient status, acidity and other habitat characteristics. Important additional information is given by adding codes from predefined lists of site and management qualifiers.

Key words: Field recording, Surveillance, Monitoring, Stratification, Habitats, Biodiversity, Life Forms

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Preface

This Handbook is the principal output from the BioHab project (A Concerted Action of the Fifth Framework – A framework for the coordination of Biodiversity and Habitats). Whilst the overall structure has been field tested in all the major Environmental Zones in Europe, some of the definitions of qualifiers need further amplification to make them consistently understood throughout the continent. Furthermore, this edition of the Handbook is being produced for the final BioHab Workshop and it is recognised that some minor modifications may result from the discussions. This version is therefore the First Edition – subsequent versions are likely to follow, including features such as diagrams of worked examples and a dichotomous key. The Handbook includes all the information in a single volume to explain and support the rule decisions for people outside the project team. However, the critical rules, instructions and blank field sheets and codes have been extracted for easy reference in the field and can be downloaded from *www.biohab.alterra.nl*. In addition this website provides a picture library of the major categories and many examples of the combinations. In due course it is hoped that all this material will be brought together in a recording system that can be held on a hand-held computer to automate field recording.

R.G.H. Bunce
El Tiemblo, Near Madrid
August 2005

1 Introduction and validation

1.1 Introduction

1.1.1 The primary objective of this Handbook is to describe the methodology appropriate for coordinating information on habitats in order to obtain statistically robust estimates of their extent and associated changes in biodiversity. Such detailed rules are necessary if surveillance; i.e., recording information at a point in time; is to be repeated subsequently as monitoring, otherwise real changes cannot be separated reliably from background noise. The recommended procedure is to record habitats in stratified random samples derived from statistical analysis of European environmental data. The samples can then be converted to European estimates because the extent of the strata is known, as well as their relationship to the entire European domain. The BioHab methodology is a system for consistent field recording of habitats and for subsequent monitoring. It is based on tried and trusted existing procedures which have been proven in practice in the field over several decades, the first handbook being produced for the GB woodland survey in 1971. Although these were all available on request, this is the first such handbook to be published. The recording procedure involves collecting disaggregated data which can then be combined in a flexible way for specific objectives using standard database management techniques.

1.1.2 The Handbook was mainly developed from the Countryside Survey 2000 Field Handbook written by C.J. Barr in 1998. It was then modified for European use in 1999 and 2000 by the ECOLAND forum (an International Association for Landscape Ecology (IALE) working group for monitoring European vegetation and landscapes) and is now the product of the BioHab project.

1.1.3 There are potentially thousands of habitats in Europe. Indeed, the habitat concept as expressed by existing classifications emphasises this dilemma; e.g., the Spanish habitat classification has about 1000 classes. Most of the classifications are theoretical, based on expert opinion, and have not been mapped in the field. Nevertheless, the BioHab procedure will map all Pan-European classifications such, as EUNIS, where possible, as a basis for their surveillance and monitoring throughout Europe. Most of the classifications are based on phytosociological associations and the team have worked closely with phytosociologists throughout the project. For example, a procedure has been set up to utilise phytosociological relevées for monitoring vegetation biodiversity in Europe.

1.1.4 The development of a relational database was considered as an alternative approach to link classifications but can only indicate the existence of relationships between classifications, and cannot provide quantitative information about the degree of correspondence. This is because the possibilities of 1>1, 1<1 and not = 1 are not quantifiable Within BioHab therefore the conclusion was that resources would be better spent in the field in order to provide quantitative comparisons,

which are statistically reliable. The data base can also then be used to compare all Pan-European classifications objectively, as well as those developed for individual countries. As has often been shown, many apparently irreconcilable approaches can be usefully linked to optimise their individual strengths, e.g. the Ellenberg values, plant traits, a statistical vegetation system and phytosociological classes are all held on the MAVIS (Modular Analysis of Vegetation Information System) available from CEH (Centre for Ecology and hydrology) *http://science.ceh.ac.uk/products_services/software/mavis.htm*

1.1.5 Existing crosswalks include some 1:1 comparisons but also include unspecified combinations, e.g. the Erico-Pinion sylvestris association includes seven different EUNIS categories; similarly one EUNIS class, G3.4 Pinus sylvestris woodlands south of the Taiga, is also included in at least seven phytosociological associations. Such crosswalks cannot therefore provide quantitative comparisons – the BioHab cate-gories are designed as a lowest common denominator to enable extant data to be coordinated and allow statistical comparisons where applicable.

1.1.6 The Handbook provides instructions for recording habitats consistently as a basis for monitoring and the assessment of extent. Monitoring requires strict rules, hence the detail in the Handbook. However, it has already become clear that there are also other potential users, who may not be able to spend the time to undertake the rigorous training that is required for setting up permanent databases. Examples of such users are students, both undergraduates and postgraduates, who need a framework for habitat description, site managers who need a basis for comparison between their own and other sites, and interested amateurs. Whilst such users may not achieve sufficiently strict maps for monitoring, it has already been shown in the Picos de Europa, that the basic rules can be understood by non-professionals, such as students, and applied sufficiently well for descriptive purposes.

1.1.7 The use of predetermined General Habitat Categories (GHC's) that can be recorded in the field for areal, linear and point habitat elements is therefore the core of the Handbook.

1.1.8 The basis of the General Habitat Categories is the classification of plant Life Forms produced by the Danish botanist Raunkiaer early in the 20th century. These Life Forms e.g. annuals or trees, transcend species and enable the consistent recording of habitats with comparable structures within contrasting biogeographical zones that nevertheless have similar habitat structures. They are based on the scientific hypothesis that habitat structure is related to the environment and therefore will correspond closely to phytosociological classes at a high level. For example, temperate grassland has comparable structures through the world but has different names e.g. veld, steppe, pampa or grass-savannah. A statistical test of this hypothesis is given in section 1.2. Below the first tier of five super-categories, all possible combinations of Life Forms are included, even though some of them may be rare. This has provided a statistical rule for determining the number of GHC's.

1.1.9 The BioHab General Habitat Categories cover the pan-European region (except Turkey) with 130 GHC's derived from 16 Life Forms (LF's). The field testing across the major environmental zones has shown that no other significant areas of other Life Forms occur although small patches below the mappable area may be present. However, generalisations have been made, e.g. for tall succulents, which would need to be expanded for extension into a world biome system.

1.1.10 Variation within a General Habitat Category is then expressed by environmental and global qualifiers, which are combinations of soil humidity, nutrient status, acidity and other habitat characteristics. Important additional information is given by adding codes from predefined lists of site and management qualifiers. Although the qualifiers are technically "softer" information, recent monitoring studies have demonstrated their value, provided there is an adequate sample size. Codes are also added to provide details on the complete LF's and dominant species. Further coding is used for recording pan-European classifications, local classifications and phytosociological associations, as required for a given survey. Local information can also be added e.g. on favourable conservation status and indicators of quality. Other Annexes contain relevant information; e.g., on details of the Life Forms and a bibliography to provide the background literature supporting the methodology.

1.1.11 The principal reason for the GHC's is that they enable the primary decision on the habitat category actually to be made in the field without the necessity of subsequent data analysis. However, the latter are necessary for many objectives; e.g., relationships with drivers; and because the data are disaggregated, they can be used for multiple objectives. The detailed rules provided for GHC's mean that they can act as the lowest common denominator to link existing habitats recorded in detailed studies of biodiversity; e.g., BioAssess and GREENVEINS. They could also be used as the basis to link other sources of data essential for defining and monitoring biodiversity e.g. phytosociology, birds and butterflies.

1.1.12 Currently a database is being prepared that will enable access to Life Forms of any species. This will be linked to *http://science.ceh.ac.uk/products_services/software/mavis.htm* which already holds information on character traits and Ellenberg values for British species.

1.1.13 The GHC's are only one reflection of biodiversity, there are three other measures included in the core procedure:

(1) Habitat structure from the records made of all Life Forms over 10% in each element
(2) Species numbers of vascular plants in grassland elements
(3) Species numbers of vascular plants in crop elements

1.1.14 It should be emphasised that although the core BioHab recording system requires all this information to be collected, recording the GHC's alone could provide rapid information for determining habitat extent and distribution in Europe. Estimates of the time involved can be obtained from the senior editor.

1.1.15 In detail, the use of GHC's has five primary objectives:

(1) To define the principal habitats of Europe on the basis of consistent field based rules
(2) To provide statistical comparisons between the extent of habitats at regional and national levels and their links to extant habitat classifications
(3) To provide a rigorous framework for monitoring habitats and biodiversity in Europe
(4) To link surveys based on objective sampling with extant relevant data from selective data collection
(5) To provide links to world biome models as a basis for assessing the impacts of climate change on habitats

1.1.16 The Handbook presents the scientific background and a field recording methodology that uses 1:5,000 or larger scale base maps, usually derived from aerial photographs, to survey sample 1 sq km areas. Other data from existing grid or random samples registered in the same scale can be converted into the General Habitat Categories and can be coordinated into European estimates using the strata of the European Environmental Stratification. In addition, the key to the General Habitat Categories can be applied to any extant habitat data or for general recording in the field as a framework for linking studies.

1.1.17 The Handbook provides the essential instructions for field recording, including mapping change and for coordination of existing habitat data.

1.1.18 The contents of the Handbook are as follows. The surveillance system is described in Section 2. The instructions for the recording of areal elements are presented in Section 3; including a description of the Life Forms and the General Habitat Categories with further detail being given in Annex 1. Section 3 also includes instructions for the recording of environmental, site and management qualifiers, species composition and information on pan-European and local habitat classifications as well as phytosociological associations. The additional codes for linear and point elements are described in Section 4. Section 5 provides a reference list of the predetermined General Habitat Categories. Section 6 describes the application of stratification. The core instructions for mapping change (monitoring) are presented in Section 7 and Section 8 includes some examples of other potential modules. Annex 1 contains lists of indicative plant species for each life form. Annex 2 contains a glossary of terms and abbreviations as they are used in the Handbook. Finally, a bibliography is included, with references divided into principal relevant topics.

1.2 Field validation

1.2.1 From the outset of the project it was considered essential that the rules should be rigorously tested in the field. This was because the ECOLAND workshops had already shown the limitations of using theoretical classifications for mapping in the field. In addition the PEENHAB project has also shown how the available infor-

mation in Priority Habitats was also not at a consistent level with some habitats having inadequate descriptions for mapping. The experience in the project team also confirmed the necessity of checking map categories, even of rules produced specifically for the field. This conclusion has been supported in the period for the project, where progressive refinement of the rules has taken place in the field. The Advisory Group workshop in the Guadarrama Natura 2000 site also showed that there was a clear distinction between recording the presence of a habitat, as opposed to mapping its extent and distribution as a basis for monitoring.

1.2.2 The instructions in the Handbook have been developed in six stages:

1. Development of initial rules
2. Discussion of rules in workshops
3. Field excursions to wide biogeographical locations
4. Discussions in the field
5. Field mapping of 1 km^2

These are described in the following sections.

1.2.3 The initial rules were developed in the two ECOLAND workshops and attempted to adopt the GB countryside field procedure to EUNIS habitats. In the first stages of BioHab it was however found that further refinement of the rules did not work because although EUNIS is hierarchical, there were gaps in the series of types presented e.g. for inland cliffs, only acid, siliceous inland cliffs 4.3.1 and basic and ultra basic cliffs 4.3.2 are included. Actually, neutral cliffs also occur widely, and indeed, in some regions e.g. Snowdonia and the English Lake District, acid, neutral and basic sections are all present in the same cliff. Many of the terms e.g. wet and acid, are not defined exactly, but are suitable for descriptive purposes, although they cannot be used to separate intergrades in the field. A test in BioHab at applying EUNIS to field mapping showed that, whilst relatively homogeneous stands could be reliably identified, intergrades presented problems. At the first workshop in Lisbon Environmental qualifiers were introduced (section 3.2) as a means of ensuring that there were no gaps in coverage and that the level was consistent.

1.2.4 The rules were discussed in BioHab workshops in Prague, Vienna and Wageningen and decisions built into the rule framework. For example detailed rules defining urban land were developed at the Wageningen workshop. A key workshop was also organised by the Swedish partners to present the approach to independent Scandinavian scientists. This meeting was supported by the Nordic Council and identified inconsistencies in the categories presented, e.g. the separation of *Fagus* from deciduous woodland. The participants also pointed out that Life Forms should be used for all categories and not existing habitat types, such as raised bogs, because they were complexes of LF's varying from forest to scrub and bog pools.

1.2.5 Throughout the project excursions were made to diverse biogeographical locations, e.g. Almeria and inside the Arctic Circle, by the senior editor with support from other team members. The distribution of the main visits is given in figure 1.

These excursions ensured that the categories included all the major areas of Life Forms. The rules and field procedures were also demonstrated to independent scientists in countries as diverse as Faro in Southern Portugal and near Brussels in Belgium.

Figure 1. Distribution of the main visits in the field validation.

1.2.6 Field excursions were linked to most BioHab workshops and enabled the rules to be tested. For example in Prague the definition of "dry" as opposed to "very dry" was discussed emphasising that such terms must be seen in the European context and must not depend upon individual indicator species, but on the overall balance in the habitat.

1.2.7 A series of mapping exercises were organised starting with Mediterranean habitats in El Tiemblo near Madrid. Other mapping was carried out in all European Environmental Zones except Pannonian, usually in 1 km squares that had previously been surveyed in regional projects. An additional test was carried out in Denmark by two students with no previous experience of BioHab and using an early version of the Handbook. These practical excursions led to progressive refinement of the field instructions, which were finally tested by the project team in 1 km square in Proprad, Slovakia in July 2005. Worked examples of a fully mapped square is given in Section 5.

1.2.8 This extensive field testing has ensured that the principal rules are sufficiently robust to be applied across Europe. However, it is recognised that there is still room for amplifications and modification- as has been the experience of First Editions of previous Handbooks. In particular some of the site and management qualifiers could be expanded.

1.3 Statistical validation

1.3.1 As has been pointed out in the introduction the use of Life Forms is based on a regression model. Thus the LF's present in the extreme environments of mountain summits and the arctic as compared with the desert of Almeria is the substance of classical biogeography. It is also recognised that in temperate zones management determines the structure within the restrictions of environmental potential. This regression model has been tested by two studies.

1.3.2 In the first study students from the Charlotte Mason Campus of St Martin's College, Lancaster surveyed 80 0.25 km^2 in the Camaleño valley in the Picos de Europa in north-west Spain. For this exercise crops and urban were considered as individual categories and the 0.25 km^2 were drawn at random from eight Environmental classes. Principal components Analysis was carried out on the mixture of GHC's within the classes and the means of the first component calculated from each class. These were then correlated with the mean altitude of each class as a measure of the environment (orthogonal regression), giving a correlation coefficient of 0.94, which was highly significant and showed that even within one valley, the regression model was valid.

1.3.3 In order to provide analytical support to the conceptual approach of Raunkiaer it was decided to use the data that had been collected on the proportion of life forms from patches of $400m^2$ visited during the excursions described in 1.2.5 and 1.2.6. These data can only act as a demonstrator as they are not collected from representative random samples. The results as shown in figure 2, support the principle of life forms and their relationship with the environment as expressed by Raunkiaer and show that in practice there are several significant dimensions e.g. from bare rock to annual vegetation (high mountain to Mediterranean) and from grasses to spiny cushions (temperate to Mediterranean). The LF's were linked to the main environmental sectors of Europe as defined by the environmental zones of the European Stratification system. Alpine North and Mediterranean South were isolated as the extremes fitting the discussion above. The other zones are clustered together, showing the influence of management.

1.3.4 This analysis shows that life form combinations are more important than the individual categories. They form complex relationships with the environment on the one hand but also show modified patterns because of management by man on the other hand. Some of these relationships are likely to be stable with the inclusion of suitably balanced datasets but other important gradients may also emerge that have not identified in this preliminary analysis. However, what has been conclusively

demonstrated is that the analysis of relatively simple life form data can identify not only principle environment gradients but also modifications caused by management by man.

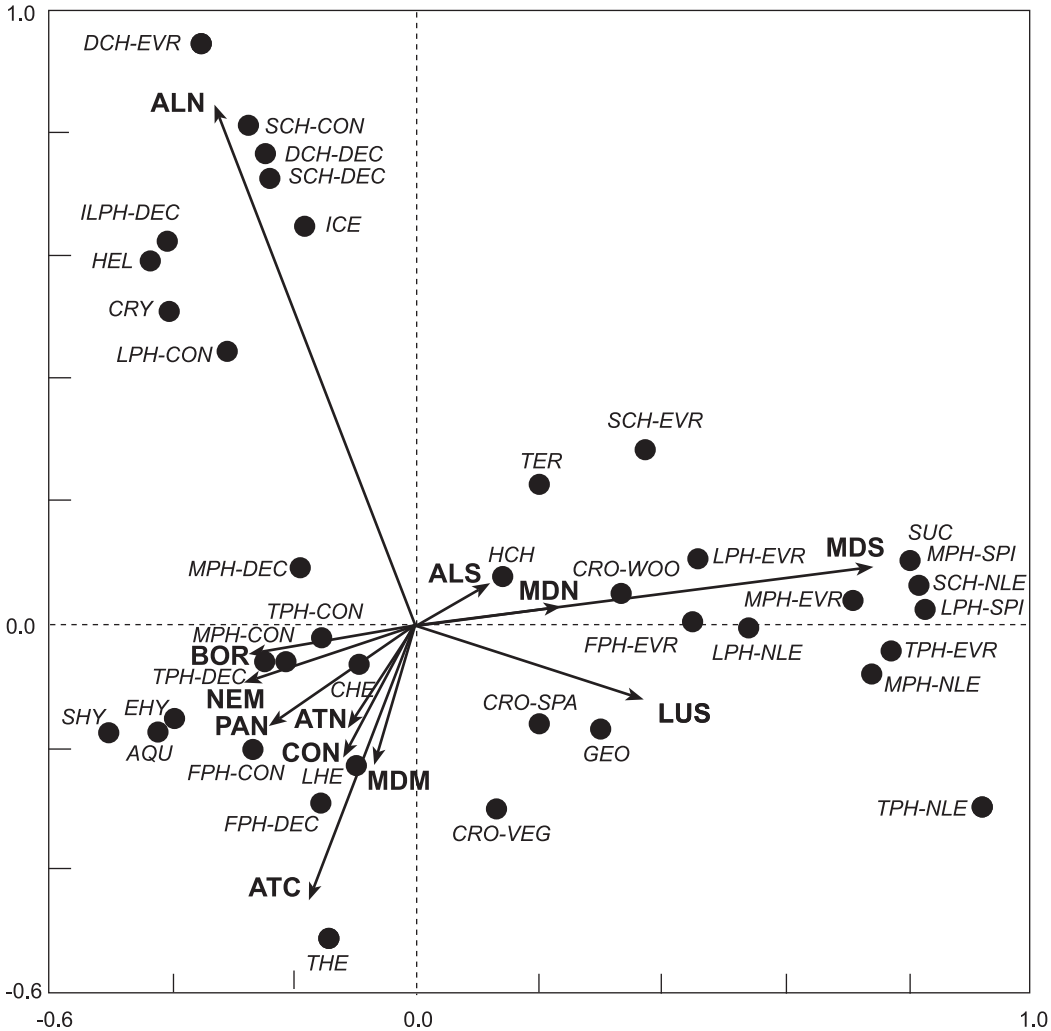

Figure 2. Biplot of General Habitat Categories (GHC's, coded as in chapter 3 and annex 3) and Environmental Zones (EnZ's) resulting from Canonical Correspondence Analysis (DCA). The first two axes are shown. Eigenvalue of Axis 1 is 0.42, eigenvalue of Axis 2 is 0.35. The coding of the EnZ's is: ALN: Alpine North, BOR: Boreal, NEM: Nemoral, ATN: Atlantic North, ALS: Alpine South, CON: Continental, ATC: Atlantic Central, PAN: Pannonic-Pontic, LUS: Lusitanean, ANO: Anatolian, MDM: Mediterranean Mountains, MDN: Mediterranean North, MDS: Mediterranean South (Metzger et al. 2005).

2 The Surveillance System

2.1 General Habitat Categories (GHC's)

The General Habitat Categories are the primary structure for recording habitats and providing links to other classifications. The General Habitat Categories are based mainly on Life Forms with added detailed information on environment, site, management and species composition.

The working definition of "habitat" developed by the BioHab project and used in this Handbook is as follows: *"An element of land that can be consistently defined spatially in the field in order to define the principal environments in which organisms live."*

2.2 The underlying principles of the BioHab General Habitat Categories

The use of General Habitat Categories (GHC's) in the BioHab Field Handbook is based on the following set of principles that have been adopted as essential for consistent recording of habitats.

2.2.1 A GHC has to be determined on one field visit, or from extant data at a scale of at least 1:10,000, which must be made in an appropriate time window for a given region, i.e. either side of the period of maximum biomass.

2.2.2 GHC's must be mutually exclusive and together cover the complete land surface of Europe, including water bodies.

2.2.3 GHC's must be a common denominator for comparison between countries using extant data and classes in current use wherever possible.

2.2.4 GHC's must be distinctive and recognisable.

2.2.5 There must be explicit rules to define GHC's.

2.2.6 Differences in management are recorded as qualifiers and are not in the definitions of GHC's.

2.2.7 Habitats are not defined on the basis of biogeographic regions because of difficulties of maintaining consistency due to the lack of adequate definitions of the multiplicity of terms. Any biogeographical term that can be determined consistently can be attached to GHC's through database management.

2.2.8 Local names of habitats are not used in the GHC definitions, because they cover different ranges of variation in contrasting regions.

2.2.9 Individual species are not used to identify GHC's, because of vicarious species and differences in species behaviour in contrasting biogeographical regions. However the use of indicator species to identify environment qualifiers is useful.

2.3 Instructions for mapping

The following sections are the general instructions comprising the rules that apply to field mapping and recording of areal, linear and point elements (see the worked examples in Section 5). The list includes some rules that are specific to either areal or linear elements. For further details regarding rules that are specific to areal elements see 2.9. For further details regarding rules that are specific to linear elements see 2.10 and 2.11 with additional codes in Section 4. For further details regarding rules that are specific to point elements see 2.12.

2.3.1 The basic survey area is 1 km^2 within which areal, linear and point elements are recorded. In complex landscapes 0.25 km^2 may be appropriate. The key to the General Habitat Categories can however be applied to any extant data or for general recording in the field.

2.3.2 Life Forms are the basis of the recording system together with qualifiers.

2.3.3 The Minimum Mappable Element (MME) for an areal element is 400 m^2 with minimum dimensions of 5 x 80 m.; if it is smaller than 5 m. the element is recorded as a linear element with a Minimum Mappable Length (MML) of 30 m. Elements that do not pass the MME criteria for either areal or linear elements can be mapped and recorded as point elements or as proportions of a larger element (see 2.12 for more detail on mapping and recording of point elements).

2.3.4 Elements with a total extent that passes the MME criteria for an areal element and lie across the edge of the survey square should be recorded as areal elements even if the part of the element that is within the survey square is below 400 m^2.

2.3.5 Canals, roads and broad rivers may be linear elements, but if they are over 400 m^2 within the survey area and at least 5 m wide, they are mapped as areal elements. (Subsequent database analysis can analyse these as linear elements, if required) If a linear element has 20 m inside the survey area and at least 10 m outside (i.e. total length is >30 m) it should also be recorded.

2.3.6 Preparatory work on delineation of the major elements within the survey area from the aerial photograph or map is strongly recommended.

2.3.7 Field mapping of elements should be made in one of the following ways:

a. In pencil, on sheets that are copied from the most recent 1:10,000 scale (or at least 1:25,000 scale if of sufficient quality) base map including topographic and/or cadastral information, enlarged to 1:5,000 scale.
b. In pencil, on transparent overlay sheets placed on aerial photography (AP) prints at a scale of 1:5,000. Aerial photographs should preferably be ortho-photos or else geometrical properties need to be assessed.
c. Elements can be determined by photo-interpretation and used directly in the field as a basis for mapping GHC's.
d. Digital outlines of the AP interpretation can be held on a field computer and the information in the field can be recorded directly.

2.3.8 Separate sheets or overlays are to be used for the mapping of areal and of linear elements. Points are to be mapped on the linear sheet, either as individuals, or groups.

2.3.9 Mapping sheets should be annotated with only alpha codes and/or (in the case of re-survey only) the global codes NEW, NOL and ERR (see 3.2.3.7).

2.3.10 The data for mapped elements are recorded on standard forms (see Section 5).

2.3.11 A 2 m pole, marked in 0.5 m intervals should be carried to check width and height estimates and for recording species numbers (see 2.9.3).

2.4 Instructions and rules for recording

2.4.1 In order to avoid inconsistency all field surveyors should make as many decisions as possible in the field and not postpone them to the laboratory. However, subsequent database management methods can be used to extract other data, e.g. calculation of slope angles, aspect and height of cliffs.

2.4.2 There are two types of data recording code: (a) the GHC's and (b) various qualifiers. All mapped elements must be recorded with a GHC entry in field one (i.e. the second column of the recording sheet).

2.4.3 Surveyors are provided with lists of GHC's and qualifiers, which should be used to describe each mapped element (area, line or point) in the survey area. Non-standard secondary codes can also be used for site and management qualifiers if the observed site or management qualification is not covered by the standard site and management qualifier code lists. If a non-standard code is used its definition (i.e. description of the observed qualification it is being used for) must be noted in the field marked "unique codes" on the appropriate data recording sheet.

2.4.4 Completed recording sheets are given in Section 5, but can be modified in detail for specific surveys.

2.4.5 The surveyor should record data of areal elements on one recording sheet and data of linear and point elements together on another recording sheet. A third sheet is provided for background information on the survey square.

2.4.6 Elements are assigned alpha codes that are the same on the map and on the corresponding recording sheet. Capital letters of the Latin alphabet should always be used for the alpha code. "I", "O" and "X" and should not be used. Once all the letters of the alphabet have been used then use double codes: e.g. AA, AB, AC etc. Separate mapping elements that have identical data coding (i.e. entries in Fields 1 – 8) have the same alpha code; otherwise a new alpha code is used. Both the areal element registration and the linear/point element registration use the full alphabetic sequence for their alpha codes; i.e. both registrations can use "A", "B", "C", etc. as their alpha codes. Examples are given in Section 5.

2.4.7 In order to give as much information as possible about LF's and the dominant species mapped elements, field five of the data recording sheet should be used to record these details for each alpha code that is used (see 3.5).

2.4.8 Total cover is estimated as from a vertical perspective.

2.4.9 The mapping of areal elements adds to 100% of the land surface. The entire survey area must be mapped, even the small corners of the square. See the worked example in 5.2. Additional codes are provided for inaccessible mountain elements and land which is inaccessible for ownership reasons.

2.4.10 Multiple vegetation layers e.g. within forests are not recorded, but could be subject of an additional module (Section 8) within regional surveying activities.

2.4.11 Environmental qualifiers are not applied to urban/constructed codes.

2.4.12 For ease of coding some linear elements e.g. fences and walls are included as qualifiers to the urban/constructed codes (see 3.3 and 4.2.1).

2.4.13 Point elements are recorded if they are considered significant in the landscape context. It must be made explicit how these have been recorded, so that they can be monitored effectively. The definition for significance will be explained in the field training course or will be made explicit for a given survey (see 2.12).

2.4.14 Any global code, e.g. height, depth or substrate (e.g. "HIG3" or "8") can be included in field two to five if appropriate, placed on separate lines. They must be placed below the code to which they refer. Unique codes can only be recorded for qualifiers in field three and higher.

2.4.15 Linear landscape elements within areal urban elements and linear elements that form the boundary of and urban element are not recorded (see 4.1).

2.4.16 For determining the GHC's there are only two percentage rules: over 70% for single GHC's or 40-60% GHC's that are combinations of two LF's (see 3.1).

2.4.17 Where there are over two Life Forms in elements with over 40% bare ground then the GHC is determined according to the precedence rules given in 3.1.

2.4.18 All Life Forms present with a cover over 10% and single species present over 30% are recorded in field five.

2.4.19 In case of complex elements the composition consists of mixtures of GHC's which are recorded in field 5. The GHC's reflect the dominant Life Forms and in general, larger elements should be mapped rather than attempting to map small patches which do not have distinct boundaries.

2.4.20 There is a mapping code for ecotones (see 3.2.3.5).

2.4.21 Separating map elements is based on strict rules (see 2.8).

2.4.22 An entry must be made in all fields of the recording system; even if the entry is one of the three global "absence of data" codes (see 3.2.3.6).

2.4.23 All mapped elements must be annotated with one GHC in field 1.

2.4.24 A procedure is defined for recorded species numbers from grasslands and crops (see 2.9.3).

2.5 Operational considerations

2.5.1 For monitoring, the recording of the GHC's should be made in a time window either side of the period of maximum biomass; i.e., as close as possible to the height of the growing season. This window is likely to be

before maximum biomass in the Mediterranean, but after in Scandinavia. The extent of the window should be set by region, using local phenological information. Repeat surveys should be carried out at the same time. This time differs between Environmental Zones, Strata and countries and will be determined before any major survey is carried out. Some local flexibility may be required for annual variations in weather which is likely to be greatest in the Mediterranean region. A separate sheet (see 5.1) is provided for background information on the 1 km square. The information on this sheet should be completed using the same procedure and codes as other data. Separate alpha codes should be used for ownership.

2.5.2 Environmental conditions must be considered at a continental scale: e.g., "dry" in Scotland may be "mesic" compared with southern Italy (see 3.2).

2.5.3 Within this handbook a Pan-European working definition of urban land and constructed elements has been produced. Recreation areas and parks are included in this category of "urban" elements (see 3.1.1).

2.5.4 A procedure for coordination of unique codes needs to be set up before any major survey is undertaken.

2.5.5 There has to be adequate field training for all surveyors. The actual period of field training depends on the experience of the surveyors but will be at least one week. The training must be coordinated by experienced people.

2.5.6 Combined teams, probably with a botanist and an experienced mapper, are needed to ensure that optimal expertise is available. A field team should consist of at least two people for safety and for consultation.

2.5.7 Field teams should consist of personnel with appropriate regional experience.

2.5.8 Quality assurance and control are essential and should be carried out regularly with standard protocols.

2.5.9 The Handbook must be used continually in order to optimise field performance.

2.6 The Recording Format

The same recording format is to be used for areal and linear and point elements. The recording form has an alpha identifier and eight subsequent recording fields as shown in section 6.1.

2.6.1 The *first field* is for entry of the GHC (see 3.1).

2.6.2 The *second field* is for entry of the environmental qualifiers and global codes, for expressing moisture regime and acidity variations between elements that otherwise may have the same GHC (see 3.2).

2.6.3 The *third field* is for entry of the site qualifiers to record other characteristics, e.g. geomorphology, geology, soil or archaeology, in order to express variation between elements that may have the same GHC (see 3.3).

2.6.4 The *fourth field* is for entry of the management qualifiers to record managed characteristics, e.g. forest management, succession and recreation, expressing variations between elements that may have the same GHC (see 3.4).

2.6.5 The *fifth field* is for entry of the detailed composition of the GHC's together with the major species and percentages (see 3.5).
2.6.6 The *sixth field* is for entry of European Habitat classifications, including EUNIS and other pan European classifications (see 3.6).
2.6.7 The *seventh field* is for entry of regional or local habitat classifications (see 3.7).
2.6.8 The *eighth field* is for entry of phytosociological associations, where appropriate (see 3.8).

All fields must have an entry in order to ensure that subsequent data base management can identify that an entry has not been omitted in error. See 3.2 for coding of "absence of data" entries.

2.7 Determination of the General Habitat Category

This section describes the rules for the determination of the GHC (i.e. the primary recording code) for areal and linear elements.

2.7.1 Determination of the GHC is based upon a sequence of four dichotomous divisions (see Figure 3) related to a set of five super-categories, which determine the set of LF's that can be used to identify the appropriate GHC.
2.7.2 The first decision concerns whether the element is Urban, the second whether it is a Crop, the third whether it is Sparsely Vegetated and the fourth whether it is Trees or Shrubs. If the result of any of these decisions is positive (e.g. "it is Urban"), the subsequent decision(s) is skipped. The rules for making these four decisions are as given below.
2.7.3 These categorical divisions need a series of supporting rules as given in Section 3.

All subsequent decisions for identification of GHC's are determined by percentage rules:

2.7.4 An element with >70% cover of a single life form or urban, crops and sparsely vegetated category is a GHC with 48 single codes.
2.7.5 Elements with 40-60% cover of two life forms or the subcategories of urban, crops and sparsely vegetated categories are also GHC's with 82 double codes.
2.7.6 If there are equal proportions of life forms then precedence rules are provided (see 3.1).
2.7.7 If there are equal proportions of life forms in elements with a cover of bare ground or rock up to 60% then the same precedence rules are followed, even although the percentages of life forms may be below 30%.
2.7.8 If there are three or more herbaceous life forms then the percentages of the top two are added and the percentages recalculated to obtain a GHC.

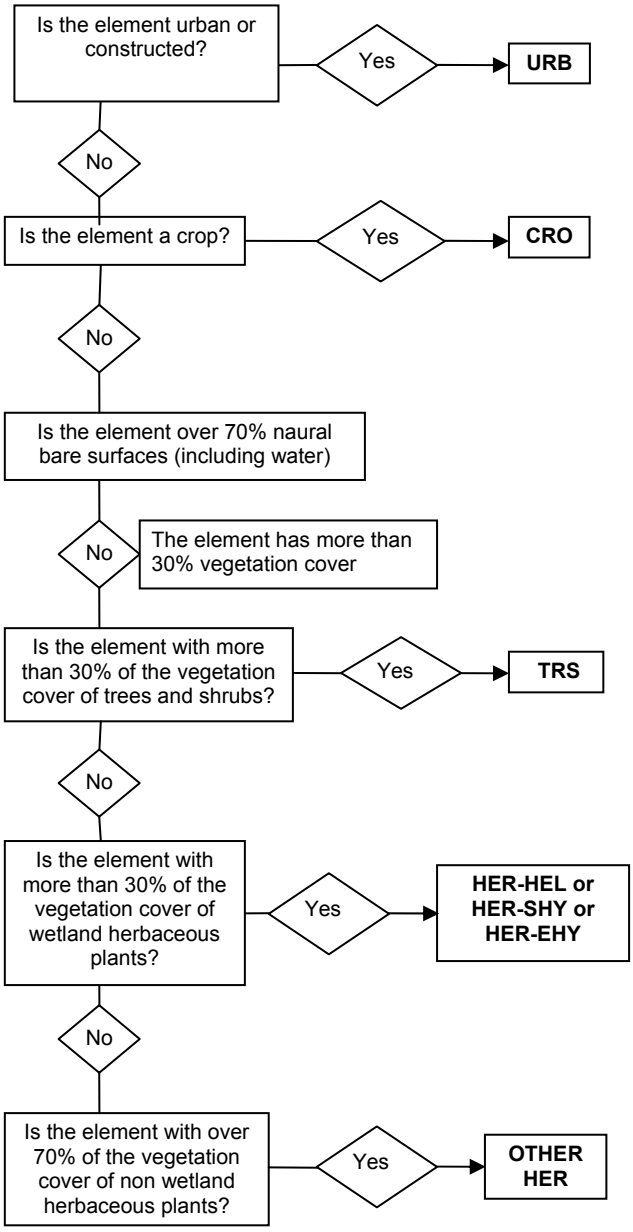

Figure 3. Decision tree for super categories. Futher detailed rules are given in Section 3.

2.8 Rules for separating map elements (i.e. new Alpha codes)

A new areal or linear element will be mapped and separated from adjacent or surrounding elements if any one of the following seven rules is true:

2.8.1 A change in GHC.
2.8.2 A change in environmental qualifier.
2.8.3 A change in site qualifier.
2.8.4 A change in the occurrence of point elements.
2.8.5 A change in management qualifier e.g. a fence line or age of forest trees.

2.8.6 A change of at least 30% in the cover of an individual species.
2.8.7 A change in any other specified habitat classification e.g. Annex 1/Priority Habitat or EUNIS.

2.9 Mapping and recording of areal elements

2.9.1 Most of the rules for mapping areal elements have been laid out in Section 3.
2.9.2 The alpha code for an aerial element should be placed as closely as possible to the centre of the element, as shown in the worked examples.
2.9.3 For each new element in habitats dominated by grasses, broad leaved herbaceous species and mixtures (Section 3.1.4) and herbaceous crops (section 3.1.2.11) according to the rules outlined above, an area of 2 x 2 or 4 x 1 m should be estimated using a 2 m marker, 1 m from the edge, at the centre of the longest boundary. The number of species should be counted and recorded on the unique code/species number section of the recording form. The location of the plot on the areal base map should be marked with an X and a number attached sequentially e.g. X A = 1; X B = 2.

2.10 Mapping and recording of linear and point elements

It is generally recognised that linear elements are critical habitats in many agricultural and cultural landscapes. They are included in the core module and tests have shown that with two surveyors, under 20% more time is required in the field. Exceptional landscapes of great linear complexity e.g. bocage will need more time.

2.10.1 Linear and point habitat elements are to be mapped on the same separate map or overlay, with a linked recording sheet, which has a comparable format to the areal elements form.
2.10.2 GHC's are recorded as linear elements if they have a width of less than 5 m and are longer than 30 m with appropriate qualifiers.
2.10.3 Elements that are smaller than 400 m^2 and shorter than 30 m can be recorded as point elements.
2.10.4 An element that has a width below 0.5 m is not recorded unless it is a global code (see 3.3 global codes). Other elements that are associated with a linear element have to be at least 0.5 m wide before they are mapped and recorded. Thus a strip of grass 0.30 m wide between cereal fields is not recorded.
2.10.5 Some habitats may have an actual significant surface extent that classes them as areal element, but are so steep in the vertical perspective that they have to be regarded and recorded as linear elements (e.g. cliffs and screes). The global code "HIG" plus the appropriate qualifier has to be used to record their vertical extent (see 3.3).
2.10.6 It is not uncommon for linear elements to form complexes, with several distinct linear elements adjacent to each other, such as a hedge next to a ditch next to a track. The rules for mapping and coding these cases are described below.

2.10.7 An element 5 m wide but less than 80 m is recorded as a linear and not as an area because it does not reach the 400 m^2 threshold.

2.10.8 If several linears are over 5 m wide and over 80 m long then they should be recorded as areal elements with appropriate GHC's and other percentages in field 5 but lines of trees/shrubs or watercourses should be mapped within them.

2.11 Detailed mapping and recording rules for linear elements

2.11.1 Linear elements are always mapped individually as lines on the map using alpha codes.

2.11.2 All GHC's and appropriate qualifiers can be used to record linear elements.

2.11.3 The same precedence rules for areal tree/shrub GHC's apply to linear elements.

2.11.4 If two linear elements both over 30 m long are close together i.e. side by side, but are of different GHC (e.g. a ditch alongside a road verge) they are mapped as one line with a combined primary code (e.g. A/B).

2.11.5 The 30 m rule is applicable to decide whether or not to map a habitat element as a linear, but also to determine the composition within this length. Therefore contrasting parts within 30 m are recorded as combinations, but the 30% rule then applies within that length. Otherwise contrasting parts which are each at least 30 m are mapped separately.

2.11.6 Separating different parts of a linear element is based on the same rules as for areal elements (see 2.7).

2.11.7 If the GHC near a road, track, footpath or river, is the same as that of the adjacent areal elements it will not be mapped as a linear element. For example a track within a grassland GHC will only be recorded as a track.

2.11.8 Linear elements over 0.5 m high (e.g. cliffs) must have height global codes added (see 3.2).

2.11.9 The width of roads, tracks and rivers includes the banks and verges, where the GHC differs from the surrounding land.

2.11.10 The width (global code) of rivers excludes overhanging trees.

2.11.11 Within forests linear elements are not mapped beneath the canopy except for water courses and roads and constructed tracks.

2.11.12 Subterranean watercourses are not recorded.

2.11.13 Linear elements that are within or border urban elements are not mapped.

2.11.14 The only linear element recorded adjacent to an urban element is a road.

2.11.15 In some cases a linear element may be part of a group. In this case the elements are linked to an areal element and their presence is recorded within that element (e.g. erosion gulleys in arable fields or terraces below 5 m wide in vineyards).

2.11.16 Lines of trees/shrubs must have at least ten individuals over at least 30 m length, otherwise they may be recorded as points, if ecologically significant (see 2.12).

2.11.17 All GHC's and qualifiers available for areal elements can be used. Codes are to be used in the same way and attached to defined lengths and width and

additional characteristics. Multiple codes may be attached to elements with several lines for linear elements, the upper layer always being placed first in the list of codes.

2.12 Detailed mapping and recording rules for point elements

There are two situations that help to define the *ecological significance of point features*:

2.12.1 ***Point features add to the landscape diversity***

Point features represent a particular habitat that adds to the habitat diversity significantly i.e. the habitat is absent as an areal feature. The point feature is thus distinct compared to the surrounding habitat area, because of a sudden change in GHC, environmental qualifier or management qualifier e.g. rocky outcrops and boulders in grassland where no bare rocks are present in the vicinity and cattle ponds in agricultural land.

2.12.2 ***Point features which affect the ecological functions on a landscape scale***

The point feature is important as a habitat, but has a significant influence on the wider landscape. Such features, by their presence i) induces an ecological process that has an effect that exceeds the area that is occupied by the point feature, or ii) affects an existing ecological process acting on the landscape scale. Examples of i) are: solitary trees, shrubs, clumps of invasive species that may invade the surrounding landscape; drinking places that attract animals and increase overall carrying capacity and karstic caves that provide nesting places for birds and bats. Examples of ii) are: weirs on watercourses that hinder migration and constructions for animal crossings across roads.

2.12.3 Because of the wide diversity in point element density there are three rules to record them that have to be agreed upon before going into the field.

- All point elements are recorded.
- All ecologically significant point elements are recorded, including those inside of forests.
- No point elements are recorded.

There is a space on the Background Information Sheet (see 5.1) to register the procedure that is being followed.

2.12.4 The criteria to record point features are as follows:

- The feature is a GHC with an area between 100 m^2 and 400 m^2 (minimum square: 10 x 10 m; circle 11 m diameter) and has an *ecological significance in a landscape ecological perspective*.
- The feature is included in the list of distinct point features (see below).
- The feature is smaller than 100 m^2 but has a clear *ecological significance in a landscape ecological perspective*, e.g. springs, moorland pools; earth pillars and barrows.
- Point features may be recorded in all GHC's except urban e.g. individual buildings in forests.

2.12.5 Linear and point habitat elements are to be mapped on the same separate map or overlay, with a linked recording sheet, which has a comparable format to the areal elements form.

2.12.6 There are two possibilities to map point elements: Either record a point by an x in the centre of the landscape element with an attached label. (e.g. for a building below 400m^2), or a group of point elements should be delineated as an area on the linear/point elements sheet (e.g. a group of boulders in an arable field).

3 Areal Elements

3.1 Field one: Rules for determining GHC's

Although the GHC's can also be applied to linear features they are included here because they are first used in Field one. Short descriptions of BioHab life forms are given in Annex 1.

All codes are unique e.g. ART or GRA, so that on the recording form the first identifier URB, CUL, SPV, HER and TRS can be omitted to save recording time and space.

3.1.1 URBAN/CONSTRUCTED

The urban categories have aggregated life forms to form the second tier, e.g. herbaceous includes all herbaceous life forms e.g. caespitose, hemicryptophytes and therophytes.

The term urban applies to technically "urban" or "built-up" land, within the boundary of the land functionally related to buildings, but also refers to parks and recreation areas. It is recognised that the term is not based on life forms, but is a land-use division. For example, two grasslands that are identical in terms of life forms and species may be in recreational use around an Industrial building or in agricultural use and grazed by animals.

The definitions below are based on the practical experience of the GB Countryside Survey adapted for Europe on the basis of the validation workshops:

3.1.1.1 The definition of urban and constructed codes land covers "*elements associated with built structures and routes of communication. Elements which are immediately adjacent to an urban element are not to be recorded, except for roads*".

3.1.1.2 Land is defined as urban, when it *"is an area of ground that is associated with a building and which has a use linked to that building e.g. garden"*.

3.1.1.3 Individual GHC's are not recorded in urban areas if below 400 m^2.

3.1.1.4 Urban land is mapped if possible by a single boundary and not as individual buildings.

3.1.1.5 "*If in doubt whether an element is urban, then only treat it as such when linked to buildings e.g. fenced land in a large estate in Spain is not urban, unless adjacent to the house.*"

3.1.1.6 In most European countries there are clearly marked boundaries around urban land and recreation areas e.g. The Netherlands, Spain and Belgium whereas in other countries e.g. Austria, Estonia and Norway there may not be actual physical boundaries around the houses. The instruction in these cases is as follows: "*the urban boundary should be drawn around the grounds of a building where the mana-*

gement intensity changes from that of a gardening character to more extensive management types."

3.1.1.7 In case of scattered holiday homes such as caravans within semi-natural vegetation then a boundary should be drawn around the whole area and the appropriate point element procedure (see 2.12) used to record scattered buildings within the surrounding GHC.

3.1.1.8 Glasshouses and polytunnels are urban with the qualifier "agricultural use".

3.1.1.9 Before going into the field, areal cadastral maps should be consulted, as these invariably define urban areas accurately. However, they need to be checked in the field in conjunction with aerial photos because changes may have taken place and recreation areas may not be included within the urban boundary. For example a fenced football pitch will not be separated on most topographic maps as an urban element, if it is within an agricultural field.

3.1.1.10 Further indicative information can be obtained from evidence of recreational use e.g. benches, picnic sites and waste bins within public open spaces, which may not be managed as intensively as gardens. As surveys will be carried out at the height of the growing season, tourists and visitors will often be in evidence, as will be the absence of agricultural activity. The site and management qualifiers should be used to provide supportive detail and will be invaluable for validation of change during the monitoring process.

3.1.1.11 The grounds of some large country houses grade almost imperceptibly into woodland, in which case evidence of garden practice on the one hand, and forestry operations on the other, should be used to draw an arbitrary line. If necessary the justification for this line should be given using the global code for an indistinct boundary, so that repeating survey can check whether there has been real change. The transition code ECO, see 3.2.3.5 can also be used when necessary.

3.1.1.12 Buildings and associated land below 400 m^2 should be recorded as points or as groups of points as described above. Where more than three houses of 400 m^2 are adjacent they can be mapped as a single areal element with percentages in field 5 (see 2.9).

3.1.1.13 Environmental qualifiers and life form species composition are not attached to elements inside urban land, unless it is a linear element e.g. a road outside urban areas surrounded by non-urban land.

3.1.1.14 Linear elements previously outside urban areas e.g. sunken roads and hedges that have subsequently been surrounded by urban development are not recorded.

The following GHC's have been defined to cover urban elements. Some constructed elements are also included in the global and linear codes (see 3.2 and 4.2).

3.1.1.15 **Urban artificial (URB/ART):** This category includes all built up land that is covered in buildings, tarmac, concrete or other artificial material. Street lights, electric pylons and telephone poles are not recorded.

3.1.1.16 **Urban Non-vegetated (URB/NON):** This category includes all non-vegetated land that is within an urban boundary, whether a construction e.g. a fence as an arbitrary boundary e.g. around a quarry. Mostly these categories are the result of urban activity rather than agriculture e.g. quarries, excavation sites and non-tarmac car parks, but water bodies in urban areas are also included here with appropriate qualifiers.

3.1.1.17 **Urban Vegetables (URB/VEG):** This category includes land that is under vegetables and/or fruit trees within an urban area and includes, for example, allotments. These categories will rarely form over 400 m^2 as a pure category and will mainly be recorded as combinations.

3.1.1.18 **Urban Herbaceous (URB/GRA):** This category includes land that is within the urban definition and covers less than 30% woody vegetation. This will include mainly grass e.g. playing fields, lawns and recreation areas, but also includes other herbaceous life forms.

3.1.1.19 **Urban Woody (URB/TRE):** This category includes land that is over 30% tree/shrub habitats as defined by the description of urban above. It may form an MME around large houses, but will often be recorded as combinations. Percentages below 30% are not recorded as separate GHC's.

In case of equal percentages the precedence will be given to the order of the categories: ART, NON, VEG, e.g. an element with ART 30/NON 30/VEG 30/GRA 10 would be the ART/NON GHC with a full percentage in field 5. This rule does not apply to GRA or TRE as the 30% rule applies.

3.1.2 CULTIVATED

3.1.2.1 Crops are mainly the product of plant breeding, but also of native species such as walnut. Wild species collected from semi-natural vegetation are excluded.

3.1.2.2 The individual crops are recorded in the same way as plant species in field five.

3.1.2.3 Land currently occupied by crops, or bare land with less than 30% cover and evidence of cultivation is recorded within the crop category with appropriate qualifiers.

3.1.2.4 Crop land management is not always synchronic with maximum biomass. Therefore if the crop has been harvested within the last month, but evidence of the actual crop is present, then it should be recorded as such. Dual cropping cannot therefore be recorded, but only the crop at the height of the season.

3.1.2.5 Any plant cover after harvesting is not recorded.

3.1.2.6 Bare ground is not recorded in herbaceous crops.

3.1.2.7 If there is over 30% cover of native species or crops in orchards, vineyards or olive groves it should be recorded in field five using the standard life form codes.

3.1.2.8 Vines are regarded as abandoned if there is no evidence of pruning in the last five years.

3.1.2.9 Olives and orchards are regarded as abandoned (see agricultural & semi-natural vegetation state management qualifiers) if there is no evidence of pruning, recent use, or collection of fruit.

3.1.2.10 **Cultivated bare ground (CUL/SPA):** elements with no crops planted or less than 30% cover of vegetation, including volunteers (self-seeded crop plants). Includes therefore only bare fallow or recently ploughed land which otherwise is recorded as a qualifier (Section 3.4) together with appropriate GHC. This code should only be used if the element has no woody crops.

3.1.2.11 **Cultivated herbaceous crop (CUL/CRO):** includes both annual e.g. barley and sunflowers and perennials, e.g. lucerne and strawberries. Also includes crops that are technically bulbs e.g. daffodils.

3.1.2.12 **Cultivated woody crops (CUL/WOC):** includes all elements with trees or shrubs, using the definition provided in 3.1.5, e.g. orchards, vineyards and olive groves. Cover cannot be used as a criterion because of pruning. Therefore the rule is that there should be at least 20 trees/shrubs per ha, otherwise the scattered tree code can be used. The names of crops, both English and Latin are given in section 3.5.1.2 Any vegetation cover over 30% should be recorded with appropriate life forms in field five.

3.1.3 SPARSELY VEGETATED

3.1.3.1 Elements which have less than 30% cover of vegetation, excluding saxicolous, lichens and bryophytes. Percentage cover estimates should be made of the entire surface of the element regardless of slope.

3.1.3.2 **Sea (SEA):** sea below mean low water mark.

3.1.3.3 **Tidal (TID):** coastal platforms/sediments between mean low water mark and mean high water mark i.e. the main tidal zone.

3.1.3.4 **Aquatic (AQU):** permanent water bodies, whether rivers, canals, lakes or ponds, with less than 30% cover, otherwise use LF's.

3.1.3.5 **Terrestrial (TER):** naturally occurring bare ground whether of rock, soft material or peat. Record with appropriate qualifiers.

3.1.3.6 **Ice/snow (ICE):** permanent ice/snow.

3.1.3.7 Rules for precedence: precedence for equal proportions are in order AQU, TER, ICE.

3.1.4 HERBACEOUS

3.1.4.1 Examples of widespread species with short descriptions of all the following LF's are given in Annex 1.

3.1.4.2 **Submerged hydrophytes (SHY):** plants that grow in aquatic conditions (category 1, see 3.2) the whole plant in water. This cate-

gory includes marine species and floating species which overwinter below the surface. Excludes aquatic bryophytes.

3.1.4.3 **Emergent hydrophytes (EHY):** plants that grow in aquatic conditions (category 1, see 3.2) with the main plant above water.

3.1.4.4 **Helophytes (HEL):** plants that plants that grow in waterlogged conditions (category 2, see 3.2).

3.1.4.5 The presence of over 30% of the first three classes take precedence over the remaining categories, except if there is over 30% tree/ shrub cover, which then takes precedence.

3.1.4.6 **Leafy hemicryptophytes (LHE):** broad leaved herbaceous species, sometimes termed forbs.

3.1.4.7 **Caespitose hemicryptophytes (CHE):** perennial monocotyledonnous grasses and sedges.

3.1.4.8 **Therophytes (THE):** annual plants that survive during the unfavourable season as seeds.

3.1.4.9 **Succulent chamaephytes (SUC):** with succulent leaves.

3.1.4.10 **Geophytes (GEO):** plants with buds below the soil surface.

3.1.4.11 **Cryptogams (CRY):** non saxicolous bryophytes and lichens. Includes aquatic bryophytes, e.g. *Sphagna* and *Racomitrium lanuginosum* which is not saxicolous.

3.1.4.12 **Herbaceous chamaephytes (HCH):** with non succulent leaves and not shrubby form.

3.1.5 SHRUBS AND TREES

3.1.5.1 Most of the following are woody – the term usually used in habitat classifications - but some chamaephytes e.g. *Phagnalon* spp., *Artemisia* spp. and *Asparagus* spp. do not have secondary ligneous woody thickening in strict botanical terminology. However these genera have a shrubby form and have perennating buds above ground level. Height is therefore the only consistent arbiter (see 9.3 for examples of plasticity). The woody trees and shrubs refer to individual plants and life forms. In the landscape groups of trees and shrubs combine to form forest and scrub habitats.

3.1.5.2 **Dwarf chamaephytes (DCH)** dwarf shrubs: below 0.05 m e.g. *Dryas octopetala, Salix herbacea.*

3.1.5.3 **Shrubby chamaephytes (SCH)** undershrubs: 0.05-0.3 m. e.g. *Thymus vulgaris, Lavendula stoechas.*

3.1.5.4 **Low phanerophytes (LPH):** low shrubs, buds between 0.30-0.6 m, *e.g. Myrica gale, Betula nana.*

3.1.5.5 **Mid phanerophytes (MPH):** mid shrubs, buds between 0.6-2.0 m, e.g. *Pistacia lentiscus, Cornus mas.*

3.1.5.6 **Tall phanerophytes (TPH):** tall shrubs, buds between 2.0-5.0 m, e.g. *Salix cinerea, Corylus avellana.*

3.1.5.7 **Forest phanerophytes (FPH):** trees over 5.0 m, e.g. *Quercus robur, Fagus sylvatica.*

The following life forms apply to the six height categories with over 70% being a single category and 40-60% being combinations.

3.1.5.8 **Winter deciduous (DEC):** e.g. *Quercus robur, Fraxinus excelsior.*
3.1.5.9 **Evergreen (EVR):** *Quercus ilex*, *Laurus nobilis.*
3.1.5.10 **Conifers (CON):** *Pinus nigra.*, *Juniperus communis.*
3.1.5.11 **Non-leafy evergreen (NLE):** e.g. *Sarothamnus scoparia, Ulex europaeus.*
3.1.5.12 **Summer deciduous and/or spiny cushion (SPI):** *Sarcopotherium spinosum, Astragalus massiliensis.*

The following precedence rules apply to TSR categories:

3.1.5.13 The height are mutually exclusive because of the character of tree/shrub vegetation and because with combinations there would be an unmanageable number of GHC's. This decision fits with other habitat classifications.
3.1.5.14 Precedence is given to the tallest category because that expresses the environment optimally.
3.1.5.15 In cases of even phanerophyte combinations, e.g. TPH 30%, MPH 30%, LPH 30, SCH 10, then the precedence is given to the order of the tallest category.
3.1.5.16 The order of precedence is set by the conceptual nutrient/environmental demands of the species groups i.e. winter deciduous species are generally in temperate conditions, whereas summer deciduous are in xeric situations. The ranking is the same for all forest and scrub sub-categories. Precedence rules are used for combinations. E.g. 30 MPH/DEC 30 MPH/EVR 30 MPH/NLE 10 CON = DEC/EVR.
3.1.5.17 In cases of even balance within a given class, e.g. 30% TPH/DEC - 30 % TPH/EVR - 30% TPH/CON, then precedence is given to the ranking 1-5 above.
3.1.5.18 Where there is much cover of bare ground/rock then the same precedence rules apply to even percentages, even although they may be below 30%, e.g. SPV 60, SCH/SPI 10, EVR 10, MPH/EVR 10, TPH/EVR 10 = TPH/EVR.

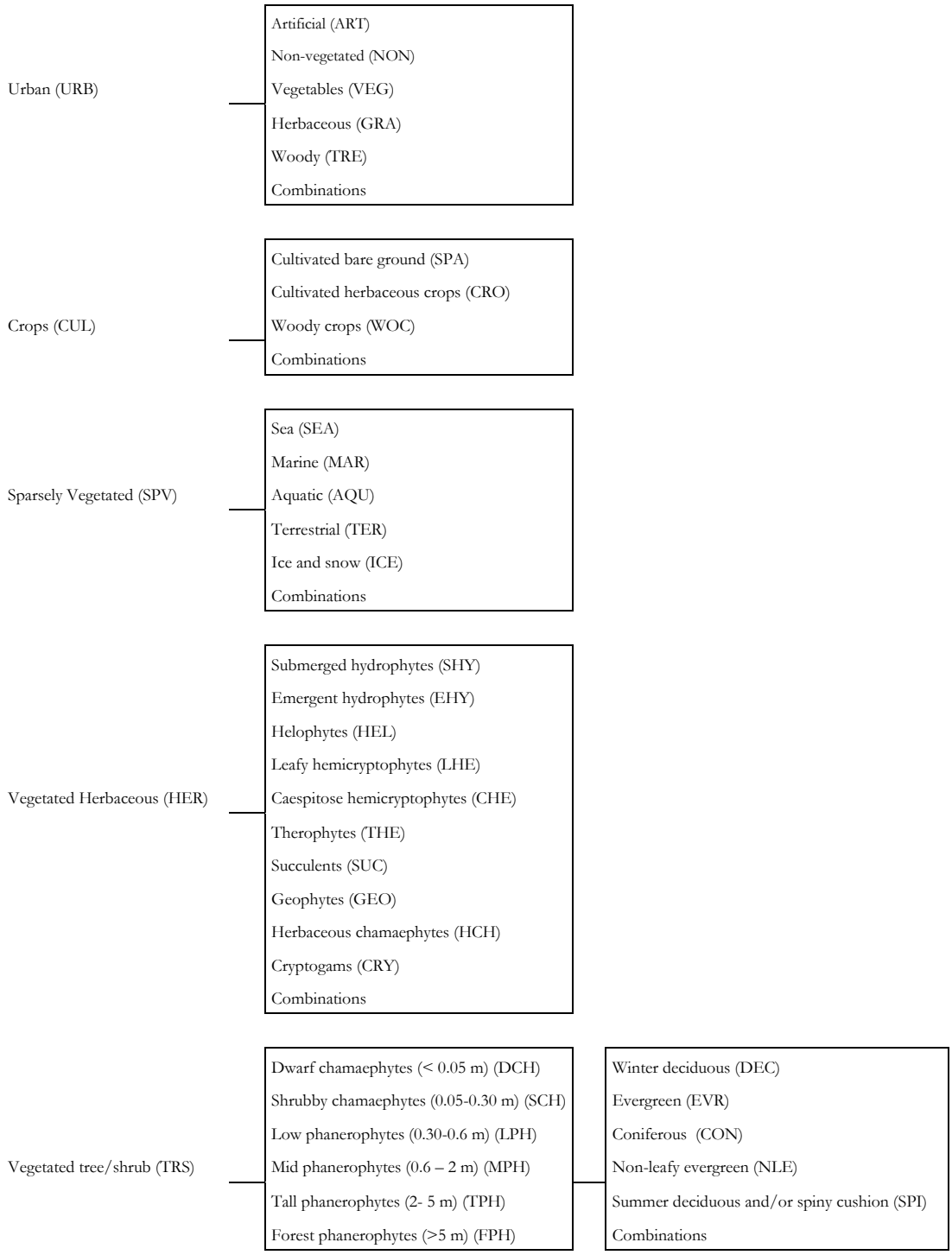

Figure 4. Diagrammatic representation of the BioHab key.

3.2 Field two: Environmental qualifiers

Environmental qualifier codes are to be entered into the second field of the habitat recording sheets for areal and for linear elements in order to express variation between elements that have the same GHC. They are not applied to urban/constructed, crop or sparsely vegetated elements. Global qualifiers may also be recorded in this field. They are given in 3.2.3.

3.2.1 Moisture regimes:

The categories below are based on the Concerted Action "Water regimes for forest productivity" coordinated by Graham Pyatt and published in 1999. The pF values are added for regional calibration of the used terms.

3.2.1.1 Aquatic covered in water over 70% of the time. e.g. *Nuphar lutea*, *Sagittaria sagittifolia, Zostera spp.*

3.2.1.2 Waterlogged/water saturated: water table at the surface with standing water for between 50 and 70% of the year or with the soil completely saturated, only small patches may become only wet in mid-summer. European soil moisture regimes: none. (pF1.7 during over 50% of the time). Peatlands or fenlands in the North, in the edges of water bodies in Central and Southern Europe e.g. *Potentilla palustris*, *Eriophorum angustifolum*, *Narthecium ossifragum.*

3.2.1.3 Wet: water table with 40 cm of the surface and soil containing free water for most of the year. European soil moisture regimes: slightly wet to moderately wet. (pF 1.7 during less than 50% of the time). Mainly in the north, but around the margins of water bodies in central and southern Europe. e.g. *Juncus effusus, Carex panacea*, *Scirpus sylvatica.*

3.2.1.4 Seasonally wet: water table variable at the surface and waterlogged for the winter months or spring flooding season, becoming wet or mesic (categories 3 & 5) during the summer period. European soil moisture regimes: none. Besides large rivers throughout Europe or in temporary water bodies. Evidence of inundation is required through landscape context or evidence in the soil profiles (young alluvial soils). Variable species but typical examples are: *Phragmites communis, Phalaris arundinacea* and *Oidensis tripatita.*

3.2.1.5 Mesic: water table 40-100 cm of the surface, available water during most of the non summer period, may dry out during the mid-summer period. European soil moisture regimes: very fresh to very moist. (pF 3.0-4.2 during 10 to 55% of the time). The middle range of soils in Central and Northern Europe and besides water receiving areas and northern mountain slopes in the Mediterranean Zones. (e.g. *Geranium sylvaticum, Corylus avellana, Oxalis acetosella, Anemone nemorosa*).

3.2.1.6 Dry: water table <100 cm of the surface, water available only during some periods, European soil moisture regimes: moderately fresh to slightly dry. (pF 3.0-4.2 during more than 55% of the time or/and

pF >4.2 for less than 15% of the time). Can occur anywhere in Europe but only skeletal or very shallow soils in the north, or on south facing slopes in Central Europe. (e.g. *Helianthemum chamaecystis*, *Sesleria caerulea, Cirsium acaule, Agrostis setacea*). Widespread in the Mediterranean where it grades in to 3.2.1.7.

3.2.1.7 Very Dry: water table <100 cm of the surface, dry throughout most of the year with only short mesic periods, European soil moisture regimes: Moderately dry. (pF > 4.2 during 15-30% of the time). Occurs throughout the Mediterranean Zone but only on shallow soils and is well indicated by the distribution of *Olea europea*, *Psoralea bituminosa* and *Euphorbia characias*. (e.g. *Cistus salvifolius, Helichrysum stoechas*). Such indicators must be dominant in the species composition –one plant of a characteristic species is not enough to categorise soil as very dry.

3.2.1.8 Xeric: water table <100 cm of the surface, dry throughout the year except in isolated rain events, European soil moisture regimes: dry. (pF > 4.2 during over 30% of the time). Xeric only occurs in the Mediterranean south Environmental Zone and is well indicated by the distribution of *Chamaerops humilis*. Usually on shallow or skeletal soils, on south facing slopes or on the driest parts of the area and extenuated by particular soil types e.g. gypsum (e.g. *Stipa tenacissima, Thymelea hirsuta, Astragalus fistulosus, Festuca scariosa*). As with 3.2.1.7 the balance of species must be considered and not one individual.

3.2.2 Ellenberg Values

These were originally developed by Ellenberg for Central Europe. They have been recalibrated for Britain and are available on the web (http://science.ceh.ac.uk/products_services/software/mavis.htm), because some species change their ecological behaviour in different climate regimes. Ellenberg values are not available for many regions, so local experience of the ecological amplitude of species is needed, especially in the Mediterranean. The following guidelines can be given:

3.2.2.1 *Eutrophic*: Ellenberg 'F' values. Fertility is often localised along landscape elements e.g. rivers and around feeding troughs. Indicator species can be used to identify such elements e.g. *Urtica spp., Stellaria media, Galium aparine, Stachys sylvatica* and *Rumex alpinum*. The two highest levels of Ellenberg F values are combined because lower levels are too difficult to record consistently in the field without full species lists.

3.2.2.2 *Acidity (acid-neutral-basic)*: The Ellenberg acidity value can be assessed in the following way:

a. Plant indicators. Although some species have wide ranges, others are reliable indicators at the local level. They are often growing with widespread ubiquitous species that form the main vegetation cover. As stated above, some species differ in their requirements in different parts of their range. e.g. *Saxifraga*

tridactylites is an obligate calcicole in Great Britain, but it is not selective in the Pannonian region.

b. Soil type/rock. Knowledge of these characteristics can provide useful information although care has to be taken with its use, because some rocks with the same name can be acid, neutral or basic.
c. In watercourses and lakes (i.e. GHC = SPV/AQU) the nutrient level can be determined only if indicator plant species are present. This is because clear water can be either basic or acid, but this can be determined only by chemical analysis if there are no indicators.
d. Landscape context: Whilst not definitive, landscape features gradients along slopes such as surrounding vegetation, flush lines and outcrops of acid rock can be useful.
e. Confirmation by soil testing equipment - this may well now be practical in terms of expense and time and could be done in different situations or to get experience in a particular site.

3.2.2.3 *Saline*: The Ellenberg salinity value can be assessed by the presence of halophytes e.g. *Salicornia spp., Puccinellia spp* and *Spartina spp*. Care is needed with some species e.g. *Armeria maritima* and *Plantago maritima* as they also grow in mountains often associated with saline conditions. Brackish conditions can be determined from the landscape context and the presence of some species that are some degree tolerant of salt e.g. *Agropyron repens* and *Zannichelia palustris*.

3.2.2.4 All the above classes must be determined by the balance of species not individuals. The majority are unlikely to change over time, so that when monitoring definitive evidence of change is required e.g. blocking of drainage ditches, before a change can be recorded. Definite mistakes can be corrected in the monitoring process by the ERR code (see 3.2.3.7).

3.2.2.5 **Coding system for environmental qualifiers**

This matrix shown in table 1 is the primary means of determining the environmental qualifier to be attached to a mapped element. The matrix consists of two primary axes, which largely determine vegetation composition i.e. humidity and nutrient content.

Table 1. Environmental Qualifiers.

	Ellenberg values	Aquatic	Water-logged	Seasonally wet	Wet	Mesic	Dry	Very Dry	Xeric
Eutrophic	F > 7	1.1	2.1	3.1	4.1	5.1	6.1	7.1	8.1
Acid		1.2	2.2	3.2	4.2	5.2	6.2	7.2	8.2
Neutral		1.3	2.3	3.3	4.3	5.3	6.3	7.3	8.3
Basic		1.4	2.4	3.4	4.4	5.4	6.4	7.4	8.4
Saline		1.5	2.5	3.5	4.5	5.5	6.5	7.5	8.5

In general, acid is below pH 4.8; neutral is between pH 4.8 and 6.0; basic is over pH 6.0.

3.2.2.6 The numbers in the matrix can be applied to all GHC's. Definitions of all categories are provided in this monitoring handbook. **It is essential to note that local use of terms, especially dry, may differ from the above matrix.** These terms must therefore be seen in the European context – that may be locally dry e.g. calcareous grasslands in Western Scotland may be wet compared with the situation of Southern Italy.

3.2.2.7 Not all cells may be occupied in a given GHC. For example broad-leaved evergreen tall scrub is not likely to be found in waterlogged conditions but all combinations have been included to cover all possible situations. Nutrient levels should only be attached to aquatic elements if there is evidence from indicators e.g. halophytic species.

3.2.2.8 The landscape context provides essential guidance in determining environmental qualifiers. Steppic elements with *Stipa* sp in Bohemia appear very dry according to the species, but considered in the context of trees growing nearby e.g. *Fraxinus excelsior* and *Crataegus monogyna* enables a decision to consider the element as dry.

3.2.3 Global codes

Global codes for size/dimension, substrate and percentage are codes that can be used as qualifiers to both areal and linear elements, mostly in field 2.

3.2.3.1 Height and depth codes

These codes are to be applied mainly to the dimensions of linear elements, but 3 and 4 can also be used to define the height of rocks and screes that may have a small area, but appreciable height.

1 = 0.5-2 m
2 = 2-5 m
3 = 5-30 m
4 = over 30 m

HIG = Height – applies to the height of the element above the average ground surface.
DEP = Depth – applies to the depth of the element below the average ground surface.
WID = Width – applies to the width of elements, e.g. watercourses and should not be applied where width is specified in the definition.

3.2.3.2 Substrate codes

These can be recorded within any GHC, so they are included as global codes.

5 = Bare rock – Areas of continuous rock divided only by cracks, crevices or gullies.
6 = Boulders – Discrete elements of rock that are above 20 cm.
7 = Rocks 5-20 cm.
8 = Stones 1-5 cm (specify if necessary in site qualifiers).
9 = Gravel/sand/silt/soil/peat (specify in site qualifiers).

3.2.3.3 Areal/linear codes

Linear landscape elements are mapped as either areal or linear elements according to the standard recording rules. They can be linked or treated separately by subsequent database management. Although most of these codes may be linear or areal, some such as fences are always likely to be linears. They are included here for ease of recording. These global codes are to be used in field two for these elements:

RAI = Railway, to include the artificial tracks, yards and sidings, the banks are included if below 5 m, when they are recorded as lines, above which as areal elements.

ROA = Road, to include tarmac roads and their verges if below 5m, where they are recorded as lines, above which as areal elements.

TRA = Track – to include unconstructed and constructed tracks and their verges, if there is a discontinuity with the surrounding vegetation.

PAT = Path – both human and animal lines of trampled material within surrounding vegetation.

FEN = Fence – a line of constructed material e.g. of wood, beneath which there may also be a strip of GHC if over 0.5 m.

WAL = Wall – a line of constructed material of rock which may have strips of over 0.5 m of GHC.

TER = Terrace – vertical element holding back a terrace for cultivation of woody crops or even if abandoned.

BAN = Bank – an element over 0.5 m above or below the surrounding landscape. Record GHC if over 30% vegetation. Includes levees and dykes as linear qualifiers see (Chapter 4).

DIT = Ditch – artificial elements that may be full of water or dry as expressed by the GHC.

For example a 20 m wide motorway verge at least 20 m long with *Ulex* bushes would be mapped as an areal element with appropriate GHC and qualifier. A 4 m wide road (tarmac cover full width) would be mapped as a linear element with appropriate GHC and qualifier if over 30 m, but if the verges were over 0.5 m then it would be an areal element, if over 80 m.

3.2.3.4 **Percentage codes**

These may be applied to any of the information in fields 3 to 5. They use the standard scientific convention for rounding.

10 = 10%
20 = 20%
30 = 30%
40 = 40%
50 = 50%
60 = 60%
70 = 70%
80 = 80%
90 = 90%
100 = 100%

3.2.3.5 **Other codes**

These codes can be applied to any GHC or element.

BUR = burnt – can be applied to most life form categories. Use this code with the life form that was present according to residual material, e.g. forest trees or grasses.

ECO = Transition zone between two GHC's where there is a continuous gradient between them, Mapped by two dotted lines with appropriate codes

BIN = seen through binoculars only. e.g. a mountain cliff or island or lake

INA = inaccessible, whether because of ownership or high altitude valleys

IND = individual trees/shrubs

CLU = clump of trees or shrubs between 2 and 10 individuals

SCA = trees/shrubs below 1% cover but between 5 and 20 individuals/ha. Can also be applied to olives/fruit trees.

OPE = trees/shrubs 1-10% cover (e.g. *dehesa, montado* or parkland)

The appropriate GHC's should follow these codes.

Note that cover of trees/shrubs over 10% but below 30% is included in field five.

3.2.3.6 **Absence of data codes**

-1 *Not included in survey*

The field has been excluded from a given survey, for example, in field eight, phytosociological associations may be excluded from a specific survey (i.e. not included in a given field survey).

0 *No record made*

No information was recorded for this field either because no qualifier applied or because the rules did not specify that an entry should be made - this entry is required to ensure that the entry in a field has not been merely forgotten i.e. if there is no qualifier to record, this code is used to show that it has not been merely forgotten.

-9 *Does not exist in this classification*
A particular element has no match within a given classification e.g. arable fields are not a class in the Habitat Directive. -1 would therefore be entered in the sixth field if this classification was being recorded.

Lines may be drawn across several fields to indicate "absence of data" codes. –1 needs only to be entered at the top of fields 7, 8 and 9 because it is exclusive.

3.2.3.7 **Change-from-reference codes**

These codes are for use where there is a deviation between the field and the reference map or reference aerial photograph (AP) in terms of the presence or absence of an areal or linear element. The codes may also be used for a boundary not apparent on the base map (e.g. an element that is forest on a base map, but agriculture when surveyed).

The reference may have been used to make an initial mapping of the site prior to going into the field, e.g. using segmentation or AP interpretation.

The reason for having these codes is to remove all ambiguity between the field recording and digitising/database entry. For example, they are to make it clear that the field surveyor has not merely made a mistake in apparently either omitting or adding an element. In all three cases the codes (NEW, NOL or ERR) are added as the first element of Field 2 (environmental qualifiers), because they refer to the rest of the data in that element.

NEW New to map

If there is an element in the field that is not apparent on the reference map, e.g. a newly planted wood or a new building, then the code "NEW" is entered in field two.

NOL No longer on Map

If there is an element shown on the reference map that is no longer present, e.g. a line of trees has been felled or a river has been piped so there is no surface water, then the code NOL is entered in field two.

ERR Recording error

This code is to be used in a re-survey there is definite evidence that a recording error has been made on the previous survey. ERR is therefore entered in field two.

3.3 Field three: Site Qualifiers

3.3.1 The site qualifiers are to be entered into the third field of the habitat recording sheets for areal and for linear elements to record characteristics of geomorphology, geology, soil, archaeology and life form complexity of elements, in order to express variations in these between elements that have the same primary code. The definitions are provisional and need to be further carefully researched for a European application.

3.3.2 As stated in the Introduction, Life Forms are a classification of plants not based on botanical, taxonomical criteria, but related to the adaptation of individual plants to climatic conditions at a geographical level. There are difficulties in making finer adaptations of plant life forms to climate as described by Raunkiaer who stated "Here we meet, as we always do in this domain of investigation, the great difficulty that the degree of adaptation cannot be determined by merely looking at the plant; while the sub-types in order to be useful to us must be recognised at sight". This is the underlying reason for the restricted number of life forms in BioHab.

3.3.3 Thus, in the BioHab Handbook methodology, the site qualifiers related to different groups of conditions for plant life should in principle be re-evaluated from a Life Form point of view. Such a structure has however not been possible to develop within the frame of the BioHab Concerted Action and the list of qualifiers below should be regarded indicators of a wider list that could eventually be considered.

3.3.4 Geomorphologic classifications are in general made according to their relevance to the understanding of the genetic and historical development of the site, area or region. These morphological forms give limited information for assisting the understanding of the relationship between climatic/environmental conditions and the composition and distribution of plant life as indicators of climatic change.

3.3.5 A more sophisticated plant life relevant geomorphological classification could be developed that was more related to landscape structure and dynamics and interconnections at different spatial levels, but is beyond the resources available within the present project.

3.3.6 **Non-Biotic**

3.3.6.1 Geomorphology Only included if it can be interpreted in the field or if local knowledge is available (after Holmes, 1946)

Qualifier name	Code	Description for use of this qualifier
Marine	101	Below mean high water mark
Coastal	102	either a change in cover and management between the element next to the shore and inland, or where the soil material had a recent marine origin above mean high water mark
Cliff	103	Vertical or near vertical area of rock
Rock outcrop	104	Isolated elements of rock emergent from surrounding vegetation
Scree	105	More or less unstable loose or shattered rock on slopes
Moraine	106	Glacial deposits of boulders, rocks and tile
Esker	107	Long winded ridges of glacial origin
Drumlin	108	Rounded or elliptical moraines
Roche moutonné	109	Ice eroded rounded rock outcrops
Kame terrace	110	Isolated or clustered mounds, derived from glacial outwash
Solifluction terrace	111	Terraces formed by trees/thaw
Splintered and shattered rock field	112	Invariably on mountain summits or in the arctic
Fjell field	113	Characteristic of high mountains in Scandinavia
Frost sorted stones/rocks	114	Evidence of frost sorting but not in patterns
Stones/rocks sorted into polygons or stripe	115	Distinct patterns of sorted rocks
Rock pavement	116	Rock pavements with over 30% vegetation cover
Bare rock pavement	117	Usually of limestone but occasionally other rocks under 30% of vegetation cover
Raised beach	118	Evidence of former beach line above high water mark
Peat hag	119	Includes any bare or eroding peat which is not vegetated and should be qualified by a percentage cover code
Current peat working	120	Where peat has obviously been extracted in the current or previous season - should be qualified by a percentage cover code
Old peat working	121	May be qualified by a percentage cover code
Soil erosion	122	Includes both human and natural erosion
Ground levelling	123	Includes any formerly raised area that has been reduced to the level of the surrounding terrain (e.g. for development)
Avalanche track	124	Self-explaining
Snow patch	125	Snow field
Glacier	126	Ice with some rock debris
Rock glacier	127	Glaciers covered by rock debris
Recent volcanic	128	Evidence of recent volcanic activity with ash and lava
Inactive volcanic	129	Old craters or calderas
Dune	130	Only included actual bare dunes otherwise life form complex 3.11.2
Canyon/gorge	131	Narrow rock valley
Wadi ("arroyo")	132	Bare depressions in dry/xeric situations
Earth Pillar	133	Caused by erosion of soft material
Additional code	134	
Additional code	135	
Additional code	136	

3.3.6.2 Geology (after Kronenberg 1998) Only included if exposures are seen in the field or if clear evidence or if local knowledge is available. Geological maps do not need to be consulted as a complete geological database is a separate exercise.

Qualifier name	Code	Description for use of this qualifier
Plutonic rock	137	e.g. granite, gabbro
Hypobyssal rock	138	e.g. dolerite, porfirite
Pyroclastic	139	e.g. ash, tuff
Volcanic	140	e.g. basalt, rhyolite
Unconsolidated clastic	141	e.g. sand, gravel, clay
Consolidated clastic siliceous	142	e.g. mudstone, shale
Calcareous	143	e.g. tufa, dolomite
Evaporite	144	e.g. gypsum, halte
Organic	145	e.g. peat, lignite
Residual	146	e.g. laterite, kaoline
Contact	147	e.g. horfeld, spotted slate
Cataclastic	148	e.g. cataclastic breccia, mylonite
Regional	149	e.g. slate, gneiss
Additional code	150	
Additional code	151	
Additional code	152	

3.3.6.3 Soils (after FAO 1974) Only record if profile is exposed or if local knowledge is available. Do not use soil maps because they are not available at consistent scale across Europe. The collection of full soil information would be subject for a separate module.

Qualifier name	Code	Description for use of this qualifier
Permafrost	153	Soils with permanent frozen layer
Skeletal/Ranker	154	Soils with no profile development
Peat	155	Organic soils usually over 0.3 m deep
Peaty podzol	156	Peat material overlaying podzol (<0.3 m)
Peaty gley	157	Peat material overlaying gley
Gley	158	Anaerobic mineral soils usually grey or mottled
Brown earth	159	Free draining, fertile soil
Rendzina	160	Shallow calcareous soils
Chernozem	161	Soils of eastern Europe
Terra rossa	162	Red soils of the Mediterranean
Terra fusca	163	Mediterranean brown soils
Sandy soil	164	Soil formed from sand
Detritic soil	165	Soil containing a high percentage of detritus
Gypsum soil	166	Soils with high gypsum content
Alluvium soil	167	Soils formed from alluvial material
Hydromorphic soil	168	Water saturated but not peaty
Laterite	169	soils containing a high percentage of iron
Additional code	170	
Additional code	171	
Additional code	172	

3.3.6.4 Inland water. Water saturated throughout the year, usually with standing water over 9 mm.

Qualifier name	Code	Description for use of this qualifier
Evidence of previous water cover	173	Evidence from flotsam and jetsam plus bare ground
Temporary running water	174	Evidence of previous running water
Films of water	175	Water running on the surface – usually over rocks
Spring	176	Point feature of emergent water
Flush	177	Lines of water flow not forming streams – wetland vegetation indicators present
Water course, running Non-tidal fast	178	River with water running over 10 m/s
Water course, running non-tidal slow	179	River with water running under 10 m/s
Water course, standing water	180	Linear feature with standing water
Canal	181	Waterways constructed for boat traffic
Irrigation canal	182	Constructed watercourse for irrigation
Canalised river	183	Rivers which have been modified (e.g. sections straightened, banks smoothed), but still follow the same direction as the natural watercourse
Tidal river	184	River influenced by tidal movement
Dry river bed	185	Temporary river bed usually with bare ground and signs of water flow
Dry ditch	186	Ditch more than 0.5 m deep with no water
Free standing water	187	Temporary standing water. Only record if evidence available.
Lake – natural	188	Inland water body over 400 m^2.
Lake – artificial	189	Usually distinguished by the presence of a dam or embankment
Pond – natural	190	Below MME record as point
Pond – artificial	191	Below MME record as point
Additional code	192	
Additional code	193	
Additional code	194	

3.3.6.5 Historical/Archaeological

Qualifier name	Code	Description for use of this qualifier
Barrow/burial mound	195	Burial mounds from prehistoric times
Ruin	196	Ruined buildings of archeological interest
Marl pit	197	Pits for extraction of marl which is formed by a deposit of calcareous algae often filled with water
Cairn/Dolmen	198	Structures of rock from prehistoric times
Bank and ditch	199	Medieval structures around woods or boundaries
Hut circle	200	Remaining walls of prehistoric sites
Stone heap	201	Heaps of stone in fields from former agriculture
Castle/fortress	202	Self-explaining
Archaeological wall	203	Walls of archeological interest
Lazy bed	204	Lines of old tilled land in W. Scotland
Aquaduct	205	Old (usually Roman) facility for transport of water made of stone

Qualifier name	Code	Description for use of this qualifier
Additional code	206	Additional code
Additional code	207	Additional code
Additional code	208	Additional code

3.3.7 Life form complexes

Life form complex site qualifiers are for use with elements that are widely recognisable habitats that comprise a mosaic of patches of several GHC's the extent of many patches being less than 400 m^2. Thus, these are situations where it would be difficult and time-consuming to make detailed mapping of each individual LF patch. They include some situations where this is also precluded by difficulty of access as for example in mires and fens. The primary codes for all the GHC's that occupy >30% of the element must also be recorded in the first field.

3.3.7.1 Sea/Marine (see 3.1) Sea is below the mean low water mark; Marine is the tidal zone.

Qualifier name	Code	Description for use of this qualifier
Submerged angiosperms	220	Cover of species such as *Posidonia*
Shipwreck	221	Self-explaining
Mussel bank	222	Habitat of mussel population
Sea weed bed	223	Cover of red, green and brown algae
Rock pool	224	Depression in rocks with remaining sea water in low tidal situations
Wave cut platform	225	Relatively level areas formed from wave action
Cultivated mussels/oysters	226	Lines of mussels/oysters in sea/tidal
Fish farm	227	Fish farm in sea/tidal
Additional code	228	
Additional code	229	
Additional code	230	

3.3.7.2 Coastal

The definition of "coastal" is that either there is a change in life form and management between the element next to the shore and inland or it is where the soil material has a recent marine origin. This definition separates coastal dunes from inland dunes and for forests would separate those growing on rocks from those growing on marine sediments (sand, gravel and shingle).

It is recognised that forests growing on bare rock surfaces would have to be covered by further qualifier e.g. wind pruned.

Qualifier name	Code	Description for use of this qualifier
Yellow dune/white dunes	231	Young dune, highly mobile sand
Grey dune	232	Mature dune, podzolised, with acidic indicators
Dune slack	233	Wetlands in or behind the dunes
Salt marsh	234	Coastal wetland with saline soils
Strand line	235	Vegetation zone between dune or cliff and the sea

Qualifier name	Code	Description for use of this qualifier
Coastal exposure	236	Vegetation affected by coastal winds but no halophytes
Additional code	237	
Additional code	238	
Additional code	239	

3.3.7.3 Bogs/mires/wetlands. On peaty soils, water saturated with the categories identified by indicator species.

Qualifier name	Code	Description for use of this qualifier
Palsa mire	240	Mires with frozen elements and pools
Aapa mire	241	Mires with frozen elements
Raised bog	242	Bogs with characteristic structure
Blanket bog	243	Bogs covering often a high proportion of the land surface, rain fed
Valley mire	244	Mires formed by high valley water levels
Poor fen	245	Nutrient poor wet organic soils, many sedges
Transition mire	246	Mires characteristic of continental regions
Fen	247	Nutrient rich, wet, organic soils, mixed vegetation
Reed beds	248	Element dominated by tall helophyte graminoids usually on the borders of lakes and rivers or because of high ground water levels
Wet heath	249	Acid soils, usually with dwarf shrubs/sedges
Snow patch vegetation	250	Vegetation often with DCH prominent but evidence of limits to snow lie
Additional code	251	
Additional code	252	
Additional code	253	

3.3.7.4 Areas with woodland or sparse trees

Qualifier name	Code	Description for use of this qualifier
Taiga	254	Open acid woodlands of Boreal/nemoral regions
Riparian	255	Riverside woodlands
Gallery	256	Narrow forest strip beside a watercourse
Swamp woodland	257	Forest over helophyte vegetation
Bog woodland	258	Forest growing over acid bogs
Additional code	259	
Additional code	260	
Additional code	261	

3.3.7.5 Additional complexes

Qualifier name	Code	Description for use of this qualifier
Terrace	262	Excavated level areas of land with retaining walls
Group of non-mappable terraces	263	Parcels with terraces that are less than 5 m apart that cannot be mapped individually
Additional code	264	
Additional code	265	
Additional code	266	

3.3.7.6 Life form Qualifiers

Qualifier name	Code	Description for use of this qualifier
Grasses over 60 cm	267	Grasses with perennial leaves over 60 cm – usually present in xeric and steppic areas
Succulents below 0.05 m	268	Record as qualifiers to DCH
Succulents 0.05 - 0.30 m	269	Record as qualifiers to SCH
Succulents 0.30 - 0.60 m	270	Record as qualifiers to LPH
Succulents 0.60 - 2 m	271	Record as qualifiers to MPH
Succulents 2- 5 m	272	Record as qualifiers to TPH
Additional code	273	
Additional code	274	
Additional code	275	

3.4 Field four: Management qualifiers

3.4.1 The management qualifiers are grouped for convenience into those which can be applied to several sections as opposed to those to those that are associated with individual enterprises.

The management qualifiers are to be entered into the fourth field of the habitat recording sheets for areal and for linear elements to record characteristics of management, in order to express variations in elements that may have the same primary code.

Management Qualifiers relate to dominant uses. For example, a field in agricultural use for most of the year with occasionally some tents for camping in the summer is not recorded.

3.4.2 **General Management qualifiers**
The following management characteristics are coded as general management qualifiers. These codes apply to both grassland and forest parcels and are therefore included here.

Qualifier name	Code	Description for use of this qualifier
Silvo-pastural	300	Used in conjunction with the appropriate forest code, if over 30% or other tree codes if under 30%
Silvo-arable	301	This will be used in conjunction with the appropriate forest code if over 30% or other tree codes if under 30%
Apiculture	302	Presence of bee hives
Additional code	303	
Additional code	304	
Additional code	305	

3.4.3. Urban state management

Qualifier name	Code	Description for use of this qualifier
Active	306	Sill being used
Disused	307	N longer in use
Vacant	308	Designated for building, i.e. cleared land for building
Derelict	309	Buildings beginning to collapse, often with broken windows/collapsed roof
Additional code	310	
Additional code	311	
Additional code	312	

3.4.4. Forest/woodland state management

Qualifier name	Code	Description for use of this qualifier
High forest	313	Mainly single stem trees, not multiple stems of coppice origin
Group selection system	314	Patches of even age c. 0.5 ha
Thinning	315	Removal of individual trees
Game management	316	Positive evidence e.g. pheasant coups
Conservation management	317	Evidence from clearing and piles of dead wood and ownership
Additional code	318	
Additional code	319	
Additional code	320	

3.4.5 Agricultural & herbaceous vegetation state management

Qualifier name	Code	Description for use of this qualifier
Unmanaged	321	Areas of herbaceous vegetation or grass left unused and with no evidence of cutting. Always with dead biomass present.
Neglected	322	Usually applies to grasslands and former arable land that have evidence of recent use e.g. cereal stubble or evidence of cutting lines. Less likely to have dead biomass present.
Abandoned	323	Agricultural land that has been left. There must be evidence of colonisation by woody vegetation. – The whole mapping element is abandoned. Can be used for orchards and vineyards. See 3.1 for rules.
Additional code	324	
Additional code	325	
Additional code	326	

3.4.6 Grazing – Domestic animals - only to be used when there is clear evidence of the influence of the qualifier on the mapped element.

Qualifier name	Code	Description for use of this qualifier
Sheep	327	Self-explaining. Add breed if possible
Goats	328	Self-explaining. Add breed if possible
Cows - dairy	329	Self-explaining. Add breed if possible
Cows - beef	330	Self-explaining. Add breed if possible
Field pig	331	Self-explaining. Add breed if possible

Free range pig	332	Self-explaining. Add breed if possible
Horses – for recreation	333	Managed for recreation with features such as jumps
Horses	334	Herds of horses mainly in semi-natural vegetation
Donkey	335	Self-explaining
Mules	336	Self-explaining
Chicken	337	Only free range not in sheds
Geese	338	Only free range not in sheds
Ostrich	339	Self-explaining
Buffalo	340	Self-explaining
Wild bulls (toros)	341	Self-explaining: only seen from a distance
Additional code	342	
Additional code	343	
Additional code	344	

3.4.7 Grazing – Wild animals - only to be used when there is clear evidence of the influence of the qualifier in the mapped element.

Qualifier name	Code	Description for use of this qualifier
Wild boar	345	Evidence from upturned patches of earth
Red deer	346	Evidence from grazing of saplings over 2 m
Roe deer	347	Evidence from bark stripping of saplings
Fallow deer	348	Usually in enclosed parks
Muncjack	349	Evidence of grazing of herbaceous vegetation in woods
Hare	350	Self-explaining but rarely seen
Rabbit	351	Droppings and burrows
Swans	352	Nests
Wildfowl	353	Ducks and geese – only wild animals – droppings and sightings
Wild cattle/bison	354	Self-explaining
Wild goats/Ibex	355	Self-explaining
Reindeer	356	Self-explaining
Moose	357	Self-explaining
Marmot	358	Evidence from burrows and culls
Beaver	359	Evidence from killed trees and dams
Additional code	359	
Additional code	360	

3.4.8 Enterprise: Urban

These Management Qualifiers are only for use where the super category is urban. These Management Qualifiers are associated with built up land and land used for other activities such as recreation, industry, quarrying, mineral extraction and gardening.

Qualifier name	Code	Description for use of this qualifier
Residential	361	Covers all domestic living areas (except farm houses)
Commercial	362	Includes all buildings devoted to selling things, including shops, garages, hotels, pubs, commercial offices
Industrial	363	Those used for the manufacture of goods and includes warehouses, workshops and associated buildings.

Qualifier name	Code	Description for use of this qualifier
Institutional	364	Includes all buildings belonging to forms of public or private institutions, such as old people's homes, local government and central government buildings, prisons, research stations.
Educational/cultural	365	Includes schools, establishments of further education, museums, theatres and cinemas
Religious	366	Confined to places of worship, including churches, mosques, synagogues and monasteries and their cartilages e.g. graveyards, cemeteries
Agricultural	367	Covers all buildings used for agricultural purposes including the farmhouse if occupied by a farmer or farm worker
Horticultural	368	Includes glass houses for non-agricultural plots and garden centres
Waste-domestic	369	Deposition localities for domestic waste
Waste-industrial	370	Deposition localities for industrial waste
Quarry	371	Area excavated for rocks e.g. marble, granites
Sand pit, gravel pit	372	Area excavated for gravel or sand; may contain water or be dry
Opencast mine	373	Large open area where coal or lignite coal is being mined
Airport	374	Area used for landing taxiing and parking aeroplanes
Port	375	Harbour area for commercial purposes
Fish farm	376	Area confined for growing fish
Crofting	377	Individual houses in the west of Scotland
Crofting township	378	Small groups of traditional houses in the west of Scotland
Holiday house(s)	379	Beach bungalows, summer houses
Mountain refuge	380	Huts in the mountains used for food/accommodation
Additional code	381	
Additional code	382	
Additional code	383	

3.4.9 Enterprise: Recreation

These Management Qualifiers are only for use where the Primary Habitat code is in the Urban/Constructed category.

Qualifier name	Code	Description for use of this qualifier
School playing field	384	Adjacent to schools
Other playing field	385	e.g. football field
Golf course	386	Self-explaining
Horse race track	387	Self-explaining
Tennis court	388	Self-explaining
Boating area	389	Open water used for storing sailing and rowing boats
Static caravan park	390	Caravan site with gardens and additional buildings
Touring caravan park	391	Caravan site for tourists
Camp site	392	Camp site mainly for tents
Launch site	393	A ramp for landing boats
Fishing	394	Evidence on banks of fishing sites
Trampling	395	Evidence of excessive recreational use
Air strip	396	Strip used for recreational flying (gliders, sport planes, model planes)

Qualifier name	Code	Description for use of this qualifier
Harbour	397	Harbour used for recreational purposes
Grouse butt	398	Shelter for shooting grouse
High seat (for hunting)	399	Wooden construction usually on woodland edges
Additional code	400	
Additional code	401	
Additional code	402	

3.4.10 Enterprise: Agriculture and Semi-natural vegetation

Qualifier name	Code	Description for use of this qualifier
Intensive crops	403	Less than 10 weed species per $10m^2$
Extensive crops	404	More than 10 weed species per $10m^2$
Terracing land	405	Terraced land retained by a wall/bank
Fallow	406	At least one year with no crop planted. Recorded in conjunction with therophytes or caespitose/leafy hemicryptophytes. Only use if there is evidence of previous crops e.g. stubble or plough lines i.e. usually less than fine years after crop.
Ploughed	407	Bare ground caused by ploughing or cultivation by harrow or rotovators
Unmanaged grass	408	Grassland outside agricultural management e.g. motorway verges
Harrowing	411	Land disturbed by harrowing that does not destroy the vegetation
Recreation mowing	412	Grassland cut for non-agricultural purposes
Burnt	413	Burnt grassland/heath under agricultural management (excludes forest burnt areas)
Irrigation	414	Canals, small ditches linked to channels, large irrigation schemes
Manure	415	Farm yard manure heaps/evidence of slurry spreading (tanks/slurry pigs in farm yards)
Cut for hay	416	Evidence of grass cut and dried for hay
Cut for silage	417	Evidence of silage essential e.g. big bales/silage pits
Cut for recreation	418	Grass removed for non-agricultural use, usually around houses or recreational areas to retain a green grass cover
Grass likely to be cut	419	Evidence of recent local cutting and no dead material in the grassland
Cut (mown)	420	Recently cut grassland with no evidence of either hay-making or silage
Additional code	421	
Additional code	422	
Additional code	423	

3.4.11 Enterprise: Forestry/woodland/fruit trees:

Ages need to be calibrated by region, because of different growth rates. Over 70%: do not record mixed ages, 40-60%: record mixed ages.

Qualifier name	Code	Description for use of this qualifier
Age less than 5 years (newly planted)	424	Usually staked/protective tubes or evidence of recent planting
Age 6 – 15 years	425	Approx: between 3 and 15 cm diameter (breast height)
Age 16 – 40 years	426	Approx: between 16 and 40 cm diameter (breast height)
Age 41 – 150 years	427	Approx: between 41 and 75 cm diameter (breast height)
Age over 150 years	428	Approx: over 76 cm diameter (breast height)
Naturalised native species	429	Once planting but now having a natural forest structure
Naturalised exotic species	430	Self-reproducing of exotic species e.g. *Robinia pseudo-acacia*
Plantation native species	431	Plantation of species of local provenance
Plantation exotic species	432	Plantation of species of non-local origin
Natural regeneration	433	Spontaneous establishment of forest
Underplanted	434	Planting of young trees beneath adult trees
Windblown tree(s)	435	Groups of trees blown over by wind
Individual tree	436	Specimen trees over 75 cm in forests
Fire break	437	Area within the forest without trees to prevent fire spreading
Ride	438	Linear area in forest for access or fire break
Extraction route	439	Route within the forest which is used to take out timber
Area for storage of logs	440	Piles of timber and associated areas
Ploughing/drainage	441	Evidence from ditches and plough lines
Succession	442	Process of forest establishment over time with a sequence of tree species e.g. *Picea abies* under *Betula* spp.
Thinning	443	Removal of young trees to leave fewer individuals
Recent felling	444	Applies to points, lines or areas
Recent pollarding	445	Regular cutting of branches over 3 m above ground level in the last ten years
Recent shredding	446	Cutting of branches back from trunks to feed animals in the last ten years
Recent coppicing	447	Cutting to the stump recognised by multiple stems in the last 20 years
Recent pruning	448	Selective removal of branches to develop tree growth within the last ten years
Standing dead tree(s)	449	Over 40 cm outside woodland
Additional code	450	
Additional code	451	
Additional code	452	

3.5 Field five: Detailed life form and species composition

3.5.1 Field five of the areal element and the linear element recording sheets is to be used for recording of the full LF and main plant and crop species associated with each recorded alpha code.

3.5.2 All LF's that constitute at least 10% of the alpha code should be recorded, one per row, in the first column of Field-5, with the appropriate % code in the second column. Taken together, the recorded LF % should total 100%.

3.5.3 The species that constitute at least 30% cover of the vegetation (as seen in vertical perspective) of each LF that has been recorded in the first column of field five should be recorded in the third column of field five. At least two species should be recorded unless there is over 70% cover of the LF by one species, in which case, just the one species is to be recorded. A maximum of three species per LF can be recorded, but usually only one or two species will be needed.

3.5.4 Separate rows in the recording sheet should be used for each species.

3.5.5 Flora Europea nomenclature should be used if possible to name the species. (These can then be converted by database management into Flora Europea master codes (as used by SynBioSys, www.synbiosys.alterra.nl).

3.5.6 If a plant species cannot be identified in the field, a specimen should be collected and later referred to an expert botanist for identification.

3.5.7 For crop types the codes provided below should be used. Latin names are not to be used for crops but only the codes since the same species may refer to wild plants e.g. Beta maritime (sugar beet).

3.5.8 Other species should be recorded using the first three letters of the Genus name and the first three letters of the species name, e.g. *Galium aparine* as "GAL APA", *Fraxinus excelsior* as "FRA EXC". Any ambiguities should be made clear by a comment in the "Species codes and non-standard site and management qualifier codes" section of the recording sheet.

3.5.9 Cryptogams should be separated into percentage bryophyte and lichen cover.

3.5.10 The percentage cover of recorded species within each LF should be recorded in the fourth column of field 5. The % cover of the species should be given in each LF, i.e. the percentages are of the LF, not of the whole element.

3.5.11 Where there is no species with over 30% of the LF then it can be recorded as 20% or 10% if present as such, or if below it should be attributed a nominal 10% (see worked examples 5.2 and 5.3).

3.5.12 The following are the common names, botanical names and codes for crops.

Qualifier name	Code*	Description for use of this qualifier
Wheat (*Triticum aestivum* and associated species)	501	wheat plants have broad, glaucous leaves with auricles, sometimes with awns
Barley (*Hordeum sativum*)	502	barley has dull green leaves and auricles
Oats (*Avena sativa*)	503	oat plants have broad soft glaucous leaves with no auricles
Rye (*Secale cereale*)	504	Tall cereal with long awns
Triticale (Hybrids between wheat and rye)	505	Grown as fodder crop - rare
Rice (*Orysa sativa*)	506	Self-explaining
Sugar beet (*Beta maritima*)	507	Excludes the wild species
Fodder crops (e.g. *Brassica oleracea*)	508	Crops grown for animal feed, excluding maize and other gramineae
Potato (*Solanum tuberosum*)	509	Self-explaining
Field bean (*Vicia faba*)	510	Self-explaining
Peas (all types) (*Pisum* spp.)	511	Self-explaining
Maize (*Zea mays*)	512	Includes Fodder maize
Oilseed rape (*Brassica* hybrid)	513	Self-explaining
Sunflower (*Helianthus annuus*)	514	Self-explaining
Flowers	515	Self-explaining
Commercial horticulture	516	To include strawberries, salad crops, cabbages and onions
Vines (*Vitis vinifera*)	517	
Olives (*Olea europea*)	518	Only cultivated – excludes wild trees
Cherries (*Prunus spp.)*	519	Excludes *Prunus avium* and other wild species
Apples (*Malus spp.*)	520	Excludes *Malus sylvestris*
Pears (*Pyrus spp.*)	521	Only cultivated – exclude wild species
Walnuts (*Juglans spp.*)	522	Only cultivated trees
Citrus fruit (*Citrus spp.*)	523	Self-explaining
Hazelnuts (*Corylus avellana*)	524	Only orchards or individual cultivated trees - exclude semi-natural stands
Additional code	525	
Additional code	526	
Additional code	527	

Instructions for native/naturalised species are given in 3.5.

3.6 Field six: Pan European Classifications

3.6.1 The coding system for these categories will be developed according to the objectives of the individual survey but many classifications have their own codes e.g. Priority Habitats.

The following are the main pan-European classifications:

EUNIS
Palaearctic
Annex I, including Priority Habitats
CORINE Biotopes

Some of the classes in these classifications are identical e.g. *Phoenix* palm groves because they have been derived from each other, so the degree of extra work is not likely to be great. However, the extent of training would need to be determined and would depend on the required accuracy. Cross-walks have been produced between the classifications and will help in training. Database management can also be used for cross-referencing classes. Also, some classes do not have criteria that can be recorded consistently in the field e.g. montane and sub-Mediterranean.

3.7 Field seven: Local classifications

3.7.1 Local classification classes are to be recorded in this field. Local experts will need no training to record these and many will be coincident with pan-European classifications especially the principal forest types which are often linked to phytosociological associations. In other situations they are likely to divide GHC's into further units, although these will often be consistent with the rules for new elements. Examples are available from Spain, Estonia, Hungary, Norway, Finland and Sweden. Other classifications e.g. Hemero-biotic state and codes for favourable conservation status could also be recorded here. Details would have to be determined before any major survey.

3.8 Field eight: Phytosociological associations

3.8.1 The taxon most likely to be used would be the association. Whilst there will be a broad coincidence with pan-European habitats because they are largely based on phytosociological principles, training will be required to gain consistent results. There will also be difficulties in attributing highly disturbed vegetation and stages of colonisation and abandonment. Details would have to be determined before any major survey.

4 Linear Elements

4.1 Linear rules

The following additional rules are required for linear elements e.g. fences and steams:

4.1.1 Hedges and lines of trees and shrubs all have height within their definition, i.e. FPH, TPH, MPH or LPH. Therefore the use of the global code HIG is not required in these cases.

4.1.2 Species and crop names are only applied to crops, herbaceous and tree/shrub elements.

4.1.3 If applicable the habitats of these additional linear elements is described with the same primary codes as for areal elements. A dyke with grassland would be recorded as follows:
FIELD 1 – LHE/CHE
FIELD 2 – BAN/HIG2/WID2
FIELD 3 – 411 Grassland outside agricultural management
FIELD 4 – 607
FIELD 5 – CHE 50 ARR ELA 90 LHE 50 TAR OFF 30

4.1.4 The boundary of a linear element is where either the management changes, or there is a difference in GHC from the surrounding vegetation. For example roadside vegetation usually is associated with land owned and managed by the highway authority and the marginal changes are in agricultural fields. Another example is riverside vegetation, which is on the banks of the river and often changes to crop land in agricultural landscapes. In both cases these elements would be recorded as lines if they were less than 8x50m.

4.1.5 Temporary electric fences are not recorded.

4.1.6 The average width of the element must be below 5 m unless below 80 m in length.

4.1.7 Watercourses, roads, tracks and lines of trees below 5 m are always recorded as linear elements even though they may be part of an areal element.

4.1.8 Linear elements are mapped as single lines with appropriate incidence or combined alpha codes e.g. A or A/B. If there is lack of space on the map, a line and arrow may be used to indicate the location exactly.

4.1.9 Verges are only recorded along metalled (tarmac) roads in forests.

4.2 List for additional qualifiers for linear elements

4.2.1 The list of site qualifiers for linear elements can be applied to areal elements, since it is possible for almost all to occur as linear elements. The hedge categories are indicative – they would need additional explanatory material for consistent application. However, the following additional qualifiers are needed.

Qualifier name	Code	Description for use of this qualifier
Bicycle path	601	Evidence of use by bicycles only – not recorded along roads
Walking footpath	602	Evidence of use by people
Horse (Bridle way)	603	Evidence of use by horses
Watercourse	604	Only use if not covered by global codes
Gully	605	Erosion feature covered by water
Levee	606	Natural raised river bank
Dyke	607	Artificial raised river bank
Wall - Dry stone	608	Wall constructed with no additional material other than rock
Wall - Mortared	609	Walls held together with mortar
Retaining wall – Earth	610	Usually a terrace wall
Retaining wall - Rock	611	Usually a roadside, terrace wall or dam with over 30% rock
Wall with gaps	612	Walls with over 30% gaps
Fence - Wood only	613	Fence of wood only
Fence - Iron only	614	Fence of iron posts/rails
Fence - Wire on posts	615	Fence with wire attached to wood posts
Fence - Wire with gaps	616	Fence with over 30% gaps
Fence – Wire on metal posts	617	Fence with wire attached to metal posts
Hedge – Trimmed hedge	618	Line of scrub below 5m with signs of regular management
Hedge - Austrian hedge	619	Hedge of trees with understorey
Hedge - Stock proof	620	Hedge able to retain stock
Hedge - Not stock proof	621	Hedge with over 30% gaps
Hedge - Recently planted	622	Hedge planted in the last 5 years
Hedge – Uncut	623	No evidence of cutting in the last 5 years
Hedge – Derelict	624	No evidence of cutting and trees in poor condition
Hedge – Relict	625	Only isolated shrubs/trees remaining
Hedge – Laying	626	Traditional management by laying of single stems
Hedge – Coppiced	627	Cut at the base in the last 5 years
Hedge – Flailed	628	Cut with mechanical flail – much debris at base
Tarmac	629	Metalled/tarmac surfaces
Constructed track	630	Track without tarmac but hardcore material brought in
Unconstructed track	631	Track with no external material brought in from outside
Tractor track	632	Tractor tyre ruts only
Excavated track – road vegetated	633	Track with excavated margins covered with vegetation
Excavated track - road sparsely vegetated	634	Track with excavated margins – vegetation cover less than 30%
Road and track - Sunken road	635	Traditional road excavated below general ground level

Qualifier name	Code	Description for use of this qualifier
Road and track – Green lane	636	Sunken lane covered with vegetation
Additional code	637	
Additional code	638	
Additional code	639	

Note that roads that are wider than 5 m are recorded under areal elements. (The 5 m includes the verge i.e. the area which general belongs to the transport authority).

5 Recording Sheets and worked examples

5.1 Background information

5.1.1 The sheet below is an example of the type of information that is necessary. For any given survey further details and modifications would be required. A map is not included as the information is confidential. Similarly telephone numbers are also not included.

5.1.2 Example of complete background information sheet

SQUARE NAME: ALLITHWAITE **OBSERVER(S): RGH BUNCE** **DATE: 31/08/05**

COUNTRY: UK

ENVIRONMENTAL STRATIFICATION CLASS ZONE: AN/1

MUNICIPALITY: GRANGE-OF-SANDS

ALL POINTS	
SIGNIFICANT POINTS	**YES**
NO POINTS	

UNIQUE COORDINATES OF THE SQUARE:

UK ORDINANCE SURVEY:			
	100 KM^2 : 76	**10 KM^2: 43**	**1 KM^2: 21**

APPROPRIATE SCALE MAPS (OR DATABASES) AVAILABLE (AT A SCALE OF E.G. ≤ 1/50.000) FOR:

	IN DIGITAL (GIS) FORM (REFERENCE)	***IF NOT*** **IN DIGITAL FORM** (REFERENCE)	**SCALE**
LAND REGISTRY	0	0	0
BASE MAPS E.G. GEOLOGY , GEOMORPHOLOGY, HYDROLOGY, SOIL	0	0	0
NATURE CONSERVATION: E.G. SPECIAL PROTECTION AREAS, NATIONAL PARKS, NATURE RESERVES, DESIGNATION 'NATURE' ON LOCAL OR REGIONAL DESTINATION PLANS	0	0	0
OTHER INFORMATION	ENVIRONMENTALLY SENSITIVE AREA		

LAND REGISTRY	**A – CODE**	**NAME AND ADDRESS**	**PHONE NUMBER**
0	A	B. JACKSON, TEMPLAND FARM	0
0	B	P. WILSON, WYKE FARM	0
0	C	I. MORIS, PELETOWER FARM	0
0	D	J. SATERTHWAITE, APPLEBURY FARM	0
0	E	D. KHAN, THE PASTURES	0

5.2 Areal Features

5.2.1 A complete map of a km^2 in Switzerland is shown in figure 5.

Figure 5. Map of the completed 1 km^2 for areal elements.

5.2.2 Example of Completed Areal Element Recording Sheet (first page)

Square name: Switzerland_1 **Observer: RGHB,GH,SD,RF Date: 20-6-2005**

code	**Field 1**	**Field 2**	**Field 3**	**Field 4**	**Field 5**				**Field 6**	**Field 7**	**Field 8**
α	General Habitat Category	Global/ Env. Qualifier	Site Qualifier	Man. Qualifier	Life form/Species				Pan Europ class	Regional-Class	Phyto-socio-logy
					Life form	%	Species	%			
A	TPH/DEC/ CON	NEW	0	421	TPH/DEC	20	Sor auc	80	-1	-1	-1
		5.3		429	TPH/CON	10	Pic abi	100			
					MPH/EVR	60	Rub fru	100			
					FPH/CON	10	Pic abi	100			
B	FPH/CON	5.3	0	423	FPH/CON	100	Pic abi	50			
				425			Abi alb	50			
				347							
C	CHE/LHE	5.3	0	416	CHE	60	Lol per	80			
					LHE	40	Tri rep	80			
D	CHE	5.3	0	416	CHE	80	Lol per	40			
					LHE	20	Tar off	10			
E	WOC	0	0	329	WOC	80	5 2 0	100			
					CHE	20	Lol per	80			
F	ART	0	0	357	ART	80	0				
					GRA	10	0				
					VEG	10	0				
G	CHE	5.3	0	329	CHE	80	Lol per	90			
				369	LHE	20	Tri rep	50			
				416							
H	CHE/LHE	5.3	0	418	LHE	30	Tri pra	10			
					CHE	70	Fes rub	10			
J	CHE	5.3	0	0	LHE	20	Ran acr	10			
					CHE	80	Lol per	50			
K		NOL	0	450	0		0				

Unique Codes/Species Numbers			
	450: Canopy now closed	C=5	D=4
G=6	H=14	J=8	

5.3 Linear features

5.3.1 A complete map of linear features in a km^2 in Switzerland is shown in figure 6. Point features and some lines have been omitted for ease of interpretation.

Figure 6. Map of the completed 1 km² for linear elements.

5.3.2 Example of Completed Linear Element Recording Sheet (first page)

Square name: Switzerland_1 Observer: RGHB,GH,SD,RF Date: 20-6-2005

code	**Field 1**	**Field 2**	**Field 3**	**Field 4**	**Field 5**				**Field 6**	**Field 7**	**Field 8**
α	General Habitat Category	Global/ Env. Qualifier	Site Qualifier	Man. Qualifier	Life form/Species				Pan Europ class	Regional-Class	Phyto-Socio-logy
					Life form	%	Species	%			
A	ART	ROA	0	0	0				-1	-1	-1
B		NOL	0	0	0						
C	WOC	0	0	0	0		520	100			
D	ART	FEN	0	615	0						
		HIG1									
E	ART/GRA	ROA	0	632	0						
F	FPH/DEC	0	0	441	FPH/DEC	100	Ace pse	100			
G	ART	0	0	383	0						
H	FPH/CON	0	0	401	FPH/CON	100	Pic abi	100			
J	NOL	0	0	451							
K	ART	0	0	450							
				369							
L	WOC	0	0	526							
M	ART	0	0	369							
				307							
N	AQU	WID1	179	0							
P	FPH/DEC	0	0	0	FPH/DEC	60	Frax exc	100			
					CHE	40	Hol lan	30			
Q	ART/GRE	TRA	0	633							
		WID2									
R	FPH/DEC	0	0	0	FPH/DEC	100	Frax exc	70			
							Fag syl	30			
S	FPH/DEC	0	0	0	FPH/DEC	100	Frax exc	100			
T	LHE/CHE	BAN	0	0	LHE	30	Tri pra	10			
		HIG1			CHE	70	Dac glo	20			
U	ART	TRA	0	632							
		WID1									
V	ART	FEN	0	615							
		HIG2									

Unique Codes			
383: Barn	450: Hut	451: Filled in stream	

6 The stratification system

6.1 The earlier sections of this book show the level of decision making needed to make consistent habitat records. It therefore follows that any significant evaluation of the environmental state and its associated habitat in Europe must be derived from field data based on a statistically sound sampling design. The field data can then be used to increase the effectiveness of remote sensed information because it can be used to interpret the simpler categories available. This is essential if there is to be an understanding of current and future dynamics of changes in habitats and the associated biodiversity and its distribution throughout Europe.

6.2 Therefore, it is necessary to develop a consistent stratification framework that optimises the selection of sampling locations. Previous experience on habitat and landscape monitoring has been based on independent environmental classifications constructed from existing biogeoclimatic information. This approach has been shown to be valid at national scales in Great Britain and Spain. It is likely to be even more efficient at a continental scale, as has been shown in Canada and Australia.

6.3 An essential part of BioHab has been the construction of an environmental stratification of Europe, including Northern Africa and Turkey. This classification system has been derived from statistical analysis of climatic and topographic data at a 1 km square level of resolution. 13 environmental Zones have been established, linked hierarchically to 84 environmental Strata. This classification can be used to derive the minimum of about 1400 1 km squares required for surveillance and monitoring the General Habitat Categories to an acceptable statistical accuracy in Europe. Existing data from objectively located samples will also be used where possible.

6.4 Such a sampling design enables data from the sample km squares to be integrated at the stratum level. The mean figures from the strata can then be extrapolated to the whole of Europe using standard statistical procedures. This method provides the bases for significant evaluation of the extent and quality of habitats at the level of the individual stratum, environmental zones and finally, at a continental scale. Data on the extent of habitats in Europe are not currently available. Furthermore, the Biohab procedure will enable changes in habitats to be linked directly to driving forces.

6.5 Because the stratification system holds information from all the 1 km squares in Europe, it can be used to display the spatial distribution of any parameter available either from each km square e.g.: altitude, or estimates of habitats extent from the records made in the environmental strata. Some initial maps of priority habitats have already been produced as part of the PEENHAB project. If the field data were available, then they could be linked to the

CORINE land cover map to develop sophisticated estimates of the distribution of the main habitats in Europe.

6.6 A further application of the stratification system is to develop models of potential changes in habitats and land use in Europe. This is already been carried out in the ATEAM project to examine the implications of climate change scenarios on habitat distribution.

6.7 This section is a summary of the application of stratification to strategic sampling and the bibliography in 12.5 gives many references describing the principles of the approach and its applicability.

7 Procedure for monitoring

7.1 Statistically, it is essential to return to the same sites to record changes. This is the procedure followed in all the major monitoring exercises in Europe. There are several networks already existing for monitoring environmental changes employing various size units from 16 km squares down to 0.25 km squares. Most of the field recording is at the 1 km^2 level, as a compromise between detail and generality, and the BioHab system has therefore been based at this level.

7.2 The General Habitat Categories are specifically designed to be recorded consistently. Whilst this is essential if statistically robust estimates of extent are to be produced, it becomes even more imperative when the recording and mapping of changes is concerned. The majority of field mapping exercises in terms of both habitat and vegetation are surveillance and are not designed to record change. More stringent criteria are required in order to ensure that real change is recorded and not results that are distorted by differences between observers and differences of recording technique. This requires that emphasis in the re-survey be placed on registration of changes compared with the recordings made previously. Thus, information from the previous survey forms the basis for the field mapping and recording in the re-survey, which is implemented as a check for change of each element recorded in the previous survey. Change detection by independent surveys and subsequent data analysis is time-consuming and can lead to uncertainties about whether the changes detected are valid.

7.3 Such monitoring has many advantages, especially when seen in the long-term, as it allows checking of the quality of each of the surveys. Each registration of a change generates the question: is it a real change, or is re-evaluation of the earlier registrations required? This permits a higher degree of confidence in the data as the number of surveillance events increases. The result of this procedure is that the monitoring has not only become more reliable, due to better registration techniques, but also the editing of former registrations has added to the quality. In fact, a considerable part of the time used for the refinement of the database has been devoted to the systematic control of all detected changes back in time. Such a rigorous change control is necessary, since landscape monitoring relies on the detection of small changes and using this procedure guarantees that the changes have actually taken place. The statistical confidence that can be attached to the measures can however be low if changes are rare. Eventually the final arbiter is the application of standard statistical techniques to detect real changes from background noise.

7.4 There is much experience in applying such methodology in the detection of change e.g.: Northern Ireland, Denmark and Great Britain, and in interpreting changes from aerial photographs e.g.: Spain, Sweden and The Nether-

lands. One of the key elements of this approach is the detection and evaluation of flows between habitats, e.g.: new forestry planted on blanket bogs is negative, but is positive if taking place on arable land.

7.5 It can be concluded that the reliability of surveillance is substantially improved by quality assurance within the monitoring programme, by repeated records of the same elements over time, and a procedure for incorporating change control as a part of the monitoring system.

7.6 References are given in the bibliography.

8 Additional Modules

These modules can be added, either as additional surveys or as further data to be collected at the same time as the BioHab core module. The list is indicative rather than exhaustive and others could be added for specific objectives.

8.1 Species richness

Further samples can be added to other GHC's for recording species richness.

8.2 Vegetation Relevés

Random, targeted or selected samples can be placed in order to obtain more details of vegetation composition – a level of biodiversity below that of habitats.

8.3 Soil Mapping

Standard soil mapping procedures can be used to map soils as a basis for detailed modelling but should be at least at 1:10 000 scale.

8.4 Forest Structure

Details of features such as dead wood and understorey characteristics can be recorded to obtain further information on forest biodiversity.

8.5 Socio-economic Interviews

Appropriate methods can be used to circulate questionnaires to obtain the views of owners and farmers, as further background to the drivers of change.

8.6 Freshwater Invertebrates

Standard procedures are available for surveillance and monitoring of freshwater invertebrates.

8.7 Birds

A standard procedure is available for recording breeding birds in 1 km squares.

8.8 Hemerobiotic state

The degree of disturbance in habitats and landscapes can be recorded using well developed protocols.

8.9 System for assessing naturalness

Protocols have been developed to record the degree of naturalness of habitats. Whilst these have been tested on a regional scale in the Czech Republic, they could be applied elsewhere Literature.

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Annex 1 Lists of indicative plant species for each Life Form

A1 Guidance notes on the identification of Life Forms

Although Life Forms originated in the early nineteenth century, they have been widely used and adopted for many recent studies. Examples and background information are given in 12.1.

A1.1 The primary sources for the Life Forms have been various floras. The height categories have been designed to fit in with previous work, especially in the Mediterranean literature. Some widely used habitat terms are not life forms, e.g. halophytes (salt tolerant plants) and chasmophytes (rock crevice plants) Cryptogams are included as a separate category because they occupy extreme environments.

A1.2 Although most species belong unequivocally to one life form, some species are in different categories in various floras. This is particularly because habitat requirements differ between regions, but also because of differences in the interpretation of anatomical features. Thus *Eriophorum angustifolium* and *Scirpus sylvestris* are given as helophytes in the British flora, but as rhizomatous geophytes in the Austrian flora.

A1.3 In practice, most of these cases are because the rhizomes are primarily for vegetative reproduction and are only secondarily perenating organs. Other species are sufficiently plastic to have different ecotypes adapted to contrasting environmental conditions, especially water logging or aquatic. One of the best examples is *Juncus bulbosus*, which can behave as a hemicryptophyte, helophyte or hydrophyte, depending whether it is growing out of the water or in waterlogged soils or wet soils. Actually, in these three situations the plant morphology is also different. As discussed in Annex 2, many phanerophytes are highly plastic according to local conditions, and hence the only consistent arbiter that can be used is height. Also, some floras give height ranges that do not fit with field observations – this is because the floras give optimal height. All the above can be determined in the field. The most difficult group to interpret are the caespitose hemicryptophytes, partly because of deciding where the soil surface actually is for the location of the buds, but also because of the wide range of rhizome types. Therefore in BioHab all *Juncaceae, Cyperaceae* and *Gramineae* are considered as caespitose hemicryptophytes. The exception is *Arundo donax*, which although technically is in the *Gramineae* it behaves as medium or tall phanerophyte.

A1.4 Whilst the majority of species only occupy a single habitat some plants are sufficiently plastic to belong to several categories. In wetlands the actual conditions pertaining to water level or the time of survey should be used to define the GHC. It is recognised that water levels often vary according to seasonal factors. The Life Form SHY, EHY and HER should therefore be applied to the water level and form of the plants at the time of survey. Qualifiers should be used to indicate temporary water bodies or exceptionally dry conditions using local indicators such as drift line or definite detritus. Temporary floods should be recorded as such. If plants which

may otherwise be regarded as caespitose hemicryptophytes are growing in wetlands, then these life forms take precedence.

A1.5 **Submerged hydrophytes (water plants)**

This habitat includes plants growing beneath the water surface. Some species, e.g. *Nuphar lutea* and *Ranunculus aquatilis* have submerged and floating leaves, in which case the higher layer should be recorded as in forest canopies. Most submerged hydrophytes are obligate, although *Lobelia dortmanna* and *Littorella aquatica* may grow on lake margins in very wet climates e.g. western Ireland.

Isoetes lacustris
Lobelia dortmanna
Zostera maritima
Zannichelia palustris

A1.6 **Emergent hydrophytes (water plants)**

Includes plants that have emergent shoots and leaves out of the water surface. For convenience floating plants are included in this category although in a world biome classification they would justify a separate category. Some otherwise caespitose hemicryptophytes may also act as hydrophytes or helophytes depending on local conditions, e.g.

Butomus umbellatus
Cladium mariscus
Sagittaria sagittifolia
Scirpus lacustris

A1.7 **Helophytes (marsh plants)**

This habitat includes plants growing in waterlogged conditions as defined in 3.2.

Potentilla palustris
Carex aquatilis
Eriophorum angustifolium
Rhynchospora alba

A1.8 **Hemicryptophytes (dicotyledonous, broadleaved plants including forms with stem leaves and rosettes. Biennials are included here, as in most floras)**

This habitat includes broadleaved plants that generally avoid the extremes of xeric conditions in southern Europe as opposed to the arctic and high mountain environment on the other. Although they vary from broadleaved plants such as *Rumex obtusifolius* and Inula *helenium* to small leaved plants such as *Ranunculus pyrenaicus* and *Silene nutans*. However, they are grouped together by most authors in the same category so are not divided in BioHab.

Campanula latifolium (leafy)
Taraxacum officinalis (rosette)
Carlina acaulis (rosette)
Dipsacus fullonum (biennial)

A1.9 **Hemicryptophytes (monocotyledons) – caespitose, most Gramineae and Cyperaceae**

Most of the *Juncaceae, Cyperaceae* and *Gramineae*, except those mentioned from wetland habitats. Many of the species from there taxa have rhizomes, but they are primarily for vegetative production and not perennation. There are also many differences between floras as to whether the species are geophytes or hemicryptophytes, depending on interpretation of the significance of the rhizome. Furthermore it is difficult in the field to determine whether those rhizomes are only creeping stems close to the soil surface, e.g. *Carex bigelonii* and *Carex flacca*. The life form caespitose hemicryptophyte is widely used and was therefore adopted to cover this group as it is readily identifiable in the field. This life Form covers the complete range from xeric to arctic environments, although forming only a high proportion of the landscape in mesic situations. An extra qualifier has been added to cover plant over 60 cm.

Lolium perenne (Gramineae)
Poa alpina (Gramineae)
Carex pendula (Cyperaceae)
Luzula sylvatica (Juncaceae)

A1.10 **Therophytes (includes both monocotyledons and dicotyledons)**

Annual life forms take precedence over whether a given plant is monocotyledonous or dicotyledonous and over soil conditions that are waterlogged. Germination may take place at any season depending on temperature and rainfall.

Aira praecox
Aegilops arvensis
Viola arvensis
Nigella damascena

A1.11 **Geophytes**

These plants are highly seasonal and relatively few species contribute cover over 30% at the height of biomass. *Pteridium* is included here because it is strictly a geophyte. However, for a world biome system it would be included as a fern life form, which actually fits better into its environmental range, but as with floating plants it is consistent with other decisions to make a separate category.

Pteridium aquilinum (rhiz)
Narcissus bulbocodium (bulb)
Crocus aureus. (corm)
Urginea maritima (bulb)

A1.12 **Herbaceous chamaephytes and cushion plants**
This category includes plants that have their buds above the ground surface, but that form mats, e.g. *Saxifraga hypnoides* and cushion plants such as *Saxifraga linguata*. This category includes plants typical of extreme environments, e.g. arctic and alpine summits, but also is typical of habitats with low competition, e.g. cliffs and screes.

Saxifraga aizoides (herbaceous)
Achillea rupestris (herbaceous)
Saxifraga lingulata (cushion)
Saxifraga caespitosa (cushion)

A1.13 **Succulent chamaephytes**
Succulent chamaephytes have succulent leaves and are characteristic of dry habitats. The taller forms are given as qualifiers.

Sempervivum tectorum
Sedum acre
Sedum anopetala
Jovibarba heuffelii

A1.14 **Cryptogams (bryophytes & lichens)**
There are non-saxicolous species that are typical of highly degraded situations or exposed habitats such as sand dunes or arctic and alpine conditions.

Racomitrium lanuginosum (br)
Sphagnum recurvum (br)
Cetraria islandica (li)
Cladonia impexa (li)

The following are life forms with buds above ground level. They may be woody or not according to species. The life forms are plants but together in habitats they form various scrub, GHC's and forest.

A1.15 **Dwarf chamaephytes, buds lower than 0.05 m forming dwarf scrub**
Some of these plants are called espaliers (*Spalierstäucher*), e.g. *Dryas octopetala*. Others are espalier forms of ligneous chamaephytes, e.g. *Betula nana*; others dwarf forms of chamaephytes due to extreme environments, e.g. *Vaccinium myrtillus*.

Dryas octopetala
Salix herbacea
Salix reticulata
Globularia saxatile

A1.16 **Shrubby chamaephytes (buds above the soil level, between 0.05 and 0.30 m, under shrubs) forming under-scrub**
This category will actually be mainly species that are ligneous. But, this category also includes some species described as nano-phanerophytes in floras, but which also

often behave as chamaephytes (e.g. *Rhododendron hirsute*). Other phanerophytes are included here because they may be present as regeneration or suppressed forms of species which may reach greater heights, e.g. *Quercus petraea* on an exposed sea cliff in South West England is 30 cm in height. Especially widespread throughout the Mediterranean region where they are adapted to dry summer periods, but present where they are often dominant in degraded habitats, but are also common in extreme situations in alpine and arctic regions.

Thymus vulgaris
Lavandula stoechas
Cistus monspelliensis
Helichrysum stoedras

All the tree shrub categories are determined on height alone as this is the only consistent parameter that is dependent not on opinion.

A1.17 **Low phanerophytes (0.30-0.6 m) low shrubs forming low scrub**
These habitats consist mainly of shrubs either of low nutrient systems, exposed situations or also may be regenerating plants of potentially taller categories. They are widespread throughout most of Europe under appropriate conditions, but absent from extreme environments.

Salix myrsinites
Daphne oleoides
Cistus monspeliensis
Betula nana

A1.18 **Mid phanerophytes (0.6-2m), mid shrubs forming mid scrub**
Myrica gale
Salix aurita
Cistus ladanifera
Daphne gnidium

A1.19 **Tall phanerophytes (2-5 m), tall shrubs forming tall scrub**
This habitat consists of tall shrubs that are often progenitors of forest, although they may form climax stands above the altitudinal limit of forest as does *Corylus avellana* in the Picos de Europa north-west Spain.

Frangula alnus
Cotoneaster nebrodensis
Amelanchier ovalis
Pistacia lentiscus

A1.20 **Forest phanerophytes (trees over 5 m) trees**
These are the main forest trees of Europe. Palms are included under Evergreen, because of their limited extent. On a world biome system, they would be assigned a separate category.

Fagus sylvatica
Quercus robur
Acer campestre
Populus tremula

The following life forms apply to the six height categories with over 70% being a single category and 40-60% being combinations.

A1.21 **Winter deciduous (DEC):** has been left as one category because no adequate rule was available to divide the species. Characteristic of environments with the winter season restricting growth e.g. *Fraxinus excelsior* and *Ulmus glabra*.

A1.22 **Evergreen (EVR):** includes sclerophylls e.g. *Quercus ilex*, and other genera such as *Ilex* or *Laurus*.

A1.23 **Non-leafy evergreen (NLE):** the majority of species in this group are Mediterranean, some genera can be heavily spiny, e.g. *Echinospartium*. They may have small leaves which are shed later (e.g. *Sarothamnus scoparia, Spartium junceum, Cytisus purgens, Retama retamoides, Ulex spp.*).

A1.24 **Conifers (CON):** Includes all taxa, e.g. *Pinus* sp., *Juniperus* sp., *Cupressus* sp., *Taxus baccata* and *Ephedra spp.*

A1.25 **Summer deciduous and/or spiny cushion (SPI):** included as LF because of its distinctive life form and ecology. Present in the Mediterranean region and characteristic of situations with extremely dry summer periods (e.g. *Sarcopotherium spinosum, Astragalus massiliensis, Euphorbia dendroides*). Summer deciduous species can be separated later by data management.

Lianes are not included as a separate life form because they rarely form cover. If they do, then they should be including in the appropriate phanerophyte category according to their height. This includes species such as *Smilax aspera* and *Clematis vitalba*. The latter is anyway included as a phanerophyte in the GB flora. Succulents are included as qualifiers to the appropriate height categories because only *Agave* spp. and *Opuntia* spp. are present on the European continent. Although widespread in the Canaries, the inclusion of these life forms individually and as combinations would add over 20 more categories, which would not be justified because of their rarity. If required they can be extracted from the qualifiers.

A2 Plasticity of tree/shrub life forms

A2.1 Many woody species are highly plastic and respond to environmental pressure. The only way to provide a system that will produce consistent data for monitoring is to use height as the arbiter, as shown below.

A2.2 The following table provides examples of phanerophytes (woody species), their potential maximum height and their possible occurrence as scrub categories. Species can occur in lower categories because either:

1. They have been heavily grazed
2. They have been burnt
3. They are regenerating
4. They are in highly exposed situations

A2.3 The first three categories are transitional i.e. seral states and the GHC's automatically enable transfer to be assessed in any direction according to driving forces. The fourth category is a climax state e.g. high altitudes, exposed sea cliffs or the arctic.

A2.4 Other species either inherently grow as low shrubs in various stages of colonisation or maybe also as a climax stage.

A2.5 Shifts can take place between categories during monitoring intervals; e.g. following abandonment with increasing height between the categories during and at increased burning with decreasing height. Monitoring intervals therefore need to be designed according to the dynamics of the vegetation.

A2.6 Examples of species that have varying degrees of plasticity are given in Table 2.

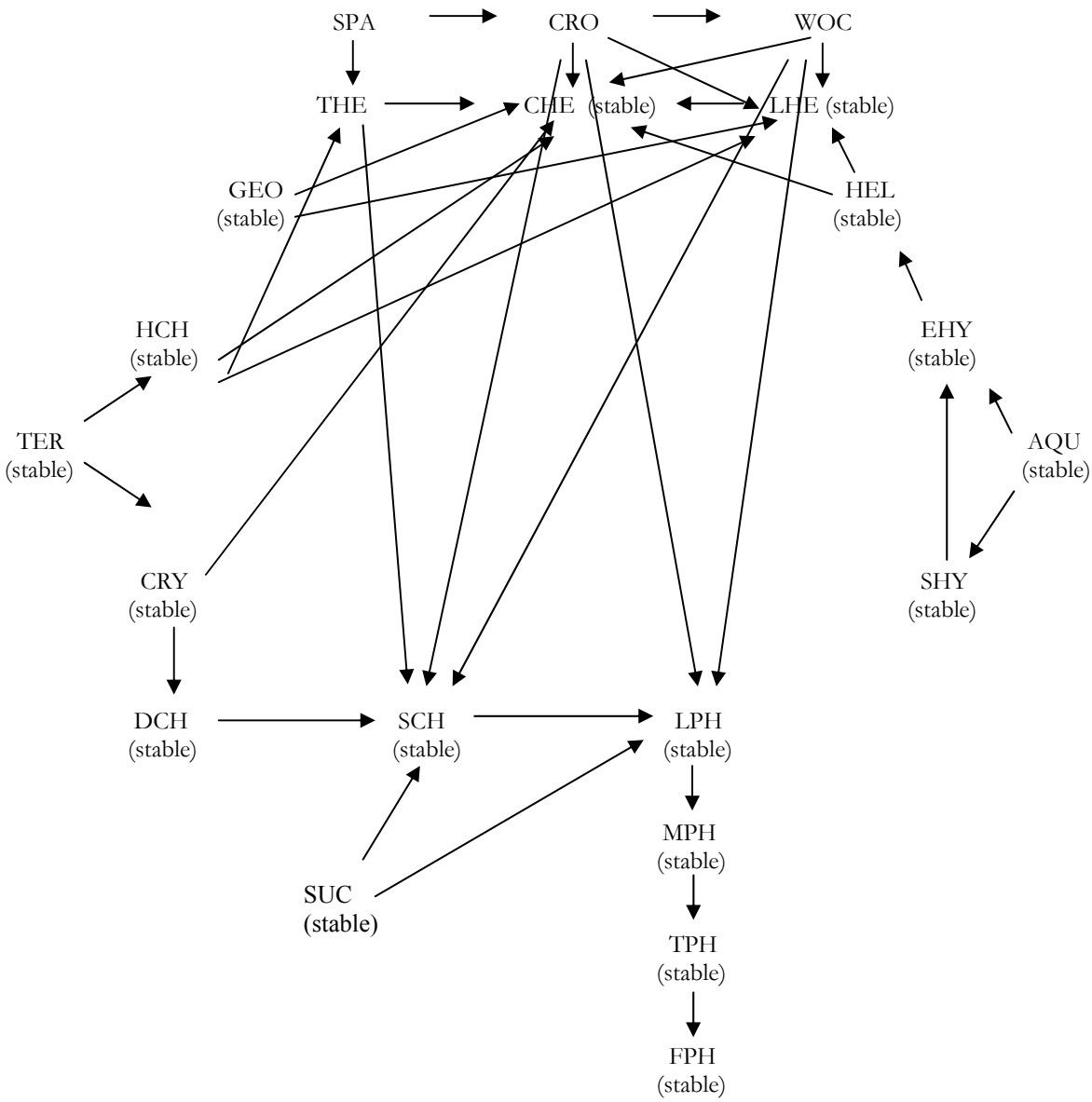
Table 2. Examples of species with varying degrees of plasticity.

	Dwarf Chamae-phytes	**Shrubby Chamae-phytes**	**Low Phanero-phytes**	**Mid Phanero-phytes**	**Tall Phanero-phytes**	**Forest Phanero-phytes**
	DCH	**SCH**	**LPH**	**MPH**	**TPH**	**FPH**
	0.01-0.05	0.05-0.30	0.30-0.60	0.60-2.00	2.00 - 5.00	>5.00
Winter deciduous						
Salix herbacea	x					
Salix serpyllifolia	x					
Betula nana	x	x				
Vaccinium myrtillus	x	x				
Myrica gale		x	x			
Rosa pimpinellifolia		x	x			
Alnus viridis		x	x	x		
Amelanchier ovalis		x	x	x		
Salix cinerea		x	x	x	x	
Frangula alnus		x	x	x	x	
Quercus petraea		x	x	x	x	x
Crategus monogyna		x	x	x	x	x
Evergreen						
Dryas octopetala	x					
Vaccinium oxycoccus	x					
Helianthemum alpestre	x					
Arctostaphylos uva-ursi	x	x				
Vaccinium vitis-idea	x	x				
Thymus vulgaris		x				
Lavandula stoechas		x				
Siderits syriaca		x				
Helichrysum stoechas		x				
Daphne laureola		x	x			
Rubus idaeus			x	x		
Vaccinium uliginosum	x	x	x			
Empetrum nigrum	x	x	x			
Calluna vulgaris		x	x	x		

	Dwarf Chamae-phytes	**Shrubby Chamae-phytes**	**Low Phanero-phytes**	**Mid Phanero-phytes**	**Tall Phanero-phytes**	**Forest Phanero-phytes**
	DCH	**SCH**	**LPH**	**MPH**	**TPH**	**FPH**
	0.01-0.05	0.05-0.30	0.30-0.60	0.60-2.00	2.00 - 5.00	>5.00
Pistacia lentiscus		x	x	x	x	
Quercus coccifera		x	x	x	x	x
Quercus ilex		x	x	x	x	x
Non-leafy Evergreen						
Echinospartium sp.	x	x				
Chamaespartium sagittaris	x	x				
Ulex gallii		x	x			
Cytisus purgens		x	x			
Ulex parviflorus		x	x	x		
Cytisus scoparius		x	x	x	x	
Spartium junceum		x	x	x	x	
Rebullia hemispaerica		x	x	x	x	
Tamarix gallica		x	x	x	x	
Coniferous						
Juniperus communis		x	x	x	x	
Pinus mugo		x	x	x	x	
Juniperus thurifiera		x	x	x	x	
Pinus sylvestris		x	x	x	x	x
Larix decidua		x	x	x	x	x
Picea abies		x	x	x	x	x
Abies alba		x	x	x	x	x
Summer deciduous						
Astragalus massiliensis		x				
Sarcopoterium spinosum		x	x			
Euphorbia arborea		x	x	x		

A3 Potential flows between life forms

A3.1 Because the LF's are related to the environment on the one hand and management on the other, there are clear pathways between them following changes in either of these two factors. The main pathways are shown in figure 7. Only the principal direction of flows are included and under exceptional circumstances flows can be the opposite of these shown in the diagram.



(Stable = possibly may stay at this level and not develop)
* All categories can change to Urban/Constructed

Figure 7. Diagram of principal potential flows between life form categories.

Annex 2 Glossary of terms and abbreviations used in the BioHab Field Handbook

This glossary provides definitions and explanations of the main terms and abbreviations used by the BioHab Field Handbook. Cross-references to further instructions relating to each term are given in parenthesis at the end of entries.

Alpha code (A, B ….)
The simple alphabetic code used to identify unique set of GHC's and qualifiers, that is applied in the left-most column of the data recording sheet and, correspondingly, for the annotation on the mapping sheet. The same alpha code is used for different mapped elements that have same set of GHC's and qualifiers. The alpha coding is refreshed for each separate mapping+recording activity, i.e. The areal element and the linear/point element activities for each survey area (i.e. 1 km sq). (see work examples in 5.2 and 5.3).

Ecologically significant
This means "significant within the context and purpose" of the surveillance/monitoring operation" and applies especially to part elements.

Element
The individual field mapping entities, whether areal, linear or points. This term is used in preference to "unit" or "patch".

Ellenberg values
Values for fertility, acidity, moisture and salinity developed by Ellenberg for central Europe and now for GB (see bibliography).

EUNIS
European Nature Information System

Life Form (LF)
Life Forms are used to build the 130 GHC's. The Life Forms are arranged in a two-level hierarchy. The first level comprises three "pseudo" LF's and two "true" LF's. The second level comprises 14 pseudo LF's and 16 true LF's. The 14 pseudo LF's are used for Urban, Crop and Sparsely Vegetated situations. The 16 true LF's are used for the two level-1 true LF's "Vegetated Herbaceous" and "Vegetated (woody)" and are based on the work of Raunkiaer. The six Vegetated (woody) level-2 LF's are associated with five level-3 LF-qualifier terms that relate to vegetation seasonality. Each Life Form and qualifier term is associated with a unique three-character alphabetic code. Life Form and LF-qualifier codes are used for recording data in Field Five of the recording sheets. For Vegetated (woody) LF's the Field Five coding is a doublet of the codes of the appropriate level-2 LF and level-3 LF-qualifier terms (e.g. SCH EVR). For the other LF's the Field Five coding is a singlet of the code of the appropriate level-2 LF (e.g. LHE). (see 3.5).

Life Form Qualifier (LF-qualifier)
This refers only to the five terms (with codes DEC, EVR, CON, NLE, SPI) that are used as seasonality qualifiers for the six level-2 Vegetated (woody) Life Forms (codes: DCH, SCH, LPH, MPH, TPH, FPH).

General Habitat Category (GHC)
The 130 GHC's are the basic recording elements of the BioHab Field Handbook. They comprise a single Life Form (e.g. Herbaceous Therophytes) or combinations of (at most two) Life Forms, e.g. Forest Phanerophytes Evergreen/Coniferous. Each GHC is associated with a unique primary code that is used to record the GHC on the data recording sheets, e.g. The primary code HER/THE is used to record the GHC "Herbaceous Therophytes".

Habitat
An element of land that can be consistently defined spatially in the field in order to define the principal environments in which organisms live.

Primary code
These are the entries made in Field-1 (i.e. 2nd column) of the data recording sheet. A primary code is the alphabetic coding used to identify a specific GHC. Primary codes comprise slash-separated duplets or triplets of three letters. (see section 3.1)

Qualifier
Code applied to provide more detail of the GHC's.

Scale
Scale is used in the cartographic sense, i.e. "smaller scale" means a smaller representative fraction, e.g. 1:25,000 is smaller scale than 1:10,000. "Scale" can refer to both the level of detail applied in creating a data source (such as a topographic map or air photograph image) and the scale at which the data is subsequently reproduced (such as in a hard copy print). Unless stated as otherwise, the use of "scale" in this manual refers to the former meaning.

Super-categories
The highest level of the hierarchy of GHC's.

Life Forms Combinations
GHC's that are combinations of two life forms.

Minimum Mappable Element (MME)
Recording element of the BioHab procedure; at least 400 m^2 and over 5 m wide.

GB Countryside Survey 2000
The survey of GB vegetation, habitats and landscape features that took place in 1998 reported in 2000 which was based on stratified random samples drawn from environmental strata. See section 12.2 for references.

Crops
Plants that are cultivated for forage, seed or forest excluding grasses. See 3.1 and 9.1 for detailed definition.

ECOLAND Forum
The ECOLAND forum is an official working group of IALE. The overall objective of ECOLAND is to create a structure for the production of an integrated assessment of change in habitats and biodiversity and the associated causes and impacts on the European landscape (see http://*www.landscape-ecology.org/about/workinggroups. htm*).

Environmental Qualifiers
Qualifiers dealing with (soil) moisture, eutrophic levels, acidity and salinity (see 3.2).

Environmental Stratification Classes and Zones
Zones of the European Environmental stratification (see *www.biohab.alterra.nl*).

European Environmental Stratification
Classification of Europe based on climate, geomorphology and geographical position (ocean influence, day length) (see *www.biohab.alterra.nl*).

Global Codes
Codes that are applicable to any areal, linear or point elements (see 3.3).

IALE
International Association for Landscape Ecology (see *www.landscape-ecology.org*).

Minimum Mappable Length (MML)
Linear recording element of the BioHab survey: width smaller than 5m and over 30m long.

Management Codes / Qualifiers
Codes for qualifiers linked to management, land use, natural processes (see 3.5).

Monitoring
Repeat surveillance for detecting change.

Point Element
Recording element of the BioHab survey for points. Recorded in different levels according to the objective of a given survey (see 2.12.3).

Secondary Code
Global, environmental, site and management qualifiers.

Site Qualifiers
A series of qualifiers with code numbers attached to provide information about …..

Sparsely vegetated
Land with less than 30% cover of semi-natural vegetation, not associated with urban/constructed elements. See 3.1.

Stratified Random Samples
Random sampling drawn from defined strata. In BioHab the procedure advocated is to use the strata from the altitude divisions of the European Environmental Stratification (EnSA's).

Surveillance
The recording of information e.g. habitats at a given moment in time.

Urban
Land associated with buildings, structures and communications. For full definition see 3.1.

Vicarious Species
Closely related species that have evolved in geographically separate areas, but often fulfilling a comparable ecological role.

Trees/shrubs
Plants with buds 0.05 m above ground level. They combine to form forest and scrub habitats. The categories reflect species plasticity – for example, trees are highly variable, whereas dwarf shrubs are fixed in their height and growth potential.

Annex 3 List of General Habitat Categories

GHC (vernacular name)	Primary code
URBAN	
Artificial (buildings and tarmac)	URB/ART
Non Vegetated (cleared land)	URB/NON
Crops (Vegetable gardens)	URB/VEG
Herbaceous (garden, parks and recreation)	URB/GRA
Woody (trees/shrubs in gardens and parks)	URB/TRE
Artificial / Non-Vegetated	URB/ART/NON
Artificial / Crops	URB/ART/VEG
Artificial / Herbaceous	URB/ART/GRA
Artificial / Woody	URB/ART/TRE
Non Vegetated / Crops	URB/NON/VEG
Non Vegetated / Herbaceous	URB/NON/GRA
Non Vegetated / Woody	URG/NON/TRE
Crops / Herbaceous	URB/LEG/GRA
Crops / Woody	URB/LEG/TRE
Herbaceous / Woody	URB/GRA/TRE
CULTIVATED	
Bare Ground (ploughed land and bare fallow)	CUL/SPA
Herbaceous Crops (crops)	CUL/CRO
Woody Crops (orchards, vineyards, olive groves)	CUL/WOC
Herbaceous/Woody Crops	CUL/CRO/WOC
SPARSELY VEGETATED	
Sea (sea)	SPV/SEA
Tidal (exposed marine substrates)	SPV/TID
Sea / Tidal	SPV/SEA/TID
Aquatic (fresh/brackish water)	SPV/AQU
Terrestrial (bare substrates inland)	SPV/TER
Ice and Snow (glaciers and snow fields)	SPV/ICE
Aquatic / Terrestrial	SPV/AQU/TER
Aquatic / Ice and Snow	SPV/AQU/ICE
Terrestrial / Ice and Snow	SPV/TER/ICE
HERBACEOUS	
Submerged Hydrophytes (submerged aquatics)	HER/SHY
Emergent Hydrophytes (emergent aquatics)	HER/EHY
Helophytes (marsh plants)	HER/HEL
Submerged Hydrophytes / Emergent Hydrophytes	HER/SHY/EHY
Submerged Hydrophytes / Helophytes	HER/SHY/HEL
Emergent Hydrophytes / Helophytes	HER/EHY/HEL
Leafy Hemicryptophytes (herbs/ forbs)	HER/LHE
Caespitose Hemicryptophytes (grasses and sedges)	HER/CHE
Therophytes (annuals)	HER/THE
Succulents (succulents)	HER/SUC
Geophytes (bulbs, rhizomes)	HER/GEO
Chamaephytes (cushion plants)	HER/HCH
Cryptogams (mosses, lichens)	HER/CRY
Leafy Hemicryptophytes / Caespitose Hemicryptophytes	HER/LHE/CHE
Leafy Hemicryptophytes / Therophytes	HER/LHE/THE
Leafy Hemicryptophytes / Succulents	HER/LHE/SUC
Leafy Hemicryptophytes / Geophytes	HER/LHE/GEO
Leafy Hemicryptophytes / Herbaceous Chamaephytes	HER/LHE/HCH
Leafy Hemicryptophytes / Cryptogams	HER/LHE/CRY

Caespitose Hemicryptophytes / Therophytes	HER/CHE/THE
Caespitose Hemicryptophytes / Succulents	HER/CHE/SUC
Caespitose Hemicryptophytes / Geophytes	HER/CHE/GEO
Caespitose Hemicryptophytes / Herbaceous Chamaephytes	HER/CHE/CHE
Caespitose Hemicryptophytes / Cryptogams	HER/CHE/CRY
Therophytes / Succulents	HER/THE/SUC
Therophytes / Geophytes	HER/THE/GEO
Therophytes / Herbaceous Chamaephytes	HER/THE/HCH
Therophytes / Cryptogams	HER/THE/CRY
Succulents / Geophytes	HER/SUC/GEO
Succulents / Herbaceous Chamaephytes	HER/SUC/HCH
Succulents / Cryptogams	HER/SUC/CRY
Geophytes / Herbaceous Chamaephytes	HER/GEO/HCH
Geophytes / Cryptogams	HER/GEO/CRY
Chamaephytes / Cryptogams	HER/HCH/CRY
TREES/SHRUBS	
Dwarf Chamaephytes Winter Deciduous (dwarf deciduous)	TRS/DCH/DEC
Dwarf Chamaephytes Evergreen (dwarf evergreens)	TRS/DCH/EVR
Dwarf Chamaephytes Coniferous (dwarf conifers)	TRS/TRS/DCH/CON
Dwarf Chamaephytes Winter Deciduous / Evergreen	TRS/DCH/DEC/EVR
Dwarf Chamaephytes Winter Deciduous / Coniferous	TRS/DCH/DEC/CON
Dwarf Chamaephytes Evergreen / Coniferous	TRS/DCH/EVR/CON
Shrubby Chamaephytes Winter Deciduous (low shrubby deciduous plants)	TRS/SCH/DEC
Shrubby Chamaephytes Evergreen (low shrubby evergreen)	TRS/SCH/EVR
Shrubby Chamaephytes Coniferous (low shrubby conifers)	TRS/SCH/CON
Shrubby Chamaephytes Non-Leafy Evergreen (low shrubby brooms/gorse)	TRS/SCH/NLE
Shrubby Chamaephytes Summer Deciduous and/or Spiny Cushion	TRS/SCH/SPI
Shrubby Chamaephytes Winter Deciduous / Evergreen	TRS/SCH/DEC/EVR
Shrubby Chamaephytes Winter Deciduous / Coniferous	TRS/SCH/DEC/CON
Shrubby Chamaephytes Winter Deciduous / Non-Leafy Evergreen	TRS/SCH/DEC/NLE
Shrubby Chamaephytes Winter Deciduous / Summer Deciduous and/or Spiny Cushion	TRS/SCH/DEC/SPI
Shrubby Chamaephytes Evergreen / Coniferous	TRS/SCH/ EVR/CON
Shrubby Chamaephytes Evergreen / Non-Leafy Evergreen	TRS/SCH/EVR/NLE
Shrubby Chamaephytes Evergreen / Summer Deciduous and/or Spiny Cushion	TRS/SCH/EVR/SPI
Shrubby Chamaephytes Coniferous / Non-Leafy Evergreen	TRS/SCH/CON/NLE
Shrubby Chamaephytes Coniferous / Summer Deciduous and/or Spiny Cushion	TRS/SCH/CON/SPI
Shrubby Chamaephytes Non-Leafy Evergreen / Summer Deciduous and/or Spiny Cushion	TRS/SCH/NLE/SPI
Low Phanerophytes Winter Deciduous (low deciduous scrub)	TRS/LPH/DEC
Low Phanerophytes Evergreen (low evergreen scrub)	TRS/LPH/EVR
Low Phanerophytes Coniferous (low coniferous scrub)	TRS/LPH/CON
Low Phanerophytes Non-Leafy Evergreen (low gorse/broom scrub)	TRS/LPH/NLE
Low Phanerophytes Summer Deciduous and/or Spiny Cushion	TRS/LPH/SPI
Low Phanerophytes Winter deciduous / Evergreen	TRS/LPH/DEC/EVR
Low Phanerophytes Winter deciduous / Coniferous	TRS/LPH/DEC/CON
Low Phanerophytes Winter deciduous / Non-Leafy Evergreen	TRS/LPH/DEC/NLE
Low Phanerophytes Winter Deciduous Summer Deciduous and/or Spiny Cushion	TRS/LPH/DEC/SPI
Low Phanerophytes Evergreen / Coniferous	TRS/LPH/ EVR/CON
Low Phanerophytes Evergreen / Non-Leafy Evergreen	TRS/LPH/EVR/NLE

Low Phanerophytes Evergreen / Summer Deciduous and/or Spiny Cushion	TRS/LPH/EVR/SPI
Low Phanerophytes Coniferous / Non-Leafy Evergreen	TRS/LPH/CON/NLE
Low Phanerophytes Coniferous / Summer Deciduous	TRS/LPH/CON/SPI
Low Phanerophytes Non-Leafy Evergreen / Summer Deciduous	TRS/LPH/NLE/SPI
Mid Phanerophytes Winter Deciduous (deciduous scrub)	TRS/MPH/DEC
Mid Phanerophytes Evergreen (evergreen scrub)	TRS/MPH/EVR
Mid Phanerophytes Coniferous (coniferous scrub)	TRS/MPH/CON
Mid Phanerophytes Non Leafy Evergreen (gorse/broom scrub)	TRS/MPH/NLE
Mid Phanerophytes Summer Deciduous and/or Spiny Cushion	TRS/MPH/SPI
Mid Phanerophytes Winter Deciduous / Evergreen	TRS/MPH/DEC/EVR
Mid Phanerophytes Winter Deciduous / Coniferous	TRS/MPH/DEC/CON
Mid Phanerophytes Winter Deciduous / Non-Leafy Evergreen	TRS/MPH/DEC/NLE
Mid Phanerophytes Winter Deciduous / Summer Deciduous and/or Spiny Cushion	TRS/MPH/DEC/SPI
Mid Phanerophytes Evergreen / Coniferous	TRS/MPH/EVR/CON
Mid Phanerophytes Evergreen / Non-Leafy Evergreen	TRS/MPH/EVR/NLE
Mid Phanerophytes Evergreen / Broadleaved / Summer Deciduous and/or Spiny Cushion	TRS/MPH/EVR/SPI
Mid Phanerophytes Coniferous / Non-Leafy Evergreen	TRS/MPH/CON/NLE
Mid Phanerophytes Coniferous / Summer Deciduous	TRS/MPH/CON/SPI
Mid Phanerophytes Non-Leafy Evergreen / Summer Deciduous and/or Spiny Cushion	TRS/MPH/NLE/SPI
Tall Phanerophytes Winter Deciduous (tall deciduous scrub)	TRS/TPH/DEC
Tall Phanerophytes Evergreen (tall evergreen scrub)	TRS/TPH/EVR
Tall Phanerophytes Coniferous (tall coniferous scrub)	TRS/TPH/CON
Tall Phanerophytes Non-Leafy Evergreen (tall gorse/broom scrub)	TRS/TPH/NLE
Tall Phanerophytes Winter Deciduous / Evergreen	TRS/TPH/DEC/EVR
Tall Phanerophytes Winter Deciduous / Coniferous	TRS/TPH/DEC/CON
Tall Phanerophytes Winter Deciduous / Non-Leafy Evergreen	TRS/TPH/DEC/NLE
Tall Phanerophytes Evergreen / Coniferous	TRS/TPH/EVR/CON
Tall Phanerophytes Evergreen / Non-Leafy Evergreen	TRS/TPH/EVR/NLE
Tall Phanerophytes Coniferous / Non-Leafy Evergreen	TRS/TPH/CON/NLE
Forest Phanerophytes Winter Deciduous (deciduous forest)	TRS/FPH/DEC
Forest Phanerophytes Evergreen (evergreen forest)	TRS/FPH/EVR
Forest Phanerophytes Coniferous (coniferous forest)	TRS/FPH/CON
Forest Phanerophytes Winter Deciduous / Evergreen	TRS/FPH/DEC/EVR
Forest Phanerophytes Winter Deciduous / Coniferous	TRS/FPH/DEC/CON
Forest Phanerophytes Evergreen / Coniferous	TRS/FPH/EVR/CON