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Manual for Habitat and Vegetation Surveillance and Monitoring

Temperate, Mediterranean and Desert Biomes

Alterra report 2154
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SEVENTH FRAMEWORK PROGRAMME

Manual for Habitat and Vegetation Surveillance and Monitoring

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Abstract

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The primary objective of this Manual is to describe the methodology appropriate for coordinating information on habitats and vegetation 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 Manual has been produced as part of the EBONE (European Biodiversity Observation Network). There have been some modifications and additional from the previous Manual published in 2005.
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 General Habitat Categories and the Life Form Qualifiers, which are for defining habitats outside Europe, have 160 GHCs derived from 16 Life Forms (LF's), 18 Non Life Forms (NLFs) and 24 Life Form Qualifiers. They have been field tested not only in all the environmental zones in Europe, but also in Mediterranean and desert biomes in Israel, Tunisia, South Africa and Australia. 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. Also full lists of GHCs are added together with information on species. A procedure is described for recording vegetation plots in the GHCs.
Every effort has been made to make the Manual consistent and robust, but inevitably a few errors may still be present, so please consult the authors if problems are encountered.

Keywords: field recording, surveillance, monitoring, stratification, habitats, biodiversity, Life Forms, Non-Life Forms, Life Form qualifiers, vegetation

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Preface

The present Biodiversity Monitoring Manual has been derived from the BioHab Monitoring Handbook developed in the EU FP5 framework. In the BioHab project the core of the methodology was developed building on existing knowledge throughout Europe. After the BioHab project work has been on-going to improve the context, correct errors and expand its use to regions outside Europe. The original BioHab Handbook, published in 2005 (Bunce et al., 2005) was the basis for developing the draft Manual for the Mediterranean biome outside Europe. The present version of the Manual includes comments from users throughout Europe, but also experiences based on its use in Israel, South Africa and Australia. Field testing has been taking place in Israel since October 2008 and the present version also contains the results of discussions held during field visits to the Negev and Sinai deserts in 2009. Information from Czech and Belgium colleagues and results from field work in Cabo da Gata (Spain) have been added as well as conclusions from the Quality Control carried out in 2010. Additional life forms have been added from experience in EBONE, but also from the literature especially for the tropical rain forest. A procedure for recording these additional Life Forms has also been included, although it is provisional and needs field testing. A further section has been added on a procedure for recording vegetation layers of forests over 5 m high, following the decision made at the start-up workshop for EBONE-WP4 in 2008. The method is based on the procedure developed by Philip Roche and was tested in the Quality Control exercises in 2010.

Many additions, especially related to desert habitats, have been made from the original Handbook, but the principles remain the same. A recommended procedure for vegetation recording has also been added which can be enhanced to cover other objectives, e.g. crop margins. The software for field recording of habitats and vegetation, which has been developed by INBO with support of Alterra, is now available for use on a PDA or field computer. A key for identifying the list contained in Annex I of the habitats has also been developed by Alterra and can be included on the field computer. It is likely that field recording over the next few years will shift progressively to field computers, which will not only assist consistent recoding, but make processing more rapid. It is recognised that the Manual reflects the objective of EBONE and BIOBIO and has been simplified, especially in the recording of linear features from the first version.

Rob Jongman, Bob Bunce, Marion Bogers and Ilse Geijzendorffer

Wageningen, January 2011

1 Introduction

The central pillar of the General Habitat Categories (GHC) is that there is a relationship between plant life forms, as described by Raunkiaer (1934), and the environment. The GHC surveillance and monitoring approach provides rules for consistent recording in the field of life forms that make up habitats. Habitats are important for biodiversity in their own right, as described in the Habitats and Species Directive of the European Union, but can also be used as a framework for sampling other aspects of biodiversity, e.g. vegetation and spider assemblages. Habitats are linked to species occurrence. For instance, birds as the bittern (*Botaurus stellaris*) are only found in reed beds and the large blue butterfly (*Phengaris arion*) only in calcareous grasslands. This is reflected in landscape level models such as LARCH (Opdam et al., 2003; Verboom and Pouwels, 2004). Projects such as EBONE (www.ebone.wur.nl) and BIOBIO (www.biobio-indicator.org) both deal with surveillance and monitoring of biodiversity, although at different levels and with different objectives. EBONE focuses on European biodiversity monitoring in general, while BIOBIO assesses agro-biodiversity in low input and organic farming. The GHC approach can be seen as a habitat framework for biodiversity monitoring.

The first predecessor of this recording system has previously been described by Bunce and Shaw (1973) and is based on a hierarchical structure as shown (Figure 1). Whilst the levels are arbitrary, they are widely recognised, e.g. in the GB Countryside Survey (Haines-Young et al. 2000), and form a tested framework for statistical analysis of stock and change. At the base of the hierarchy are individual plants, each of which is assigned to a plant life form, e.g. grasses and trees which reflect the structure of the plant (Raunkiaer, 1934). Plants grow together to form the communities recognised in phytosociology, which in the present document are recorded by analysis of species assemblages from sample vegetation plots. At the next level the habitat may be a single vegetation class or more often a complex mixture of life forms - hence the rules and procedures described in the present document.

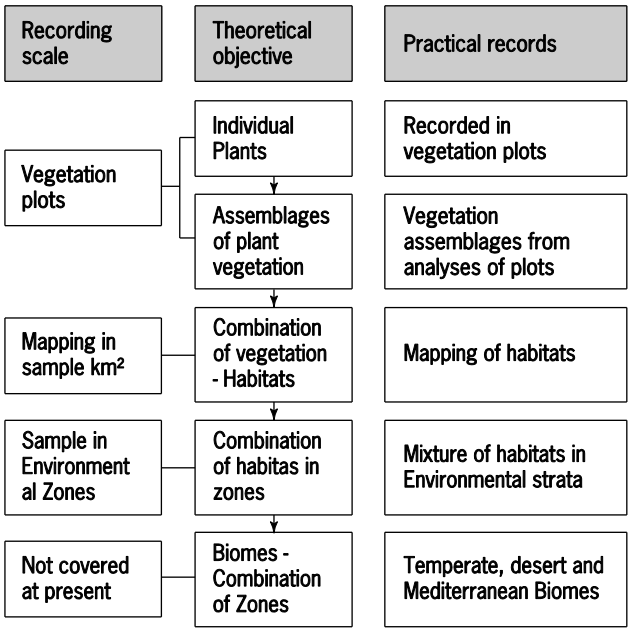


Figure 1

Hierarchical structure of the recording system.

Whilst the core procedure of the present Manual should be maintained, regional adaptation can be made, e.g. to add predefined point feature lists as was done in Switzerland in 2011 or extract only relevant management codes. However, care should be taken that the data can still be compared with other surveys using the methodology.

The transition from individual plants to habitats is recognised within the collective names of the English language, e.g. trees form forests, grasses form pasture and low scrub forms heathlands.

Above the previous level are landscapes which contain various combinations of habitats and in the present document are derived from the strata of the Environmental Zones. Whilst this level is often confused by imposition of cultural differences, it is valuable for summary reporting as in GB Countryside Survey. The highest level of biome is usually used for world modelling and can be derived from combinations of the EnZ

The recording method also contributes to the development of a global biodiversity monitoring system that is being developed under GEO BON linking in situ and earth observation information (www.earthobservations.org/cop_bi_geobon.shtml). Habitats can also be considered as an ecological refinement of the land cover categorisation as developed by FAO in the Land Cover Categorisation System (LCCS, Di Gregorio and Jansen 2000). To develop a global coverage of the General Habitat Categories and a field monitoring Manual will however mean that the method will have to be tested in all biomes of the world. Many of the optional qualifiers have been already been added to cover situations outside Europe and will need testing in a variety of situations in order to ensure that they are robust.

The Manual is organised in modules for different objectives. The core methodology of habitat recording uses General Habitat Categories (GHCs). The GHC method can be considered as a basic approach that can be diversified and upgraded by adding modules e.g. on vegetation associations and species occurrences relating to the basic habitat mapping. In some projects or programmes part of the modules may be selected only and another part omitted according to the objectives, e.g. BIOBIO (www.biobio-indicator.org) has not recorded layers of vegetation in forests. Modules have been added based on experiences and discussions in EBONE. These additional modules will be essential to developing a global biodiversity Manual with guidelines for different biomes within and outside Europe, but enabling a common exchangeable approach as is required for international cooperation projects.

The Mediterranean biome is widely recognized in the world, partly because of its distinctive character and partly because its association with products such as wines from France, Spain, Italy and Greece in Europe, and from the USA, Chile, Argentina and Australia, elsewhere in the world. Whilst there is no doubt about the general relationship between life forms and environment, questions still remain about the more refined gradient between Mediterranean, semi-desert and true desert. For example the Deserta de Tabernas in South-east Spain, frequently quoted as the only desert in mainland Europe, would not be considered as such in Israel or northern Africa because of the extent of vegetation cover. However, some patches on exposed south facing slopes would fall within an accepted desert definition because of the high cover of bare ground. A section has therefore been added for recording where there is less than 30% vegetation cover in order to enable more details to be available in desert habitats. Further testing in dry savannahs and deserts has to be carried out.

During the field work in 2010, in EBONE and BIOBIO it became apparent that in some farm types, especially arable systems, and extreme dry landscapes, that more than one visit may be required to obtain adequate information on biodiversity. Recommendations will need to be made according to the requirements of the project and country.

The situation is further complicated by the high proportion of saline soils in many low rainfall areas which emphasises the dryness of soils. The present Manual therefore includes life forms to separate Mediterranean environments from semi deserts and true deserts. Experience in Israel indicated that additional information on vegetation patterns, with less than 10% cover, will also be required. Such experiences are included in the present document. In addition because of the extremes of the desert environment between years, there can be no guarantee that rain arrives to

stimulate growth of annuals in a given year. Also some genera e.g. *Acacia* will be summer deciduous in one year but not in the next. The shifts that can occur in Sahelian environments between desert and semi-desert vegetation also require attention for monitoring semi-desert and desert in order to determine of climate change.

In Israel the gradient from Mediterranean through semi-desert to desert is over only 50 km. There is a similar gradient in Morocco and other North African countries over different distances. The recording procedure needs to be tested under these conditions to ensure that it is sufficiently robust to monitor the gradient and the variability. Visits to South Africa and Australia also have been used to add further life forms. The literature has also been consulted to include life forms characteristic of the tropical rain forest, but others may need to be included.

There is experience in applying a comparable methodology in the detection of change e.g. in Northern Ireland (Cooper and McCain, 2002), Denmark (Bloch-Petersen et al., 2006) and Great Britain (Haines-Young et al., 2000), and in interpreting changes from aerial photographs in Spain and Sweden (Skanes and Bunce, 1997). One of the key elements of this approach is its potential for the detection of change and the evaluation of flows between habitats. The planting of forest does change the stock of habitats. Evaluating ecosystem change for biodiversity conservation such a shift can be considered negative if planted on blanket bogs, but positive if planted on arable land. 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 is included as a part of the monitoring system.

The present methodology for habitat mapping and its recording remains to be continuously updated and adjusted for specific project purposes. Please report errors or inconsistencies to the authors.

The Manual has been structured as follows. Following the introduction, Chapter 2 describes the principles of the surveillance system; Chapter 3 provides details of the procedures for recording habitats. Different sections refer to areal, linear and point features. For measuring habitat diversity the core of monitoring activities is in repeated surveillance of such features. In Chapter 4 vegetation recording is described. Point features, vegetation and species information give important additional information on qualitative aspects of biodiversity and species abundance, while areal and linear features provide basic information on spatial diversity and the quantity of habitats. In Chapter 5 worked examples for habitat recording are given. Chapter 6 describes the procedure of stratification which is needed for the selection of representative samples. Annexes provide the definitive list of General Habitat Categories, examples of applied km squares and recording forms.

2 Habitat mapping and recording

2.1 General Habitat Categories (GHCs)

Ecosystem monitoring requires a definition of the scale on which systems are being observed. In general an ecosystem is a community of organisms and their associated physical environment. Ecosystems may occupy a more-or-less defined area, but can also be nested within other ecosystems, e.g. a tree could be considered as an ecosystem in its own right, but may also be in a forest. Common approaches for in situ monitoring of change require definitions and rules that are harmonised continentally and globally.

An example of inconsistencies in definitions is provided by forest agencies. Forest definitions differ between international organisations such as FAO, CBD and UNFCCC (Schoene et al., 2007), and between European countries (EEA, 2006). In the definitions height, tree density, area and species composition play a major role. In Europe differences also exist between countries in defining grazing land. Thus in some countries heathlands (low scrub) are included in agricultural land, whereas elsewhere they are excluded, depending on local interpretation of farmed land. Precise definitions are therefore important to assess forest decline, land conversion and CO_2 sequestration, but also the definition of habitats.

Habitat is a widely used term, but, the content of the concept 'habitat' remains diverse, ambiguous, and difficult to be used consistently in monitoring. There are various reasons for that, not at least because 'habitat' is used in different contexts with different meanings. It is used as a categorisation of ecologically important sites such as in the CORINE biotopes, EUNIS habitats and Palaearctic habitats. On the other hand it is also used in a *scientific, ecological research* context. In this sense, the habitat is defined as the spatial extent of a resource for a particular species.

The working definition of habitat used in this Manual as described by Bunce et al. (2008) is: an element of land that can be consistently defined spatially in the field in order to determine the principal environments in which organisms live. In addition to their recognition in their own right there are also advantages in recording habitats, because of their links to both species and reflectance data. As such habitats are an ecological refinement of land cover categorisation as developed by FAO in the Land Cover Categorisation System (LCCS, Di Gregorio and Jansen 2000).

At European level General Habitat Categories (GHCs) have been developed as the primary structure for recording ecosystems or habitats. The GHCs provide a framework for linking national and other higher level, continental classifications. The GHCs are mainly based on Life Forms (Raunkiaer, 1934) with added qualifiers on environment, site, management and species composition. The term was developed to include Life Forms (LF) and Non-Life Form Habitats (NLF) have been added to complete the system, such as crops and sparsely vegetated land. Rock and various categories and combinations of bare ground are considered as habitats in their own right and are especially important in deserts and mountains.

There is a restricted list of GHCs acting as the core of the procedure for recording habitats and linking extant data. The objective is to avoid the multiplicity of categories that would otherwise result from disaggregated recording. There are 140 GHCs, the complete list being given in Annex 1 as well as in the text in 3.4. No other combinations are allowed. The GHC methodology follows the experience of the GB Countryside Survey (GB-CS) where primary codes were developed to ensure that decisions on major categories were made in the field rather than being postponed to subsequent analysis. GHCs contain a maximum of two life forms or other non-life form habitats, again to restrict the total number for interpretative and reporting purposes as well as being the common denominator for linking extant data sets. The recording procedure adds further detail to GHCs by using various qualifiers relating to environment.

management and site characteristics. GHCs are regarded as the lowest common denominator and for each mapped unit other data are recorded to provide the full life form composition and associated major species.

Whilst the list of GHCs has been tested in Europe and the Mediterranean biome it is recognised that an extended list by upgrading some qualities into GHCs will need to be developed for other biomes such as the tropical rainforest. However a provisional list of additional life forms has been added as qualifier to indicate the possible range to be included.

2.2 Monitoring by means of GHCs

Statistically, it is optimal to return to the same sites to record changes rather than a series of random samples which require many more replicates. This is the procedure followed in all the major monitoring exercises in Europe (GB, Northern Ireland, Sweden, Spain). There are several networks already existing for monitoring ecosystems and biodiversity change employing various size units from 16 km^2 down to 0.25 km^2. Most of the field recording is at the 1 km^2 level, as a compromise between detail and generality, and the GHC methodology has therefore been described for 1 km^2, although it can also be applied at other scales.

The GHCs 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. Stringent criteria are required in order to ensure that real change is recorded and not results that are distorted by differences in definitions, between observers or in recording technique. This requires that the emphasis in re-survey must 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.

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. The systematic control of all detected changes back in time progressively improves the database. Such rigorous change control is essential, since landscape monitoring relies on the detection of small changes and needs to guarantee that the changes have actually taken place. Eventually the final arbiter is the application of standard statistical techniques to detect real changes from background noise.

Underlying principles of General Habitat Categories

EBONE has three tiers of recording of biodiversity:

1. The stratum level which is comparable to the landscape level.
2. The habitat level where complexes of habitats form landscapes.
3. The vegetation level; different types of vegetation make up the habitats.

Reporting in EBONE will be at all three levels. Both habitats and vegetation will be used as indicators of status and trends.

The use of GHCs is based on the following set of principles that have been adopted as essential for consistent recording of habitats:

- A GHC has to be determined in 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. around the period of maximum biomass.
- GHCs are mutually exclusive and together cover the complete land surface of Europe, including water bodies.
- GHCs are a common denominator for comparison between countries using extant data and classes in current use wherever possible.
- GHCs are distinctive and recognisable. Photos are available on the EBONE website: www.ebone.wur.nl/UK/Project+information+and+products/General+Habitat+Categories/
- There are explicit rules to define GHCs.
- It is essential to record the actual situation at the time of survey. In no cases should previous experience be used e.g. of grazing or height of vegetation.
- Differences in management are recorded as qualifiers and are not in the definitions of GHCs.
- Habitats are not defined on the basis of biogeographic regions because of difficulties of maintaining consistency as mostly adequate definitions are lacking and there is a multiplicity of terms. Any biogeographical term that is required consistently can be attached later to GHCs through database management.
- Local names of habitats are not used in the GHC definitions, because they cover different ranges of variation in contrasting regions. They can however be used in reporting.
- Individual species are not used to identify GHCs, because of vicarious species (i.e. comparable species in the same genus that have evolved separately in different regions, e.g. Greece and Spain) and differences in species behaviour in contrasting biogeographical regions. However the use of indicator species to identify environmental qualifiers is useful.

Non-Life Form Categories are urban (URB), crops (CUL) and sparsely vegetated habitats (SPV). (For codes see Section 3.4.5)

3 Habitat mapping and recording

3.1 General instructions

This section contains 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). For further details regarding rules that are specific to areal elements see 3.3.1. For further details regarding rules that are specific to linear elements see 3.3.2 and 3.5. For further details regarding rules that are specific to point elements see 3.3.3.

3.1.1 Survey area

The basic survey area is 1 km^2 within which areal, linear and point elements are recorded. The key to the GHCs can however be applied to any extant data or for general recording in the field. In complex landscapes 0.25 km^2 may be appropriate as in the Northern Ireland Countryside Survey (NICS).

3.1.2 Time window for survey

For monitoring, the recording of the GHCs should be made in a time window 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 latter can be determined by snow cover, in which case recording would need to be postponed in a late season. The extent of the window must be set by region, using local phenological information. In desert environments and very dry Mediterranean climates the recording of vegetation plots may only be possible after a rain event and may therefore be determined by when these occur. The habitats can be surveyed using the Sparsely Vegetated Categories.

Repeat surveys should be carried out in the same time span as the baseline surveillance with squares being surveyed as close as possible to the same date of the original survey. This time differs between Environmental Zones, Strata and countries and will have to be determined before any major survey is carried out. Local flexibility may be required for annual variations in weather, which in Europe is likely to be greatest in the Mediterranean region. Records are required of the date and location of the square as well as ownership where required. This information should be included in the field computer database.

3.1.3 Field team

A field team should consist of at least two people for safety and for consultation. Mixed teams, preferably with a botanist and an experienced mapper or GIS expert, are needed to ensure that the team is balanced. Field teams should consist of personnel with appropriate regional experience.

Adequate field training is required for all surveyors. The actual time needed for field training depends on the experience of the surveyors but should be at least two days and preferably one week. The experience in both the EBONE and BIOBIO project is that for large scale monitoring field training is better in individual countries or regions rather than at one location. It is recognised that there is a problem with learning all the rules. Experience in EBONE has shown that at the European level local training courses are probably more efficient than central sessions. The

level of experience of surveyors is also a critical parameter. Further checking by quality control teams of possible inconsistencies is also advised. The training must be coordinated by experienced people as confirmed by the work in Israel and elsewhere.

There is also a difference between surveillance and monitoring. The latter needs much more training to ensure that only real changes are later identified in a consistent way.

3.1.4 Background Information Sheet: meta data

A Background Information Sheet (meta data) need to be constructed to record information such as ownership boundaries, contact names, addresses and telephone numbers of owners, inaccessible patches and any other relevant information. This sheet will vary between counties and has to be drawn up for each survey. It also has to fulfil the requirements of INSPIRE metadata.

3.1.5 Quality control and assurance

Quality control is essential and involves regular liaison with staff in the field, and direct supervision and consultation. Modern communication means that regular contact can be made and new decisions or clarifications conveyed immediately to the surveyors.
The Manual must be referred to continually in order to optimise field performance, especially when working in landscapes that have contrasting elements, e.g. polyculture landscapes with many small patches.

Quality assurance involves repeated recording by independent observers of previously surveyed squares. The Countryside Survey of Great Britain (GB-CS) has used grids of points from random squares to check on the quality of data from different surveyors to identify errors. More information on www.countrysidesurvey.org.uk/tech_reports.html

An alternative procedure was later developed for the Northern Ireland Countryside Survey (www.science.ulster.ac.uk/nics) in 2007 in order to increase the range of squares and land cover. The squares were drawn at random from the environmental strata used for the survey. A specified time was taken to walk through the square along roads or tracks checking the Broad Habitats. Whilst the procedure is not as statistically robust as the grid method it successfully showed that less than 1% of codes had been incorrectly recorded and identified. Figure 2 illustrates the procedure of field work preparation, field mapping and correction/check. In EBONE a further compromise was used because of the time and cost constraints that included limited quality control and assurance in the same exercise. A report is available at www.ebone.wur.nl

3.1.6 Database checks

When data are collected and put into the project database, the first stage is to carry out automated checking, e.g. for the removal of overlapping parcels and double recording. However whatever procedure has been followed it is still essential to carry out manual checks with an expert observer to ensure that the data are as consistent as possible, e.g. for the removal of impossible combinations such as a salt marsh at the top of a mountain. Such checks must be done manually because it has been shown in the GB CS that it is not possible to develop an automatic procedure to identify such ecologically impossible situations.

Another guideline is to look for any code which stands out as being different from the others in the square. Some mistakes will be common and recognised in the Quality Control e.g. putting the Life Forms as a GHC. These can be readily identified.

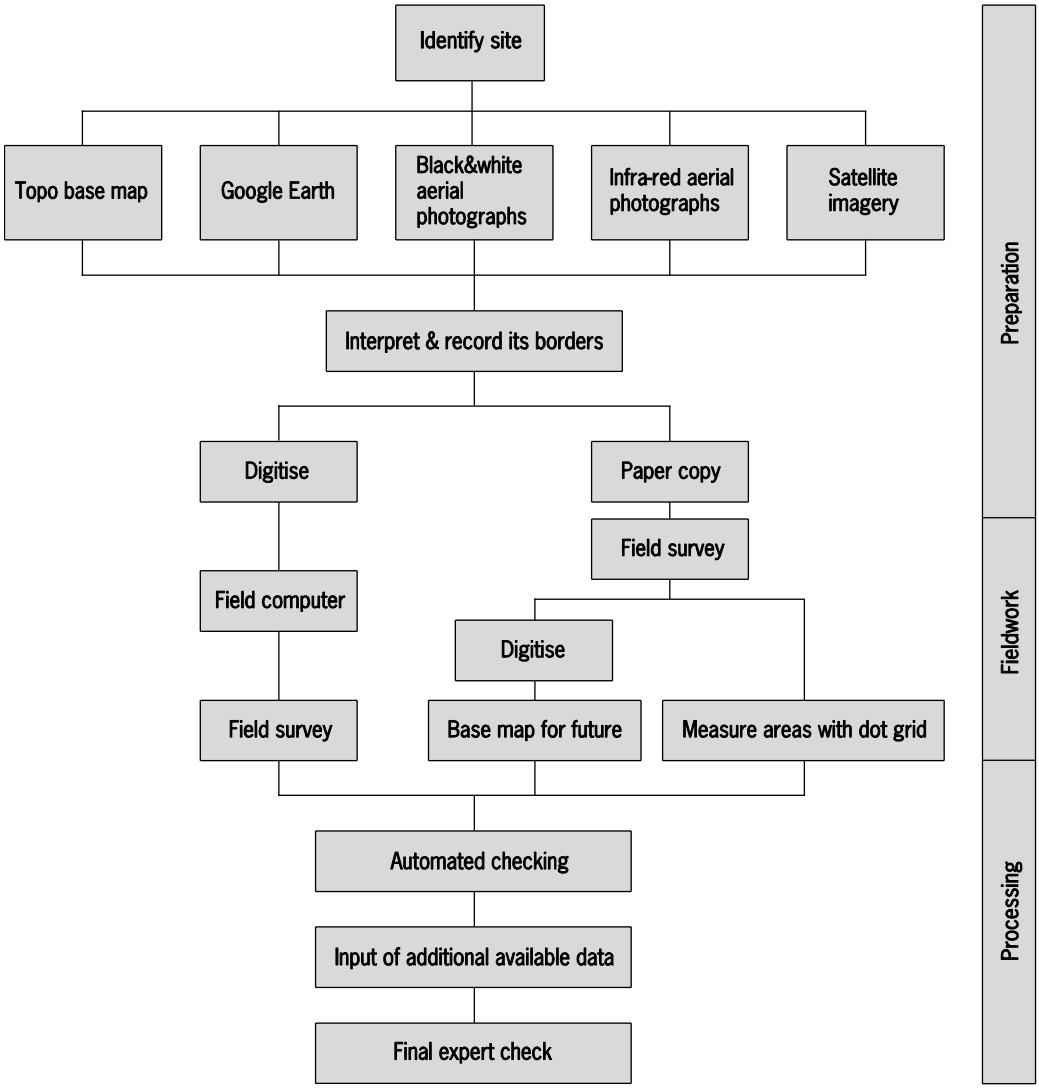


Figure 2

Procedure of field monitoring, including preparatory work of preparing field maps and checking/correction of field information afterwards.

3.2 Field work preparation

3.2.1 Map and aerial photo information

For the scanning of the area and the following field work, one or more of the following sources should be used:

a. 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. 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. Digital outlines of the AP interpretation held on a field computer and the information in the field recorded directly.
d. Maps derived from satellite imagery. Image segmentation offers a further option for preparation before going into the field.

3.2.2 First scan

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

Figure 3
Achterhoek, The Netherlands, aireal photograph dissected.

3.2.3 Equipment

Mapping of elements in the field should be made in one or a combination of the following ways:

a. In pencil, on sheets that are copied from the most recent 1:10,000 scale 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 GHCs.
d. Digital outlines of elements can be held on the field computer.
e. Following the field visits the procedures for validation and finalisation of the data vary according to the recording method used.

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.

The data for mapped elements are recorded on standard forms or on a field computer (see Section 3.2.5). Procedures for recording vegetation are given in Chapter 4.

3.2.4 Photographs

It is strongly recommended that during field work a photograph of each GHC is taken including a GPS position for the following reasons:

– Illustration of the local conditions at the time of recording;
– As input for later quality assessment;- As a record for later recording.

3.2.5 Application of field computers

Since the first version of the Manual was produced major advances have taken place in the application of field computers for the recording of habitat data. Various options are now available and, except in GB, the spatial data is not yet stored in a fully integrated way within a GIS environment. It is important to note that all systems involve previous interpretation of different types of aerial photographs to produce parcel outlines which are then validated in the field. The following systems are available within the EBONE consortium, but others are also available:

– The GB-CS has a fully integrated system in which spatial data are held, modified in the field and then directly placed into a database management system. The system has been proven in the GB survey in 2007, but the resources required both in terms of software and hardware are beyond the financial capacity of most organizations,
– The NICS has a partially automated system, with boundaries available in the field linked to GIS but not linked directly to a server and records have to be transferred manually.
– The National Inventory of Swedish landscapes (NILS) records field records that are currently manually downloaded into the database system. A system is under development that will link field computers to a PC in the field for downloading directly into the database.
– The Flemish Institute for Nature and Forest Research (INBO) has developed a system for recording GHCs and associated data on qualifiers and species in the field which is transferrable to other machines. The system developed by INBO has been adopted for EBONE for input into a PDA. The PDA also includes the key to Annex I Habitats developed by Alterra. A Manual is available for application of the system.

Within the EBONE consortium CEMAGREF has developed a system for tablet PC within an Access environment that is available for use inside and outside the consortium.

3.3 Habitat identification and mapping

In this section the methodology of how to identify and map the habitats is described. Each field in the recording sheet is explained and decision rules are presented. The actual definitions of all the categories and qualifiers can be found in the sections further below.

Separating map elements is based on strict rules (see 3.3.2). 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. It is important to consider that in general, larger elements should be mapped rather than attempting to map small patches, which do not have distinct boundaries.

To determine what an element is, here are the decision rules:

1. The Minimum Mappable Element (MME) for an areal element is 400m^2 with minimum dimensions of 5 x 80m or 20 x 20m.
2. If the element is smaller than 5m. it is recorded as a Linear element with a Minimum Mappable Length (MML) of 30m.
3. Elements that do not pass the MME or MML criteria for either areal or linear elements can be mapped and recorded as point elements or as proportions of a larger element (see 3.3.3 for more detail on mapping and recording of point elements).

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 400m^2.

If an area is less than 400m^2 in the survey square but belongs to a larger element outside, it should be mapped as an area.

If a linear element has 20m inside the survey area and at least 10m outside (i.e. total length is >30m) it should also be recorded.

Canals, roads and broad rivers may be linear elements, but if they are over 400m^2 within the survey area and at least 5m wide, they are mapped as areal elements. Subsequent database analysis can analyse these as linear elements, if required.

3.3.1 Mapping Areal elements

Areal elements are drawn on a separate map from the linear elements. Elements are assigned alpha codes as identification codes that are the same on the map and on the corresponding recording sheet. They link the recorded data to its geographical unit. Capital letters of the Latin alphabet are used for the alpha code. I, O and X should not be used. Once all the letters of the alphabet have been used then double codes are used: e.g. AA, AB, AC etc.

The alpha code for an areal element should be placed as closely as possible to the centre of the element, as shown in the worked examples.
Separate mapping elements that have identical data coding (i.e. entries in Fields 1 - 8) have the same alpha code but should be recorded as in a numerical order A1, A2, etc. on the map to allow their separation; 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. Although fences are not recorded, if they separate fields then each field should be drawn separately.

3.3.2 Mapping Linear elements

GHCs are recorded as linear elements if they have a width of less than 5m and are longer than 30m with appropriate qualifiers. Linear and point habitat elements are to be mapped on a separate, identical map or overlay, with a separate recording sheet, which has a comparable format to the areal elements form. Linear landscape elements within areal urban elements and linear elements that form the boundary of an urban element are not recorded.

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.

Rules for mapping linear elements:
- The width of hedges, lines of scrub and lines of trees does not include the canopy.
- An element that has a width below 0.5m is not recorded unless it is a wall or a watercourse. Other elements that are associated with a linear element have to be at least 0.5m wide before they are mapped and recorded. Thus a strip of grass 0.30m wide between cereal fields is not recorded.
- If there are several linear elements which are close together then record them a series of lines with a label by each line. Inevitable these will be diagrammatic and with not reflect the actual distance of the lines on the map. Another possibility is to record as a single line with multiple labels (alpha codes). The procedure for recording such complex of linears should be agreed with GIS experts before the start of the survey.
- 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 5m wide in vineyards).

Linear elements are always mapped as individual lines on the map using alpha codes.
If there is a strip of vegetation next to a road or track that is the same as that of the adjacent areal elements it is not mapped as a linear element. However where the GHC beside a linear element differs from the surrounding land, than it is recorded as a separate line.

Within forests linear elements are not mapped beneath the canopy except for watercourses, roads and constructed tracks as these elements are important in further spatial analysis. Under lines of trees (LTR) walls, watercourses and hedges under 5m wide are recorded.

Isolated clumps of wetland species along temporary water bodies are not indicative of a wetland linear.
Subterranean watercourses are not recorded.

Watercourses include the whole riverbed, not just the stream itself. For dry riverbed a GHC is added from the TER subdivisions.

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

Lines of trees/shrubs must have at least ten individuals or 30% cover over at least 30m length, otherwise they may be recorded as points, if ecologically significant (see 3.3.3).

There are three main options for recording linear elements:
1. Full details as described in the areal elements including all the rules for alpha code changes.
2. Mapping the restricted list of linear elements included in Section 3.5 together with GHCs.
3. An option of a more restricted list of linear features (e.g. see the BIOBIO manual) or a more expanded list according to specific project objectives.

3.3.3 Mapping Point elements

Elements that are smaller than 400m2 and shorter than 30m can be recorded as point elements. Point habitat elements are mapped on the same sheet or overlay as the linear features, with a separate recording sheet, which has a comparable format to the areal elements form.

The criteria to record point features are as follows:
- The feature is a GHC with an area between 100m^2 and 400m^2 (minimum square: 10 x 10m; circle 11m diameter) and has an *ecological significance in a landscape ecological perspective*.
- The feature is smaller than 100m^2 but has a clear *ecological significance in a landscape ecological perspective*, e.g. springs, moorland pools, earth pillars and barrows.

There are two situations that help to define the ecological significance of point features:
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. **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 feature, by their presence:
   i. Induce an ecological process that has an effect, which exceeds the area occupied by the point feature: 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;
   ii. Affect existing ecological process acting on the landscape scale: weirs on watercourses that hinder migration and constructions for animal crossings across roads.

   Point features of ecological significance may be recorded in all GHCs except urban e.g. individual buildings in forests, because they often contribute useful information regarding the character of the element.

Because of the wide diversity in point element density there are four options to choose from in recording them. Before going into the field it has to be agreed upon which rule will be followed:
1. All point elements are recorded.
2. All ecologically significant point elements are recorded, including inside forests.
3. All point elements that are mentioned in Annex I.
4. A restricted list of point elements for a given survey.
5. No point elements are recorded.

There should be a space on the Background Information Sheet to register the procedure that is being followed. If point elements are recorded 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 should be made explicit during training for a given survey.

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).

In EBONE all ecologically significant point elements are recorded for surveillance. GHCs need to be added.
For monitoring new points may be added if they have become significant over the time period.

3.3.4 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 ten rules is true (for explanation of the GHC rules and qualifiers see Section 3.4):

- A change in GHC;
- A change of more than 30% of a cover of a GHC;
- A change in environmental qualifier;
- A change in site or global qualifier;
- A change in the occurrence of point elements;
- A change in management qualifier e.g. a fence line or age of forest trees;
- A change of at least 30% in the cover of an individual species over the whole element;
- A change of at least 30% in any of the TRS layers, if they are being recorded under forest canopies;
- A change in any other specified European habitat, especially the habitats of Annex I of the Habitats Directive;
- A change in the proportion in the Annex I habitats.

In lowland landscape separate fields should be mapped individual, even though the boundaries may not be delimited by fence lines or grass strips. In most cases these will already be marked as separated elements on the AP. These data are required for subsequent spatial analyses.

Photographs should therefore be linked to a given polygon, line or point feature.

3.4 Recording of individual elements

3.4.1 Using the Recording Form

Elements are assigned alpha codes for identification of units that are the same on the map and on the corresponding recording sheet. The alpha codes are unique for the map and the recording sheet, linking both (see Section 3.3.1). On the recording sheets the alpha codes are put in the first column.

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 should be developed for background information on the survey square. Examples of completed recording sheets are given in Chapter 5. If a field computer is used then the appropriate instructions should be followed, but the structure is the same as when paper is used.

On the recording form all mapped elements must be annotated with one GHC in field 1.

All fields on the recording form must have an entry in order to ensure that subsequent database management can identify that an entry has not been omitted in error. See Section 3.4.8.1 for coding of 'absence of data' entries.

In order to avoid inconsistency 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. The creation of new categories is not encouraged, but when a major survey is underway surveyors should contact the survey coordinator to assign new classes if needed.

The GHC methodology is based on Life Forms (LF) and Non-Life Form (NLF) categories with specific qualifiers. For European coherence in data environmental conditions must be considered at a continental scale: e.g., 'dry' in Scotland may be 'mesic' compared with southern Italy (definitions are provided in Section 3.4.7).

There are two types of data to be recorded: (a) the GHCs 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).

Surveyors are provided with lists of GHCs 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. Different sets of qualifiers can be developed for different regions and biomes.

The limited list of GHCs and specific rules to define them is designed to avoid a potential multiplicity of codes and mosaics and to provide a lowest common denominator for linking disparate datasets. The full spectra in Field five are recorded later.

In order to give as much information as possible about a GHC and the dominant species of mapped elements, Field five of the data recording sheet is reserved to record these details for each alpha code that is used (see 3.5).

When recording it is best to first fill in the alpha code, then fill in Field 5 (full list of habitats) and then decide upon the GHC in Field 1, because of the full list of LFs and NLFs provides the basis for the selection of the GHC.

Elements on the map that are identical are given the same alpha code, but are indicated by additional codes: A1, A2 have the same GHC, but are different units on the map e.g. s series of cereal fields. For each map element a recording is made in which the following rules are applied:

- The *first field* is for entry of the GHC (see 3.4.2).
- The *second field* is for entry of the global and the environmental qualifier, for expressing moisture regime and acidity variations between elements that otherwise may have the same GHC (see 3.4.7 and 3.4.8). An instruction on assessment of these qualifiers needs to be included in the field training (e.g. regional plant indicators).
- 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 3.4.9).
- 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 3.4.10).
- The *fifth field* is for entry of the full list of habitats within the GHC together with the major species and percentages (see 3.4.11).
- The *sixth field* is for entry of European Habitat classifications, including EUNIS, Annex I and other pan European classifications (see 3.4.12).
- The *seventh field* is for entry of Farmed and Non-Farmed features, if appropriate (see 3.4.13).
- The *eighth field* is for entry of regional or local habitat classifications and/or phytosociological associations, where appropriate (see 3.4.14).

The EBONE project has used a simplified recording sheet for linear elements with a predefined list of linear elements. All ecological significant point features have been recorded. The eighth field is not recorded in EBONE.

3.4.2 Field one: Rules for determining GHCs

This section describes the rules for the determination of the GHC (i.e. the primary recording code) for areal elements. All the GHCs are given in Section 3.4. No other combinations of LFs and NLFs are allowed than given in this list. The objectives of GHCs are to provide the lowest common denominator for European wide habitat statistics. The full breakdown of LF and NLF is given in column five.

Although the GHC is recorded in field one, the full breakdown may be completed first in order to clarify difficult decisions. However the decision on the GHC must be made in the field to ascribe the given element a single category as it is not possible to derive them automatically from the full data of field five in the case of marginal decisions. These categorical divisions need a series of supporting rules as given in Section 4.1.

3.4.3 Determining the super categories of the GHCs

Determination of the GHC is based upon a sequence of five dichotomous divisions (Figure 4) related to a set of six super-categories, (Urban, Cultivated, Sparsely Vegetated, Tree and Shrubs, Herbaceous wetland and other Herbaceous) which determine the series of LFs and NLFs and that are used to identify the appropriate GHC.

The cover of the surface of a given habitat is estimated from a vertical perspective. It is therefore cover of the land surface of LFs and NLFs and combinations as seen from above, not that which is beneath a given canopy, except for forest canopies overlapping roads, tracks or rivers over 5m. wide (See the worked example in Chapter 5).

The GHCs are formed of individual LFs or NLFs and all possible combinations within each of the supercategory. No other combinations are possible i.e. there is a maximum number of 140 GHCs.

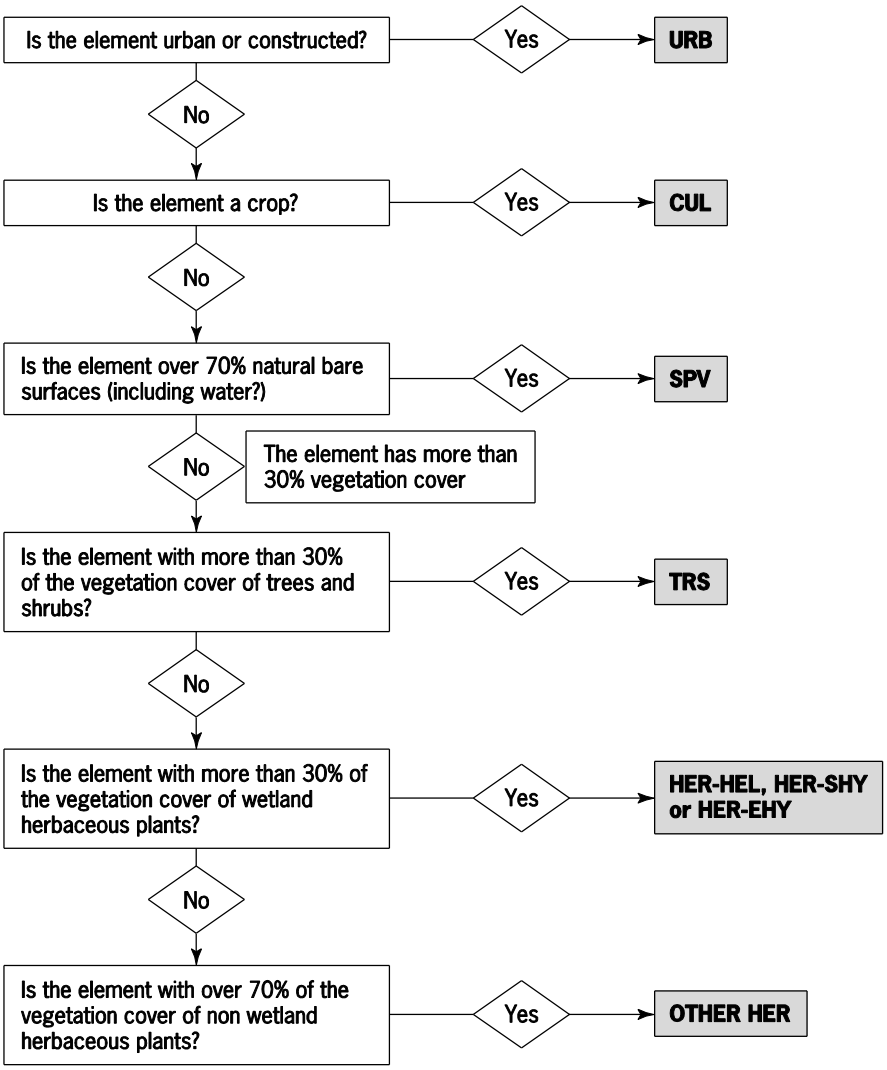


Figure 4

Decision tree for super categories. Further detailed rules are given in Chapter 3.4.

3.4.4 Percentage rules for determining the GHC

For determining the GHCs there are only two percentage rules: over 70% for single GHCs or 40-60% for GHCs that are combinations of two habitats (see Table 1).
An element with >70% cover of a single life form or non life form category is a GHC with a single code e.g. ART= Urban/Artificial or HEL= Herbaceous/Helophytes or a double code if the GHC belongs to the TRS supercategory e.g. FPH/CON and FPH/DEC.

Elements with 40-60% cover of two life forms or two non-life form categories belonging to the same super category of in case of TRS belonging to the same height category, are also GHCs, but with a double code, e.g. ROC/GVR or SHY/EHY or with a triple code if belonging to the TRS supercategory e.g. mixed Deciduous/Conifer Forest (FPH/DEC/CON).

If there are equal proportions of life forms then *precedence rules* are provided. The precedence will be given in the order of the GHCs as listed in Figure 5, e.g. if an element has a coverage of ART 30/NON 30/VEG 30/GRA 10, the GHC would be ART/NON with full percentages in field 5.

Table 1

Examples of single LFs and combinations of LFs and their notation on the field sheets. Note that because the recording is in 10% bands, rounding up is needed, so that for example 30% could actually be 25% rounding up to 30%.

% FPH/DEC	% FPH/CON	GHC to be recorded	% LHE	% CHE	GHC to be recorded
0	100	FPH/CON	0	100	CHE
10	90	FPH/CON	10	90	CHE
20	80	FPH/CON	20	80	CHE
30	70	FPH/CON	30	70	CHE
40	60	FPH/DEC/CON	40	60	LHE/CHE
50	50	FPH/DEC/CON	50	50	LHE/CHE
60	40	FPH/DEC/CON	60	40	LHE/CHE
70	30	FPH/DEC	70	30	LHE
80	20	FPH/DEC	80	20	LHE
90	10	FPH/DEC	90	10	LHE
100	0	FPH/DEC	100	0	LHE

3.4.5 Definition and description of GHCs

GHCs are applied to areal and linear features. Both are included here because they have a common identity, but differ in size and form. Short descriptions of the LFs and associated Life Form Qualifiers are given below. There are also GHCs based on NLF as indicated below.

All codes are unique e.g. ART or GRA. This means that on the recording form the first identifier URB, CUL, SPV, HER and TRS (see Figure 4) can be omitted to save recording time and space. GHCs may be LF or NLF Categories or combinations. Short descriptions and pictures of actual GHCs are provided on the EBONE website: www.ebone.wur.nl/UK/Project+information+and+products/General+Habitat+Categories/

Sections 3.4.5.1, 3.4.5.2 and 3.4.5.3 cover the NLF Categories. These are identified by urban, crop and natural non-vegetated categories. The Sections 3.4.5.4 -3.4.5.6 cover the LF Categories. These can be qualified by the list of LF Qualifiers. These LFs and LF Qualifiers avoid a great increase in the number of GHCs and will express local variation. The GHCs reflect the dominant plant cover. More complete information about the whole range of LFs can be obtained by analysis of the vegetation plots. Experience with analysis of the Ellenberg values suggests that dominants can be more informative about the general relationships of the vegetation, but nevertheless complete spectra also convey important information on biodiversity. The LFs are based on the definitions available from plant morphology. As this discipline is now virtually absent from university courses, many users will not be familiar with the terminology involved so the descriptions have been made as general as possible. For example the 'leaves' of some *Acacia* species are actually modified shoots that behave as leaves and are treated as such. In some cases also the strict morphological definitions have not been used in order to be as close as possible to the concept of the regression of Life Forms on

the environment. The most widely used modification from the original Raunkiaer definitions is of rhizomes, which in general, act as organs of vegetative reproduction. Originally this modification was only included for grasses and sedges but has now been extended to all rhizomatous species in order to be consistent.

The GHC can only be LF or NLF. The complete list of GHCs is given in Annex 1. It is advisable to complete Field 5 of the recoding form first before determining the GHC. Remember that if there are equal proportions of three LFs or NLFs within the supercategory, then the GHC is determined by the ranking within each supercategory (precedence rules).

The division in NLF Categories and LF Categories as well as its subdivisions and life form qualifiers is presented in Figure 5.

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. In other continents additional categories and refinement of definitions might be needed.

3.4.5.1 Urban/Constructed

These GHCs are Non Life Forms (NLF); urban categories have aggregated LFs as a second tier, e.g. herbaceous includes all herbaceous LFs, e.g. grasses and annual plants.

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 in a sport facility or in agricultural use and grazed by animals.

The definitions below are based on the practical experience of the GB-CS adapted for Europe over the last ten years and on the basis of the quality control exercise in EBONE:

- The definition of urban and constructed land cover codes is 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.
- 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.
- **The dominant function** of the land should be considered, e.g. if an area is used as a camp site and recreation for two weeks a year and the other 50 weeks it is grazed by cattle and sheep then it is not urban. Similarly a park in a town may have trees removed for timber, but its **primary objective** is for recreation.
- Roads that are generally passing within the countryside when becoming adjacent to urban areas should be mapped as roads not joined with the urban areas.
- Linear and point elements are not recorded in urban areas. These include linear elements around urban areas, e.g. elements on the yard around farm houses.
- Linear elements previously outside urban areas e.g. sunken roads and hedges that have subsequently been surrounded by urban development are not recorded.
- **Urban land** is mapped if possible by a single boundary and not as individual buildings.
- **Water bodies** are recorded as artificial (ART) if they have concrete bases, non-vegetated (NON) if they have no vegetation or herbaceous (GRA) if they have plants over 30% cover. Use the codes from Section 4 of the site qualifiers to describe them.

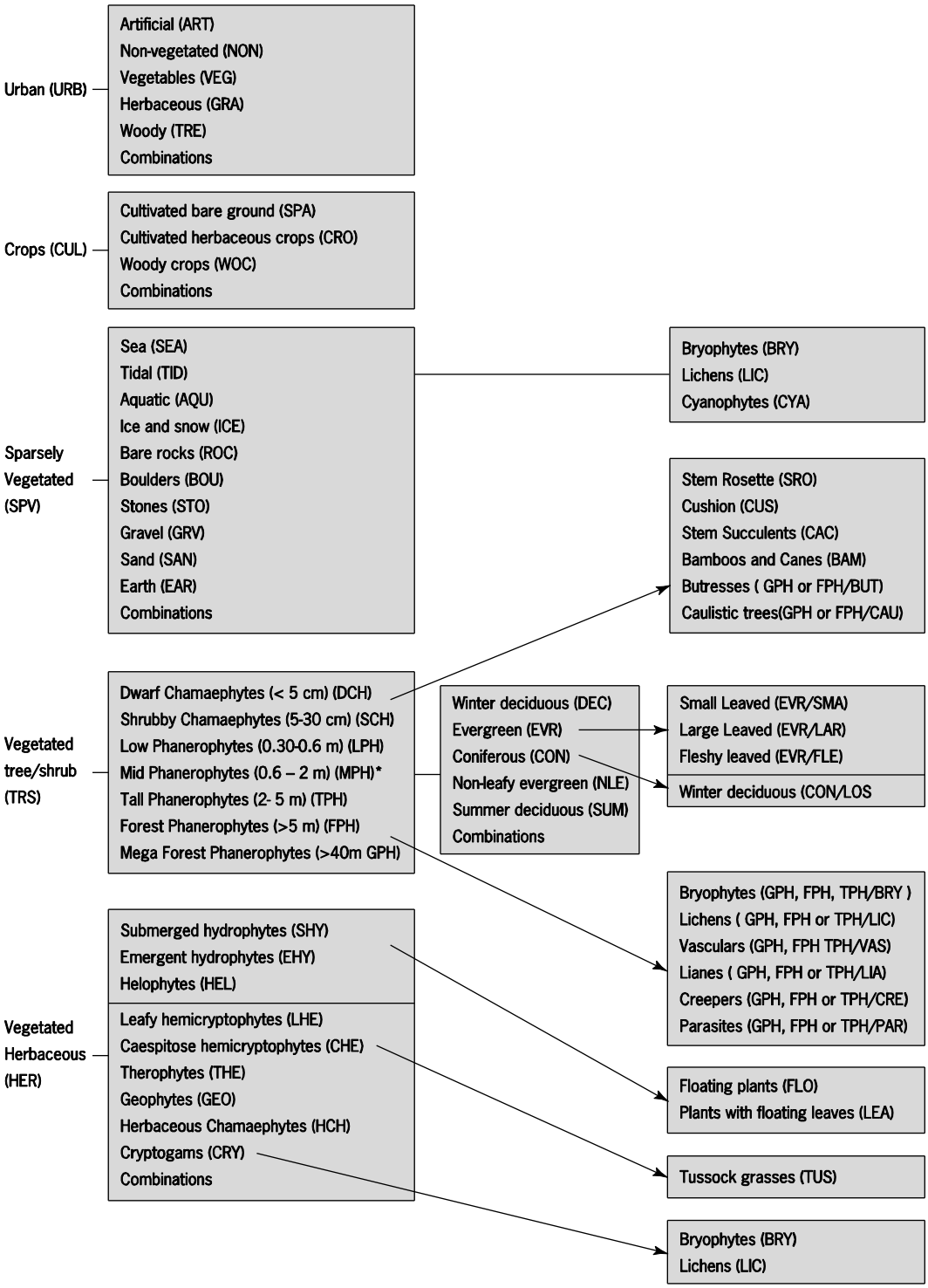


Figure 5

Diagrammatic representation of the GHC key. The optional Life Form Qualifiers are given in blue.

– 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.
– In many 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 management intensity changes from that of a gardening character to more extensive management types*.

- The use of the land needs to be taken into account. E.g. an area of grass used for parking cars is urban: GRA not CHE.
- 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 general code (see 3.4.8.4) used to record scattered buildings within the surrounding GHC.
- Glasshouses and polytunnels are Urban Artificial (ART) with the qualifier 'horticultural use" (A5.7 as shown in Table 7) regardless of what is actually under the glass/polytheen, because it is not possible see what is growing inside.
- Rubbish tips and derelict land are urban. If they have been abandoned for more than ten years and are mainly covered by vegetation they are no longer considered urban, but should be given the appropriate GHC. Qualifiers are available for describing their origin.
- Before going into the field, recent areal cadastral maps, if available, 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 as there are large differences between countries in cartography. For example a fenced football pitch will not be separated in some countries on topographic maps as an urban element, if it is within an agricultural field. In other countries it may be clearly defined.
- 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 visitors and recreational use 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.
- The dominant character of the element should always be used to determine the GHC. For example a forest mainly used for timber but with one or two benches within it would not be included in the urban category. Likewise a visitor centre in a nature reserve would be urban, but although there may be evidence of recreational use elsewhere, the rest of the area would have life forms applied to it.
- 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 3.4.8.4, can also be used when necessary.
- Buildings and associated land below 400m^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. Elements of semi-natural vegetation within an urban element that are clearly designated for building should be recorded the percentage of TRE or GRA of the whole unit.
- Environmental qualifiers and Life Form species composition are not attached to elements inside urban land.
- Each group of super categories must be recorded with the highest value first or in the order given below.
- If an urban element has been left unmanaged for about ten years and has a dominant cover of vegetation it can no longer be considered as urban and will get the appropriate Life Form GHC.

The following GHCs have been designed to cover urban elements. Some constructed elements e.g. walls are also included in the global and linear codes. The sequence provides the precedence rules as described below.

- **Urban artificial (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. Water bodies with concrete bases are included here.
- **Urban Non-vegetated (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. Water bodies in urban areas if they have no vegetation are included here with appropriate site qualifiers.

– **Urban Vegetables (VEG).** This category includes land that is under vegetables and/or fruit trees, such as black currents and gooseberries, within an urban area and includes, for example, allotments. These categories will rarely form over 400m^2 as a pure category and will mainly be recorded as combinations. Fruit trees over 0.6m are included in TRE.
– **Urban Herbaceous (GRA).** This category includes land that is within the urban definition and has vegetation cover less than 30% trees and scrub. Life Forms are **not** recorded. This will include mainly grass e.g. playing fields, lawns and recreation areas, but also includes other herbaceous life forms, such as those growing on derelict sites. Waterbodies with aquatic vegetation are recorded here and include all wetland Life Forms
– **Urban Woody (TRE).** This category includes land that is covered by woody vegetation over 0.6m. Life Forms are **not** recorded. This category includes fruit trees such as apple, pear and plum, used for home consumption, as well as tall shrubs and trees. This rule is because satellite images will not be able to separate any of these groups. It may form an area around large houses, but will often be recorded as combinations. Percentages below 30% are not recorded as separate GHCs.

The GHCs and their combinations in this supercategory are:

URBAN	**URB**
Artificial	ART
Non Vegetated	NON
Vegetables	VEG
Herbaceous	GRA
Woody vegetation	TRE
Artificial / Non-Vegetated	ART/NON
Artificial / Vegetables	ART/VEG
Artificial / Herbaceous	ART/GRA
Artificial / Woody	ART/TRE
Non Vegetated / Vegetables	NON/VEG
Non Vegetated / Herbaceous	NON/GRA
Non Vegetated / Woody	NON/TRE
Vegetables / Herbaceous	VEG/GRA
Vegetables / Woody	VEG/TRE
Herbaceous / Woody	GRA/TRE

If there are equal proportions of three NLFs, the GHC is determined by the ranking as given above.

3.4.5.2 Cultivated

Crops are mainly the product of plant breeding and are usually readily separated from their wild counterparts. However some native species such as walnut and carob are not distinct but should only be included as crops if they show definite evidence of having been planted. Wild species collected from semi-natural vegetation are excluded.

– The individual crops are recorded in the same way as plant species in Field five. The percentages are not necessarily cover, but rather the percentage of the crop plants. If it is just recently sown or germinated the cover is a nominal figure. The percentages are needed because sometimes there are mixed crops, e.g. oats and barley.

- 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. Guidelines for determining whether the element should be still considered as a crop following abandonment are given in 4.6.
- 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.
- Any plant cover after harvesting, e.g. stubble, is not recorded.
- 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.
- If there is still evidence of cut stems in a crop even if there is over 30% cover of vegetation then it should still be recorded as crop. If the colonizing vegetation has smothered the crop stems-usually 3-7 years then it should be recorded as life forms only with a qualifier that there was evidence of former cropping e.g. plough lines.
- Vines are regarded as abandoned if there is no evidence of pruning in the last seven years.
- Olives and orchards are regarded as abandoned (see agricultural & semi-natural vegetation management qualifiers in Table 7) if there is no evidence of pruning in the last seven years, nor collection of fruit.

The following NLF-GHCs have been defined to cover crop elements. The sequence provides the precedence rules as described below.

- **Cultivated bare ground (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.
- **Cultivated herbaceous crop (CRO):** includes both annual e.g. barley, fodder crops and sunflowers and perennials, e.g. Lucerne and sown clover. Also includes crops that are technically bulbs e.g. daffodils.
- **Cultivated woody crops (WOC):** includes all elements with cultivated trees or shrubs, e.g. orchards, vineyards and olive groves. Chestnut forests where there is direct evidence of management for nut collection are also included here. Cover cannot be used as a criterion to determine this GHC 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. If the crop has not been managed for over ten year it can no longer be considered as cultivated and should have the appropriate Life Form GHC. The names of crops, both English and Latin are given in Table 8. Any vegetation cover, e.g. of annual species, below or beneath the woody crop, over 30% should be recorded with appropriate life forms in field five.

The GHCs and their combinations in this supercategory are:

CULTIVATED	**CUL**
Bare Ground	SPA
Herbaceous Crops	CRO
Woody Crops	WOC
Herbaceous/Woody Crops	CRO/WOC

Chestnuts (Castanea sativa) as woody Crops (Tras os Montes Portugal)

3.4.5.3 Sparsely Vegetated

Elements which have less than 30% cover of vegetation fall in the GHC sparsely vegetated (SPV) - e.g. 20% vegetation and 80% rock is ROC - whether lichens and bryophytes growing on the surface or not. Cover of these life forms can be added as life form qualifiers. Percentage cover estimates should be made of the entire surface of the element regardless of slope. Note that chasmophytes, plants growing in crevices, are recorded as HER cover.

The first four categories can occur as individual or combination GHCs in conjunction with TER without its subdivisions. The divisions of the terrestrial NLF Categories described below form individual GHCs and combinations because they form distinctive habitats such as cliffs and screes but especially in deserts, where for example colluvial fans are often linked to cliffs.

The following GHCs have been defined to cover sparsely vegetated categories. The sequence provides the precedence rules as described below.

- **Sea (SEA):** sea below mean low water mark.
- **Aquatic (AQU):** permanent water bodies, whether rivers, canals, lakes or ponds, with less than 30% vegetation cover otherwise the codes **EHY** (emergent hydrophytes) or **SHY** (submerged hydrophytes) apply.
- **Ice/snow (ICE):** permanent ice/snow.

For the recording of combination of the five categories above TER, which consists of all the terrestrial categories as listed below, is treated as a single category in order to avoid large number of GHCs.

The GHCs and their combinations in this supercategory are:

– **Terrestrial (TER):** includes six subdivision described below

SPARSELY VEGETATED	SPV
Sea	SEA
Aquatic	AQU
Ice and Snow	ICE
Terrestrial	TER
Sea/Ice	SEA/ICE
Sea/Terrestrial	SEA/TER
Aquatic/Ice	AQU/ICE
Aquatic/Terrestrial	AQU/TER
Ice/Terrestrial	ICE/TER

Field testing in Almeria and Israel showed that there are many types of bare ground and the definition of the biodiversity characteristics of deserts needed further division to define the complex mixtures of GHCs. Therefore a number of codes have been defined for unvegetated terrestrial GHCs. The combined categories will be widespread because they are derived from erosion processes which often do not sort the size levels onto large units-except in some cases such as estuaries where large areas of sand and mud will be found.

– **ROC** continuous rock divided by cracks, crevices or gullies
– **BOU** boulders over 0.20m diameter
– **STO** rocks and stones 0.05-0.20m diameter
– **GRV** gravel 0.01-0.05m diameter
– **SAN** sand 0.001-0.01m diameter
– **EAR** earth, mud, silt and bare soil below 0.001m diameter

The GHCs and their combinations in this category are:

TERRESTRIAL	TER	TERRESTRIAL	TER
Bare Rock	ROC	Boulders/Stones	BOU/STO
Boulders	BOU	Boulders/Gravel	BOU/GRV
Stones	STO	Boulders/Sand	BOU/GRV
Gravel	GRV	Boulders/Earth	BOU/EAR
Sand	SAN	Stones/Gravel	STO/GRV
Earth, Mud	EAR	Stones/Sand	STO/SAN
Rock/Boulders	ROC/BOU	Stones/Earth	STO/EAR
Rock/Stones	ROC/STO	Gravel/Sand	GRV/SAN
Rock/Gravel	ROC/GRV	Gravel/Earth	GRV/EAR
Rock/Sand	ROC/SAN	Sand/Earth	SAN/EAR
Rock/Earth	ROC/EAR		

If there are equal proportions of three NLFs, the GHC is determined by the ranking as given above.

These Non Life Form habitats are not recorded in aquatic/marine habitats below the water line. Areas of bare peat larger than the MME are only in extraction zones and would therefore be recorded as **NON** in the **URB** category.

In order to increase the information in deserts, where the **vegetation cover is often below 10%, the life form composition should be recorded as actual percentages** in order to provide more detail where the vegetation cover is very low. GHCs cannot be calculated from these figures, because the element is already assigned to one of the TER codes. Percentages could be determined subsequently by database management if required, but most observers will wish to apply multivariate analyses to the full profile of life form and non-life form habitats. It is recognised that the estimate of cover at such low percentages could be inaccurate, but otherwise no information would be available on the sparse vegetation cover in deserts. See also Section 3.4.8.4 for codes on scattered trees and open trees/shrubs.

Whilst deserts are often considered only as hot there are also cold deserts. These can be separated by database management according to the Environmental Zone, in which they occur combined with altitude in some cases. Coastal habitats also need to be separated, for example the sands of Morecambe Bay in North-West England are regionally called the wet Sahara.

Introduction to the Life Form categories

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 further below.

The primary sources for the Life Forms have been various floras (e.g. Clapham et al., 1952: Oberdorfer, 1990). 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.

Although most species belong unequivocally to one life form, some species are in different categories in various floras. This is particular 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 (Clapham et al., 1952), but as rhizomatous geophytes in the Austrian flora (Oberdorfer, 1990). All rhizomatous plants have now been excluded from geophytes because of disagreement between authors. Qualifiers will be listed for different types of geophyte.
In practice, most of these cases are because the rhizomes are primarily for vegetative reproduction and are only secondarily acting as perennating 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. 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 and some ferns, 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 EBONE all *Juncaceae, Cyperaceae* and *Gramineae* are considered as caespitose hemicryptophytes. Exceptions are these genera which have perennial apices above ground level, e.g. *Arundo donax*. These are herbaceous phanerophytes with the height category according to the height of the apex. Note that some genera e.g. Phragmites may be caespitose hemicryptophyte in Atlantic climate and herbaceous phanerophyte in semi-desert.

Whilst the majority of species only occupies 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.

3.4.5.4 Herbaceous wetland

– **Submerged hydrophytes (SHY):** plants that grow in aquatic conditions with the whole plant in water. This category includes marine species and floating species which overwinter below the surface. Such plants are included as life form qualifiers to this GHC. The class excludes aquatic bryophytes. Most are obligate, but some can survive if water levels decline.
  Isoetes lacustris
  Lobelia dortmanna
  Zostera maritima
  Zannichelia palustris
  Emergent hydrophytes (EHY): plants that grow in aquatic conditions and have emergent shoots out of the water.
  Butomus umbellatus
  Cladium mariscus
  Sagittaria sagittifolia
  Scirpus lacustris
– **Helophytes (HEL):** plants that grow in waterlogged conditions.
  Potentilla palustris
  Carex aquatilis
  Eriophorum angustifolium
  Rhynchospora alba

The presence of over 30% of the these three classes take precedence over SPV and Herbaceous LF categories. Some species behave very differently in different situations. For example *Phragmites* if growing in water or waterlogged conditions would come within this class, but it can often grow outside waterlogged areas. In Israel it often grows as *Arundo donax* away from water with permanent tall stems and is therefore a phanerophyte. In these cases it is therefore considered as MPH or TPH with the appropriate life form qualifier for bamboos and canes. The water level at the time of survey is what is recorded. Whilst there may be differences between years experience in the GB-CS shows that this procedure works in practice. Exceptional conditions can anyway be recorded.

The GHCs and their combinations in this supercategory are:

HERBACEOUS WETLAND	HER
Submerged Hydrophytes	SHY
Emergent Hydrophytes	EHY
Helophytes	HEL
Submerged Hydrophytes / Emergent Hydrophytes	SHY/EHY
Submerged Hydrophytes / Helophytes	SHY/HEL
Emergent Hydrophytes / Helophytes	EHY/HEL

If there are equal proportions of three LFs, the GHC is determined by the ranking as given above.

3.4.5.5 Other Herbaceous

- **Leafy hemicryptophytes (LHE)**: biannual or perennial broad leaved herbaceous species, sometimes termed forbs. Annual species are considered as **THE** (see below).
  Campanula latifolium (leafy)
  Plantego coronopus (rosette)
  Carlina acaulis (rosette)
  Dipsacus fullonum (biennial)
- **Caespitose hemicryptophytes (CHE):** perennial monocotyledonous grasses, sedges and rushes regardless as to whether they have rhizomes which in some floras are regarded as geophytes. Annual species are considered as **THE** (see below).
  Lolium perenne (Gramineae)
  Poa alpina (Gramineae)
  Brachypodium retusum (Gramineae)
  Carex pendula (Cyperaceae)
  Luzula sylvatica (Juncaceae)
- **Therophytes (THE):** annual plants that survive during the unfavourable season as seeds. Small patches of therophytes of about 40m^2 will not feature as GHCs except for in desert areas. In other cases they will only be recorded in field five if over 10% cover of the total area in the element. Therophytes cannot be used to identify true deserts as where they may not be present for several years but are often characteristic of semi-deserts and true xeric conditions. The recording of Therophytes in deserts is linked to rainfall events. Note that annual grasses need to be separated from perennials and recorded as THE, but some annual species can behave as perennials, e.g. *Poa annua*. In the latter case it should be recorde as CHE.
  Aegilops arvensis
  Aira praecox
  Bromus madritensis
  Nigella damascena
  Viola arvensis

Vegetation dominated by Therophytes in the semidesert of Almeria

- **Geophytes (GEO):** plants with buds below the soil surface. But not those with rhizomes. *Crocus aureus.* (corm)
  Narcissus bulbocodium (bulb)
  Tulipa australis (bulb)
  Urginea maritima (bulb)
  Asphodelus alba (tuber)
- **Cryptogams (CRY): bryophytes and lichens that are growing on the soil surface and some** aquatic bryophytes, e.g. *Sphagnum spp.* Cryptogams growing on rock surfaces are recorded as life form qualifier to the appropriate TER divisions.
  Cetraria islandica (lichens)
  Cladonia impexa (lichens)
  Usnea barbata (lichens, epiphytic)
  Racomitrium lanuginosum (bryophytes)
  Sphagnum recurvum (bryophytes)
- **Herbaceous Chamaephytes (HCH):** cushion plants usually with perennial leaves.
  Achillea rupestris (herbaceous)
  Saxifraga aizoides (herbaceous)
  Saxifraga caespitosa (cushion)
  Saxifraga lingulata (cushion)
  Oxyria digyna (herbaceous)

The GHCs and their combinations in this supercategory are:

HERBACEOUS	**HER**
Leafy Hemicryptophytes	LHE
Caespitose Hemicryptophytes	CHE
Therophytes	THE
Geophytes	GEO
Chamaephytes	HCH
Cryptogams	CRY
Leafy Hemicryptophytes / Caespitose Hemicryptophytes	LHE/CHE
Leafy Hemicryptophytes / Therophytes	LHE/THE
Leafy Hemicryptophytes / Geophytes	LHE/GEO
Leafy Hemicryptophytes / Herbaceous Chamaephytes	LHE/HCH
Leafy Hemicryptophytes / Cryptogams	LHE/CRY
Caespitose Hemicryptophytes / Therophytes	CHE/THE
Caespitose Hemicryptophytes / Geophytes	CHE/GEO
Caespitose Hemicryptophytes / Herbaceous Chamaephytes	CHE/HCH
Caespitose Hemicryptophytes / Cryptogams	CHE/CRY
Therophytes / Geophytes	THE/GEO
Therophytes / Herbaceous Chamaephytes	THE/HCH
Therophytes / Cryptogams	THE/CRY
Geophytes / Herbaceous Chamaephytes	GEO/HCH
Geophytes / Cryptogams	GEO/CRY
Chamaephytes / Cryptogams	HCH/CRY

The sequence above provides the precedence rules for equal proportions of life forms, i.e. CHE 30/THE 30/GEO 30/CRY 10. The General Habitat Category is CHE/THE. The full formation is recorded in column five.

Other groupings e.g. carnivorous plants could be derived from analysis of the data from field 5 and the botanical plots.

3.4.5.6 Trees and shrubs

Most of the following habitats 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 sense. However these genera have a shrubby form and have perennating buds above ground level. Height is therefore the only consistent arbiter. Note that all the classes below are rooted in the ground. See 3.4.6.1 for epiphytes.

The term trees and shrubs refers to individual plants and life forms. In the landscape groups of trees and shrubs combine to form **forest** and **scrub** habitats. The term shrub land is often used in the literature as land cover. E.g. in the Manual for the CORINE land cover map, but it is not the correct English usage.

The first stage is the definition of the height categories and the second stage the definition of the biome (often termed phenological) categories as height alone is not an adequate descriptor and also will not link with other modelling procedures.

The global codes **SCA** and **OPE** can be applied if the cover of trees and shrubs is below 10%. Clumps of trees and shrubs below 400m^2 can recorded as points. Individual trees or shrubs can be recorded as points if ecological significant (see 3.3.3). Do not record the GHC or species.

In young plantations the cover of GHCs should be recorded. There is an appropriate code in the forest qualifiers for a young plantation so that they can be extracted as forest land use later.

- **Dwarf Chamaephytes (DCH)** dwarf shrubs: below 0.05m.
  Dryas octopetala
  Globularia saxatile
  Salix herbacea
  Salix reticulate
  Loisleuria procumbens
- **Shrubby Chamaephytes (SCH**) undershrubs: 0.05-0.3m.
  Cistus monspeliensis
  Helichrysum stoechas
  Lavandula stoechas
  Thymus vulgaris
  Daboica cantabria
- **Low Phanerophytes (LPH):** low shrubs, buds between 0.30-0.6m.
  Lavendula stoechas
  Cistus albidus
  Calluna vulgaris
  Daphne oleoides
  Salix myrsinites
- **Mid Phanerophytes (MPH):** mid shrubs, buds between 0.6-2.0m.
  Pistacia lentiscus
  Cistus ladanifera
  Daphne gnidium

Myrica gale
Rosmarinus officinalis
Salix aurita

- **Tall Phanerophytes (TPH):** tall shrubs, buds between 2.0-5.0m.
  Salix cinerea
  Amelanchier ovalis
  Cotoneaster nebrodensis
  Frangula alnus
  Phyllirea angustifolia
  Pistacia lentiscus
- **Forest Phanerophytes (FPH):** trees between 5.0 and 40m.
  Quercus robur
  Acer campestre
  Fagus sylvatica
  Pinus halepensis
  Populus tremula
- **Mega forest phanerophytes (GPH): trees over 40m.**
  Sequoia gigantia
  Sequoia sempervirens
  Auracaria heterophylla
  Eucalyptus regnans
  Picea sitchensis
  Pseudotsuga menziesii

The GHCs and their combinations in this supercategory are:

TREES/SHRUBS	**TRS**
Dwarf Chamaephytes Winter Deciduous	DCH/DEC
Dwarf Chamaephytes Evergreen	DCH/EVR
Dwarf Chamaephytes Coniferous	DCH/CON
Dwarf Chamaephytes Winter Deciduous / Evergreen	DCH/DEC/EVR
Dwarf Chamaephytes Winter Deciduous / Coniferous	DCH/DEC/CON
Dwarf Chamaephytes Evergreen / Coniferous	DCH/EVR/CON
Shrubby Chamaephytes Winter Deciduous	SCH/DEC
Shrubby Chamaephytes Evergreen	SCH/EVR
Shrubby Chamaephytes Coniferous	SCH/CON
Shrubby Chamaephytes Non-Leafy Evergreen	SCH/NLE
Shrubby Chamaephytes Summer Deciduous and/or Spiny Cushion	SCH/SUM
Shrubby Chamaephytes Winter Deciduous / Evergreen	SCH/DEC/EVR
Shrubby Chamaephytes Winter Deciduous / Coniferous	SCH/DEC/CON
Shrubby Chamaephytes Winter Deciduous / Non-Leafy Evergreen	SCH/DEC/NLE
Shrubby Chamaephytes Winter Deciduous / Summer Deciduous	SCH/DEC/SUM
Shrubby Chamaephytes Evergreen / Coniferous	SCH/ EVR/CON
Shrubby Chamaephytes Evergreen / Non-Leafy Evergreen	SCH/EVR/NLE
Shrubby Chamaephytes Evergreen / Summer Deciduous	SCH/EVR/SUM
Shrubby Chamaephytes Coniferous / Non-Leafy Evergreen	SCH/CON/NLE
Shrubby Chamaephytes Coniferous / Summer Deciduous	SCH/CON/SUM
Shrubby Chamaephytes Non-Leafy Evergreen / Summer Deciduous	SCH/NLE/SUM
Low Phanerophytes Winter Deciduous	LPH/DEC
Low Phanerophytes Evergreen	LPH/EVR
Low Phanerophytes Coniferous	LPH/CON

TREES/SHRUBS	TRS
Low Phanerophytes Non-Leafy Evergreen	LPH/NLE
Low Phanerophytes Summer Deciduous	LPH/SUM
Low Phanerophytes Winter deciduous / Evergreen	LPH/DEC/EVR
Low Phanerophytes Winter deciduous / Coniferous	LPH/DEC/CON
Low Phanerophytes Winter deciduous / Non-Leafy Evergreen	LPH/DEC/NLE
Low Phanerophytes Winter Deciduous Summer	LPH/DEC/SUM
Low Phanerophytes Evergreen / Coniferous	LPH/ EVR/CON
Low Phanerophytes Evergreen / Non-Leafy Evergreen	LPH/EVR/NLE
Low Phanerophytes Evergreen / Summer Deciduous	LPH/EVR/SUM
Low Phanerophytes Coniferous / Non-Leafy Evergreen	LPH/CON/NLE
Low Phanerophytes Coniferous / Summer Deciduous	LPH/CON/SUM
Low Phanerophytes Non-Leafy Evergreen / Summer Deciduous	LPH/NLE/SUM
Mid Phanerophytes Winter Deciduous	MPH/DEC
Mid Phanerophytes Evergreen	MPH/EVR
Mid Phanerophytes Coniferous	MPH/CON
Mid Phanerophytes Non Leafy Evergreen	MPH/NLE
Mid Phanerophytes Summer Deciduous and/or Spiny Cushion	MPH/SUM
Mid Phanerophytes Winter Deciduous / Evergreen	MPH/DEC/EVR
Mid Phanerophytes Winter Deciduous / Coniferous	MPH/DEC/CON
Mid Phanerophytes Winter Deciduous / Non-Leafy Evergreen	MPH/DEC/NLE
Mid Phanerophytes Winter Deciduous / Summer Deciduous	MPH/DEC/SUM
Mid Phanerophytes Evergreen / Coniferous	MPH/EVR/CON
Mid Phanerophytes Evergreen / Non-Leafy Evergreen	MPH/EVR/NLE
Mid Phanerophytes Evergreen / Broadleaved / Summer Deciduous	MPH/EVR/SUM
Mid Phanerophytes Coniferous / Non-Leafy Evergreen	MPH/CON/NLE
Mid Phanerophytes Coniferous / Summer Deciduous	MPH/CON/SUM
Mid Phanerophytes Non-Leafy Evergreen / Summer Deciduous	MPH/NLE/SUM
Tall Phanerophytes Winter Deciduous	TPH/DEC
Tall Phanerophytes Evergreen	TPH/EVR
Tall Phanerophytes Coniferous	TPH/CON
Tall Phanerophytes Non-Leafy Evergreen	TPH/NLE
Tall Phanerophytes Summer Deciduous	TPH/SUM
Tall Phanerophytes Winter Deciduous / Evergreen	TPH/DEC/EVR
Tall Phanerophytes Winter Deciduous / Coniferous	TPH/DEC/CON
Tall Phanerophytes Winter Deciduous / Non-Leafy Evergreen	TPH/DEC/NLE
Tall Phanerophytes Evergreen / Coniferous	TPH/EVR/CON
Tall Phanerophytes Evergreen / Non-Leafy Evergreen	TPH/EVR/NLE
Tall Phanerophytes Evergreen / Summer Deciduous	TPH/EVR/SUM
Tall Phanerophytes Coniferous / Non-Leafy Evergreen	TPH/CON/NLE
Tall Phanerophytes Coniferous / Summer Deciduous	TPH/CON/SUM
Forest Phanerophytes Winter Deciduous	FPH/DEC
Forest Phanerophytes Evergreen	FPH/EVR
Forest Phanerophytes Coniferous	FPH/CON
Forest Phanerophytes Summer Deciduous	FPH/SUM
Forest Phanerophytes Winter Deciduous / Evergreen	FPH/DEC/EVR
Forest Phanerophytes Winter Deciduous / Coniferous	FPH/DEC/CON
Forest Phanerophytes Evergreen / Coniferous	FPH/EVR/CON
Forest Phanerophytes Evergreen / Summer Deciduous	FPH/EVR/SUM
Forest Phanerophytes Coniferous/ Summer Deciduous	FPH/CON/SUM
Mega Forest Phanerophytes Deciduous	GPH/DEC
Mega Forest Phanerophytes Evergreen	GPH/EVR
Mega Forest Phanerophytes Conifer	GPH/CON
Mega Forest Phanerophytes Summer deciduous	GPH/SUM
Mega Forest Phanerophytes Winter Deciduous / Evergreen	GPH/DEC/EVR

TREES/SHRUBS	TRS
Mega Forest Phanerophytes Winter Deciduous / Coniferous	GPH/DEC/CON
Mega Forest Phanerophytes Evergreen / Coniferous	GPH/EVR/CON
Mega Forest Phanerophytes Evergreen /Summer Deciduous	GPH/EVR/SUM
Mega Forest Phanerophytes Conifer /Summer Deciduous	GPH/CON/SUM

If there are equal proportions of three LFs, the GHC is determined by the ranking as given above.

A further optional division is required for the MPH category in the Fynbos of South Africa and can be recorded as MPH1 for 0.6-1.2m and MPH2 for 1.2-2.0m. This division will nest into the MPH category. See Height categories in the global codes (see 3.4.8).

The following leaf subcategories, are designed to fit into world biome systems and apply to the six shrubs and tree categories with over 70% being a single category and 40-60% being combinations. They are discussed by Raunkiaer, although he was more concerned with the position of buds, whereas these classes are linked primarily to phenological status.

One problem with most world biome classifications is that the term broadleaved is often used and usually refers to both evergreen and deciduous trees/shrubs. Database management will therefore be needed if comparisons are to be made between biomes and the Life Form categories described in the present document.

In Israel and Africa spiny cushions are primarily the result of grazing. Cushions have been added as a qualifier because of their importance mainly outside Europe. In extreme desert environments some trees may not have leaves for several years and are therefore variably deciduous.

The groupings below are mandatory and are the major categories forming GHCs, as they are the lowest common denominators for classifying trees and shrubs.

- **Winter deciduous (DEC)**
  Fraxinus excelsior
  Ostrya angustifolia
  Quercus pubescens
  Ulmus minor
  Acer campestre
- **Evergreen (EVR)**
  Laurus nobilis
  Phoenix canariensis
  Quercus ilex
  Viburnum tinus
  Ilex aquifolium
- **Conifers (CON)**
  Cupressus sempervirens
  Abies alba
  Juniperus communis
  Pinus halepensis
  Taxus baccata
- **Non-leafy evergreen (NLE)**
  Sarothamnus scoparia
  Ulex europea

Some of these species have leaves which are short lasting.

Cytisus purgens
Retama retamoides
Sarothamnus scoparia
Spartium junceum
Ulex parviflorus

– **Summer deciduous (SUM)**
Acacia spp.
Euphorbia dendroides
Euphorbia spinosa
Xizyphus lotus

The following precedence rules apply to **TRS** categories:

– The height categories are mutually exclusive i.e. if FPH reaches 30% it cannot be combined with other height categories, because of the character of tree/shrub vegetation and because by introducing combinations there would be an unmanageable number of GHCs. This decision fits with other habitat classifications.
– **Where there are equal percentages of height categories then precedence is given to the tallest category with over 30% cover, because that expresses the environment optimally,** e.g. TPH 30%, MPH 30%, LPH 30%, SCH 10%, then the precedence is given to the tallest category: TPH.
– 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. MPH/DEC 30, MPH/EVR 30, MPH/NLE 20, LPH/CON 20 = MPH/DEC/EVR.
– **In cases of even balance within a given class,** e.g. TPH/DEC 30, TPH/EVR 30, MPH/CON 30, LPH/CON 10, then precedence is given to the ranking above i.e. TPH/DEC/EVR.
– These examples are designed to cover all eventualities, but in practice the majority of elements are not so complex. Also the GHCs are designed to link data sets and the full spectrum is anyway recorded in field 5. These data can be used for more detailed analysis of life forms and can also be linked to vegetation relevees which give complete spectra for samples.
– **Where there is much bare ground then the percentages are taken of the actual vegetation cover to determine the GHC. Strictly the percentages should be recalculated but in most cases the GHC is clear without extra notes.** For example, EAR 60, TPH/EVR 20, MPH/EVR 10, MPH/EVR 10 = TPH/EVR as it is over 30% of the vegetation cover.

3.4.6 Recording of Life Form Qualifiers

The **Life Form Qualifiers** can be used to further refine the GHCs so that post-processing can be carried out to see if there are consistent variations within a GHC category. They are included as qualifiers because otherwise the number of GHCs would become prohibitively large.

A full procedure for recording life form qualifiers still needs to be developed and tested in the field. E.g. the recording the species of vascular epiphytes.

For stem succulents and cacti the mean height of the stem should be used rather than the height of the buds. For fleshy leaved succulents the mean height of the leaves should be used which better reflect the actual structure of the vegetation. These last two rules differ from those elsewhere in the Manual, because of the inherent character in these groups.

A number of Life Forms can be added as an additional code to the GHCs in column 5. If no code is added it is assumed that the surveyor considered that the description of the GHCs is adequate to that the particular survey does not require the GHCs to be qualified. This information is entered on the Background Information Sheet. Many other life forms are quoted in the literature, but the present list includes the most widespread categories and excludes those such as base rosettes, which do not contribute additional information to the structure of the vegetation.
Examples of the following Life Form Qualifiers are given in here below.

3.4.6.1 Life Form Qualifiers applying to SPV categories

These codes are optional and concern taxa that live on the surface of these NLF habitats.

- **BRY:** Bryophytes, includes both mosses and liverworts
  Grimina maritima on the surface of the rock
  Racomitrium heterostichus
- **LIC:** Lichens
  Rhizocarpon geographicum
- **CYA:** Cyanophyta and algae growing as crusts on the soil or rock surfaces especially in deserts

These codes are the same as those indicated for Herbaceous but are linked to SPV codes which means that they can be analysed separately. In some situations e.g. the *Fynbos* the cover of these groups will cover the whole surface of the rock so is not strictly bare in absolute terms.

3.4.6.2 Life Form Qualifiers applying to the HER categories

Life Form Qualifiers applying to the SHY category

- **FLO**: Floating plants
  Lemna gibba
  Eichornia crassipes
- **LEA**: Plants with floating leaves
  Nymphaea alba
  Nuphar lutea

Such groups could also be derived from analysis of the species data from field 5.

Life Form Qualifiers applying to the CHE category

The following Life Form Qualifier is optional and can be applied to the CHE category.

- **TUS:** Tussock grasses over 60 cm typical of xeric conditions.
  Stipa gigantea
  Cortaderia selloana

Life Form Qualifiers applying to the CRY category

The optional Life Form Qualifiers given below are plants growing on the ground below or between other life forms. They apply to the CRY category and can be recorded optionally.

- **BRY:** mosses and liverworts.
  Pleurozium schreberi
  Marchantia polymorpha
- **LIC:** lichens.
  Cladonia rangiferina
  Peltigera canina

3.4.6.3 Life Form Qualifiers applying to TRS categories

- **SRO:** Stem Rosettes/caulinosulate are rosettes on the top of the stem. The latter may be with leaf bases consolidated into a stem-especially in Australia and South Africa e.g. *Xanthoria* spp and *Espalazia* spp. Tree ferns and palms also fall within this group.
  Xanthoria parietina
  Phoenix dactylifera
- **CUS:** Cushions. These are distinctive tight cushions of xeric conditions. Plants from mesic situations e.g. *Ulex gallii* which coincidentally have a cushion type form are excluded as are plants which have been heavily grazed.
  Fredolia acricoides
  Astagulus tragantha
- **CAC:** Swollen stems-cacti and succulents are plants with swollen stems with maybe a few residual leaves or leaf scales.
  Opuntia vulgaris
  Carnegiea gigantean
- **BAM:** Bamboos and canes are herbaceous plants with buds above ground level and evergreen leaves.
  Arundo donax
  Bambusa vulgaris
- **BUT:** Trees with butress trunks. Applies to FPH and GPH.
  Ceiba pentandra
  Huberodendron duckei
- **CAU:** Tree with stem fruits. Applies to FPH and GPH.
  Cercis seliquatrum
  Theobroma cacao

The following additional optional leaf qualifiers are given below:

- **EVR/SMA:** Small leaved (length less than 2cm).
  Quercus ilex
  Erica tectralix
- **EVR/LAR:** large leaved (over 2cm).
  Laurus nobilis
  Ilex aquifolium
- **EVR/FLE:** fleshy leaved but excluding marginally fleshy leaves on genera.
  Agave americana
  Aloe vera
- **CON/LOS:** lose needles in winter i.e. winter deciduous.
  Larix decidua
  Taxodium mucronatum

Epiphytes, lianes and creepers

These are optional Life Forms. They are present locally in Europe e.g. in forests with high humidity or riparian woodlands. Elsewhere in the world e.g. tropical and temperate rain forests they are omnipresent and define the character of the forest. Note that the same codes are used for bryophytes and lichens as in SPV and HER; they will in this case be linked to trees on the recording form.

- **BRY:** Bryophytes and liverworts.
  Frullania tamarisci
  Isothecium myosuroides
- **LIC:** Lichens foliose only.
  Lobaria pulmonaria
  Usnea longissima

- **VAS:** Vascular plants, plants which grow beneath the canopy.
  Orchis spp
  Phalaenopsis amabilis
  Polypodium vulgare
- **LIA:** Lianes, plants which use trees/shrubs for support but are not attached.
  Smilex aspera
  Humulus lupulus
- **CRE:** Creepers and stranglers, plants which attach themselves to trees/shrubs rather than just using them as support.
  Hedera helix
  Ficus virginiana
- **PAR:** Parasites, plants which depend on trees/ shrubs for nutrients e.g. *Viscum album.*
  Viscum album
  Buckleya distichophylla

This group will grow mainly on forest trees (FPH or GPH) or occasionally on tall scrub (TPH) or mid scrub MPH. The percentage cover on the trees should be recorded as shown in Table 2. Whilst many of these species could be derived from database management of detailed species records their occurrence throughout an element would not be available.

Table 2

Example of recording Life Form Qualifiers. The alpha codes C and D did not need Life Form Qualifiers and the GHC alone is adequate.

Alpha code	GHC	Life Form Qualifier	%	Species	%
A	CHE	CHE/TUS	70	Sti pen	100
		CHE	10	Ave pra	90
		SCH/EVR/SMA	20	Hal umb	10
B	MPH/EVR	MPH/EVR/CAC	100	Opu vul	100
C	MPH/DEC	0	100	Bet odo	100
D	FPH/DEC	0	100	Cas sat	100
E	FPH/EVR	FPH/EVR/SMA	80	Que ile	100
		FPH/EVR/LAR	20	Lau nob	100

3.4.7 Field two: Environmental Qualifiers

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

Environmental Qualifiers include indicators for humidity and acidity. Indication from the right category can be determined by means of the substrate identification, direct measuring, Ellenberg values or indicative species. It is essential to note that local use of terms, especially dry, may differ from a European standard. For European projects the European standards should be used for a correct analysis.

3.4.7.1 Moisture regimes

The categories below are based on the Concerted Action 'Water regimes for forest productivity' (Pyatt, 1999) except for the semi-desert and desert categories. The figures are based on Bruelheide et al. (2009), but further literature research and local knowledge is required to provide more details.

The pF values are added for regional calibration of the used terms.

- **Aquatic** covered in water over 70% of the time. e.g. *Nuphar lutea*, *Sagittaria sagittifolia, Zostera* spp.
- **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. (pF 1.7 during over 50% of the time). Peat lands or fenlands in the North, in the edges of water bodies in Central and Southern Europe e.g. *Potentilla palustris*, *Eriophorum angustifolum*, *Narthecium ossifragum*.
- **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 panicea*, *Scirpus sylvaticus*.
- **Seasonally wet**: water table variable at the surface and waterlogged for the winter months or spring flooding season, becoming wet or mesic (categories 3 and 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 australis, Phalaris arundinacea* and *Bidens tripartita.*
- **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*).
- **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 the very dry category.
- **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.
- **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 year. Also here the balance of species must be considered and not one individual. In Europe xeric soils are common in the Mediterranean south zone but the next category is restricted to two areas in southern Spain and Greece, although wider presence in Israel and North Africa.
- **Semi-desert**: water table <200 cm and not detectable outside the distinct rain season. There is usually less than 10-30% vegetation cover and with very little organic matter incorporated into the soil profile. The rainfall is 200-300 mm, erratic but relatively regular.
- **Desert:** water table <400 cm and not simply detectable except for occasional rain events. The vegetation cover is less than 10% and restricted to linear features where there is concentration of water. There is no organic matter present in the profile. The rainfall is below 200 mm and may not occur for several years.

3.4.7.2 Other environmental conditions: Ellenberg Values

In 1974 the first version of Ellenberg's Zeigerwerte has been published (Ellenberg et al., 1992). This contains environmental indicators for Central Europe based on indicator plant species; they can be searched on the internet (http://statedv.boku.ac.at/zeigerwerte/). Ellenberg values have also been recalibrated for Great Britain; also these are available on the web (www.ceh.ac.uk). Ellenberg figures have also been calculated by Pignatti for the Italian flora and published in Braun-Blanquetia (Pignatti et al., 2005; Schwabe et al., 2007). A table with the Italian species is available on the EBONE website (www.ebone.wur.nl) as well as an explanatory text.

Some species change their ecological behaviour in different climate regimes. For many regions Ellenberg values are not available, so local experience of the ecological amplitude of species is needed, especially in the Mediterranean.

The following guidelines can be given:

- *Eutrophy*: Ellenberg Fertility 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.
- *Acidity (acid-neutral-basic)*: The Ellenberg acidity value can be assessed based on 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.

- Other ways to determine acidity are:
  a. 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.
  b. In watercourses and lakes (i.e. GHC = AQU) the nutrient level can be determined 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.
  c. Landscape context - whilst not definitive, landscape features gradients along slopes such as surrounding vegetation, flush lines and outcrops of acid rock can be useful.
  d. 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.
- *Salinity*: 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 but are often associated with saline conditions. A problem remains where slainisation has taken place due to irrigation, but as yet no halophytes are present. A management qualifier has been added to include this feature. 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*. Because Ellenberg values are not be available for most of the biomes we have taken levels of salinity from the soil map of Israel are as follows:
  a. **Low:** Below 0-45 units of salt slight to moderately saline
  b. **Medium:** 0.45-0.8 units of salt highly saline
  c. **High:** Over 0.8 units of salt very highly saline

3.4.7.3 Determination of Environmental Qualifiers

All the above classes must be determined by the balance of species and their abundance. The majority of environmental qualifiers is unlikely to change quickly over time, so that when monitoring 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 below).

The matrix shown in Table 3 is the means of recording the environmental qualifier linked to a mapped element. The matrix consists of two primary axes, which largely determine vegetation composition i.e. humidity and nutrient content. The eutrophic row overrides the other nutrient levels.

Table 3

Matrix and unique coding of Environmental Qualifiers. In general, acid is below pH 4.8; neutral is between pH 4.8 and 6.0; basic is over pH 6.0.

	Ellenberg values	Aquatic	Water-logged	Seasonally wet	Wet	Mesic	Dry	Very Dry	Xeric	Semi desert	Desert
Eutrophic	F > 7	1.1	2.1	3.1	4.1	5.1	6.1	7.1	8.1	9.1	10.1
Acid		1.2	2.2	3.2	4.2	5.2	6.2	7.2	8.2	9.2	10.2
Neutral		1.3	2.3	3.3	4.3	5.3	6.3	7.3	8.3	9.3	10.3
Basic		1.4	2.4	3.4	4.4	5.4	6.4	7.4	8.4	9.4	10.4
Saline low		1.5	2.5	3.5	4.5	5.5	6.5	7.5	8.5	9.5	10.5
Saline medium		1.6	2.6	3.6	4.6	5.6	6.6	7.6	8.6	9.6	10.6
Saline high		1.7	2.7	3.7	4.7	5.7	6.7	7.7	8.7	9.7	10.7

The numbers in the matrix can be applied to all GHCs. Definitions of all categories are provided in this monitoring Manual. **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.

Not all cells may apply to 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. Especially 10.1 is a theoretical value because there is virtually no organic matter in a desert. Nutrient levels should only be attached to aquatic elements if there is evidence from indicators e.g. halophytic species.

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

3.4.8 Field two: Global codes

Global qualifiers are to be recorded in the second field together with environmental qualifiers. Global qualifiers refer to the setting of an element (height or scattered trees) or to the accessibility of the element or reference previous data (data missing). Global qualifiers are optional and only have to be recorded when it is thought to be significant, such as in the case of tree cover less than 10%.

3.4.8.1 Absence of data codes

-1: Not included in survey. The field has been excluded from a given survey, for example, in field eight, phytosociological units 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 forgotten i.e. if there is no qualifier to record.

-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. -9 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.

3.4.8.2 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.

3.4.8.3 Height and width codes

These codes are to be applied to linear elements and to define the height of rocks and screes that may have a small area, but appreciable height. Cliffs and rock outcrops over 0.5 m high must have height global codes added. The global code 'HIG' plus the appropriate qualifier has to be used to record their height. For linear elements only the first two categories are used.

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

These scaling codes are combined with the Code HIG or WID

HIG: Height - applies to the height of the element above the average ground surface.

WID: Width - applies to the width of the element.

3.4.8.4 Other general 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 GHCs 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 in lake.

INA: Inaccessible, whether because of ownership or high altitude valleys.

COM: Many small patches of a given different GHC or different management status within an element of a single GHC.

Other TRS codes. Individual or clumps of trees/shrubs should be coded as points (see 3.14 for guidance of mapping point elements):

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

OPE: trees/shrubs 1-10% cover (e.g. *Dehesas, Montados* or parkland).

The appropriate GHCs should follow these codes. If the cover of trees/shrubs is over 10% but below 30%, then it is included in field five.

Where the vegetation cover is below 10% - mainly in deserts - then the percentage cover is the actual cover present. See section 3.6 and 4.1.3.

3.4.9 Field three: Site Qualifiers

The Site Qualifiers (Table 4 and 5) are to be entered into the third field of the habitat recording sheets for areal and for linear elements to record characteristics of geomorphology, archaeology and life form complexity of elements, in order to express variations in these between elements that have the same primary code. Part of the definitions are provisional and need to be carefully researched further for pan-European application.

In the original Field Manual geological and soil qualifiers were included. However, experience in the Quality Control has emphasised that both these attributes do not have a common European interpretation yet. They have therefore been excluded from the present Manual although regional surveys have the option for including local classifications. It should be emphasised that the lists are provisional and can be converted into a list suitable for a particular project and additional codes added or left out as required.

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.

Habitat complex site qualifiers are for use with elements that are widely recognisable and comprise a mosaic of patches of several GHCs of which the extent might be less than 400 m^2. 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 GHCs that occupy >30% of the element must also be recorded in the first field.

The definition of 'coastal' is that either there is a change in LF 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 separates forests 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.

Further categories can be added for a given survey, but remember that unique codes should be checked by a central system.

For both site and management qualifiers it is useful to have a laminated sheet of all codes for reference in the field.

Table 4

Site Qualifiers and code names.

Qualifier name	Code	Description
Geomorphological element	**1**	
Cliff	1.1	Vertical or near vertical area of rock
Rock outcrop	1.2	Isolated elements of rock emergent from surrounding vegetation
Scree	1.3	More or less unstable loose or shattered rock on slopes
Moraine	1.4	Glacial deposits of boulders, rocks and tile
Esker	1.5	Long winded ridges of glacial origin
Drumlin	1.6	Rounded or elliptical moraines
Roche mouton	1.7	Ice eroded rounded rock outcrops
Kame terrace	1.8	Isolated or clustered mounds, derived from glacial outwash
Solifluction terrace	1.9	Terraces formed by trees/thaw
Splintered and shattered rock field	1.10	Invariably on mountain summits or in the arctic
Fjell field	1.11	Characteristic of high mountains in Scandinavia
Frost sorted stones/rocks	1.12	Evidence of frost sorting but not in patterns
Stones/rocks sorted into polygons or stripe	1.13	Distinct patterns of sorted rocks
Rock pavement	1.14	Rock pavements with over 30% vegetation cover
Bare rock pavement	1.15	Usually of limestone but occasionally other rocks under 30% of vegetation cover
Raised beach	1.16	Evidence of former beach line above high water mark
Peat hag	1.17	Includes any bare or eroding peat which is not vegetated and should be qualified by a percentage cover code
Soil erosion	1.18	Includes both human and natural erosion
Avalanche track	1.19	Self-explaining
Snow patch	1.20	Snow field
Glacier	1.21	Ice with some rock debris
Rock glacier	1.22	Glaciers covered by rock debris
Recent volcanic	1.23	Evidence of recent volcanic activity with ash and lava
Inactive volcanic	1.24	Old craters or calderas
Dune	1.25	
Canyon/gorge	1.26	Narrow rock valley
Wadi (“arroyo”)	1.27	Intermittent 1-2m
Earth Pillar	1.28	Caused by erosion of soft material
Inland water	**2**	
Evidence of previous water cover	2.1	Evidence from flotsam and jetsam plus bare ground
Temporary running water	2.2	Evidence of previous running water
Films of water	2.3	Water running on the surface – usually over rocks
Spring	2.4	Point feature of emergent water
Flush	2.5	Lines of water flow not forming streams – wetland vegetation indicators present

Qualifier name	Code	Description
Water course, running, non-tidal fast	2.6	River with water running over 10 m/s
Water course, running non-tidal slow	2.7	River with water running under 10 m/s
Water course, standing water	2.8	Linear feature with standing water
Canal	2.9	Waterways constructed for boat traffic
Irrigation canal	2.10	Constructed watercourse for irrigation
Canalised river	2.11	Rivers which have been modified (e.g. sections straightened, banks smoothed), but still follow the same direction as the natural watercourse
Tidal river	2.12	River influenced by tidal movement
Dry river bed	2.13	Temporary river bed usually with bare ground and signs of water flow
Dry ditch	2.14	Ditch more than 0.5 m deep with no water
Free standing water	2.15	Temporary standing water. Only record if evidence available.
Lake - natural	2.16	Inland water body over 400 m^2.
Lake - artificial	2.17	Usually distinguished by the presence of a dam or embankment
Lake - temporary	2.18	Turlough
Pond - natural	2.19	Below 400 m^2 record as point
Pond - artificial	2.20	Below 400 m^2 record as point
Pond - temporary	2.21	
Bog pools	2.22	
Bog pools - temporary	2.23	
Salt marsh pools	2.24	
Discontinuous streams	2.25	
Discontinuous streams - temporary	2.26	
Historical/archaeological element	**3**	
Barrow/burial mound	3.1	Burial mounds from prehistoric times
Ruin	3.2	Ruined buildings of archaeological interest
Marl pit	3.3	Pits for extraction of marl which is formed by a deposit of calcareous algae often filled with water
Cairn/Dolmen	3.4	Structures of rock from prehistoric times
Bank and ditch	3.5	Medieval structures around woods or boundaries
Hut circle	3.6	Remaining walls of prehistoric sites
Stone heap	3.7	Heaps of stone in fields from former agriculture
Castle/fortress	3.8	Self-explaining
Archaeological wall	3.9	Walls of archaeological interest
Ridge and furrow	3.10	Lines of old tilled land in W. Scotland
Aquaduct	3.11	Old (usually Roman) facility for transport of water made of stone
Sea/Marine element	**4**	
Submerged angiosperms	4.1	Cover of species such as *Posidonia*
Shipwreck	4.2	Self-explaining
Mussel bank	4.3	Habitat of mussel population
Sea weed bed	4.4	Cover of red, green and brown algae
Rock pool	4.5	Depression in rocks with remaining sea water in low tidal situations
Wave cut platform	4.6	Relatively level areas formed from wave action
Cultivated mussels/oysters	4.7	Lines of mussels/oysters in sea/tidal
Fish farm	4.8	Fish farm in sea/tidal
Tidal element	4.9	Vegetation or TER codes covered by tidal movement
Coastal elements	**5**	
Yellow dune/white dunes	5.1	Young dune, highly mobile sand
Grey dune	5.2	Mature dune, podzolised, with acidic indicators
Dune slack	5.3	Wetlands in or behind the dunes
Salt marsh	5.4	Coastal wetland with saline soils
Strand line	5.5	Vegetation zone between dune or cliff and the sea

Qualifier name	Code	Description
Maritime exposure	5.6	Vegetation affected by coastal winds but no halophytes
Bogs/mires/wetlands	**6**	
Palsa mire	6.1	Mires with frozen elements and pools
Aapa mire	6.2	Mires with frozen elements
Raised bog	6.3	Bogs with characteristic structure
Blanket bog	6.4	Bogs covering often a high proportion of the land surface, rain fed
Valley mire	6.5	Mires formed by high valley water levels
Poor fen	6.6	Nutrient poor wet organic soils, many sedges
Transition mire	6.7	Mires characteristic of continental regions
Fen	6.8	Nutrient rich, wet, organic soils, mixed vegetation
Reed beds	6.9	Element dominated by tall helophyte graminoids usually on the borders of lakes and rivers or because of high ground water levels
Wet heath	6.10	Acid soils, usually with dwarf shrubs/sedges
Snow patch vegetation	6.11	Vegetation often with DCH prominent but evidence of limits to snow line
Element with woodland or sparse trees	**7**	
Taiga	7.1	Open acid woodlands of Boreal/Nemoral regions
Riparian	7.2	Riverside woodlands
Gallery	7.3	Narrow forest strip beside a watercourse
Swamp woodland	7.4	Forest over helophyte vegetation
Bog woodland	7.5	Forest growing over acid bogs
Additional habitat complexes	**8**	
Terrace	8.1	Excavated level areas of land with retaining walls
Group of non-mappable terraces	8.2	Parcels with terraces that are less than 5m apart that cannot be mapped individually

Table 5

Site Qualifier codes for linear elements

Qualifier name	Code	Description for use of this qualifier
Related to water(ways)	**9**	
Watercourse	9.1	Only use if not covered by global codes
Gully	9.2	Erosion feature covered by water
Levee	9.3	Natural raised river bank
Dyke	9.4	Artificial raised river bank
Paths and tracks	**10**	
Bicycle path	10.1	Evidence of use by bicycles only - not recorded along roads
Walking footpath	10.2	Evidence of use by people
Horse (Bridle way)	10.3	Evidence of use by horses
Tarmac	10.4	Metalled/tarmac surfaces
Constructed track	10.5	Track without tarmac but hardcore material brought in
Unconstructed track	10.6	Track with no external material brought in from outside
Tractor track	10.7	Tractor tyre ruts only
Excavated track - road vegetated	10.8	Track with excavated margins covered with vegetation
Excavated track - road sparsely vegetated	10.9	Track with excavated margins - vegetation cover less than 30%
Road and track - Sunken road	10.10	Traditional road excavated below general ground level
Road and track - Green lane	10.11	Sunken lane covered with vegetation

Qualifier name	Code	Description for use of this qualifier
Walls	**11**	
Wall - Dry stone	11.1	Wall constructed with no additional material other than rock
Wall - Mortared	11.2	Walls held together with mortar
Retaining wall - Earth	11.3	Usually a terrace wall
Retaining wall - Rock	11.4	Usually a roadside, terrace wall or dam with over 30% rock
Wall with gaps	11.5	Walls with over 30% gaps
Fences	**12**	
Fence - Wood only	12.1	Fence of wood only
Fence - Iron only	12.2	Fence of iron posts/rails
Fence - Wire on posts	12.3	Fence with wire attached to wood posts
Fence - Wire with gaps	12.4	Fence with over 30% gaps
Fence - Wire on metal posts	12.5	Fence with wire attached to metal posts
Hedges	**13**	
Hedge - Trimmed hedge	13.1	Line of scrub below 5m with signs of regular management
Hedge - Austrian hedge	13.2	Hedge of trees with understory
Hedge - Stock proof	13.3	Hedge able to retain stock
Hedge - Not stock proof	13.4	Hedge with over 30% gaps
Hedge - Recently planted	13.5	Hedge planted in the last five years
Hedge - Uncut	13.6	No evidence of cutting in the last five years
Hedge - Derelict	13.7	No evidence of cutting and trees in poor condition
Hedge - Relict	13.8	Only isolated shrubs/trees remaining
Hedge - Laying	13.9	Traditional management by laying of single stems
Hedge - Coppiced	13.10	Cut at the base in the last five years
Hedge - Flailed	13.11	Cut with mechanical flail - much debris at base

3.4.10 Field four: Management Qualifiers

The Management Qualifiers are organised in several levels, the first level (Table 6) being the time of the management, the second level (Table 7) are the general categories where management is taking place, e.g. forest or urban, and the third level is a more specific management activity. In some cases the third level is specified in a fourth level. This structure will be implemented in the Field Computer after the field season 2010. It can be useful to add more guidance to these qualifiers in a given survey. Also additional regional qualifiers can be added.

Table 6

Management code names for level 1.

Code	Definition for agriculture and semi-natural vegetation	Definition for forestry
A	Active - Now	Just planted
B	Recent - Less than three years	Newly planted - Less than three years
C	Neglected - No evidence of management for three to ten years	Young plantation - Three to ten years old - 3 to 15 cm diameter
D	Abandoned - Ten to 50 years, colonisation by shrubs	Mature plantation - Ten to 50 years - 16 to 40 cm diameter
E	Ancient - Evidence of former use (50 to 150 years)	Old forest - 50 to 150 years - 41 to 75 cm diameter
F	No Management - No evidence of any management	Ancient forest- >150 years old - over 75 cm diameter

Table 7

Management code names for level 2 and 3.

Qualifier name level 2	Code	Qualifier name level 3	Code	Qualifier level 3 definition
Agricultural	1	Annual Crops	1.1	Indicated the crop name (see table below)
		Apiculture	1.2	Evidence of bees hives
		Controlled Burning	1.3	Usually burning of grassland in spring
		Fallow	1.4	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.
		Farmyard Manure	1.5	Farm yard manure heaps/evidence of slurry spreading (tanks/slurry pigs in farm yards)
		Liquid slurry	1.6	Liquid material pumped from storage tanks of dairy farms
		Grazed	1.7	Indicated grazing animal (see table below)
		Harrowed	1.8	Land disturbed by harrowing to create a till for sowing
		Hay Cut	1.9	Evidence of grass cut and dried for hay
		Irrigation	1.10	Canals, small ditches linked to channels, large irrigation schemes
		Mown	1.11	Recently cut grassland with no evidence of either hay-making or silage
		Multiple Systems	1.12	
		Permanent Crops	1.13	Indicate the cultivation (see table below)
		Ploughed	1.14	Bare ground caused by ploughing or cultivation by harrow or rotovators
		Sillage Cut	1.15	Evidence of silage essential e.g. big bales/silage pits
		Large terraces	1.16	Terraces over 400 m2
		Small terraces	1.17	Collections of small terraces below 400m2
		Ridge and Furrow	1.18	Evidence of ancient cultivation patterns
		Chaffed	1.19	
		Bags of silage	1.20	Big bags of silage in heaps or separate
		Salinisation	1.21	Bare fields with no crops and evidence of previous irrigation
Semi-natural	2	Apiculture	2.1	Evidence of bees hives
		Controlled burning	2.2	Usually of heath land
		Ploughing	2.3	Ploughing for game management or fire protection
		Field Margins	2.4	Conservation field margins
		Hunting	2.5	Cartridges
		Intermittent Grazing	2.6	Self-explaining
		Regular Grazing	2.7	Self-explaining
		Scrub clearence	2.8	By mowing to encourage young growth of heath land
		Peat Working	2.9	Extraction of peat for local use
		Cañada	2.10	Drove roads
		Abandoned orchard	2.11	Use with age code
		Abandoned vineyard	2.12	Use with age code
		Abandoned olive grove	2.13	Use with age code
		Abandoned WOC	2.14	Use with age code
		Mowing	2.15	Recently cut grassland with no evidence of either hay-making or silage
		Unmanaged grass	2.16	E.g. motorway verges
Forestry	3	Charcoal	3.1	Evidence of charcoal burning
		Clear-Cut	3.2	Applies to points, lines or areas
		Controlled Burning	3.3	Usually of under shrubs in the Mediterranean
		Coppicing	3.4	Cutting to the stump recognised by multiple stems in the

Qualifier name level 2	Code	Qualifier name level 3	Code	Qualifier level 3 definition
				last 20 years
		Conservation Management	3.5	Evidence of ownership/management by conservation agencies
		Dead wood/trees	3.6	Stems over 5m and 10cm diameter
		Animal Grazing	3.7	Grazing by domestic stock
		Group selection	3.8	Removal of selected individual trees
		Planting Exotic	3.9	Plantation of species of local provenance
		Planting Native	3.10	Plantation of species of non-local origin
		Ploughing/Drainage	3.11	Evidence from ditches and plough lines
		Pruning	3.12	Selective removal of branches to develop tree growth within the last ten years
		Scrub clearence	3.13	Removal of trees under 5m either beneath or between forest canopies
		Thinning	3.14	Removal of young trees to leave fewer individuals
		Underplanted	3.15	Planting of young trees beneath adult trees
		Shredding	3.16	Cutting of branches back from trunks to feed animals in the last ten years
		Pollards	3.17	Regular cutting of branches over 3m above ground level in the last ten years
		Failed plantation	3.18	Over 50% of planted trees dead
		Mowing	3.19	Mowing for fire control
		Ploughing	3.20	Ploughing for fire control
		Fire break	3.21	Area within the forest without trees to prevent fire spreading
		Ride	3.22	Linear area in forest for access or fire break
		Extraction route	3.23	Route within the forest which is used to take out timber
		Succession	3.24	Process of forest establishment over time with a sequence of tree species e.g. *Picea abies* under *Betula* spp.
		Windblown tree(s)	3.25	Groups of trees blown over by wind
Recreational	4	Beach Facilities	4.1	Umbrellas and sun shades
		Boating Area	4.2	Open water used for storing sailing and rowing boats
		Fishing	4.3	Evidence on banks of fishing sites
		Game management	4.4	Pheasanr pens and annual plantings
		Golf course	4.5	Self-explaining
		Horse	4.6	Self-explaining
		Hunting	4.7	Cartridges
		Motor sport	4.8	Self-explaining
		Occasional Camp site	4.9	Self-explaining
		Other Sport	4.10	Self-explaining
		Permanent Camp site	4.11	Camp site mainly for tents
		Picnic area	4.12	Self-explaining
		Playing field	4.13	e.g. football field
		Shooting range	4.14	Self-explaining
		Trampling	4.15	Evidence of severe trampling, not just a few foot prints
Urban	5	Agricultural	5.1	Buildings used for agricultural purposes including the farmhouse if occupied by a farmer or farm worker
		Airport	5.2	Area used for landing taxiing and parking aeroplanes
		Commercial	5.3	Buildings for selling things, shops, garages, hotels, pubs, commercial offices
		Educational/Cultural	5.4	Includes schools, establishments of further education, museums, theatres and cinemas
		Fish Farm	5.5	Area confined for growing fish
		Ground Levelling	5.6	Leveling of land usually for building, but occasional for agricultural improvement

Qualifier name level 2	Code	Qualifier name level 3	Code	Qualifier level 3 definition
		Horticulture	5.7	Includes glass houses and polytunnels in both open country side and garden centres, but not small green houses attached to residential houses
		Industrial	5.8	Used for the manufacture of goods and includes warehouses, workshops and associated buildings.
		Institutional	5.9	Buildings for public or private institutions, such as old people's homes, local government, central government buildings, prisons, research stations.
		Moutain refuge	5.10	Self-explaining
		Opencast mine	5.11	Open area for coal or lignite coal mined
		Port	5.12	Harbour area for commercial purposes
		Quarry	5.13	Area excavated for rocks e.g. marble, granites
		Railway	5.14	Self-explaining
		Recreational	5.15	Self-explaining
		Religious	5.16	Places of worship, churches, mosques, synagogues and monasteries and their cartilages e.g. graveyards, cemeteries
		Residential	5.17	Houses used for permanent accomodation
		Road	5.18	Include verges of the road
		Sand pit, gravel pit	5.19	Area excavated for gravel or sand; may contain water or be dry
		Spoil hips	5.20	Mine tips
		Track	5.21	Includes verges of the track
		Waste-Domestic	5.22	Deposition localities for domestic waste
		Waste-Industrial	5.23	Deposition localities for industrial waste
		Derelict land	5.24	Land no longer used in urban context
		Designated for building	5.25	Land with evidence of waiting new bulding construction
		Derelict building	5.26	Building with no evidence of management – use age code
		Demolished building/structure	5.27	Builing or structure that has been actively destroyed
		Holiday houses	5.28	Both wooden and constructed houses for holiday use only - often scattered in semi-natural vegetation
Inland Water	6	Artificial Water body	6.1	
		Dams	6.2	Self-explaining
		Canal	6.3	Self-explaining
		Irrigation Canal	6.4	Self-explaining
		Digues	6.5	Self-explaining

Table 8

Specifications of crops and grazing animals (level 4).

Annual crops (management codes 1.1, 1.16, 1.17)		
Wheat (Triticum aestivum and associated species)	1	Wheat plants have broad, glaucous leaves with auricles, sometimes with awns
Barley (Hordeum sativum)	2	Barley has dull green leaves and auricles
Oats (Avena sativa)	3	Oat plants have broad soft glaucous leaves with no auricles
Rye (Secale cereale)	4	Tall cereal with long awns
Triticale (Hybrids between wheat and rye)	5	Grown as fodder crop - rare
Rice (Orysa sativa)	6	Self-explaining
Sugar beet (Beta maritima)	7	Excludes the wild species
Fodder crops (e.g. Brassica oleracea)	8	Crops grown for animal feed, excluding maize and other gramineae

Annual crops (management codes 1.1, 1.16, 1.17)

Potato (Solanum tuberosum)	9	Self-explaining
Field bean (Vicia faba)	10	Self-explaining
Peas (all types) (e.g. Pisum sativum, Cicer arientinum)	11	Self-explaining
Maize (Zea mays)	12	Includes Fodder maize
Oilseed rape (Brassica hybrid)	13	Self-explaining
Sunflower (Helianthus annuus)	14	Self-explaining
Flowers	15	Self-explaining, e.g. Gladioli and daffodils
Commercial horticulture	16	E.g. strawberries, salad crops
Cover crop	17	Ploughed in later for soil improvement
Forage crop	18	For animal feed. E.g. turnip and cabbages

Permanent crops (management codes 1.12, 1.13, 1.16, 1.17)

Vines (Vitis vinifera)	31	Applies to lines and areas
Olives (Olea europea)	32	Only cultivated - excludes wild trees
Cherries (Prunus spp.)	33	Excludes *Prunus avium* and other wild species
Apples (Malus spp.)	34	Excludes *Malus sylvestris*
Pears (Pyrus spp.)	35	Only cultivated - exclude wild species
Walnuts (Juglans spp.)	36	Only cultivated trees
Citrus fruit (Citrus spp.)	37	Self-explaining
Hazelnuts (Corylus avellana)	38	Only orchards or individual cultivated trees - exclude semi-natural stands
Almonds (Prunus amygdalus)	39	Self-explaining
Prickly pear (Opuntia spp)	40	Self-explaining
Pistacio nuts (Pistacia sativa)	41	Self-explaining
Apricots (Prunus amygdalus)	42	Self-explaining
Peaches/Nectarines (Prunus persica)	43	Self-explaining
Medicago arborea	44	Fodder crop in Africa

Domestic grazing animals (1.6, 2.7 and 3.8)		**Wild grazing animals (2.6, 2.7, 3.8)**	
Buffalo	1	Moose	31
Bulls	2	Munjack	32
Camel	3	Porcupine	33
Chicken	4	Rabbit	34
Cow general	5	Red deer	35
Cow beef	6	Reindeer	36
Cow dairy	7	Rodents	37
Donkey	8	Roe deer	38
Field pig	9	Swans/geese/wildfowl	39
Free range pig	10	Wild boar	40
Geese/Duck	11	Zebras	41
Goat	12	Elephant	42
Horses	13	Antilopes	43
Lamas	14	Bison/wisent	44
Mules	15	Wild horses	45
Ostrich	16	Wild cattle	46
Red Deer	17		
Sheep	18		
Bison	19		

3.4.11 Field five: Full list of habitats

3.4.11.1 Detailed life forms

In order to enable further analysis all LF and NLF categories present in a given element with a cover of over 10% are recorded in Field five. These data can subsequently be analysed by multivariate analysis to determine gradients at the regional level. In addition species present with significant cover in a given Life Form are also recorded in field five as shown in Chapter 5. Note that the proportions of life forms in Field five should add to 100%, see Table 9. In case of complex elements the GHC composition summarises the mixtures of LFs and the full details of the spectra of a given element are recorded in Field five. The GHCs therefore reflect the dominant LFs.

RULES

Each LF/NLF with a cover of >10% will be recorded in column five.
The total % of the LF/NLF should add up to 100% with exception of vegetation layers in forests. The percentage of all GHCs can be recorded for each layer of vegetation regardless of what the GHC is under where the % for all the layers together will probably be over 100%. (See Table 9). For the species in Field five the percentage cover within the LF/NLF is given
In desert categories also Life Forms below 10% will be recorded as actual percentages.

Table 9

Elaboration of column 5 for different GHCs. The qualifiers are not included in this table. Note that in this table only Life Forms are included but the same applies to categories such as urban and the divisions of Sparsely Vegetated.

Code	Field 1	Field 5			
α	General Habitat Category	Life form/Species			
		Life form	%	Species	%
A	FPH/DEC/CON	FPH/DEC	60	Que pub	80
		FPH/CON	40	Pic abi	100
B	FPH/DEC/EVR	FPH/DEC	40	Que pyr	100
		FPH/EVR	30	Que ile	40
				Que sub	30
		FPH/CON	30	Pin pin	100
C	FPH/CON	FPH/CON	70	Pic abi	100
		FPH/DEC	30	Que rob	60
				Fag syl	40

It is recognised that in many cases the vegetation layers will not be discrete but the objective is to separate complex forests from those which have a simple structure because of the significance of this difference for biodiversity.

If layers are recorded then this will be done from the whole element and regardless of their spatial arrangement and the total cover for the whole element will usually be over 100%. The understory layer may not all be below the canopy, but also between the trees, as in the above example. Note that leaf litter is not a stratum.

If there are several low percentage covers then decide which has the highest cover and record that. It is recognised that low covers will not be adequately represented but these can be derived from the vegetation plots if required. 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. If there is over 70% cover of the LF by one species, just the one species is to be recorded. If more species have a cover over 30% then

other species should be recorded. If no species reaches 30% then the two species with the highest cover should be recorded. (see worked examples in Chapter 5).

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

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

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

For crop types the codes are used (Table 8). 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 maritima* (sugar beet).

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. For instance *Pinus pinaster* and *Pinus pinea* should be distinguished as 'Pin pin' and 'Pin pi1. Cryptogams should be separated into percentage bryophyte and lichen cover.

The percentage cover of recorded species within each LF or non life form habitat should be recorded in the fourth column of Field five. The % cover of the species should be given in each LF, i.e. **the percentages are of the LF, not of the whole element.**

3.4.11.2 List of species

For habitat mapping detailed knowledge of species is not needed. However a short targeted list of common species for the survey area can be helpful when recording species in Field five and it is therefore recommended. In the field computers list of species are made available for each region/country through the SynBioSys database (www.synbiosys.alterra.nl/synbiosyseu/)

3.4.12 Field six: Habitat and Species Directive, Annex I habitats

This field is to be used for recording the Annex I habitats of the Habitats Directive. There is a direct link between these habitats and the CORINE Biotopes and Palaearctic classification.

Within EBONE a rule based key to Annex I habitats has been produced using GHCs to provide a hierarchical key. The Key is available as EBONE Deliverable 4.2 through www.ebone.wur.nl. Annex I of the EU Habitats and Species Directive is available at http://ec.europa.eu/environment/nature/legislation/habitatsdirective/index_en.htm

The key is available for field computers and will lead the surveyor to an individual class, which can then be checked with the full descriptions within Annex I. Apart from the more usually recogised habitats, there are 46 landscape units and habitat complexes, which contain at least three GHCs. It is necessary to treat these separately as they often contain other habitats within the landscape. It is recommended that surveyors familiarise themselves with these categories so that they know, when dual mapping is likely to be required-although the key does not assume this to be the case. Checks with a local expert are also often helpful.

Many intensively managed sites will not contain any Annex I habitats. Often only a GHC will be recorded. On the other hand, many upland areas will have several because of the bias towards semi-natural vegetation in the selection of Annex I habitats. With the expansion of the European Union the member states have interpreted the descriptions in the Interpretation Manual rather widely, so that not all combinations of GHCs within a given landscape are included in the key. Hence the Key is described as an expert system, particularly as it is seen as a live document that will gradually include local expertise and further detail as it becomes available.

The introduction to the Annex I key should be consulted before carrying its identification in the field. Within the key to Annex I all landscape classes and habitat complexes are treated first and then the key follows the GHC structure. The majority of intensively managed lowland landscapes have no Annex I habitats.

RULES

All landscape classes and habitat complexes need to have the GHCs mapped within them using the usual procedure. Allocation can be done according to the decision tree in Figure 6.

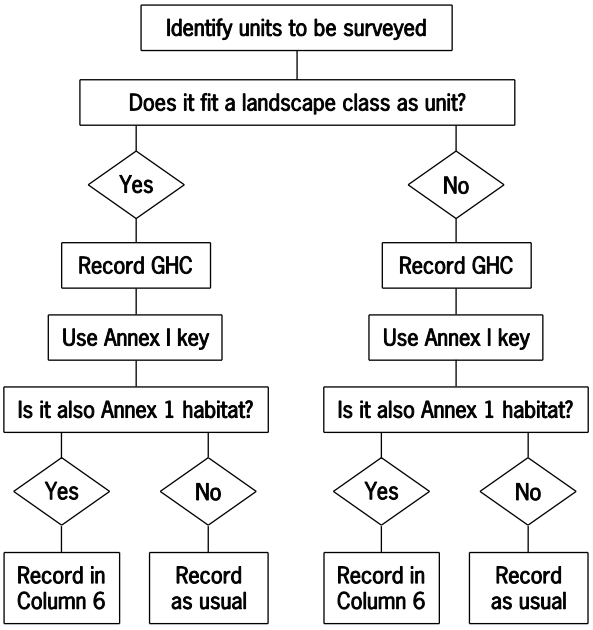


Figure 6

Decision tree to determine if an Annex I code should be recorded.

The procedure is as follows:

1. Identify that the site or habitat element falls within the definition of a landscape or habitat complex by using the key;
2. Progressively move through the site using the standard rules for mapping.

The key to Annex I habitats, which are not landscape classes or habitat complexes involves putting codes in column 6 as shown in Table 10. There are the following dual and single codes:

1. Annex I habitat complex with GHC only, which is not an Annex I single habitat;
2. Annex I habitat complex also with a GHC which is also an Annex I single habitat;
3. GHC only with no Annex I habitat complex or Annex I single habitat;
4. Annex I single habitat only;
5. Mosaics of Annex I habitats where a given habitat is below 30% coverage.

EXAMPLES

In Belgium INBO recorded the following information within a site that came within the definition of 1130 Estuaries: - the code for estuaries is recorded in Field 6 of the form (Table 10).

Table 10

Habitat recording with inclusion of Annex I codes.

Code	Field 1	Field 2	Field 3	Field 4	Field 5				Field 6
	GHC	Environ-mental Qualifier	Site Qualifier	Management Qualifier	Life Form/ species				Annex I code
					Life form	%	Species	%	
A	SAN	4.6	3.12	0	SAN	100			1130
B	THE	4.6		0	EAR	70			1130/1170
					THE	30	Sal mar	100	
C	CRO	5.3	0		CRO	100	Wheat	100	
D	FPH	5.3	0	0	FPH	100	Que rob	100	91F0
E	SCH/EVR	2.2	7.3	0	SCH/EVR	60	Cap vul	80	4020 80% 7150 20%
					CHE	20	Tri cae	10	
					LHE	10	Suc pra	10	

Follow the key e.g. LHE/CHE and then determine whether it fits into an Annex I class; if so then the Annex I code is added in Field 6 (Table 11). If the element does not fit into one of the Annex I Habitats then it will not have an Annex I code in column 6.

Table 11

Mapped data of an Annex I site in a floodplain.

Code	Field 1	Field 2	Field 3	Field 4	Field 5				Field 6
	GHC	Environ-mental Qualifier	Site Qualifier	Management Qualifier	Life Form/ species				Annex I code
					Life form	%	Species	%	
A	LHE/CHE	7.3		A1.8	LHE	60	Ach pan	70	6250
					CHE	40	Bro ine	60	

Clear guidelines have to be developed for the boundaries of the landscape units e.g. whether crops and urban areas should be included inside estuaries. This can done using expert judgement, but it is recommended to involve the European Topic Centre for Biodiversity in difficult cases. For example from recent work it might be concluded that the boundary of the estuary should be drawn where the water table is influenced by the movement of the water in the

tidal area. As explained above once the surveyor moves out of the recognised landscape class then the mapping procedure would be as usual i.e. without the Estuary 1130 code and be only a single GHC.

Note that some habitats especially those with different combinations of scrub categories may appear in more than one place in the key. For example pre-desert scrub may be SCH/EVR or LPH/EVR and MPH/EVR depending upon local conditions.

Allocation of existing data to Annex I. In many cases e.g. in GB-CS and NILS sufficient supporting data is available to apply the key and identify whether the element fits into Annex I classes. For example in GB-CS heath land LPH/EVR fits into dwarf shrub heath 6110.

3.4.13 Field seven: Farmed and Non-Farmed features

This typology was developed for a European project on Farmland features and the classes are given in Table 12. They are designed to enable habitats, which are not within the main enterprise of the farm and are important for analysis e.g. fields used for horses often have higher species number.
The patterns of the different farmed and unfarmed categories in the landscape may vary over distances of a few metres in some regions but hundreds of metres elsewhere. Similarly they may occupy whole landscapes, as in high mountains, or may only be in fragments of only tens of square metres, as in cereal prairies. The typology described below should be used to determine whether the area should be mapped and/or have vegetation plots placed within it (Jongman and Bunce, 2009).

Table 12

Classes for defining farmland features as farmed and unfarmed land. Classes 1, 3, 5 and 6 are unequivocally part of farmed land; class 4 has different interpretations in member states e.g. it is included in GB but excluded in Greece; class 2, 7 and 8 are unfarmed (Jongman and Bunce, 2009).

1. *Fields managed only for agricultural objectives.* Such fields are usually intensively used but may also involve extensive systems. Usually there is a division between:
    a. *Cultivated land used for arable (e.g., wheat) or perennial or woody crops (e.g., fruit trees, vineyards)*
    b. *Grasslands used directly (grazing) or indirectly (hay, silage) by livestock*
2. *Fields managed regularly for non-agricultural objectives.* Usually these fields are used for horses or donkeys held for recreational purposes but could also include fields and mesotrophic grasslands managed primairily for nature conservation and landscape objectives.
3. *Unenclosed land used regularly by stock, usually sheep and goats but also cattle and horses for meat.* This category has a wide range of use intensity and varies in character both regionally and locally. It includes many upland grasslands and heath lands but also *Dehesas, Montados* and wood pastures elsewhere. There is a potential overlap here with forests grazed by domestic stock where the tree cover is over 30%, so such land should be included here as the structure and character of the ecosystems present are determined by grazing.
4. *Unenclosed land used occasionally by sheep or goats but not in regular agricultural use and minimally affected by grazing* (e.g., some blanket bogs and mountain summits, e.g. in Britain, Norway and Switzerland).
5. *Linear or point features on, or adjacent to, farmland that are managed directly or are likely to be highly influenced by farming activities e.g., hedges on farmland and grass strips between fields*[1].
6. *Linear or point features on, or adjacent to, farmland that are indirectly influenced by current agriculture but are not managed actively* (e.g., field corners and small woodlands surrounded by agricultural land).
7. *Land not used by agriculture (usually urban herbaceous) and managed usually by mowing, e.g., roadside verges, recreation areas and sport fields.*
8. *Land not used by agriculture but maybe managed for forestry, nature conservation except where grazing is involved or urban objectives*
    a. *Abandoned fields and unenclosed land no longer used by agriculture*. Long term set-a-side could be included here. This category would also include habitats under nature conservation management e.g., wetlands, some salt marshes and heath lands.
    b. *Land which has never been used by agriculture or managed e.g., steep roadside banks, cliffs and scree.*
    c. *Forests.* These could be divided into three categories if a relationship was required with intensity of management
        (i) Forests managed regularly often for nature conservation objectives using active management e.g., coppice woods for vernal flowers and for firewood
        (ii) Commercial forests of planted species e.g., Sitka spruce in the UK and Norway Spruce in northern and central Europe. Small recent amenity plantations are not included here as they are still indirectly affected by agricultural practices
        (iii) Forests that have not been managed in recent times, say about 50 years
    d. *Urban land within the definition provided by in this Manual and in Bunce et al. (2008)*

3.4.14 Field eight: Local classifications and Phytosociological units

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 GHCs into more detailed units, although these will often be consistent with the rules for new elements. Examples are available from Spain, Estonia, Hungary,

1 The separation of categories 5 and 6 is to some degree arbitrary. But was determined on the basis that class 5 actually had deliberately inputs from farmers, e.g.,cutting hedges. Class 6 will have only indirect effects from farming, e.g.,spray drift.

Norway, Finland and Sweden. Other classifications e.g. Hemerobiotic state and codes for favourable conservation status could also be recorded here. Details would have to be determined before any major survey.

The syntaxonomic level 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.

3.5 Recording linear elements

There are the two main possibilities:

1. Full details are recorded of linear elements, all GHCs and qualifiers available for areal elements can be used. Codes are to be used in the same way and attached to defined length 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. The same precedence rules for areal tree/shrub GHCs apply to linear elements. This procedure delivers most information especially on biodiversity in agricultural landscapes, but it is also a time consuming procedure especially in small scale agricultural landscapes.
2. In the second option linear elements are mapped using a predefined list. The descriptions are based on the information in the field Manuals of the GB-CS and NICS, supplemented by European experience. See definitions below.

EBONE uses in its field testing this second option of a predefined list for linear features including the GHC, but not species composition. The list below defines the linear features to be recorded in EBONE. The descriptions are based on the information in the field Manuals of the GB-CS and NICS, supplemented by European experience:

- **Lines of trees: (LTR+FPH/DEC, CON, EVR, NLE, SUM, WOC)** includes lines of **trees over 5m** in height whether spontaneous or planted. They must be qualified by the GHCs. The LTR has to be over 30m long regardless of how many trees are present. If the canopy width is over 5m it is still recorded as a LTR not as an area. To become an area it has to be two trees or more wide. There may be an under-storey, if this is managed, it should be treated as a hedge, otherwise it is not recorded. GST, HST and LSC underneath the canopy is not recorded, but WAL, BAN, WAT, TRA, ROA, SRH and HED are recorded. If trees are recently felled, estimate where the canopy was. If the canopy is covering a road then the road recorded as well.
- **Hedges (HED)**: includes lines of woody tree and scrub vegetation (LPH, MPH and TPH) with evidence of positive management, whether coppicing, laying (in GB), flailing, cutting or pruning. There may be gaps but these must not be more than 50% - otherwise they are patches of scrub. *Ulex spp.* is not generally considered as a hedge species, except in south-west England where it may be flailed, as may lines of *Rubus spp.* occasionally; however, both should be considered scrub. Locally, hedges are often growing on banks of stone or earth but the hedge takes precedence. If a line of managed scrub fits the definition of a hedge, it takes precedence over lines of trees which form a canopy above it - a situation common in Northern Ireland and Austria. Hedges form the basis of distinctive landscapes, such as the bocage of western France, but they are also common in western Britain, southern Lower Saxony (northern Germany), the Auvergne (central France), eastern part of The Netherlands and locally elsewhere. Hedges around woodlands are recorded.
- **Species Rich Hedges (SRH)**: are defined above. Species Rich Hedges have five or more woody species per 30 m length, including species such as *Hedera helix* and *Rosa spp.*
- **Lines of scrub (LSC)**: includes lines scrub (LPH, MPH and TPH) with no evidence of management. In some regions, these are widespread on unmanaged banks by streams or on hillsides. Elsewhere they may occur along unmanaged field margins or terraces. Often they consist only of *Rubus* or *Arundo donax* in the Mediterranean, but may consist of different species elsewhere. They are also often in unmanaged strips beside roads.
- **Watercourses/water bodies (WAT) i**ncludes AQU+SHY, +EHY, +HEL or +TER divisions: seepage and spring lines with standing water, streams, rivers, canals, ditches of variable width with free standing water. In ponds (but

not temporary ones) and lakes (including artificial water bodies) WAT forms the edges of the waterbody. They are very variable, from the major rivers of Europe, to small alpine streams. Elements wider than 5m and over 80m in length will be mapped as areas, but the two edges on either side should be mapped as linear features (WAT). Waterbodies with an edge over 30m will qualify as WAT and should be mapped.

- **Herbaceous strips (HST):** includes grasses mixed with broadleaved plants **(LHE/CHE)** or only broadleaved plants **(LHE)**. These comprise boundaries between crop fields as well as vineyards and olive groves. Strips of herbaceous vegetation under fences are included, if of a different GHC than the surrounding land. Otherwise fences are not recorded separately because they are primarily landscape features and of minimal importance for biodiversity, this saves much time in some situations. The edges of crops where there is perennial vegetation e.g. against woodlands, but not under the canopy, are included. Herbaceaous strips in the centre of roads and tracks are not recorded as HST, but a part of the road.
- **Grass strips (GST):** includes strips where grass **(CHE)** is 70% of the vegetation cover otherwise the information given in the section above equally applies. Grass strips in the centre of roads and tracks are not recorded as GST, but a part of the road.
- **Annual strips (ANN):** includes THE alone or mixtures of THE with 40-60% LHE or CHE. Annual strips are usually around the edge of agricultural fields and should not be reorded between , but not within fields. This include also lines of annual crops qualified by the GHC CRO.
- **Walls (WAL)**: includes dry stone, mortared and brick walls with or without capping. The walls may retain terraces or be free standing. Ruined walls are included in the category, as long as some sections are still standing, but not lines of rocks from former constructed elements. Height may be variable, as may width and style, depending on local materials and traditions. Walls are dominant linear features in some upland landscapes and on terraced hillsides in the Mediterranean. Elsewhere, in lowland situations, they are often linked to large estates. Walls within woodlands are not recorded. Walls under lines of trees or shrubs are recorded.
- **Banks (BAN)**: raised linear features covered with over 30% vegetation. Includes levees and dykes, banks between fields, terrace edges, but most commonly banks which have been constructed for planting a hedge on top.
- **Tracks (TRA)**: temporary and tractor tracks are excluded, but could be included as a HST or GST if over 30% vegetated. If tracks are over 5m wide and 80m long they are recorded as areas. Verges over 0.5m wide should be recorded as GST, HST or LSC only if the GHC is different from the surrounding land.
- **Roads (ROA)**: includes roads with pavement or asphalt. The verges are recorded as for tracks. Motorways and other roads wider than 5m. are recorded as areas. Verges over 0.5m wide should be recorded as GST, HST or LSC only if the GHC is different from the surrounding land.
- **Lines of Sparsely Vegetated (LSV)**: includes all linear features with less than 30% vegetation cover. This category includes cliffs, rock outcrops, screes, erosion features and roadside cuttings. It excludes strips adjacent to roads and tracks, that have been disturbed by vehicle tyres. Height qualifiers may be added were appropriate.

If two elements have the same linear code, but different GHCs, then they are assigned a new alpha code. This means, that a line of crops will be ANN with CRO and lines of vines could be LTR with CRO or LSC with CRO depending on the height of the vines. Where linear elements are mixtures of different categories and no individual category is over 30 m, then record only as points if ecologically significant.

Also note that neither GST nor HST are included under the canopy of trees and hedges.

In lakes and rivers SHY or EHY, which are actually in the water, may be linear but should be recorded as the percentage cover of the whole element in field 5.

Note that recording waterbodies, roads and tracks is obligatory under lines of trees or in forest as they are important in spatial analysis. Measuring the length can be done as a GIS exercise.

Neither GST nor HST are included when under the canopy of trees and hedges. Do not record banks if they are not different from the surrounding vegetation. Site qualifiers are optional for linear elements.

Fences are not recorded unless there is a GST or HST beside them.

3.6 Rules for recording vegetation layers

Procedure for block of forests under 20 ha
The procedure described below applies to blocks of forests under 20 ha. Layers of vegetation are recorded (FPH and GPH) as forest layers in order to provide important information on structure and succession. The only exception is at present *Fynbos* where MPH may be divided into two sub-classes, but it would also be possible for regional surveys to record layers in other TRS categories.

A layer can be recorded if it has over 10% cover, as in the full recording of Life Forms in field 5 (see below). The records of a layer is irrespective of what is above it. Inevitably these records in complex forest will be approximate, but the objective is to give an overview of the whole element.

RULES
Firstly the normal procedure for determining GHCs is followed and recorded in the first line of the recording sheet. In the example below the GHC would be FPH/CON 70 TPH/CON 30 i.e. adding up to 100%.

Secondly the layers are recorded. The Layers are coded AL1, AL2, etc. An example of a forest could be as follows:

Tree layer:	FPH/CON	(i.e. 70% cover of spruce trees)
Understory:	TPH/DEC	(i.e. 40% regenerating beech)
Ground cover:	HER/CHE	(i.e. 10% cover grasses)

Other recording procedures are possible depending on the configuration of the Field Computer.

The GHCs of the different layers are given together with the major species and percentages in field 5. The layers together do not have to add up to 100%, but are often higher.

Only the heights associated with Life Forms are used, so that separate layers of FPH are not recorded.

A single layer may overlap into lower layers, but the average height of the canopy of each layer should be considered. There should be only one layer for each of the TRS categories.

Once the principal of recording various layers has been established, it is also possible to record epiphytes on the tree layer. These are now included in the life form qualifier list (Section 3.3) and worked examples will be given in due course.

Dead trees could also be recorded as a separate module The NILS procedure has rules for these that can be applied if required (see http://nils.slu.se/)

EXAMPLES
Two examples of recording vegetation layers in forests are given in Table 13. The different layers have the same alpha code but are set apart from each other by height. Different layers are usually shown by their GHC code.

Thus in Table 2, patch A, there was coniferous forest with 70% cover (FPH/CON 70), with an understory of tall scrub some of which was between the trees and some outside with a total cover of 40% (TPH/DEC 40), some CHE.

A frequent occurrence in Estonia would be FPH/CON/DEC 90, TPH/CON 60 LPH/EVR 100 HER/CRY 50. Over time it is likely that the conifer would dominate; so after 10 year the unit would become: FPH/CON 100 TPH/CON 30 LPH/EVR 100 HER/CRY 20. See Table 13, patch B.

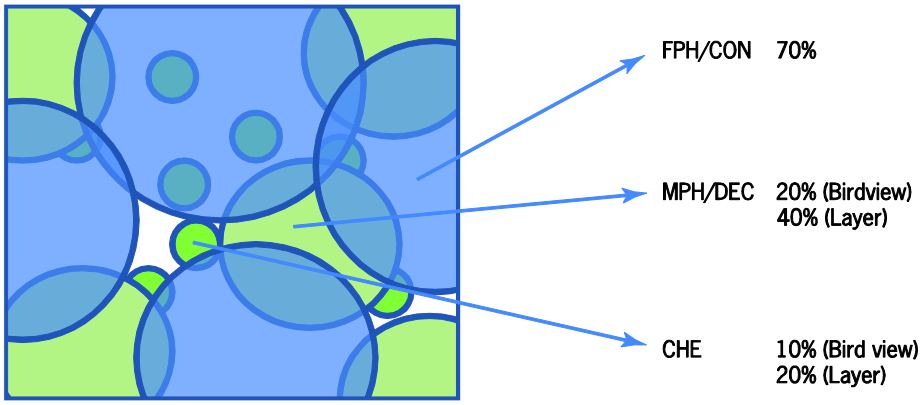


Figure 7
Forest including species in different layers.

Table 13
Forest recording including species in different layers. Different layers are shown by their GHC code. In case of two GHCs of within one category with different heights, this is indicated with a Global code.

Code	Field 1	Field 2	Field 3	Field 4	Field 5				Field 6
α	General Habitat Category	Global/ Env. Qualifier	Site Qualifier	Management Qualifier	Life form/Species				
					Life form	%	Species	%	
A	FPH/CON	5.3	149	3.10	FPH/CON	70	Pic abi	100	
					TPH/DEC	20	Fag syl	100	
					CHE	10	Agr cap	60	
AL1	FPH/CON					70	Pic abi	100	
AL2	TPH/DEC					40	Fag syl	100	
AL3	CHE					10	Agr cap	60	
B	FPH/DEC/CON	5.2	153	B 3.5	FPH/CON	40	Pic abi	100	
					FPH/DEC	50	Bet pen	100	
					TPH/DEC	10	Sor auc	100	
BL1	FPH/CON					40	Pic abi	100	
	FPH/DEC					50	Bet pen	100	
BL2	TPH/DEC					60	Sor auc	100	
	TPH/CON					30	Pic abi	100	
BL3	LPH/EVR					100	vac myr	90	
BL4	CRY					100	Rhy tri	20	

Procedure for block of forests over 20 ha

The procedure above has been tried and tested in the Quality Control excersice described in Section 3.1.5. Larger blocks of forest had problems, because of boundary delineation within them and the additional time required.

Whilst purely descriptive estimates can be made from the edge of these forests, a new procedure needs to be developed to enable the layers of the larger units of forests to be mapped consistently. Such a procedure will need to be tried and tested.

4 Vegetation recording

4.1 Preparation for vegetation recording

There are three widely used terms for recording vegetation data: relevees, quadrates and plots. The first term is commonly used in the phytosociological literature, where relevees are placed in patches of vegetation. Usually semi-natural in order to describe plant associations (Braun-Blanquet, 1928). The second term is mainly used in quantative ecological studies (Bunce and Shaw, 1975) and the third for recording at the landscape level (Haines-Young et al., 2000). Whilst all three terms involve making lists of species with coverage from defined areas, the latter term is used throughout the present document. Kirby et al. (2005) have shown how relocatable random plots can be used to assess long term changes in woodland vegetation over 30 years.

The habitat mapping of the km square should be carried out first in order to produce the map which is then used to locate the vegetation plots. Preferably these are recorded immediately afterwards to save travelling time but in some situations may be delayed if the mapping has been carried out early in the season.

The procedure for recording vegetation plots used in the GB-CS, can involve over 40 samples per 1 km-square, but can be adapted according to project means. GB-CS uses two types of plots, square and linear plots. Square X-plots are placed in areal and point features and linear L-plots are placed in linear features.

The procedure below will provide basic information on the species position of vegetation with the GHCs in the sample squares and also allow estimation of quality for assessing future change.

Additional vegetation plots can also be placed at random or targeted on specific features to add further detail on vegetation, e.g. small patches of vegetation not in Annex I habitats, along the igues to record woody species only and along the edge of arable fields for ruderal species.

The principle for allocating vegetations plots is to place **one plot in each GHC,** Grasslands (LHE/CHE and CHE) need to be **further subdivided according to the moisture and nutrient levels** as indicated by the environmental matrix (see Table 3). One plot is placed in each GHC with a different code for the environmental indicator (field 2). No plots are placed in Urban and Sparsely Vegetated categories except terrestrial (TER), which includes deserts and beaches.

There are three factors which also influence plot selection:

1. If the location of the plot is in water, that is too deep for access, then no record is made.
2. Plots must be done on all SPV classes, even if there is no vegetation. Such site may be colonised in future.
3. If the plot location is inaccessible because of dangerous terrain there are two possibilities: a) move to plot to the nearest safe location or b) re-randomise and select a different patch.

The subdivision in the grasslands is because there are major differences in biodiversity between different types of grassland which therefore need vegetation data to define the detailed composition. In most squares there will be only one extra plot.

If there are several patches of one GHC, then a transparant grid (of one ha units) should be placed over the square and random numbers used to select a patch from the grid. If a field computer is being used, then the grid can selected using ArcPad and with random numbers.

Dehesas can have ground vegetation dominated by Therophytes (THE) usually fallow, mixtures of LHE/CHE or herbaceous crops. Each one of these will be a different GHC if there is below 30% tree cover, but otherwise will be mapped as different elements because of different management. A separate X-plot should be put into each of such elements following the rules. See section 3.4.8. for global codes to cover scattered shrubs, cultivated woody trees and shrubs and other trees.

In EBONE vegetation plots are only recorded in point features, which are Annex I habitats. See the website of the GB-CS for the protocol: www.countrysidesurvey.org.uk/

4.2 Method for recording vegetation

4.2.1 General rules

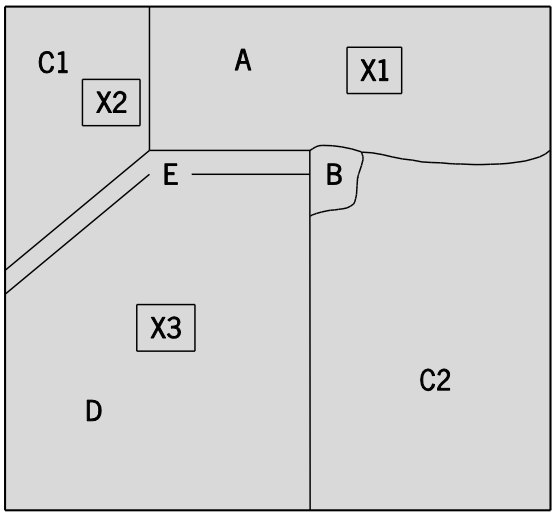
The survey requires recording from different sizes of vegetation plots, depending on whether the plot is placed in an areal, linear or point feature. A fuller description is given below and shown in Table 14. The basic recording procedure is the same for all types of plots.

Table 14
Vegetation plot characteristics.

Code	Name	Other names	Where	Size	No. per Square	EBONE
X	Areal plots	GHC plot	Centroid at random points in polygons	100 m^2	variable	Yes
L	Linears plots	Linear features	Centroid at random along linear features	10x1 m	variable	Yes
Y	Point plots	Targeted habitats	Centroid points in polygon	2x2 m	variable	Annex I habitats only

The X main plots (see Table 14) are placed in the centre of the element concerned (Figure 8). The L linear plots should be placed in the centre of the linear feature in both cases to avoid edge effects (Figure 9). The Y plots are also placed in the centre of the point element. Examples are given below.

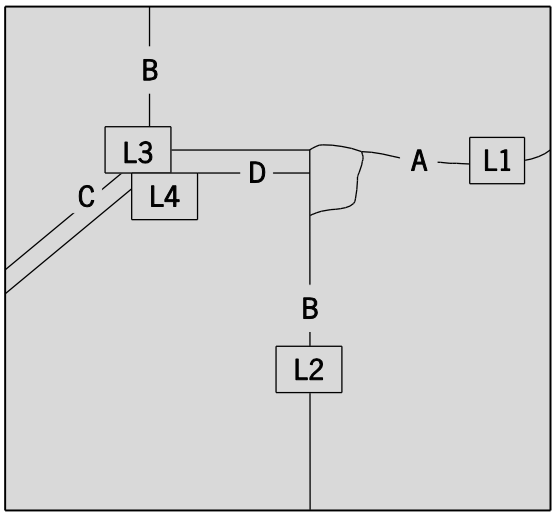
a. Header: information on the broad environmental and management attributes of the plot should be recorded using the environmental site and management qualifiers where appropriate.
b. Listed species. All vascular plants should be recorded, but no lichens or bryophytes. Epiphytes on rocks or trees should not be recorded. the listed species will be held on the field computer adapted for local situations and recorded using the relevant instructions.
c. Unlisted species. These will be rare species or unusual crops or invasive species and will be recorded according to the instruction on the field computer.
d. On completion of recording of the whole plot, then the estimated cover % for the whole plot should be listed against each species, using 5% cover categories.
e. The position of the plots should be located by GPS and marked on the map. A photograph should be taken including a clear land mark to assist relocation of the plot.



Location of X main plots

X1: in CHE field
X2: random selecting from crop fields
X3: in LHE/CHE field
E and B do not have plots because they are Non-Life Form habitats (URB)

Figure 8
Location of X main plots.



Location of L- Linear plots

L1: Hedge (HED)
L2: Random selecting from two grass strips (GST)
L3: Line of trees (LTR)
L4: Herbaceous strip next to a track (HST)

Figure 9
Location of L linear plots.

4.2.2 Vegetation sampling procedure for areal features

The procedure used in EBONE in 2010 was as follows:
- No vegetation plots in URB, SEA, TID or AQU too deep to sample or dangerous terrain.
- One vegetation plot per GHC or linear element category.
- One plot per grassland category (CHE, LHE, CHE/LHE) per environmental qualifier.

Mark the position of the plot on the map. Vegetation plots will not be marked permanently.

Plots are in the middle of areal and linear elements. If there is more than one element of a certain GHC, than select randomly where the plot will be (e.g. using a grid as in Figure 10.)

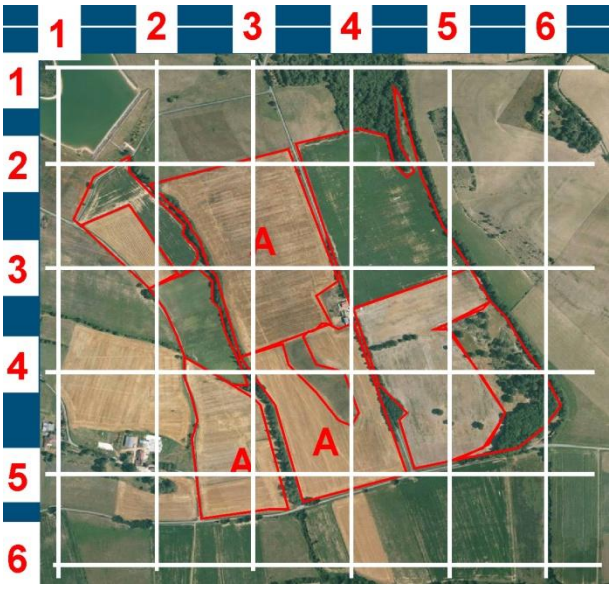


Figure 10

Placement of a gird to select randomly which polygon should be sampled.

Whilst the procedures used previously are objective, they do not strictly answer the requirements of probability sampling. This requires that any point in a given GHC should have an equal chance of being sampled. A futher provision is that field margins (usually 3m wide should be avoided because of the edge effect. Two possibilities exist:

1) If the polygons are held in a GIS then a random point can be selected either with a single GHC patch or from several patches of the same GHC. Full details of the procedure would need to be worked out for any given GIS and also field tested in any survey.
2) If paper maps are being used than a transparent overlay of an appropriate size can be overlaid as the square of the field survey is complete. Random points can then be identified using (1). Again the procedure will need to be given in detail and field tested in any survey.

4.2.3 Method for recording vegetation for linear features

As with areal features also this procedure is not strictly probablistic, although in GB-CS it does allow the linear plot to be any inconjunction with adjacent X plots. Again the principle is that each length of the linear elements represented in the square given must have an equal change of being selected. As described above a random intersect should be selected ans the nearest point on the given element used for the sample point, which should be done on the same side as the intersect. A procedure will need to be developed according to the possibilities of the given survey and the equipment available.

4.2.4 Main vegetation or X plot

A main vegetation or X plot is 100 m^2 in the centre of the GHC and is set up using survey poles with the strings forming the diagonals of the square as shown in Figure 11. If the plot is in a patch that is less than 10m wide then the shape of the plot must be altered to fit within the patch. This procedure was developed in the GB-Woodland Survey in 1971 and guarantees that the plots have an accurate size. The diagonals must be orientated carefully at right angles and the plot must be orientated with the strings on the north-south and east-west axes. The different nested plots are shown in Figure 11.

The strings or tapes must be of medium grade polyester that are unlikely to stretch. The half diagonals are 1.42m, 3.54m, 5.00m and 7.07m and these must be laid out in the directions as shown in the diagram below. The objective of this lay out is to ensure that the total area of the plots is always exactly correct, because trying to lay out square plots results in inaccuracies, as emphasised by Bunce and Shaw (1973).

All species must be recorded from the inner nested plot first. When the inner plot has been completed the second nested plot will be examined and any **additional** species will should be recorded. Each additional nested plot is examined in this way. Cover estimates are **only made for the whole plot** when all sizes have been completed. All vascular plants, but not bryophytes or lichens are recorded. The standard practice in vegetation science is used i.e. only plants rooted in the plot are recorded, including trees and seedlings.

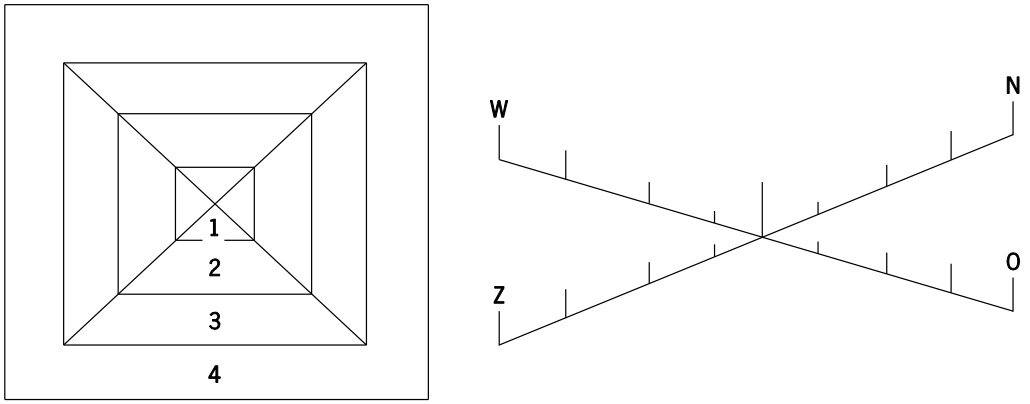


Figure 11

Design of the X plot (After GB Countryside Survey Manual 2007). The lengths of the sides in square are 1: 2.00m, 2: 5.00m, 3: 7.0 m and 4: 10m. This produces nested plots of respectively 4m^2, 25m^2, 50m^2 and 100m^2.

For estimates of cover (in steps of 5%) it is necessary to constantly check between partners to avoid over estimates or under estimates. Total cover maybe over a 100% if several layers are present. E.g. *Pteridium* 100% over *Agrostis* 25%. Species with less than 5% cover are given a nominal cover of 1%. Bare ground includes leaf litter and rock.

In case the plot has to be done in a field with a growing crop or hayfield, then the plot should be moved to the edge of the field. The new plot should be taken as a 100 m^2, (but estimated not measured, because the plot cannot be laid out) starting 3m into the plot to avoid any edge effect. Access should be made using drill lines where possible and causing minimum disturbance to the crop or hayfield. A species list should be compiled from what can be seen in the crop.

4.2.5 Linear or L plot

Plots from linear features are only recorded if the vegetation answers the criteria of a GHC, which is different from the adjacent vegetation. For example, a strip of grass between crops could be LHE/CHE whereas the crop would be CRO. In the opposite case, a fence line between two grass fields would often have the same GHC as the fields themselves and will not be eligible for a linear plot, unless the strip of vegetation is different from the surrounding vegetation. Streams that do not have a different GHC from the surrounding vegetation should not have a vegetation plot. In streams in woodland, plots are not recorded if no ground vegetation is present at all.

– The predefined list of linear features to be recorded is described in Section 4.2. The following guidelines apply:
– If the vegetation by a wall is not different from the surrounding vegetation no plot is placed. Vegetation on top and sides of walls is not recorded.
– In case of grass strips the plot is placed along the edge of the field and the plot is away from the crop edge into the strip. If the strip is over 2m wide then the plot is placed as in a hedge plot.
– The plot is placed according to the same randomization procedure as for the areal features. The side of the plot along the linear feature is determined according to the nearest large X-plot.
– The plot is 1 x 10 m and is laid out along the feature as shown in Figure 10. If the linear feature is less than 1m wide, then the plot will extend into the field. In case of multiple boundaries a plot is placed in each linear according to the appropriate rules. However, plots cannot overlap.

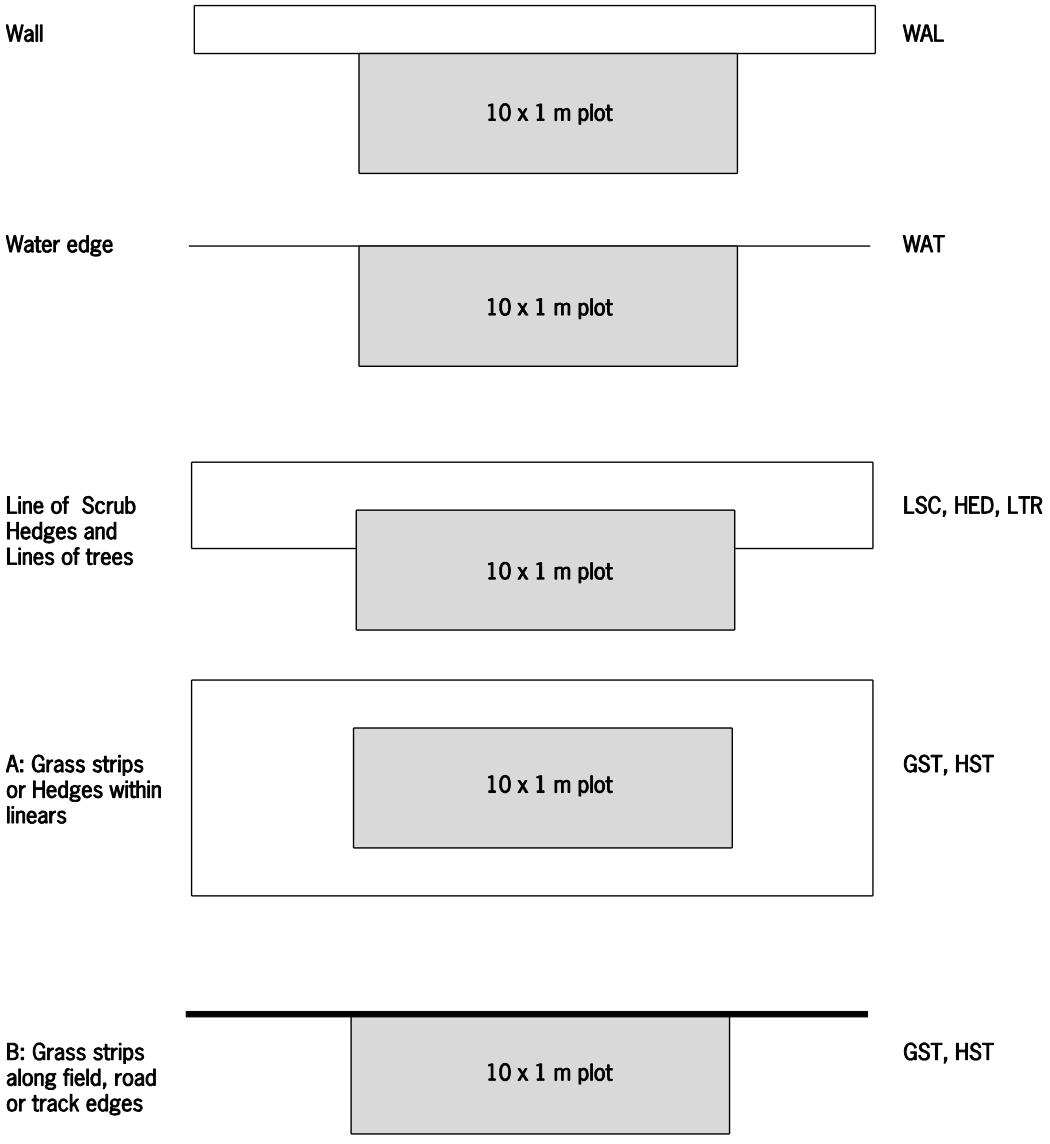


Figure 12

Location of plots along linear features, wall, water edge, hedge and grass strip. The plots are 1x10m.

4.2.6 Habitat targeted Y plot

Targeted Y plots - Habitat targeted plots should be placed in GHCs between 25 and 400m^2 which fulfil the descriptions of Annex I of the Habitats Directive (Table 14). The plot size is 2x2m laid out using the same poles as the main plots. This size is used because the patch may only be 25m^2. If the plot is in a patch that is smaller than 2m wide then the shape of the plot should be altered to fit within the patch. Likely candidates are indicated in the Annex 1 key and range from Tufa springs to herb rich annual grasslands.

4.2.7 Quality assurance

Quality assurance of vegetation plots should be undertaken in stratified random samples. In contrast to the mapping of habitats, where the existing data are taken into the field, the species data are recorded independently and then checked against the list obtained from the initial surveyors. Differences are then identified using statistical procedures to check on the source of error and whether it is due to season, observer or location, i.e. if the plot has been put in a different place than the year before.

5 Recording sheets and worked examples

For any given survey an appropriate form would need to be developed with necessary background information. This information should be treated with confidentiality where needed.

5.1 Areal features

An example of the mapping and recording of areal elements is given below.

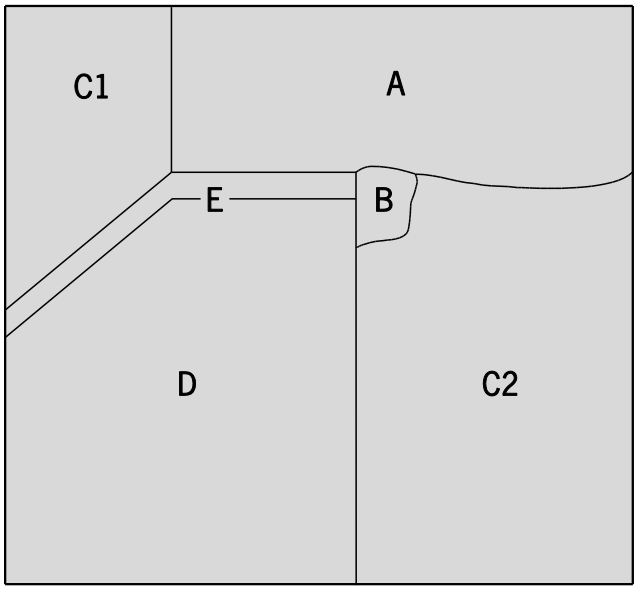


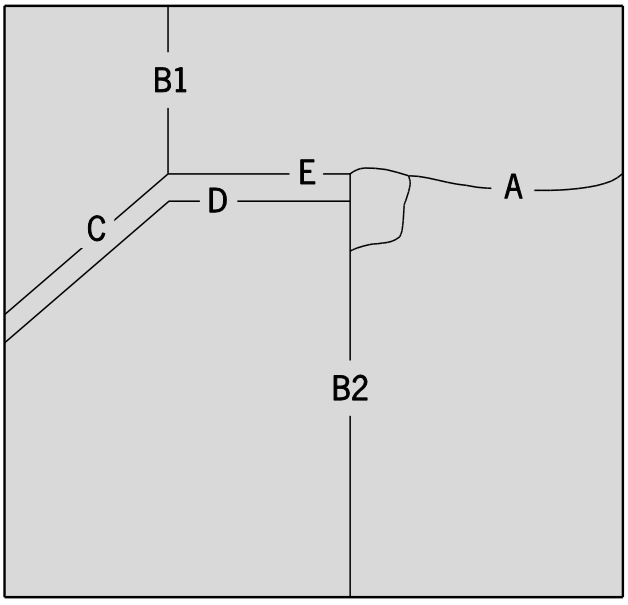
Figure 13
Example of areal coding for EBONE (part of a km^2).

Code	Field 1	Field 2	Field 3	Field 4	Field 5				Field 6	Field 7
α	General Habitat Category	Global/Env. Qualifier	Site Qualifier	Management Qualifier	Life form/Species				Annex I	Regional/ Farmland Class
					Life form and% Non Life Form		Species	%		
A	CHE	5.3	0	A1.6.7	CHE	90	Lol per	100		
					THE	10	Poa ann	60		
B	ART	0	5.1	0	ART	70				
					NON	30				
C	CRO	0	0	A1.1.1	CRO	100	Wheat	100		
D	LHE/CHE	5.3	1.18	A1.8	LHE	60	Chr leu	10		
					CHE	40	Agr cap	50		
E	NON		5.20	0	0					

Figure 14
Areal recording sheet.

5.2 Linear features

A example of mapping and recording of linear features is given in Figure 15.



α code	Linear element
A	HED
B	HST
C	GST
D	HST
E	TRA

Figure 15
Map and recording sheet for linear elements.

6 Stratification system

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 derived from field data must 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 EO data categories available. This is essential if there is to be an understanding of current and future dynamics of changes in habitats, the associated biodiversity and its distribution throughout Europe.

Therefore, it is necessary to develop a consistent stratification framework that optimises the selection of sampling locations. The development of the core methodology is described by Sheail and Bunce (2003). 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 (Bunce et al., 1996) and Spain. It is likely to be even more efficient at a continental scale, as has been shown in Australia (Newton et al., 2008*)*.

An essential part of the BioHab project was the construction of an environmental stratification of Europe, including Northern Africa and Turkey (Metzger et al., 2008*)*. This classification system was derived from statistical analysis of climatic and topographic data at a resolution of 1 km square. A total of 84 environmental strata (EnS)were established, linked hierarchically into 13 zones (EnZ). This classification can be used to derive the minimum of about 10,000 km^2 possibly 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.

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, as described by Haines-Young et al., 2000) for GB. This method provides the basis 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 recording procedure described in the present Manual will enable changes in habitats to be linked directly to driving forces through the records of management qualifiers. The European Environmental Stratification presents a framework of the environment of Europe based on a statistical approach that enables the determination of areas that are relatively homogeneous in the major environmental parameters at the European level. The use of this stratification allows cost-efficient monitoring and makes reporting stock and change of land use and biodiversity possible (Jongman et al., 2006)

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 (Mucher et al., 2005*)*. When the field data become available, they can be linked to the CORINE land cover map to develop sophisticated predicted distribution maps of the main habitats in Europe.

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 (Metzger and Rounsevell, 2006) to examine the implications of climate change scenarios on habitat distribution.

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Annex 1 List of General Habitat Categories

GHC (vernacular name)	Primary code
URBAN	**URB**
Artificial	ART
Non Vegetated	NON
Crops	VEG
Herbaceous	GRA
Woody vegetation	TRE
Artificial / Non-Vegetated	ART/NON
Artificial / Crops	ART/VEG
Artificial / Herbaceous	ART/GRA
Artificial / Woody	ART/TRE
Non Vegetated / Crops	NON/VEG
Non Vegetated / Herbaceous	NON/GRA
Non Vegetated / Woody	NON/TRE
Crops / Herbaceous	VEG/GRA
Crops / Woody	VEG/TRE
Herbaceous / Woody	GRA/TRE
CULTIVATED	**CUL**
Bare Ground	SPA
Herbaceous Crops	CRO
Woody Crops	WOC
Herbaceous/Woody Crops	CRO/WOC
SPARSELY VEGETATED	**SPV**
Sea	SEA
Tidal	TID
Aquatic	AQU
Ice and Snow	ICE
Terrestrial	TER
Sea/Tidal	SEA/TID
Sea/Ice	SEA/ICE
Sea/Terrestrial	SEA/TER
Tidal/Aquatic	TID/AQU
Tidal/ Terrestrial	TID/TER
Aquatic/Terrestrial	AQU/TER
TERRESTRIAL	**TER**
Bare Rock	ROC
Boulders	BOU
Stones	STO
Gravel	GRV
Sand	SAN
Earth, Mud	EAR
Rock/Boulders	ROC/BOU
Rock/Stones	ROC/STO
Rock/Gravel	ROC/GRV
Rock/Sand	ROC/SAN
Rock/Earth	ROC/EAR
Boulders/Stones	BOU/STO

Boulders/Gravel	BOU/GRV
Boulders/Sand	BOU/GRV
Boulders/Earth	BOU/EAR
Stones/Gravel	STO/GRV
Stones/Sand	STO/SAN
Stones/Earth	STO/EAR
Gravel/Sand	GRV/SAN
Gravel/Earth	GRV/EAR
Sand/Earth	SAN/EAR
HERBACEOUS WETLAND	**HER**
Submerged Hydrophytes	SHY
Emergent Hydrophytes	EHY
Helophytes	HEL
Submerged Hydrophytes / Emergent Hydrophytes	SHY/EHY
Submerged Hydrophytes / Helophytes	SHY/HEL
Emergent Hydrophytes / Helophytes	EHY/HEL
HERBACEOUS	**HER**
Leafy Hemicryptophytes	LHE
Caespitose Hemicryptophytes	CHE
Therophytes	THE
Geophytes	GEO
Chamaephytes	HCH
Cryptogams	CRY
Leafy Hemicryptophytes / Caespitose Hemicryptophytes	LHE/CHE
Leafy Hemicryptophytes / Therophytes	LHE/THE
Leafy Hemicryptophytes / Geophytes	LHE/GEO
Leafy Hemicryptophytes / Herbaceous Chamaephytes	LHE/HCH
Leafy Hemicryptophytes / Cryptogams	LHE/CRY
Caespitose Hemicryptophytes / Therophytes	CHE/THE
Caespitose Hemicryptophytes / Geophytes	CHE/GEO
Caespitose Hemicryptophytes / Herbaceous Chamaephytes	CHE/HCH
Caespitose Hemicryptophytes / Cryptogams	CHE/CRY
Therophytes / Geophytes	THE/GEO
Therophytes / Herbaceous Chamaephytes	THE/HCH
Therophytes / Cryptogams	THE/CRY
Geophytes / Herbaceous Chamaephytes	GEO/HCH
Geophytes / Cryptogams	GEO/CRY
Chamaephytes / Cryptogams	HCH/CRY
TREES/SHRUBS	**TRS**
Dwarf Chamaephytes Winter Deciduous	DCH/DEC
Dwarf Chamaephytes Evergreen	DCH/EVR
Dwarf Chamaephytes Coniferous	DCH/CON
Dwarf Chamaephytes Winter Deciduous / Evergreen	DCH/DEC/EVR
Dwarf Chamaephytes Winter Deciduous / Coniferous	DCH/DEC/CON
Dwarf Chamaephytes Evergreen / Coniferous	DCH/EVR/CON
Shrubby Chamaephytes Winter Deciduous	SCH/DEC
Shrubby Chamaephytes Evergreen	SCH/EVR
Shrubby Chamaephytes Coniferous	SCH/CON
Shrubby Chamaephytes Non-Leafy Evergreen	SCH/NLE
Shrubby Chamaephytes Summer Deciduous and/or Spiny Cushion	SCH/SUM
Shrubby Chamaephytes Winter Deciduous / Evergreen	SCH/DEC/EVR
Shrubby Chamaephytes Winter Deciduous / Coniferous	SCH/DEC/CON
Shrubby Chamaephytes Winter Deciduous / Non-Leafy Evergreen	SCH/DEC/NLE
Shrubby Chamaephytes Winter Deciduous / Summer Deciduous	SCH/DEC/SUM
Shrubby Chamaephytes Evergreen / Coniferous	SCH/ EVR/CON
Shrubby Chamaephytes Evergreen / Non-Leafy Evergreen	SCH/EVR/NLE

Shrubby Chamaephytes Evergreen / Summer Deciduous	SCH/EVR/SUM
Shrubby Chamaephytes Coniferous / Non-Leafy Evergreen	SCH/CON/NLE
Shrubby Chamaephytes Coniferous / Summer Deciduous	SCH/CON/SUM
Shrubby Chamaephytes Non-Leafy Evergreen / Summer Deciduous	SCH/NLE/SUM
Low Phanerophytes Winter Deciduous	LPH/DEC
Low Phanerophytes Evergreen	LPH/EVR
Low Phanerophytes Coniferous	LPH/CON
Low Phanerophytes Non-Leafy Evergreen	LPH/NLE
Low Phanerophytes Summer Deciduous	LPH/SUM
Low Phanerophytes Winter deciduous / Evergreen	LPH/DEC/EVR
Low Phanerophytes Winter deciduous / Coniferous	LPH/DEC/CON
Low Phanerophytes Winter deciduous / Non-Leafy Evergreen	LPH/DEC/NLE
Low Phanerophytes Winter Deciduous Summer	LPH/DEC/SUM
Low Phanerophytes Evergreen / Coniferous	LPH/ EVR/CON
Low Phanerophytes Evergreen / Non-Leafy Evergreen	LPH/EVR/NLE
Low Phanerophytes Evergreen / Summer Deciduous	LPH/EVR/SUM
Low Phanerophytes Coniferous / Non-Leafy Evergreen	LPH/CON/NLE
Low Phanerophytes Coniferous / Summer Deciduous	LPH/CON/SUM
Low Phanerophytes Non-Leafy Evergreen / Summer Deciduous	LPH/NLE/SUM
Mid Phanerophytes Winter Deciduous	MPH/DEC
Mid Phanerophytes Evergreen	MPH/EVR
Mid Phanerophytes Coniferous	MPH/CON
Mid Phanerophytes Non Leafy Evergreen	MPH/NLE
Mid Phanerophytes Summer Deciduous and/or Spiny Cushion	MPH/SUM
Mid Phanerophytes Winter Deciduous / Evergreen	MPH/DEC/EVR
Mid Phanerophytes Winter Deciduous / Coniferous	MPH/DEC/CON
Mid Phanerophytes Winter Deciduous / Non-Leafy Evergreen	MPH/DEC/NLE
Mid Phanerophytes Winter Deciduous / Summer Deciduous	MPH/DEC/SUM
Mid Phanerophytes Evergreen / Coniferous	MPH/EVR/CON
Mid Phanerophytes Evergreen / Non-Leafy Evergreen	MPH/EVR/NLE
Mid Phanerophytes Evergreen / Broadleaved / Summer Deciduous	MPH/EVR/SUM
Mid Phanerophytes Coniferous / Non-Leafy Evergreen	MPH/CON/NLE
Mid Phanerophytes Coniferous / Summer Deciduous	MPH/CON/SUM
Mid Phanerophytes Non-Leafy Evergreen / Summer Deciduous	MPH/NLE/SUM
Tall Phanerophytes Winter Deciduous	TPH/DEC
Tall Phanerophytes Evergreen	TPH/EVR
Tall Phanerophytes Coniferous	TPH/CON
Tall Phanerophytes Non-Leafy Evergreen	TPH/NLE
Tall Phanerophytes Summer Deciduous	TPH/SUM
Tall Phanerophytes Winter Deciduous / Evergreen	TPH/DEC/EVR
Tall Phanerophytes Winter Deciduous / Coniferous	TPH/DEC/CON
Tall Phanerophytes Winter Deciduous / Non-Leafy Evergreen	TPH/DEC/NLE
Tall Phanerophytes Evergreen / Coniferous	TPH/EVR/CON
Tall Phanerophytes Evergreen / Non-Leafy Evergreen	TPH/EVR/NLE
Tall Phanerophytes Evergreen / Summer Deciduous	TPH/EVR/SUM
Tall Phanerophytes Coniferous / Non-Leafy Evergreen	TPH/CON/NLE
Tall Phanerophytes Coniferous / Summer Deciduous	TPH/CON/SUM
Forest Phanerophytes Winter Deciduous	FPH/DEC
Forest Phanerophytes Evergreen	FPH/EVR
Forest Phanerophytes Coniferous	FPH/CON
Forest Phanerophytes Summer Deciduous	FPH/SUM
Forest Phanerophytes Winter Deciduous / Evergreen	FPH/DEC/EVR
Forest Phanerophytes Winter Deciduous / Coniferous	FPH/DEC/CON
Forest Phanerophytes Evergreen / Coniferous	FPH/EVR/CON
Forest Phanerophytes Evergreen / Summer Deciduous	FPH/EVR/SUM
Forest Phanerophytes Coniferous/ Summer Deciduous	FPH/CON/SUM

Mega Forest Phanerophytes Deciduous	GPH/DEC
Mega Forest Phanerophytes Evergreen	GPH/EVR
Mega Forest Phanerophytes Conifer	GPH/CON
Mega Forest Phanerophytes Summer deciduous	GPH/SUM
Mega Forest Phanerophytes Winter Deciduous / Evergreen	GPH/DEC/EVR
Mega Forest Phanerophytes Winter Deciduous / Coniferous	GPH/DEC/CON
Mega Forest Phanerophytes Evergreen / Coniferous	GPH/EVR/CON
Mega Forest Phanerophytes Evergreen /Summer Deciduous	GPH/EVR/SUM
Mega Forest Phanerophytes Conifer /Summer Deciduous	GPH/CON/SUM

Annex 2 Plasticity of tree/shrub life forms

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.

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

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.

Other species either inherently grow as low shrubs in various stages of colonisation or maybe also as a climax stage. 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. Examples of species that have varying degrees of plasticity are given in the table below.

Examples of species with varying degrees of plasticity

	Dwarf phytes	**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						
Arctostaphylos uva-ursi	x		x				

Vaccinium vitis-idaea	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		
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				
Chamaespartium sagittarius		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	
Reboullia hemisphaerica		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		

Potential flows between Life Forms

Because the Life Forms 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 the figure below. Only the principal directions of flows are included and under exceptional circumstances flows can be the opposite of these shown in the diagram.

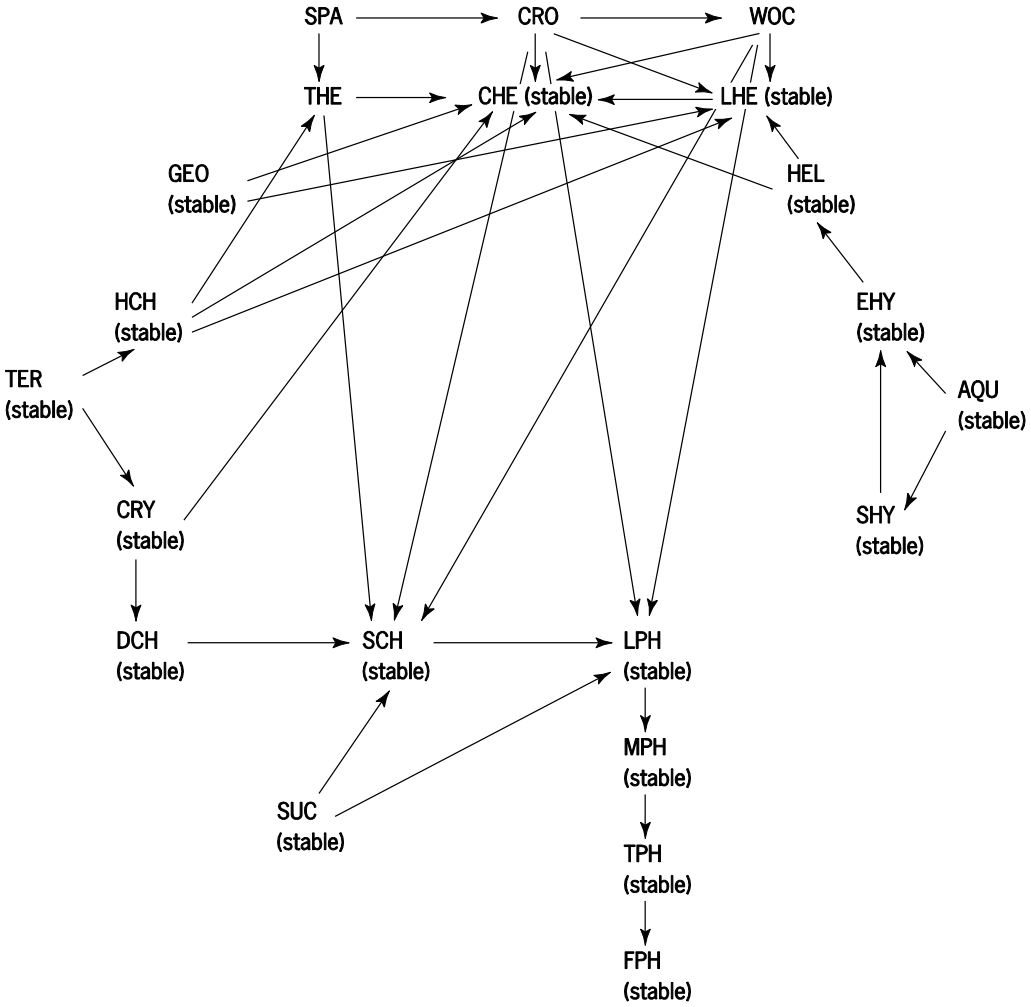


Diagram of principal potential flows between Life Form categories. (Stable = possibly may stay at this level and not develop). All categories can change to Urban/Constructed.

Annex 3 List of Tables and Figures

List of Figures

List of Tables

Annex 4 Recording form for areal elements

Observers: **Date:** **Location:**

Code	**Field 1**	**Field 2**	**Field 3**	**Field 4**	**Field 5**				**Field 6**	**Field 7**
α	General Habitat Category	Global/ Env. Qualifier	Site Qualifier	Man. Qualifier	Habitats/Species				Annex I	Farmland Class
					Full list of Habitats	%	Species	%		
Additional codes/Comments										

Annex 5 Recording form for linear elements

Observers: **Date:** **Location:**

Code	Linear-Element	Farmland Class	Code	Linear Element	Farmland Class
Comments					

Annex 6 Recording form for main X and Y plots

Observers: **Date:**

Location: **GHC/Env.Qua:**

Plot	Code	Species	%	Plot	Code	Species	%
4m²				**4m²**			
25m²				**25m²**			
50m²				**50m²**			
100m²				**100m²**			
Comments							

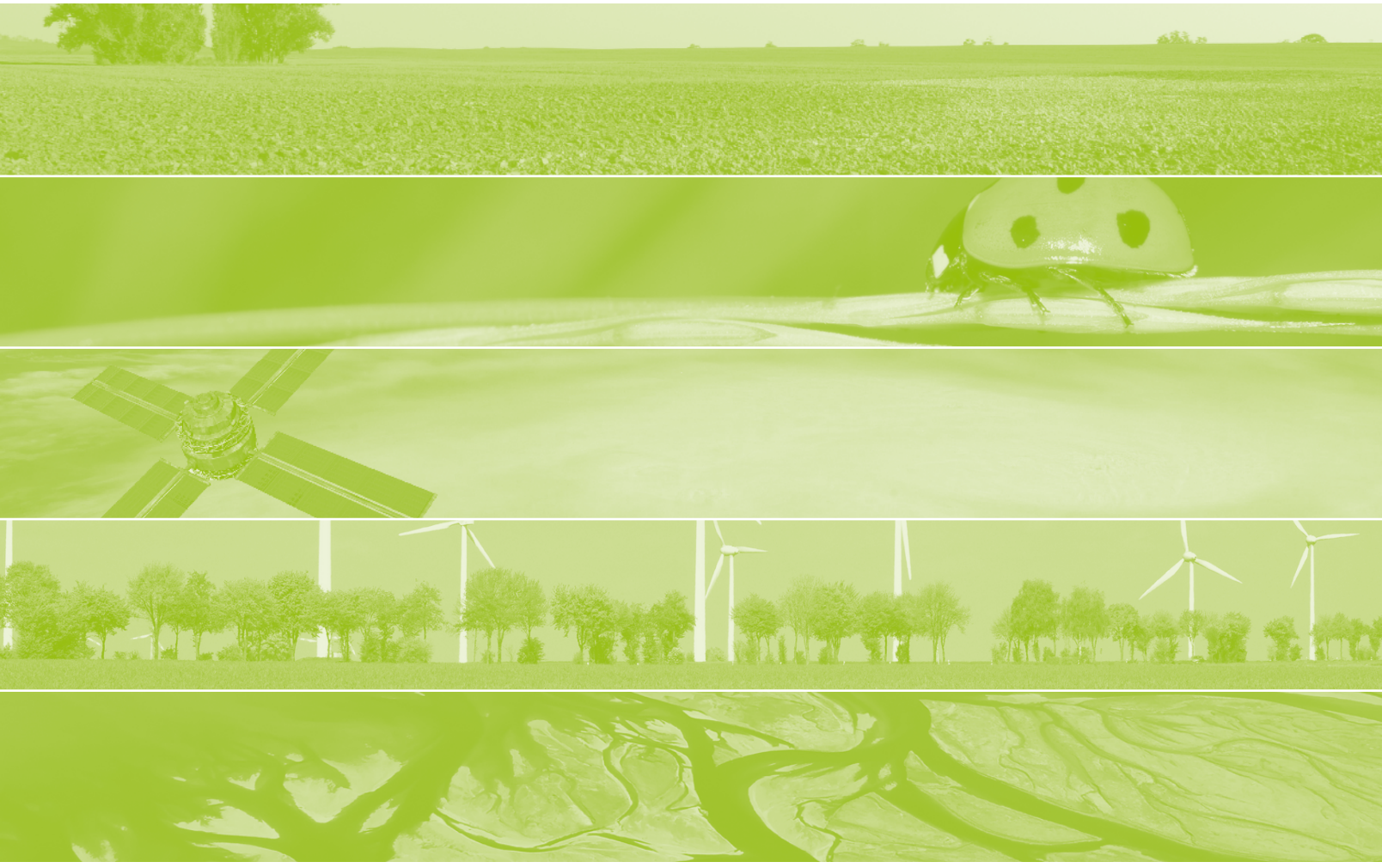
Annex 7 Recording form for linear plots

Observers: **Date:**

Location: **Linear feature:**

Code	Species	%	Code	Species	%

Comments



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