

Handbook for Surveillance and Monitoring of Habitats, Vegetation and Selected Species

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Reviewer

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Preface

The present Biodiversity Monitoring Handbook has been derived from the BioHab Monitoring Handbook developed in the EU FP5 framework. In the BioHab project the core of the GHC methodology was developed building on existing knowledge throughout Europe. After the BioHab project work has been ongoing to improve the context, correct errors and expand its use to regions outside Europe. The original BioHab Handbook was the basis for developing the draft Handbook for the Mediterranean biome outside Europe. The present version of the Handbook includes comments from users throughout Europe, but also after use in Israel, South Africa and western 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 as well as results from field work in Cabo da Gata (Spain) have been added. Additional life forms have been included especially from Philip Roche and a procedure included for recording them. A further section has been added on a procedure for recording multiple layers of vegetation 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 in southern France. The procedure has also tested in the Italian Alps, Northern Portugal, Belgium and Northern Britain.

Many additions, especially related to desert habitats, and minor qualifications have been made from the original BioHab Handbook published in 2005, but the principles remain the same. The software and the key to Annex I habitats, which is developed by INBO with support of Alterra, is now available for use on a PDA or field computer. In due course also a laminated booklet will be produced with the major recording rules for use in the field.

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1 Introduction

There is a relationship between habitats and biodiversity and the General Habitat Types (GHC) represent an important level of information on the status of nature. Habitats of good quality can be considered as a proxy for species occurrence. For instance, birds as the bittern (*Botaurus stellaris*) can only be found in reed marshes 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 (<http://www.ebone.wur.nl>) and BIOBIO (<http://www.biobio-indicator.wur.nl/UK/>) both deal with surveillance and monitoring of biodiversity, although at different levels and with different objectives. EBONE is focussing on European biodiversity monitoring in general, while BioBio has its focus on agro-biodiversity in low input and organic farming. However, because the methodologies of habitat data collection do not differ in principle, both are using the common habitat monitoring approach as basis for biodiversity monitoring. BioBio is using the habitat maps for further selection of vegetation and species monitoring plots.

This handbook 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 (http://www.earthobservations.org/cop_bi_geobon.shtml). To develop a global handbook 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 handbook is organised in modules for different objectives. The core methodology of habitat recording is the GHC methodology in which GHC stands for general Habitat Category. In some part of the modules may be selected only and another part omitted according to the objectives of the projects, e.g. BioBio will not need to record layers of vegetation in forest and can exclude that part from its project manual. For other projects new modules have been added based on experiences and discussions in EBONE. These additional modules will be essential to developing a global biodiversity handbook 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 one of the most well recognized biomes in the world partly because of its distinctive character and partly because its products such as wines from France, Spain, Italy and Greece in Europe, from California, Chile, Argentina and Australia, olives and fruits help to define its world wide distribution. 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 of a high cover of bare ground. A section has been added for recording where there is less than 30% vegetation cover in order to enable more details to be available in desert habitats.

The situation is further complicated by the high proportion of saline soils in many low rainfall areas which emphasises the dryness of soils. EBONE therefore included life forms which help to separate Mediterranean environments from semi deserts and true deserts. Experience in Israel suggests that additional information on the patterns of vegetation will also be required. Such experiences are included in the present document. An additional point is that 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 species 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 as indicators of climate change.

In Israel the gradient from Mediterranean through semi-desert to desert is over 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 in the gradient. Furthermore a brief look at the literature suggests that there are many other modifications of life forms in South Africa which warrant consideration. However these need to be considered carefully as they may be minor variations due to local conditions.

There is experience in applying a GHC methodology in the detection of change such as in Northern Ireland, Denmark and Great Britain, and in interpreting changes from aerial photographs in Spain, Sweden and The Netherlands. One of the key elements of this approach is its potential for the detection and evaluation of flows between habitats. The planting of forest does change the stock of habitats. Evaluating ecosystem change for biodiversity conservation such a change can be considered negative if planted on blanket bogs, but is positive if planted on arable land. However, when evaluating the capacity for food production the evaluation results are opposite.

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

The GHC methodology for habitat mapping and its recording remains to be continuously updated and adjusted for specific project purposes.

The handbook has been structured as follows. Chapter 2 describes the principles of the surveillance system and Chapter 3 the procedures of recording habitats. In Chapter 4 the general Habitat Categories, Qualifiers, Life forms and related species are being described. Different sections refer to areal, linear and point features. For measuring habitat diversity the core of monitoring activities is in repeated surveillance of areal and linear features. In Chapter 5 vegetation recording is elaborated. 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 6 worked examples for habitat recording are given. Annexes have been added lists of indicative plant species for each Life Form (for Europe), a glossary of terms and a list of General Habitat Categories.

2 The Surveillance System

2.1 General Habitat Categories (GHCs)

Ecosystem monitoring implies a definition of the scale on which the systems are being observed. In general an ecosystem is a community of organisms and their physical environment, existing within a defined habitat, and the interactions among them. Ecosystems occupy a more-or-less defined area, and can be nested within other ecosystems. Common approaches for in situ monitoring how ecosystem extent is changing require definitions that are harmonised continentally and globally.

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; in some countries heath lands (low scrub) are included in other they are excluded, depending on farming practice. These definitions are important to define forest decline, land conversion and CO₂ sequestration.

At the level of biomes and therefore at the European level General Habitat Categories (GHCs) can be used as the primary structure for recording ecosystems or habitats. It provides links to national and other higher level, continental classifications. The GHCs are mainly based on Life Forms (Raunkiaer 1934) with added detailed information on environment, site, management and species composition. The term was developed to include Life Forms (LF) and other Non Life Form Habitats such as urban, crops and sparsely vegetated. Rock and various categories and combinations of bare ground are also considered as habitats in its own right and are especially important in deserts and mountains, although they are often also important in combination with life forms as in limestone pavements.

A list of GHCs is provided which act as the core of the procedure for recording habitats and linking extant data. The reason to develop this system is to avoid the multiplicity of categories that would otherwise result from disaggregated recording. 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 data sets. Many GHCs can be expanded by various qualifiers if further detail is required.

The working definition of “habitat” developed in the BioHab project and used in this Handbook is as follows: “An element of land that can be consistently defined spatially in the field in order to define the principal environments in which organisms live.” In this way it is the spatial identification of an ecosystem as it is not strictly linked to a single species.

2.2 Monitoring by means of GHCs

Statistically, it is essential to return to the same sites to record changes. This is the procedure followed in all the major monitoring exercises in Europe, in forestry, air quality. There are several networks already existing for monitoring ecosystems and biodiversity change employing various size units from 16 km squares down to 0.25 km squares. Most of the field recording is at the 1

km² level, as a compromise between detail and generality, and the GHC methodology has therefore been based at this level.

The General Habitat Categories (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 emphasis in the 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. In fact, a considerable part of the time used for the refinement of the database has been devoted to the systematic control of all detected changes back in time. Such a rigorous change control is necessary, since landscape monitoring relies on the detection of small changes and using this procedure guarantees that the changes have actually taken place. The statistical confidence that can be attached to the measures can however be low if changes are rare. Eventually the final arbiter is the application of standard statistical techniques to detect real changes from background noise. Regular reference to the Handbook is essential especially in difficult situations.

2.3 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.

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: <http://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 due to the lack of adequate definitions of the multiplicity of terms. Any biogeographical term that can be determined consistently can be attached 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 and differences in species behaviour in contrasting biogeographical regions. However the use of indicator species to identify environment qualifiers is useful.

Non Life Form Categories are urban (URB), crops (CUL) and sparsely vegetated habitats (SPV). These are dominated by absence of Life Forms (see 3.5).

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 3.4. For further details regarding rules that are specific to linear elements see 3.12 and 3.13 with additional codes in Section 4.2. For further details regarding rules that are specific to point elements see 3.14.

3.1.1 The survey area

The basic survey area is 1 km² 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 km² 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 and in which case a later start would be preferable in a late season. The extent of the window must be set by region, using local phenological information. In the desert environment the survey of vegetation may only be possible after a rain event and may therefore be determined by when these occur.

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

3.1.3 The 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. Further checking of possible inconsistencies is also advised. The training must be coordinated by experienced people as confirmed by the experience in Israel. 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 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 Handbook must be referred to continually in order to optimise field performance, especially when working in landscapes that have contrasting elements, e.g. vineyards.

Quality assurance involves repeated recording by independent observers of previously surveyed squares. Both the Countryside Survey of Great Britain (GB-CS) and the Northern Ireland Countryside Survey (NICS) have used grids of points from random squares to check on the quality of data from different surveyors to identify errors.

A procedure was 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 1 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.

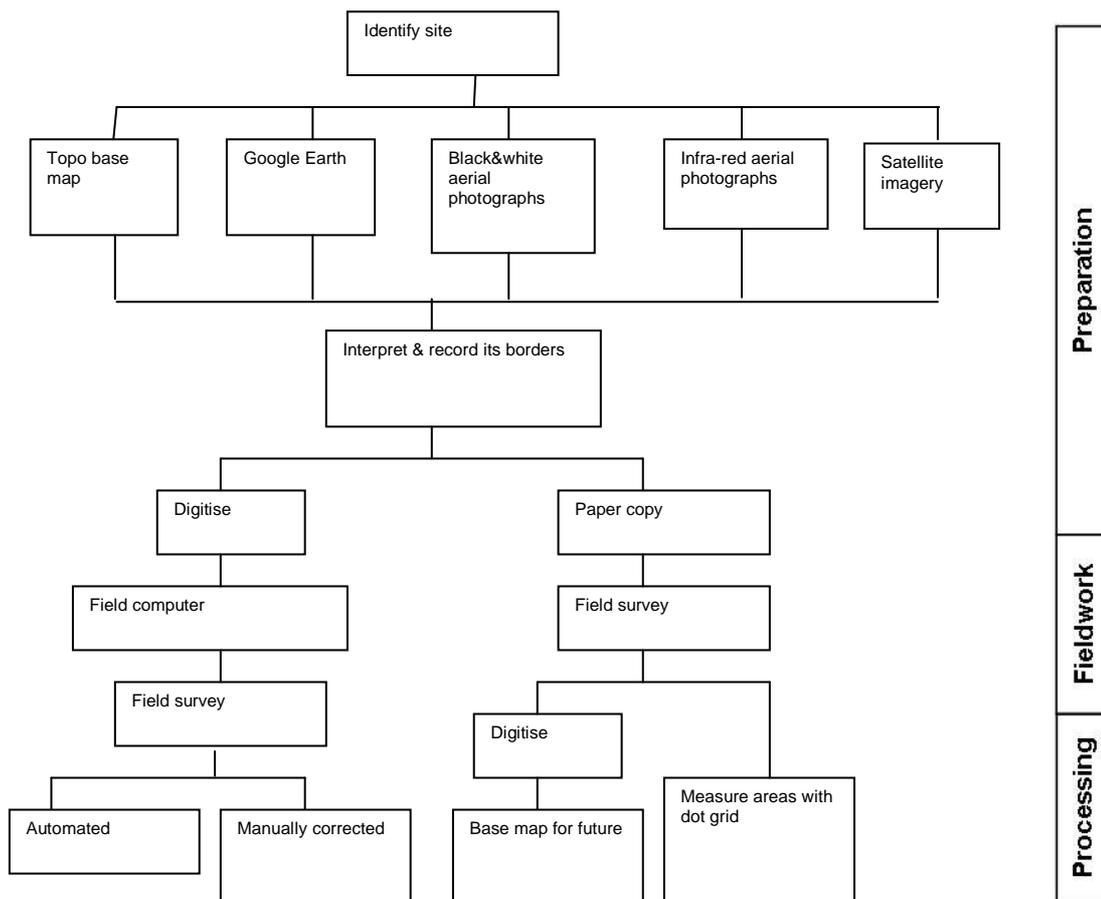


Figure 1. Procedure of field monitoring, including preparatory work of preparing field maps and checking/correction of field information afterwards

3.2 Preparation

3.2.1 Aerial 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.

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 Chapter 4). Procedures for recording vegetation are given in section 5.

3.2.4 Application of field computers

Since the first version of the handbook 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 with one exception, 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 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 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. 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 will be available within the consortium.

3.3 Habitat mapping: general rules

In this chapter the methodology of how to 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 chapter 4.

3.3.1 Mapping of individual elements

Separating map elements is based on strict rules (see 3.4.1). The mapping of areal elements adds to 100% of the land. 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 400m² 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 2.13 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 400m²

If an area is less than 400m² 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 400m² 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)

It is not uncommon for linear elements to form complexes, with several distinct linear elements adjacent to each other, such as a hedge next to a ditch next to a track. If there are several linear elements, which are less than 5m wide, but combined together form an area of over 5 m wide and over 80m long, then they should be recorded as an areal element. The linear features making up the areal element should then be mapped separately. (See Figure 13)

3.3.2 Recording of individual elements

Elements are assigned alpha codes as identification codes that are the same on the map and on the corresponding recording sheet. The alpha codes are unique for the map.

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

All fields 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 4.4 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.

The GHC methodology is based on Life Forms and Non Life form 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 4.3.1).

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 are recorded later.

The surveyor should record data of areal elements on one recording sheet and data of linear and point elements together on another recording sheet. A third sheet is provided for background information on the survey square. Examples of completed recording sheets are given in Chapter 6.

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 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 column 5 (full list of habitats) and then decide upon the GHC in column 2.

3.3.3 Recording Form

In all cases the field surveyor should make a decision in the field, as emphasised above. There is a separate recording format to be used for areal and linear and point elements. The recording form for areal elements has an alpha identifier and eight subsequent recording fields. If a Field Computer is used then the appropriate instructions should be followed, but the structure is the same.

The first entry is for the alpha code which links the map with to the GHC. All alpha codes are unique. Elements on the map that are the same can get the same alpha code, but are indicated by additional codes: A1, A2 have the same GHC but are different map elements.

- The *first field* is for entry of the GHC (see 4.1).
- 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 4.3 and 4.4 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 4.5).
- 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 4.6).
- The *fifth field* is for entry of the full list of habitats within the GHC together with the major species and percentages (see 4.7).
- The *sixth field* is for entry of European Habitat classifications, including EUNIS, Annex I and other pan European classifications (see 4.8).
- The *seventh field* is for entry of Farmed and Non-Farmed features, if appropriate (see 4.9).
- The *eighth field* is for entry of regional or local habitat classifications and/or phytosociological associations, where appropriate (see 4.10).

The EBONE project will use a simplified recording sheet for linear elements with a predefined list of linear elements. All ecological significant point features will be recorded. The eighth field is not recorded in EBONE.

3.4 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. Capital letters of the Latin alphabet are used for the alpha code. “I”, “O” and

“X” and should not be used. Once all the letters of the alphabet have been used then 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; 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.

Successive paths with the same alpha code should be recorded as A1, A2, etc on the map. Although fences are not recorded, if they separate fields then each field should be drawn separately.

3.4.1 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 nine rules is true:

- 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.

3.4.2 Photographs

It is strongly recommended that a photograph 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.

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

3.5 Determination of the General Habitat Category

This section describes the rules for the determination of the GHC (i.e. the primary recording code) for areal elements. For the full list of GHCs see Annex 3.

Determination of the GHC is based upon a sequence of five dichotomous divisions (Figure 2) 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 Non Life Form Categories (NLF) and Life Form Categories (LF) that can be used to identify the appropriate GHC. The GHC is determined first so that a decision is 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. These categorical divisions need a series of supporting rules as given in Section 4.1.

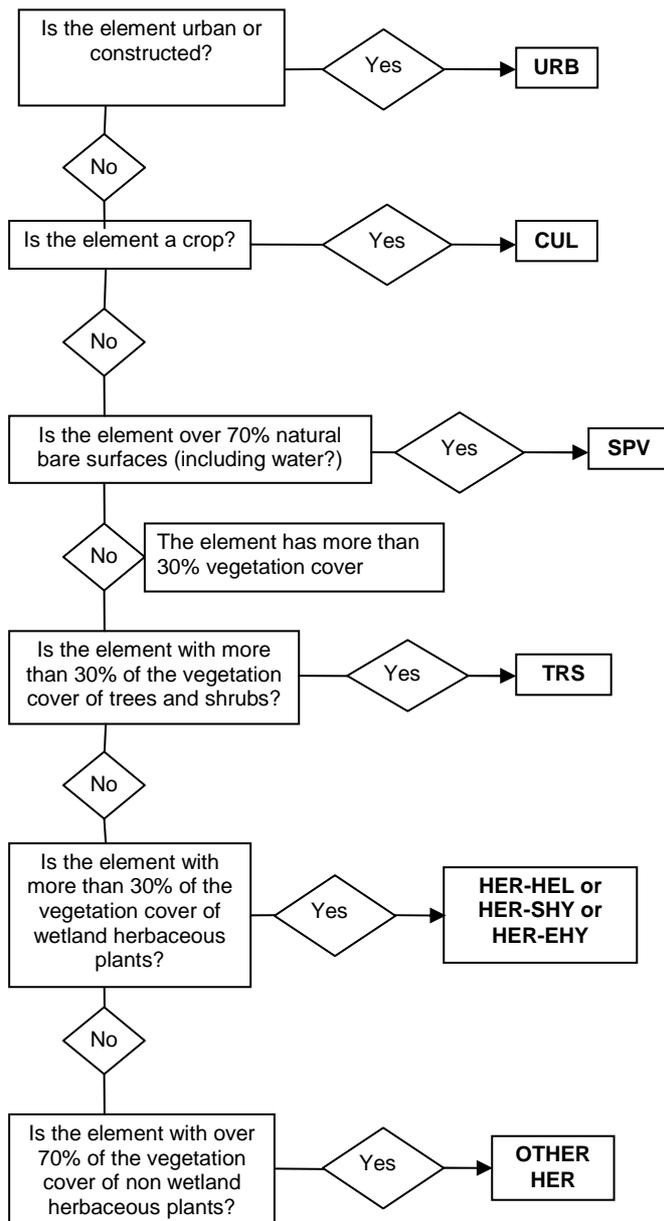


Figure 2. Decision tree for super categories. Further detailed rules are given in Section 3.

The cover of surface a given habitat is estimated from a vertical perspective that is the land cover is as seen from above not that which is beneath a given canopy (See the worked example in Chapter 7).

3.5.1 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 and Annex 3).

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) See Table 1.

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. Possible combinations of forest life forms and their notation on the field sheets. Note that because the recording is only 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
0	100	FPH/CON
10	90	FPH/CON
20	80	FPH/CON
30	70	FPH/CON
40	60	FPH/DEC/CON
50	50	FPH/DEC/CON
60	40	FPH/DEC/CON
70	30	FPH/DEC
80	20	FPH/DEC
90	10	FPH/DEC
100	0	FPH/DEC

3.5.2 Rules for recording vegetation layers.

In forests 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.

A layer is 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, but no new boundaries for elements are to be drawn. 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 five. 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.

EXAMPLES

Two examples of recording vegetation layers in forests are given in Table 2. 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 2, patch B.

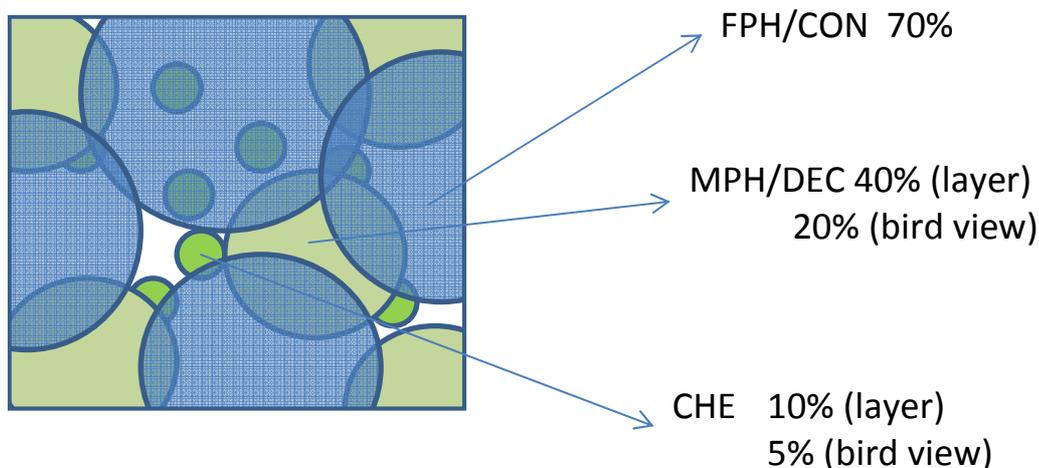


Figure 3. Forest including species in different layers

Table 2. 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	

3.6 Full list of habitats

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 5. 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 7. See Section 4.7 for rules about recording species. Note that the proportions of life forms in field 5 should add to 100%, see Table 3. 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 5. The GHCs therefore reflect the dominant LFs. For the full list of habitats see Annex 3.

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 are then 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 2)

In desert categories also Life Forms below 10% will be recorded as actual percentages.

Table 3. 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	30	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.

The layers are recorded 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.

3.7 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 5 and it is therefore recommended. In the field computers list of species are made available for each region/country through the SynBioSys database (<http://www.synbiosys.alterra.nl/>).

3.8 Global qualifiers.

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% or in the case of a complex of linear elements. For the full list of global quantifiers see section 4.4.

3.9 Environmental qualifiers.

Environmental qualifier codes are to be entered for areal and linear elements in order to express variation between elements that have the same GHC. They are not applied to urban/constructed, crop or sparsely vegetated elements. 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. A full description of the environmental qualifiers is given in section 4.3.

3.10 Landscapes, Habitat complexes and Habitats of Annex I, Habitats Directive

Within EBONE a rule based key to Annex I habitats has been produced using GHCs to provide a hierarchical key. This key is provided in Annex 4 of this manual, and is available as PDA software on field computers. The Key is also available as EBONE-Deliverable 4.2 through <http://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.

When the information is put on the field computer, the key will lead the surveyor to an individual class, which can then be checked with the full descriptions within Annex I. Apart from the vegetation defined habitats there are over 40 landscape units and habitat complexes. It is necessary to treat these separately as they may contain other habitats within them. It is suggested 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.

Many sites will not contain any Annex I habitats. Some guidance is given about what is included but inevitably many situations will not be covered and only a GHC will then be recorded. With the expansion of the European Union the member states have interpreted the descriptions in the Interpretation manual rather widely, so that not all possibilities 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 Annex I habitats contain 46 landscape classes and habitat complexes which consists of more than three GHCs. The approximately 200 remaining habitats will usually equate with one GHC, but sometimes two or three in which case they have multiple entries. 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. On the other hand, many upland areas will have several because of the bias towards semi-natural vegetation.

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 4.

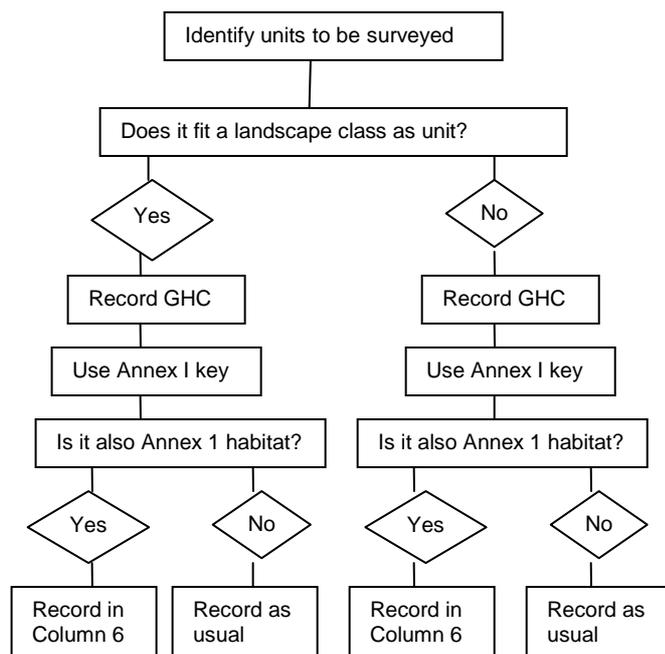


Figure 4. Decision tree to determine if an Annex I code should be recorded.

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 procedure for using the key to Annex I habitats which are not landscape classes or habitat complexes involves putting a code in column 6 as shown in Table 4. There are therefore 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 one 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 4).

Table 4. Habitat recording with inclusion of Annex I codes

code	Field 1	Field 2	Field 3	Field 4	Field 5				Field 6
	GHC	Environ 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	Salicornia	100	
C	CRO	5.3	0		CRO	100	Wheat	100	0
D	FPH	5.3	0	0	FPH	100	Que rob	100	91F0
E	SCH/EVR	2.2	7.3	0	SCH/EVR	60			4020 80% 7150 20%
					CEH	20			
					LHE	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 5). 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 5. 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 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 cannot be done without involvement of the European Topic Centre for Biodiversity. 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 landscape class then the mapping procedure would be as usual i.e. without the Estuary 1130 code and be the usual 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 LPH/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.

3.11 Farmland classes

This typology was developed for a European project on Farmland features. Farmland classes indicate which elements are directly or indirectly affected by farming. See section 4.9.

3.12 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

The width of hedges, lines of scrub and lines of trees include the canopy.

An element that has a width below 0.5 m 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 0.5 m wide before they are mapped and recorded. Thus a strip of grass 0.30 m wide between cereal fields is not recorded.

If there are several linear elements, which are less than 5 m wide, but combined together form an area of over 5 m wide and over 80 m long, then they should be recorded **as an areal element with a global code LCO**. The linear features making up the areal element should then be mapped separately on the linear elements sheet.

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 will not reflect the actual distance of the lines on the map as comparable to Figure 13.

In some cases a linear element may be part of a group (see example in section 6.3). In this case the elements are linked to an areal element and their presence is recorded within that element (e.g. erosion gulleys in arable fields or terraces below 5 m wide in vineyards).

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

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

If this is a different in GHC next to a road, track, footpath or river, 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, the banks and verges are included in the width of roads, tracks and rivers and also recorded as separate lines.

Within forests or under lines of trees (30% cover of trees over 5m) linear elements are not mapped beneath the canopy except for water courses, public roads and constructed tracks as these elements are important in further spatial analysis.

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

Subterranean watercourses are not recorded.

Water courses 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 over at least 30 m length, otherwise they may be recorded as points, if ecologically significant (see 3.14).

There are two main options for recording linear elements:

1. Full details as described in the areal elements including all the rules for alpha code changes. The 30 m rule is applicable to decide whether or not to map a habitat element as a linear, but also to determine the composition within this length. Therefore different parts within 30 m are recorded as combinations, but the 30% rule then applies within that length. Otherwise different parts which are each at least 30 m are mapped separately. Separating different parts of a linear element is based on the same rules as for areal elements (see 3.4.1).
2. Mapping only specific categories of linear features such as listed in section 4.2 as for the BioBio project without GHC and species detail. A hedge between two and five meters will not be separated into different lengths if the species composition were different. Also changes in GHC would not be recorded, e.g. water course may contain several GHCs, but in this procedure would only be mapped as a single line.

3.13 Recording linear elements

These 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 handbooks of the GB-CS and NICS, supplemented by European experience. The full description of the linear categories can be found in section 4.2.

Walls	WAL
Water edges	WAT
Lines of scrub	LSC
Hedges	HED
Species Rich Hedge	SRH
Lines of trees	LTR
Herbaceous strips	HST
Grass strips	GST
Tracks	TRA
Roads	ROA
Lines of SPV	LSV

Table 6. Predefined list of linear element as used by EBONE

EBONE will use this second option of a predefined list for linear features including the GHC.

Note that recording the length of the hard surface of roads or tracks is optional and can be done as a GIS exercise. Also note that neither GST nor HST are included under the canopy of trees and hedges.

3.14 Mapping Point elements

Elements that are smaller than 400m² and shorter than 30m can be recorded as point elements. 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.

The criteria to record point features are as follows:

- The feature is a GHC with an area between 100m² and 400m² (minimum square: 10 x 10m; circle 11m diameter) and has an *ecological significance in a landscape ecological perspective*.
- The feature is an ecologically important element according to the criteria below.
- The feature is smaller than 100m² but has a clear *ecological significance in a landscape ecological perspective*, e.g. springs, moorland pools, earth pillars and barrows.
- 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 rules 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 Annex I
4. No point elements are recorded.

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 features, 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 an existing ecological process acting on the landscape scale: weirs on watercourses that hinder migration and constructions for animal crossings across roads.

There should be a space on the Background Information Sheet (see 7.1) 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 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 400m²), 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 ecological significant point are recorded for surveillance.

For monitoring new points may be added if they have become significant over the time period.

4 GHCs, Qualifiers, Life Forms and Species composition

4.1 Field one: Rules for determining GHCs

GHCs can be 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 Life Forms and associated Life Form Qualifiers are given in Annex 1. There are also GHCs based on non Life Forms (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 2) can be omitted to save recording time and space. GHCs may be LF or NLF Categories or combinations. The complete list of GHCs is given in Annex 3. and pictures of actual GHCs are provided on the EBONE website <http://www.ebone.wur.nl/UK/Project+information+and+products/General+Habitat+Categories/>.

Sections 4.1.1 to 4.1.3 cover the NLF Categories. These are identified by urban, crop and natural non-vegetated categories. The sections 4.1.4-4.1.6 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. The LFs are based on the definitions available from plant morphology, a discipline now virtually absent from university courses. Many users will not therefore 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, but behave as leaves. In some cases also the strict morphological definitions have not been used in order to be as close as possible to the regression concept of Life Forms. 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 was extended to all rhizomatous species in order to be consistent.

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

In this handbook a Pan-European working definition of urban land and constructed elements has been produced. Recreation areas and parks are included in this category of “urban” elements. In other continents additional categories and refinement of definitions might be needed.

4.1.1 Urban/Constructed

These GHCs are Non Life Forms (NLF) urban categories have aggregated some LFs as a second tier, e.g. herbaceous includes all herbaceous life, 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 around an industrial building or in agricultural use and grazed by animals.

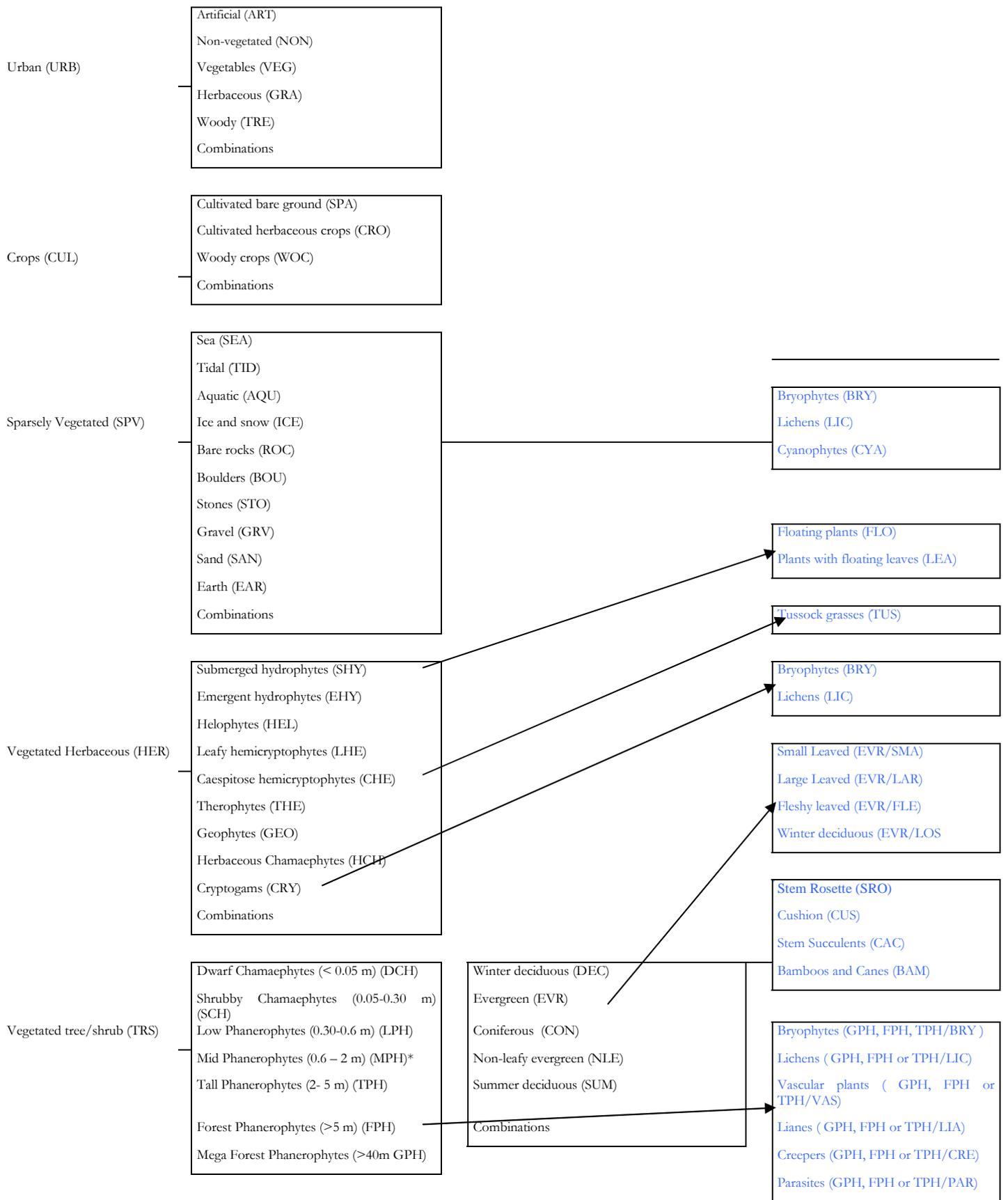


Figure 5. Diagrammatic representation of the GHC key. The optional Life Form qualifiers are given in blue.

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

- 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, 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 adjacent to urban areas should be included within the urban boundary the rural vegetation starts with the verge on the side of the road next to the non-urban elements.
- Linear and point elements are not recorded in urban areas. This include linear elements around urban areas., e.g. elements 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 wet plants over 30% cover. Use the codes from section 4 of the site qualifiers to describe them.
- 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 most European countries there are clearly marked boundaries around urban land and recreation areas e.g. The Netherlands, Spain and Belgium whereas in other countries e.g. Austria, Estonia and Norway there may not be actual physical boundaries around the houses. The instruction in these cases is as follows: “*the urban boundary should be drawn around the grounds of a building where the management intensity changes from that of a gardening character to more extensive management types.*”
- In case of scattered holiday homes such as caravans within semi-natural vegetation then a boundary should be drawn around the whole area and the appropriate point element procedure (see 2.13) used to record scattered buildings within the surrounding GHC.
- Glasshouses and polytunnels are Urban artificial (ART) with the qualifier “horticultural use” (A5.7) regardless of what is actually under the glass/polythene, because it is not possible see what is growing inside.
- Before going into the field, recent areal cadastral maps should be consulted, as these invariably define urban areas accurately. However, they need to be checked in the field in conjunction with aerial photos because changes may have taken place and recreation areas may not be included within the urban boundary 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 is 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, tourists and visitors will often be in evidence, as will be the absence of agricultural activity. The site and management qualifiers should be used to provide supportive detail and will be invaluable for validation of change during the monitoring process.
- 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 3.2.4, can also be used when necessary.
- Buildings and associated land below 400m² should be recorded as points or as groups of points as described above. Where more than three houses of 400 m² are adjacent they can be mapped as a single areal element with percentages in field 5 (see 2.9).
- Environmental qualifiers and life form species composition are not attached to elements inside urban land, unless it is a linear element e.g. a road outside urban areas surrounded by non-urban land.
- Each group of super categories must be recorded with the highest value first or in the order given below.

The following GHCs have been defined to cover urban elements. Some constructed elements 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 400m² as a pure category and will mainly be recorded as combinations. Fruit trees over 2m 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. 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 2m (i.e. TPH + FPH) this category includes fruit trees such as apple, pear and plum, 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.

4.1.2 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 5 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 state management qualifiers) if there is no evidence of pruning in the last seven years, recent use, or collection of fruit (see 4.6).

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 and sunflowers and perennials, e.g. Lucerne and strawberries. 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. 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. The names of crops, both English and Latin are given in section 4.6. Any vegetation cover, below or beneath the woody crop, over 30% should be recorded with appropriate life forms in field five.

4.1.3 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 covered by saxicolous, lichens and bryophytes 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.

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

- **Terrestrial (TER):** includes six subdivision describe below

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 0.20 m diameter
- **STO** rocks and stones 0.05-0.20 m diameter
- **GRV** gravel 0.01-0.05 m diameter
- **SAN** sand 0.001-0.01 m diameter
- **EAR** earth, mud, silt and bare soil below 0.001 m diameter

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 4.4.4 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.

Life Form Qualifiers for the terrestrial SPV codes

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

- **BRY**-Bryophytes, includes both mosses and liverworts
- **LIC**-Lichens
- **CYA**-Cyanophyta and algae

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.

4.1.4 Herbaceous wetland

Examples of widespread species with short descriptions of all the following LFs are given in Annex 1.

- **Submerged hydrophytes (SHY):** plants that grow in aquatic conditions (see 4.3.1) 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.

- **Emergent hydrophytes (EHY):** plants that grow in aquatic conditions (category 1, see 4.3.1) with the main plant above water.
- **Helophytes (HEL):** plants that grow in waterlogged conditions (category 2, see 4.3.1).

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 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 that which 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.

Optional Life Form qualifiers apply to SHY:

- **FLO:** Floating plants, e.g. *Lemna spp.* and *Eichornia crassipes*
- **LEA:** Plants with floating leaves, e.g. *Nymphaea alba* and *Nuphar lutea*

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

4.1.5 Herbaceous

Guidelines for the identification and further details of widespread species with short descriptions are given in Annex 1

- **Leafy hemicryptophytes (LHE):** biannual or perennial broad leaved herbaceous species, sometimes termed forbs. Annual species are considered as **THE** (see below).
- **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).
- **Therophytes (THE):** annual plants that survive during the unfavourable season as seeds. Small patches of therophytes of about 40m² 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.
- **Geophytes (GEO):** plants with buds below the soil surface. But not those with rhizomes-see further information in section Annex 1.
- **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.

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. Those growing on the ROC, BOU or STO categories are included in 4.1.3:

- **BRY** mosses and liverworts
- **LIC** lichens

- **Herbaceous Chamaephytes (HCH)**: cushion plants usually with perennial leaves.

This sequence 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.

The following Life Form qualifier is optional and can be applied to CHE category:

- **CHE/TUS** Tussock grasses over 60 cm typical of xeric conditions e.g. *Stipa*. Height excludes inflorescences

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

4.1.6 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 terminology. However these genera have a shrubby form and have perennating buds above ground level. Height is therefore the only consistent arbiter (see Annex 2 for examples of plasticity). Note that all the classes below are rooted in the ground. See 3.1.7 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 400m² can be recorded as points. Individual trees or shrubs can also be recorded as points if they are ecologically significant (see 3.2.4). 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 to show that it is a young plantation so that they can be extracted as forest land use later.

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

- **Shrubby Chamaephytes (SCH)** under shrubs: 0.05-0.3 m. e.g. *Thymus vulgaris*, *Lavendula stoechas*.
- **Low Phanerophytes (LPH):** low shrubs, buds between 0.30-0.6 m, e.g. *Myrica gale*, *Betula nana*.
- **Mid Phanerophytes (MPH):** mid shrubs, buds between 0.6-2.0 m, e.g. *Pistacia lentiscus*, *Cornus mas*.
- **Tall Phanerophytes (TPH):** tall shrubs, buds between 2.0-5.0 m, e.g. *Salix cinerea*, *Corylus avellana*.
- **Forest Phanerophytes (FPH):** trees between 5.0 and 40 m, e.g. *Quercus robur*, *Fagus sylvatica*.
- **Mega forest phanerophytes (GPH)** trees over 40 m e.g. *Sequoia gigantea*, *Sequoia sempervirens*

A further optional division is required for the MPH category in the Fynbos of South Africa and can be recorded as MPH1 for 0.6-1.2 m and MPH2 for 1.2-2.0 m. This division will nest into the MPH category. See Height categories in the global codes (see 4.4.3).

Optional Life Form qualifiers to all TRS Life Form categories are:

- Stem Rosettes/caulinosulate (**SRO**) are stem 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 *Espalazja* spp. Tree ferns and palms also fall within this group.
- Cushions (**CUS**) 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, e.g. *Fredolia acricoides* and *Astragalus tragantha*.
- Swollen stems-cacti and succulents (**CAC**) are plants with swollen stems with maybe a few residual leaves or leaf scales e.g. *Opuntia* and *Cactus* spp.
- Bamboos and canes (**BAM**) are herbaceous plants with buds above ground level and evergreen leaves e.g. *Arundo donax* and *Bambusa* spp.

The following leaf subcategories, are designed to fit into world biome systems and apply to the six shrubs and trees 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 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):** e.g. *Quercus robur*, *Fraxinus excelsior*.
- **Evergreen (EVR):** *Quercus ilex*, *Laurus nobilis*.
- **Conifers (CON):** *Pinus nigra*, *Juniperus communis*.
- **Non-leafy evergreen (NLE):** e.g. *Sarothamnus scoparia*, *Ulex europea*. Some of these species have leaves which are short lasting e.g. *Cytisus* and *Ulex*
- **Summer deciduous (SUM):** *Acacia species*, *Zyziphus lotus*

The following additional optional leaf qualifiers are given below:

- **EVR/SMA:** small leaved (length less than 2cm) e.g. *Quercus ilex*, many *Cistus spp*
- **EVR/LAR:** large leaved (over 2 cm) e.g. *Laurus nobilis*, *Viburnum tinus*
- **EVR/FLE:** fleshy leaved but excluding marginally fleshy leaves on genera such as *Chenopodium* e.g. *Agave ssp* and *Aloe ssp*
- **CON/LOS:** will lose needles in winter i.e. winter deciduous e.g. *Taxodium mucronatum*, *Larix decidua*

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.
- In cases of even phanerophyte combinations, e.g. TPH 30%, MPH 30%, LPH 30, SCH 10, then the precedence is given to the tallest category.
- 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 releves 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.

4.1.7 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.

- **Bryophytes and liverworts (BRY)** e.g. *Frullania*, *Isothecium myosuroides*
- **Lichens (LIC)** foliose only not crustose e.g. *Lobaria*, *Usnea barbata*;
- **Vascular plants (VAS)** plants which grow beneath the canopy e.g. many *Orchis spp* and *Bromeliads*
- **Lianes (LIA)** plants which use trees/shrubs for support but are not attached e.g. *Smilax aspera*, *Humulus lupulus*, *Clematis vitalba*;
- **Creepers (CRE)** plants which attach themselves to trees/shrubs rather than just using them as support;
- **Parasites (PAR)** plants which depend on trees/ shrubs for nutrients e.g. *Viscum album*.

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 7 Whilst many of these species could be derived from database management of detailed species records their occurrence throughout an element would not be available.

4.1.8 The use 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 (Table 7). They are included as qualifiers because otherwise the number of GHCs would become prohibitively large. The list of **Primary Life Forms and Life Form Qualifiers** is given in Annex 1.

Table 7. 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	20	Hal umb	10
B	MPH/EVR	MPH/EVR/CAC	100	Opu vul	100
C	MPH/EVR	0	100	Bux sem	100
D	FPH/DEC	0	100	Cas sat	100
E	FPH/EVR	FPH/EVR/SMA	80	Que ile	100
	FPH/EVR	FPH/EVR/VAS	20		
	FPH/EVR	FPH/EVR	10		
	MPH/EVR	MPH/EVR	10	Cis lad	80
	CHE	CHE/TUS	10	Sti cap	100

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 Handbook, 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.

4.2 Predefined list of linear elements

The list below defines the linear features to be recorded in EBONE. The descriptions are based on the information in the field handbooks of the GB-CS and NICS, supplemented by European experience:

- **Walls (WAL):** includes dry stone, mortared and brick walls with or without capping, as well as earth walls and banks, but not levees. The walls may retain terraces or be free standing. Ruined walls are included in the category, as long as there 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.
- **Watercourses/water bodies (WAT+SHY, EHY, HEL, AQU, TER divisions):** includes seepage and spring lines with standing water, streams, rivers, canals, ditches of variable width with free standing water, ponds (but not temporary ones), lakes (including artificial water bodies). They are very variable, from the major rivers of Europe, to small alpine streams. Elements over 5m wide and 80m long or over 400m square will be mapped as areas, but the edges should be mapped as linear features.
- **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.
- **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 Netherlands and locally elsewhere. Hedges around woodlands are recorded.

- **Species Rich Hedges (SRH):** The definition of a hedge is given above. Species Rich Hedges have 5 or more wooded species per 30m length.
- **Lines of trees: (LTR +FPH+ DEC, CON, EVR, NLE, SUM)** includes lines of **trees over 5 m** in height whether spontaneous or planted. There may be an under-storey, but if this is managed, it should be treated as a hedge, otherwise it is not recorded. They may have developed along field margins, beside walls, on steep banks or occasionally may be relicts of the original forest cover. They may also be present beside water courses/water bodies - see precedence rules for recording plots in 2.11 and 2.12. If recently felled, estimate where the canopy was.
- **Herbaceous strips (HST):** includes grasses mixed with broadleaved plants (**LHE/CHE**) or only broadleaved plants (**LHE**). **THE** and combinations with LHE or CHE may also be included. 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.
- **Grass strips (GST):** includes strips where grass (**CHE**) is 70% of the vegetation cover as shown in 3.1.5. otherwise the information given in the section above equally applies.
- **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 80 m 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):** Roads with pavement or asphalt. The verges are recorded as for tracks. Motorways and other roads wider than 5m. are recorded as areas.
- **Lines of Sparsely Vegetated (LSV):** All linear features with less than 30% vegetation cover. This includes cliffs are 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 are added were appropriate.

Note that recording walls, 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.

4.3 Field two: Environmental qualifiers

Environmental qualifier codes are to be entered into the second field of the habitat recording sheets for areal and for linear elements in order to express variation between elements that have the same GHC. They are not applied to urban/constructed, crop or sparsely vegetated elements. Global qualifiers may also be recorded in this field. They are given in Section 4.4.

4.3.1 Moisture regimes:

The categories below are based on the Concerted Action “Water regimes for forest productivity” coordinated by Graham Pyatt and published in 1999 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 angustifolium*, *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 & 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. As with 3.2.1.7 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 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 200mm and may not for several years.

4.3.2 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 (http://science.ceh.ac.uk/products_services/software/mavis.htm). 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. 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 highly saline
 - c. **High**: Over 0.8 very highly saline

4.3.3 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 8 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 8. 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 handbook. **It is essential to note that local use of terms, especially dry, may differ from the above matrix.** These terms must therefore be seen in the European context – that may be locally dry e.g. calcareous grasslands in Western Scotland may be wet compared with the situation of Southern Italy.

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.

4.4 Global codes

Global codes for height/depth and substrate are codes that can be used as qualifiers in field 2. They must be placed below the code to which they refer.

4.4.1 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.

4.4.2 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.

4.4.3 Height and depth codes.

These codes are to be applied to additional height classes of TRS (see 3.5.2), to the dimensions of linear elements and to define the height of rocks and screes that may have a small area, but appreciable height. The coding is an extension of the height categories of the GHCs. In most cases they are not needed, but they can be important for identifying of layers in forests and Fynbos. 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.

- 1 < 0.05 m
- 2 = 0.05-0.3 m
- 3 = 0.3-0.6 m
- 4 = 0.6-1.2 m
- 5 = 1.2-2 m
- 6 = 2–5 m
- 7 = 5-15 m
- 8 = 15 – 40 m
- 9 > 40 m

These scaling codes are combined with the Code HIG or DEP

HIG = Height – applies to the height of the element above the average ground surface.

DEP = Depth – applies to the depth of the element below the average ground surface.

4.4.4 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
- LCO** = A complex of linear elements

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.

4.5 Field three: Site Qualifiers

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

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 400m². 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.

Table 9. 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 moutonné	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
Geological element	2	Description for use of this qualifier
Plutonic rock	2.1	e.g. granite, gabbro
Hypobysal rock	2.2	e.g. dolerite, porphyry
Pyroclastic	2.3	e.g. ash, tuff

Volcanic	2.4	e.g. basalt, rhyolite
Unconsolidated clastic	2.5	e.g. sand, gravel, clay
Consolidated clastic siliceous	2.6	e.g. mudstone, shale
Calcareous	2.7	e.g. tufa, dolomite
Evaporite	2.8	e.g. gypsum, halite
Organic	2.9	e.g. peat, lignite
Residual	2.10	e.g. laterite, kaoline
Contact	2.11	e.g. horfeld, spotted slate
Cataclastic	2.12	e.g. cataclastic breccia, mylonite
Regional	2.13	e.g. slate, gneiss
Soil	3	
Permafrost	3.1	Soils with permanent frozen layer
Skeletal/Ranker	3.2	Soils with no profile development
Peat	3.3	Organic soils usually over 0.3 m deep
Peaty podzol	3.4	Peat material overlaying podzol (<0.3 m)
Peaty gley	3.5	Peat material overlaying gley
Gley	3.6	Anaerobic mineral soils usually grey or mottled
Brown earth	3.7	Free draining, fertile soil
Rendzina	3.8	Shallow calcareous soils
Chernozem	3.9	Soils of eastern Europe
Terra rossa	3.10	Red soils of the Mediterranean
Terra fusca	3.11	Mediterranean brown soils
Sandy soil	3.12	Soil formed from sand
Detritic soil	3.13	Soil containing a high percentage of detritus
Gypsum soil	3.14	Soils with high gypsum content
Alluvium soil	3.15	Soils formed from alluvial material
Hydromorphic soil	3.16	Water saturated but not peaty
Laterite	3.17	soils containing a high percentage of iron
Inland water	4	
Evidence of previous water cover	4.1	Evidence from flotsam and jetsam plus bare ground
Temporary running water	4.2	Evidence of previous running water
Films of water	4.3	Water running on the surface – usually over rocks
Spring	4.4	Point feature of emergent water
Flush	4.5	Lines of water flow not forming streams – wetland vegetation indicators present
Water course, running, non-tidal fast	4.6	River with water running over 10 m/s
Water course, running non-tidal slow	4.7	River with water running under 10 m/s
Water course, standing water	4.8	Linear feature with standing water

Canal	4.9	Waterways constructed for boat traffic
Irrigation canal	4.10	Constructed watercourse for irrigation
Canalised river	4.11	Rivers which have been modified (e.g. sections straightened, banks smoothed), but still follow the same direction as the natural watercourse
Tidal river	4.12	River influenced by tidal movement
Dry river bed	4.13	Temporary river bed usually with bare ground and signs of water flow
Dry ditch	4.14	Ditch more than 0.5 m deep with no water
Free standing water	4.15	Temporary standing water. Only record if evidence available.
Lake – natural	4.16	Inland water body over 400 m ² .
Lake – artificial	4.17	Usually distinguished by the presence of a dam or embankment
Pond – natural	4.18	Below MME record as point
Pond – artificial	4.19	Below MME record as point
Historical/archaeological element	5	
Barrow/burial mound	5.1	Burial mounds from prehistoric times
Ruin	5.2	Ruined buildings of archaeological interest
Marl pit	5.3	Pits for extraction of marl which is formed by a deposit of calcareous algae often filled with water
Cairn/Dolmen	5.4	Structures of rock from prehistoric times
Bank and ditch	5.5	Medieval structures around woods or boundaries
Hut circle	5.6	Remaining walls of prehistoric sites
Stone heap	5.7	Heaps of stone in fields from former agriculture
Castle/fortress	5.8	Self-explaining
Archaeological wall	5.9	Walls of archaeological interest
Ridge and furrow	5.10	Lines of old tilled land in W. Scotland
Aqueduct	5.11	Old (usually Roman) facility for transport of water made of stone
Sea/Marine element	6	
Submerged angiosperms	6.1	Cover of species such as <i>Posidonia</i>
Shipwreck	6.2	Self-explaining
Mussel bank	6.3	Habitat of mussel population
Sea weed bed	6.4	Cover of red, green and brown algae
Rock pool	6.5	Depression in rocks with remaining sea water in low tidal situations
Wave cut platform	6.6	Relatively level areas formed from wave action
Cultivated mussels/oysters	6.7	Lines of mussels/oysters in sea/tidal
Fish farm	6.8	Fish farm in sea/tidal
Coastal elements	7	

Yellow dune/white dunes	7.1	Young dune, highly mobile sand
Grey dune	7.2	Mature dune, podzolised, with acidic indicators
Dune slack	7.3	Wetlands in or behind the dunes
Salt marsh	7.4	Coastal wetland with saline soils
Strand line	7.5	Vegetation zone between dune or cliff and the sea
Maritime exposure	7.6	Vegetation affected by coastal winds but no halophytes
Bogs/mires/wetlands	8	
Palsa mire	8.1	Mires with frozen elements and pools
Aapa mire	8.2	Mires with frozen elements
Raised bog	8.3	Bogs with characteristic structure
Blanket bog	8.4	Bogs covering often a high proportion of the land surface, rain fed
Valley mire	8.5	Mires formed by high valley water levels
Poor fen	8.6	Nutrient poor wet organic soils, many sedges
Transition mire	8.7	Mires characteristic of continental regions
Fen	8.8	Nutrient rich, wet, organic soils, mixed vegetation
Reed beds	8.9	Element dominated by tall helophyte graminoids usually on the borders of lakes and rivers or because of high ground water levels
Wet heath	8.10	Acid soils, usually with dwarf shrubs/sedges
Snow patch vegetation	8.11	Vegetation often with DCH prominent but evidence of limits to snow line
Element with woodland or sparse trees	9	
Taiga	9.1	Open acid woodlands of Boreal/Nemoral regions
Riparian	9.2	Riverside woodlands
Gallery	9.3	Narrow forest strip beside a watercourse
Swamp woodland	9.4	Forest over helophyte vegetation
Bog woodland	9.5	Forest growing over acid bogs
Additional habitat complexes	10	
Terrace	10.1	Excavated level areas of land with retaining walls
Group of non-mappable terraces	10.2	Parcels with terraces that are less than 5 m apart that cannot be mapped individually

Table 10. Site qualifier codes for linear elements

Qualifier name	Code	Description for use of this qualifier
Related to water(ways)	11	
Watercourse	11.1	Only use if not covered by global codes
Gully	11.2	Erosion feature covered by water

Levee	11.3	Natural raised river bank
Dyke	11.4	Artificial raised river bank
Paths and tracks	12	
Bicycle path	12.1	Evidence of use by bicycles only – not recorded along roads
Walking footpath	12.2	Evidence of use by people
Horse (Bridle way)	12.3	Evidence of use by horses
Tarmac	12.4	Metalled/tarmac surfaces
Constructed track	12.5	Track without tarmac but hardcore material brought in
Unconstructed track	12.6	Track with no external material brought in from outside
Tractor track	12.7	Tractor tyre ruts only
Excavated track – road vegetated	12.8	Track with excavated margins covered with vegetation
Excavated track – road sparsely vegetated	12.9	Track with excavated margins – vegetation cover less than 30%
Road and track – Sunken road	12.10	Traditional road excavated below general ground level
Road and track – Green lane	12.11	Sunken lane covered with vegetation
Walls	13	
Wall – Dry stone	13.1	Wall constructed with no additional material other than rock
Wall – Mortared	13.2	Walls held together with mortar
Retaining wall – Earth	13.3	Usually a terrace wall
Retaining wall – Rock	13.4	Usually a roadside, terrace wall or dam with over 30% rock
Wall with gaps	13.5	Walls with over 30% gaps
Fences	14	
Fence – Wood only	14.1	Fence of wood only
Fence – Iron only	14.2	Fence of iron posts/rails
Fence – Wire on posts	14.3	Fence with wire attached to wood posts
Fence – Wire with gaps	14.4	Fence with over 30% gaps
Fence – Wire on metal posts	14.5	Fence with wire attached to metal posts
Hedges	15	
Hedge – Trimmed hedge	15.1	Line of scrub below 5m with signs of regular management
Hedge – Austrian hedge	15.2	Hedge of trees with understory
Hedge – Stock proof	15.3	Hedge able to retain stock
Hedge – Not stock proof	15.4	Hedge with over 30% gaps
Hedge – Recently planted	15.5	Hedge planted in the last 5 years
Hedge – Uncut	15.6	No evidence of cutting in the last 5 years
Hedge – Derelict	15.7	No evidence of cutting and trees in poor condition
Hedge – Relict	15.8	Only isolated shrubs/trees remaining
Hedge – Laying	15.9	Traditional management by laying of single stems

Hedge – Coppiced	15.10	Cut at the base in the last 5 years
Hedge – Flailed	15.11	Cut with mechanical flail – much debris at base

4.6 Field four: Management qualifiers

The management qualifiers are organised in several levels, the first level being the time of the management, the second level 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.

Table 11. Management code names for level 1

Qualifier name	Code	Definition
Active	A	Now
Recent	B	less than three years
Neglected	C	Evidence of undermanagement, 3-10 years
Abandoned	D	Over ten years, colonisation by shrubs
Ancient	E	Evidence of former use (>50years)
No Management	F	No evidence of any management

Table 12. Management code names for level 2, 3 and 4

Qualifier name level 2	Code	Qualifier name level 3	Code	Qualifier name level 4
Agricultural	1	Annual Crops	1.1	Indicated the crop name (see table below)
		Apiculture	1.2	
		Controlled Burning	1.3	
		Fallow	1.4	
		Farmyard Manure/Slurry	1.5	
		Grazed	1.6	Indicated grazing animal (see table below)
		Harrowed	1.7	
		Hay Cut	1.8	
		Irrigation	1.9	
		Mowned	1.10	
		Multiple Systems	1.11	
		Permanent Crops	1.12	Indicate the cultivation (see table below)
		Ploughed	1.13	
		Silage Cut	1.14	
		Unidentified	1.15	

		Large terraces	1.16	
		Small terraces	1.17	
		Ridge and Furrow	1.18	
		Chaffed	1.19	
Semi-natural	2	Apiculture	2.1	
		Controlled burning	2.2	
		Deep ploughing	2.3	
		Field Margins	2.4	
		Hunting	2.5	
		Intermittent Grazing	2.6	
		Regular Grazing	2.7	
		Scrub clearing	2.8	
		Peat Working	2.9	
Forestry	3	Charcoal	3.1	
		Clear-Cut	3.2	
		Controlled Burning	3.3	
		Coppicing	3.4	
		Conservation Management	3.5	
		Dead wood	3.6	
		Deep ploughing	3.7	
		Animal Grazing	3.8	
		Group selection	3.9	
		Planting Exotic	3.10	
		Planting Native	3.11	
		Ploughing/Drainage	3.12	
		Pruning	3.13	
		Scrub clearing	3.14	
		Thinning	3.15	
		Underplanted	3.16	
Recreational	4	Beach Facilities	4.1	
		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	
		Golf course	4.5	
		Horse	4.6	
		Hunting	4.7	

		Motor sport	4.8	
		Occasional Camp site	4.9	
		Other Sport	4.10	
		Permanent Camp site	4.11	
		Pic-nic area	4.12	
		Playing field	4.13	
		Shooting range	4.14	
		Tramplng	4.15	
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	
		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	
		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	
		Recreational	5.15	
		Religious	5.16	Places of worship, churches, mosques, synagogues and monasteries and their car-tilages e.g. graveyards, cemeteries
		Residential	5.17	
		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	
		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
Inland Water	6	Artificial Water body	6.1	
		Dams	6.2	
		Canal	6.3	
		Irrigation Canal	6.4	
		Digues	6.5	

Table 13. Specifications of crops and grazing animals (level 4)

Annual crops (1.1, 1.16, 1.17)		Permanent corps (1.12, 1.16, 1.17)	
Wheat (<i>Triticum aestivum</i> and associated species)	1	Vines (<i>Vitis vinifera</i>)	31
Barley (<i>Hordeum sativum</i>)	2	Olives (<i>Olea europea</i>)	32
Oats (<i>Avena sativa</i>)	3	Cherries (<i>Prunus</i> spp.)	33
Rye (<i>Secale cereale</i>)	4	Apples (<i>Malus</i> spp.)	34
Triticale (Hybrids between wheat and rye)	5	Pears (<i>Pyrus</i> spp.)	35
Rice (<i>Oryza sativa</i>)	6	Walnuts (<i>Juglans</i> spp.)	36
Sugar beet (<i>Beta maritima</i>)	7	Citrus fruit (<i>Citrus</i> spp.)	37
Fodder crops (e.g. <i>Brassica oleracea</i>)	8	Hazelnuts (<i>Corylus avellana</i>)	38
Potato (<i>Solanum tuberosum</i>)	9	Almonds (<i>Prunus amygdalus</i>)	39
Field bean (<i>Vicia faba</i>)	10	Prickly pear (<i>Opuntia</i> spp)	40
Peas (all types) (<i>Pisum</i> spp.)	11	Pistacio nuts (<i>Pistacia sativa</i>)	41
Maize (<i>Zea mays</i>)	12	Apricots (<i>Prunus amygdalus</i>)	42
Oilseed rape (<i>Brassica</i> hybrid)	13	Peaches/Nectarines (<i>Prunus persica</i>)	43
Sunflower (<i>Helianthus annuus</i>)	14		
Flowers	15		
Commercial horticulture	16		
Vines	17		
Cover crop	18		
Forage crop	19		
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/Wildfowls	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		

4.7 Field five: Detailed life form and species composition

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

All LFs and NLFs that constitute at least 10% of the alpha code should be recorded, one per row, in the first column of Field-5, with the appropriate % code in the second column. Taken together, all recorded LF and NLF within a layer should add up to a total of 100%.

If there are several covers with low % 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.

The species that constitute at least 30% cover of the vegetation (as seen in vertical perspective) of each LF that has been recorded in the first column of field five should be recorded in the third column of field five. 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 7.2 and 7.3).

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 (SynBioSys, www.synbiosys.alterra.nl).

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 be used. Latin names are not to be used for crops but only the codes since the same species may refer to wild plants e.g. *Beta 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 pinea* and *Pinus pinaster* 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 5. The % cover of the species should be given in each LF, i.e. **the percentages are of the LF, not of the whole element.**

4.8 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. Instructions are given in 2.15. There is a direct link between these habitats and the CORINE Biotopes and Palaeartic classification.

4.9 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 14.

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 14. 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.	<i>Fields managed only for agricultural objectives.</i> Such fields are usually intensively used but may also involve extensive systems. Usually there is a division between: <ol style="list-style-type: none"> a. <i>Cultivated land used for arable (e.g., wheat) or perennial or woody crops (e.g., fruit trees, vineyards)</i> b. <i>Grasslands used directly (grazing) or indirectly (hay, silage) by livestock</i>
2.	<i>Fields managed regularly for non-agricultural objectives.</i> Usually these fields are used for horses or donkeys held for recreational purposes but could also include fields and mesotrophic grasslands managed for nature conservation and landscape objectives.
3.	<i>Unenclosed land used regularly by stock, usually sheep and goats but also cattle and horses for meat.</i> 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.	<i>Unenclosed land used occasionally by sheep or goats but not in regular agricultural use and minimally affected by grazing</i> (e.g., some blanket bogs and mountain summits in Britain).
5.	<i>Linear or point features on, or adjacent to, farmland that are managed directly or are likely to be highly influenced by farming activities</i> e.g., hedges on farmland and grass strips between fields ¹ .
6.	<i>Linear or point features on, or adjacent to, farmland that are indirectly influenced by current agriculture but are not managed actively</i> (e.g., field corners and small woodlands surrounded by agricultural land).
7.	<i>Land not used by agriculture (usually urban herbaceous) and managed usually by mowing, e.g., roadside verges, recreation areas and sport fields.</i>

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.

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 handbook and in Bunce et al. (2008)*

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

5 Recording vegetation

5.1 Preparation for vegetation recording

There are three widely used terms for recording vegetation data: releves, quadrates or plots. The first term is commonly used in the phytosociological literature. The second term is mainly used in quantitative ecological studies and the third for recording at the landscape level. Whilst all three terms involve making lists of species with coverage from defined areas, the latter term is used throughout the present document.

. The 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.

RULES

The principle for allocating vegetations plots is to place **one plot in each GHC, except in the case of grasslands (CHE and CHE/LHE) which need to be further subdivided according to the moisture and nutrient levels** as indicated by the environmental matrix (see section 3.2.3). There the environmental indicator also is decisive in deciding on plots.

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 transparent grid (of 1 ha units) should be placed over the square and random numbers used to select a field from the grid. If a field computer is being used, then the grid can be selected using ArcPad and with random numbers.

Dehezas 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 3.2.4. 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 in which are Annex I habitats. See the website of the GB-CS for the protocol: <http://www.countrysidesurvey.org.uk/>.

If the position of vegetation plots is in dangerous terrain, then there are two possibilities. One is to move the plot to the nearest safe location within the element and the other is to rerandomise and select a different patch.

5.2 Method for recording vegetation

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 15. The basic recording procedure is the same for all types of plots.

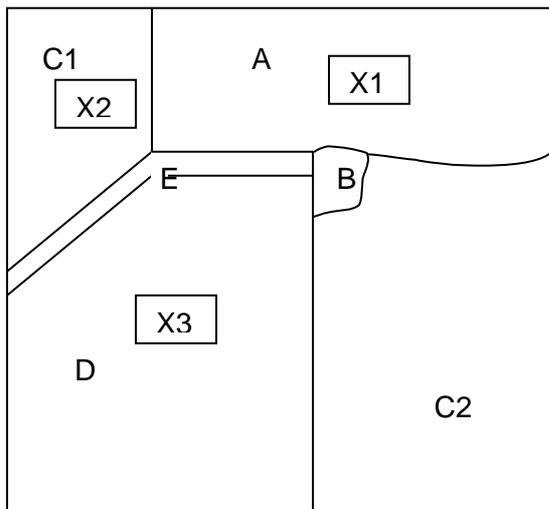
Table 15. *Vegetation plot characteristics*

Code	Name	Other names	Where	Size	No. per Square	EBONE
Areal plots						
X	Large	GHC plot	Centroid points in polygons	100 m ²	variable	Yes
Linear plots						
L	Linears	Linear features	Centroid along linear features	10x1m	variable	Yes
Point plots						
Y	Small	Targeted habitats	Semi-natural vegetation	4m ²	variable	Annex I habitats only

RULES

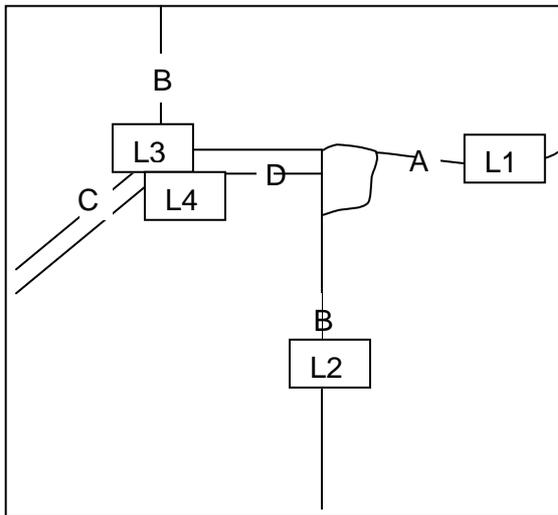
The X main plots (see table 15) should be placed in the centre of the element concerned (Figure 6). The L linear plots should be placed in the centre of the linear feature. In both cases to avoid edge effects (Figure 7). The Y plots should also be placed in the centre of the point element. Examples are given here 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 marked on the map. A photograph should be taken including a clear land mark to assist relocation of the plot. A GPS position should also be recorded.



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

Figure 6. 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 7. Location of L linear plots.

5.2.1 The main vegetation or X plot

A main vegetation or X plot is 100m² 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 8. This procedure was developed in the GB-Woodland Survey in 1971 and guarantees that the plots have an accurate size. The diagonals should be orientated carefully at right angles and the plot should be orientated with the strings on the north-south and east-west axes. The different nested plots are shown in Figure 6.

The strings or tapes should 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 should 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 should be recorded from the inner nested plot first. When the inner plot has been completed the second nested plot should be examined and any **additional** species 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.

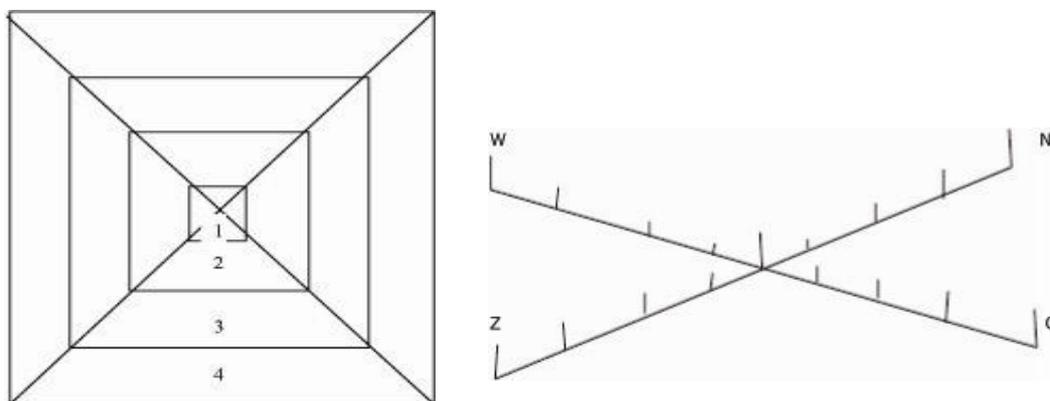


Figure 8. Design of the X plot (After GB Countryside Survey Handbook 2007). The lengths of the sides are in square 1: 2.00m, 2: 5.00m, 3: 7.07m and 4: 10m. This produces nested plots of respectively 4m², 25m², 50m² and 100m².

For estimates of cover 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.

If the plot falls 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 100m², (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.

5.2.2 The 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 donot 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.

If a linear feature is less than 0.5 m wide then no plot is placed (cf. mapping rules). In the case of a wall the width of the wall is not included.

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 2 m 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 10m and is laid out along the feature as shown in Figure 9. If the linear feature is less than 1 m 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. In a complex linear features they should be placed 10 meters apart.

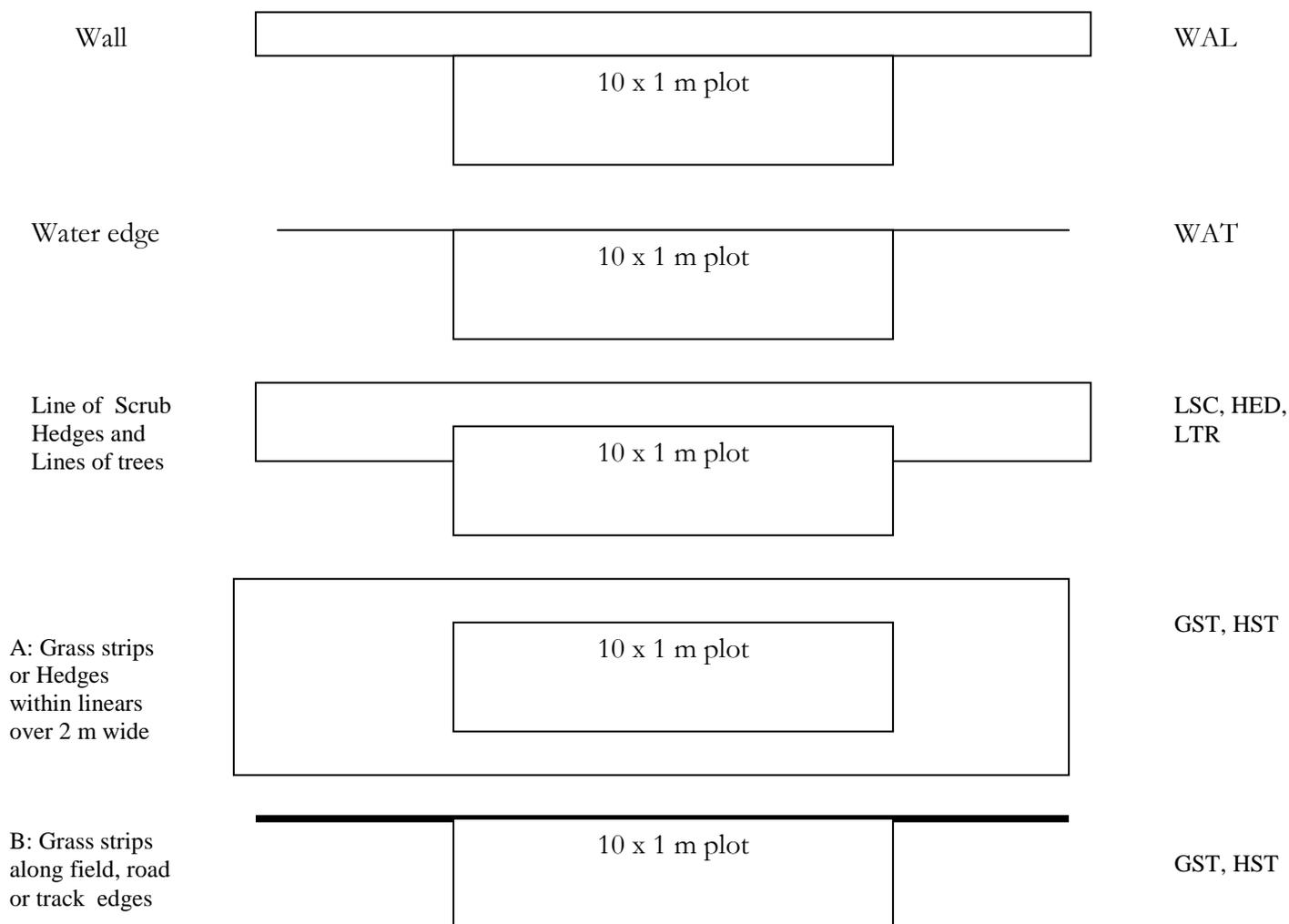


Figure 9. Location of plots along linear features, walls, water edges, hedge and grass strips. The plots are 1x10 m.

5.2.3 Habitat targeted Y plot

Targeted Y plots – Habitat targeted plots should be placed in GHCs between 25 and 400m² which fulfil the descriptions of Annex I of the Habitats Directive (Table 15). 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 25m². Likely candidates are indicated in the Annexe 1 key and range from Tufa springs to herb rich annual grasslands.

5.2.4 Quality assurance

Quality assurance of vegetation plots is also undertaken by 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 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.

6 Recording sheets and worked examples

6.1 Background information

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.

6.2 Areal Features

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

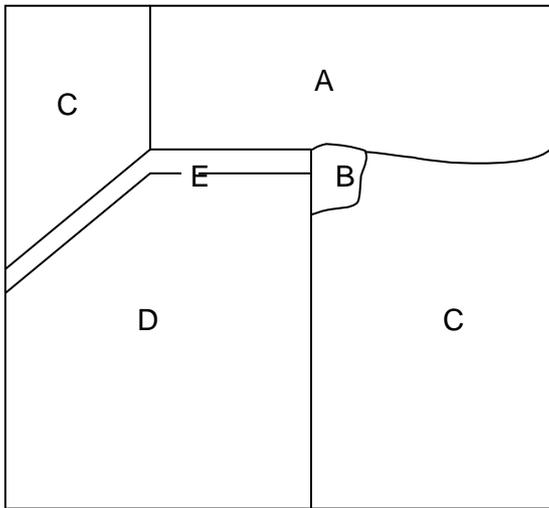


Figure 10. Example of areal coding for EBONE (part of a km²) and Bio Bio (a farm).

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	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 11. Areal recording sheet

6.3 Linear features

An example of mapping and recording of linear features is given in figure 11

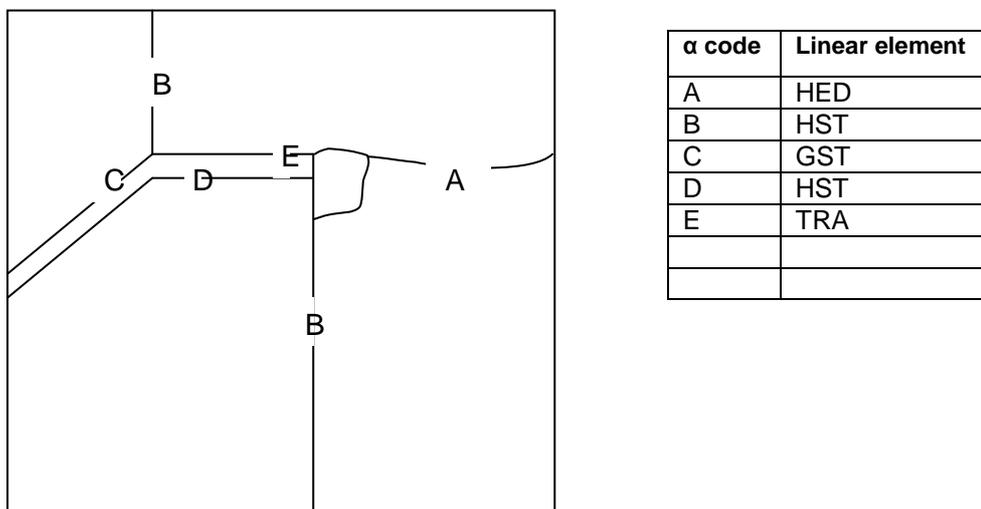


Figure 12. Map and recording sheet for linear elements.

An example of a complex feature is given in figure 13. Note that when estimating the percentage cover of complex linears the estimate should be from a vertical perspective, e.g. a stream beneath a line of trees will have no areas and will only be a linear feature. The feature consists of several lines, each of which is below 5 m. wide, but together they are over 5m. wide: a line of grass, a watercourse, a line of grass and a line of trees. Therefore the feature will be mapped as an area as well as a complex of different lines.

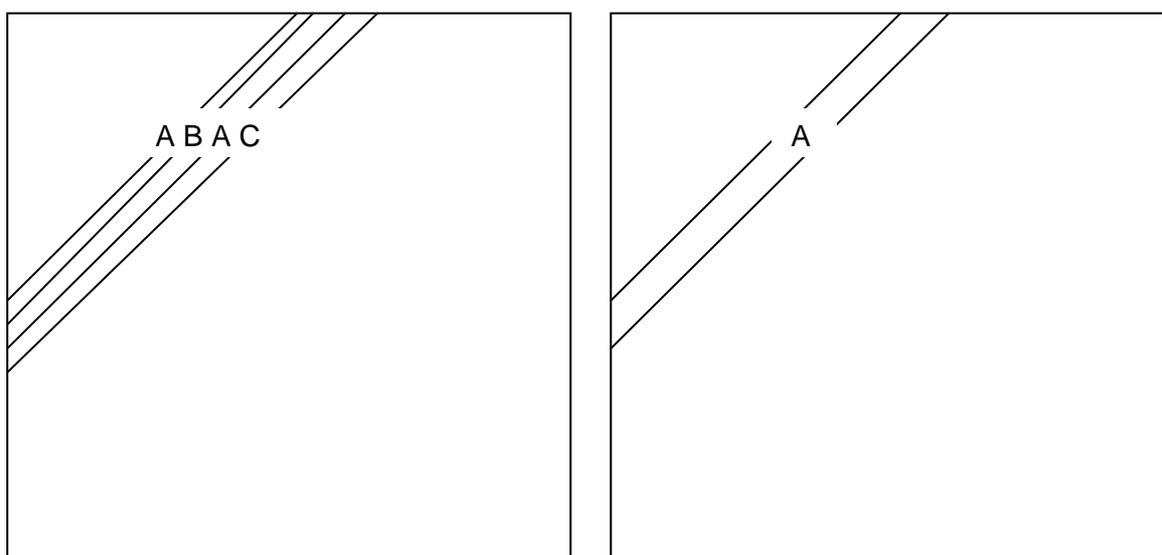


Figure 13. Linear map and map of an areal feature consisting of a complex of different lines (LCO)

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	Life form/Species				Annex I	Regional/Farmland Class	
					Life form and Non Life Form Habitats		%	Species	%		
A	CHE	LCO	0	F	CHE		50	Dec glo	50		
		5.3			LHE		10	Her dio	30		
					AQU		20				
					FPH		20	Que rob	100		

A code	Linear element
A	GST
B	WAT
C	LTR

Figure 14. Recording sheets for an areal feature consisting of a complex of different lines

7 The 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 must be derived from field data based on a statistically sound sampling design. The field data can then be used to increase the effectiveness of remote sensed information because it can be used to interpret the simpler categories available. This is essential if there is to be an understanding of current and future dynamics of changes in habitats and the associated biodiversity and its distribution throughout Europe.

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

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

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

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

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

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

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Annex 1 Lists of indicative plant species for each Life Form

A1 Guidance notes on the identification of Life Forms

A1.1 Introduction

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

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

Although most species belong unequivocally to one life form, some species are in different categories in various floras. This is particularly because habitat requirements differ between regions, but also because of differences in the interpretation of anatomical features. Thus *Eriophorum angustifolium* and *Scirpus sylvestris* are given as helophytes in the British flora, but as rhizomatous geophytes in the Austrian flora. 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. As discussed in Annex 2, many Phanerophytes are highly plastic according to local conditions, and hence the only consistent arbiter that can be used is height. Also, some floras give height ranges that do not fit with field observations – this is because the floras give optimal height. All the above can be determined in the field. The most difficult group to interpret are the caespitose hemicryptophytes, partly because of deciding where the soil surface actually is for the location of the buds, but also because of the wide range of rhizome types. Therefore in 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 accoply 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 occupy a single habitat some plants are sufficiently plastic to belong to several categories. In wetlands the actual conditions pertaining to water level or the time of survey should be used to define the GHC. It is recognised that water levels often vary according to seasonal factors. The Life Form SHY, EHY and HER should therefore be applied to the water level and form of the plants at the time of survey. Qualifiers should be used to indicate temporary water bodies or exceptionally dry conditions using local indicators such as drift line or definite detritus. Temporary floods should be recorded as such. If plants which may

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

A1.2 Life Forms

Submerged hydrophytes (water plants)

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

Isoetes lacustris

Lobelia dortmanna

Zostera maritima

Zannichelia palustris

Emergent hydrophytes (water plants)

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

Butomus umbellatus

Cladium mariscus

Sagittaria sagittifolia

Scirpus lacustris

Helophytes (marsh plants)

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

Potentilla palustris

Carex aquatilis

Eriophorum angustifolium

Rhynchospora alba

Some species can survive in different water levels. Again the record should be made at the period of maximum biomass. Qualifiers can be added if there is evidence of changing water levels. Note that several Annex I habitats require such information.

Hemicryptophytes

This habitat includes broadleaved plants that generally avoid the extremes of xeric conditions in southern Europe as opposed to the arctic and high mountain environment on the other. It includes dicotyledonous, broadleaved plants including forms with stem leaves and rosettes. Also biennials are included here, as in most floras.

Although they vary from broadleaved plants such as *Rumex obtusifolius* and *Inula helenium* to small leaved plants such as *Ranunculus pyrenaicus* and *Silene nutans*. However, they are grouped together by most authors in the same category so are not divided. Annual species with broadleaves are THE

Campanula latifolium (leafy)

Plantago coronopus (rosette)

Carlina acaulis (rosette)

Dipsacus fullonum (biennial)

Hemicryptophytes (monocotyledons) – caespitose,

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

Lolium perenne (Gramineae)

Poa alpina (Gramineae)

Brachypodium retusum (Gramineae)

Carex pendula (Cyperaceae)

Luzula sylvatica (Juncaceae)

Therophytes (both monocotyledons and dicotyledons)

Annual life forms take precedence over whether a given plant is monocotyledonous or dicotyledonous and over soil conditions that are waterlogged. Germination may take place at any season depending on temperature and rainfall. Note that some species e.g. *Poa annua* may be annuals in some situations and perennials in others. In such cases use the context of the vegetation.

Aegilops arvensis

Aira praecox

Bromus madritensis

Nigella damascena

Viola arvensis

Geophytes

These plants are highly seasonal and relatively few species contribute cover over 30% at the time of maximum biomass. Geophytes are restricted to bulbs, corms and tubers. Rhizomatous plants are included as either CHE or LHE.

Crocus aureus. (corm)

Narcissus bulbocodium (bulb)

Tulipa australis (bulb)

Urginea maritima (bulb)

Asphodelus alba (tuber)

Herbaceous Chamaephytes and cushion plants

This category includes plants that have their buds above the ground surface, but that form mats, e.g. *Saxifraga hypnoides* and cushion plants such as *Saxifraga linguata*. They are usually evergreen having evolved to make use of the short growing season. This category includes plants typical of extreme environments, e.g. arctic and alpine summits, but also is typical of habitats with low competition, e.g. cliffs and screes.

Achillea rupestris (herbaceous)

Saxifraga aizoides (herbaceous)

Saxifraga caespitosa (cushion)

Saxifraga linguata (cushion)

Oxyria digyna (herbaceous)

Cryptogams (bryophytes & lichens)

These include all groups which are not vascular plants and are recorded as Life Form Qualifiers, except when growing on the soil surface.

Cetraria islandica (lichens)

Cladonia impexa (lichens)

Usnea barbata (lichens, epiphytic)

Racomitrium lanuginosum (bryophytes)

Sphagnum recurvum (bryophytes)

The following are life forms with buds above ground level. They may be woody or not according to species. The life forms are plants but together in habitats they form various scrub and forest GHC's. All TRS categories are determined according to their actual average height as this is the only parameter which can be consistently recorded.

Dwarf Chamaephytes, buds above the soil surface, but lower than 0.05 m forming dwarf scrub

Some of these plants are called espaliers (*Spaliersträucher*), e.g. *Dryas octopetala*. Others are espalier forms of ligneous Chamaephytes, e.g. *Betula nana*; others are dwarf forms of Chamaephytes due to extreme environments, e.g. *Vaccinium myrtillus* in the Scandinavian Mountains.

Dryas octopetala

Globularia saxatile

Salix herbacea

Salix reticulata

Loisleuria procumbens

Shrubby Chamaephytes (buds above the soil level, between 0.05 and 0.30 m, under shrubs) forming under-scrub

This category will actually be mainly species that are ligneous. But, this category also includes some species described as nano-phanerophytes in floras, but which also often behave as Chamaephytes (e.g. *Rhododendron hirsutum*). Other Phanerophytes are included here because they may be present as regeneration or suppressed forms of species which may reach greater heights, e.g. *Quercus petraea* on an exposed sea cliff in South West England may be 30 cm in height. Especially widespread throughout the Mediterranean region where they are adapted to dry summer periods, but present where they are often dominant in degraded habitats, but are also common in extreme situations in alpine and arctic regions.

Cistus monspelliensis

Helichrysum stoechas

Lavandula stoechas

Thymus vulgaris

Daboica cantabria

Low Phanerophytes (0.30-0.6 m) low shrubs forming low scrub

These habitats consist mainly of shrubs either of low nutrient systems, exposed situations or also may be regenerating plants of potentially taller categories. They are widespread throughout most of Europe under appropriate conditions, but absent from extreme environments.

Lavandula stoechas

Cistus albidus

Cistus albedas

Daphne oleoides

Salix myrsinites

Mid Phanerophytes (0.6-2m), mid shrubs forming mid scrub

This habitat in its climax form occurs widely in the Mediterranean region where it has replaced grassland following abandonment, but is too dense for trees to colonise. It has many names in the Mediterranean region such as Matorral (ES), Maquis (FR) and Macchia (IT). It may also be transitional to the next category.

Cistus ladanifera

Daphne gnidium

Myrica gale

Rosmarinus officinalis

Salix aurita

Tall Phanerophytes (2-5 m), tall shrubs forming tall scrub

This habitat consists of tall shrubs that are often progenitors of forest, although they may form climax stands above the altitudinal limit of forest as does *Corylus avellana* in the Picos de Europa north-west Spain.

Amelanchier ovalis

Cotoneaster nebrodensis

Frangula alnus

Phyllirea angustifolia

Pistacia lentiscus

Forest Phanerophytes (trees between 5 and 40 m) trees forming forest

These are the main forest trees of Europe.

Acer campestre

Fagus sylvatica

Pinus halepensis

Populus tremula

Quercus robur

Mega Phanerophytes (trees over 40 m) trees forming very tall forest

These are the main tropical forest trees but are also present in some sheltered sites in Mediterranean climates in Australia. There are also temperate rain forests and some ancient conifer forests in western North America. Elsewhere individual trees may reach this height but do not form forests with over 30 % cover.

Sequoia sempervirens

Araucaria heterophylla

Eucalyptus regnans

Picea sitchensis

Pseudotsuga menziesii

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

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

Fraxinus excelsior

Ostrya angustifolia

Quercus pubescens

Ulmus minor

Acer campestre

Evergreen (EVR): includes sclerophylls, palms and broadleaved evergreens. There are optional Life Form Qualifiers for this category given below.

Laurus nobilis

Phoenix canariensis

Quercus ilex

Viburnum tinus

Ilex aquifolium

Conifers (CON): Includes all taxa, but not Ephedra, which is a gymnosperm and not a conifer. .

Cupressus sempervirens

Abies alba

Juniperus communis

Pinus alephensis

Taxus baccata

These species are mainly evergreen but *Larix decidua* may be recorded with a optional Life Form Qualifier (see below).

Non-leafy evergreen (NLE): the majority of species in this group are Mediterranean, some genera can be heavily spiny, e.g. *Echinopartium*. The category may have small leaves which are shed later e.g.

Cytisus purgens

Retama retamoides

Sarothamnus scoparia,

Spartium junceum,

Ulex parviflorus

Summer deciduous (SUM): included because leaf loss is in the unfavourable growing season-in this case summer. Some species are present in the Mediterranean region and are characteristic of situations with extremely dry summer periods (e.g. *Euphorbia dendroides*). Tall shrubs and trees are present only outside Europe although they may be planted eg

Acacia spp.

Euphorbia dendroides

Euphorbia spinosa

Xizyphus lotus

A1.3 Life Form Qualifiers

The Life Forms below are to be recorded as optional qualifiers to the respective Life Forms or Non Life Form categories.

Qualifiers belonging to SPV

Bryophytes. Mosses and liverworts:

Frullania spp.

Isoetecium myosuroides

Lichens. Mainly foliose-crusaceous species

Lobaria spp.

Usnea spp.

Cyanophyta. Growing as crusts on the soil or rock surfaces especially in deserts

Qualifiers belonging to HER wetland

Floating plants.

Lemma spp

Eichornia crassipes

Floating leaves

Nymphaea alba

Nuphar lutea

Qualifiers belonging to HER

Tussock. Grasses over 60 cm. Typical of xeric conditions Height does not include inflorescence

Stipa spp

Cortaderia spp

Bryophytes. Mosses and liverworts:

Frullania spp.

Isoetecium myosuroides

Lichens. Mainly foliose-crusaceous species

Lobaria spp.

Usnea spp.

Qualifiers belonging to TRS

Stem Rosettes/Caulinosulte. Stem rosettes on the top of the stem including grass trees. The latter may be based with leaf bases consolidated into a stem. Especially in Astralia and South Africa

Xantoria spp.

Espalazia spp.

Cushions. These are the distinctive tight cushions of xeric conditions and are often spiny.

Fredolia acricoides

Astagulus tragantha

Cacti and Succulents. Plants with swollen stems with sometimes a few residual leaves or leaf scales

Opuntias spp

Cactus spp

Bamboos and canes. Herbaceous plants with buds above ground level and evergreen leaves

Arundo donax

Bambusa spp.

Qualifiers belonging to TRS - Leaf types

Small leaved. Plants with leaved less than 2 cm.

Quercus ilex

Erica tectralix

Large leaved. Plants with leaves more than 2 cm

Laurus nobilis

Ilex aquifolium

Fleshy leaved

Agave americana

Aloe vera

Loosing needles in winter

Larix decidua

Taxodium mucronatum

Ephiphytes: Qualifiers belonging to trees

Vascular plants. Plants which grow beneath the canaopy.

Orchis spp

Bromelia spp

Lianes. Plants which use trees/shrubs for support but are not attached.

Smilex aspera

Humulus lupulus

Creepers. Plants which attaché themselves to trees/shrubs rather than just using them for support.

Hedera helix

Fitus virginiana

Parasites. Plants which depend on trees/shrubs for nutrients

Viscum album

Viscum rubrum

A2 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 Table 16.

Table 16. 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
Crataegus monogyna			x	x	x	x	x
Evergreen							
Dryas octopetala	x						

	Dwarf phytes	Chamae- phytes	Shrubby Chamae- phytes	Low Phanero- phytes	Mid Phanero- phytes	Tall Phanero- phytes	Forest Phanero- phytes
Vaccinium oxycoccus	x						
Arctostaphylos uva-ursi	X		x				
Vaccinium vitis-idaea	X		x				
Thymus vulgaris			x				
Lavandula stoechas			x				
Sideritis 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							
Echinopartium sp.			x				
Chamaespartium sagittaris			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	
Rebulla hemispaerica			x	x	x	x	
Tamarix gallica			x	x	x	x	
Coniferous							
Juniperus communis			x	x	x	x	
Pinus mugo			x	x	x	x	
Juniperus thurifera			x	x	x	x	
Pinus sylvestris			x	x	x	x	x
Larix decidua			x	x	x	x	x
Picea abies			x	x	x	x	x
Abies alba			x	x	x	x	x
Summer deciduous							
Astragalus massiliensis			x				
Sarcopoterium spinosum			x	x			
Euphorbia arborea			x	x	x		

A3 Potential flows between life forms

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 figure 15. Only the principal directions of flows are included and under exceptional circumstances flows can be the opposite of these shown in the diagram.

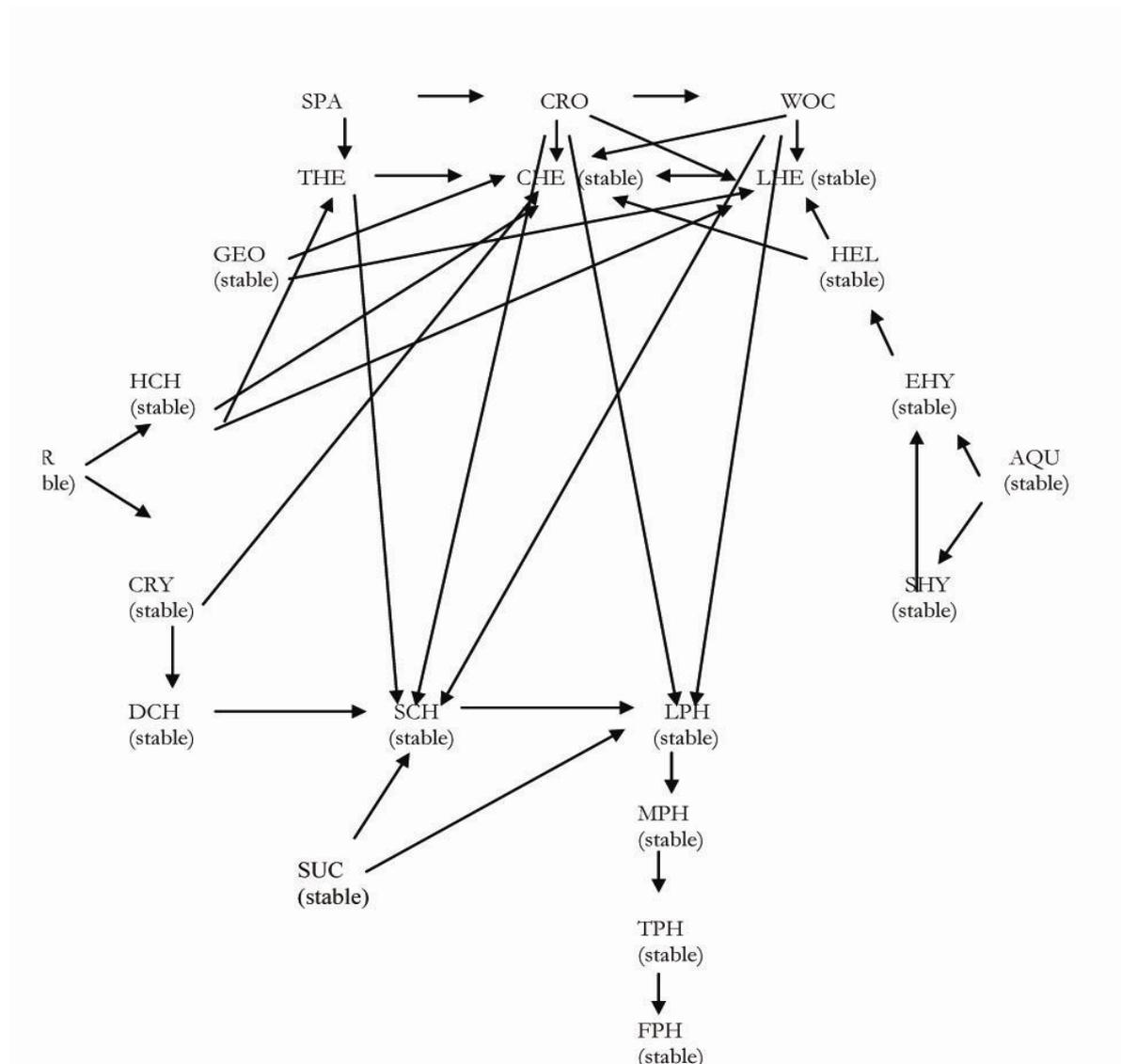


Figure 15. Diagram of principal potential flows between life form categories. (Stable = possibly may stay at this level and not develop). All categories can change to Urban/Constructed.

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

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

- Alpha code (A, B):** The simple alphabetic code used to identify unique set of GHC's and qualifiers, that is applied in the left-most column of the data recording sheet and, correspondingly, for the annotation on the mapping sheet.
- AP:** Aerial Photograph
- BioHab:** Project for Biodiversity and Habitat Monitoring (EU-FP5 project)
- Crops:** Plants that are cultivated for forage, seed or forest excluding grasses.
- EBONE:** European Biodiversity Observation Network (EU-FP7 project)
- ECOLAND Forum:** Official working group of IALE with the objective to create a structure for the production of an integrated assessment of change in habitats and biodiversity and the associated causes on the European landscape (<http://www.landscape-ecology.org/about/workinggroups.htm>).
- Ecologically significant:** This means "significant within the context and purpose" of the surveillance/monitoring operation" and applies especially to part elements.
- Element:** The individual field mapping entities, whether areal, linear or points.
- Ellenberg values:** Values for fertility, acidity, moisture and salinity developed by Ellenberg for central Europe and now for GB and Switzerland (see bibliography).
- EnS:** Environmental Stratum
- Environmental Qualifiers:** Qualifiers dealing with (soil) moisture, eutrophic levels, acidity and salinity (see 3.2).
- EnZ:** Environmental Zone
- EUNIS:** European Nature Information System
- GB-CS:** Countryside Survey for Great Britain
- GHC:** General Habitat Category, that are the basic recording elements of this Field Handbook.
- Habitat:** An element of land that can be consistently defined spatially in the field in order to define the principal environments in which organisms live.
- IALE:** International Association for Landscape Ecology (see www.landscape-ecology.org)
- INBO:** Flemish Institute for Nature and Forest Research
- LF:** Lifeform, Life Forms are used to build the 130 GHC's together with the NON Life Form Categories

Life Form Qualifier:	This refers to the terms (such as DEC, EVR, CON, NLE and SUM) that are used as specification of the Life Forms They are explained in Section 3.1
Management Qualifiers:	Codes for qualifiers linked to management, land use, natural processes (see 3.5).
MME:	Minimum Mappable Element (400m ²), more than 5 m wide
MML:	Minimum Mappable Length (30m, smaller than 5 m)
Monitoring:	Repeat surveillance for detecting change.
NICS:	Countryside Survey for Northern Ireland
NILS:	National Inventory of Landscape Structure Sweden
Non Life Form Category	The units that consist of Urban, crops or sparsely vegetated habitats
Point Element:	Recording element of the BioHab survey for points. Recorded in different levels according to the objective of a given survey (2.13)
Qualifier:	Code applied to provide more detail of the GHC's.
Scale:	Scale is used in the cartographic sense, i.e. "smaller scale" means a smaller representative fraction, e.g. 1:25,000 is smaller scale than 1:10,000. "Scale" can refer to both the level of detail applied in creating a data source (such as a topographic map or air photograph image) and the scale at which the data is subsequently reproduced (such as in a hard copy print). Unless stated as otherwise, the use of "scale" in this manual refers to the former meaning.
Site Qualifiers:	A series of qualifiers with code numbers attached to provide information about the mapping units
Sparsely vegetated:	Land with less than 30% cover of semi-natural vegetation, not associated with urban/constructed elements. See 3.1.
Stratified Random:	Random sampling drawn from defined strata. In BioHab the procedure advocated is to use the strata from the altitude divisions of the European Environmental Stratification (EnS).
Super-categories:	The highest level of the hierarchy of GHC's.
Surveillance:	The recording of information e.g. habitats at a given moment in time.
Trees/shrubs:	Plants with buds 0.05 m above ground level. They combine to form forest and scrub habitats. The categories reflect species plasticity, see Annex 1.
Urban:	Land associated with buildings, structures and communications.
Vicarious Species:	Closely related species that have evolved in geographically separate areas, but often fulfilling a comparable ecological role.

Annex 3 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

GHC (vernacular name)	Primary code
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

GHC (vernacular name)	Primary code
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

GHC (vernacular name)	Primary code
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

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Annex 7 The recording form for Main X and Y plots

Observers:

Date:

Location:

GHC/Env.Qua:

Plot	code	Species	%	Plot	code	Species	%	
4m ²				4m ²				
25m ²				25m ²				
50m ²				50m ²				
100m ²				100m ²				
Comments								

