# SECTION 2. GENERAL STANDARDS

The general standards consist of information that should be entered for each record that is added to the Traitbase. These include information on the origin of the data (references and organisation), description of original habitat where the data was collected (habitat characteristics) as well as the methods used to collect the data.

## 1. REFERENCES CITED AND ORGANISATION

*R.M. Bekker and I.C. Knevel*

To any single data entry a reference or data source has to be added. In the Traitbase output the references will appear in a short abbreviated format as a result of the queries of the user. A full reference list can always be produced when the output of the database is being exported to a user readable file. When new references are entered, it will be possible to check whether this source has already been entered.

### 1.1. REFERENCE FORMAT

When a reference is a published source, the format followed will be that of the Journal of Ecology, which cites papers, books and chapters in books as follows:

> Boutin, C. & Harper, J.L. (1991) A comparative study of the population dynamics of five species of Veronica in natural habitats. *Journal of Ecology*, 79, 199-221.
> Clarke, N.A. (1983) *The ecology of Dunlin* (*Calidris alpina* L.) *wintering on the Severn estuary*. PhD thesis, University of Edinburgh.
> Pimm, S.L. (1982) *Food Webs*. Chapman and Hall, London.
> Sibly, R.M. (1981) Strategies of digestion and defecation. In: *Physiological Ecology* (eds C. R. Townsend & P. Calow), pp. 109-139. Blackwell Scientific Publications, Oxford.

Multiple authors (as well as book editors) are entered as separate entries in separate cells, to be able to query the database on author name. When data originating from grey literature (i.e. MSc thesis, reports) are entered, the field 'location' has to be filled to inform the users of the database where this literature can be found. For published sources this field is optional. The field 'ISXN-number' is for books, and is therefore optional for the other literature sources. A language field is available to store the language of a literature source, as only the original title of the source needs to be stored in the database. When the data source is one of the current partner's databases, the data will be labelled with the subsequent database ID. When data in one of these databases carry information about the original (or old) reference behind a review-type reference, the original reference needs to be stored as well but this will be done separately for each trait.

When the data originate from a non-published source, the data should be entered under the contributor's name instead of the reference name. A contributor record will always hold the email address to identify the person.
*Note:* For the time being, this can only be one of the partners of the LEDA Traitbase-consortium, as other contributors need to pass the editorial board to check the validity of the data.

## 1.2. GEOGRAPHICAL REFERENCE

**Introduction**
Each data entry needs to have a geographical reference to be able to map the distribution of trait values within Northwest Europe. For the purpose of detailed research it is crucial to be able to determine the variation of trait values over different regions or countries, and if the variation is large, the user might want to work with values originating from a certain region only. Geographical information will be used in query options as well as for processes such as data aggregation. For each data entry the country where the measurement was taken has to be recorded. LEDA will use the 2-letter country code of the International Organization for Standardisation (ISO 3166; see Appendix A).

*Sample range*
The size of the area sampled is important information that is needed to determine the quality of the sampled data. Therefore, independent of the habitat, the size of the collecting area should be recorded. For the size of sample area the choice is between four categories:

1. < 0.5 ha (or <50 m length for line transects/habitats)
2. 0.5-1 ha (or 50-100 m length for line transects/habitats)
3. >1 ha (or > 100 m length for line transects/habitats)
4. Unknown

For all data sets, where the size of the collecting area is unknown or where the samples for one record are collected in bigger areas (> 1 ha), the coarse scale should be used.

*Sample site co-ordinates*
To give detailed site description, the UTM or Universal Transpose Mercator co-ordinates are used. UTM provides a constant distance relationship anywhere on a map. UTM divided the earth into 60 zones of each 6° of longitude width. These zones define the reference point for UTM grid co-ordinates within the zone. UTM zones extend from 80°S latitude to 84°N latitude. The zones are numbered 1 through 60, starting at the International Date Line, longitude 180°, and are proceeding east. A square grid is superimposed on each zone, with the vertical grid lines aligned with the meridian, the centre of the zone.
The UTM grid co-ordinates are expressed as a distance in metres to the east ('UTM easting') and a distance in metres to the north ('UTM northing'). UTM easting is reference to the central line of the zone known as the central meridian, whereas UTM northing represents the number of metres from the equator, either north or south.
The UTM system allows the co-ordinate numbering system to be tied directly to a distance measuring system (see also http://www.maptools.com/UsingUTM).

To give information on the global co-ordinating references systems used, there are 4 categories to choose from:

1. World Geodetic System 1984 (WGS84)
2. European terrestrial reference system 1989 (ETRS89)
3. European 1950 (ED50)
4. Unknown

## 1.3. SOURCE DESCRIPTOR

This field can be used to enter a code or description to identify the source from which the entered data originated from (e.g. the database or files used by the user). The function of the source descriptor is entirely for the benefit of the user that entered the data. This field can be seen as a sort of personal administration when he or she wants to verify where his or her data was extracted from.

### Data structure

| Data characteristic | Description | Format | Level |
|---|---|---|---|
| *Reference format:* | | | |
| Refname | Short abbreviated name of the data source | text | optional |
| Reftype | 1. Contributor, 2. publication, 3. database | text | **obligate** |
| Author | List of names of authors (all separately stored) | text | **obligate** |
| Year | Year of publication | number | **obligate** |
| Title | Full title of publication | text | **obligate** |
| Publisher | Name of publisher (e.g. Chapman and Hall, London) | text | **obligate** |
| Journal | Name of journal (chosen from journal list or to add manually) | text | optional |
| Number | Edition/volume identifier | number | optional |
| Pages | Range of pages, when part of a large volume (e.g. 19-29) | number | optional |
| Book title | Full title of the book when the source is part of a larger reference | text | optional |
| Editor | List of names of editors | text | optional |
| ISXN | ISSN or ISBN number of the source | number | optional |
| Type | Type of publication e.g. report, PhD-thesis, diplomarbeit | text | optional |
| Location | Location of the library | text | **obligate**[1] |
| Language | Language of the data source | text | optional |
| Person name | Person name (in reference format) e.g. Thompson, K. | text | optional |
| Person info | The persons email address | text | optional |
| Database ID | Unique code for the different partner databases | text | optional |
| Database admin | Contact address the database (email address) | text | optional |
| Database address | Name, address or web address (URL) of hosting organisation | text | optional |
| Comment | E.g. comment on database | text | optional |

| Data characteristic | Description | Format | Level |
|---|---|---|---|
| *Geographical references:* | | | |
| Study area | Whether the measured material originated from NW Europe (= 1) or from outside NW-Europe (= 0) | 0/1 | **obligate** |
| Country code | ISO-3166 two-letter country code where the measured material originated from | text | **obligate** |
| Altitude | In metres (with unknown projection) | number | optional |
| Sampling range | Range within which samples were taken: 1. < 0.5 ha or < 50 m 2. 0.5-1 ha or 50-100m 3. >1 ha or > 100m 4. Unknown | number | optional |
| Sampling range unit | 1. m 2. ha | number | optional |
| Precision | Precision of sampling in metres | number | optional |
| Geodetic reference | WGS84 (= 1), ETRS89 (= 2), ED50 (= 3), unknown (= 4) | number | optional |
| UTM zone [2] | According to UTM-grid and Geodetic reference (m) | number | optional |
| UTM easting [2] | According to UTM-grid and Geodetic reference (m) | number | optional |
| UTM northing [2] | According to UTM-grid and Geodetic reference (m) | number | optional |
| Longitude | East or West (e.g. 156° 59’ 59’’ E) | number | optional |
| Latitude | North or South (e.g. 89° 59’ 59’’ N) | number | optional |
| Map date | Editorial date of the map used (year) | number | optional |
| Comment | For e.g. comments on nearest town or nature reserve | text | optional |
| *Source descriptor:* | | | |
| Source descriptor | Origin of data (administration) | text | optional |
| Comment | E.g. description of personal source | text | optional |

[1] Only obligate for non-published sources
[2] Note that when no UTM data are available they can be obtained by converting latitude/longitude co-ordinates at http://www.dmap.co.uk/ll2tm.htm (Morton 2003). This site provides a facility to convert the full latitude/longitude co-ordinates to co-ordinates in metres on a Transverse Mercator projection (UTM). When no GPS readings are available from a study or sample site the longitude/latitude and allotted values of cities or towns situated near the study site can be found on http://www.calle.com/ world/index.html. Please note that the range of error, i.e. how many km the town from which the co-ordinates are used is situated from the study site, is obligatory information when using this method.

## 2. DESCRIPTION OF ORIGINAL HABITAT AND METHODS

*R.M. Bekker, I.C. Knevel, G. Boedeltje, J.P. Bakker and D. Kunzmann*

Each data entry needs to have a reference to the habitat characteristics of the habitat in which the measurement took place or where plant material was collected, as well as information on other site characteristics. Obviously, not all data will be assembled in a natural field situation; therefore the field ‘Method of measurement’ will explicitly state the origin of the data.

# 2.1. HABITAT TYPE

*I.C. Knevel and R.M. Bekker*

### Introduction

For the habitat type the EUNIS Habitat Classification (EEA 2002) will be adopted. The EUNIS Habitat classification has been developed to facilitate harmonised description and collection of data across Europe through the use of criteria for habitat identification. It is a comprehensive pan-European system, covering all types of habitats from natural to artificial, from terrestrial to freshwater and marine habitats types. The habitat classification system is hierarchic with each habitat type letter-number coded, with the first levels the letters A to J and for the following habitat levels a number code is added.

### LEDA Traitbase habitat type categories

For each data entry a category that indicates the highest hierarchical level (corresponding with the EUNIS codes A to J) has to be filled in. To the EUNIS habitat categories an extra category was added for sites with no vegetation and for greenhouse studies or garden experiments.

The LEDA Traitbase habitat type categories (with corresponding EUNIS habitat codes) are:

1. Marine habitats [EUNIS code A]
2. Coastal habitats [EUNIS code B]
3. Inland surface water habitats [EUNIS code C]
4. Mire, bog and fen habitats [EUNIS code D]
5. Grassland and tall forb habitats [EUNIS code E]
6. Heathland, scrub and tundra habitats [EUNIS code F]
7. Woodland, forest habitats and other wooded land [EUNIS code G]
8. Inland unvegetated or sparsely vegetated habitats [EUNIS code H]
9. Regularly or recently cultivated agricultural, horticultural and domestic habitats [EUNIS code I]
10. Constructed, industrial and other artificial habitats [EUNIS code J]
11. No vegetation (also including laboratory, greenhouse or garden experiments) [LEDA code]
12. Unknown

*Note*: When entering the data in the Traitbase, a pop-up menu will give the choice of subcategories consisting of the habitat types of the second and third hierarchical level. See Appendix B for overview of the first three EUNIS habitat levels. Further hierarchical habitat levels can be found under the ‘Hierarchical visualisation of EUNIS habitat type’ classification at: http://eunis.eea.eu.int/habitats.jsp.

### Data structure

- Data characteristic: Habitat type
- Description: Categories of EUNIS habitat types
- Format: Category (number)
- Level: **Obligate**

## 2.2. HABITAT CHARACTERISTICS – TERRESTRIAL PLANTS

*R.M. Bekker, I.C. Knevel and J.P. Bakker*

Habitat characteristics are not available for all species of the NW European flora. We will not measure habitat characteristics for the database. Hence, we will rely on our own classification of habitat characteristic values based on indicator values such as Ellenberg *et al*. (1991) for 2726 Central European vascular plant species. The most often applied indicator values are those for light, temperature, continentality, moisture, soil reaction (acidity/lime content), and nitrogen. Indicator values for temperature and continentality indicate large-scale biogeographical issues, which are beyond the scope of the LEDA Trait-database. We will focus on site characteristics. Indicator values for light may be negatively related to plant productivity; hence, we propose to restrict the habitat characteristics to the soil parameters <u>moisture</u>, <u>acidity</u> and <u>nitrogen status</u>. The Ellenberg indicator values were developed mainly on the basis of field experience, and quantification generally follows a nine-point scale. The indicator values reflect the ecological behaviour of species, not their physiological preferences (Ellenberg *et al*. 1991). They summarise complex environmental factors (e.g. groundwater level, soil moisture content, precipitation, humidity etc.) in a single figure. Values do not refer to conditions at one moment, but present integration over time (Schaffers & Sykora 2000).

Although Ellenberg indicator values were designed for Central Europe, they have also been used outside that region, e.g. The Netherlands (Van der Maarel *et al*. 1985, Bakker 1987), Norway (Vevle & Aase 1980), Sweden (Diekmann 1995), Estonia (Pärtel *et al*. 1996, 1999), Poland (Roo-Zielinska & Solon 1998), Great Britain (Hawkes *et al*. 1997) and Northeast France (Thimonier *et al*. 1994). The values can be used to indicate changes in environmental conditions during restoration management (Bakker *et al*. 2002).

Ellenberg values are most commonly used in calculations based on the complete species composition of plant communities. The consistency of the Ellenberg indicator values (not the relation to field measurements) has been studied. Van der Maarel (1993) reported that the socio-ecological species-groups defined for the Netherlands contain species with very similar indicator values. Ter Braak & Gremmen (1987) showed that the moisture values have a reasonable internal consistency in the Netherlands.

Bakker (1987) reported that the Ellenberg indicator values assigned to three groups, namely, indicating nutrient-poor, intermediate- and nitrogen-rich soil conditions were similar to the indicator values of other authors (Germany; Klapp 1965, The Netherlands - Kruijne *et al*. 1967).

Thompson *et al*. (1993) found a close correlation between Ellenberg indicator values and the affiliation of species with dry or moist habitats or wetlands in Great Britain. Böcker *et al*. (1983) assert that groundwater level is the parameter that can be expected to show closest relation to moisture values in Germany. However, these authors did not measure soil moisture or groundwater levels.

Schaffers & Sykora (2000) tested the reliability of the Ellenberg indicator values for moisture, soil reaction and nitrogen for the Netherlands, by using measured parameters. They conclude that the Ellenberg indicator system provides a very valuable tool for habitat calibration, provided the appropriate parameters are considered.

Ellenbergs moisture values probably integrate both groundwater level and soil moisture content. At low moisture content, a high groundwater level may still supply deeper plant roots with sufficient water. At a low groundwater level the high moisture content may still be retained if physical soil characteristics are favourable.
Ellenberg nitrogen values provide an effective integration of several ecological parameters and do not reflect the availability of nitrogen only. Various other factors determine productivity, such as moisture availability, soil aeration, soil acidity and phosphate availability. Productivity can be regarded as a measure of fertility as 'perceived' by the vegetation. The results of Schaffers & Sykora (2000) are in line with those of Hill & Carey (1997), and suggest that Ellenberg nitrogen values should rather be referred to as 'productivity values'.
The mean reaction values accurately indicate soil total calcium over a wide range of conditions, whereas the indication of soil pH is problematic. Hence, Schaffers & Sykora (2000) suggest that the Ellenberg reaction values are better referred to as 'calcium values'.
The habitat characteristics 'soil moisture', 'productivity' and 'acidity' for the species of the LEDA Traitbase are mainly obtained by measurements or derived from literature sources (i.e. Landolt 1977). The values for each of the habitat characteristics are allocated to the LEDA categories of the characteristics concerned. Species with no available data are allocated to the LEDA categories, based on their Ellenberg indicator values following Ellenberg *et al*. (1992), Thompson *et al*. (1993), Hill & Carey (1997) and Schaffers & Sykora (2000).

## 2.2.1. SOIL MOISTURE CONDITION

**Introduction**

Soil moisture is often depending on the height of the ground water that in turn is part of precipitation that seeps down through the soil until it reaches rock material. Groundwater slowly moves underground, generally at a downward angle (because of gravity), and may eventually seep into streams, lakes, and oceans.

**LEDA Traitbase moisture condition classification**

In the LEDA Traitbase the soil with groundwater level of below 60cm depth are called dry, soils with a depth of 20-60 cm is called moist, and soils with a level of ≤ 20 cm is called wet soil (Table 2.1). The moisture condition of the soil is the condition of the soil measured or estimated in <u>the wettest</u> period of the year.

**Data structure**

- Data characteristic: Soil moisture
- Description: Moisture status of the soil of the sample site
- Format: Category (number)
- Level: Optional

***Table 2.1.*** *The LEDA categories of soil moisture presented with their description and some species examples. In the description the corresponding Ellenberg value for moisture indication (mF) is mentioned in brackets (after Schaffers & Sýkora 2000).*

| Category | Description | Species examples |
|---|---|---|
| 1. Dry | Indicator of extreme dryness, restricted to soils that often dry out for some time to dry-site indicator, more often found on dry ground than in moist places (mF <5) | *Corynephorus canescens, Helianthemum apenninum, Koeleria vallesiana, Clinopodium acinos, Saxifraga tridactylites, Sedum acre, Asplenium trichomanes, Centaurea scabiosa,* (Fig.2.1A) *Spergularia rubra, Arctium minus, Helictotrichon pratense, Iris foetidissima, Thymus polytrichus* |
| 2. Moist | Moist-site indicator, mainly on fresh soils of average dampness to Dampness indicator, mainly on constantly moist or damp, but not on wet soils (mF 5-7) | *Anthriscus sylvestris, Euphorbia amygdaloides, Hyacinthoides nonscripta, Solanum nigrum, Agrostis stolonifera, Empetrum nigrum, Rumex crispus, Carex ovalis, Dactylorhiza maculata, Pulicaria dysenterica, Ranunculus repens* |
| 3. Wet | Wet-site indicator, often on water-saturated, badly aerated soils to Indicator of shallow-water sites that may lack standing water for extensive periods to Plant rooting under water, but often time exposed, or plant floating on the surface to Submerged plant, permanently or almost constantly under water (mF >7) | *Cardamine pratensis, Equisetum telmateia, Phalaris arundinacea, Schoenus nigricans, Drosera rotundifolia, Myosotis scorpioides, Vaccinium oxycoccus, Viola palustris, Alisma plantago-aquatica, Carex limosa, Ranunculus lingua, Typha latifolia, Lemna minor, Nuphar lutea, Sagittaria sagittifolia, Schoenoplectus lacustris, Isoetes lacustris, Potamogeton crispus, Ranunculus circinatus, Zostera marina* |

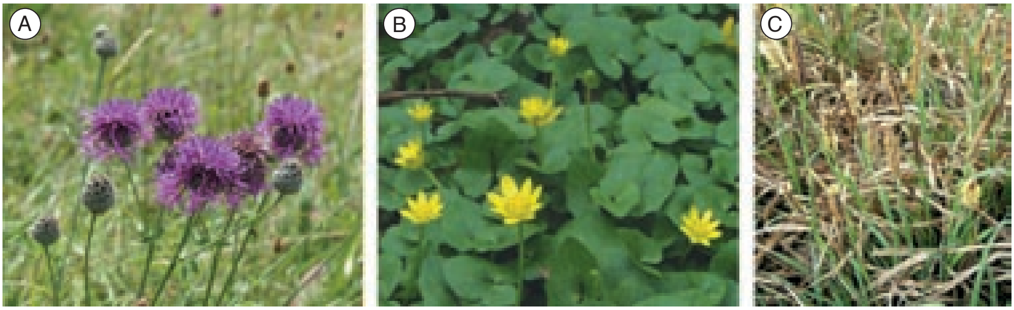


***Figure 2.1.*** *The dry-site indicator Centaurea scabiosa (A), weakly acid Ranunculus ficaria (B) and a species from infertile sites Carex panicea (C) (Photo: see source list).*

## 2.2.2. SOIL ACIDITY

**Introduction**

Soil acidity (pH) affects the availability of soil constituents (i.e. nutrients) to plants and soil micro-organisms. For most plants, the ideal soil pH test result is pH 6 - 7.5, although many will tolerate pH 5.5 - 8.5. However, the tolerance to extremes in pH varies between plant species and within species. Some plant species have quite different preferred pH ranges (see Table 2.2).

The soil pH is a measure of how acidic or basic the soil is and is measured using a pH scale ranging from 0 to 14. Soil with a pH less than 6.5 is called acid soil and is regarded as 'very acid' when the reaction is less than pH 5.0, whereas soils with a reaction between 6.5 and 7.2 are regarded as neutral (EUNIS 2002). Soils with a pH greater than 7.2 are called alkaline (or basic) soils. The full range of the pH scale (0-14) is not used in soils, as the reaction of most soils is between pH 3.5 and pH 10.0 (EUNIS 2002). Some species examples of acid to alkaline soil are listed in table 2.2.

***Table 2.2.*** *The LEDA ranges for acidity (pH) presented with their description and some species examples. In the description the corresponding Ellenberg value for acidity (mR; Ellenberg et al. 1991) is mentioned in brackets.*

| pH (H2O) | Description | Species example |
|---|---|---|
| 1. <5.0 | Extremely acid to acid (mR <4) | *Andromeda polifolia, Lycopodium clavatum, Rubus chamaemorus, Ulex minor, Agrostis curtisii, Calluna vulgaris, Drosera rotundifolia, Polygala serpyllifolia, Agrostis vinealis, Dactylorhiza maculata, Galium saxatile, Pteridium aquilinum* |
| 2. 5.0-6.4 | Acid to weakly acid (mR 4-6) | *Agrostis capillaris, Carex panicea, Juncus effusus, Teucrium scorodonia, Cardamine pratensis, Cirsium palustre, Rubus idaeus, Ulex europaeus, Ammophila arenaria, Carex sylvatica, Lolium perenne, Ranunculus ficaria* (Fig. 2.1B) |
| 3. 6.5-7.2 | Weakly acid to weakly basic (mR 7-8) | *Agrimonia eupatoria, Atriplex prostrata, Nuphar lutea, Phleum pretense, Artemisia vulgaris, Carduus nutans, Iris foetidissima, Viola hirsuta* |
| 4. >7.2 | Basic (or alkaline) (mR 9) | *Bunium bulbocastanum, Clinopodium calamintha, Dryopteris submontana, Primula farinosa* |

*Note*: The Nordic Vegetation Classification defines soils with a reaction of <pH 4.5 as highly acid; pH 4.5-5.5, acid; and pH 5.6-6.5, moderately acid, pH 7.2-8.5 as slightly alkaline; 8.5-9.5 as alkaline; and more than 9.5 as highly alkaline.

**Categories**

The soil pH is usually given in a range and therefore no pH classes will be administered for data obtained from measurements. However for the pH-values obtained from, e.g. indicator paper, the following categories will be used:

1. <5.0
2. 5.0-6.4
3. 6.5-7.2
4. >7.2

For all pH values entered into the database the method used needs to be stated:

1. pH $H_2O$
2. pH KCl
3. pH $CaCl_2$
4. Other (e.g. estimation (i.e. from Ellenberg), indicator paper)
5. Unknown

**LEDA Traitbase soil acidity classification**

The soil pH is usually given in a range and therefore no pH classes will be administered. LEDA prefers pH measurements, but when no data is available the LEDA pH-categories adapted from the Elleneberg values (Table 2.2) will be used. When data are obtained by measurements (traditionally measured by inserting a pH electrode into a suspension of 1 part soil and 5 parts water), the pH method used (pH $H_2O$, pH KCl, pH $CaCl_2$), the number of replicates (minimal 3), the mean, standard deviation/standard error, and the minimum and maximum pH values are all obligatory information.

For data obtained from literature the pH range should be recorded as a mean value with the minimum and a maximum pH value, with the number of replicates (N).

**Data structure**

- Data characteristic : Soil acidity
- Type of variable: Numerical
- Sample size: 3 replicated samples per growing area of the species (or per site)
- Unit: -
- Values: N, minimum, maximum, mean, standard deviation, standard error, or (for estimations, indicator paper values) the range categories
  1. <5.0
  2. 5.0-6.4
  3. 6.5-7.2
  4. >7.2
- Method used:
  1. pH $H_2O$
  2. pH KCl
  3. pH $CaCl_2$
  4. Other (e.g. estimation (Ellenberg), indicator paper)
  5. Unknown

- Validity range: 0-10
- Collecting date: day/month/year (dd.mm.yy)

## 2.2.3. SOIL NUTRIENT STATUS

**Introduction**

All plants require adequate amounts of water, light, carbon dioxide and nutrients in order to allow them to grow to their maximum potential and a shortage of nutrients can cause serious restrictions to growth. There is a wide range of essential plant nutrients (e.g. N, P, and K). Nitrogen, for example, is essential for plant growth and thus causes problems when it is deficient (Russell 1973), whereas phosphorus plays an essential role in agriculture and for all forms of life: respiration, photosynthesis in green leaves, microbial turnover and decomposing litter all require adequate levels of P in specialised forms (Cole *et al*. 1977).

In extensively managed land, where biodiversity and species richness is a priority, the abundance of soil nutrients (i.e. due to intensive crop production) can reduce the floristic qualities of meadows (Vickery *et al*. 2001). High soil N and P is a key factor limiting increase in botanical diversity of many extensively managed types of grassland after the conversion from intensive agricultural management (Tallowin & Smith 2001) or where atmospheric deposition occurs on upland. Specifically, for example, Goodwin (1998) has shown that high soil P levels are negatively correlated with species diversity.

Soils that are poor in nutrients are called oligotrophic and have in general a low primary productivity. Mesotrophic soils have a moderate or intermediate nutrient status; whereas eutrophic soils have a high nutrient content supporting a high productivity, originally applied to nutrient-rich waters with high primary productivity but now also applied to soils (see Table 2.3).

**LEDA Traitbase soil nutrient categories**

Information on the soil nutrient status of the sampled sites in the literature is often not given, hence the soil nutrient status has to be derived/estimated from the species pool of the present vegetation. Therefore the nutrient status is divided into three coarse LEDA categories with the corresponding Ellenberg indicator values for nitrogen status (mN) in brackets behind each category (Table 2.3).

**Data structure**

- Data characteristic: Soil nutrient status
- Description: Nutrient status the sample sites estimated from vegetation present
- Format: Category (number)
- Level: Optional

***Table 2.3.*** *The LEDA categories of soil fertility presented with their description and some species examples. In the description the corresponding Ellenberg value for nitrogen status (mN; Ellenberg et al. 1991) is mentioned in brackets.*

| LEDA Category | Description | Example species |
|---|---|---|
| 1. Oligotrophic | Extremely infertile sites - More or less infertile sites (mN <4) | *Agrostis curtisii, Clinopodium acinos, Drosera rotundifolia, Rubus chamaemorus, Aira praecox, Carex panicea* (Fig 2.1C), *Linum catharticum, Scabiosa columbaria, Centaurea scabiosa, Galium saxatile, Pimpinella saxifraga, Teucrium scorodonia* |
| 2. Mesotropic | Intermediate fertile sites (mN 4-6) | *Agrostis capillaris, Cirsium palustre, Plantago lanceolata, Primula vulgaris, Angelica sylvestris, Digitalis purpurea, Iris foetidissima, Trifolium pratense, Cirsium arvense, Glyceria fluitans, Poa trivialis, Rumex crispus* |
| 3. Eutrophic | Fertile places (mN ≥ 7) (e.g. cattle resting places) | *Atriplex prostrata, Epilobium hirsutum, Stellaria media, Typha latifolia, Beta vulgaris, Galium aparine, Lamium album, Urtica dioica, Arctium lappa, Artemisia absinthium, Hyoscyamus niger, Rumex obtusifolius* |
| 4. Unknown | | |

## 2.3. HABITAT CHARACTERISTICS - AQUATIC PLANTS

*G. Boedeltje*

### Introduction

Between 1978 and 1983 an extensive survey was carried out to record the flora and vegetation and physico-chemical parameters of the water column and sediment of c. 600 fresh water bodies including ditches, streams, rivers, canals, ponds, lakes and fens throughout The Netherlands (De Lyon & Roelofs 1986). This comprehensive dataset was used to calculate the weighted mean value and an ‘indication weight’ of each parameter measured for the species involved. From this dataset, the species’ responses to three parameters were selected to be incorporated into the LEDA Traitbase including pH and alkalinity of the water layer and redox potential of the sediment. These factors are known to be important in determining the distribution of aquatic plants (Wetzel 2001).

*Trait definition*

The pH is a measure of the acid balance of a solution and is defined as the negative of the logarithm to the base 10 of the hydrogen concentration. As it influences many biological and chemical processes, it is considered an important parameter in water quality assessments (Chapman 1996). In unpolluted waters, pH is principally controlled by the balance between the carbon dioxide, bicarbonate and carbonate ions (Fig. 2.2). On account of the photosynthesis and respiration cycles of aquatic plants, seasonal and diel variations in pH are common.

The term alkalinity is used to express the total quantity of base (usually in equilibrium with carbonate or bicarbonate) that can be determined by titration with a strong acid. The milliequivalents of acid required neutralising the hydroxyl, carbonate, and bicarbonate ions in 1 L water are known as the total alkalinity (Wetzel 2001).

The redox potential characterizes the oxidation-reduction state of sediments of natural waters. Ions of the same element but different oxidation states form the redox system which is characterised by a certain value. The co-existence of a number of such systems leads to an equilibrium which determines the redox state of the sediment (Chapman 1996). The redox potential controls to a large extent the microbial pathways that contribute to the oxidation of organic matter.

**Measurements**

For additional measurements the following guidelines should be taken into account.

The pH of the water column should be determined *in situ* with a standard KCl pH-electrode at a depth of 20 cm below water surface after calibration against buffer solutions pH 4.0, pH 7.0 or pH 10.0 (depending on the water body to be sampled).

Samples of the water column should be taken at a depth of 20 cm below water surface after which 50 mL of the sample is titrated down to pH 4.2 using 0.01 M $L^{-1}$ HCl. The amount of HCl required (expressed as meq $L^{-1}$) is the total alkalinity.

Redox potential should be measured in the upper 0-5 cm of the sediment with a Pt Ag/AgCl electrode. A constant stabilization time of three minutes should be used for each measurement. Redox-values should next be converted to the potential relative to a normal hydrogen reference electrode ($E_h$).

All parameters should be measured during the growing season within the aquatic vegetation to be sampled. Because pH features diel variations, measurements are taken preferably between 8.00 and 12.00 a.m.

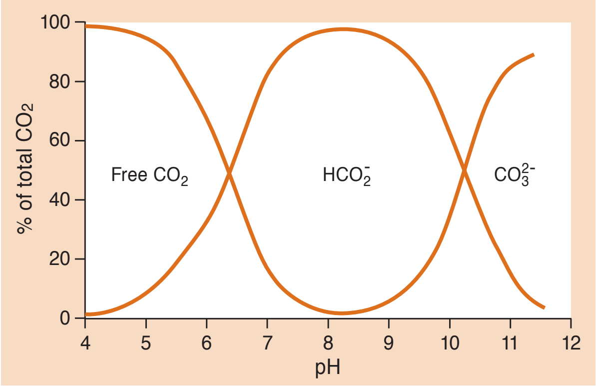


***Figure 2.2.*** *The relative proportions of different forms of inorganic carbon in relation to the pH of water (Golterman 1969).*

**Categories and classification**

For each parameter, species are divided into two groups of aquatic plants:

i) Floating and submerged aquatic plants
ii) Emergent aquatic plants.

pH of the watercolumn (see also Appendix C)

Within both aquatic plants groups, species are classified into six categories according to the weighted mean (wm) value of the pH:

1. Species of acid waters (wm $< 5.0$)
2. Species of weakly acid waters ($5.0 \leq$ wm $< 6.0$)
3. Species of weakly acid waters - circum neutral waters ($6.0 \leq$ wm $< 7.3$)
4. Species of circum neutral waters - alkaline waters ($7.3 \leq$ wm $< 8.5$)
5. Species of alkaline waters (wm $\geq 8.5$)
6. Indifferent species

Alkalinity of the water column

Within both aquatic plants groups, species are classified into seven categories according to the weighted mean (wm) value of the alkalinity:

1. Species of un-buffered waters (wm $\leq 0.1$ meq $L^{-1}$)
2. Species of very soft waters ($0.1 <$ wm $< 0.5$ meq $L^{-1}$)
3. Species of soft waters ($0.5 \leq$ wm $< 1.0$ meq $L^{-1}$)
4. Species of soft waters - moderately hard waters ($1.0 \leq$ wm $< 2.0$ meq $L^{-1}$)
5. Species of hard waters ($2.0 \leq$ wm $< 4.0$ meq $L^{-1}$)
6. Species of very hard waters (wm $\geq 4.0$ meq $L^{-1}$)
7. Indifferent species

Sediment redox potential

Within both aquatic plants groups, species are classified into six categories according to the weighted mean (wm) value of the hydrogen reference electrode ($E_h$):

1. Species of very reductive sediments (wm $< -175$ mV
2. Species of reductive sediments ($-175 \leq$ wm $< -100$ mV)
3. Species of moderately reductive sediments ($-100 \leq$ wm $< 0$ mV)
4. Species of moderately oxidizing sediments ($0 \leq$ wm $< 100$ mV)
5. Species of oxidizing sediments (wm $\geq 100$ mV)
6. Indifferent species

**Minimal requirements**

At least 6 populations of each species with a minimum surface area of 10 $m^2$ occurring in different water bodies should be sampled.

**Data structure**

To collect: 1 measurement of pH, alkalinity and sediment redox potential within each population

Obligate:
- Type of variable: numerical
- Units:

Water column pH categories:
1. Species of acid waters (wm < 5.0)
2. Species of weakly acid waters (5.0 ≤ wm < 6.0)
3. Species of weakly acid waters – circum neutral waters (6.0 ≤ wm < 7.3)
4. Species of circum neutral waters – alkaline waters (7.3 ≤ wm < 8.5)
5. Species of alkaline waters (wm ≥ 8.5)
6. Indifferent species

Alkalinity of watercolumn categories:
1. Species of un-buffered waters (wm ≤ 0.1 meq $L^{-1}$)
2. Species of very soft waters (0.1 < wm < 0.5 meq $L^{-1}$)
3. Species of soft waters (0.5 ≤ wm < 1.0 meq $L^{-1}$)
4. Species of soft waters – moderately hard waters (1.0 ≤ wm < 2.0 meq $L^{-1}$)
5. Species of hard waters (2.0 ≤ wm < 4.0 meq $L^{-1}$)
6. Species of very hard waters (wm ≥ 4.0 meq $L^{-1}$)
7. Indifferent species

Redox potential sediment categories:
1. Species of very reductive sediments (wm < -175 mV
2. Species of reductive sediments (-175 ≤ wm < -100 mV)
3. Species of moderately reductive sediments (-100 ≤ wm < 0 mV)
4. Species of moderately oxidizing sediments (0 ≤ wm < 100 mV)
5. Species of oxidizing sediments (wm ≥ 100 mV)
6. Indifferent species

- Method used:
  1. Obtained by measurements (standardised protocol)
  2. Obtained from published data
- Collecting date: day/month/year (dd.mm.yy)

# 2.4. SOIL SUBSTRATE

*I.C. Knevel and R.M. Bekker*

**Introduction**

The three major groups of soil particles are sand, silt and clay. Soil texture refers to the relative proportions of sand, silt and clay particles in soil material that has a particle size less than 2 mm in diameter. As only the first three soil substrate categories of LEDA are based on soil texture classes, the trait was called soil substrate.

The soil texture triangle is used to classify the texture class of a soil (Fig. 2.3). The sides of the soil texture triangle are scaled for the percentages of sand, silt, and clay. Clay percentages are read from left to right across the triangle, whereas silt is read from the upper right to lower left and sand from lower right towards the upper left portion of the triangle. The boundaries of the soil texture classes are marked bold with the intersection of the three sizes on the triangle giving the texture classes. For instance, a soil with 20% clay, 60% silt, and 20% sand it falls in the 'silt loam' class. Soil texture is an indicator of infiltration capacity, permeability, degree of aeration, and drainage as well as other physical characteristics of a soil material (USDA 1993).

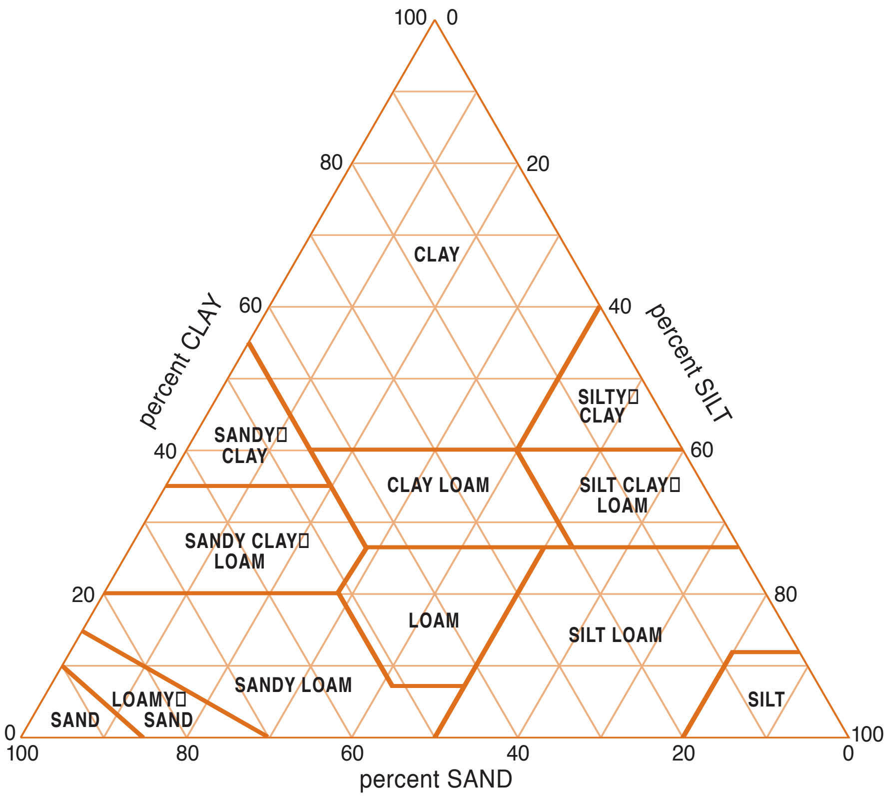


***Figure 2.3.*** *Soil texture triangle (USDA 1993).*

**Soil substrate categories**

The main indication will be the choice of six soil substrate categories:

1. Sand Majority of particle size ranging from 0.05 mm to 2.0 mm in diameter (Ø).
2. Loam Particle size ranging from 0.002 mm to 0.05 mm in Ø.
3. Clay Particle size less than 0.002 mm in Ø.
4. Peat Heterogeneous organic substance (incomplete decomposition of plants).
5. Rocky Rocky fragements (unattached rock pieces) of ≥ 2 mm in Ø and solid rock.
6. Others In general an artificial or anthropologically influenced soil substrate, i.e. parks, gardens, experimental potting soil.

When entering the data into the Traitbase, a pop-up menu will give the choice to choose from more detailed sub-categories for the soil substrate categories sand, loam, clay, and rock (Table 2.4).

***Table 2.4.*** *Descriptions of the five soil substrate categories with their sub-categories (for definitions see Glossary – Appendix E).*

| Category | Sub-category |
|---|---|
| 1. Sand | 1.1. Sand<br>1.2. Loamy sand |
| 2. Loam | 2.1. Loam<br>2.2. Silt loam<br>2.3. Silt<br>2.4. Sandy loam<br>2.5. Sandy clay loam<br>2.6. Silty clay loam<br>2.7. Clay loam |
| 3. Clay | 3.1. Clay<br>3.2. Sandy clay<br>3.3. Silty clay |
| 4. Peat | No sub-categories |
| 5. Rocky | 5.1. Pebbles/gravel 2-75 mm Ø<br>5.2. Cobbles 75-250 mm Ø<br>5.3. Stones 250-600 mm Ø<br>5.4. Boulders >600 mm Ø<br>5.5. Bed rock (solid rock) |
| 6. Others | |

**Data structure**

- Data characteristic: Soil substrate
- Description: One of the soil substrate categories
- Format: Category (number), sub-category (number)
- Level: Category **obligate**, sub-category optional

# 2.5. SOIL TYPE

*I.C. Knevel and R.M. Bekker*

## Introduction

For soil type, the classification system used is based on the World Reference Base for Soil Resources (WRB) (FAO 1998). In this classification there are 30 reference soil groups. Soils are assigned to a group based on the presence or absence of a limited number of diagnostic horizons, diagnostic properties, or diagnostic constituents. The 30 major soil groups can be assembled in 10 classes: Organic soils, and mineral soils from which the formation is conditioned by human influences, parent material (i.e. volcanic material, residual and shifting sands, expanding clays), topography/ physiography (i.e. soils in lowlands (wetlands) with level topography), their limited age (not confined to any particular region), (sub-)humid tropics, climate of arid and semi-arid regions, climate of steppes and steppic regions, (sub)humid temperate climate, and permafrost (see Fig. 2.4; Grissino-Mayer 1999, Zobler 1986).

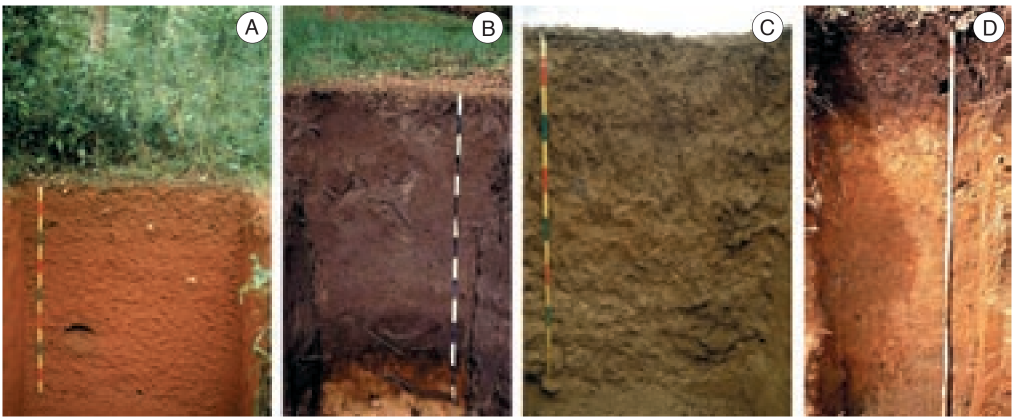


***Figure 2.4.*** *Some soil profile examples of soil types from the different categories; anthrosols (category 2; A), andosol (category 3; B), cambisol (category 5; C), acrisol (category 6; D) (Photo: see Source list).*

## LEDA Traitbase Soil type categories

The LEDA Traitbase soil types are corresponding with the WRB soil types. One category was added to account for the greenhouse or garden experiments. The 11 soil type categories are:

1. Organic soils
2. Mineral soils - human influences
3. Mineral soils - parent material
4. Mineral soils - topography/physiography
5. Mineral soils - conditioned by limited age
6. Mineral soils - (sub-)humid tropics

7. Mineral soils - climate of arid/semi-arid regions
8. Mineral soils - climate of steppes/steppic regions
9. Mineral soils - (sub-)humid temperate climate
10. Mineral soils - permafrost
11. Other
12. Unknown

When entering data in the Traitbase a pop-up menu will give the optional choice of different sub-categories (Table 2.5). More detailed information on these soil types and their sub-categories can be found in the World Soil Resources Report series (FAO 1998, 2001).

***Table 2.5.*** *The soil type categories of LEDA with their sub-categories. Note that the full description of the WRB soil types is given in the glossary (see Appendix E).*

| Soil type category | Sub-category |
|---|---|
| 1. Organic soils | 1.1. Histosols |
| 2. Mineral soils (human influences) | 2.1. Anthrosols (Fig. 2.4A) |
| 3. Mineral soils (parent material) | 3.1. Andosols (Fig. 2.4B) |
| | 3.2. Arenosols |
| | 3.3. Vertisols |
| 4. Mineral soils (topography/physiography) | 4.1. Fluvisols |
| | 4.2. Gleysols |
| | 4.3. Leptosols |
| | 4.4. Regosols |
| 5. Mineral soils (limited age) | 5.1. Cambisols (Fig. 2.4C) |
| 6. Mineral soils ((sub-)humid tropics) | 6.1. Plinthosols |
| | 6.2. Ferralsols |
| | 6.3. Nitisols |
| | 6.4. Acrisols (Fig. 2.4D) |
| | 6.5. Alisols |
| | 6.6. Lixisols |
| 7. Mineral soils (climate of arid and semi-arid regions) | 7.1. Solonchaks |
| | 7.2. Solonetz |
| | 7.3. Gypsisols |
| | 7.4. Durisols |
| | 7.5. Calcisols |
| 8. Mineral soils (climate of steppes and steppic regions) | 8.1. Kastanozems |
| | 8.2. Chernozems |
| | 8.3. Phaeozems |
| 9. Mineral soils ((sub-)humid temperate climate) | 9.1. Podzols |
| | 9.2. Planosols |
| | 9.3. Albeluvisols |
| | 9.4. Luvisols |
| | 9.5. Umbrisols |
| 10. Mineral soils (permafrost ) | 10.1.Cryosols |
| 11. Other | |
| 12. Unknown | |

**Data structure**

- Data characteristic: Soil type
- Description: One of the soil type categories
- Format: Category (number), sub-category (number)
- Level: Category and sub-category both optional

## 2.6. MANAGEMENT & FERTILISER APPLICATION

*R.M. Bekker*

Different management practices as well as fertiliser application are of influence on plant communities and should therefore be indicated when this information is available. The different management categories for LEDA are:

Management:

1. Grazing
2. Hay-making
3. Burning
4. Logging/thinning
5. Unmanaged
6. Other
7. Unknown

When information is available on the use of fertiliser on the site this should also be indicated, in the comment field details on the fertiliser used can be given when appropriate.

Fertiliser application:

1. Yes
2. No
3. Unknown

**Data structure**

| | | |
|---|---|---|
| • Data characteristic: | <u>Management</u> | <u>Fertiliser application</u> |
| • Description: | Management practices | Fertiliser application yes or no |
| • Format: | Category (number) | Category (number) |
| • Level: | Optional | Optional |

# 2.7. METHOD OF MEASUREMENT

*R.M. Bekker*

**Introduction**

Data entries may have many different origins and various ways of being obtained. To be able to query the database on different methods of measurement each entry must be allocated one of the below listed choices. The ranking of each method responsible for high or low data quality (e.g. to indicate different levels of data aggregation per plant species) will be indicated at each individual trait standard.

Method of measurement:

1. Estimation
2. Actual measurement (following LEDA standards)
3. Actual measurement
4. Categorized from original source
5. Estimation (following LEDA standards)
6. Derivation from morphologies or plant traits
7. Derivation from photo's or drawings
8. Observation (i.e. such as obvious taxonomical traits)
9. Field experiment
10. Laboratory, greenhouse or garden experiment
11. Modelling
12. Other
13. Unknown

To each of the methods choices a comments field will be attached as an optional field that may contain information on the original method, if second hand data are used, or that may contain more details about a used method.

**Data structure**

- Data characteristic: Method of measurement
- Description: Method used to obtain data
- Format: Category (number)
- Level: **Obligate**

# 3. SUMMARY

Summary of the data structure of the characteristics of the general standards with their description, data format and indication if the information is obligatory (indicated by X):

| Data characteristic | Description | Format | Obligate |
|---|---|---|---|
| *Reference cited:* | | | |
| Refname | Short abbreviated name of the data source | text | |
| Reftype | Person, publication or database | text | X |
| Author | Authors, all separately stored (in J. Ecol. format) | text | X |
| Year | Year of publication | number | X |
| Title | Full title of publication | text | X |
| Publisher | Name of publisher, e.g. Chapman and Hall, London | text | X |
| Journal | Name of journal | text | |
| Number | Edition/volume identifier | number | |
| Pages | Range of pages, when part of a large volume, e.g. 199-220 | number | |
| Book title | Full book title when the source is part of a larger reference | text | |
| Editor | List of names of editors | text | |
| ISXN | ISSN or ISBN number of the source | number | |
| Type | Type of publication (e.g. report, PhD-thesis, MSc-thesis) | text | |
| Location | Location of the library | text | |
| Language | Language of the data source | text | |
| Number of Trials | Total number of trials per source number | text | |
| Person name | Person name in the reference format (e.g. Thompson, K.) | text | |
| Person info | The persons email address | text | |
| Database ID | Unique code of one of the five different databases | text | |
| Database admin | Contact email address | text | |
| Database address | Name, address or web address (URL) of organisation | text | |
| *Geographical reference:* | | | |
| Study area | Whether the measured material originated from NW Europe (= 1) or from outside NW-Europe (= 0) | 0/1 | X |
| Country code | ISO-3166 two-letter country code where the measured material originated from | text | X |
| Altitude | In metres (with unknown projection) | number | |
| Sampling range | Range within which samples were taken | number | |
| Sampling range unit | In m or ha | number | |
| Precision | Sampling precision in metres | number | |
| Geodetic reference | WGS84 (= 1), ETRS89 (= 2), ED50 (= 3), unknown (= 4) | number | |
| UTM zone | According to UTM-grid and Geodetic reference (m) | number | |
| UTM easting | According to UTM-grid and Geodetic reference (m) | number | |
| UTM northing | According to UTM-grid and Geodetic reference (m) | number | |
| Longitude | East or West (e.g. 156° 59’ 59’’ E) | number | |
| Latitude | North or South (e.g. 89° 59’ 59’’ N) | number | |
| Map date | Editorial date of the map used (year) | number | |
| Source descriptor | Origin of data (administration) | text | |
| Comment | For e.g. comments on nearest town or nature reserve | text | |

| Data characteristic | Description | Format | Obligate |
|---|---|---|---|
| *Description habitat*: | | | |
| Habitat type | Categories that corresponds with EUNIS habitat types | category | X |
| *Habitat characteristics – terrestrial plants*: | | | |
| Soil acidity | pH of the soil of the sample site | range | |
| Soil moisture | Moisture status of the soil of the sample site | category | |
| Soil nutrients | Nutrient status the sample sites | category | |
| *Habitat characteristics – aquatic plants*: | | | |
| Water column acidity | pH of water column sample site | category | |
| Water column alkalinty | Alkalinity water column sample site | category | |
| Sediment redox potential | Sediment redox potential of sample site | category | |
| Soil substrate | One of the categories | category | X |
| Soil type | One of the main soil type categories | category | |
| Management | Management practices of sample site | category | |
| Fertiliser application | Fertiliser (yes/no) | category | |
| Method of measurement | Method used to obtain data | category | X |
| Collection date | Date of data collection (dd.mm.yy) | number | X |
| Comment | Any comments | text | |