Forest Research

Field Guide

The identification of soils for forest management

Forest Research

Field Guide

The identification of soils for forest management

Fiona Kennedy

Forest Research: Farnham

This publication is also available on our website at www.forestresearch.gov.uk/publications

First published by the Forestry Commission in 2002.
Reprinted with amendments in 2012. Reprinted in 2023 by Forest Research.

ISBN 978-1-83915-023-4

KENNEDY, FIONA. (2002)
The identification of soils for forest management
Forestry Commission Field Guide
Forestry Commission, Edinburgh. i–iv + 1–56pp.

Keywords: soil; soil classification; sustainable forest management.

FCFG001/FC-GB(KMA)/IVH-500/OCT23

Enquiries relating to this publication should be addressed to:

Forest Research
Alice Holt Lodge
Farnham
Surrey GU10 4LH
E: publications@forestresearch.gov.uk

Acknowledgements

I am grateful to all those who offered their advice and assistance in the development the keys, in particular Graham Pyatt, Bill Raynor, Janet Dutch, Helen McKay and Rona Pitman. Finally, I would like to thank Kirstie Adamson for her excellent work in the design and layout of the keys and Field Guide.

Contents

Introduction

Soils are complex and variable mediums comprising mineral particles, organic matter, water, air and living organisms. They are vital components of our forest ecosystems and represent a valuable and irreplaceable resource – not least for the valuable habitat they provide for many woodland species. Forest soils supply water, nutrients and anchorage to trees and other plant life. They also provide an important filtering and buffering action that protects other parts of the ecosystem from pollution and damage. They are increasingly considered for their important role in forest, and global, carbon cycles.

The preservation of the soil resource is a fundamental concept in sustainable forest management and this is reflected in the UK Forestry Standard (UKFS) and its supporting guidelines on Forests and soil. It is a requirement of the UKFS that the physical, chemical and biological properties of forest soils are protected or enhanced, soil fertility is maintained, and damage to soils – for example that which may occur through forest operations – is avoided.

The Forestry Commission (FC) soil classification system was developed in the 1960s (the most current system in 1982) to serve silviculture. It does this by distinguishing soil types on the basis of drainage and nutrition. This classification is the most commonly used system in British forestry and it is referred to in all relevant Forestry Commission and Forest Research (FR) literature. However, for the classification system to serve a useful purpose, there is a need to provide information on the definitive horizons of each soil type.

The aim of this Field Guide is to help forestry practitioners make responsible management decisions by providing them with a means of rapid soil identification. This is done via a series of decision keys aimed at those with little or no experience of soil classification. To avoid the unnecessary reading of text that may prove to be irrelevant, guidance on specialised terminology is given as and when it is required. Only a brief introduction to soil science is needed before using the keys.

Scope

The structure of the keys in this Guide complies with the FC soil classification system and they are also compatible with 'ESC' (the Ecological Site Classification: a PC-based decision support system for British forests). Inevitably, because the FC system has evolved since its conception, some soil types have been removed and others introduced. Also, in some FC and FR publications, names from other classification systems have occasionally been referred to. Where these instances are known, explanations are given at the relevant point in the keys. However, the outline summary in Section 1 is the current version of the FC system.

Guidance to managers is also frequently given on the basis of soil particle size distribution (or texture). Descriptions with one or a combination of terms such as sand(y), silt(y), clay or loam(y) indicate the use of this approach. For this reason a separate key is provided in Section 3 to classify soils into textural categories.

Before using the keys

Before the keys can be used a suitable soil profile at or near the point of interest must be found or dug. Before digging a pit it is worth saving time and energy by looking for exposures such as those above road cuttings or at the base of fallen trees. If none are available then ideally the area should be surveyed using a soil auger prior to digging. This ensures that the pit will not be located in an atypical or unrepresentative area. If time is short and a survey is not done, try to select a location away from man-made structures such as roads or walls where the soil profile may have been disturbed beyond the levels of normal cultivation. Find somewhere that is typical of the slopes and vegetation of the area. The pit should be dug to at least 60 cm (or bedrock if it occurs sooner) and the soil placed on plastic sheeting, separated into topsoil and subsoil, so that it can be replaced afterwards with any turfs on the top.

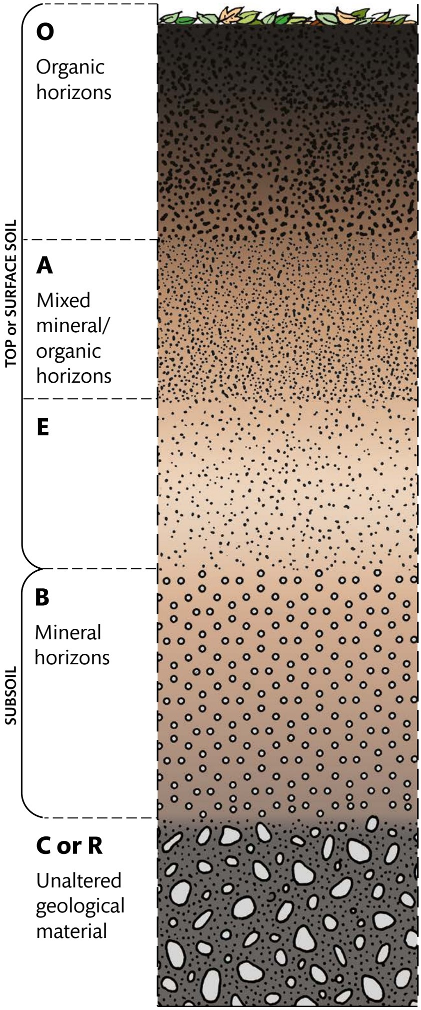
Once a profile is available, clean up the face with a penknife so that any smearing caused by the spade or any weathered material is removed. If a Deep peat soil currently under forestry is anticipated, some litmus paper or a field pH meter may be required for a basic pH determination.

Basic soil horizon nomenclature

Horizons are layers of soil that can be distinguished by properties such as colour and particle size distribution. Most soil profiles contain more than one horizon. These may be clearly distinct with sharp boundaries, or they may be only barely divisible with boundaries that merge considerably. The presence of a certain horizon or horizons is often used to diagnose a soil group or type. There are only a few, basic kinds of horizon which are depicted by capital letters. The horizon types necessary to use these keys are described in Figure 1. Note that not all horizons necessarily exist in any given soil.

A number of varieties of these basic horizon types exist. Subdivisions are denoted by a lower case letter following the capital letters given in Figure 1. Where such a level of detail is necessary for soil identification using these keys, a description always accompanies the notation.

Figure 1 Horizon types.



Organic matter includes loose, fresh litter; partially decomposed litter from previous years; and decomposed litter in which the original plant structures are no longer recognisable, i.e. the litter has humified to form humus or peat. Mineral grains are not necessarily absent in these horizons. Following the FC classification system, more than 30% organic matter constitutes an organic horizon.

This is a mineral horizon into which humified organic matter has been incorporated. This may or may not be the surface horizon. 'A' horizons contain between 1 and 30% organic matter which stains the minerals resulting in dark coloured soil.

As above, but oxides and/or organic matter and/or clays have been removed and transported downwards resulting in a pale colour.

A mineral horizon which lies beneath either an A or an E. It may have received oxides, organic matter or clay from the horizon above or it may simply be a weathered form of the 'parent' material (see paragraph below for definition). Colours therefore vary.

This may be a loose unconsolidated C horizon or hard bedrock (R). It is *usually* the source of the mineral component of the soil above, i.e. it is *usually* the 'parent' material.

Forestry Commission soil classification system

Under this system soils are divided into groups, types and phases. (Phase descriptions provide a means of communicating local variations in the more widespread soil types.) The keys provided in Section 2 should be followed for identification, but for reference purposes, Tables 1–3 summarise the 15 soil groups and the types within them.

Table 1 The Forestry Commission classification system for the main mineral and shallow peaty soils.

	Soil group	Soil type	Code
Soils with well-aerated subsoil	1. Brown earths	Typical brown earth Basic brown earth Upland brown earth Podzolic brown earth	1 1d 1u 1z
	3. Podzols	Typical podzol Hardpan podzol	3 3m
	4. Ironpan soils	Typical ironpan soil Podzolic ironpan soil Intergrade ironpan soil	4 4z 4b
	12. Calcareous soils	Rendzina Calcareous brown earth Argillic brown earth	12a 12b 12t
Soils with poorly aerated subsoil/gleys	5. Ground-water gley soils	Typical ground-water gley	5
	6. Peaty (surface-water*) gley soils	Typical peaty surface-water gley Podzolic peaty surface-water gley	6 6z
	7. Surface-water gley soils	Typical surface-water gley Podzolic surface-water gley Brown surface-water gley	7 7z 7b

*Can be omitted for brevity

Table 2 The Forestry Commission classification system for Deep peats.

	Soil group	Soil type	Code
Flushed peatlands	8. Juncus (or basin) bogs	Phragmites (or Fen) bog	8a
		Juncus articulatus or acutiflorus bog	8b
		Juncus effusus bog	8c
		Carex bog	8d
	9. Molinia (or flushed blanket) bogs	Molinia, Myrica, Salix bog	9a
		Tussocky Molinia bog, Molinia, Calluna bog	9b
		Tussocky Molinia, Eriophorum vaginatum bog	9c
		Non-tussocky Molinia, Eriophorum vaginatum, Trichophorum bog	9d
		Trichophorum, Calluna, Eriophorum, Molinia bog (weakly flushed)	9e
Unflushed peatlands	10. Sphagnum (or flat or raised) bogs	Lowland Sphagnum bog	10a
		Upland Sphagnum bog	10b
	11. Calluna, Eriophorum, Trichophorum (or unflushed blanket) bogs	Calluna blanket bog	11a
		Calluna, Eriophorum vaginatum blanket bog	11b
		Trichophorum, Calluna blanket bog	11c
		Eriophorum blanket bog	11d
	14. Eroded bogs	Shallow hagged eroded bog	14
		Deeply hagged eroded bog	14h
		Pooled eroded bog	14w

Table 3 Other soils covered by the Forestry Commission classification system.

Soil group	Soil type	Code
2. Man-made soils	Mining spoil, stony or coarse textured	2s
	Mining spoil, shaly or fine textured	2m
13. Rankers and Skeletal soils	Brown ranker	13b
	Gley ranker	13g
	Peaty ranker	13p
	Podzolic ranker	13z
	Rock	13r
	Scree	13s
15. Littoral soils	Shingle	15s
	Dunes	15d
	Sand with deep water-table (or Excessively drained sand)	15e
	Sand with moderately deep water-table	15i
	Sand with shallow water-table	15g
	Sand with very shallow water-table	15w

Phases

Once the soil group and type have been identified using the keys (pages 15–50), phase descriptions may be added to communicate further information. They are particularly useful in some of the more common forest soil groups such as the Podzols and Gleys. Table 4 (pages 10–11) lists the phase descriptions that are available.

If phase descriptions are considered appropriate, they should be expressed as follows:

Abbreviation	
1ua	**Upland brown earth, shallow phase**
6lp	**Peaty surface-water gley, deeper peat and loamy phase**

Phase letters always follow type letters. If more than one phase letter is applicable these should be written in the following order:

v, l, p, h, z, x, g, i, s, a, f, k, c, e

Note: any more than three phase letters is confusing and unnecessary.

Problem soils

The purpose of a classification system is to communicate what you have seen to others. Provided you can do that, your goal has been achieved. There are two instances where this should be borne in mind:

- Frequently throughout the keys users are asked to decide whether a soil characteristic is significant or not. In these cases no definitive percentage occurrence can be given, rather, users must ask themselves the following. If they were to list the characteristics of this soil for a colleague, how high up their priority list would they put the particular feature of concern?

Table 4 Phases applicable to the soil types listed in Tables 1–3.

Suffix	Name	Applies to
a	Shallow	All except Rankers, Rendzinas and Rock
c	Cultivated	All
e	Ericaceous	All except Calcareous soils
f	Flushed	Gleys
g	Slightly gleyed	Brown earths, Podzols and Ironpans
h	Humose	Gleys
i	Imperfectly aerated	Gleys
k	Calcareous	Gleys
l	Loamy	Gleys
p	Peaty (or deeper peat)	Podzols, Ironpan soils, Ground-water and Peaty surface-water gleys
s	Extremely stony	All except Deep peats, Rock and Scree
v	Alluvial	All except Peatland, Man-made, Calcareous, Littoral and Skeletal soils
x	Indurated	All of Table 1 except Calcareous soils
z	Podzolic	All non calcareous mineral soils

	Description	Tip
	Predominantly 30–45 cm of soil to bedrock (0–45 cm for Man-made soils)	Unlikely to occur with v, cannot occur with x
	Considerable alteration to physical or chemical properties or to vegetation by former agricultural use	Cannot occur with e
	Vegetation contains sufficient Calluna (heather) (dominant to frequent) to become a weed problem after planting	Cannot occur with c or f. Often replaced by the term 'heathland [soil type]'
	Considerable enrichment with nutrients from flushing water, as indicated by the presence and vigour of tall Juncus species (rushes), Deschampsia caespitosa (tufted hair grass) or Molinia (purple moor grass).	Unlikely to occur with i
	Subsoil slightly mottled or with grey patches	See page 17 for definitions of gleying and mottling
	Topsoil contains between 8 and 30% organic matter	Cannot occur with p
	Grey colouration is less prominent than usual, but doesn't quite qualify as type 7b	Unlikely to occur with f
	Has a pH greater than 7 in the A, E or B horizons.	Unnecessary if x or v have been used
	Texture throughout is not finer than sandy clay loam (see Section 3)	
	A surface horizon containing more than 25% organic matter. Note: for types 3 and 5 to become 3p and 5p requires 5–45 cm of peat; For types 6 and 6z to become 6p and 6zp requires 25–45 cm of peat as they have more than 5 cm already. Definitions of 'peaty' for type 4, the Ironpans, have varied. It is suggested here that 15–45 cm of peat should be present to allocated this phase to Ironpan soils.	Cannot occur with h
	Stones occupy more than 35% of the soil volume	Scree (13s) already has this characteristic
	Soil developed in recent alluvium (river sediment) of sandy or coarse loamy texture (see Section 3)	Cannot occur with x
	Has strongly indurated material within 45 cm of the soil surface. Implies a loamy texture (see page 52). Where the induration is moderately developed or at 45–60 cm depth an x is used	For a definition of 'induration' see page 23. Cannot occur with a or v
	Presence of bleached Ea horizon or humus rich Bh horizon	

To some extent, as with all keys, this means looking at the questions ahead. For example, if the user has reached the question ‘Is significant **gleying** present in the B horizon(s)?’ in the Mineral Soils key on Page 18, and they are confronted with a soil which has both signs of **podzolic** B horizons and **gleying**, they must ask themselves: ‘Which of these is the most important feature of the soil from a management point of view?’ If it is the acidity associated with podzolisation, they should answer ‘no’ and move on to the next question. If it is the seasonal waterlogging problems reflected by the degree of **gleying**, they should answer ‘yes’ and go to the Gleys key on page 28. If the decision is difficult, guidance can be taken from the order in which the author has chosen to key out the characteristics. For example, gleys are intentionally placed before podzols because a propensity for water logging is considered to be the more important feature from the point of view of forest management.

- If it seems impossible to choose between two soil types, then perhaps it is incorrect to call it either. In these cases the soil can be described as an ‘intergrade’ between the two. This is so common in Ironpans (intergrading to Upland brown earths, 1u) that a type is already provided in the keys.

Soil keys

Design of the keys

Soil identification begins with the General key opposite*. From here the user is guided through the keys via a series of decision boxes beginning at the top left of each new page. The keys guide the user to a soil classification at **group** or **type** level, indicated by boxes with a coloured left-hand column and dashed or solid borders for group and type respectively. With the exception of some afforested Deep peats on page 41, the keys always guide the user to a classification at type level.

Information on important phases is given in the text and tables on pages 4–11.

Additional information designed to assist the user working through the decision boxes is given in the accompanying text or in 'tip' boxes which are divided into the following categories:

- **?** Help boxes
- **!** Warning boxes
- ***i*** Information boxes

A fold-out tab on the back cover summarises details of common diagnostic soil features and explains the terms given in bold in the main text.

*It is assumed that 'Basic soil horizon nomenclature' on page 3 has been read.

Does the soil profile contain >45cm of **Organic matter**, OR >30cm of Organic matter if it is directly overlying rock or loose deposits?

N → 1-7, 12, 13, 15 — Mineral soils Go to page 18

Y → 8-11, 14 — Deep peats Go to page 40

i **Organic matter** includes clearly definable loose, fresh litter, partially decomposed litter and fully decomposed humus which is no longer recognisable as plant material. It is acceptable for some mineral grains (up to 70%) to be present in this humus – to test this smear the humus across your finger and look for mineral grains catching the light.

Figure 2 This is a mineral soil (a Peaty surface-water gley – group 6) because although it has a substantial humus layer, the humus is less than 45 cm in depth.

Figure 3 This soil is clearly classed as a Deep peat because the humus depth is greater than 45 cm.

Mineral soil groups are summarised in Tables 1 and 3 on pages 6 and 8. Two important processes that occur in mineral soils are **gleying** and podzolisation. Recognition of one or both of these is often necessary for the successful identification of mineral soils.

A **Gleyed** horizon is either grey due to permanent waterlogged conditions or it is **Mottled**. **Mottling** is an effect produced when soil horizons are seasonally waterlogged. In some parts of the profile iron is present in its reduced, green/grey form and in others it is oxidised and red/orange. The result is a patchy effect, examples of which can be seen in Figures 2 and 4. Note that **mottling** also exists in Ironpan soils but this is in an E horizon.

The characteristic process that forms podzols is the downward transport of iron and/or organic material. Definitive **podzolic** B horizons therefore include red iron enriched (**Bs**) and black **humus** enriched (**Bh**) sub-surface horizons. In some cases the **Bs** has hardened (by being cemented with oxides) to form an 'ironpan' called a **Bf**. This may be red or black in colour. Frequently these **podzolic** horizons coexist with a bleached layer just above them, an **Ea**, from which the iron and **humus** have been removed. If a **Bh** or a **Bf** is present an **Ea** is not required for you to answer 'yes' to this question, but if a **Bs** only is present then an **Ea** must also be present. Note: more than one **podzolic** B horizon may exist in a single soil profile. Also be aware of the possibility that cultivation may have reversed a soil profile creating what appears to be a **Bh** but is actually buried topsoil.

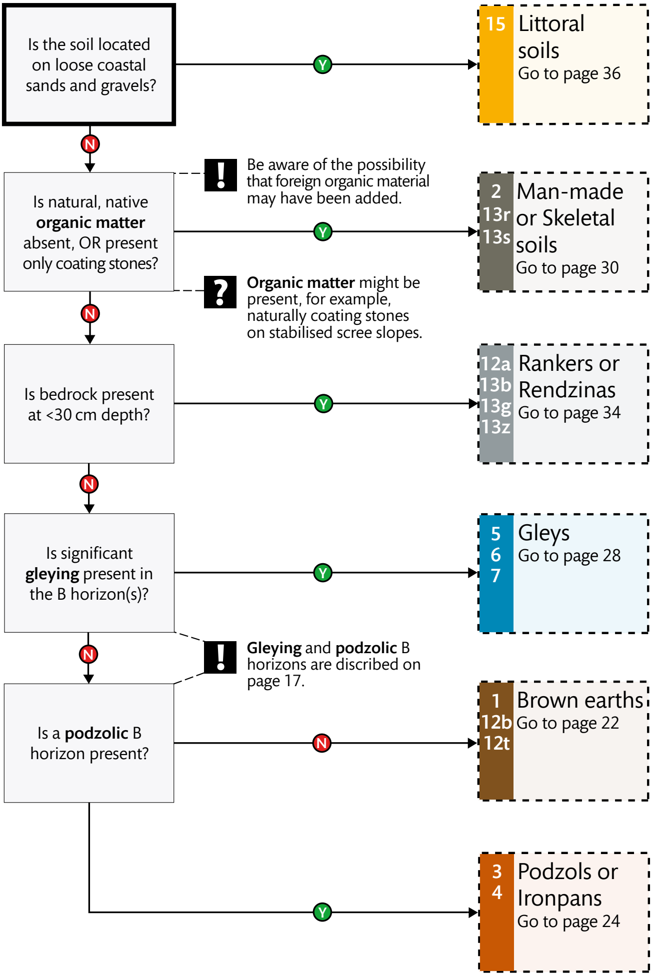

Is the soil located on loose coastal sands and gravels?
Y
15 Littoral soils
Go to page 36
N
Is natural, native **organic matter** absent, OR present only coating stones?
Be aware of the possibility that foreign organic material may have been added.
Y
2 13r 13s Man-made or Skeletal soils
Go to page 30
Organic matter might be present, for example, naturally coating stones on stabilised scree slopes.
N
Is bedrock present at <30 cm depth?
Y
12a 13b 13g 13z Rankers or Rendzinas
Go to page 34
N
Is significant **gleying** present in the B horizon(s)?
Y
5 6 7 Gleys
Go to page 28
N
Gleying and **podzolic** B horizons are discribed on page 17.
Is a **podzolic** B horizon present?
N
1 12b 12t Brown earths
Go to page 22
Y
3 4 Podzols or Ironpans
Go to page 24

Figure 4 A Brown surface water gley (type 7b) showing mottling or gleying in the subsurface horizon.

Figure 5 A Typical podzol (type 3) with an Ea and a Bh horizon.

Ea

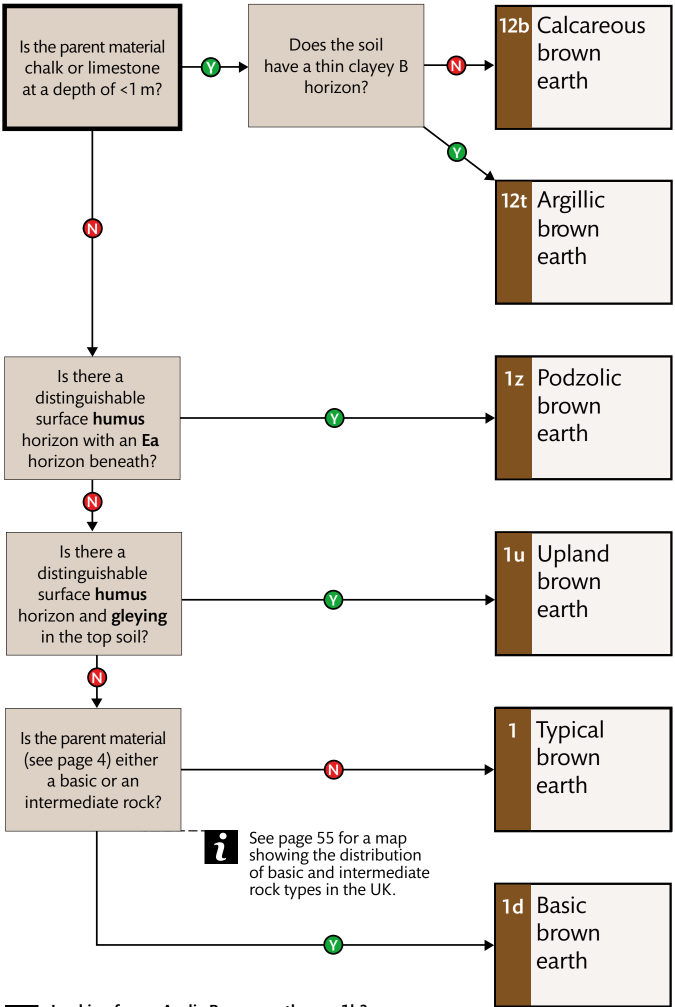
Bh

Figure 6 A Typical brown earth (type 1).

These are soils with brownish or reddish colours, free drainage and good aeration throughout the profile. Organic matter is well incorporated into the mineral soil to give a dark brown A horizon; there is no E horizon and the B horizon is a rich brown colour due to weathering and residual accumulation of iron oxides.

Inconsistencies exist among the various published versions of the classification system regarding the terms Basic and Andic brown earths and the lettering used to identify them. For a time the name Andic brown earth was used instead of Basic brown earth for the type 1d. This was named after Andesite which is an intermediate igneous rock. The purpose of this change was to free up the name 'Basic' brown earth for a new soil type, 1b, designed to encompass any base-rich Brown earth regardless of parent material. However, with the development of soil nutrient regimes in ESC we now have a mechanism for classifying sites directly on the basis of nutrition. There is no longer a need for the short-lived type 1b and the classification system has reverted to its original form, i.e. there is no 1b and no Andic brown earth. In fact, type 1b was so short-lived that it has never appeared on any FC soil map.

The term Brown sand has occasionally been used in FC and FR literature. It comes from the Soil classification for England and Wales. In this classification system Brown sands are distinguished from Brown earths on the basis of particle size distribution. If a distinction between the two is necessary, refer to the keys to soil texture identification on page 54. Note though that in the FC classification system Brown sands are included in the Brown earth group and are most likely to belong to type 1z, Podzolic brown earths.



See page 55 for a map showing the distribution of basic and intermediate rock types in the UK.

Looking for an Andic Brown earth, or a 1b?
These types have been removed from ESC though you may see them in other current publications. For an explanation see page 21.

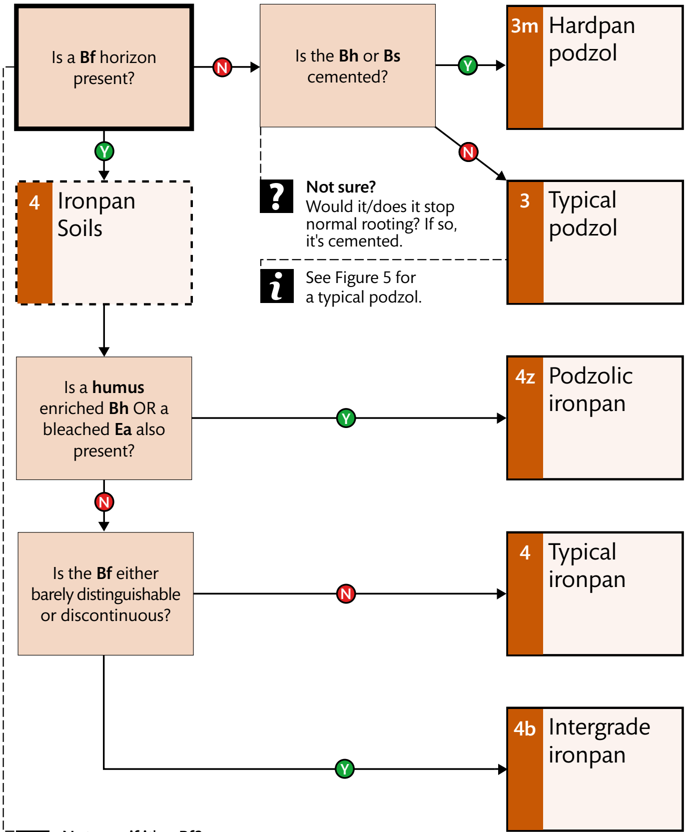
Podzols and Ironpan soils develop on freely draining material in areas with high rainfall. The two groups are distinguished from each other by the presence of a pan (**Bf**) that is dense enough to significantly reduce the downwards movement of water. If the latter is the case then the soil is an Ironpan; thus Ironpan soils are identified by the presence of a **gleyed** layer directly above the pan.

Two types of Podzol are distinguished depending on whether the **Bh** and/or **Bs** horizons are sufficiently cemented to prevent intensive rooting. In the Typical podzol the **Bh** and **Bs** horizons may be slightly cemented, but can be readily penetrated by fine roots. In the Hardpan podzol the **Bh** and/or **Bs** are strongly cemented and few roots penetrate. Hardpan podzols are mainly found in very sandy or stony textured soils in the lowlands.

Common phases

Two important common phases (page 9) associated with these soil groups are indurated and peaty layers. Typical podzols with peaty phases are so common that they are often referred to as 'Peaty podzols'. Similarly, Podzols with ericaceous phases are commonly called 'Heathland podzols'. Such shortenings are natural, but one should be aware that no such soil type exists. Note that to qualify as a peaty phase, Ironpans must have 15 cm of peat overlying them (up to a maximum of 45 cm) whereas Podzols only require 5 cm of peat (again up to a maximum of 45 cm). If greater than 45 cm of peat is present then the soil belongs to the Deep peat group.

Indurated phases are common in Ironpan soils but can exist at depth in Podzols. Indurated horizons are very dense and when well developed can also be brittle. Despite their high density, they are not clay rich (maximum approximately 15% clay). They often take the form of horizontal plates stacked in columns so that when a horizontal



Not sure if it's a Bf?
Is there any evidence of **gleying** directly above the suspected horizon? If so, it's a **Bf**.

Looking for a Peaty podzol?
This is actually a phase allocation; see page 10 for this and other common phases associated with Podzols and Ironpans.

cross section is cut, a polygonal pattern can be observed. In the UK indurated horizons may also be cemented. Indurations are thought to be a relic from glacial deposits which were permanently frozen during the ice age and consequently may be present in E, B or C horizons.

Figure 7 This soil is actually a Deep peat because the humus layer is just greater than 45 cm. However the mineral soil beneath is a good example of an Ironpan (Bf).

Figure 8 A podzolic peaty surface-water gley (type 6z).

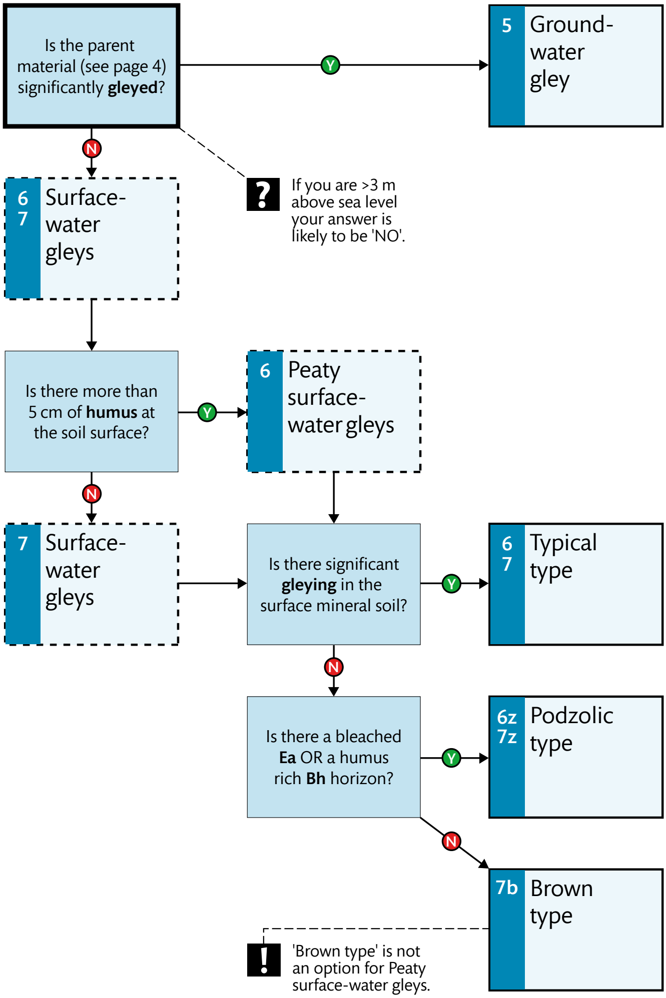
Ea

Bh

Gley soils are characterised by permanent or seasonal waterlogging. They are among the most common forest soils and are of particular importance because they can be problematical due to poor oxygenation and susceptibility to compaction. There are two causes of **gleying**; either the waterlogging is caused by a shallow water table in the case of the Ground-water gleys, or an impermeable layer within the soil profile, usually a clay layer or induration, impeding drainage – the Surface-water gleys. Within the FC classification system Surface-water gleys are further divided into those which are peaty (group 6) and those which are non-peaty (group 7); the former, however, are frequently shortened to 'Peaty gleys'.

In theory, distinction between the two types is straightforward. In a Ground-water gley the underlying geological material is waterlogged or **mottled**, whereas in a Surface-water gley it is not. In practice, differentiation between the two can be difficult, often because the two causes of **gleying** are occurring simultaneously. While it is important to distinguish the main cause wherever possible (as it may have implications for ground preparation) it is convention that where there is doubt, the Surface-water gley option is selected for classification purposes. This is because Ground-water gleys are not as common as Surface-water gleys; one classification system defines them as only occurring at <3 m above sea level. For this reason there is no need to further subdivide the Ground-water gleys in the same way as the Surface-water gleys, and the subdivisions have been dispensed with.

Due to their widespread nature, if necessary, a number of phase descriptions are available to further characterise Gley soils. For details of these see page 10.



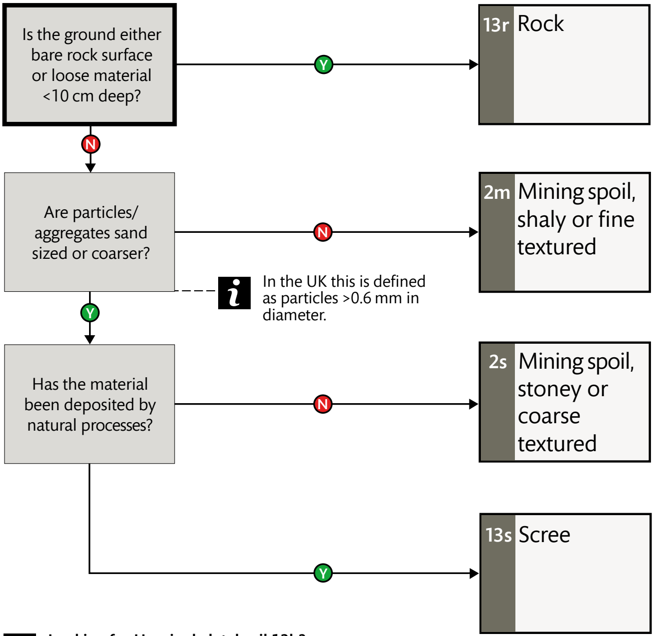
The term 'Valley bottom complex' occasionally appears in FC and FR literature. As with 'Ranker complex', this term is a mapping unit rather than a soil type. It represents the occurrence of a number of different gley (and possibly other) soil types in a small area. If using this term bear in mind that it is not an option in ESC.

Man-made and Skeletal soils

Man-made soils are highly diverse in nature. They include spoil from mineral workings, tipped waste and industrial by-products. Consequently pH, toxicity, depth, particle size and moisture availability can range to far greater extremes than those typically observed in natural soils. The FC classification deals only with mineral spoil, crudely differentiating types on the basis of particle size, which in turn reflects the potential for compaction or droughtiness. Depth is not used as a basis for determining types but is easy to measure and crucial in assessing the potential for root development and hence tree establishment. It is therefore recommended that full use is made of the phase description 'shallow' (see page 10). For natural soils this is used when a soil is between 30 and 45 cm in depth, but for Man-made soils 'shallow phase' can be attached when the material is any depth under 45 cm.

If required, a more comprehensive classification of Man-made and modified soils is given in The classification of soils in urban areas. Guidance on reclaiming such soils to forestry is also given in FC Bulletin 110 Reclaiming disturbed land for forestry.

Skeletal soils include Scree, Rock and formerly Humic skeletal soils. Soils in this group usually consist of naturally occurring stones or boulders. As such they push the boundary of the term 'soil' to its limits and are rarely plantable.



Looking for Humic skeletal soil 13h?
This soil type has been included in the classification system in the past, but is no longer used. It was essentially a scree with humus coatings on the stones. In practice, such soils, along with Screes, are rarely plantable hence their amalgamation into one type for ESC.

Figure 9 Coarse textured colliery spoil (type 2s) in Derbyshire.

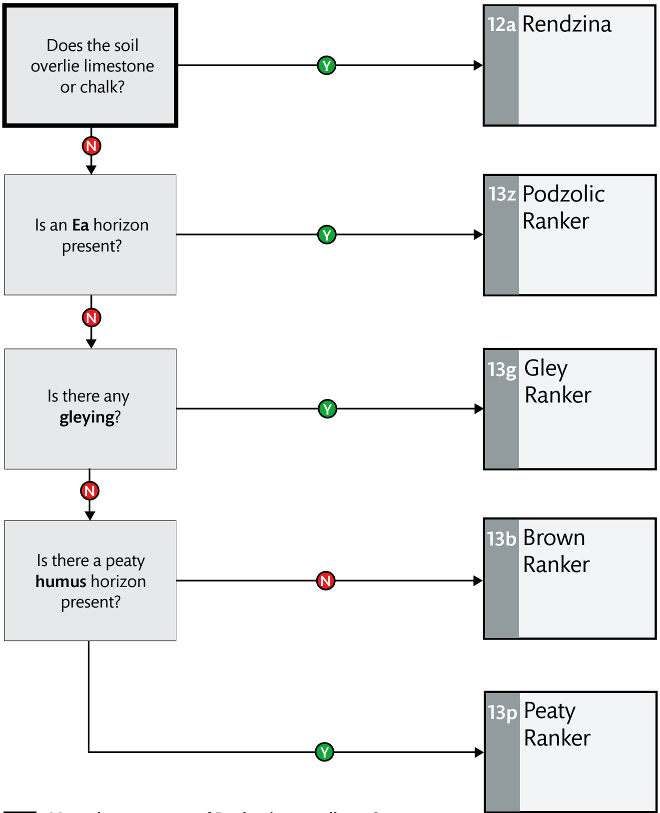
Figure 10 A Rendzina (type 12a), Selbourne Common, Hampshire.

Figure 11 A Rendzina (type 12a), taken from a distance to show the shallowness of the soil.

Rankers and Rendzinas

12a | 13b | 13g | 13z

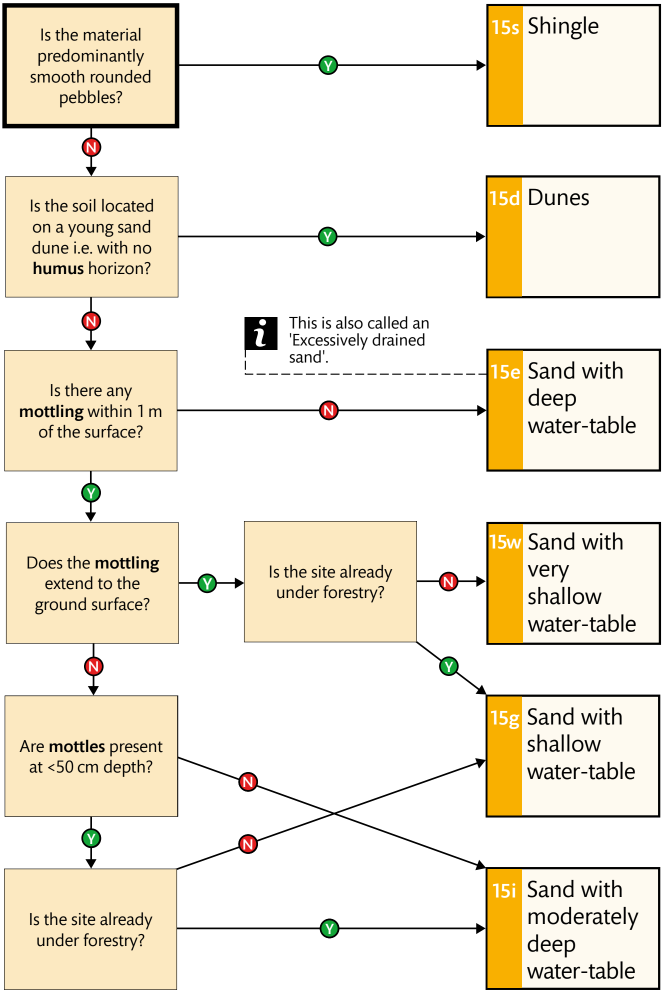
Rankers and Rendzinas are the classical names for shallow soils. As the volume of rootable material is crucial to so many landuses, such soils are frequently moved into their own group. Thus 'depth' overrides the presence of soil characteristics that are commonly used to define Mineral soils (such as podzolisation and **gleying**). These latter characteristics are then used to subdivide Rankers (Rendzinas are a special case) into a 'mini' suite of Podzol, Ironpan, Gley and Brown earth types, mirroring the names of the deeper soil groups.



More than one type of Ranker in a small area?
You could use 13c 'Ranker complex'. This is a mapping designation which indicates a lot of spatial variation in soil types. Note, though, that as 13c is not a specific soil type, you will not be able to use it in ESC. If you are using ESC, you will have to choose the most commonly occurring type.

Littoral soils

Soils formed on coastal sands and shingles are known as Littoral soils. The majority of Littoral soils are defined on the basis of their minimum water-table depth. It is likely that a surveyor will only have the opportunity to visit a site once; they will therefore need to rely on the presence or absence of **mottling** to estimate the annual minimum water-table depth. However, where the land use is forestry, **mottling** may reflect higher water tables prior to afforestation. Where this is the case the view is taken that the trees have changed the soil type and the **mottles** can no longer be regarded as representative of the current water-table level. For forested sites the scheme below therefore shifts the classification to a soil type with a deeper water-table than the relic **mottling** suggests.



Is the material predominantly smooth rounded pebbles?
Y
N
15s Shingle
Is the soil located on a young sand dune i.e. with no **humus** horizon?
15d Dunes
This is also called an 'Excessively drained sand'.
Is there any **mottling** within 1 m of the surface?
15e Sand with deep water-table
Does the **mottling** extend to the ground surface?
Is the site already under forestry?
15w Sand with very shallow water-table
Are **mottles** present at <50 cm depth?
15g Sand with shallow water-table
Is the site already under forestry?
15i Sand with moderately deep water-table

Figure 12 An example of a Littoral soil. Sometimes faint horizontal lines are distinguishable (not seen here); these are sediment deposits, i.e. they are a geological feature and not a result of soil processes.

Figure 13 Red and green Sphagnum moss adjacent to each other, Shortheath Bog, East Hampshire.

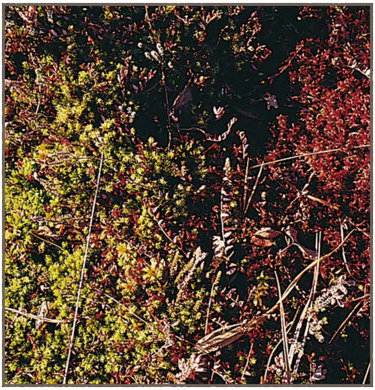


Figure 14 Juncus effusus (soft rush), Whixall Moss.

Andrew N. Gagg's PHOTO FLORA

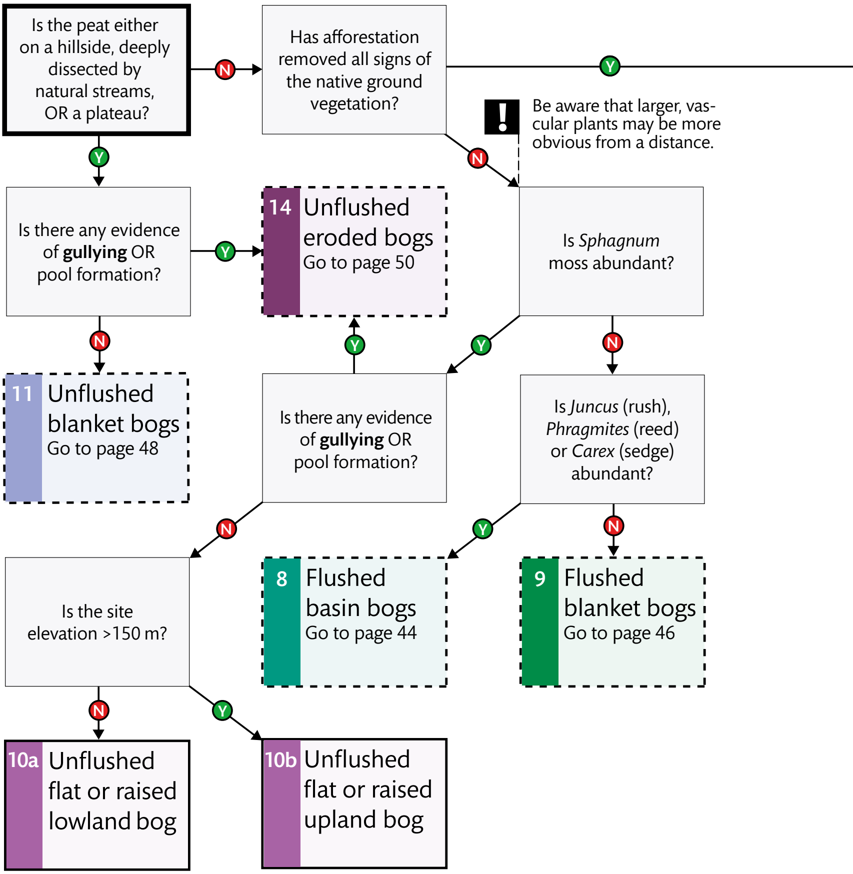
Figure 15 Winter seed heads of Phragmites communis (common reed), Blackwater Reservoir, Surrey.

Figure 16 Carex cf. strigosa (thin-spiked wood sedge), Alice Holt Forest, Hampshire.

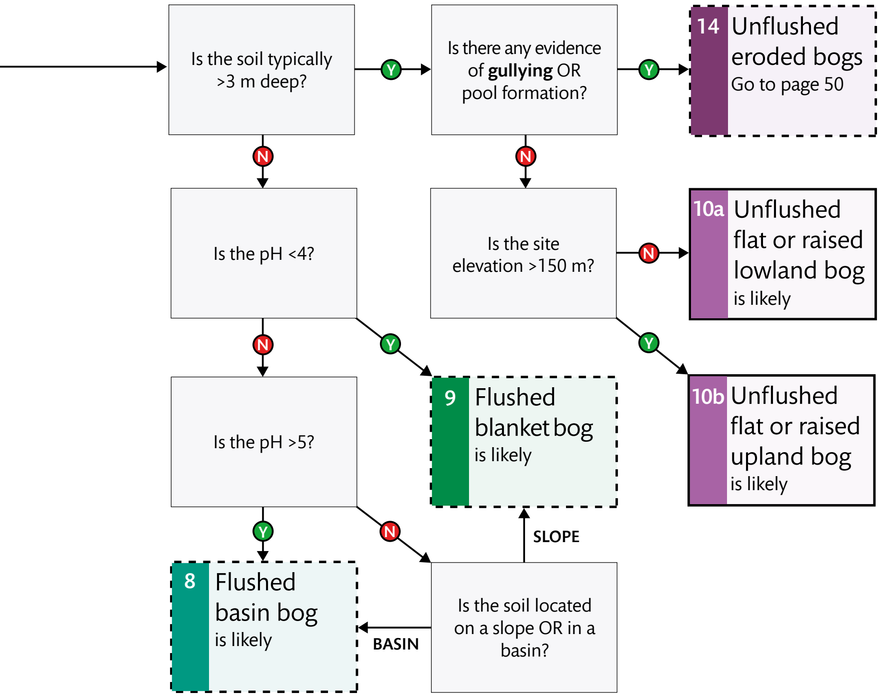
Deep peats develop where plant remains accumulate under wet conditions. These soils can be broadly divided into those that receive water, and therefore nutrients, from higher ground (flushed peats) and those which are dependent on precipitation for water and nutrients (unflushed peats). A spectrum of peat groups of varying nutritional status are therefore defined. As natural species communities reflect site nutrition, these have traditionally been diagnostic in soil classification systems. In the FC system they are frequently used to define peat types. Where peatlands are already under forestry, pre-existing species communities may be impossible to identify, making classification difficult. For this reason an alternative key has been devised to facilitate identification to the soil group level only (page 41). However, use of the keys must be combined with an understanding of the factors driving peat development and particularly if the alternative system is employed. In this way an awareness of the location of the soil within the landscape will enable the correct classification.

The development of peat soils

Peat development is best understood through the description of a theoretical sequence of events. Beginning with the scenario of a basin receiving surface or subsurface water from the surrounding area, the vegetation that exists within the basin has a substantial supply of nutrients originating from the rocks through which the water has travelled. The peat that develops as the vegetation in the basin dies and decays is therefore high in nutrients and contains some mineral grains but has not yet developed to great depths. This is the typical flushed 'basin bog' (group 8) which is commonly black and amorphous and is usually dominated by Juncus (rush) species (8b, 8c) but may be a Phragmites (reed) or Fen bog (8a) if the flushing water is from calcareous rocks and therefore particularly high in nutrients.



Sphagnum, *Juncus*, *Phragmites* and *Carex* are shown in Figures 13, 14, 15, and 16 respectively. Further information on distinguishing between these species is given on page 44.



! The use of depth and pH to identify peats is crude. Please read the accompanying text.

i **Gullying** or 'hagging' refers to the development of a network of narrow erosion channels.

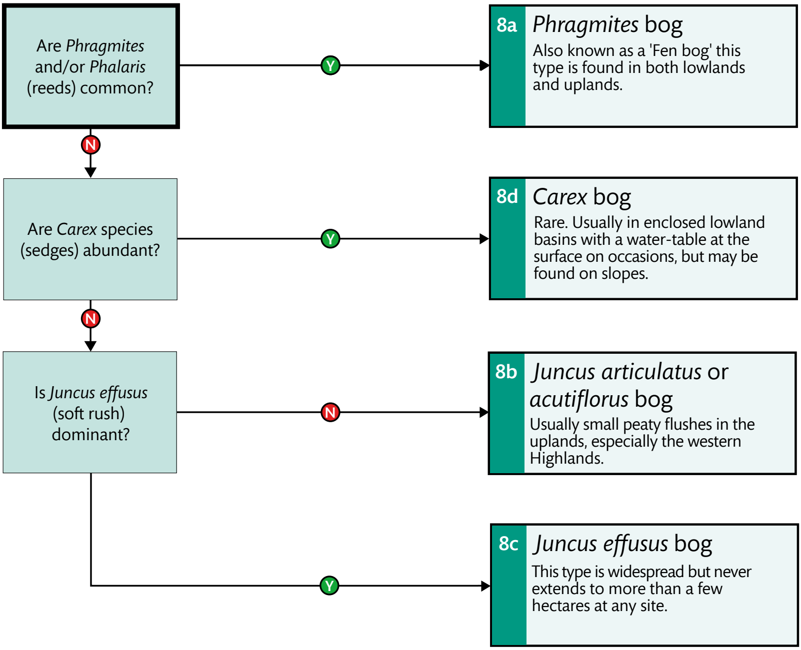
After considerable time the peat accumulates until a dome shape develops; water from the surrounding rocks is no longer available to the surface layers of the peat and the vegetation is predominantly dependent on precipitation for nutrients. This is the classic unflushed 'raised bog' dominated by Sphagnum moss, which is placed into group 10 of the FC classification. It is deep, the surface layers are fibrous with a reddish-brown colour and mineral grains are absent. In terms of nutrition and depth, in between these two extremes are the flushed blanket or Molinia (purple moor grass) bogs (group 9). In reality they do not necessarily represent a historical step between basin and raised bogs, but often exist on concave hillsides that are flushed to varying degrees (represented by the different types within this group). Furthermore it is important to note that the flat Sphagnum moss bogs are placed in the same group as the raised Sphagnum bogs – group 10. It is in fact rare to observe the domed shape described above and most of the peats in this group will be flat. Finally, group 11, the unflushed blanket bogs, are unflushed because of their location, having no higher ground around them, rather than as a consequence of the accumulation of peat. Commonly these include the hill peats located on upland plateaux, but they may also form on hillsides deeply dissected by streams that divert nutrients away from the soil.

Figure 17
Phalaris arundinacea (reed canary-grass), New Mill Bridge.
Figure 19
Juncus articulatus (jointed rush), Allimore Green Common.
Figure 21
Juncus acutiflorus (sharp-flowered rush), Torver Tarn.

Figure 18
Phalaris arundinacea (reed canary-grass), Tocil Wood.
Figure 20
Juncus articulatus (jointed rush), Wicken Fen.
Figure 22
Juncus acutiflorus (sharp-flowered rush), Torver Tarn.





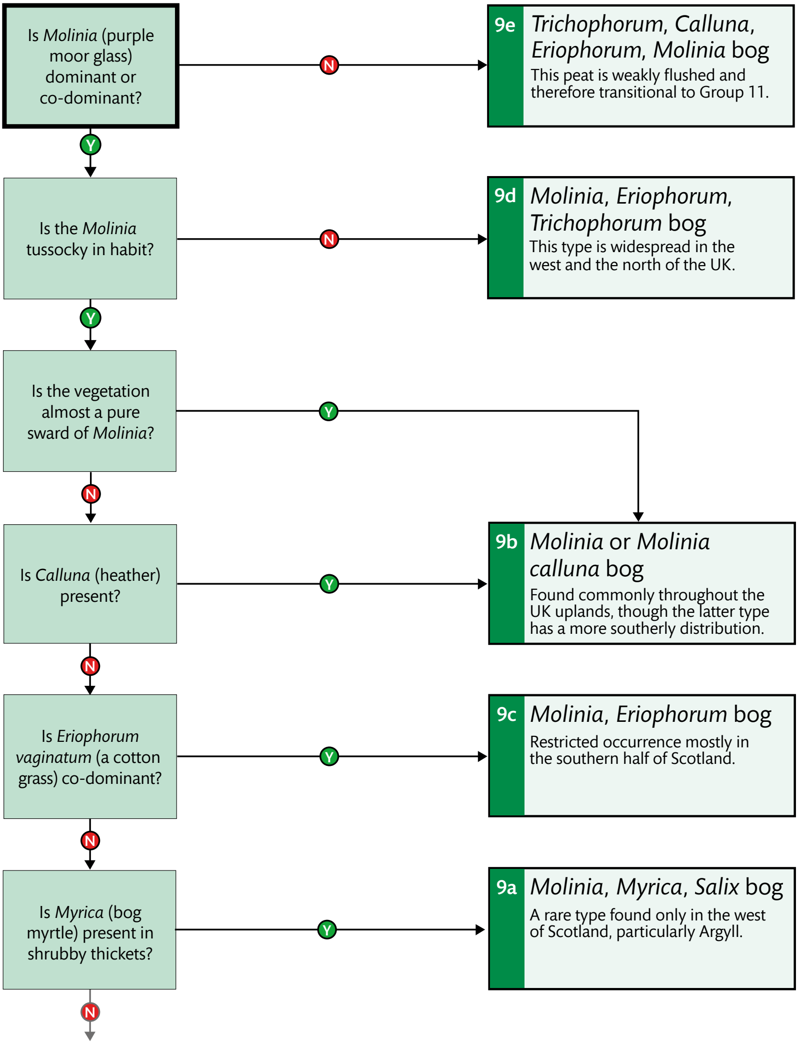



i *Carex* species (sedges) are distinguished by their flower stems which are triangular in cross-section. *Juncus* species (rushes), on the other hand, have a round flower stem which is often filled with a white pith. Grasses can also have a round stem cross-section, but generally speaking their form is flaccid compared to the *Juncus* species which are quite stout. *Phragmites* and *Phalaris* (reeds) are best distinguished from the other species in this key by their height; *Phragmites* will be in excess of 1 m and *Phalaris* greater than 60 cm.

Figure 23 Molinia caerulea tussocks under Pinus sylvestris in autumn. Shortheath Common, East Hampshire.

Figure 24 Eriophorum vaginatum showing autumn seed heads.

Figure 25 Myrica gale showing flower heads.

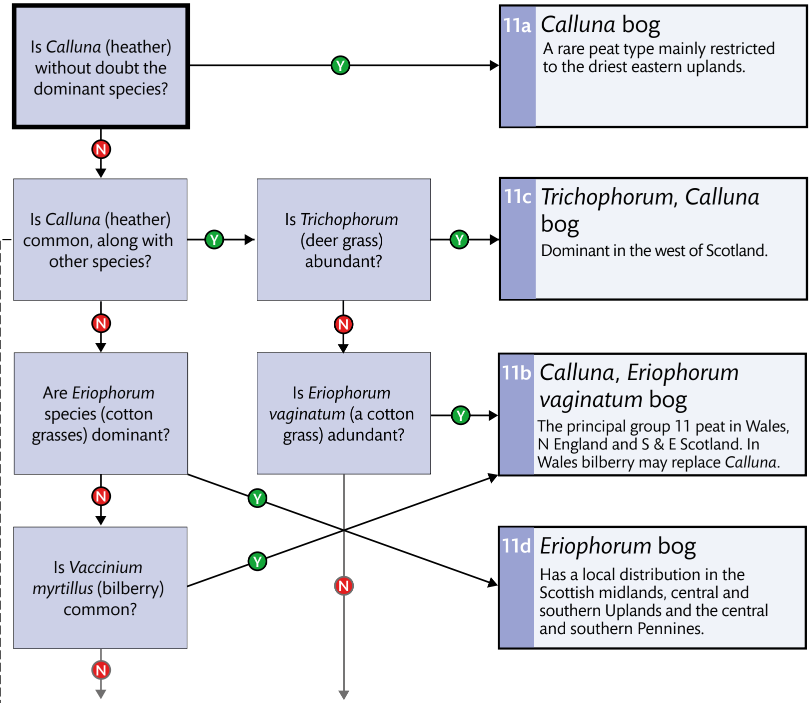


Your vegetation community does not fit any of those commonly found in Group 9. This group is transitional between the heavily flushed bogs (group 8 – page 44) to which 9a is closest, and the unflushed bogs (group 11 – page 48) to which 9e is closely related.

Figure 26 Calluna vulgaris (showing flower heads).

Figure 27 Vaccinium myrtillus (showing flower heads).

Figure 28 Tricophorum cespitosum (deer grass).

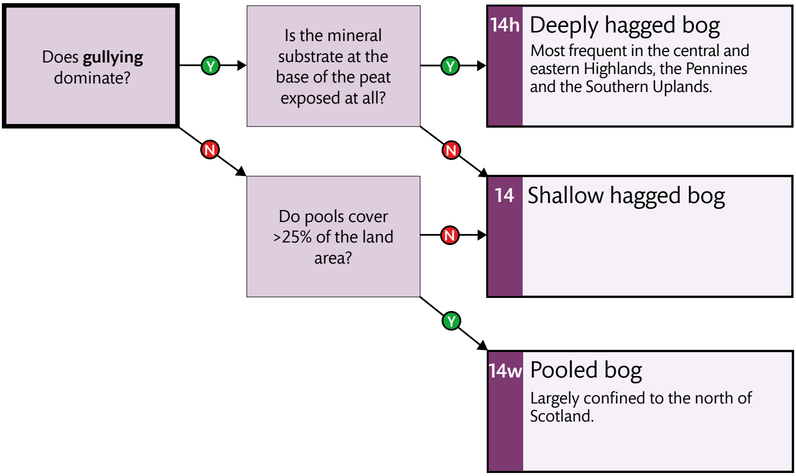


Your vegetation community does not fit any of those commonly found in group 11. The peat types most closely related to group 11 are the weakly flushed *Molinia* bog (9e – page 46) and the upland *Sphagnum* bog (10b – page 40).

! Be aware of the possibility that species such as cotton grass recover more quickly after burning than *Calluna*. If this has taken place in the recent past, charred remains of *Calluna* may have to be included in your assessment.

Figure 29 Gulley erosion of blanket mire in the South Pennines.

Figure 30 Gulley erosion of blanket mire at Knockfin Heights, on the Caithness/Sutherland border.


Does **gullying** dominate?
Y
N
Is the mineral substrate at the base of the peat exposed at all?
Y
N
Do pools cover >25% of the land area?
N
Y
14h Deeply hagged bog
Most frequent in the central and eastern Highlands, the Pennines and the Southern Uplands.
14 Shallow hagged bog
14w Pooled bog
Largely confined to the north of Scotland.

Resources

Particle size key

The behaviour of a soil, for example in terms of drainage or load bearing capacity, is closely related to its particle size distribution (or texture). For this reason forest managers are sometimes given guidance on the basis of a textural classification system as an alternative, or in addition to the system in Section 1. Reference to a textural soil classification is indicated by the use of the terms sand, silt, clay or loam and this section explains one method of applying them.

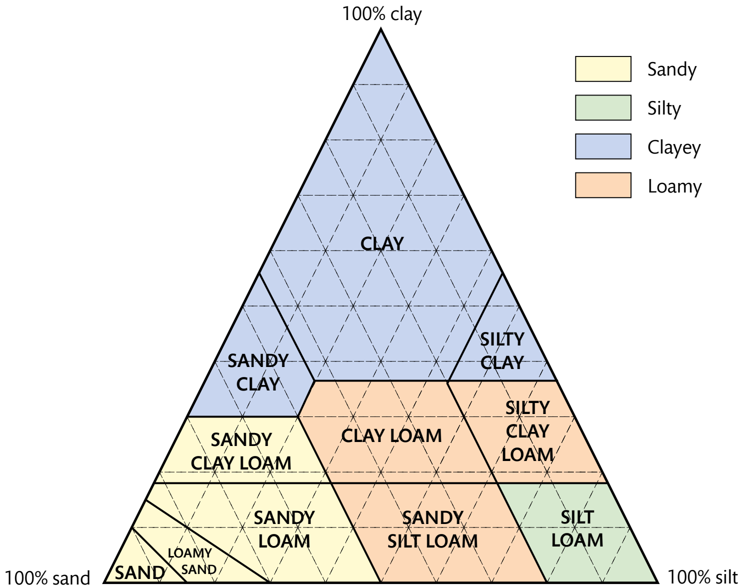
Under the classification system of the Soil Survey and Land Research Centre, outlined in the Soil survey field handbook, soil particles smaller than 2 mm in diameter are separated into three size classes:

Clay size	< 0.002 mm
Silt size	0.002–0.063 mm
Sand size	0.063–2 mm

The textural classification system is presented on a triangular diagram (Figure 31) in which each corner represents 100% clay, silt and sand respectively. The percentages of sand, silt or clay can be plotted onto the graph to determine the texture type which will be named using one or a combination of the words sand(y), silt(y), loam(y) and clay. (‘Loam’ is a word traditionally applied to a soil with a good mix of the three particle size classes.) Clearly in the field these percentages will be unknown so a number of systems have been devised to estimate soil texture; one such system is provided in Figure 32.

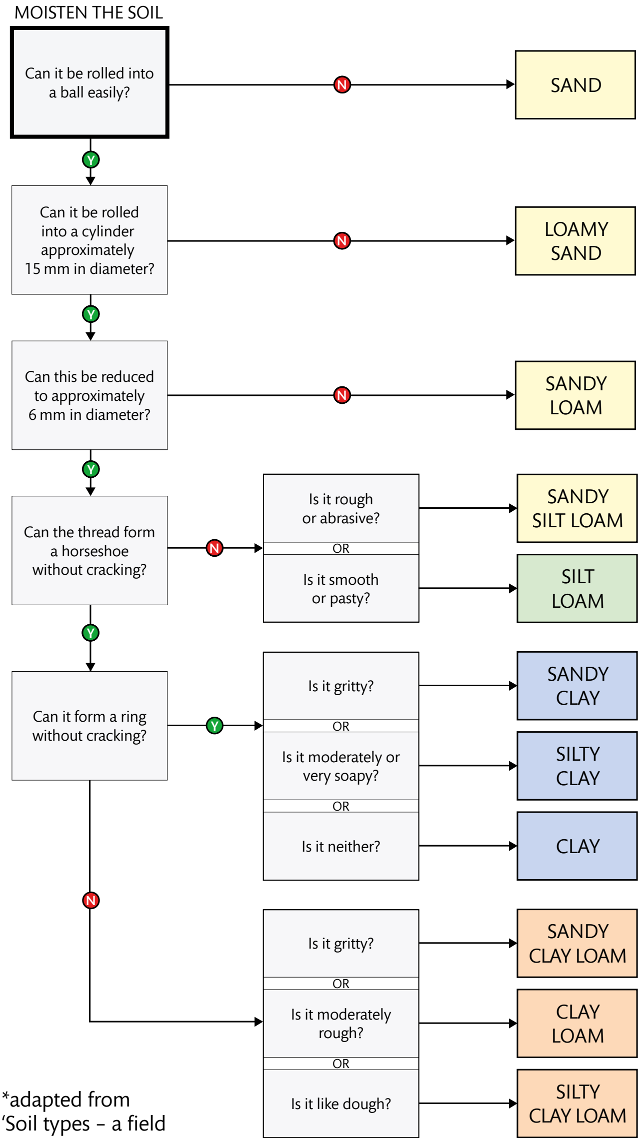
Sometimes these texture classes are grouped together into broader groups such as ‘clayey’ soils, ‘loamy’ soils. These broader groupings are also defined in Figure 31.

Figure 31 Textural classification system*.



*adapted from the 'Soil survey field handbook'.

Figure 32 Manual soil texture key*



*adapted from 'Soil types – a field identification guide'.

Distribution of Basic and Intermediate rock types in the UK

Map provided by the British Geological Survey

Further reading

Forestry Commission / Forest Research publications

- The UK Forestry Standard (UKFS).
- UKFS Guidelines on Forests and soil.
- UKFS Guidelines on Forests and water.

Guidance and research

- An Ecological Site Classification for forestry in Great Britain (FCBU124).
- Cultivation of soils for forestry (FCBU119).
- Ecological Site Classification: A PC-based decision support system for British forests.
- Environmental effects of stump and root harvesting (FCRN009).
- Reclaiming disturbed land for forestry (FCBU110).
- The use of herbicides in the forest (FCFG008).
- Transforming even-aged stands to continuous cover management (FCIN040).
- Use of sewage sludges and composts in forestry (FCIN079).
- Whole-tree harvesting: a guide to good practice (FCPG011).

Other publications

- Soil classification for England and Wales. Soil Survey Technical Monograph 14. Harpenden*.
- Soil survey field handbook. Soil Survey Technical Monograph 5, Silsoe*.
- Soil types – a field identification guide. Field Studies Council.
- The classification of soils in urban areas (In Soils in the urban environment). Blackwell.
- FAO Guidelines for soil description (4th Edition). FAO, Rome.
- World reference base for soil resources 2006 (First update 2007). World soil resources report 103. FAO, Rome.

*Available from National Soil Resources Institute, Cranfield University

Glossary

Ea
A near surface horizon which is pale in colour (bleached) due to the downwards transport of oxides and humus from it.

Bf
A Bs so heavily cemented that it prevents water movement. It may be red or black in colour.

Bh
A subsurface **podzolic** horizon black in colour due to the downwards transport of humus.

Bs
A subsurface **podzolic** horizon, red in colour due to the downwards transport of iron oxides.

Gleying
The soil is either grey due to permanent water-logging or **mottled**, i.e. patchy with areas of both green/grey and orange/red coloration.

Gullying
Or 'hagging' refers to the development of a network of narrow erosion channels.

Humus/Peat
Organic matter that has reached the end of the decomposition process in temperate climates, and in which animal and plant detritus is no longer recognisable. A peat soil contains over 45 cm of humus. The words humus and peat are often used interchangeably.

Organic Matter
Includes fresh, partially decomposed and fully decomposed plant and animal detritus (litter).

0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20

Forest Research

Alice Holt Lodge
Farnham
Surrey
GU10 4LH

www.forestresearch.gov.uk

£17