# Environmental Inventories in Forests

# Environmental Inventories in Forests – Biodiversity

A manual for conducting inventories of forest habitats

Part 2:
Forest Habitats

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# 1. Snags

A large number of forest organisms are associated with snags. These include species that decompose wood, species that live on decomposers and species living in deadwood. Such species are mainly found among insects, birds, fungi and crustose lichens. Natural tree death can be caused by a number of factors, such as drought, wind, fire, nutrient deficiency, insects and fungi. Trees that die due to old age are usually quite large, whereas those that are outcompeted by other trees (natural thinning) are generally smaller. In Norway, about 150 Red List species are associated with snags. Most of these are insects, mainly beetles.

## Which habitats shall be surveyed?

Of the species associated with deadwood, relatively few are specialized on a certain tree species. However, many insect and fungus species are specifically adapted to living on either conifers or deciduous trees. The inventory therefore distinguishes between coniferous and deciduous deadwood. In general, the species composition of xylophagous beetles differs considerably between deadwood on dry, sunny sites and decaying wood in moist, shady places. The same seems to apply to xylophagous fungi. The inventory thus also distinguishes between dry and moist habitats, based on the predominant type of vegetation and local topography. If both dry and moist habitats occur within the same locality, the area is classified according to the most common type.

**In Norway, about 150 Red List species are associated with snags.**

| | |
|---|---|
| Conifers – moist | Hardwoods – moist |
| Conifers – dry | Hardwoods – Dry |

## What shall be recorded?

Areas with a high density of snags in moist habitats are mapped, and the number of deciduous and coniferous snags within each area recorded. Such high-density areas can later be ranked by snag density per hectare. In such areas, as well as in stands with a certain percentage of snags, data on tree species and dimensions are recorded. Certain insects prefer large-sized snags, which is why the inventory distinguishes between small and large snags. Snag species are also recorded, so that the inventory can give us information about the frequency and distribution of snags among the various tree species.

## Regional conditions

Snags are very important habitats for forest-dwelling Red List species throughout Norway. Species associated with deciduous trees in Southeastern Norway (Region 2a) are extremely important. Aspen (*Populus tremula*) is an important tree species in the Boreal Main Region (1a). In Northern Norway (Regions 4 a and b), looper attacks can result in large, continuous areas of dead birch forests. Such areas are important for species associated with deadwood. Accordingly, occasional attacks of the spruce bark beetle (*Ips typographus*) in Eastern and Central Norway can lead to high concentrations of dead spruce trees.

© Photo: Ingvar Stenberg

*Longhorn beetle larva.*

© Photo: Svein Grønvold

# 2. Logs

When trees are storm-felled or broken by wind, important habitats are created for species that are rare in Norwegian forests. The decay of wood lying on the ground is quite different from the breakdown of snags. A total of about 360 Red List species are associated with logs, making up about 22 % of all forest-dwelling Red List species. Quantitatively, fungi and insects are the most important groups (217 and 132 Red List species, respectively). Many bryophytes also live on logs, and 20-25 species (of which 9 are Red List species) live exclusively on decaying wood.

## Which habitats shall be surveyed?

**The inventory distinguishes between coniferous and deciduous logs.**

As for snags, the inventory also distinguishes between coniferous and deciduous logs as well as moist and dry environments, since these habitats differ in their species composition.

| | |
|---|---|
| Conifers – moist | Hardwoods – moist |
| Conifers – dry | Hardwoods – Dry |

## What shall be recorded?

Areas with a high density of logs are marked on the map, and the number of deciduous and coniferous logs within each area recorded. Species associated with logs vary, depending on such factors as log size and the stage of decay. The probability of observing a high species diversity increases with increasing variation of deadwood types. Thus, recorded logs are classified according to their size (large / small logs) and

their stage of decay (early / advanced). After being recorded, areas with a high log density can be ranked according to a «deadwood profile», which combines the amount of deadwood per hectare and the occurrence of different types of deadwood. Sites with a lot of different types of deadwood thus rank highest.

In stands with a certain percentage of logs, but which are not defined as high-density areas, only data on log sizes and stage of decay are recorded. The tree species to which the logs belong is also recorded.

## Regional conditions

Logs as a habitat element represent an important habitat for forest-dwelling Red List species throughout all of Norway. Most of the species associated with deciduous trees are found in Southeastern Norway (Region 2a), while most species associated with coniferous trees are found in the Boreal Main Region (1a). Large logs retain moisture better than small ones. For this reason, the occurrence of large logs as a habitat for hydrophilic species may be more important in the (drier) continental areas than in moister coastal regions (e.g., Western Norway, Region 3).

**Logs represent an important habitat for forest-dwelling Red List species.**



Cystostereum murraii *lives on dead wood.*

© Photo: Svein Grønvold

# 3. Trees with Nutrient-rich Bark

Many mosses and lichens grow on nutrient-rich bark with a relatively high pH (> 5.0). Trees with such bark are usually deciduous trees. Within each tree species, the pH of the bark varies with type of soil, tree age and the degree of pollution. On trees with nutrient-rich bark, about 50 different Red List species can be found. Within this group, several different sub-groups with different habitat requirements can be identified: the Lobarion lichens, characterized by several foliose lichens, such as the large species in the genus Lobaria (e.g., lungwort, *Lobaria scrobiculata* and *Lobaria amplissima*). This sub-group includes many of the Red List lichen species. Lobarion lichens are often found on old trees with rough, cracked bark. Species composition differs somewhat between moist and dry environments. Several rare species of mosses can also occur in Lobarion lichen communities.

**Pioneer moss communities are found on aspen and other broad-leaved deciduous trees.**

Another type of plant community on trees with nutrient-rich bark can be called *pioneer mosses*. These communities consist of several rare mosses that are poor competitors, and which require a high pH, a sufficient amount of light and average humidity. These species are mostly found on middle-aged trees, but are often outcompeted on older trees. Such *pioneer moss* communities are found on aspen and other noble hardwoods. The bark of Norway maple (*Acer platanoides*) seems to be an especially suitable substrate for the species in this community.

The Xanthorion community consists of light-demanding, drought-resistant lichens. The community contains a few Red List species, and is especially associated with aspen. This community is covered when recording late successions of aspen under the habitat element «late successions of deciduous trees» and «old trees».

## Which habitats shall be surveyed?

By definition, trees with nutrient-rich bark represent nutrient-rich habitats, however, the inventory distinguishes between such trees in moist and dry environments. As for other habitat elements, the distinction between moist or dry habitat is based on vegetation type and site topography.

| | |
|---|---|
| | TREES WITH NUTRIENT-RICH BARK – MOIST |
| | TREES WITH NUTRIENT-RICH BARK – DRY |

## What shall be recorded?

The occurrence of Lobaria species is used as an indicator of sufficiently nutrient-rich bark. Trees with such lichens are recorded in the field. Red List mosses that are rare in Lobarion communities can grow on Norway maple, and therefore this tree species is recorded separately. Numerous moss and lichen species live on nutrient-rich bark of broad-leaved deciduous trees. These are not included in the inventory of nutrient-rich bark habitats, unless Lobaria species are also found on the trees. Such sites will nevertheless be included when recording the habitat elements «rich ground vegetation», «old trees» and «hollow deciduous trees».

Areas with a high density of trees with nutrient-rich bark are marked on the map, and the number of Norway maples and trees with Lobaria lichen species within each area recorded. Areas with the highest density of trees with Lobaria lichens are ranked highest. Outside of these areas, the occurrence of Norway maples and trees with Lobaria lichens in dry and / or moist environments are noted. The species of the trees with Lobaria lichens are also recorded in order to facilitate their localization when planning the harvest of the stand. Since trees with nutrient-rich bark are more common in Western, Central and Northern Norway, it is possible to apply more stringent requirements when defining high-density areas in these regions.



*Norway maple (*Acer platanoides*) with pioneer mosses.*

## Regional conditions

**The bark of broad-leaved deciduous trees generally has a high pH, and is thus an important habitat for species found on trees with nutrient-rich bark.**

Broad-leaved deciduous trees generally have nutrient-rich bark. These tree species are thus important habitats for the species in question. Norway maple is important in Southern and Southeastern Norway, especially for the pioneer mosses. In other regions, the pioneer moss communities are included in the habitat elements «late successions of deciduous trees», «old trees» and «rich ground vegetation». Rowan (*Sorbus aucuparia*) is an important species for Lobarion communities, especially in Western and Central Norway. The European hazel (*Corylus avellana*) is also important in Western Norway. Aspen and goat willow (*Salix caprea*) are especially important for Lobarion communities in the eastern coniferous forests, and in the mountains, Lobaria lichens may occur on birch. In Northern Norway, extensive occurrences of Lobarion communities are found on bay willow (*Salix pentandra*) and grey alder (*Alnus incana*). In ravines in Central and Northern Norway, Lobarion communities occur on branches and twigs of spruce and deciduous trees. A characteristic Red List species in this group is the lichen *Pseudocyphellaria crocata* (see photo below).

*The lichen* Pseudocyphellaria crocata *in a coastal spruce forest in Trøndelag.*

# 4. Trees with Pendant Lichens

© Photo: Vegard Gundersen

Trees with abundant filamentous lichen hanging from their branches and trunks («pendant lichens») represent a unique forest environment. Large amounts of such pendant lichens usually occur in old forest stands. However, pendant lichens can also be found on moist rock walls and stream gorges. There are three Red List species among the pendant lichens, the best known of these is presumably Methuselah's beard (*Usnea longissima*), see photo on page 10. Such lichens are habitats for numerous insects and arachnids, but the habitat element has not been sufficiently studied, and important groups of associated organisms have not been evaluated for the Red List. It is also known that tits and other bird species catch insects and arachnids in pendant lichens. The aim of recording significant occurrences of pendant lichens thus extends beyond the value of the lichens themselves.

## Which habitats shall be surveyed?

Based on present knowledge, conifers with pendant lichens in humid environments are considered to be the most valuable, and thus in need of conservation. In such environments, we find most of the Red List species Methuselah's beard (*Usnea longissima*), *Evernia divaricata* and *Ramalina thrausta*. These are often found on spruce in humid environments such as northern slopes, stream gorges, ravines, and along streams and rivers. Trees with lots of pendant lichens in drier environments are important habitats for insects and arachnids. The pendant lichen environments are defined as nutrient-poor (e.g., often on conifers), and the inventory distinguishes between moist and dry habitats.

**Trees with pendant lichens are important habitats for insects and arachnids.**

| | |
|---|---|
| Trees with pendant lichens – moist | |
| Trees with pendant lichens – dry | |

## What shall be recorded?

Areas with a high density of trees with pendant lichens are mapped, and their number within each area recorded. Areas with the highest density of trees with the species *Usnea longissima* or *Evernia divaricata* are ranked highest. Outside of these areas, occurrences of these two lichen species are recorded and designated as localities with «threatened or vulnerable species». Areas with an abundance of non-Red List pendant lichens are ranked on the basis of the density of trees with such lichens.

Areas that do not qualify as high-density areas are recorded as occurrences of trees with a lot of pendant lichens.

## Regional conditions

**Red List species of pendant lichens are mainly found in coniferous forests in Eastern and Central Norway.**

Red List species of pendant lichens are mainly found in coniferous forests in Eastern and Central Norway. In stands with substantial lichen populations, insects and arachnids as a source of winter food for birds are most important in those areas with a continental winter climate.



*Methuselah's beard (*Usnea longissima*) is a Red List species.*

# 5. Late Successions of Deciduous Trees

© Photo: Børn Moe

Natural regeneration of open spaces in coniferous forests usually begins with a deciduous pioneer stand, which then is gradually outcompeted by conifers (succession). Typical northern European hardwoods in this context are aspen (*Populus tremula*), grey alder (*Alnus incana*), birch (*Betula* spp.), goat willow (*Salix caprea*) and rowan (*Sorbus aucuparia*). In the transition between deciduous and coniferous forest (late successions of deciduous trees), many large deciduous trees will be found in the stand. However, these will eventually die. Note that late successions with a lot of deadwood, but few living deciduous trees, will be recorded under the habitat elements «logs» or «snags». Late successions of deciduous trees are important habitats for numerous insect species and soil fungi. About 30 Red List species are associated with late successions of deciduous trees. Old aspen trees are an important habitat for certain mosses (see «trees with nutrient-rich bark»). Late successions of deciduous trees are also home to many birds. The white-backed woodpecker feeds on beetle larva in dead and decaying trees (see photo page 12), and in the coniferous forest zone, the species is associated with Late successions of deciduous trees.

**Late successions of deciduous trees represent a transition between deciduous and coniferous forests.**

## Which habitats shall be surveyed?

The most important habitats are the trees and their litter. Late successions of deciduous trees are thus classified as nutrient-rich environments. The inventory distinguishes between dry and moist environments, based on vegetation type and site topography.

| | |
|---|---|
| | Successions of deciduous trees – moist |
| | Successions of deciduous trees – dry |

*A white-backed woodpecker in an old aspen.*



If the inventory shows that late successions of deciduous trees are rare or absent in mature forests within a management area, deciduous stands in the maturity class 3 can be identified by interpreting aerial photographs. Such stands can then be used to develop late successions of deciduous trees in the long run.

## What shall be recorded?

The area covered by late successions of deciduous trees is marked on the map. Most such successions can presumably be delimited beforehand by using aerial photographs. The dominating trees in a succession are even-aged. The number of trees and the dominating diameter class are thus recorded for each delimited area. In addition, the dominating tree species and vegetation types are also recorded. Many of the Red List species associated with late successions of deciduous trees prefer large trees. Areas with large trees are thus ranked highest. Within each diameter class, further ranking can be made on the basis of the density of old deciduous trees.

## Regional conditions

There are substantial regional differences for this habitat element. Even though the percentage of hardwoods in Eastern and Central Norway[1] is increasing, there are still few stands with late successions of deciduous trees in these regions. In contrast, large parts of Western and Northern Norway are dominated by deciduous successions, as a result of the overgrowing of previously open pastures and hayfields. However, aspen has a patchy distribution in these regions as well, and in Western and Northern Norway only aspen groves are thus recorded as late successions of deciduous trees.

[1] These have traditionally been typical spruce-growing regions

# 6. Old Trees

© Photo: Svein Grønvold

Trees change as they get older. Old trees develop a cracked, porous bark, which retains moisture well and which is more stable, since tree growth stagnates. Old trees have a greater diversity of small-scale structures than younger trees, and these structures provide food and shelter to many different kinds of organisms. The trees' crowns are usually increasingly inhabited by lichens and bryophytes as they age. This in turn can affect the occurrence of invertebrates. Furthermore, the chemical composition of buds, leaves, bark and wood can also change with increasing age. These parameters also influence the species living on the tree. About 60 Red List species are estimated to be directly associated with old trees, but this figure is expected to rise with increasing knowledge about tree crown ecology, and new species are evaluated with regard to inclusion on the Red List.

New studies show that old conifers can have unique insect populations. Staghorn (or wolf) lichen (*Letharia vulpina*), occurring on old pine trees, is a Red List species that is easy to identify (see photo on page 15). It is also known that old conifers can be covered by certain crustose lichens, such as members of the «pin-head lichens» (order Caliciales).

Old broad-leaved deciduous trees are important habitats for many bryophytes, mosses, insects and arachnids. Certain soil-dwelling (mycorrhizal) fungi also seem to be dependent on old hardwoods, as well as many crustose lichens. Old pollards (tree whose branches and leaves have been repeatedly cut off for livestock feed) can be important for species associated with old hardwoods, since they often represent the only really old trees. Some insects, fungi, lichens and bryophytes are asso-

**The age of old, coniferous trees is assessed subjectively according to visual criteria and experience regarding trees older than 150-200 years.**

ciated with large, old trees of the typical boreal deciduous species aspen (*Populus tremula*), goat willow (*Salix caprea*) and grey alder (*Alnus incana*).

## Which habitats shall be surveyed?

Most of the Red List species associated with the habitat element «old trees» are associated with either coniferous or deciduous trees. The inventory thus distinguishes between these two habitats, and further subdivides these into moist and dry environments, based on vegetation type and site topography.

| | |
|---|---|
| OLD CONIFEROUS TREES – MOIST | OLD DECIDUOUS TREES – MOIST |
| OLD CONIFEROUS TREES – DRY | OLD DECIDUOUS TREES – DRY |

## What shall be recorded?

**The age of deciduous trees is assessed by using breast-height diameter.**

Areas with a high density of old trees are delimited on a map. The age of coniferous trees is assessed subjectively according to visual criteria and experience regarding trees older than 150-200 years. The age of deciduous trees is assessed by using breast-height diameter. Within each high-density area, the number of old trees within each species is recorded. For old deciduous trees, the localities are ranked on the basis of diameter classes. Within each diameter class, ranking is based on the density of old trees. Old conifer localities are ranked by the number of old trees per hectare.

Outside of high-density areas, occurrences of old trees, species and diameter class are recorded at the stand level.

In management areas with few occurrences of old trees, stands with a relatively high economic age can be used as a basis for defining areas that can develop the habitat element «old trees» in the long run.

## Regional conditions

Old conifers are found spread throughout the entire country, but are generally more frequent in northern regions and at higher altitudes. In managed forests in the lowlands, old trees can be very rare. As some tree-dwelling species probably are dependent on old trees in a lowland climate, protection of such trees may be of particular importance.

Old broad-leaved trees are mainly found in the regions 2 and 3 (Southeastern, Southern and Western Norway). Pollards are also mainly found in the same regions, and are most common in the transition between cultivated land and forests in the coastal and fjord regions.

**Old conifers are found spread throughout the entire country, but are generally more frequent in northern regions and at higher altitudes.**



*Staghorn lichen (*Letharia vulpina*) grows on old and dry trees.*

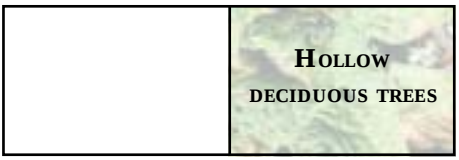
© Photo: Bjørn Moe

# 7. Hollow Deciduous Trees

Hollow deciduous trees are defined as trees which are more or less hollow in their centre due to decay. Many insects are associated with the habitat element «hollow deciduous trees». Some species are associated with rotting wood which tends to accumulate in the hollow tree cavities. A few bat species are also associated with hollow deciduous trees. A total of 54 Red List species are associated with this habitat element. Trees with woodpecker holes are not defined as «hollow trees», and important localities for woodpeckers and species that use woodpecker holes will be covered in the inventory by the habitat elements «late successions of deciduous trees» and «old trees».

## Which habitats shall be surveyed?

Hollow deciduous trees are rare and usually scattered in any area. The inventory does thus not require finding areas with high densities of hollow deciduous trees, and no distinction between moist and dry habitats are made.




Ampedus hjorti *is one of the insect species that thrives in hollow oaks.*

© Photo: Torstein Kvamme

## What shall be recorded?

Some of the Red List species in hollow trees are associated with specific tree species, and many prefer large trees. The number of hollow trees, their species and diameter class are thus recorded for each stand.

**The number of hollow trees, their species and diameter class are recorded.**

## Regional conditions

Southeastern Norway (Region 2a) is by far the most important region for this habitat. Hollow oaks (*Quercus* spp.) in the region are known to contain especially many rare insect species. Similar features can be found along the Western Norwegian fjords (Region 2b).



*An old pollard covered by bryophytes and lichens.*

© Photo: Vegard Gundersen

# 8. Burned Forest

Forest fires are a natural part of the dynamics of the coniferous forest landscape. Fires can vary in intensity from surface fires, in which only some of the ground vegetation is burned, to full-scale crown fires, in which the ground vegetation (including the humus layer) and the trees burn. Certain organisms are adapted to survival in recently burned forest areas. Examples include fungi and vascular plants that only produce fruit-bodies or germinate after a forest fire, and insects adapted to burned wood and sooty bark. The Red List includes 19 species considered to be more or less dependent on forest fires. One of these is the cranesbill *Geranium bohemicum*, whose seeds only germinate after a fire. Species adapted to fires usually have a good seed dispersal capacity and / or «dormant stages» (seeds or spores), but they are nevertheless dependent on access to new burned areas.

**The Red List includes 19 species considered to be more or less dependent on forest fires.**

## Which habitats shall be surveyed?

Newly burned areas are recorded, without considering moisture or nutrient status of the habitat. However, dry and low-nutrient areas are more prone to forest fires. Most of the species adapted to burned areas reproduce during the first few years after the fire. Thus, only areas that have burned within the past ten years are recorded in the inventory.

**Forest area burned less than 10 years ago**

## What shall be recorded?

In most cases, a newly burned area can be delimited and mapped from an aerial photograph. Most of the species adapted to burned areas are found on burned wood. Areas with burned wood can be delimited in situ, and a selection of such areas can be based on the amount of burned snags. In addition, the percentage of birch is noted, since several Red List species are associated with burned birch trees.

**Most of the species adapted to burned areas are found on burned wood.**

Forest fires do not occur often within any given management area. Ranking of burned areas is thus only relevant if parts of such areas are to be set aside for natural development for a certain period.

## Regional conditions

For climatic reasons, forest fires mainly occur in areas with a relatively dry, continental climate. Concerning the inventory of Red List species specifically adapted to burned areas, the following areas are thus most relevant in Norway: Boreal Main Region (Region 1a), Gudbrandsdal and its side valleys (Region 1b), as well as inland parts in Northern Norway (Regions 4a and b).

© Photo: Egil Bendiksen

*Fertile fungus* Geopyxis carbonaria *after forest fire.*

© Photo: Svein Grønvold

# 9. Rich Ground Vegetation

Rich ground vegetation develops on fertile soils as a result of the interaction between local factors (e.g., soil-forming rocks and climate), flora and fauna. Rich ground vegetation can thus only develop in areas with favourable natural conditions. Nutrient-rich vegetation types usually have higher species diversity than poorer types. This applies to plants, fungi and invertebrates (arachnids seem to be one exception). Even if numerous species are associated with the forest floor, they are very often dependent on the occurrence of trees. Some species depend on the shade provided by the trees, others live in symbiosis with their roots (mycorrhizal fungi), and many invertebrates depend on forest litterfall. With its approximately 450 Red List species, «rich ground vegetation» is beyond doubt one of the most vital habitats for Red List species in Norwegian forests. Broad-leaved deciduous and calcareous forests (see photo above) are especially important, since these forest types contain many Red List species in spite of their limited extent.

**With its approximately 450 Red List species, «rich ground vegetation» is one of the most vital habitats for Red List species in Norwegian forests.**

## Which habitats shall be surveyed?

Among nutrient-rich vegetation types, species composition varies considerably between dry and moist environments. The inventory thus distinguishes between rich-dry and rich-moist vegetation types. Some of the recorded vegetation types cover relatively large areas (e.g., the low-herb and tall-herb woodlands), so for these, only the most calcareous types are recorded.

| | |
|---|---|
| | Rich & moist ground vegetation |
| | Rich & dry ground vegetation |

## What shall be recorded?

Areas dominated by rich ground vegetation that are larger than 0.2 hectare are recorded and marked on a map. The vegetation types are determined by means of indicator species. Several of the Red List species associated with rich ground vegetation are found on deep brown forest soils, whereas other are associated with shallow, rocky soils. The inventory thus distinguishes between localities on deep soils and those on shallow, rocky soils. Areas with hepatica (*Hepatica nobilis*) are recorded in low-herb woodlands or low-herb oak forests, since the species is regarded as a good indicator for areas with lots of Red List fungi.

*An alluvial forest.*

© Photo: Svein Grønvold

When ranking «rich ground vegetation», nationally rare vegetation types should be given high priority. Such vegetation communities include calcareous low-herb woodlands, low-herb beech forests (= sweet woodruff-beech forests), black alder-bog forests and nutrient-rich spring woodland. Following these, priority should be given to regionally rare vegetation types and rich ground vegetation that is not sufficiently represented in the management area via otherwise recorded habitats.

**When ranking «rich ground vegetation», nationally rare vegetation types should be given high priority.**

© Photo: Svein Grønvold

*Hepatica*
(Hepatica nobilis).

© Photo: Magne Setersdal

*Narrow-leaved helleborine*
(Cephalanthera longifolia).

## Regional conditions

In Southern Norway, there are certain species of mycorrhizal fungi associated with nutrient-rich mixed oak forests or low-herb oak forests. These include such species as *Albatrellus cristatus* and *Tricholoma pardinum*.

**Several of the rare vegetation types are geographically extremely limited.**

*Hepatica* seems to be a good indicator for the most fertile of these communities. Several of the rare vegetation types are geographically extremely limited: sweet woodruff-beech forests are only found in Vestfold County, while horsetail-ash forests are found west of the Oslo fjord down to Telemark County. Remote sedge-alder forests are quite common in Western Norway (Region 3), but also occur sporadically in Region 2a.



*The mycorrhizal fungus* Tricholoma ustaloides.

# 10. Rock Walls

Rock walls represent the habitat with the highest diversity of bryophytes . In addition, many lichen species are also associated with such environments. Most Red List species associated with rock walls require a lot of moisture, and especially important habitats can be found in gorges and on moist slopes facing north (Western Norway). The Norwegian Red List includes 64 species that are associated with rock walls.

© Photo: Svein Grønvold

## Which habitats shall be surveyed?

Rock walls are classified as moist if they face north or east, and as dry if they face south or west. Rock walls can in addition be roughly classified as either nutrient-poor or nutrient-rich by comparing their location with geological (bedrock) map data.

| | |
|---|---|
| Nutrient-poor – moist rock walls | Nutrient-rich – moist rock walls |
| Nutrient-poor – dry rock walls | Nutrient-rich – dry rock walls |

## What shall be recorded?

Only rock walls more than three metres high are included in the inventory. This is partially for practical reasons, but also since these are considered to be most important with regard to species diversity. For each stand, the occurrence and aspect of rock walls is recorded. In the coastal areas of Western Norway (Region 3), rock walls situated on the lower parts of steep, north-facing slopes or in narrow valleys are specifically marked on the map. Such extremely moist rock face environments contain bryophyte and lichen species which are only found in this region in Norway. Rock walls in other regions are only recorded if present in other recorded habitats.

**The main nutrient-rich rocks are limestone and calcareous slate.**

**Red List species associated with nutrient-poor, moist rock walls are mainly found in Western Norway.**

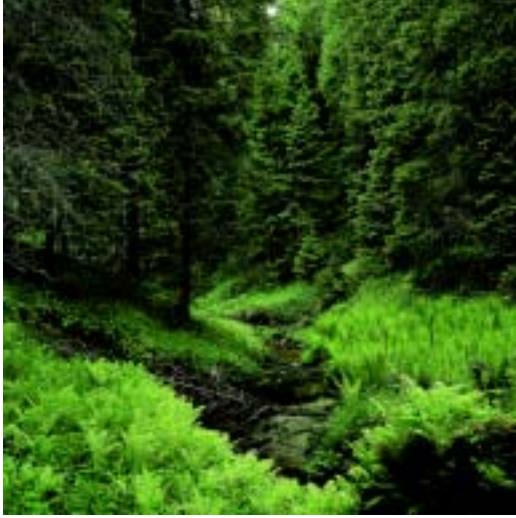
## Regional conditions

Red List species associated with nutrient-poor, moist rock walls are mainly found in the coastal areas of Western Norway (Region 3), whereas Red List species associated with nutrient-rich rock walls mainly occur in Eastern (Regions 1a, 1b and 2a) and Northern Norway (especially Region 4b).



*Wilson's filmy fern* (Hymenophyllum wilsonii) *grows on moist, nutrient-poor rock walls.*

# 11. Clay Ravines



© Photo: Svein Grønvold

A clay ravine is an elongated depression caused by water running through very fine-grained marine deposits over a period of time. Clay is usually rich in nutrients and has a high water-holding capacity. These habitats are characterized by a high soil pH and thus often a high pH of the trees' bark, even in coniferous trees. Part of the coastal spruce forests («boreal rainforests») found in the counties of Trøndelag and southern Nordland occur on clay ravines. These forests are especially rich in rare lichen species. Certain species associated with the habitat elements «trees with nutrient-rich bark» and «trees with pendant lichens» are most commonly or only found in clay ravines in Norway.

## Which habitats shall be surveyed?

All clay ravines are classified as nutrient-rich and moist habitats.

| | NUTRIENT-RICH AND MOIST |
|---|---|
| | |

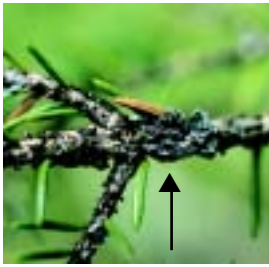
## What shall be recorded?

The entire area of the actual ravine as well as small, level areas between tributary ravines are marked on a map. If ravines are to be ranked, this is done according to the occurrence of trees with nutrient-rich bark and pendant lichens in the ravines.

## Regional conditions

The clay ravines in the coastal spruce forests of Trøndelag have a unique lichen community on nutrient-rich bark of spruce branches – the so-called «Namdal» type. A characteristic species for this community is the lichen *Fuscopannaria ahlneri*. Otherwise, clay ravines are especially common in the southern parts of Eastern Norway.

© Photo: Jørund Rolstad



*The lichen* Fuscopannaria ahlneri.

© Photo: Svein Grønvold

# 12. Stream Gorges

Streams that form gorges in bedrock represent a unique habitat. The stream moistens the environment in the gorge, and due to the topography, the humidity in the gorge is kept consistently high. Nutrients often accumulate in the gorge, enabling the establishment of richer vegetation types than in the surroundings. Stream gorges are important habitats for many species that require moist environments, such as bryophytes on decaying wood and pendant lichens on conifers. Stream gorges can show considerable variation, especially in gorges running east-west. Here we often find north and south-facing rock walls in the same gorge, with a unique combination of high temperatures on the side facing south and a generally humid environment.

## Which habitats shall be surveyed?

**Stream gorges are classified as moist habitats.**

All stream gorges are classified as moist habitats. The inventory distinguishes between nutrient-rich and nutrient-poor gorges on the basis of vegetation types. If one or more rich vegetation types are found, the gorge is defined as nutrient-rich.

| Nutrient-poor and moist gorges | Nutrient-rich and moist gorges |
|---|---|
| | |

## What shall be recorded?

Stream gorges in productive forests are delimited on the basis of topographical maps and aerial photographs. The direction of the gorge shall be noted, i.e., in which direction the stream runs. Gorges with streams running west or east often have the greatest species diversity, and gorges with streams running north often have very moist and shady habitats.

## Regional conditions

The stream gorges in the Gudbrandsdal contain plant species which are not found anywhere else in Norway. These include such unique vascular plants as *Clematis sibirica* and the bladder fern *Cystopteris sudetica*. Other areas known for stream gorges with a high species diversity are, among others, the counties of Telemark and Buskerud.

**The stream gorges in the Gudbrandsdal contain plant species which are not found anywhere else in Norway.**



Clematis sibirica *is very rare in Norway.*

# Notes

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Landbruksdepartementet = Norwegian Ministry of Agriculture
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NIJOS = Norwegian Institute of Land Inventory

The manual for environmental inventories of forest habitats consists of four parts:

Part 1: Background and Principles
Part 2: Forest Habitats
Part 3: Inventory Guidelines 2001 (Norwegian only)
Part 4: Guidelines for Ranking and Selection 2002

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