

Insights into the Swiss forest

The National Forest Inventory provides a representative picture of the condition and development of Switzerland's forest.

Until the second half of the 20th century, the basis for a nationwide assessment of the condition of Switzerland's forests was largely lacking. In 1981 the Federal Council agreed to fund the first National Forest Inventory. Its findings were published in 1988.

Two subsequent surveys followed at 10-yearly intervals. Thanks to these follow-up inventories, it was possible to show the direction of development of Swiss forests. The third National Forest Inventory (NFI) was completed in 2010, and collection of data for the fourth is already under-way.

NFI is a joint project of the Federal Office for the Environment (FOEN) and the Swiss Federal Institute for Forest, Snow and Landscape Research WSL.



The Swiss Federal Institute for Forest, Snow and Landscape Research WSL in Birmensdorf (ZH) serves as the hub of the NFI. This is where all the information comes together. The NFI benefits from the scientific environment at WSL.

The National Forest Inventory (NFI) provides objective information about the Swiss forest and a central basis for national forest policy. It is the most important instrument for monitoring sustainable forest management.



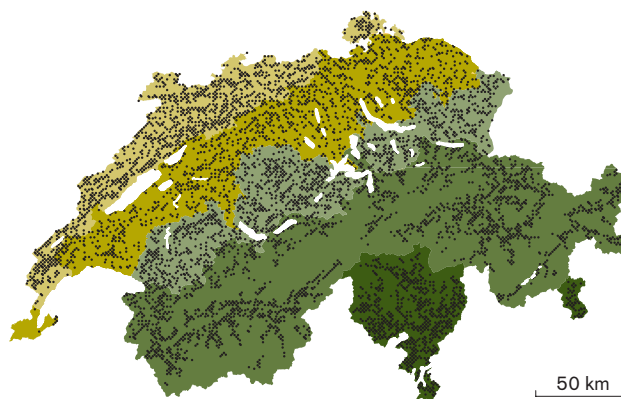
A sampling inventory

The NFI is based on 6,500 sample plots, systematically distributed across the whole country.

Roughly 500 million trees grow in Switzerland's forest. It is thus impossible to record each tree, which is why the NFI uses a sampling method. If enough sample plots are surveyed, then the findings can be extrapolated with sufficient accuracy to all of Switzerland's forest or to large regions.

The sampling plots are predetermined by the sampling grid, which has a mesh size of 1.41 km. This results in around 6,500 sample plots located in the forest, each representing 2 km² of forest in a 1.41 × 1.41 km square.

The NFI provides average values for the whole of Switzerland. Estimations for the regions Jura, Swiss Plateau, Pre-Alps, Alps and Southern Alps are also often made. These geographic regions are typical for Switzerland and differ considerably with respect to production and growth conditions.



Regions and position of the sample plots

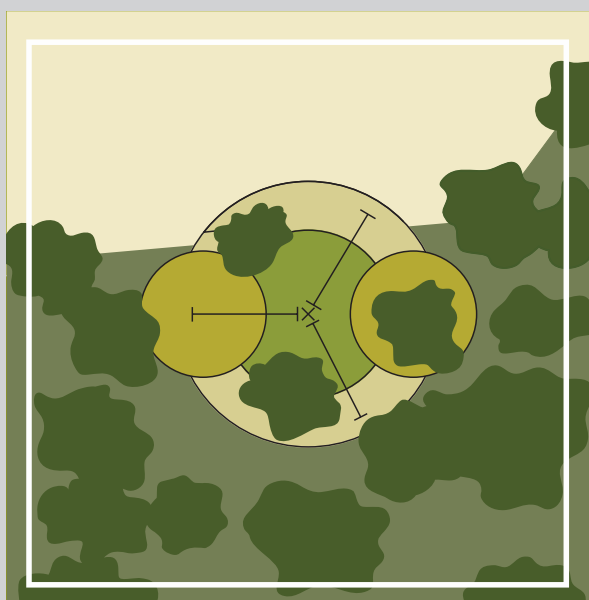
• plots

■ Jura ■ Swiss Plateau ■ Pre-Alps ■ Alps ■ Southern Alps

With this inventory design, the growing stock can be estimated to a 1 to 2% level of accuracy.

Many of the results of the National Forest Inventory are given separately for the regions Jura, Swiss Plateau, Pre-Alps, Alps and Southern Alps. These geographic regions are typically Swiss, and differ from each other considerably.

The NFI sample plots



NFI staff record the height and diameter at breast height (DBH) of single trees on the sample plots, their state of health and other parameters. On average, 13 sample trees are documented on each plot, and around 84,500 trees in the whole of the NFI.

The teams assess the attributes of the tree stand and the site, recording up to 300 characteristics.

- Sample plot circle for trees with DBH ≥ 36 cm (500 m², radius 12.6 m)
- Sample plot circle for trees with DBH ≥ 12 cm (200 m², radius 8 m)
- Sample plot circle for recording small trees and shrubs ≥ 10 cm in height up to a DBH of 12 cm
- Interpretation area (50 × 50 m) for stand and surface data
- ┊ Assessment of the lying deadwood along three 10 m transect lines

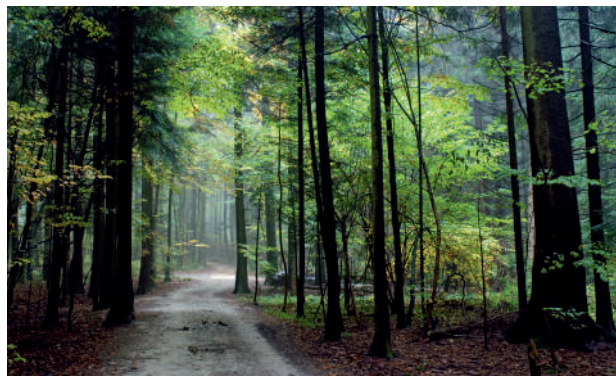
Forest area and growing stock are increasing

Regionally the increase in forest area varies greatly in size. It is mainly taking place in the mountains.

About 31% of Switzerland's surface area, i.e. 12,800 km², is covered with forest. The Southern Alps are the most heavily forested, with a forest cover of 51%, whereas on the Swiss Plateau it is just under 25%.

The forest area has been increasing continuously for 150 years. In the 11 years alone since the NFI2 inventory, the forest has expanded by almost 600 km² – an area nearly the size of Canton Glarus. The increase has mostly been in the Alps and on the Southern slopes of the Alps. On the Swiss Plateau, in contrast, little has changed.

The total stock, i.e. the volumes of wood from living and dead trees more than 12 cm in diameter, has also increased. It amounts to, on average, 364 m³ per hectare. The 3% increase in the stock of living trees is, however, less pronounced than in previous periods due to windthrow and more exploitation of wood. In comparison with the rest of Europe, Switzerland has very large stock per hectare.



Forests in Switzerland are predominantly closed. In the Jura, however, there are half-open types in the form of wooded pastures. The chestnut orchards (see the picture below) on the Southern slopes of the Alps are similar. They were originally used for wood and fruit production, as well as for haymaking or pasturing.

The forest is spreading mainly in the Alps and on the Southern slopes of the Alps in places where agriculture has been abandoned. The large wood stock has also increased further, although less strongly than in the preceding period.



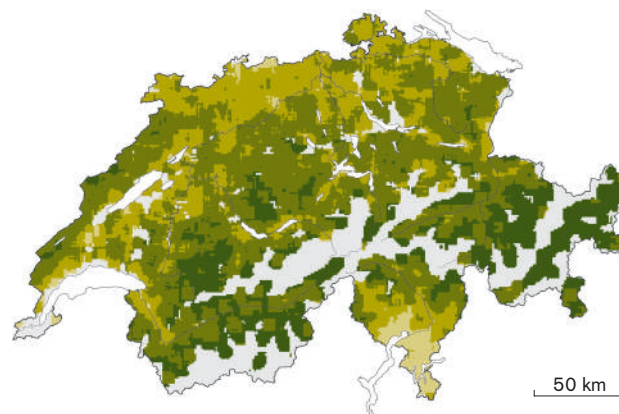
Tree species in the Swiss forest

Just a few tree species shape the appearance of Switzerland's forest. The most frequent tree species is spruce.

Of the 7 conifer species and 40 broadleaf species, around 30 are relatively frequent and are represented by more than a million trees each. But only about 10 are really in a position to decisively influence the forest structure. At lower altitudes beech is often naturally dominant, whereas in mountain forests the dominant species are spruce, larch and Swiss stone pine. One of the key tasks of the National Forest Inventory is to estimate the growing stock and the number of stems of the most important tree species in Switzerland.

Conifers make up 69% of the growing stock. Of all tree species, spruce forms the largest proportion of the growing stock (44%), followed by beech (18%) and silver fir (15%).

In comparison with the last Inventory, the growing stock of spruce on the Swiss Plateau and in the Pre-Alps, in particular, has decreased as the result of storms, insect infestations and increased exploitation. Broadleaves have, in contrast, generally increased. In terms of number of trees, the numbers of stems of the three most frequent species, spruce, fir and beech, have gone down, while those of larch, maple and ash have been able to rise.



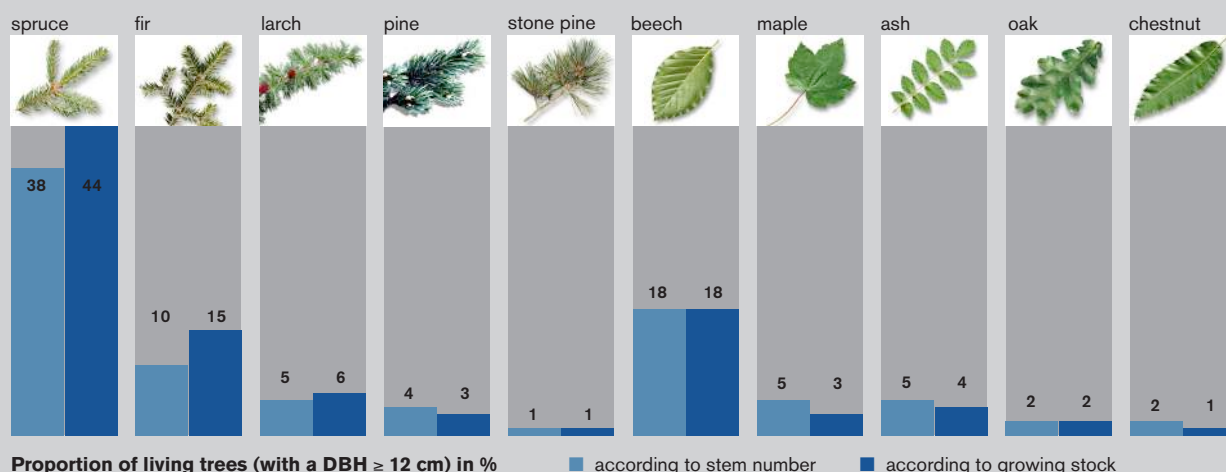
Proportion of conifers

0–10% 11–50% 51–90% 91–100%

Forest management and, in particular, climate influence the proportion of conifers. Thus the higher the altitude, the higher the proportion of conifers.

Of the conifers, spruce and fir are by far the most dominant, and considerably more frequent than larch and pine. Of the broadleaf trees, beech is the most common, followed by maple, ash and oak.

Frequency of the 10 main tree species in the NFI



Proportion of living trees (with a DBH ≥ 12 cm) in %

■ according to stem number ■ according to growing stock

The 10 most important native tree species or tree genera are referred to as the main tree species in NFI. These make up 90% of

the tree stems. In terms of growing stock, their dominance is even greater, namely 97%.

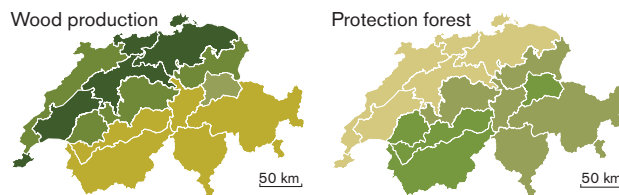
From wood supplier to multifunctional forest

According to the Swiss Constitution, the Confederation is responsible for maintaining all the forest functions.

For hundreds of years, the forest was mainly a supplier of wood. In industrial countries, it has been understood for some time now as an ecosystem that provides numerous services for society's very different requirements. It is in this sense that we talk about forest functions.

In the Constitution and the Forest Act, the protection, production and social functions are explicitly mentioned. These refer to providing protection against natural hazards, protection of drinking water, timber and energy wood production, providing a forest habitat for plants and animals, and the use of the forest for public recreation.

Most forests perform several functions at the same time (multifunctionality). Forest functions are often specified in forest management plans, where functions can also be ranked to determine which have priority for management.



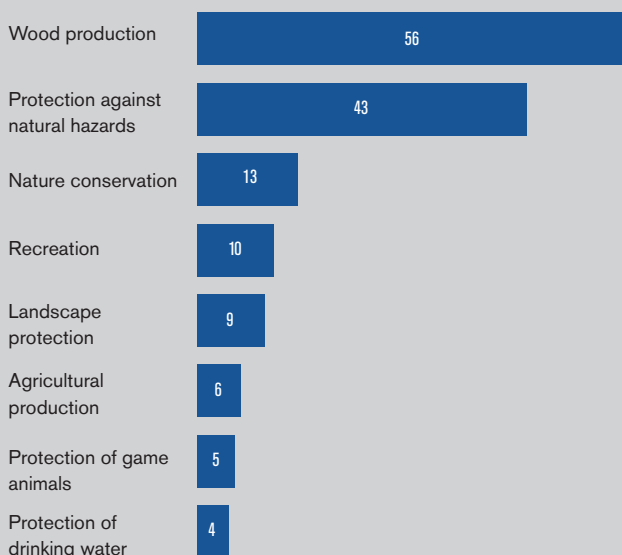
Proportion of forest area with production or protection functions in %

■ < 20% ■ 21–40% ■ 41–60% ■ 61–80% ■ > 80%

Wood production is especially important on the Swiss Plateau and in the Jura. In the Alps and Southern Alps, however, providing protection against natural hazards is the most important forest function.

In densely populated Switzerland, the forest tends, as a rule, to perform several different tasks on the same areas. Data on the forest functions were collected for the first time nationwide in the NFI.

The Swiss forest's most important tasks



Proportional areas of individual forest functions relative to the whole forest area in Switzerland in %

In the NFI, data on the forest functions were collected in an interview survey of the district foresters. Since a forest can have several functions, the total number of functions is greater than 100%.

Wood production, protection against natural hazards, habitats for plants and animals – these are the most important tasks of the Swiss forest.

A mixed picture

All in all the Swiss forest is really full of life and healthy. Nevertheless negative trends are also evident.

The forecasts 30 years ago were pretty dire – but the feared forest dieback (Waldsterben) did not occur. Since then the forest has been diligently observed. The NFI also provides some information about its health and vitality. The main focus is on damage to individual trees, compaction of forest soil, incidents involving extensive damage and the stability of the forest.

Of all trees 12 cm in diameter or more, 70% show no signs of damage. One in ten trees are dead or severely damaged. This mortality rate is, however, within the normal range and presents, in most cases, no problems. In young forest the most frequent damage is caused by game, which has reached critical levels in the case of young fir and oak.

The proportion of damaged forest stands has risen since the inventory in the mid 1990s from 53 to 56%. On 7% of the forest area, stands are severely to very severely damaged.



Clearly visible vehicle tracks are found on less than 1% of the forest area, but on the Swiss Plateau the proportion is higher and amounts to 2%. Damage to the remaining trees from timber harvesting has fallen considerably since the second Inventory NFI2.

In many places the condition of the forest is good. In some parts game damage is a problem. The increase in damaged forest stands, mostly due to storms and insect infestations, is cause for concern.



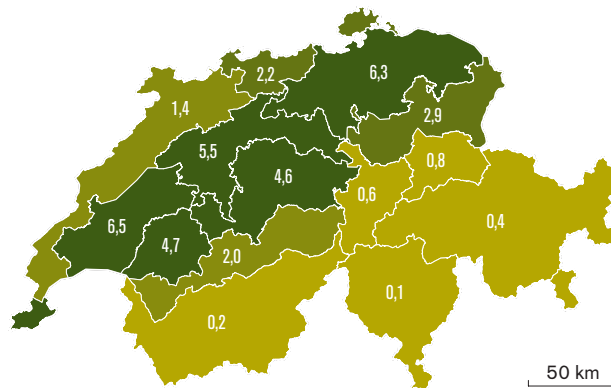
High proportion of damaged wood

Storms like Lothar and severe insect infestations have led to substantial sanitary felling.

Since the NFI2 survey in the mid 1990s, natural events have destroyed a forest area of around 49,000 hectares, i.e. 4% of the forest area. This has been mostly due to storms. As a consequence of these storms and of the record hot summer in 2003, bark beetles proliferated, causing the deaths of many trees, especially spruce.

Storms and bark beetles have negative consequences for the forest enterprises: the harvesting of damaged wood (sanitary fellings) amounts to 41% of the total wood production. Sanitary fellings were already frequent in earlier periods. Of these unforeseen fellings, windthrow made up 65% and insect infestations 30%.

The high proportion of sanitary fellings greatly restricts forest enterprises' room for manoeuvre. After storm events, large quantities of wood often land on the market within a short time and prices fall. A deliberate decision was therefore made after the winter storm Lothar not to clear all the storm-damaged wood and thus also to promote biodiversity.



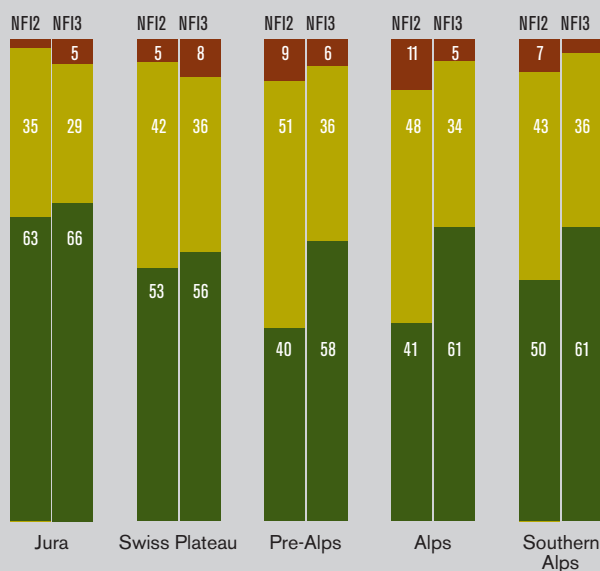
Sanitary fellings due to windthrow and bark beetle infestations
in m³/ha/year

■ < 1 ■ 1.1-2 ■ 2.1-3 ■ > 3

The sanitary fellings on the Swiss Plateau and in the Pre-Alps were particularly extensive.

A high proportion of storm- and beetle-damaged wood means a financial and organisational burden for the forest enterprises. Sanitary fellings currently account for 41% of the total wood production.

Stable forests are the aim



Proportion of forest area according to stand stability in %

■ stable ■ reduced stability ■ critical

The storm damage in recent years shows clearly how important stable and well-structured forest stands are as these are less vulnerable to storms and insect infestations.

Since NFI2 (1995) the situation has mainly developed positively, with a larger proportion of stable stands in NFI3 (2005) in all regions in Switzerland. In recent years much old growth has been replaced by younger more stable stands.

On the Swiss Plateau and in the Jura, however, stands with critical stand stability have increased, with 6% of the total forest area in the whole of Switzerland in this category.

Wood – a valuable commodity

**The forest supplies wood, a renewable commodity.
Three quarters of the total yield is in the form of conifers.**

On the Swiss Plateau, 90% of the forest area is important for wood production, while in the Jura over 80% is and in the Pre-Alps 70%. In the Alps, in contrast, only 34% of the forest area is used for wood production and on the Southern slopes of the Alps the proportion is even smaller, only 21%.

On over 80% of the exploited forest area, trees are felled with chainsaws. In recent years the use of forest machinery that can fell trees and remove branches has increased markedly. On steep slopes, stems are transported to the closest forest road with the help of cable cranes. If timber is to be harvested efficiently, forest roads are indispensable. Most forests today are sufficiently accessible in this way.

The forest economy is characterised by production periods that are several decades long. This means that thinking and planning must take a long-term perspective. Regional forest plans focus on public interests, while local planning is more directed towards the forest enterprises.



Certified forests stand for timber production that is particularly environmentally and socially responsible. Labels like 'FSC' or 'PEFC' provide consumers with useful information. Around half of Switzerland's growing stock can be found in certified forests.

Wood is an important domestic commodity and a significant source of income for forest enterprises. Timber production is important on 56% of the forest area in Switzerland. On the Swiss Plateau, 90% of the forests are used for wood production.



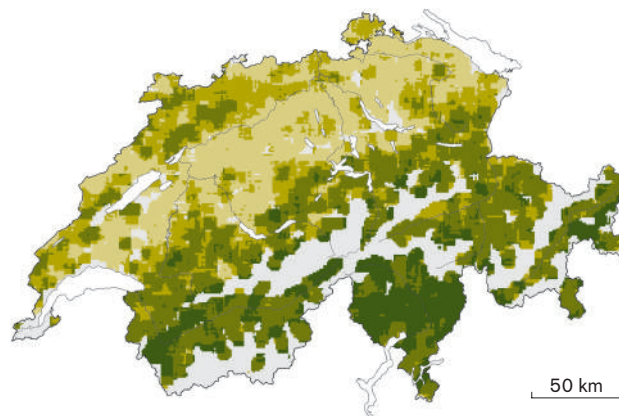
More wood from the Swiss forest?

The timber yield (fellings) could, in principle, be increased a little, but the potential is limited.

The NFI provides a differentiated picture of the wood increment and current yield. The regional differences in timber production are considerable, largely because the cost of harvesting varies so much.

The most recent NFI findings indicate that the volume of harvested or dead trees in the whole of Switzerland during the last inventory decade from 1993 was smaller than the increment. In comparison with the last Inventory 1993/1995, more timber today is growing in the Swiss forest.

The increment in the whole of Switzerland is therefore not fully exploited everywhere. On the Swiss Plateau, however, the drain (timber yield and natural tree mortality) is much higher than the wood increment. The situation in the Alps and on the Southern slopes of the Alps is, in contrast, completely different. There comparatively little wood is produced, particularly on steep slopes and in less accessible forests.



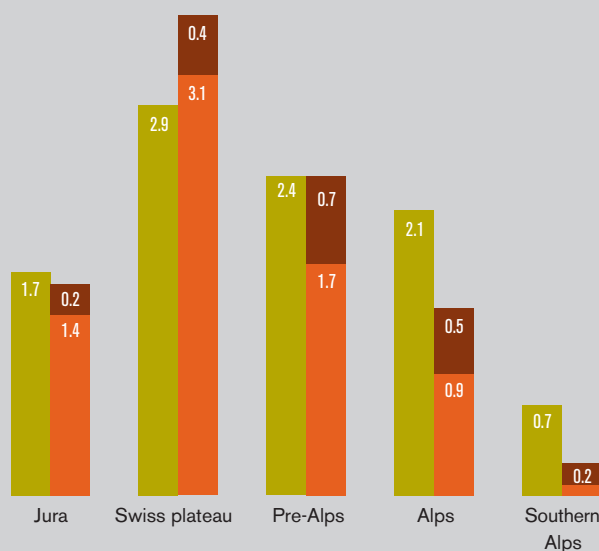
Potential costs of timber harvesting in Fr./m³

■ < 50 ■ 51-100 ■ 101-150 ■ > 150

The cost of timber harvesting consists of the expenditure for felling and logging the stems to the nearest road that is accessible by truck.

Unlike on the Swiss Plateau, timber harvesting in the Alps and on the Southern slopes of the Alps often does not cover its cost. Under these circumstances, it is uncertain whether a marked increase in timber harvesting would be possible.

Big differences in the use of the increment



Comparison of the increment and the yield and mortality in million m³/year

■ increment ■ yield ■ mortality

The increment is calculated as the increase in volume of the trees between two inventories. The yield corresponds to the volume of the trees harvested in the same period, and mortality to the volume of trees that have died. In Switzerland, the yield and mortality together amount to 94% of the increment.

- On the Swiss Plateau, the most important region for the forest economy, the yield plus mortality adds up to more than 23% of the increment.
- In the Pre-Alps and Jura, the yield plus mortality is roughly the same as the increment.
- In the Alps, the yield plus mortality amounts to only 66% of the increment, and on the Southern slopes of the Alps to only 35%.

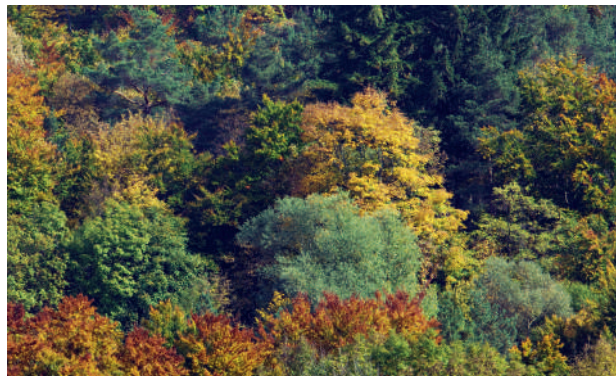
A rich habitat

More than a third of native animals and plants rely on the forest for survival.

The forest and forest edges provide habitats for numerous species, and therefore play a central role in maintaining biodiversity. The Swiss forest is also a near-natural ecosystem because foresters usually apply natural seeding to regenerate the forest. About 80% of stands today have developed from purely natural regeneration. This is one of the highest percentages in West European countries.

In the most recent survey, the length of the forest edge was estimated for the first time, and found to be 117,000 km or 63 times the length of Switzerland's national border. From the point of view of the quality of nature conservation, however, there is room for improvement. Many forest edges are still rather monotonous.

The increases in the quantities of deadwood in the forest over the past decade is gratifying, as is the high proportion of old forest (old growth stands). In contrast, the way the forest has become "darker" can be considered a negative trend because species that require light and warmth are then suppressed.



The forests with the highest proportion of species-rich stands in Switzerland can be found in the Jura. At higher altitudes, the diversity of tree species naturally decreases. Foreign tree species, so-called exotics, proportionally make up a mere 0.6%.

The NFI's findings indicate that, with respect to biodiversity, Switzerland's forest is mostly developing positively. In particular, tree species have become more diverse and the structure of the forest richer with more deadwood available.



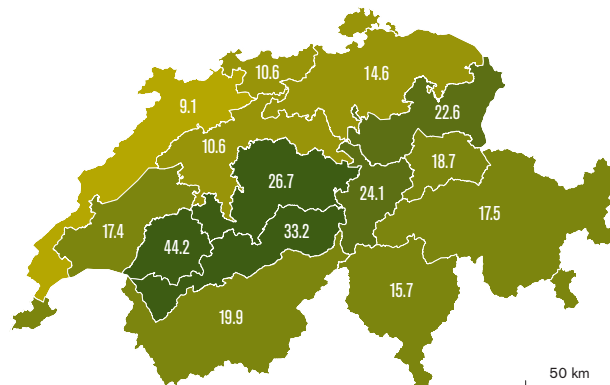
Deadwood lives

Many species in the forest rely on dead trees and rotted wood as the basis for life.

Around a fifth of the animals living in the forest and 2,500 of the higher fungal species require deadwood to survive. Over the centuries Swiss forests were intensively used and, for a long time, deadwood was scarce. Many species dependent on it have therefore become rare.

The current supply of deadwood is 18.5 m³ per hectare, or 32.8 m³ per hectare if lying deadwood is included. The regional differences are, however, considerable. The supply of deadwood has increased by 80% since the last Inventory. One reason for these larger quantities of deadwood is that, in recent years, more wood has been left lying in the forest, partly because removing it does not pay. The boom in using wood for energy could, however, swing the pendulum in the other direction.

What quantities of deadwood are necessary to maintain endangered species is still the subject of research. In European virgin forests, the volume of deadwood ranges from 20 to 250 m³ per hectare, and in some places as much as 400 m³ per hectare, depending on the phase of development.



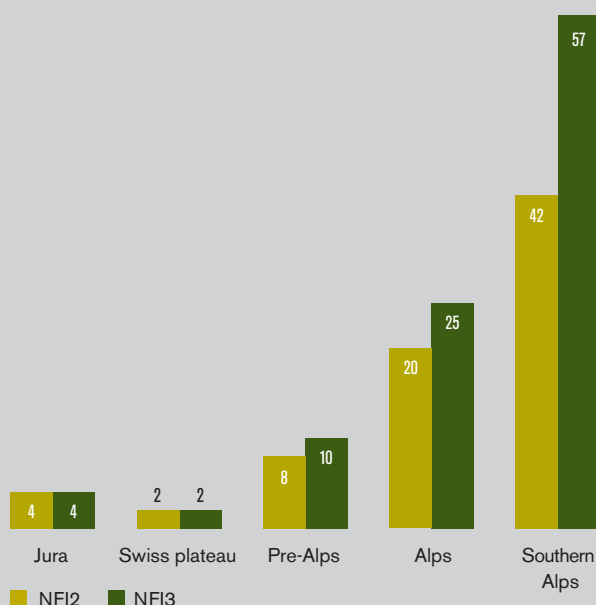
Supply of deadwood in m³/ha

0–10.0 10.1–15 15.1–20 20.1–25 > 25

Wide regional variation in the supply of deadwood. Experts believe the quantities, especially in the Jura and on the Swiss Plateau, are too small to maintain biodiversity in the long term.

Deadwood is typically found in natural forest ecosystems. The supply of deadwood in Swiss forests has improved in recent years. The average supply of deadwood in Switzerland is 18.5 m³ per hectare, which compares well with the rest of Europe.

The “hidden” natural forest reserves



Proportion of the forest area without silvicultural interventions for over 50 years in % in NFI2 (1995) and NFI3 (2005)

In natural forest reserves, nature is left to take its course. According to the joint federal and cantonal policy on forest reserves, the proportional area of reserves should increase to 5% of the forest area by 2030. It should be sufficiently representative of all types of forest community in Switzerland.

Currently another type of natural forest reserve is developing. In almost a fifth of Swiss forests, no silvicultural treatments have been made for over 50 years. These “hidden” natural forest reserves are, however, very unevenly distributed. On the Swiss Plateau they make up just 2% of the forest area, but on the Southern slopes of the Alps more than half. Indeed, in Ticino an increasing forest wilderness is developing.

Protection against natural hazards

More than a third of the forest serves primarily as protection forest. The condition of protection forests has improved.

The forest protects residential areas, roads and railway lines against avalanches, rockfall, landslides and debris flow. If a forest can prevent, or at least mitigate, the disastrous and sometimes fatal effects of such natural hazards, it is called a protection forest.

According to the NFI interview survey of the district foresters, 43% of the Swiss forest has a protective function with regard to natural hazards. On 36% of the forest area, this protective function has priority. Tending the protection forest is difficult and time consuming, and is mostly funded by the public sector.

The NFI provides valuable information about the condition of protection forests. It indicates that the protective effect has improved since the last survey. The stability of the stands has also developed positively. Many stands, however, lack regeneration. Two thirds of protection forests are sufficiently accessible, and some even very accessible.



A densely stocked forest prevents the formation of avalanches and is able to stop or break falling rocks. Photo of Disentis (Grisons)

For protection forests to fulfil their functions well, they normally require tending. In recent decades, interventions have been made in almost a third of the protection forests. Building protective structures in the place of protection forests would be much more expensive.



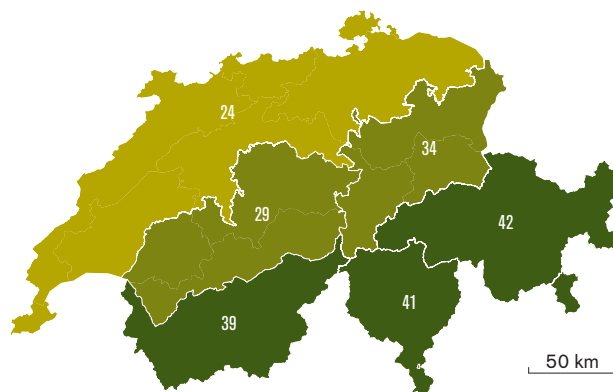
Maintaining protection forests

The maintenance of protection forests involves mainly improving the stability and regeneration of stands.

For a protection forest to be able to perform its function, it should ideally be permanently stocked with trees and no large gaps should form. This is why the replacement of the tree generations or, as forest professionals term it, forest regeneration, should take place on small areas.

Since the survey in the mid 1990s, the regeneration has improved a bit, but not in all regions. Today 36% of the protection forests still have a critical to insufficient level of regeneration. One reason for this is the browsing damage caused by wild animals.

During the last decade, almost a third of the protection forests have been silviculturally treated. Such measures usually aim to improve the structure and stability of stands and create suitable conditions for regeneration.



Proportion of protection forests with critical or insufficient regeneration

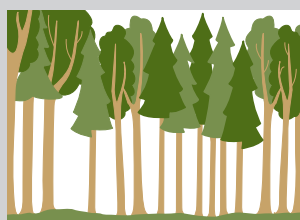
■ < 25% ■ 26–35% ■ > 35%

The protection forests on the Swiss plateau, in the Jura and on the northern Pre-Alps have much better regeneration than those in Valais, Grisons and Ticino.

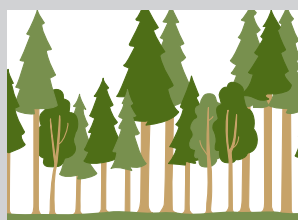
Regenerating the protection forest requires particular care. It takes several decades for a seedling to grow into a tree that provides protection against natural hazards. More than a third of the protection forests have insufficient regeneration.

Well-structured stands are the goal

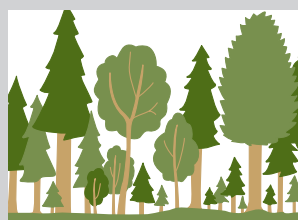
The NFI distinguishes between four types of stand structure in the protection forest (relative proportions in brackets).



single-layered (44%)



multi-layered (32%)



stepped (21%)



cluster structure (3%)

Not all forests provide equally good protection against natural hazards. The presence of gaps, the density of the canopy as well as the number, distribution and density of the trees are decisive for the effectiveness of the protection.

Uniformly structured stands in protection forests are unsuitable because the likelihood that they will collapse over a large area is greater. The aim of maintaining the protection forest is to have stands with a multi-layered, stepped or cluster structure. This goal has been reached in 56% of the protection forest.

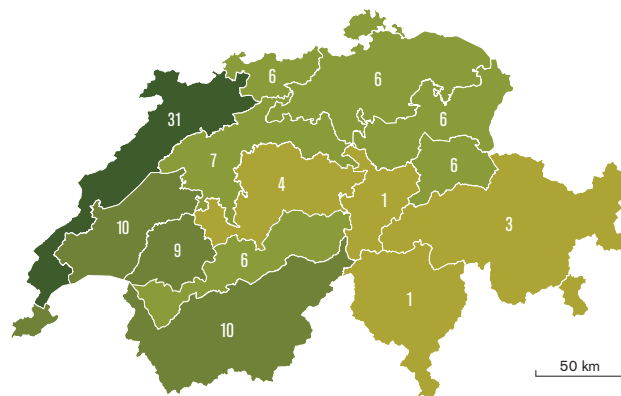
Protection of drinking water

The forest protects our drinking water. Broadleaf stands have a particularly positive effect on water quality.

All tapped groundwater is surrounded by groundwater-protection zones. These are exactly demarcated. 47% are located in the forest, while most of the rest can be found in agricultural areas.

According to the NFI, 8% of Swiss forests are located in a groundwater protection zone. In the western Jura, the proportion is 31%, which is particularly large. The protection zones there are especially large because deposition such as fertiliser in the limestone can quickly get into the groundwater. This is why the risk of contaminating the drinking water with pollutants is high.

Groundwater-protection zones are incorporated in the regional forest planning and should be considered in forest management. Broadleaf stands are more suitable for drinking-water protection than pure conifer stands. The groundwater-protection forests have improved considerably in this respect since the NFI survey in the mid 1990s.



Proportion of forest areas within a groundwater-protection zone

■ 1–4% ■ 5–8% ■ 9–12% ■ > 12%

In the western Jura, where limestone is frequent, around a third of the forest area is located in a protection zone. The smallest proportions are in the central Alps, the Grisons and Ticino.

Almost half of the Swiss groundwater-protection zones are located in forested areas. It is forbidden to spread fertiliser in the forest or use pesticides. This regulation, as well as the increasing proportion of broadleaves, contributes to the good quality of the drinking water.

Good spring water from the forest



According to the Swiss Association for the Gas and Water Sector (Schweizerischen Vereins des Gas- und Wasserfachs - SVGW), 40% of Swiss drinking water comes from groundwater, 40% spring water and 20% lake water.

The quality of the drinking water in forested areas is generally better than in agricultural regions as applying fertiliser is not permitted in the forest (nitrate pollution).

Springs with catchment areas in the forest generally supply perfect drinking water that requires no further treatment. Thus no costs for treatment are incurred, which, according to the Federal Office for the Environment, are on average 20 cents per cubic metre.

The catchment areas for tapped springs include forest areas outside the groundwater-protection zone. According to the NFI survey, 200'000 hectares of forest or 16% of the Swiss forest area is within the catchment area of a spring intake.

Invaluable space for recreation

The forest is very popular as a place for recreation. A large proportion of the Swiss population visit the forest regularly.

Most people visit the forest in their freetime for recreation. For each inhabitant on the densely populated Swiss Plateau, there is on average almost 600 m² of forest, which is an area the size of the land needed for an average detached house.

10% of Switzerland's forest area is important for recreation. On the Swiss Plateau the proportion is as much as 20%. 3% of the forest area hosts more than 100 people per day. This sometimes has adverse effects on the forest ecosystem and requires more expenditure for forest management.

31% of Switzerland's forest is privately owned. Of the around 250,000 owners of private forest, many have just very small lots. The areas with the largest proportion of privately owned forest are in the Pre-Alps (50%) and on the Swiss Plateau (41%). 69% of the forest is publicly owned by: local citizens' communities (Bürgergemeinden) 34%, political municipalities 22%, corporations 8%, cantons 4%, and the Confederation 1%.



Many people seek recreation in the forest, especially in agglomeration areas. The activities that are particularly popular are, in descending order of popularity: hiking, walking, mountain biking, riding and jogging. Only a third of Switzerland's forest area is visited by fewer than 10 people annually.

Estimating the usefulness of the forest as a recreational space for people's leisure activities is difficult and requires making many assumptions. A study commissioned by the Federal Office for the Environment evaluated such use of the Swiss forest as worth over 10 billion Swiss francs per year.

