

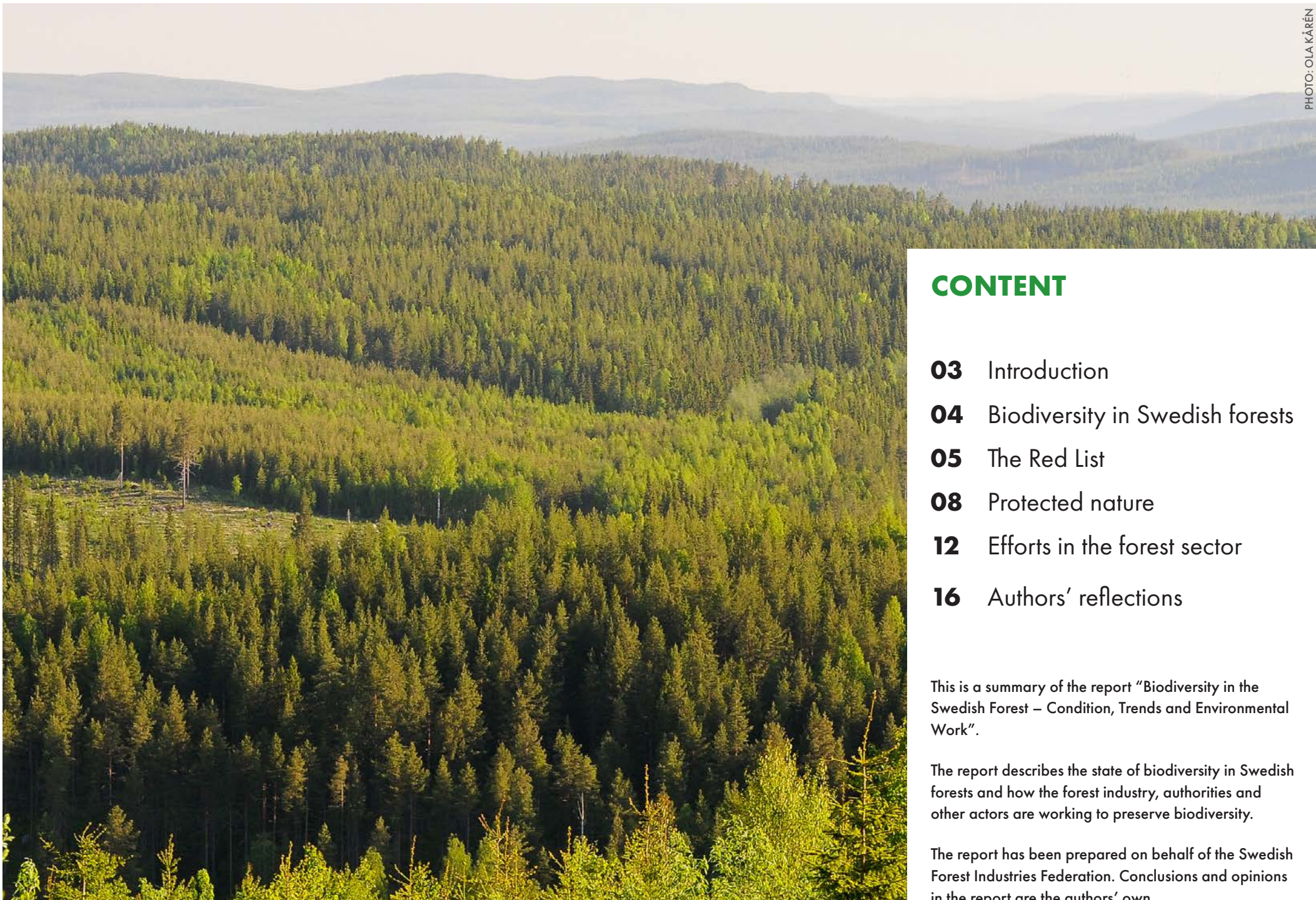
BIODIVERSITY IN SWEDISH FORESTS

Condition, Trends and Environmental Work

Mats Hannerz and Per Simonsson 2023

A SUMMARY





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This is a summary of the report "Biodiversity in the Swedish Forest – Condition, Trends and Environmental Work".

The report describes the state of biodiversity in Swedish forests and how the forest industry, authorities and other actors are working to preserve biodiversity.

The report has been prepared on behalf of the Swedish Forest Industries Federation. Conclusions and opinions in the report are the authors' own.



... as an epilogue, we would like to emphasize that biodiversity is indeed under threat. However, the state of the Nordic forests is far from catastrophic, as is sometimes the perception.

On the contrary, environments and species composition are relatively stable, and with appropriate stewardship, the vast majority of species will be able to thrive in managed forests, which make up the majority of Sweden's forest land.

To do this, we need to continue to protect and nurture forests with high conservation values and ensure that green infrastructure is in place, in which species are able to both disperse and establish themselves.

MATS HANNERZ OCH PER SIMONSSON

November 2023

Biodiversity is necessary for viable and prosperous forests that are well prepared for climate change and more extreme weather conditions.

The Swedish Forest Industries Federation believes that forests should be used in ways that increase both production and biodiversity. Swedish forestry has developed over time, in no small part due to research into forest management methods. Many trends in the forest are going in the right direction due to the actions of the forestry sector and steps taken by forest owners and the Swedish state. Work on developing nature conservation and forestry methods must continue.

Even if biodiversity improves, there are species that struggle to thrive in managed forests. The Swedish forest industry therefore, works actively to protect and improve biodiversity.

Our hope is that this report will contribute to a continued fact-based discussion about biodiversity, and to ongoing efforts to create viable forests with richer biodiversity.

Viveka Beckeman,
Director General, Swedish Forest Industries Federation

BIODIVERSITY IN SWEDISH FORESTS

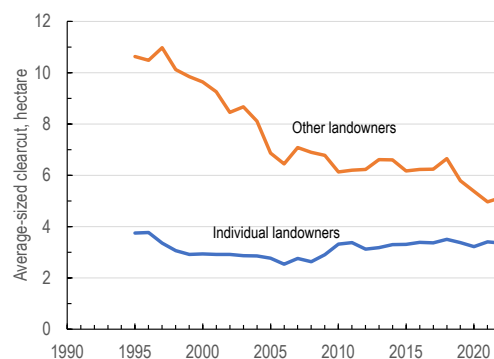
Swedish forests have a long history of human impact, which has left its traces. Species composition in the forest is the result of thousands of years of natural processes and migration since the Ice Age, as well as grazing, farming, slash-and-burn agriculture, drainage, air pollution, forestry and much more.

We know relatively little about how biodiversity in the forest has changed throughout history. It is difficult to estimate past population sizes of insects, fungi, lichens and mosses. However, we can look at structures and habitat conditions needed by different species, and how these change over time. The amount of dead wood, the area of old forest, and the number of old deciduous trees are increasing. However, this is still from a low level compared to former old-growth forest.

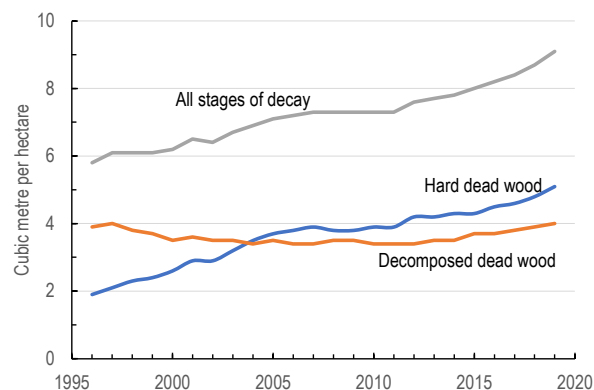
FOREST, YOUNG AND OLD

In the past 30 years, the size of clearcuts in Swedish forests has decreased, but forests are becoming denser and darker, which is disadvantageous for reindeer lichens and berries. Landscapes are becoming more mixed – partly protected areas of old forest, partly younger managed forest. It is estimated that approximately 100 species of insects and fungi depend on fire for their survival, but nowadays we fight fires in a way that has not been previously possible.

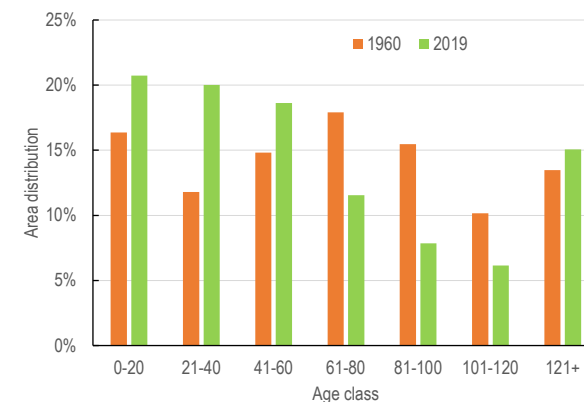
Data on population sizes over extended periods of time are not widely available, but it is reasonable to assume that species dependent on old-growth forests have declined. However, there are other species that are increasing or that have arrived in Sweden. There is an urgent need for research into the ability of species to survive and spread in managed landscapes, as well as how different species can survive and re-establish after forest has been felled.



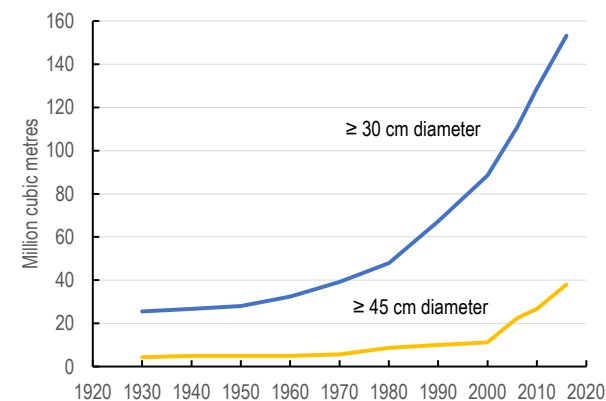
Clearcuts of today are smaller than they were 30 years ago. The average area of reported regeneration fellings greater than 0.5 hectares according to data from the Swedish Forest Agency.



The amount of dead wood (in cubic metres per hectare) 1996–2019 (five-year averages) in different stages of decay, on productive forest land outside formally protected areas. Source: Swedish National Forest Inventory.



Greater areas of forest are either younger or older, while forests aged between 60 and 120 years are decreasing. Productive forest, including formally protected forest. Source: Swedish National Forest Inventory.

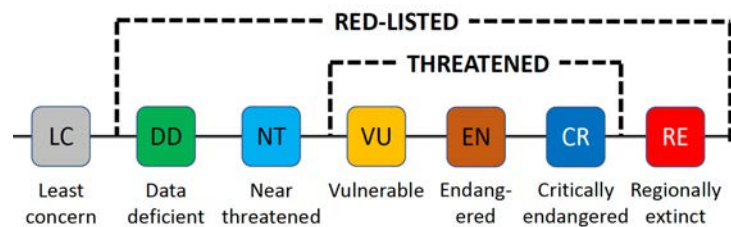


The volume of coarse deciduous trees has increased throughout the last century, deciduous trees >30 cm from approximately 25 million cubic metres in 1926 to 150 million in 2016. Source: Forest statistics 2023, Swedish University of Agricultural Sciences.

THE RED LIST

The Swedish Red List is a key indicator of the conservation status of Swedish species. It is based on the Red List of Threatened Species developed in 1964 by the International Union for Conservation of Nature (IUCN)*. The international Red List currently includes more than 150,000 species. Sweden published its first national Red List in 2000.

Red-listing is used to indicate the degree of risk a species has of going extinct, nationally or globally. The main criterion for red-listing is that a species is declining in number now, in the near future or in the past 10-20 years, and for long-lived organisms up to 100 years. For some species it is possible to estimate the size of the population, but for the majority, assessments are based on an interpretation of how species' habitats and substrates develop over time.



All species that are assessed for the Red List are rated in terms of likely they are to go extinct. Species that are considered most threatened are classed as VU (vulnerable), EN (endangered), or CR (critically endangered). Most of the species on the Red List are uncommon or have a severely limited distribution, but there are also common species that are added to the list because they are declining. A species that declines by 15 per cent over a 10-year period is automatically considered NT (near threatened). If a species decreases by 50 per cent in the same time period, it becomes critically endangered.

Species common in Sweden, such as the hooded crow, field-fare and black-headed gull, were classed as NT in the 2020 list, as their numbers had declined in the past decade.

WHY ARE SPECIES THREATENED?

On the 2020 Red List, felling and overgrowth were judged to be the most serious threats to species. Felling is believed to have a highly negative impact for 1,375 red-listed forest species and overgrowth for almost 300 species.

Of the 1,375 species that are severely affected by felling, 750 species live in hardwood forests and 620 species are highly dependent on the same forest type. Hardwood forest in Sweden is protected by the Hardwood Forest Act and may not be felled and replaced with coniferous forest.

HOW MANY SPECIES ARE THERE?

It is estimated that there are currently at least 60,000 multicellular species (and more will surely be discovered) in Sweden.

In the 2020 Red List, 21,740 species were assessed, (there are also a number of subspecies and forms), and of these, 4,746 were red-listed.

Sweden's forests are home to almost 30,000 species. Of the red-listed species, 728 are mainly found in forests, where felling is judged to have considerable negative impacts.

*International Union for Conservation of Nature and Natural Resources (IUCN) has more than 1,000 member organisations and co-ordinates work to produce the Red List of threatened plant and animal species.

Species	Last recorded	Probable causes
Lichen <i>Erioderma pedicellatum</i> (värmlandslav)	1962	Found on a protected area where a nearby forest was felled. The local climate in the protected premises probably deteriorated.
Lichen <i>Lichinodium ahlneri</i> (lillkuddlav)	1956	Disappeared together with <i>Erioderma pedicellatum</i> and <i>Szczawinskia leucopoda</i> .
Lichen <i>Szczawinskia leucopoda</i> (skafflav)	1956	Disappeared together with <i>Erioderma pedicellatum</i> and <i>Lichinodium ahlneri</i> .
Black stork (svart stork)	1953	Drainage, disturbances, felling of nest trees, hunting during migration.
Beetle <i>Acritus minutus</i> (droppstumpbagge)	1950	Reduced amount of old deciduous trees.
Beetle <i>Aradus aterrimus</i> (svart barkskinnbagge)	1944	Absence of forest fire.
Beetle <i>Corticaria andreaei</i> (brandmögelbagge)	1966	Absence of forest fire.
Beetle <i>Platysoma elongatum</i> (tallmostumpbagge)	1940	Absence of forest fire, reduced area of old pine stands.
Beetle <i>Nivellia sanguinosa</i> (blodbock)	1950	Probably reduced deciduous trees in managed forest.

ARE SPECIES ON THE RED LIST AT RISK OF EXTINCTION?

Since 1850, around 70 forest-dwelling species have disappeared from Sweden, for example wild reindeer and black stork. However, extinction rates in general have not accelerated, which has led some to question the effectiveness of the Red List in gauging actual extinction risk. Only one Swedish species has gone globally extinct: the herb *Taraxacum polium*. However, many species have disappeared locally, from at least one county.

The Swedish Species Information Centre, which draws up Sweden's Red List, explains that the reason why many species are threatened but few are registered as extinct is that threatened

species are noticed and are granted protection, for example, with nature reserves and management measures. Another reason is that it takes a long time before an extinction can be established, sometimes several decades. There may therefore be a lag in the national extinction category.

GONE FOREVER?

It is understandable that rare species, especially when they are difficult to inventory, are difficult to record and are therefore classified as nationally extinct. However, new inventories occasionally rediscover species. Some species fluctuate between years and may disappear "off the radar" after a period of harsh weather, for example, only to reappear in a subsequent survey.

IMPACTS OF CURRENT FORESTRY PRACTICES

The Swedish Species Information Centre has analysed the latest Red List on coniferous forest species that have disappeared or are threatened by today's forestry practices. They say that it is reasonable to assume that forestry has caused or contributed to the disappearance of nine species from Sweden (see table).

Three of these species disappeared before 1950, for example the black stork, while six species have disappeared since 1950. A lack of wildfire is considered to be a key reason for the disappearance of three species.

A MIXED PICTURE

The Red List Index is based on the IUCN Red List of Threatened Species, (see previous page), and is an internationally accepted measure of biodiversity. On its scale of between zero and one, zero indicates that all species in a sample are extinct, while one means that all species are thriving. The Species Information Centre has calculated the Red List Index for a selection of species groups, including vascular plants, mosses,



AT THE OUTER LIMITS OF DISTRIBUTION

Analysis of Red Lists and Red List Indexes for the Nordic countries suggests that many species in the region are at the edge of their distribution ranges. Norway is home to a large number of western species that originate in the British Isles, while, many eastern species reach Finland, and in Sweden several southern species reach their northerly limit.

bees, butterflies, and vertebrates. The comparison between the Red List and the Red List Index for 2000 to 2020 suggests that biodiversity is relatively stable but decreasing. Biodiversity in frogs, reptiles and mammals improved noticeably, while it deteriorated in birds and mosses.

IS FORESTRY A THREAT TO RED-LISTED SPECIES?

Of the 4,746 species on the Red List, forests are important habitats to 1,375, habitats that are strongly negatively affected by felling. Of these, 728 species are classified as threatened.

Many of the species are rare and only occur in protected areas, for example Braun's holly fern, which is critically endangered and has been recorded in Söderåsen National Park.

A handful of red-listed beetles are only found on the island of Gotska Sandön, which was made a national park more than 100 years ago and where no logging takes place. However, these beetles are still considered to be threatened by felling.

OLD FOREST AND FIRES

Many red-listed forest species are judged to be dependent on old forest and continuity of its forest habitat. However, there are many examples of species that do well in a managed landscape if there is the right amount of substrate, such as dead wood and deciduous trees.

Many forest-dwelling, red-listed species are disadvantaged by the fact that forests burn far less frequently today than 150 to 200 years ago. There are 107 forest-dwelling species on the Red List for which "forest fire prevention" is listed as a negative impact. Today, large forest companies carry out controlled conservation burning to benefit these species.

IS THE RED LIST AN EFFECTIVE MEASURE OF BIODIVERSITY?

The total number of forest-dwelling red-listed species is often considered to be an indicator of the state of the forest environ-

EXTINCT SPECIES ON SWEDEN'S 2020 RED LIST:

Forest-dwelling species that entered the category of nationally extinct on the 2020 list having been classified as critically endangered in 2010:

Pseudosagedia interjungens, a lichen previously found in Halland, Bohuslän, and Västergötland. Last observed in Bohuslän 1984 on moist, shaded rock in a broadleaf forest. Missing from Denmark. Still found in Germany, Norway, and the UK.

Rinodina polyspora, a lichen previously found in Närke, Sörmland, and Uppland. Last observed on Gotland in 1990. Grows on smooth bark of aspen, rowan and ash. Present in Northern and Central Europe. Most recent sighting outside Sweden was made in Switzerland in 1962.

Aradus aterrimus, a flat bug that lives under the bark of spruce and pine trees. A small number of sightings in Stockholm in the 19th century, Gästrikland in 1944 and a beach drift find on Fårö in 1981. Also disappeared from Finland; present throughout Europe to eastern Siberia, although rare.

ment. The Red List includes species that are declining or are threatened. However, numbers of many other species increase over time. Significant numbers of species have always been rare or are only found in specific limited areas. "Usual" levels for the majority of species are that they are unusual. It is therefore entirely natural for a species to be red-listed.

The Red List therefore provides an incomplete picture of biodiversity in forests. To be able to establish accurate trends in the state of the environment, measures other than the Red List are therefore needed, for example a complementary "green list", i.e., a list of species whose numbers are increasing.

HOW GREAT IS THE RISK OF EXTINCTION?

Only a small number of species have gone extinct in Sweden since the 1950s. The lichen *Erioderma pedicellatum* is the most well-known example, with deforestation likely to have accelerated its demise. The lichen was known to exist in a small, protected area in northern Värmland. The felling of a nearby forested area is believed to have affected the area's microclimate resulting in the lichen's extinction.

Other species that may have died out as a result of forestry since 1950 include the *Szczawinskia leucopoda* lichen, (recorded in one area and last seen in 1956); *Lichinodium ahlneri* (one area in Värmland, last seen in 1956); the *Lamprotes c-aureum* moth (one area in Skåne, most recently recorded in 1993); and the *Lacon lepidopterus* beetle, (recorded until 1967 on Öland).

Across all habitat types in Sweden, 202 species have been registered as having disappeared since 1850. At the same time, significantly more species have established themselves. Between 1850 and 2009, 12 bird species disappeared – but 38 new species have been recorded.

NATURE PROTECTION

Virtually all forest land in Sweden is subject to some form of regulatory protection to prevent overexploitation and depletion. Restrictions range from absolute protection that amounts to bans on access, to requirements for nature to be considered in decision making related to forest management. Statistics on protected forests differ markedly between different types of forests and different countries, making comparisons challenging.

SWEDEN HAS SEVERAL FORMS OF PROTECTION

In Sweden, permanent, formal protection extends to national parks, nature reserves, nature conservation areas, biotope protection areas, and Natura 2000.

Formal protection means that a forest is protected by law. Protection may be eternal, which is common for nature reserves, or time-limited, for example in nature conservation agreements.

Land may be owned by the state or other public owner after redemption or remain with the original owner following agreement on economic compensation.

The formally protected forest that is left for free development is of great importance for the long-term conservation of species

Forestry is conducted on 73 per cent of Sweden's forested land.



The other 27 per cent is subject to formal or voluntary protection or otherwise exempt from forestry.

that need forest continuity and large contiguous areas. There are also many nature reserves and other forms of protection that depend on management measures such as nature-conservation thinning, burning or grazing.

In addition to the formally protected forest, large areas are exempted from forestry through voluntary commitments. This may be voluntary deposits or the tree retention during felling. A large proportion of forest land in Sweden is also excluded from forestry due to insufficient low biomass production (low-productive forest land).

Of Sweden's formally protected productive forest land, approximately 60 per cent is below the boundary of the Scandinavian Mountains, with approximately 40 per cent above. Nationwide, approximately nine per cent of forest land and six per cent of productive forest land are formally protected.

NOT FORMALLY PROTECTED, BUT EXEMPT FROM FORESTRY:

VOLUNTARY SET-ASIDES are not formally protected, and it is up to landowners to decide how long protection remains. To be counted, however, set-asides must be documented as being subject to a long-term preservation plan. In total, 1.4 million hectares

TOP OR BOTTOM OF INTERNATIONAL RANKINGS?

International comparisons of protected nature and forest are highly dependent on the type of protection that is included and how it is defined.

In its reporting to the IUCN and the EU, Sweden has a low proportion of protected nature compared to many countries. But if only areas with more strict protection are included, Sweden and Finland end up among the countries in Europe with the most protected forests.

(about 6 per cent) of Sweden's productive forest land is today voluntarily set aside according to the Swedish Forest Agency.

GENERAL NATURE CONSIDERATION (RETENTION FORESTRY)

can consist of retained individual trees, logs and high stumps, biotopes with high conservation values and retention of tree groups and buffer zones (which may vary in size up to a hectare).

Individual landowners left an average of nine per cent of harvested areas for retention and other landowners 13.5 per cent, an average of 11 per cent.

LOW-PRODUCTIVE FOREST LAND is land with less timber production than one cubic metre per hectare and year, for example wooded bogs, outcrops and parts of the mountain birch forest. Felling is not permitted on unproductive forest land according to Sweden's Forestry Act.

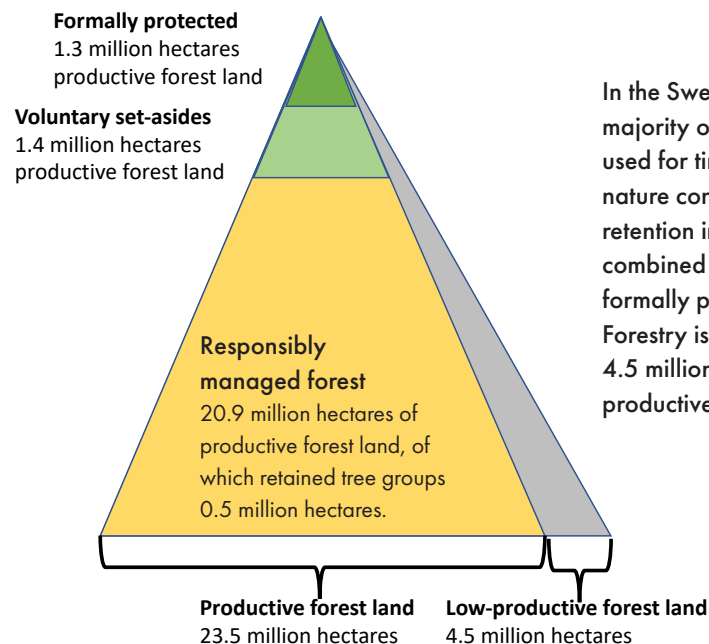
Sweden's low-productive forest constitutes a highly valuable complement to formally protected and voluntarily set aside productive forest.

Because low-productive forest makes up such a large proportion of Sweden's total forested area, it is also important in terms of contributing to a network of permanently wooded land together with formally and voluntarily protected forests. Low-productive forests are therefore a major green infrastructure asset.

There is approximately 4.5 million hectares of low-productive forest in Sweden, corresponding to 16 per cent of the country's total forest land. In the region around the Scandinavian Mountains, a full 60 per cent of forest land is low-productive (mainly mountain birch forest and mountain conifer forest).

CHALLENGES OF COMPARING COUNTRIES' FOREST PROTECTION

Comparison between countries is complicated due to historical and natural differences as well as differing interpretations of



In the Swedish forestry model, the majority of productive forest land is used for timber production with nature consideration (11 per cent retention in regeneration fellings), combined with voluntarily and formally protected forest areas. Forestry is not carried out on 4.5 million hectares of low-productive forest land.

reporting rules. Protection levels may range from strict protection in national parks and nature reserves to landscape protection with limited restrictions. Differences in legal status, site conditions, interventions and restrictions on land use further complicate comparisons.

Sweden mainly reports on formally protected areas that are strictly regulated, while other countries have more flexible landscape protection areas that allow agriculture and forestry under certain conditions. This has led to Sweden's reporting being compared unfavourably with other countries' because Sweden does not report certain forms of protection, or because they are simply not counted as protected in Swedish statistics.

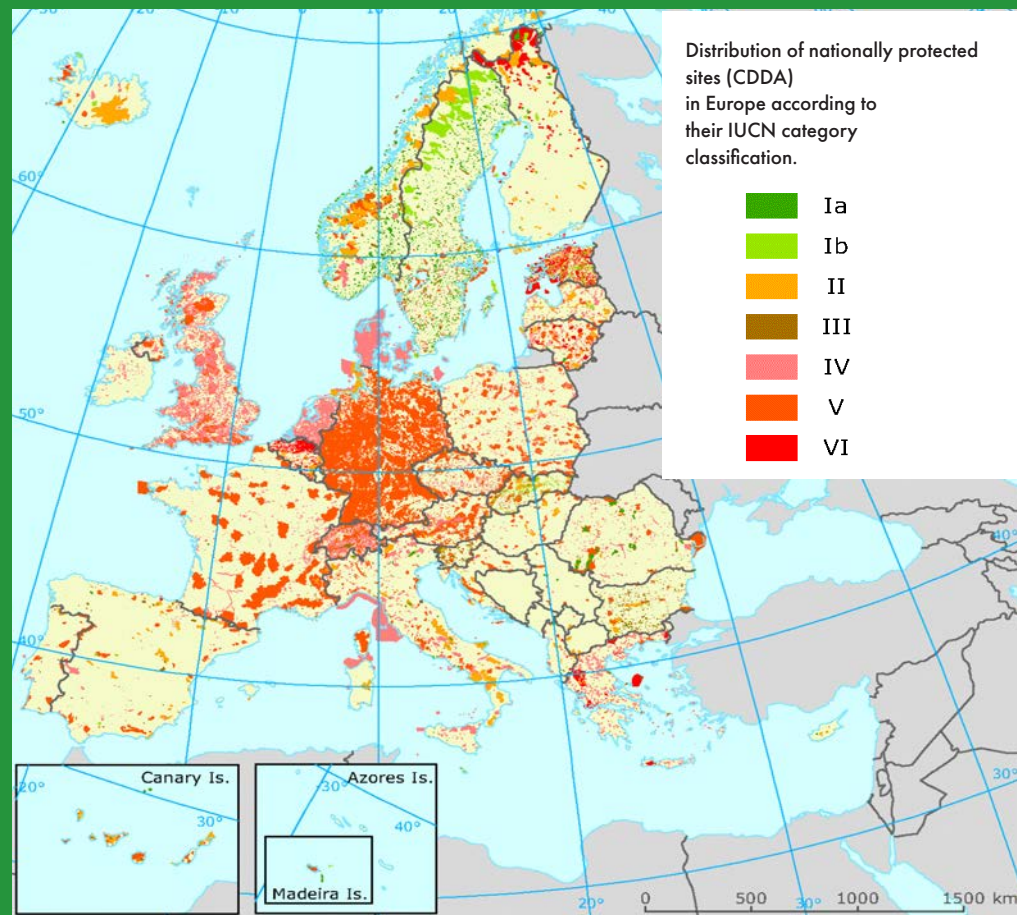
When it comes to statistics on protected forests in Europe, Sweden ranks low if all protected forests are included. However, if only strictly protected forests are counted, Sweden and Finland rank highly. Since 2022, Sweden has started to report on areas that are not formally protected from forestry, including Natura 2000 areas, nature conservation agreements and voluntary set-asides in conservation parks.

NATURE PROTECTION COMPARED WITH OTHER COUNTRIES

European statistics on protected areas according to IUCN categories indicate that the most common protection category is category V, protected landscape, and category VI, protected area with sustainable use of natural resources.

These are areas that primarily aim to preserve the character of the landscape, and forestry and agriculture are usually permitted. This explains why Central and Southern Europe are so dominated by red on the map. In contrast, Sweden and Finland have larger category I protected areas, strict nature reserve, which usually excludes forestry and farming (showing in green in the map). This type of protection is not as common in Central and Southern Europe.

Source: European Environment Agency, EEA



HOW DATA IS COMPILED

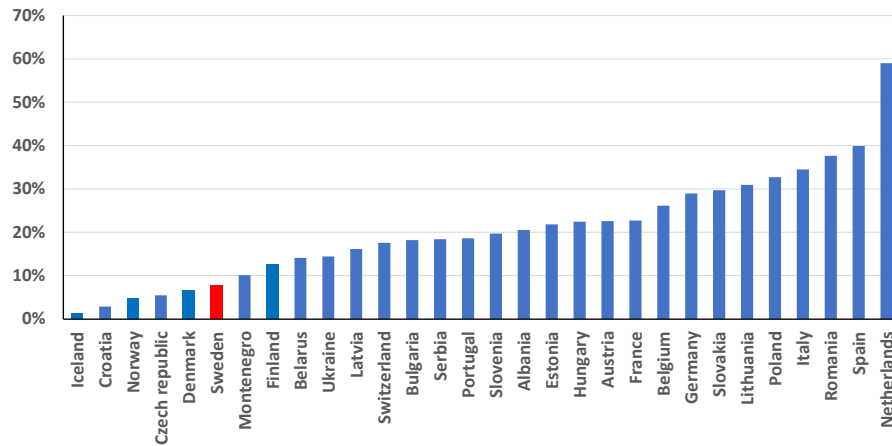
Sweden provides data yearly on protected areas to the European Environment Agency (EEA), which compiles the Common Database on Designated Areas (CDDA) for member states and seven partner countries.

The data is then used by a large number of other organisations, including the IUCN, which compiles the World Database on Protected Areas (WDPA).

Governments, international and voluntary organisations use the data for a variety of purposes. WDPA data can be found in OECD environmental target indicators, for example.

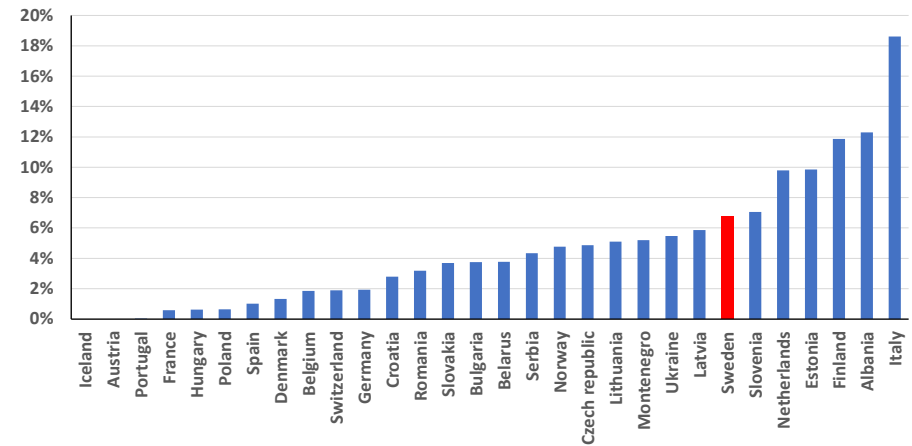
The IUCN also compiles the Protected Planet Report every second year, which presents countries' work on protected areas.

Protected forest, All categories



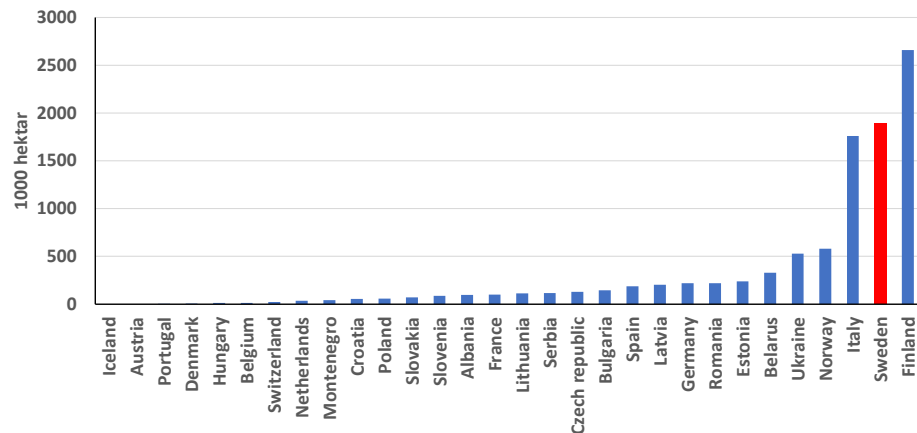
Proportion of protected area with forest for European countries, all protection categories, according to Forest Europe. Data from 2015.

Protected forest, Category "no" och "minimum intervention"



Proportion of strictly protected area with forest (category 1.1-1.2 in Forest Europe) for European countries. The protection classes correspond to no impact or only certain conservation management. Data from 2015.

1000 hectares protected forest, Categories "no" och "minimum intervention"



Just over 45 percent of the strictly protected forest area in Europe is found in Finland and Sweden. Area of strictly protected forest in thousands of hectares in the European countries according to Forest Europe (category 1.1–1.2). Data from 2015.

SWEDEN REPORTS on mainly formally protected areas that are subject to relatively strict protection, while other countries report on a larger proportion of landscape protection, which allows agriculture and forestry with certain restrictions, for example.

In Forest Europe's statistics on protected forests, Sweden is ranked lower when all protected forests are included.

However, if only protected forests in categories 1.1–1.2 according to Forest Europe are included, Sweden and Finland are among the countries with the highest proportion of protected forests in Europe. Forests in these categories are considered forests that are essentially free of development (no or minimal impact). Sweden and Finland's high rankings become even more striking when areas of protected forest in these categories are included.

EFFORTS IN THE FOREST SECTOR

At the same time as forest is felled, natural values are created and preserved by forestry through voluntary set-asides and general consideration for nature. This contributes to increased amounts of old forest and structures that are important for biodiversity. Other measures include ecological landscape plans, nature conservation burning, active creation of dead wood areas, and targeted efforts against different species groups.

THE IMPORTANCE OF FIRE

Ecologists have realized that various disturbances such as fire, storm, flood, grazing, insect attacks and fungal damage have had a decisive impact on the development of forests.

Gaps created in forest canopy following high winds may provide opportunities for new trees to grow, and dead trees become important substrates for many living organisms. Such a gap dynamic is important, especially in wet and moist areas, and many species adapt to environments with a continuous supply of dead trees and moderate variation in light, humidity and temperature.

Fire has had significant impacts on Swedish forests particularly on dry and mesic land. On average, approximately one per cent of forest land is burned annually, and fires occur at intervals of 40 to 50 years in the south of Sweden and 80 to 100 years in the north of the country.

Forest fires vary in intensity and scale, and although fires can be devastating, there are trees that survive such events and become part of new forest ecosystems.

Burnt forest is particularly important for species that need burnt wood and land as well as a brighter and drier environment. Immediately after fires, pioneer species such as pine, aspen and birch often establish themselves, and even species that live on these trees are indirectly dependent on forest fires or other large-scale disturbances. It is therefore important to consider these natural processes in nature conservation in order to preserve diversity and the function of the ecosystem. By adapting forest management and nature conservation measures to natural disturbances, it is possible to imitate the natural dynamics of the forest.

ECOLOGICAL LANDSCAPE PLANNING

Landscape planning focuses on the fact that different types of nature conservation measures are suited to different areas or "landscapes". This can be based on different criteria such as catchment areas, geological conditions, or administrative boundaries. With knowledge of natural values and general information about forests, such as age and tree species distribution, it is possible to conduct a landscape analysis that describes the forests and their characteristics as well as which special qualities

ONE PER CENT HARVESTED

Almost half of Sweden's surface area - just under 20 million hectares - is managed for timber production to varying degrees. Approximately 200,000 hectares, i.e., 1 per cent of the area, are felled for regeneration annually, and thinning is carried out on approximately 300,000 hectares. Including pre-commercial thinning and reforestation, various forestry measures are carried out on approximately one million hectares annually.

THE SWEDISH MODEL

Swedish forestry has been shaped by a combination of natural conditions, a long history of land use and a mutual respect between different ownership groups, the public, and society. The Swedish Forestry Act from 1903, which was the first in the world to require reforestation, and Sweden's well-established right to public access, are two examples where Swedish forests stand out. Today, a balance between production and environmental goals, as well as the motto "freedom under responsibility" are also distinguishing features of the Swedish forest industry.

need to be preserved or strengthened.

The result is an approach to forest planning that incorporates guidelines for managing nature conservation.

VOLUNTARY SET-ASIDES

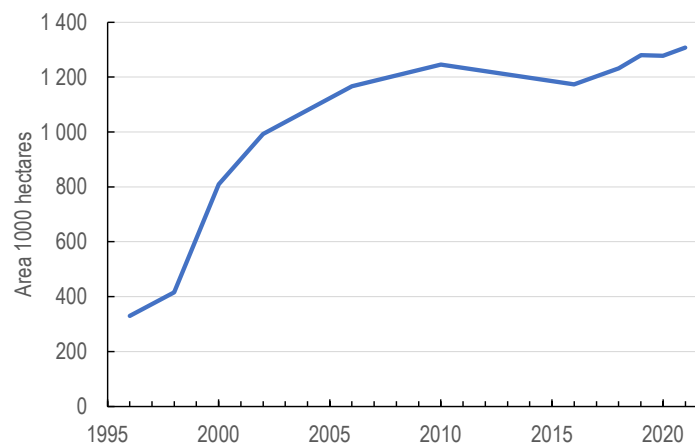
Voluntary set-asides are an important resource for preserving biodiversity and different values in Swedish forests.

Voluntary protected areas generally constitute areas of high conservation value, including old natural forests, old deciduous forests, or swamp forests. They may also contain areas of social or cultural historical value and often prioritize key woodland biotopes.

Studies show that voluntary set-asides contain significant amounts of natural values and structures that are important for biodiversity. They form an important complement to formally protected areas and often have a higher timber volume, more aspen and willow, and larger amounts of dead wood than ordinary production forest.

GENERAL CONSIDERATION FOR NATURE Forest areas that are largely retained out of consideration for nature in Sweden are those that are unlikely to be subject to fire, such as moist and wet areas. General nature consideration is practiced in all fellings in a number of ways. These include preserving buffer zones against watercourses, lakes or marshes, not logging small areas of water-saturated soil in a depression and retaining diverse hardwoods or coarse pines. Special attention is given to preserving high-value habitats such as cold springs, small bodies of water, overgrown meadows, older outcrop forests or pristine forest remnants.

General consideration that is retained is normally preserved permanently and becomes an integral part of new forest that establishes after felling. New forest therefore consists of a mixture of newly planted productive forest and areas that were retained as consideration.



Area of voluntary set-asides 1996–2021. The decline between 2010 and 2016 is mainly due to voluntary set-asides being transferred to formal protection.

The Forestry Act, the forest sector's joint target images and certification standards contain guidelines for how the general consideration should be designed.

DIFFERENT TYPES OF NATURE CONSIDERATION

BUFFER ZONES along watercourses play an important role for many different organisms, including mosses, lichens, land snails and birds. Moreover, these effects have been shown to be long-lasting, and 30 to 50 years after logging, mosses are more common if buffer zones have been preserved rather than logged.

It is particularly important to protect buffer zones on moist ground, and if there are blocks, logs and stones in the buffer zone, its value as a habitat increases.

Buffer zones have also been shown to be important for small

FORESTS AND FIRE

In boreal forest, fire frequency varies depending on soil type. In wet forest land, fires are extremely rare, and small-scale disturbances such as wind shear and tree diseases are also important dynamics. Moist forest land is rarely subject to fire and is usually found at the edge of watercourses and wetlands.

Mesic forests, the largest proportion of forest land in Sweden, burns occasionally, on average once a century. Dry forest land burns more often, on average twice a century.

To imitate the dynamics of unmanaged forest, it is important to consider the propensity to fire in forest management and nature conservation measures. Clearcut forestry with consideration is carried out primarily on land that has burned occasionally or often, while wet land (which has almost never been subject to fire) is left for free development and moist land (which rarely burns) is often managed with alternative forestry methods.

butterflies associated with forest habitats, and they can act as dispersal corridors between different forest areas. The width of the buffer zone plays a role in its usefulness to different species groups.

CONSIDERATION AREAS Groups of trees that are left in felling areas, also known as consideration areas, have been the subject of several scientific studies. Consideration areas are usually relatively small, often less than half a hectare. Research shows that consideration areas must be large enough to provide protection for species that thrive in shady and climate-stable environments.

There is limited information on how consideration areas develop over time, but some studies have shown that mosses decrease over time, while certain lichen species increase in small consideration areas.

HIGH STUMPS are created by cutting trees at a height of 2-3 metres, to contribute sunlit, standing wood, which is important for many organisms. Approximately one million tree stumps are cut annually in Sweden.

Research shows that high stumps are beneficial to a variety of species during different phases of the stumps' decay. It has been observed that high stumps develop differently, both within and between different tree species.

It is important to preserve and create high stumps of different tree species and size in order to promote biodiversity in the forest landscape.

DEAD WOOD The amount of dead wood in Swedish forest landscapes has increased in recent decades. It is important to leave and create dead wood of the right tree species, coarseness, and degree of decay to benefit various beetles and wood fungi. Researchers recommend prioritizing which type of dead wood is



PHOTO: OLA KÄRÉN

CONSIDERATION AREAS BENEFIT DIFFERENT SPECIES

The purpose of consideration areas is to act as “lifeboats” for forest species by giving them an opportunity to survive and spread as the new forest grows. They also provide dead wood and live trees in sunlit environments, benefiting many rare species that depend on these structures.

most important in each individual forest stand, instead of leaving “a little of everything” in all areas. This is because different species and ecosystems have different requirements depending on the type and quantity of dead wood.

MANY SPECIES BENEFIT FROM NATURE CONSIDERATION

Combining regeneration harvesting with strategically placed consideration is an effective method for conserving many forest-dwelling species and their habitats. The size of the consideration areas left plays a decisive role in how many species can survive.

Analysis carried out by the Swedish Species Information Centre on 850 forest-dwelling species on the Swedish Red List and the EU's directive lists showed that 90 per cent of these species are able to survive locally after a felling if consideration measures are applied. The larger an area of consideration, the more species are able to survive.

It is worth noting that approximately one tenth of the assessed species can survive the felling and the young forest stage even without consideration. This mainly applies to certain mammals, birds, vascular plants and beetles which are more adaptable to changes in the forest.

FORECASTING THE NEXT 50 TO 100 YEARS

In conservation biology, the term “extinction debt” is used to describe how long-lived species can survive for long periods of time even if environmental conditions deteriorate. This means that species can remain in a certain environment even if it gradually changes or decreases in quality.

Over time, however, these species may disappear completely when they can no longer adapt to changed structures and environments, especially if habitats become too small or too isolated.

An opposite process is the possibility of new establishment of



PHOTO: DAVID RÖNNBLOM

In Västerbotten, northern Sweden, extensive burnings have been conducted for 20 years to benefit fire-dependent insects and plants. A species that was previously considered “extinct” in Västerbotten is the *Tragosoma deparium* beetle, which has now re-established itself.

species in areas where they previously did not occur. This may happen in reserves, voluntary set-asides and consideration areas where, for example, the amount of dead wood and old trees increases.

The Swedish Forest Agency’s project “Forest Impact Analyses 2022” has made forecasts for how forest structures will change over the next 50 to 100 years. The forecasts show that the amount of old and coarse trees, and the amount of dead wood, will increase in various forms of protected areas, such as voluntary set-asides.

Establishment possibilities for species in managed forest can be more difficult to assess and vary between different species. For species that depend on slow wood decay and forest continuity, re-establishment may take many years. Voluntary set-asides and consideration areas can play an important role as potential establishment areas for several species in the forest landscape.

HOW MUCH DOES FOREST PROTECTION COST?

The responsibility for protection of forests in Sweden is shared between the state and the forest sector and includes various costs and measures. The direct costs of forest protection include the redemption of land and the value of protected forests. These costs are mainly financed by the state through grants to the Swedish Environmental Protection Agency and the Swedish Forest Agency.

Approximately SEK 1 billion is used annually for the purchase of land, including forests and other natural areas such as bogs, wetlands and lakes.

A rough estimate of the value of voluntarily set aside forest land based on the costs of biotope protection is SEK 180 billion (1.8 million hectares at SEK 100,000 per hectare).

This gives an idea of the magnitude of the forestry industry’s investment in biodiversity.

AUTHORS' REFLECTIONS

Forestry has developed enormously in terms of consideration for nature over the past 35 years. In the 1970s and 1980s, large forest companies' clearcuts were several hundred hectares in size and more or less without any consideration; forest drainage was extensive and deciduous trees in young forest areas were treated with chemicals.

Much has changed since then, with nature considerations and large areas of forest with high natural values being voluntarily set aside. However, there is still considerable room for improvement.

The proportion of forest that is naturally regenerated has decreased, and it would be desirable if larger areas under seed could be regenerated with pine and that limestone-coniferous forests could be managed with continuous-cover forestry so that mycorrhizal fungi in these environments can survive. Despite efforts to reduce damage from forest machines, felling areas are still subject to extensive soil impacts from machinery, and today's scarification methods are sometimes quite radical.

KNOWLEDGE IS KEY

Forests with high conservation values are still being harvested, and it is important that all those involved in planning felling have knowledge of identifying biotopes of concern.

Studies have shown that many individual forest owners put greater value on the social and/or environmental values of their land than economic ones. It is therefore important that timber purchasing organisations become more responsive to the wishes of individual forest owners and present alternative options for how forest land can be used.

Sweden's species protection regulation has strengthened

species protection in the face of different interests. Despite the adjustment that was made to the regulation in 2022, there is uncertainty about how the presence of species such as capercaillie, Siberian jay, lesser woodpecker, the *Goodyera repens* orchid and others affect forest owners' ability to carry out felling and thinning. Court orders will gradually clarify the rules of the game. There are species subject to the regulation that can hardly be considered endangered.

Continued discussions are therefore necessary, and there is an urgent need to review Sweden's laws and regulations governing species protection.

VALUABLE IF USED CORRECTLY

The Red List is a valuable source of information on the status of species, but it is often used incorrectly as a value gauge of biodiversity. The Red List includes species that are declining or rare and therefore considered endangered or near-threatened. At the same time, there are many species that are increasing or stable, and a more complete picture of the status of diversity should take these into account as well.

The Red List's connection to which processes threaten species also needs to be nuanced. Since half of the red-listed forest species are found in hardwood forest, (which is felled only to a small extent), the information about the forest industry's threat to the entire country's forest species is also greatly exaggerated. The Red List is used to highlight the risk of a species going extinct. Many people misunderstand this and think that all species on the Red List are endangered, but this is not the case. There are many common species such as the hooded crow, laughing gull and fieldfare that are red-listed without being threatened.

ABOUT THE AUTHORS

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Per Simonsson is a biologist and has worked with nature conservation since the 1970s, first at Västernorrland Municipality and from 1992 as nature conservation specialist at forestry company SCA. He has a doctorate from SLU on the extent and development of nature conservation in Sweden. Per Simonsson also received an honorary doctorate from Mid Sweden University.

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