Forest Stewardship Council®
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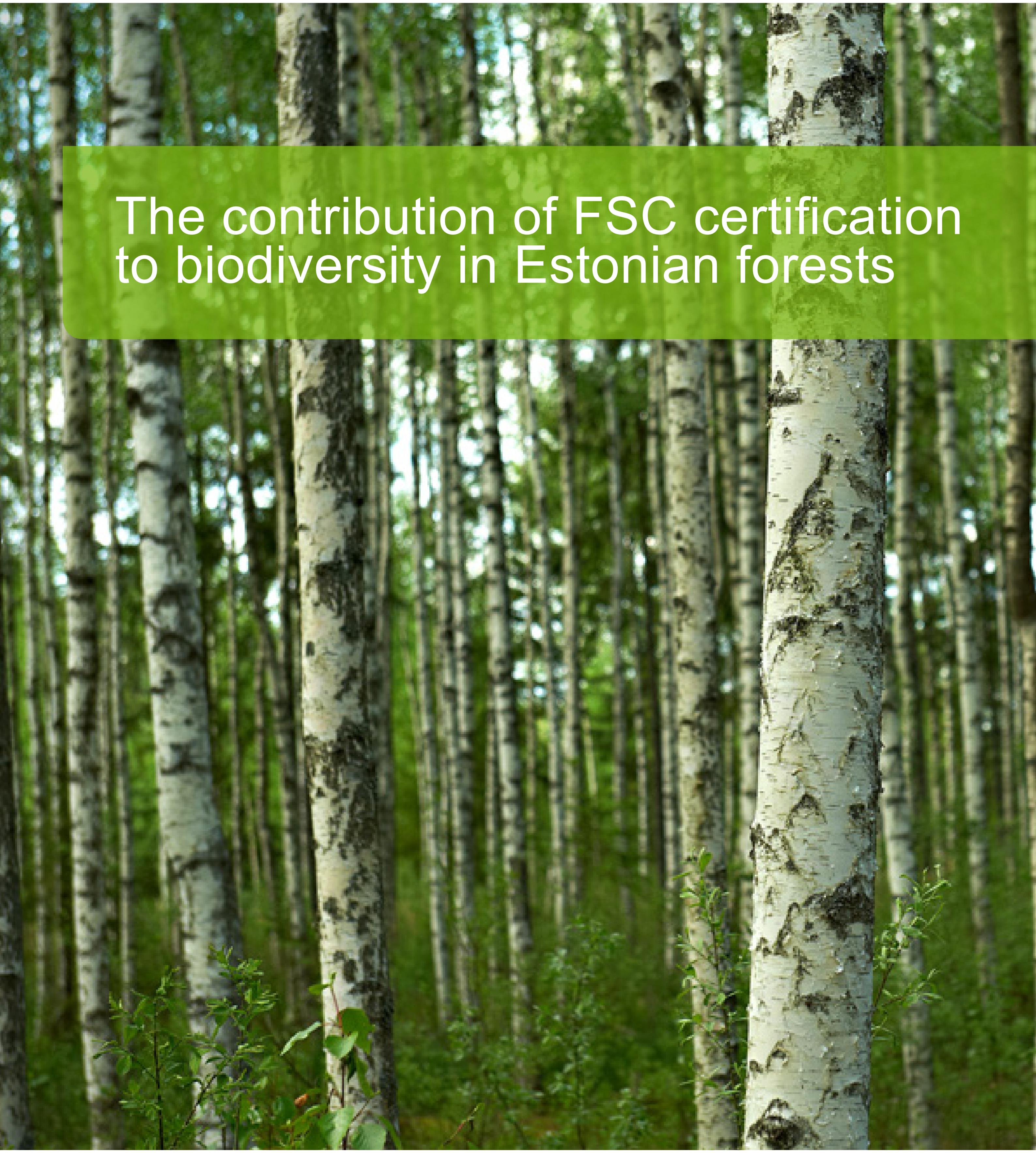
The contribution of FSC certification to biodiversity in Estonian forests



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Report 2016

SUMMARY

This study evaluates the impact of FSC certification to biodiversity in the Estonian forest. The benefits for forest biodiversity are most apparent regarding preserving different dead wood types, prohibiting forest drainage, and maintaining noble hardwoods. These conservation requirements are not covered by Estonian legislation. FSC also contributes to a larger tree species variation, more retained trees in harvested areas, and protection of large Woodland Key Habitats. The impacts of these considerations have been validated based on scientific literature. When evaluating the FSC impact one must keep in mind that biodiversity is only one of the three pillars of FSC and sustainable forestry, together with social considerations and economic viability. FSC certification shall be seen as an effective and complementary tool to other conservation practices.

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Cover photo front page: A managed birch stand. Birch is the third most common tree comprising almost ¼ of the total forest volume in Estonia. Photo by RMK/Jüri Pere.

Cover photo end page: A remnant oak tree in a Woodland Key Habitat. Photo by RMK/JüriPere.

TABLE OF CONTENTS

The contribution of FSC certification to biodiversity in Estonian forests

The value of FSC certification for biodiversity 4
Background on Estonian forest and forestry 6
Protected Areas and Habitats 8
- FSC places large Woodland Key Habitats under protection 8
- Enhancing the capacity for biodiversity features 8
- Protected areas provide shelter for forest species 10
- Habitat protection for rare, threatened and endangered species 10

Native Tree Species 12
- FSC promotes native biodiversity 12
- Native noble hardwoods are unique biodiversity features 13

Mixed Forests 14
- FSC increases the proportion of mixed forests in the landscape 14

Retention Trees 16
- FSC increases the standards of tree retention required by law 16
- Retention trees function as lifeboats 16
- Preserving biodiversity features in harvested areas 16

Dead Wood 18
- FSC promotes high quality dead wood 18
- Facilitating the continuous input of dead wood over time 19

Forest Drainage 20
- FSC contributes to preserving wet forest types 20

Landscape Planning 22
Forest Roads 22
Damage to Ground and Water 23
Discussion 26
- How much is enough? 26
- Where FSC does not contribute biodiversity benefits beyond that of legislation 27
- Where more research is needed 28

References 30

THE VALUE OF FSC CERTIFICATION FOR BIODIVERSITY

Sustainable forest management is becoming increasingly important as we witness the effects of worldwide forest degradation and deforestation. One way to work toward sustainable forest management is through certification. The Forest Stewardship Council, FSC, promotes environmentally appropriate, socially beneficial, and economically viable forest management. On a national level, this is facilitated through a FSC standard for forest certification in accordance with these goals. FSC Estonia supports and advances the national FSC standard for forest certification, and spreads awareness about good forest management practices in Estonia. Crucial for sustainable forest management is preservation of natural forest biodiversity. Preserving biodiversity is of concern for the intrinsic value of forest biodiversity and the cultural value of forests, as well as for the link between high biodiversity and increased ecosystem function, resilience to disturbances such as extreme weather events and pests, and forest productivity.

In Estonia, the management of forests and their biodiversity is regulated by law through the Forest Act, Rules of Forest Management, and the Nature Conservation Act. FSC certification complements legal requirements by setting additional prerequisites for sustainable forest management. The requirements, presented in the FSC Interim Standard for Assessing Forest Management in Estonia - herein referred to as the FSC standard, are divided into ten basic principles. This report explores the biodiversity considerations associated with the requirements in principle 6, which states that *"Forest management shall conserve biological diversity and its associated values, water resources, soils, and unique and fragile ecosystems and landscapes, and, by so doing, maintain the ecological functions and the integrity of the forest."* Some requirements in principle 9 (High Conservation Value Forests) provide additional benefits through the protection of Woodland Key Habitats, Natura 2000 areas, and other areas important for biodiversity, but these are not discussed at length in the report.

Currently, over 1.2 million hectares (ha) of Estonian forest are FSC certified. This is all state-owned, except for 10 000 ha that is private-owned. This amounts to half of the forest area in Estonia. This report demonstrates some of the ways in which FSC certification provides additional benefits for biodiversity in comparison to Estonian legislation on forest management. The biodiversity impacts of the FSC standard versus legislation are discussed based on relevant scientific literature, and divided into nine environmental aspects. Of these, six aspects are highlighted where the FSC standard provides clear and/or quantifiable benefits for biodiversity over legislation: 1) Protected areas and habitats, 2) Native tree species, 3) Mixed forests, 4) Retention trees, 5) Dead wood, and 6) Forest drainage. For the remaining aspects (Landscape planning, Forest roads, Damage to ground and water), the comparison between FSC requirements and Estonian legislation is difficult to assess. These are discussed briefly at the end of the report. Finally, the key findings and limitations in assessing biodiversity benefits are discussed in relation to the biodiversity considerations of FSC certification as a whole.

GLOSSARY

Biological diversity: The United Nations Convention on Biological Diversity defines biological diversity as *"the variability among living organisms from all sources, including, inter alia, terrestrial, marine, and other aquatic ecosystems, and the ecological complexes of which they are part: this includes diversity within species, between species and of ecosystems"*. Referred to as *biodiversity* in this report.

Global Principles and Criteria - local adaptation

FSC's role is to raise the level of responsibility within the conventional forestry on a national level.

All ten principles and criteria must be applied in any forest management unit before it can receive FSC certification. The Principles & Criteria apply to all forest types and to all areas within the management unit included in the scope of the certificate. The P&C are applicable worldwide and relevant to forest areas and different ecosystems, as well as cultural, political and legal systems. This means that they are not specific to any particular country or region.

ENVIRONMENTALLY APPROPRIATE

Environmentally appropriate forest management ensures that the harvest of timber and non-timber products maintains the forest's biodiversity, productivity, and ecological processes.

SOCIALLY BENEFICIAL

Socially beneficial forest management helps both local people and society at large to enjoy long-term benefits and also provides strong incentives to local people to sustain the forest resources and adhere to long-term management plans.

ECONOMICALLY VIABLE

Economically viable forest management means that forest operations are structured and managed so as to be sufficiently profitable, without generating financial profit at the expense of the forest resource, the ecosystem, or affected communities. The tension between the need to generate adequate financial returns and the principles of responsible forest operations can be reduced through efforts to market the full range of forest products and services for their best value.

BACKGROUND ON ESTONIAN FOREST AND FORESTRY

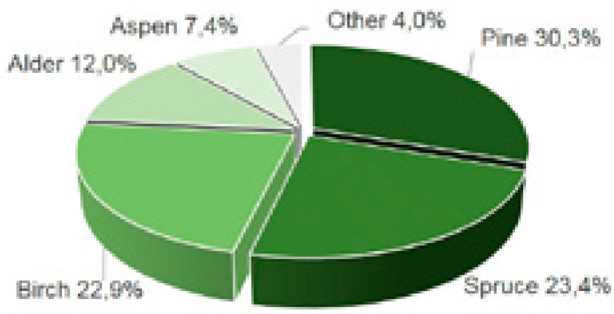
Estonia has one of the largest forest areas per capita in Europe, with forests making up half of its land area. Of the 2.27 million ha of forest in Estonia, half is owned by the state and mostly managed by the State Forest Management Centre, and half is privately owned. 10% of all forests in Estonia are under strict protection from economic activity.

The main focuses of Estonian forestry are to ensure the productivity and viability of the forests, to use forests in a varied and sustainable way, to preserve the natural habitats and environment, to leverage the development of forest and wood industry sectors, to diversify recreational use of forests, and to improve the management of private forests.

The total forest area in Estonia has changed significantly over time, with the total forest area in 1942 estimated at 65% of the present forest area. This increase resulted from intensive drainage of forest lands, a low annual felling during the Soviet era, and former agricultural lands being reforested. The proportion of regeneration felling has also increased over the years due to the increase in mature forest stands. Clearcut felling is the primary method of regeneration felling in Estonia, while other felling methods make up less than 10% of felling.

The wood processing industry has been a major contributor for recent growth in the overall manufacturing industry in Estonia. Forestry, together with the wood processing, paper and pulp, and furniture industries contributed 5.3% of the Estonian GDP in 2014.

More than 80% of the Estonian population considers forests to be an important and natural part of their lives, both in terms of leisure and for their education and/or careers. Both state and private-owned forests are freely accessible for recreational activities, unless stated otherwise.



Proportion of the main forest trees in the Estonian forest, based on volume.

Picking forest mushrooms is a popular activity by Estonians. This basket is full of the delicious orange milkcap. Photo by RMK/Jüri Pere.

PROTECTED AREAS AND WOODLAND KEY HABITATS

Requirements for establishing protected areas and protecting rare, threatened or endangered species often go hand in hand. Retaining their natural habitats is a major aspect of species protection. Detailed guidelines for managing protected areas are provided in Estonian legislation. These areas are delimited across the country by a regulation of the government, with the aim to maintain or restore the area to its natural state. Currently, 10.1% of the total Estonian forest area is protected from all management activity by law, of which the large majority is within state-owned forests. Estonia also aims to place a minimum of 17% of total land area under protection, as required in the Aichi biodiversity targets of the Convention on Biological Diversity's Nagoya Protocol.

FSC places large Woodland Key Habitats under protection

The FSC standard requires that FSC certified large forest owners protect a minimum of 5% of their forest area from economic activity. For small forest owners, the FSC standard requires a representative amount of rare and/or endangered ecosystems within the forest area to be protected. Set-aside areas can consist of state-designated protected areas: as such, this FSC requirement does not contribute with additional protected forest area in state-owned forests where protected areas have already been designated. Rather, it is the protection of larger Woodland Key Habitats (WKHs) that is the FSC contribution.

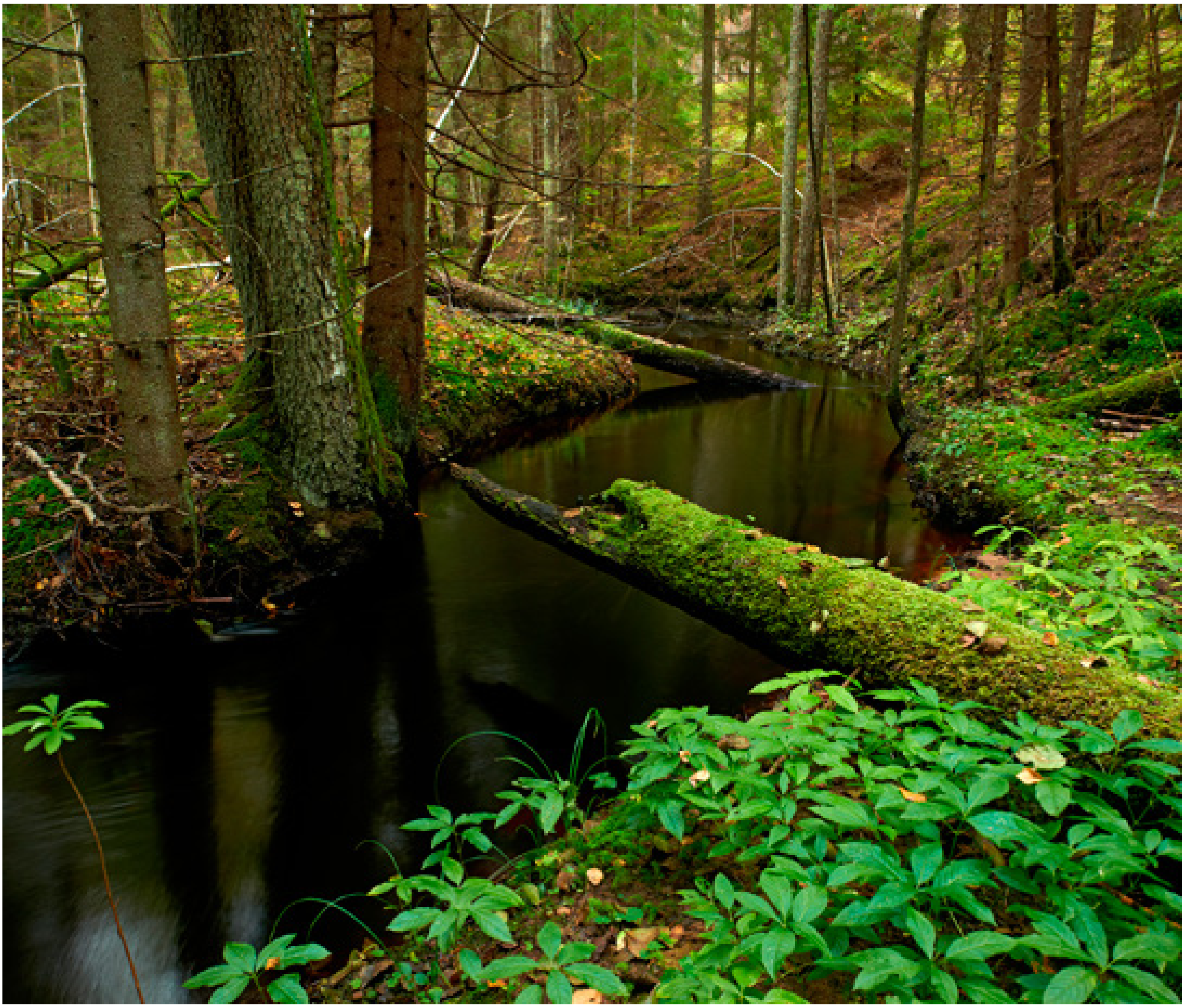
The Estonian legislation requires all WKHs under 7 ha in size to be protected. While WKHs currently only comprise approximately 0.7% of nationally protected forests, they are an integral component of species protection because they are designated in areas that are considered to be important for threatened species. Fennoscandian WKHs have been shown to host a significantly higher abundance and diversity of dead wood and more old-growth features, and support more diverse species communities, including more red-listed species, than surrounding managed forests. However, WKHs with small areas are rendered particularly prone to edge effects, whereby microhabitats on the edges of WKHs may change due to exposure to the conditions surrounding the WKH. As such, the area that retains the conditions corresponding to intact forests is smaller than the whole WKH area, and their capacity for protecting threatened species may be reduced. The FSC standard minimizes this risk and complements legal requirements by requiring all WKHs, including those above 7 ha, to be protected under Principle 9 (Maintenance of High Conservation Value Forests) of the standard. As well as decreasing the proportion of area in WKHs subject to edge effects, the additional protection of large WKHs could increase connectivity between WKHs, thereby increasing their capacity to protect species with large geographic ranges or low dispersal ranges.

The additional forest area placed under protection following to the FSC requirements benefits biodiversity by enhancing the capacity for biodiversity features and providing intact forest patches as shelter for forest species to survive.

Enhancing the capacity for biodiversity features

Key biodiversity features typical of natural forests are important to preserve in the landscape, as they provide a large array of habitats and microclimates for species to colonize and coexist in. This, in turn, allows for higher species diversity to be preserved in forests. These features include old and large trees, higher tree species diversity, more dead wood types, higher structural diversity, and varied light availability within forest patches. While such features can also be promoted in managed forests through measures such as creating dead wood and preserving old and large trees, protected areas allow for a natural development and succession of the forest area, thereby enhancing their capacity to retain these biodiversity features. A computer simulation of growth in a Swedish productive boreal forest over 200 years showed that setting aside 5% of a forest can contribute 2.5 times more dead wood over 200 years and contribute with significantly more coarse coniferous trees within the forest landscape.

When protected areas are maintained over time, old-growth features can develop and enhance biodiversity benefits. A study in Estonian forests showed that a higher diversity of calicioid fungi, of which many species are threatened, is found in old-growth forests than managed forests due to the presence of a larger range of suitable substrates and microhabitats. Another Estonian study showed a higher bird species diversity and abundance in old-growth forests than mature forests. Bird communities in old-growth forests were also more site-specific: this indicates that as old-growth forest area increases, bird communities may be more heterogeneous and bird species specialized on rarer ecosystems can persist across the landscape.



Woodland Key Habitas are forest patches consisting of habitats that are considered important to sustain forest biodiversity. In Estonia, WKHs are designated in areas with a high probability of supporting rare, threatened and endangered species. Photo by RMK/Kaupo Kikkas.

Protected areas provide shelter for forest species

Protected areas provide intact forest patches with biodiversity features that many forest species depend upon. Viable populations of many species of lichens, plants and fungi can persist in small forest patches in a managed area this way. Such species can then recolonize harvested areas later in the forest succession, when the necessary biodiversity features have regenerated. A study in Estonia showed that managed forests left to naturally regenerate had higher species richness of polypore fungi than planted forests and clearcuts. The naturally regenerated forests also sustained more unique species assemblages than planted forests at the landscape scale.

The benefits of protected areas can be enhanced if intact forest patches maintain connectivity. This will allow species with lower dispersal distances to spread over larger areas, decreasing their vulnerability to local extinction threats. A modelling study based on Fennoscandian boreal forests showed that many red-listed epiphytic fungi are specialized on resources within their habitat and cannot survive in a fragmented landscape, while non-red-listed generalist species were able to spread through such a landscape. Other studies show the importance of connectivity between forest patches for lichens and bryophytes to persist in managed landscapes in Estonia, including red-listed species such as the epiphytic lichen *Lobaria pulmonaria*. Well-connected forest patches can also provide habitats for species with larger foraging and dispersal ranges, such as mammals and birds. Other requirements in the FSC standard further increase the proportion of intact forests, for instance, by developing mixed forest stands and prohibiting the drainage of previously undrained forests.

Habitat protection for rare, threatened and endangered species

Habitat conservation for protected species is included within legal requirements for establishing protected areas, along with specifications to protect brown bear hibernation sites, as well as nesting sites and territories of flying squirrels and birds of prey. Both legislation and the FSC standard also prohibit activity around nesting sites of protected species during breeding periods. In practice, FSC certification does not implement additional considerations into species protection relative to legislation. However, there is potential for an increase in the proportion of protected habitats in FSC certified forests compared to non-FSC certified forests.

Estonian legislation divides protected species into three categories, where all known habitats, 50% of habitats, and 10% of habitats are to be legally protected for species in categories I, II and III respectively. This habitat protection occurs on a nation-wide level, and thus may be unevenly distributed across forest owners. Meanwhile, the FSC standard requires protection of rare and threatened species from all FSC certified forest owners, which could increase both the proportion of protected habitats across Estonia, and increase connectivity between protected habitats. Such considerations can make species less vulnerable to both large and small-scale extinction threats: for instance, a long-term study on woodpecker populations across Estonian forests showed an overall increase in the abundance of 6 woodpecker species (of which 5 are protected by Estonian legislation under categories II or III), with similar abundances observed across both protected forests and forests managed under similar principles to FSC certification. The study also predicts that woodpeckers can be expected to double in number as existing protected areas grow into old-growth forests. Given that woodpeckers typically act as indicator species, associated with many threatened species in northern Europe, these protected areas can sustain diverse communities of other threatened species as well.

GLOSSARY

Protected areas: Protected natural objects in which, according to the Nature Conservation Act, timber harvesting is prohibited, and human activity is restricted depending on the level of protection of the area. Natural objects are protected according to the prerequisite that they are under risk, rare or typical, have scientific, historic, cultural or esthetical value or are subject to protection under an international agreement. Protected areas designated by law include national parks, nature reserves, landscape protection areas, strict nature reserves, conservation zones, and limited management zones. In this report, only strictly protected areas with no management activity are considered in the legal definition of protected areas.

Old-growth forest: A forest that has been allowed to grow undisturbed over many generations and exhibits ecological features that are unique or enhanced by old-growth characteristics. Such forests are usually classified as late-successional communities, hosting species that coexist in a steady state and have inhabited the forest over time through the process of ecological succession.

Old-growth features: Ecological or biodiversity features typical of old-growth forests. Dead wood is a characteristic old-growth feature, due to the high proportion of old trees and their natural mortality.

Epiphytic species: Plant species that grow on other plants without taking nutrients or water from the host plant. Host plants are typically trees.

Calicioid fungi: A group of fungi characterized by asci (sexual spore-bearing cells) that disintegrate early, releasing reproductive spores as a powder-like mass.

Woodland Key Habitats (WKHs): Forest patches consisting of habitats that are considered important to sustain forest biodiversity. In Estonia, WKHs are designated in areas with a high probability of supporting rare, threatened and endangered species.

NATIVE TREE SPECIES

FSC promotes native biodiversity

The Estonian Forest Act states that forests should be managed so that the gene pool and overall ecosystem in each forest is not endangered. The FSC standard provides an extra consideration by prohibiting the cultivation of non-native tree species (except in cases with special permission), while legislation allows the use of suitable non-native species.

Every species in a forest has adapted to the abiotic and biotic conditions present in their ecosystem, resulting in a community of species with survival strategies that allow them to coexist. Native tree species with such adaptations are more likely to enhance ecosystem function and resilience to disturbances than non-native species, which can support the native biodiversity that has developed over time, and create a more stable ecosystem that can be sustainably managed. In a stable ecosystem, the biodiversity benefits of other management activities may be more prominent as well.

The European yew (*Taxus baccata*) is native to Estonia and is protected under species protection category II by Estonian legislation, meaning that at least 50% of its habitat is formally protected. European yew grows best in open woodlands and deciduous forests. Previous land management and a loss of deciduous forests has led to a considerable decline of the species in Estonia, with approximately 2000 known specimens left in the country. FSC certification requires all specimens of European yew to be retained undamaged, increasing the proportion of European yew being protected in Estonia.

The epiphytic lichen Lobaria pulmonaria is associated with many other red-listed species. Here it grows on an aspen tree together with the red-listed moss Neckera pennata. Photo by Asko Lõhmus.

Native noble hardwoods are unique biodiversity features

Noble hardwoods are a group of tree species with high cultural and/or historic value that are considered important for biological diversity in forests. Several of these also have a high timber value. These species tend to be present at low proportions in the environment due to historic exploitation and degradation of forests, the favoring of coniferous trees in productive forests, and the allocation of sites with rich soils, naturally favored by noble hardwoods, to agriculture rather than forestry. Furthermore, many noble hardwood species grow in late-successional forests, while a large proportion of Estonian forests are harvested as early-successional forests.

In Estonia, less than 4% of the total proportion of forests consists of the six native noble hardwood species. White elm (*Ulmus laevis*) is the only native noble hardwood protected by Estonian law (under species protection category III, entailing that at least 10% of white elm stands are formally protected). FSC certification builds on this by requiring the existing proportion of all native noble hardwoods to be maintained or increased in forests.

Many noble hardwood species provide unique biodiversity benefits in forests. Hardwood species tend to have coarser bark than other species, which is favored by many epiphytic lichens. An Estonian study found that oak (*Quercus robur*) and ash (*Fraxinus excelsior*) both host significantly more red-listed lichen species than other tree species. Since many hardwood species attract specialists and persist for long time periods in the landscape, even singly trees left in the forest can be of significant biodiversity value. Retaining noble hardwoods in early-successional forests or clearcuts also allows the additional benefits of late-successional tree species, such as providing late-successional-type microhabitats, to be preserved in managed forests.

Lobaria pulmonaria is a red-listed epiphytic lichen that typically grows on mature hardwood trees in old-growth forests where the humidity is high and stable. Due to its habitat requirements, the species has widely been used as an indicator species for intact forest ecosystems with high continuity. However, the loss and fragmentation of old-growth forests has reduced the range of the lichen to a few, scattered mature forest fragments around Estonia. A study in Estonia from 2010 showed that the species has become locally extinct in 81% of the sites it historically inhabited, and endangered in a further 19% of sites. Additionally, 86% of surviving specimens were located in protected areas, of which 69% were fragments of forest designated as Woodland Key Habitats.

While conserving the forest fragments that *L. pulmonaria* is present in is important to protect the species, there is a risk that such fragmented populations will not be able to persist in the landscape over many generations. As such, other conservation methods can be used to supplement protected areas.

L. pulmonaria thrives on the bark of ash (*Fraxinus excelsior*), aspen (*Populus tremula*) and oak (*Quercus robur*), among other hardwood species. Retaining individuals of these tree species, particularly large old specimens, across large areas could allow the lichen to spread across the landscape. Maintaining mixed forests would also provide potential habitat for colonization. Since *L. pulmonaria* tends to associate with many other red-listed lichens, as well as beetles typical of old-growth forest, conserving this species is likely to create secondary benefits to other species in forest ecosystems.

GLOSSARY

Noble hardwoods in Estonia:

In Estonia, six species of native noble hardwood are identified:

Norway maple (*Acer platanoides*)

Ash (*Fraxinus excelsior*)

Oak (*Quercus robur*)

Lime (*Tilia cordata*)

Wych elm (*Ulmus glabra*)

White elm (*Ulmus laevis)*

Early- versus late-successional forest: Refers to the development of forest structure and composition over time as a result of ecological succession. In early-successional forests, fast-growing pioneer species typically dominate. In late-successional forests, a higher proportion of long-lived, slow-growing and shade tolerant species are able to mature, and may replace pioneer species due to competition.

MIXED FORESTS

FSC increases the proportion of mixed forests in the landscape

The FSC standard states that mixed stands are to be developed in forests, which provides both ecological and economic benefits. A large-scale study on boreal and temperate forests showed that forests with many tree species significantly outperformed single-species forests in soil carbon storage, understory plant diversity, dead wood production, berry production, and food for wildlife. Additionally, the tree growth rate in forests with five tree species was 54% higher than in single-species forests. Although most forests in Estonia are naturally regenerated, forestry in Estonia has historically valued high-volume production of coniferous trees, such as Norway spruce *(Picea abies*) and Scots pine (*Pinus sylvestris*).

Retaining higher tree species diversity can significantly increase ecosystem resilience and habitat availability in a forest. For instance, one study showed that maintaining higher tree species diversity in the Estonian landscape can buffer the impacts of ash dieback: a fungal disease of ash trees characterized by leaf loss and crown dieback in infected trees. In particular, late-successional trees such as old aspen (*Populus tremula*) and elm (*Ulmus spp*.) provided substrates for retaining vulnerable epiphyte populations in affected stands, further emphasizing the importance of maintaining deciduous species in productive forests. Bird biodiversity also tends to be higher in mixed forests than pure coniferous forests on both a stand and landscape level, with one Swedish study suggesting that a pure coniferous forest would have to be four times larger in area than a mixed forest to harbor the same bird species diversity. Mixed stands may also maintain the diversity of woodpeckers in Estonia: for instance, while most native woodpecker species favor deciduous stands, the Three-toed Woodpecker favors coniferous stands. In fact, one study highlights retaining mixed stands in Estonian managed forests as the most important factor in explaining increased woodpecker abundance over the last 80 years.

A study comparing old-growth forests and FSC certified mature forests in Estonia showed no significant difference in tree diversity and abundance between the two forest types. In this way, FSC certified forests can provide similar biodiversity benefits from high tree species diversity to those of natural, undisturbed forests. However, managed forests cannot replace old-growth forests, as some gaps still exist in the biodiversity aspects preserved in managed stands.

Aspen is an early-successional species that is rarely maintained at high proportions in managed forests. Aspen plays a vital role in maintaining diverse forest communities: Estonian aspen stands host approximately 2000 species, of which 5 – 15% of species only colonize aspen. An Estonian study showed that maintaining viable populations of aspen-specific epiphytic fungi, many of which are of conservation concern, would require more variation in current silvicultural techniques that allow aspen of different age classes to be retained in managed mixed forests. While a variation in silvicultural techniques is not explicitly required by the FSC standard, the development of mixed forests in the landscape allows a range of microhabitats provided by deciduous species to be retained, which is an important step in restoring these features in managed forests across Estonia.

A mixed managed forest stand of pine and birch. Mixed forests have higher bird diversity then the same area of coniferous stand. Photo by RMK/Rando Kall.

GLOSSARY

Mixed forests: In the context of Estonian forest types, this refers to forests with a mix of coniferous and broad-leaved deciduous tree species.

While most native woodpecker species favor deciduous stands, the Three-toed Woodpecker favors coniferous stands. Photo by Asko Lõhmus.

RETENTION TREES

FSC increases the standards of tree retention required by law

The FSC standard requires a minimum of 10 living biodiversity trees to be retained per ha in clearcuts, or a minimum of 5 living trees if noble hardwoods are retained. Assuming that retained trees normally consist of approximately 1 – 1.5 m³ wood volume each, this corresponds to a requirement of retaining approximately 10-15 m³ per ha (or 4 – 6% of the wood volume per ha, assuming that 250 m³ of wood is harvested per ha). Legislation places a requirement of retaining a minimum of 5 m³ of trees per ha, and 10 m³ per ha in clearcuts over 5 ha. As such, FSC certification requires two to three times more biodiversity trees to be retained per ha in clearcuts compared to legislation, and at least matches the number to be retained in clearcuts over 5 ha in size. When only noble hardwoods are retained, FSC requirements match that of Estonian legislation. Both also state that these trees will be preserved through subsequent generations; however, a crucial difference is that the FSC standard requires these trees to be living, while Estonian legislation allows for the tree retention quota to be met with both live and dead trees. As such, trees retained by law can consist only of dead trees or a small proportion of living trees.

By placing minimum requirements on retention of living trees as well as retaining all standing dead trees with diameter over 25 cm, FSC certification allows the biodiversity features of living and dead trees, as well as the cumulative benefits of retaining both tree types, to be preserved. This, in turn, may benefit a larger variety of species: for instance, an Estonian study showed that while the total abundance and diversity of breeding birds increased with the proportion of retained dead trees in managed forests, the presence of bird species of national conservation concern was associated with higher densities of live trees. The natural mortality of retained trees over time may also allow communities of polypore fungi that are dependent on a steady input of dead wood to survive through future forest generations.

Retention trees function as lifeboats

Many forest species are dependent on mature trees and biodiversity features found in late-successional forests, and cannot inhabit harvested areas. Retaining mature trees in such areas can help to preserve some of these features, allowing such species to persist in the landscape. This 'lifeboating' function is shown to be particularly successful for ectomycorrhizal fungi, epiphytic lichens, invertebrates, and small ground-dwelling animals. Animals with larger area requirements, such as birds, also benefit from retention trees - particularly when they are retained in groups. Retention trees in groups can partly preserve the microclimates found within forests, creating a wider array of habitats and allowing for a greater diversity of species to persist in a harvested forest until it can be recolonized.

Despite the benefits retention trees provide to forest species, it is worth noting that some species groups cannot survive in this way and require intact forest patches to persist. For instance, one study showed that while epiphytic lichens in Estonian forests were generally well conserved in managed forests with retention trees, epiphytic bryophytes were not sustained in the same way. A follow-up study in Estonia indicated that epiphytes of conservation concern rarely colonized retention trees, requiring intact forests to survive. Some species may also require higher levels of retention than specified by legislation or the FSC standard.

Preserving biodiversity features in harvested areas

Both legislation and the FSC standard set priorities for the selection of retention trees from the most biologically valuable specimens. These priorities include choosing specimens of the largest diameter, and that they remain in the forest through subsequent harvesting cycles. Additionally, FSC certification requires the retention of all old and hollow standing trees, as well as trees with bird nests, in clearcuts, regardless of quantity. This may be of particular significance to raptor populations that may otherwise be limited by a lack of suitable nest trees in Estonian managed forests. Other large retained trees may also provide new nest sites to sustain raptor populations in the future.

Retaining old and hollow standing trees will also contribute to the dead wood supply in managed forests: a study on retention tree survival in Estonian harvested forests showed that over 6 years, 35% of the retained trees died, contributing 4.4 m³ of downed dead wood and 1 m³ of standing dead wood per ha. Fresh dead wood on clearcuts is favored by many red-listed beetles that specifically inhabit sun-exposed dead wood. Disturbance events such as forest fires were historically important disturbance factors in unmanaged forests, allowing for substrates such as sun-exposed wood to be created; however, disturbance-creating practices are uncommon in conventional forestry. These trees also contribute important habitats while they are standing: for instance, another Estonian study showed that rare lichen species can still inhabit standing dead trees retained in a clearcut up to 10 years after harvest. The retention of larger trees in clearcuts has also been shown to contribute dead wood over longer time periods, since large specimens typically survive for longer in clearcuts, and stay standing for longer after death. Tree retention also preserves some forest ecosystem functions, such as carbon cycling and water retention, in harvested areas.

One simulation study showed that retaining 5% of trees in clearcut boreal forests could create 2.5 times more dead wood and convert 7% of the area into old-growth forest, as well as creating 4 large live trees per ha. Developing these kinds of key features in harvested forests can alleviate the negative impacts of harvesting on biodiversity.

GLOSSARY

Retention trees: Trees that are retained after harvest as a nature consideration, and are left in the forest through all subsequent rotation cycles.

Biodiversity trees: Trees with a high natural value for biodiversity conservation. The Estonian Forest Act refers to these as old crop trees, and are regarded under the same definition for this report.

Invertebrates: Organisms that do not have vertebral columns. In forests, this includes species groups such as insects, spiders, snails, and worms.

Ectomychorrhizal fungi: Fungi that form symbiotic relationships with plants through plant roots.

Polypore fungi: A group of wood-decomposing fungi with fruiting bodies on their undersides. Typically found growing on tree trunks or branches.

Retention trees can help some species dependent on mature trees to persist during the open phase after harvesting. Photo by Indrek Talpsep.

DEAD WOOD

Estonian legislation merges the retention of dead wood and living trees after harvest; requiring 5 m³ of trees per ha, and 10 m³ per ha in clearcuts over 5 ha to be retained, dead or living. FSC certification requires all dead trunks with diameters above 25 cm, as well as all snags (standing dead trees), to be preserved. There is a restriction in the Estonian legislation, requiring woody debris, as well as undried or unbarked coniferous wood when present at over 10 m³ per ha, to be removed from the forest. Such precautions may be taken to reduce the impact of potential pests, and to prepare for future harvest activities.

Dead wood provides habitats for a variety of forest dwelling organisms, including food for saprotrophic species of invertebrates and fungi, substrates for lichens, fungi and bryophytes to colonize, shelter for a variety of invertebrates, mammals, reptiles and amphibians, and nesting sites for birds and small mammals. For example, studies in Estonia have shown that woodpecker abundance is almost directly correlated with abundance of dead wood in forests. Given that many tree-living species will use old tree cavities created by woodpeckers, retaining dead wood benefits these species indirectly as well. Dead wood also influences forest carbon stocks and the input of organic matter and nutrients into the soil. The FSC requirements for preserving dead wood allow the biodiversity benefits associated with dead wood to be retained, while the retention of large live trees and promotion of old-growth features in forests will contribute with new dead wood in future forest generations.

FSC promotes high quality dead wood

The dead wood created in conventional forestry practices typically represents only one age class and few tree species, while other types of dead wood become scarce in harvested areas. A variety of saproxylic (dead wood-dependent) species, of which many are red-listed, only colonize dead wood of a specific tree species, decay stage or size. A comprehensive analysis of saproxylic species in Sweden showed that invertebrates were mainly found on standing dead wood, while fungi and mosses were primarily found on downed wood. 50% of all saproxylic species, and 75% of red-listed saproxylic species, occurred on deciduous trees – of which 380 species occurred on oak, and 300 species occurred on beech. Furthermore, 15% of all saproxylic species in Sweden were found on wood in late stages of decay.

Similarities in forest types between Sweden and Estonia imply that many of these associations will apply to Estonian forests as well.

Studies in Estonian forestry have shown that Estonian productive forests tend to harbor higher volumes of coarse and fine woody debris than what is typically reported of European boreal forests, mainly due to a history of less intensive forestry practices. However, the effects of harvesting are still evident: a study in pre- and post-felled Estonian forests showed that while coarse woody debris amounts did not significantly change after felling, the amount of large downed coarse woody debris, such as logs, was significantly reduced. The number of snags also decreased from 15 – 17 m³ per ha to 1 – 2 m³ per ha after felling. These losses could be significant for many saproxylic species – for example, 50% of all bryophyte species in Sweden occur on logs with diameters over 20 cm, of which 15% occur only on logs with diameters over 40 cm. Cumulative effects on dead wood supply may also be observed in the loss of snags, since snags are a major contributor of downed wood over time. One study attributed a lower species richness of calicioid fungi in Estonian clearcuts to a reduction in snag volume. The FSC standard directly counteracts such reductions by requiring the retention of all snags and large logs in managed forests.

Research has shown that the open areas created by felling can provide microhabitats for some saproxylic species in the form of sun-exposed dead wood. However, the potential for these habitats to harbor diverse and abundant saproxylic communities depends on the availability of different types of sun-exposed wood. Typically, dead wood in clearcuts is of lower quality than in forests where natural disturbances have created open areas: in Estonia, clearcuts harbor an average of 11 m³ per ha of coarse woody debris, compared to an average of 450 m³ of coarse woody debris per ha in burned old-growth boreal forests. Additionally, low stumps constitute approximately 80% of all coarse woody debris in slash-harvested clearcuts compared to an average 28% in boreal forest landscapes. FSC requirements contribute to increasing the diversity of dead wood microhabitats found in clearcuts, particularly in requiring trees of many species to be retained and left to die naturally over time.

Facilitating the continuous input of dead wood over time

Continuous supplies of dead wood are important to preserve wood in both the early and later stages of decay. Tree retention, as required by both the FSC standard and Estonian legislation, provides dead wood over time in clearcuts. In particular, large specimens of both live trees and snags are shown to persist in harvested areas for longer, preserving future sources of dead wood over longer time periods. While both legislation and the FSC standard promote the retention of large specimens, only the FSC standard requires both live and dead trees to be retained, ensuring that both current and future sources of dead wood are maintained.

Despite the benefits of retention trees, studies have documented declines in dead wood input on such clearcuts after the first decade of felling. This emphasizes the importance of preserving undisturbed forests as well as managing harvests in order to sustain high quality dead wood over time. One study in Estonian boreal forests showed that bryophyte communities were more diverse in old-growth forests than young mature forests since old-growth forests harbored up to eight times more dead wood, as well as a wider array of sizes and decay stages. In particular, older forest stands were correlated with an increase in large downed logs. Similar diversity patterns have been shown for saproxylic beetles.

A study examining differences in dead wood in Estonian forests showed significantly higher snag volume in protected forests than managed forests, but no significant differences in the abundance of other dead wood types. Overall, the diversity and quality of old-growth structural elements was similar between protected and managed forests, which the authors attribute to a higher proportion of structurally rich mesic stands being present in managed forests, as well as previous harvesting in protected areas. This highlights the need for the preservation of productive forests in Estonia as a mechanism for maintaining high quality dead wood supplies over time, particularly as old-growth features are allowed to develop.

GLOSSARY

Saprotrophic species: Species that feed on dead organic matter.

Saproxylic species: Species that are dependent on dead wood to survive.

Snags: Standing dead trees.

The red-listed beetle Ampedus cinnaberinus requires sun-exposed large diameter dead wood from aspen, beech, birch or oak for their larvae to develop. The beetle was supposedly extinct in Estonia but has been found in recent years in six harvested sites in the Estonian state forest. Photo by Ann Kraut.

FOREST DRAINAGE

The presence of wet forest types and their associated ecosystems has decreased as a consequence of drainage practices to increase timber production in such areas. Currently, 36.4% of the total Estonian forest area is wet forest, while a further 12.5% of the total Estonian forest area has been drained. The FSC standard prohibits the construction of new drainage ditches, thereby contributing to the proportion of wet forests maintained in the landscape, and allowing their natural ecosystems to be maintained.

Retaining forests with their natural water regime is important both for forest productivity and to preserve the range of biodiversity present within forests. An Estonian study demonstrated that species richness of lichens and bryophytes is significantly lower in drained forests compared to their wet forest counterparts, and unique plant species adapted to wet forests are lost in drained forests. Another study showed that forest drainage caused substantial changes in the forest hydrological cycle, resulting in a degradation and loss of amphibian breeding sites. Furthermore, Estonian studies on drainage ditches have shown that both fish and macroinvertebrate communities are less diverse on a landscape scale when compared to natural water bodies.

FSC contributes to preserving wet forest types

Wet forest types generally retain a higher proportion of dead wood, shaded areas and a hydrological cycle which includes short periods of flooding. Other biodiversity features, such as noble hardwoods and high structural variation within forest stands, also tend to be more prominent in wet forest types than their dry counterparts. For instance, the noble hardwood ash (*Fraxinus excelsior*) grows on rich wet soil types. Many wet forest species tend to be highly adapted to these conditions, and the loss of such characteristics through deforestation or drainage often leads to the loss of these species as well as an overall reduction of biodiversity on a landscape scale. For example, swamp forest types in Estonia have been shown to host unique assemblages of bird species. Historically, wet forests have also been less intensively managed due to their lower productivity compared to dry forests, which contributes to a higher proportion of old-growth features in wet forests. As such, wet forests may also act as refugia for forest species dependent on old-growth features in a managed landscape. By prohibiting the drainage of previously undrained forests, FSC certification allows more of the unique biodiversity features and ecosystems that wet forests harbor to be maintained.

A drained forest site with the characteristic development of birch often coming after drainage. Photo by Indrek Talpsep.

LANDSCAPE PLANNING

Landscape planning is an integral concept in biodiversity conservation, and can be used to manage biodiversity at larger spatial and temporal scales. For instance, maintaining connectivity between forest fragments allows species to spread across the landscape, decreasing their vulnerability to extinction threats. The FSC standard requires landscape-level impacts to be considered in forest management, including the maintenance of existing forest edges as stable ecosystems. Estonian legislation addresses more specific aspects of landscape planning, including the protection of areas such as shores and riverbanks, spawning areas of salmon, trout, and grayling, and along wildlife migration routes. Guidelines to ensure reforestation in clearcuts and degraded forests are also detailed. As such, while neither the FSC standard nor legislation explicitly require landscape planning to be implemented as a direct measure of biodiversity conservation, landscape planning is integrated into biodiversity considerations through other requirements. The differences between legal and FSC required considerations, however, are difficult to compare since landscape planning overlaps with and interlinks many other aspects of biodiversity conservation.

FOREST ROADS

Roads are essential for efficient harvesting activities, but they can harm the forest ecosystem through fragmentation and soil erosion. Estonian legislation includes specifications for the width of drag roads and landings with the intention of minimizing damage to forest roads and the surrounding area. In comparison, the FSC standard explicitly requires negative environmental impacts of road construction to be identified and avoided, as well as written guidance to be provided for field staff for road maintenance. FSC certification allows for further environmental considerations to be implemented in forestry; however, both legislation and FSC requirements are broad and difficult to compare from a biodiversity perspective.

A newly reconstructed forest road for timber transport running through a pine stand. Photo by RMK/Rando Kall.

DAMAGE TO GROUND AND WATER

Organisms in a given forest ecosystem are adapted to abiotic characteristics such as soil chemistry, nutrient cycling and water availability. These components are often altered in the process of harvesting and replanting productive forests. Damage to such characteristics should be minimized according to both national legislation and the FSC standard. Where legislation gives limits on damage in the form of maximum areas and soil depths where damage may occur, FSC certification maintains soil and water regimes through restrictions on economic activities. The FSC Standard also bans forwarding and harvesting in wet spring and autumn seasons in areas sensitive to harvesting, and requires wet soil types to be handled with precaution.

While the impacts of forestry on soil are documented, secondary impacts on biodiversity are difficult to track because of the complexity of above- and below-ground ecosystem dynamics. If the soil and water regimes of forests are damaged, existing biodiversity could be lost and replaced with generalist species that can survive in unstable conditions. Over large areas, this can lead to homogenization of species communities and lower species diversity across the landscape. Minimizing such alterations can help existing biodiversity to persist in forests. Legislation and FSC requirements are rather similar and broad, thus difficult to compare from a biodiversity perspective.

Forest streams can be affected from soil damage from harvesting leaking particles or methyl mercury that can harm regeneration of fish. Photo by RMK/Jüri Pere

OVERVIEW OF FSC IMPACT

This table shows an overview on how different environmental aspects are treated in the Estonian legislation and in the FSC standard, what differences that can be found in an FSC certified forest compared to a forest only following the legislation

Environmental Aspect	Estonian Legislation	FSC Standard
Protected areas and habitats	Key habitats, including habitats of protected species, brown bear hibernation sites, nesting trees, nesting periods, and WKHs < 7 ha are protected.	All WKHs and habitats of protected species are protected. No harvesting during nesting periods and in nesting areas of protected species.
Native tree species	Damage to the forest ecosystem and gene pool is prevented. Exotic tree species may be used in reforestation when suitable.	Exotic species are not used in forest regeneration, except with special permission. European yew and native noble hardwoods are preserved in forests.
Mixed forests	-	Economic activity in forests favors the development of mixed forests.
Retention trees	5 m^3 volume of biodiversity trees, living or dead, with priority to large trees with high natural value, are retained per ha in harvests (or 10m^3 per ha when the harvest area exceeds 5 ha) through subsequent generations.	10 *living* biodiversity trees (or 5 noble hardwood trees) are retained per ha in harvests, through subsequent generations. Priority to large trees with high biodiversity value. Old or hollow trees and trees with bird nests are retained.
Dead wood	Standing dead trees may be preserved as retention trees.	All standing dead trees and dead wood with diameters above 25 cm are preserved.
Forest drainage	Regulation of the forest water regime is permitted with some restriction. Management shall not endanger the forest soil or water regime.	Drainage of previously undrained forests is prohibited.
Landscape planning	Large-scale management including establishment of protected areas along shores and banks, in spawning areas of salmon, trout and grayling, and along animal migratory routes.	Landscape-level impacts of forest management are considered, including the conservation of viable forest edges.
Forest roads	-	Negative environmental impacts of planned road construction are assessed and avoided.
Damage to ground and water	The forest nutrition and water regime, and the soil more than 30 cm below ground, shall not be substantially damaged.	Soil erosion and damage to unstable or wet soil types shall be avoided. Forwarding and harvesting are prohibited during wet spring and autumn seasons on vulnerable soils.

and how this contributes to biodiversity. The impact of FSC certification has been quantified, when possible. The assessment shows the contribution of the FSC-standard.

Difference in the Forest	Impact on biodiversity	Quantification	Assessment
WKHs > 7 ha are protected. Biodiversity features, including old-growth features, are promoted.	More habitats and higher connectivity for species requiring late-successional forest.	An additional 4000 ha of WKHs protected in FSC-certified forests.	✓
Native tree species maintained at a higher proportion and diversity. Low proportion of exotic species.	Species-specific benefits from more native tree species. Red-listed species associated with noble hardwoods favored.	Not quantifiable.	✓
Higher diversity and proportion of deciduous trees in forests.	More habitats for birds, epiphytes, etc. connected to deciduous or mixed stands.	Not quantifiable.	✓
More trees retained in harvests. Minimum 10 living trees retained, as well as all old and hollow trees or trees with bird nests.	Retention trees function as 'lifeboats' for forest species. Future inputs of dead wood are secured.	More than 80 000 trees retained annually in FSC-certified Estonian forests.	✓
Dead wood of many species/age classes retained in forests, as well as over time.	Habitats for a large array of species dependent on dead wood, including many red-listed species.	Not quantifiable.	✓
No new drainage of forests.	Wet forest ecosystems are preserved with unique biodiversity features.	Approximately 300 000 ha of wet forests remain undrained.	✓
Some landscape-level aspects considered in management.	Cannot be estimated.	Not quantifiable.	?
Roads are better planned to avoid negative impacts on water.	Cannot be estimated.	Not quantifiable.	?
Some extra considerations made to avoid damage to forest soil and water regimes.	Cannot be estimated.	Not quantifiable.	?

DISCUSSION

In this report, the potential biodiversity benefits of FSC certification have been evaluated in the context of current scientific literature. In some aspects, the FSC standard provides clear benefits to forest biodiversity, with major contributions found for promoting protected areas and habitats, mixed forests, native tree species, tree retention, dead wood, and forest drainage.

The most obvious biodiversity benefits in FSC certification arise from conservation requirements that are not covered in Estonian legislation. These requirements include preserving a variety of dead wood types, retaining both living and dead biodiversity trees, maintaining noble hardwoods, prohibiting the cultivation of non-native tree species, and prohibiting the drainage of previously undrained forests. Other clear benefits can be identified where extensive research shows the link between FSC requirements and biodiversity benefits, particularly through studies that focus on FSC certified stands as in the 'Mixed forests' aspect. Further biodiversity benefits can be identified where requirements are presented as quantifiable values in the FSC standard; this includes requiring at least 10 living biodiversity trees to be retained, which is up to three times the amount of retained trees as required by law. While increased minimum thresholds of conservation do not immediately signify an increased biodiversity benefit, they are easier to evaluate in a research perspective, and allow for concrete effects of FSC certification to be studied.

How much is enough?

In specifying minimum thresholds for conservation, some FSC requirements can be quantified to help identify the biodiversity benefits those measures entail. However, it is challenging to define a minimum threshold that will allow biodiversity to be preserved as a whole. For example, the FSC standard requires a minimum of 5% of productive forest to be set aside for conservation. One modeling study estimated that given current forest management intensity, approximately 10% of all forest land in Estonia should be set aside to maintain a representative proportion of forest biodiversity. However, the present proportion of forest types would need to be considered in order to get a full representation of natural habitats since heath and dry boreal forest types and drained peatland forest are overrepresented in protected areas today, while fertile swamp forests are underrepresented. Given that the FSC required proportion of protected areas may consist of protected areas already designated by the state, the additional area under protection is unlikely to significantly contribute to the proportion of forests under protection by law, or to the amount required to preserve forest biodiversity as a whole. However, the 5% minimum supplements such protected areas by ensuring a spread of protected forest area across all FSC certified forests, and there is potential for the contribution of FSC required protected areas to increase if FSC certification is implemented in large-scale private forests in the future.

The FSC standard also requires a minimum of 10 biodiversity trees, or 5 trees in the case of noble hardwoods, to be retained per ha. About 8000 hectares are cut annually for generation felling in FSC certified forests. This equals ca 80 000 biodiversity trees retained annually. Minimum thresholds of retention for biodiversity conservation suggested in literature reviews vary between 5 – 20% of the total tree volume, depending on the requirements of the studied organism groups. One study suggests that 9 – 15 m³ of wood (9 – 15 biodiversity trees) should be retained per ha to sustain vertebrates of conservation concern, while another recommends 10 – 50 m³ (10 – 50 biodiversity trees) to sustain beetle communities. While the FSC required minimum is on the lower end of this spectrum, it may function as a stepping stone to preserve biodiversity in harvested forests.

When evaluating the level of biodiversity consideration in the FSC standard, it is also important to remember that FSC certification strives for a balance between environmental, social and economic values. Whether the FSC specified values are high enough to conserve forest biodiversity will depend on the cumulative effect of all conservation measures on the whole of FSC certified forest ecosystems. The quality in conservation measures is also equally important: for example, the biodiversity benefits will be higher in set-asides with high structural diversity and ecological connectivity than in degraded and fragmented set-asides. Furthermore, understanding what is needed to preserve forest biodiversity depends on what we define as a representative amount of biodiversity in Estonia – this will inevitably vary across species groups, habitats, and whole regions. Given these considerations, it seems we cannot view the biodiversity impacts of FSC certification through a strictly quantitative perspective. Rather, the identified thresholds should be viewed as one of the many aspects through which FSC certification complements legislative requirements for conserving forest biodiversity.

A mature coniferous forest containing different types of dead wood; both snags and downed woody debris. Photo by Indrek Talpsep

Where FSC does not contribute biodiversity benefits beyond that of legislation

While the effects of implementing conservation measures in some aspects are well documented, others are less well-known. As such, it is difficult to determine whether FSC requirements in such aspects do not provide biodiversity benefits, or if the lack of effect is simply due to limitations in the knowledge and technology needed to identify them. Through this report, few or no biodiversity benefits were identified above that of legislation for landscape planning, forest roads, and damage to ground and water. A lack of knowledge to compare legislation and FSC requirements is a limiting factor for each of these aspects. For the protection of species, FSC certification also provided few practical benefits beyond that of legislation, although other potential benefits from an increase in the proportion of protected habitats were identified. Given our current knowledge, the benefits of these aspects should be evaluated on a case by case basis rather than across all FSC certified Estonian forests.

Where more research is needed

Our ability to analyze the effects of many forestry practices on the whole biodiversity of a forest depends on our understanding of the interactions between organisms and their environment. Much of current literature examines the effects of harvesting practices on specific species groups, because the effects of biodiversity conservation are easier to pinpoint on a smaller group of test subjects. A majority of the studies highlighted in this report focus on the effects of various conservation measures on birds, bryophytes, fungi, and lichens. Many studies also only examine the effect of one conservation measure.

Differences in available literature may lead to a bias in how we interpret the biodiversity benefits of FSC certification and legislation. Literature searches reveal that more studies conducted in Estonia are available for the environmental aspects of protected areas and habitats, mixed forests, retention trees, dead wood, and forest drainage, while the aspects of native tree species, damage to ground and water, and forest roads are less extensively studied. Many studies incorporate landscape planning when explaining patterns in forest biodiversity, but this aspect is generally difficult to evaluate as it interlinks local biodiversity effects across larger areas. Long-term studies are also particularly important for understanding cumulative biodiversity benefits of forest management: for instance, one study analyzing woodpecker populations across Estonian forests over 80 years showed an increase in abundance of 6/8 native woodpecker species, attributable to the retention of biodiversity features, such as native tree species and dead wood, over time. Long-term studies focusing directly on the effect of FSC certification on biodiversity, however, are currently constrained by the time that FSC certification has been implemented in Estonia. Future research needs to focus on large-scale spatial and temporal impacts, as well as expanding our knowledge of less well-known biodiversity effects. In the absence of such studies, research can incorporate modelling methods and meta-analysis of existing smaller studies to predict large-scale biodiversity patterns. Finally, the requirements for many biodiversity considerations are interlinked, and as such, the cumulative benefits need to be evaluated for these considerations as a whole. For instance, dead wood is provided over time when trees are retained on clearcuts, as well as when wet forests and protected areas form old-growth features. Filling these knowledge gaps will allow for a more comprehensive understanding of the cumulative effects of FSC certification on biodiversity.

Oak stand in FSC certified state forest. Photo by RMK/Rando Kall.

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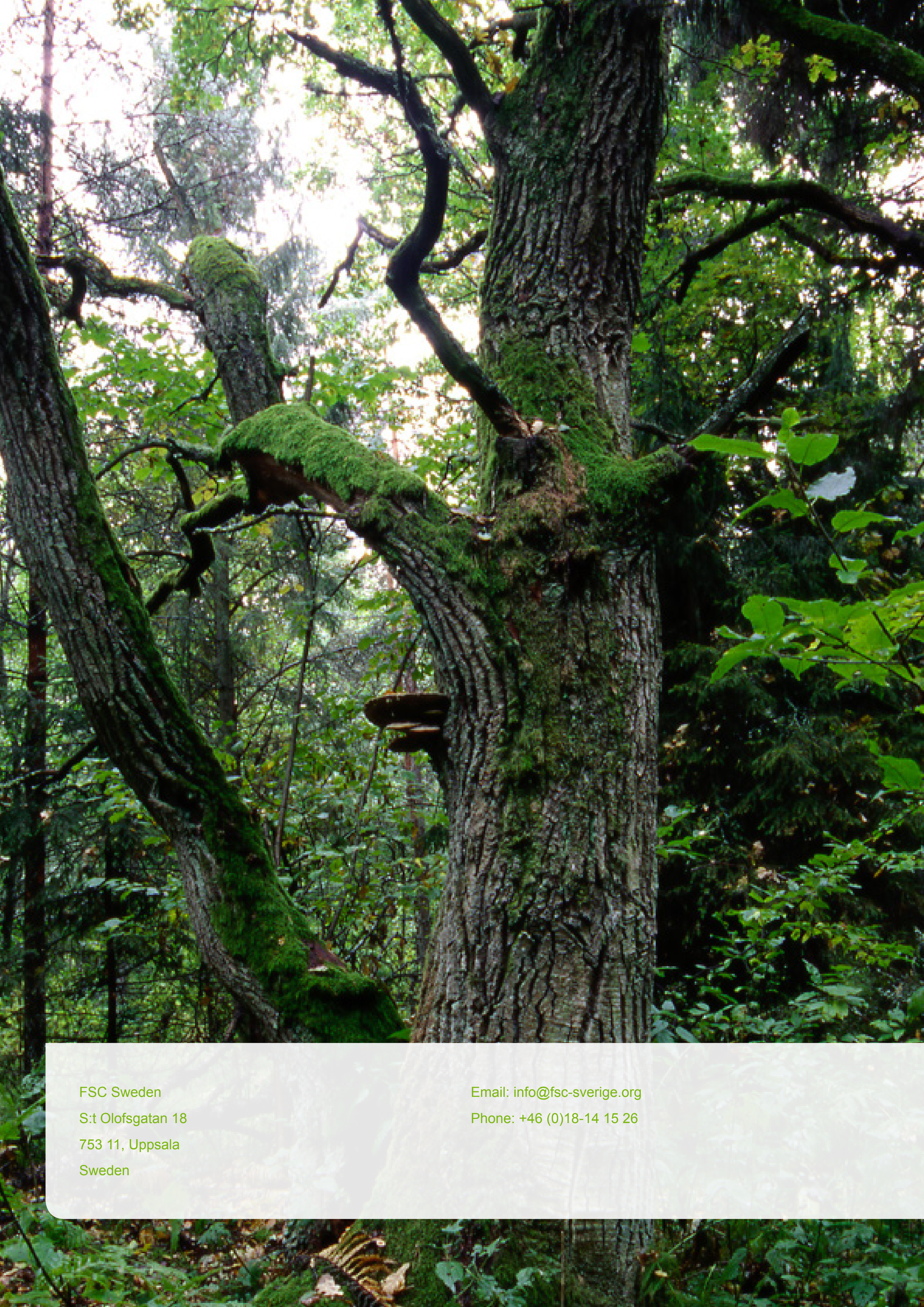

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